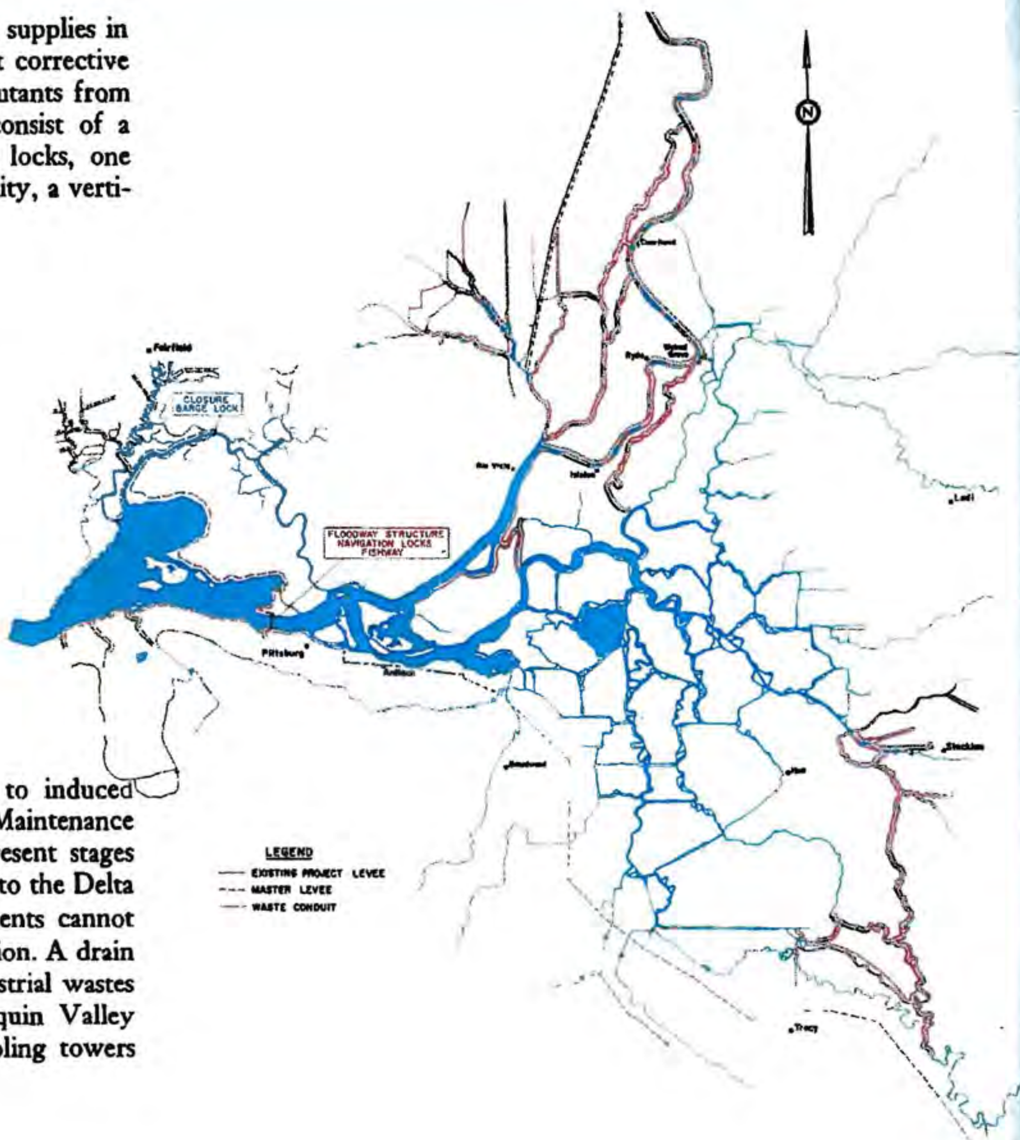
Chipps Island Barrier Project—physical works

A barrier at Chipps Island would insure the water supplies in the Delta against salinity incursion from the Bay, but corrective features would be necessary to dispose of other pollutants from sources upstream. The principal structure would consist of a gated floodway section, two deep-draft navigation locks, one barge lock, one small craft lock, a tug assistance facility, a vertical baffle fishway, emergency navigation access, and appurtenant operating facilities. The floodway section would have a net area of openings equivalent to the existing channel in order to preclude interference with flood flows. The conventional navigation locks would allow a limited amount of denser saline water to enter the upstream pool, but this water would be removed from a sump by a salt-scavenging system of pipes and pumps. A barge lock would be located on Montezuma Slough near the new Grizzly Island bridge, about ten miles north of Chipps Island.

A barrier at the Chipps Island site would require a master levee system along principal channels in Suisun Bay to contain the high tidal stages, which would be higher than the present high stages. Additional dredging of navigation channels also would be necessary, due to induced lower low tidal stages downstream from the barrier. Maintenance of water levels in Delta channels at lower than present stages during summer months would require improvements to the Delta levees, but the nature and extent of the improvements cannot be accurately evaluated without the project in operation. A drain would be constructed to convey municipal and industrial wastes and agricultural drainage water from the San Joaquin Valley into tidal water downstream from the barrier. Cooling towers

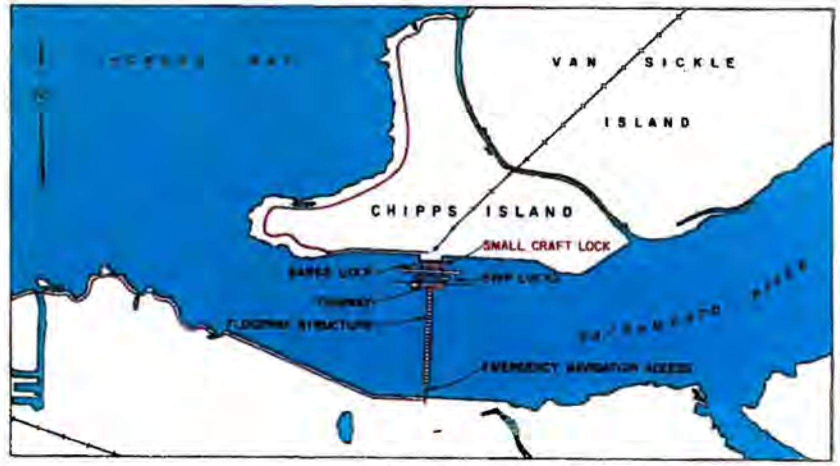


would be required for the two principal power plants which would discharge warm water into the barrier pool.

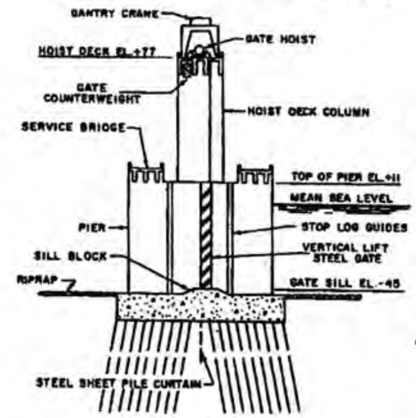
The type and design of the facilities described in this report incorporate results of preliminary designs and quantity estimates of the Corps of Engineers in current work on barriers in the San Francisco Bay system. Estimates of the capital cost of the facilities were based on construction costs prevailing in 1960, plus 15 percent for contingencies and 15 percent for engineering and overhead. The anticipated schedule of construction of the facilities is indicated in the tabulation of estimated capital costs.

SUMMARY OF ESTIMATED CAPITAL COSTS
CHIPPS ISLAND BARRIER PROJECT

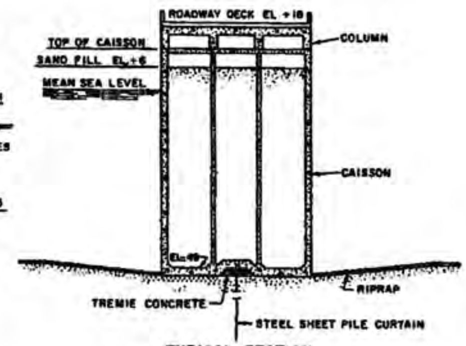
Feature and date of construction	Capital cost
On Site Features	
Floodway structure (1964-70)	$44,119,000
Locks (1964-70)	74,278,000
Salt-scavenging system (1968-70)	3,768,000
Emergency navigation access (1964-66)	6,092,000
South abutment and access facilities (1964-65)	723,000
Fishway (1969)	79,000
Buildings and miscellaneous (1966)	2,062,000
Montezuma Slough closure and barge lock (1968-70)	3,492,000
Subtotal, On Site Features	$134,613,000
Off Site Features	
Waste disposal facilities (1967-70)	$26,914,000
Extension San Joaquin Valley drain (1967-70)	17,356,000
Suisun Bay levee system (1964-73)	21,608,000
Shoreline facilities and dredging (1968-70)	1,481,000
Subtotal, Off Site Features	$67,359,000
TOTAL CAPITAL COST, CHIPPS ISLAND BARRIER PROJECT	$201,972,000



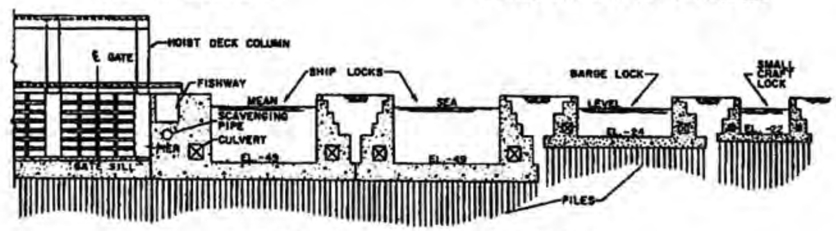
CHIPPS ISLAND BARRIER SITE



TYPICAL SECTION
FLOODWAY STRUCTURE



TYPICAL SECTION
EMERGENCY NAVIGATION ACCESS



TYPICAL SECTION OF FISHWAY AND LOCKS

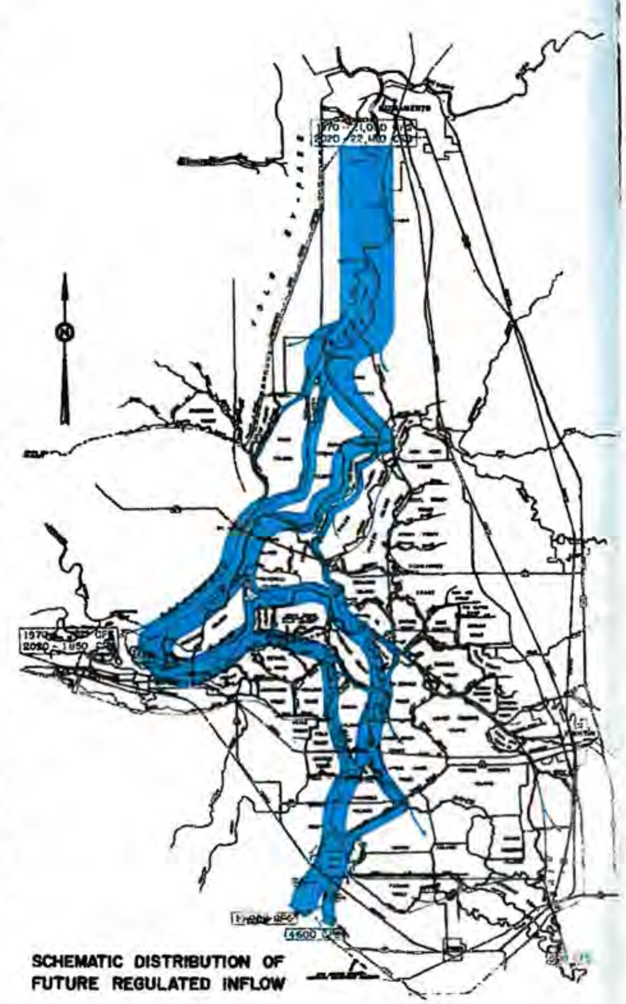
Chipps Island Barrier Project — operation

A barrier at Chipps Island would provide a definite separation between saline water in the Bay system and fresh water in the Delta channels, thereby preventing salinity incursion and assuring adequate water supplies in the Delta. However, there would be attendant operating problems, and the barrier and appurtenances would not provide flood control and related benefits to the Delta.

With the floodway gates closed, the inflow to the Delta to supply local uses and export pumping plants would be distributed in the channels as shown in the schematic diagram. Large quantities of water would be directed through channels in the western Delta to remove heat wastes and maintain satisfactory water quality conditions. Storage in the channels could be utilized to achieve a limited amount of regulation. However, navigation requirements would prevent controlling the water level lower than one foot below mean sea level, without additional dredging. Seepage and levee stability problems would limit the maximum level for sustained storage to about two feet above mean sea level. Economic analyses of various operating ranges indicate that a three-foot range in water levels for conservation of flood water would be most economical.

Electric analog model studies reveal that the barrier would increase the tidal amplitudes downstream from the structure. An unusually large amplitude of 6.3 feet at Chipps Island under present conditions would be increased to about 12 feet by a barrier. Changes indicated on the electric analog model were generally confirmed by preliminary tests by the U. S. Corps of Engineers on a hydraulic model which indicated slightly smaller increases in tidal amplitudes and a slight decrease in the mean tide level. The lower low water would seriously affect navigation depths, and the higher high water would seriously affect levees along the downstream bays and municipal, industrial, and military installations along the shore lines. Remedial measures would be necessary.

Disposal of cooling water from power plants and other industries would cause an increase in temperature in the nearly quiescent barrier pool. This increase in temperature would reduce the efficiency of cooling equipment and adversely affect fish, and could cause significantly increased corrosion in equipment exposed to the warmer water. The monetary magnitude of these effects would be dependent upon the amount of heat energy dissipated in the pool by existing and future industries, and many other factors which cannot be fully evaluated at this time. Satisfactory conditions could probably be achieved by passing cool-



SCHEMATIC DISTRIBUTION OF FUTURE REGULATED INFLOW

ing water from the principal power plants over cooling towers.

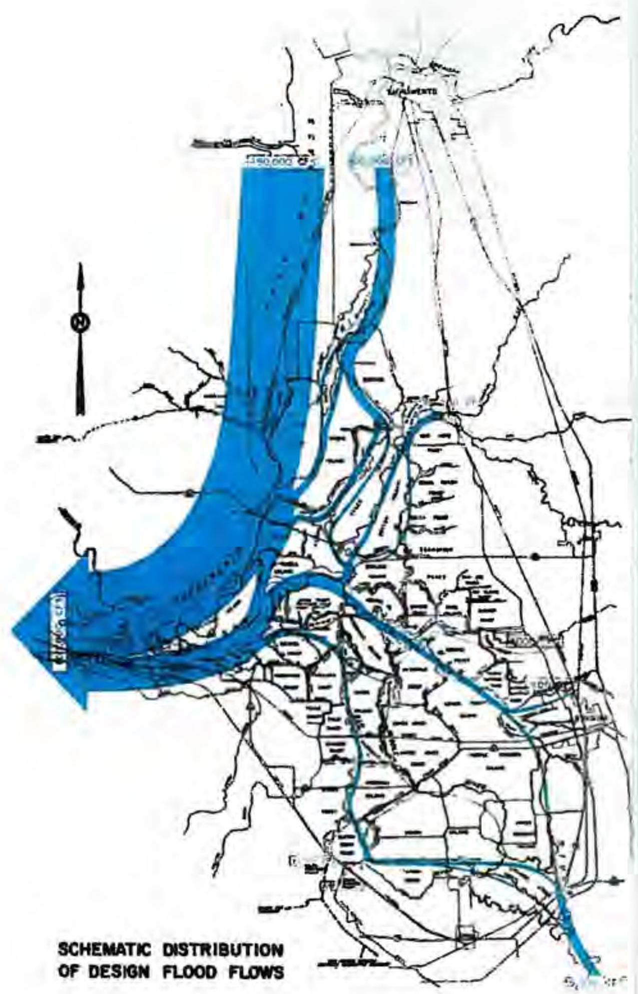
To maintain satisfactory water quality conditions in the barrier pool, it would be necessary to convey industrial and municipal wastes to tidal water. Drainage water from the San Joaquin Valley would also have to be discharged into tidal water.

Saline water entering the pool through the locks would be allowed to settle in a sump from which it would be pumped by a salt-scavenging system. Operation of locks would cause delays of about 35 minutes per transit for deep-draft vessels and 20 minutes for tugs and smaller vessels. Assistance would have to be provided to maneuver deep-draft ships through the locks. A tug and operating crew for this purpose would be necessary at all times.

National defense aspects dictate that an emergency navigation access be incorporated in the barrier. This access would consist of concrete bins filled with sand in a section of the barrier. In an emergency, the sand would be pumped out and the bins towed out of the channel.

Anadromous fish would be passed through a vertical baffle fishway, comprising a series of baffles with vertical slots extending to the bottom to provide passages for water and fish. The baffles would dissipate the energy of the water and create a series of bays with a slightly lower water level in each adjacent downstream bay. The bays would provide resting areas for the fish after passing through short distances of high velocity water in the slots. During high tides downstream from the barrier, the fishway would be closed by a gate to prevent saline water from entering the pool.

During flood conditions the gates in the barrier floodway would be opened. Flood stages in the Delta would be essentially the same as under present conditions for comparable flood flows. Since master levees in the Delta are not incorporated in this plan, high flood water would occur in all the channels. Although the flood stages would not be changed, levee stability problems would increase. Tidal fluctuations presently keep the levees saturated a few feet above the mean tide elevation, but under barrier conditions the peat levees would dry out and crack when water levels would be drawn down to about one foot below sea level. Should a sudden flood occur the open barrier gates would permit tidal fluctuations throughout the Delta and sections of some dried-out levees might become unstable and fail as the water levels rapidly rise and fall. Remedial work would be required as problems develop. Allowances for cost of this as yet undefined work are not included in the cost estimate.



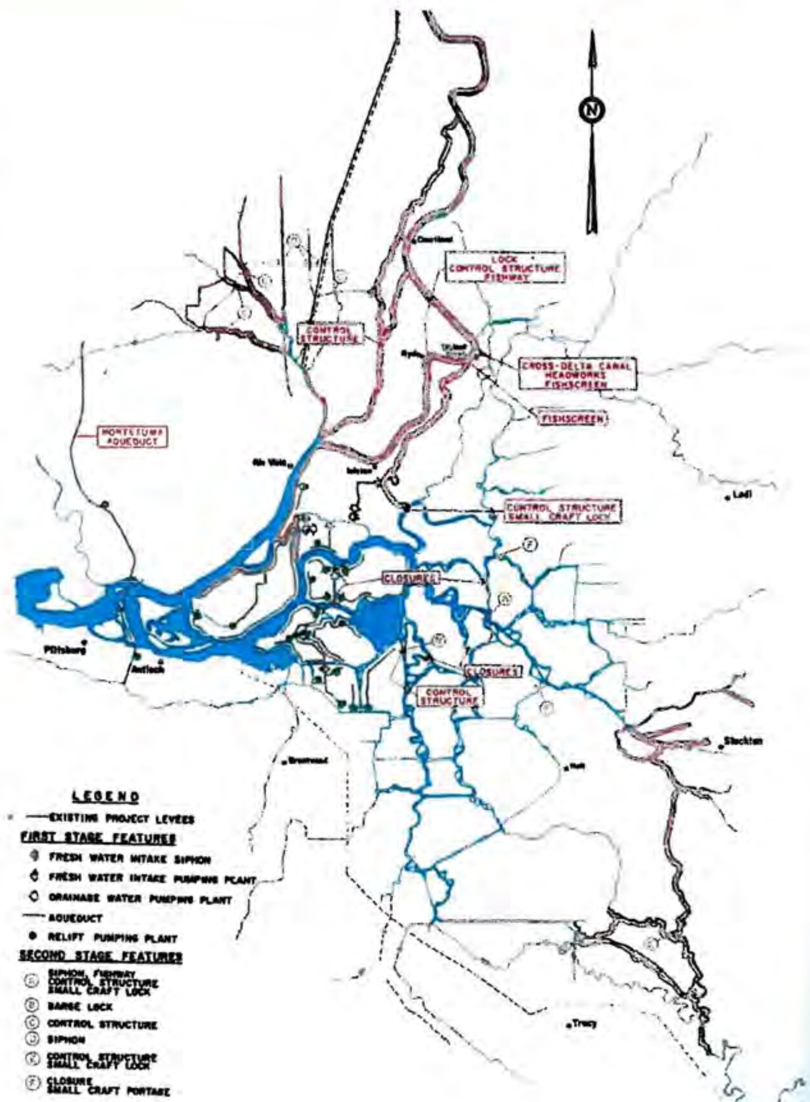
SCHEMATIC DISTRIBUTION OF DESIGN FLOOD FLOWS

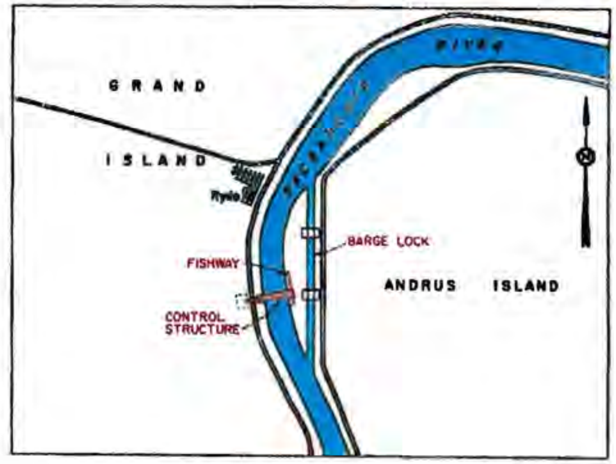
Single Purpose Delta Water Project—physical works

This system of works would accomplish essentially the same results as a barrier at Chipps Island, that is, adequate water supplies for the Delta and for export therefrom, but would not necessitate costly remedial works. Good quality water supplies for the Delta and export pumps would be separated from saline water by control structures operated with a relatively small rate of fresh water outflow. Water would be supplied in the western Delta area through new supply facilities, and in the rest of the Delta existing irrigation and drainage works would continue in operation. There are no flood control features in this plan.

Control structures with gated openings for discharging flood flows would be located on channels of the Sacramento, Mokelumne, and San Joaquin Rivers. A barge lock and fishway would be incorporated in the Sacramento River control structure. Earth fill channel closures would be constructed at four locations. In 1980-82, additional gates would be constructed at the existing headworks of the Delta Cross Channel of the Central Valley Project. Small craft locks and portage facilities would be incorporated in certain control structures and channel closures. Vertical louver fish screens would be constructed at the head of Georgiana Slough and at the Delta Cross Channel near Walnut Grove, and rotary drum fish screens would be constructed at other diversions.

Water supply facilities would serve areas in the western Delta. The Montezuma Aqueduct would be constructed in about 1968-71 and in subsequent stages to serve water to potential industrial land and some agriculture in central southern Solano County, and to supplement supplies in Contra Costa County. Works would also be included to remedy detrimental effects of project operation, such as seepage alleviation along the Sacramento River channels and modifications to existing irrigation and drainage works made necessary by the project.





RYDE STRUCTURE SITE

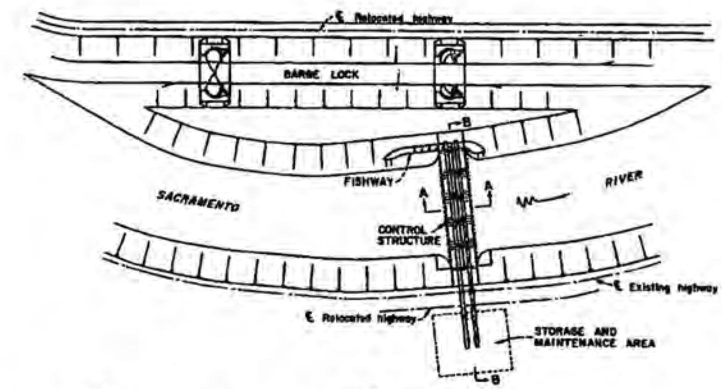
About 1,900 acres of land in the Delta, mostly small unreclaimed islands, would be used for disposal of excess dredged material. Many of these areas would be available and desirable for development as recreation areas.

Additional water could be salvaged by completely separating good quality cross-Delta flows from tidal water, and thereby reducing the amount of fresh water outflow needed for salinity repulsion. These second stage features would include a siphon under the San Joaquin River, additional channel closures, control structures and appurtenances, and water supply facilities. These works may be indefinitely deferred, depending on their need.

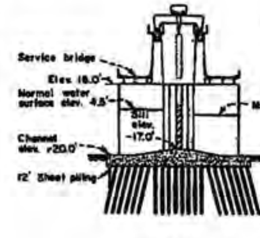
Estimates of the capital costs reflect 1960 construction costs, plus 15 percent for contingencies and 15 percent for engineering and overhead. The anticipated construction schedule is indicated in the following tabulation:

SUMMARY OF ESTIMATED CAPITAL COSTS
SINGLE PURPOSE DELTA WATER PROJECT

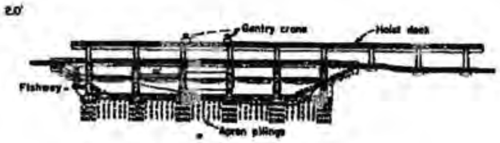
Feature and date of construction	Capital cost
Steamboat Slough control structure (1968-70)	$2,943,000
Miner Slough closure (1970)	108,000
Ryde control structure, barge lock, and fishway (1968-71)	5,653,000
Holland Cut control structure (1973-75)	2,761,000
Mokelumne River control structure and small craft lock (1973-75)	1,951,000
Cross-Delta Canal headworks (1980-82)	1,223,000
Fish screens: Cross-Delta Canal and Georgiana Slough (1968-70)	3,500,000
Closures: Potato Slough, Old River, and Middle River (1974-76)	404,000
Fishermans Cut closures (2) (1964)	133,000
Agricultural water facilities (1963-65)	4,300,000
Municipal and industrial water facilities (1968-71, 1980, 1995, 2010)	13,952,000
Channel dredging (1974-78)	7,154,000
Bank protection (1976-78)	1,880,000
Seepage alleviation facilities (1971)	593,000
TOTAL CAPITAL COST, FIRST STAGE FEATURES	$46,555,000
TOTAL CAPITAL COST, SECOND STAGE FEATURES	$23,765,000



PLAN
CONTROL STRUCTURE, FISHWAY AND LOCK



SECTION A-A
CONTROL STRUCTURE



SECTION B-B
CONTROL STRUCTURE AND FISHWAY

Single Purpose Delta Water Project—operation

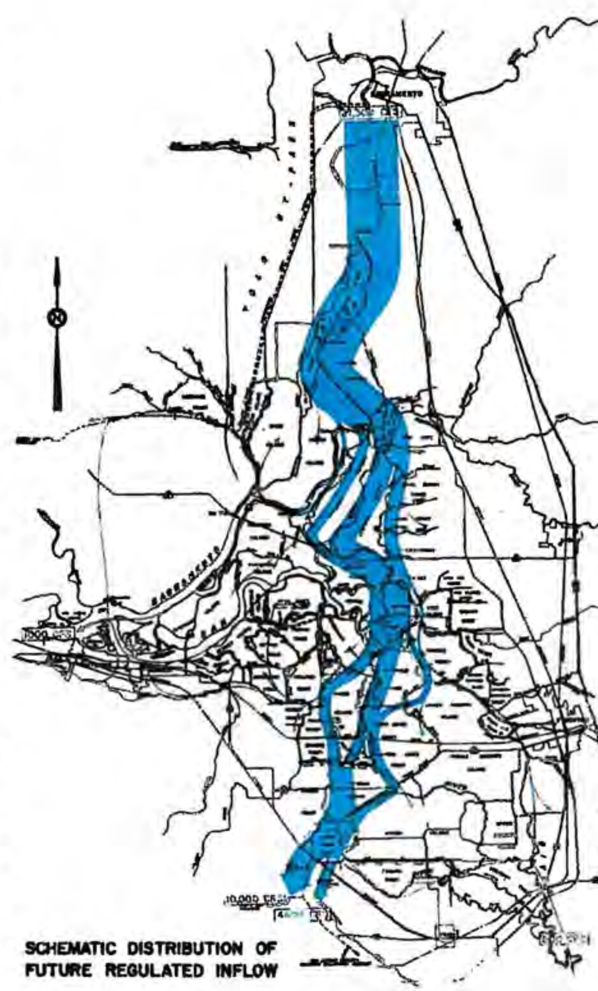
A Single Purpose Delta Water Project would salvage water otherwise wasted to Suisun Bay for salinity control, and would provide water supplies for the Delta and for export and use in areas of deficiency. The project would allow salinity to encroach somewhat farther into the Delta than under present operations; however, the area affected by this controlled incursion would be supplied water by new facilities. Certain aspects of operation described in the following paragraphs would also apply to other variations of the Delta Water Project.

Control structures on the Sacramento River system would divert water southward toward the center of the Delta. Control structures and closures on channels east of Franks Tract would cause the water to flow toward the export pumping plants in channels in the center of the Delta. With this type of operation, it would be necessary to prevent brackish saline water from mixing with fresh water in the center of the Delta. This control could be accomplished by providing fresh water outflow in the Sacramento and San Joaquin Rivers.

The salinity control line, with control to a mean concentration of 1,000 parts of chlorides per million parts of water (1,000 ppm), would be maintained in the San Joaquin River near the mouth of False River, about 7 miles upstream from Antioch and in the Sacramento River at Decker Island, about 1½ miles below Threemile Slough. Salinity control at these locations could be accomplished by maintaining an outflow from the Delta of 1,000 second-feet, of which about 60 percent would be released through the San Joaquin River and the remainder through the Sacramento River.

Good quality water from the cross-Delta flows would be available in existing channels throughout 90 percent of the Delta lowlands. Water would be provided to all agricultural lands downstream of the line of *maximum* salinity encroachment of 500 ppm of chlorides. The mean concentration of chlorides would be about 250 ppm at locations on this line. Research studies by the University of California indicate that seepage of any brackish water from the channels into the Delta islands can be controlled below the plant root zone by application of good quality water on the surface. The supplies diverted from the cross-Delta flows would normally contain between 20 and 80 ppm of chlorides.

Water would also be provided to municipalities and for certain industrial uses in the western Delta area. Most of the required industrial cooling water could be supplied from the adjacent channels. The Contra



SCHEMATIC DISTRIBUTION OF FUTURE REGULATED INFLOW

Costa Canal could serve the projected industrial requirements in its service area until about 1970, and significant industrial development in southeastern Solano County is not anticipated before 1980. The Montezuma Aqueduct would be constructed to convey supplemental water from the proposed North Bay Aqueduct and would be linked to the Contra Costa Canal near Pittsburg in 1980. The capacity of the Contra Costa Canal would then be utilized primarily between the Delta and the connection with the Montezuma Aqueduct. The estimated quality of the water would be very good, with a chloride content generally ranging between 15 and 80 ppm, total dissolved solids ranging between 125 and 300 ppm, and with total hardness of between 40 and 160 ppm.

Existing irrigation water supply facilities throughout most of the Delta would not be affected by operation of the export pumps, but the average water level in the southern portion of the Delta would be lowered slightly. Irrigation facilities affected thereby would be modified under the project.

Small increases in tidal amplitudes of about 1.5 feet would occur at the Sacramento River and Steamboat Slough control structure sites, but the mean water level would not significantly change. The effects would be very minor at Rio Vista.

The average water level upstream from the control structures would be gradually raised to a maximum of about 2.5 feet under full project operation in about 30 years. The increase would occur during summer months, and any resultant increased seepage from the channels would be fully consumed by crops on adjoining lands without damage.

During flood periods, the control structures would be opened and flood stages throughout the Delta would be similar to those under present conditions. Flood stages on the Sacramento River would be slightly higher for longer periods due to closing of Miner Slough. This effect would tend to increase seepage conditions during a critical crop planting time, and might necessitate installation of seepage alleviation works. Such works would also alleviate existing seepage problems.

The future value of water and quality considerations might justify construction of the second stage features to permit further reduction in the fresh water outflow from the Delta. The outflow could be reduced to the amount of unavoidable losses, or about 750 second-feet. The value of the additionally salvaged water would probably not justify construction of these works before 1990.

SCHEMATIC DISTRIBUTION OF DESIGN FLOOD FLOWS

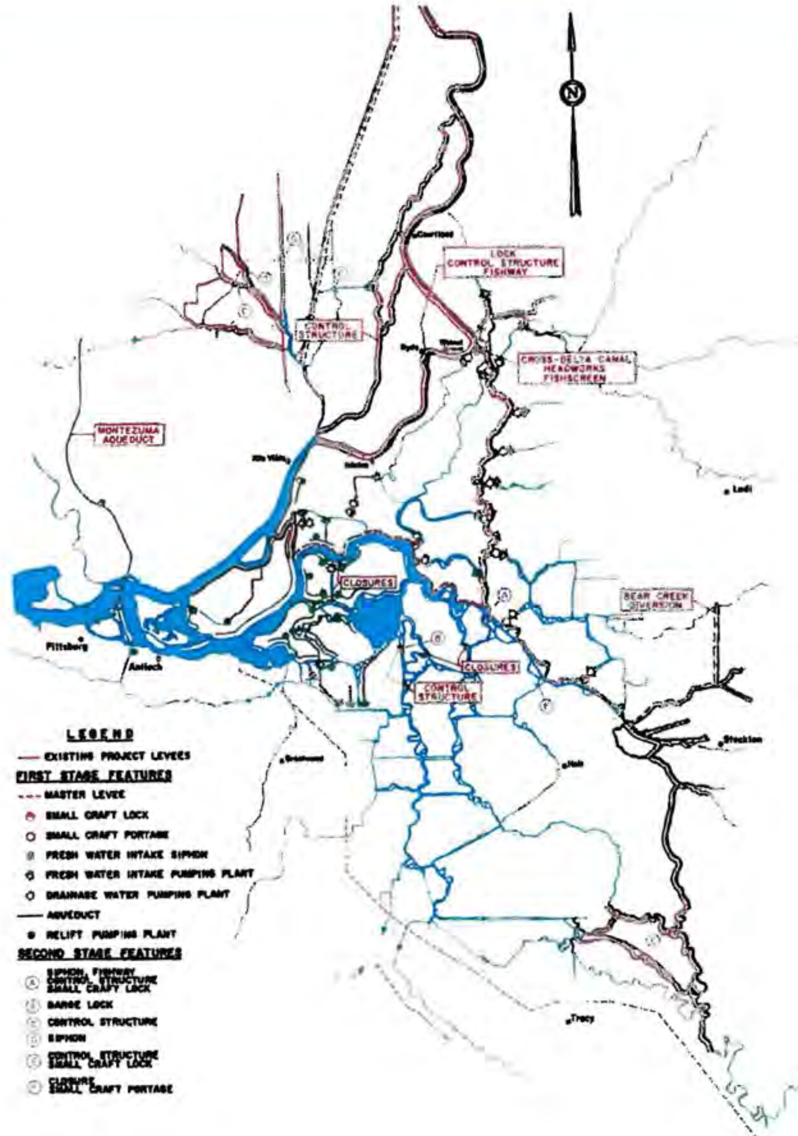
Typical Alternative Delta Water Project — physical works

Several additional features can be added to the basic Single Purpose Delta Water Project to provide varying degrees of local benefits, in addition to adequate water supplies. These additional features would be for flood and seepage control, transportation, and recreation. While the economics of construction and operation factors would dictate grouping certain islands within encircling master levee systems, flood protection for any one or more of several groups of islands could be undertaken.

The Typical Alternative Delta Water Project, one of several alternative plans, would include flood protection for the islands in the north central portion of the Delta around Isleton, and for the northeastern islands in the vicinity of Lodi. Fourteen channel closures would be required in addition to those incorporated in the Single Purpose Delta Water Project. Minor modifications and additions would be made in the irrigation water supply and drainage facilities. Rotary drum fish screens would be incorporated where required in all water supply works, and a vertical louver screen would be constructed at the headworks of the Cross-Delta Canal at Walnut Grove. Bear Creek would be diverted into the Calaveras River.

The master levee system would include existing levees of the Sacramento River Flood Control Project. Other existing levees would be improved by constructing a berm on the landward side, and by raising the levee crown where necessary to increase the freeboard. Public roads would be relocated from levee crowns to the berms. A service and maintenance road would be placed on the crown of the levees.

Small craft locks would be constructed at certain channel closures. At locations where rapid transits of boats under 25 feet long would be necessary, a tank elevator boat portage would be installed.



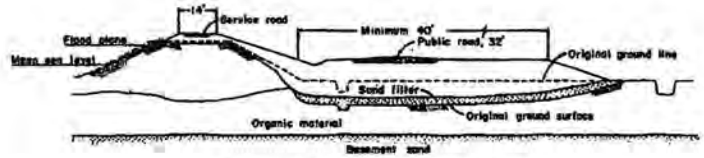
About 1,900 acres of Delta land would be filled with excess dredged material, and most of this land would be available for recreational development. The additional gates on the Cross-Delta Canal headworks and the extensions of the adjacent highway and railroad bridges would be constructed with about 16 feet of clearance above the present average water level to improve small craft access between the Sacramento River and channels of the Mokelumne River system.

The second stage features of this project would be similar to those contemplated for the Single Purpose Delta Water Project.

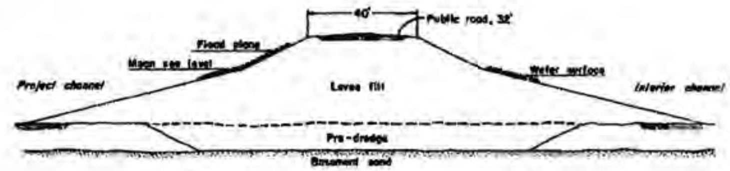
Estimates of capital cost were based on 1960 construction costs plus 15 percent for contingencies and 15 percent for engineering and overhead.

SUMMARY OF ESTIMATED CAPITAL COSTS
TYPICAL ALTERNATIVE DELTA WATER PROJECT

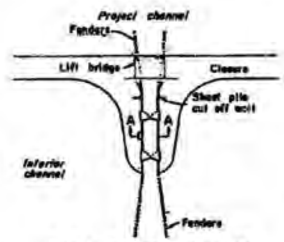
Feature and date of construction	Capital cost
Steamboat Slough control structure (1968-70)	$2,943,000
Miner Slough closure (1970)	108,000
Ryde control structure, barge lock, and fishway (1967-70)	5,653,000
Holland Cut control structure (1973-75)	2,761,000
Cross-Delta Canal headworks (1975-77)	1,998,000
Cross-Delta Canal fish screen (1968-70)	3,500,000
Old River and Middle River closures (1975)	258,000
Fishermans Cut closures (2) (1964)	133,000
Agricultural water facilities (1963-65)	4,282,000
Municipal and industrial water facilities (1968-71, 1980, 1995, 2010)	13,952,000
Channel dredging (1974-78)	7,224,000
Master levee system (small craft locks and portages, irrigation and drainage works)	
Isleton island-group (1964-80)	12,610,000
Lodi island-group (1964-81)	11,439,000
Bear Creek diversion (1967-70)	670,000
TOTAL CAPITAL COST, FIRST STAGE FEATURES	$67,531,000
TOTAL CAPITAL COST, SECOND STAGE FEATURES	$23,635,000



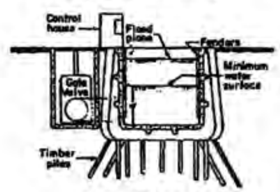
TYPICAL SECTION OF MASTER LEVEE



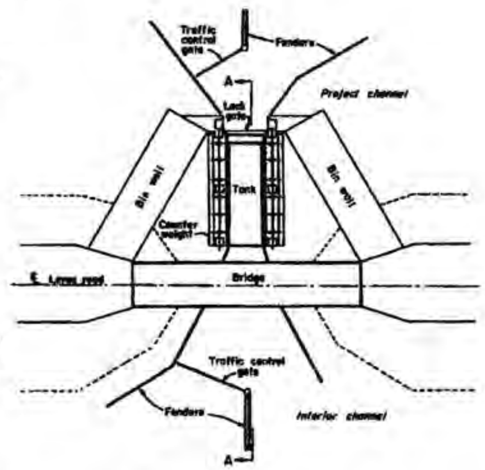
TYPICAL SECTION OF CHANNEL CLOSURE



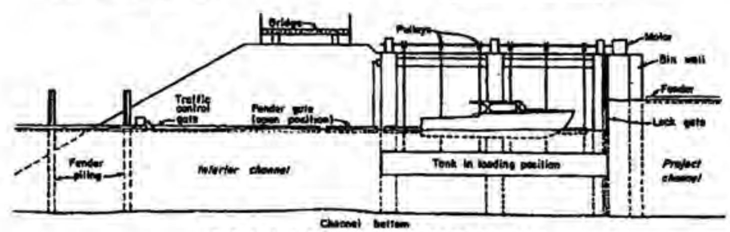
SMALL CRAFT LOCK SITE



SECTION A-A
SMALL CRAFT LOCK



PLAN OF SMALL CRAFT PORTAGE



SECTION A-A OF SMALL CRAFT PORTAGE

Typical Alternative Delta Water Project — operation

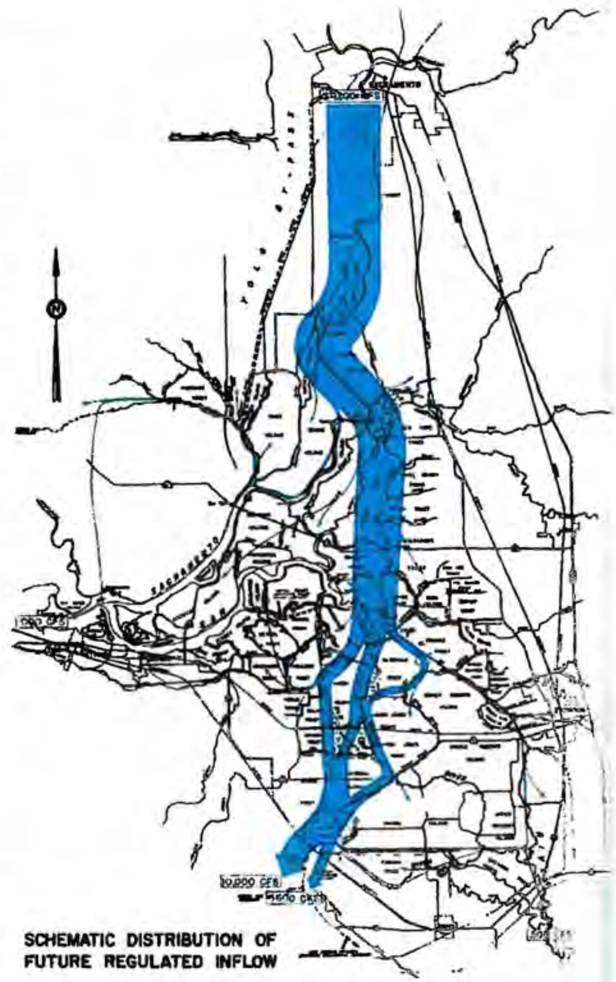
Operation of the Typical Alternative Delta Water Project would be basically the same as with the Single Purpose Delta Water Project. Good quality water would be transferred directly across the Delta and degradation in water quality from salinity incursion would be prevented by limited releases of fresh water with the same degree of control as under the Single Purpose Delta Water Project. Water supplies for the Delta would be distributed from the cross-Delta flows.

Irrigation water for the Isleton island-group and the Lodi island-group would be diverted through siphons from the Cross-Delta Canal into interior channels. Existing diversion works out of the Cross-Delta Canal, which would be rebuilt during construction of the master levees, and diversion works out of the interior channels would continue in operation. Drainage pumping plants at channel closures would have capacity to remove all water pumped from the islands into the interior channels. Under all alternative plans for the Delta Water Project, the irrigation and drainage works would be managed by local districts. Adjustments in costs of operation and maintenance would be made with the districts to reflect costs allocated to interests other than the local districts. Water supply facilities serving several districts or agencies would be operated by the State or by an appropriate master district or agency.

Flood flows would be contained in principal project channels in those portions of the Delta protected by the master levee system, and levees along interior channels would no longer be subject to high flood stages. Levees on interior channels would not need to be as high as for present conditions, and could be allowed to settle. Experience has shown that Delta levees reach a state of equilibrium if they are allowed to settle a limited amount. Thus much of the periodic reconstruction of the interior levees would no longer be necessary. Bank erosion problems due to flood flows also would be eliminated on interior levees.

Storm runoff from upland areas surrounding the Delta would be pumped into flood channels, except in the case of Bear Creek which would be diverted into flood channels.

Water levels in the interior channels could be lowered to achieve reductions in the amount of seepage into the islands. In



SCHEMATIC DISTRIBUTION OF FUTURE REGULATED INFLOW

practically all channels the level could be five feet lower than the present average level, or about three feet below sea level, without causing maneuvering problems for small craft. Any resultant shallow depths in specific locations could be increased by dredging.

Small craft locks and portage facilities would be operated without cost to the boating public as the costs would be allocated to beneficiaries of the master levee system. The locks would be operated in a standard manner with pumps for filling and draining. The boat portages would be tank elevators with a gate at one end. The tank would be lowered below the hull of the boat, and the boat would then move between guides over the tank. The counterweighted tank would then be raised to the higher water level and the gate opened to permit the boat to move out under its own power. The time for operation after positioning of the boat over the tank would be less than one minute. The boat would be in the water at all times and there would be no contact with the bottom of the hull.

The operation and maintenance of public roads located on the berm of the master levees would be less costly than for existing roads, which must be periodically reconstructed due to levee settlement and levee rebuilding. Maintenance of the public roads would be by local agencies. Closures in the master levee system of this plan would eliminate the need for continued operation of four ferries.

Reduction of the water surface area under tidal influence would cause limited increases in tidal amplitudes in the Delta, but no significant changes in the average water levels. Such changes on the Sacramento River and Steamboat Slough would be similar to those under the Single Purpose Delta Water Project, and amplitude changes in the San Joaquin River in the heart of the Delta would be less than one foot. However, dredging would be necessary in some navigable channels.

Small islands in bends and side channels, which would be reclaimed and raised by filling, would be available for recreational development after the areas are no longer needed for disposal areas. It is contemplated that arrangements would be made with local governmental agencies for recreational development of the lands, either by direct means or by leasing to concessionaires.

SCHEMATIC DISTRIBUTION
OF DESIGN FLOOD FLOWS

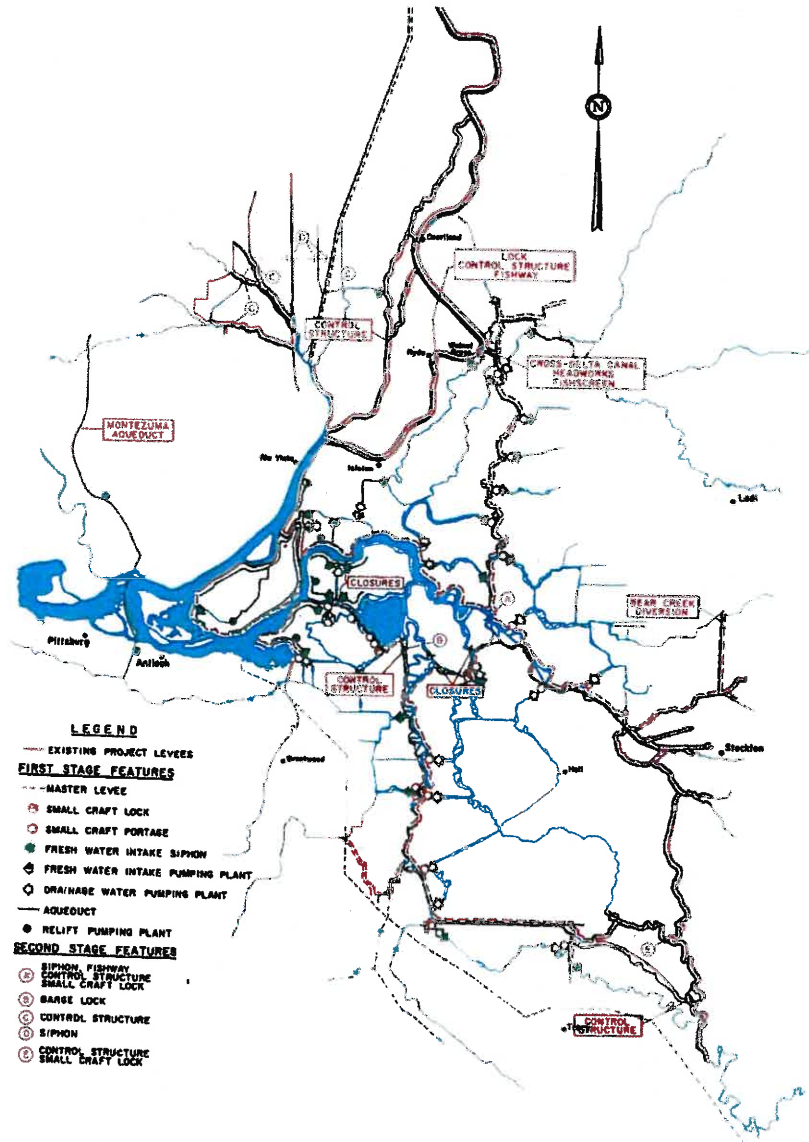
Comprehensive Delta Water Project—physical works

The Comprehensive Delta Water Project would salvage water otherwise needed for salinity control and provide water for the Delta. In addition, the project would provide flood and seepage control, transportation, and recreation benefits for most of the Delta. New master levees would encompass five principal groups of islands and Sherman Island. Works for water supply and drainage in the Delta would include those of the Typical Alternative Delta Water Project, with some modifications, plus other works to serve the newly formed island-groups. Additional small craft facilities would also be constructed.

Flood waters of the San Joaquin River would be divided between the main channel and an improved chain of distributary channels to the west, the two branches coming together in the western Delta. Improved channels of the Lower San Joaquin River Tributaries Flood Control Project would be incorporated.

The master levee along Piper Slough east of Bethel Island would be constructed on old levees on Franks Tract to minimize interference with existing developments on the Bethel Island levee.

The additional interior channels created by the project in northeastern Contra Costa County would contain good quality water, and would serve as a fresh water distribution system for the adjacent islands. Intensive small craft traffic in the vicinity of Bethel Island would necessitate the construction of four small craft portage facilities in adjacent channels and one small craft lock at Sand Mound Slough.

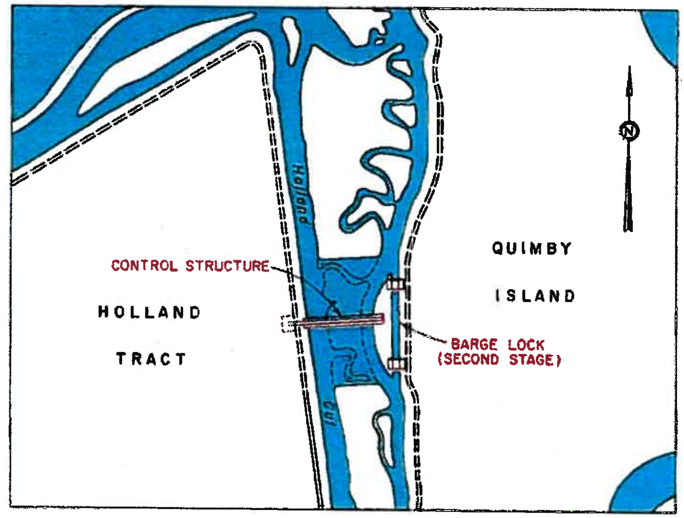


The second stage features of the Comprehensive Delta Water Project would be similar to those in other variations of the Delta Water Project.

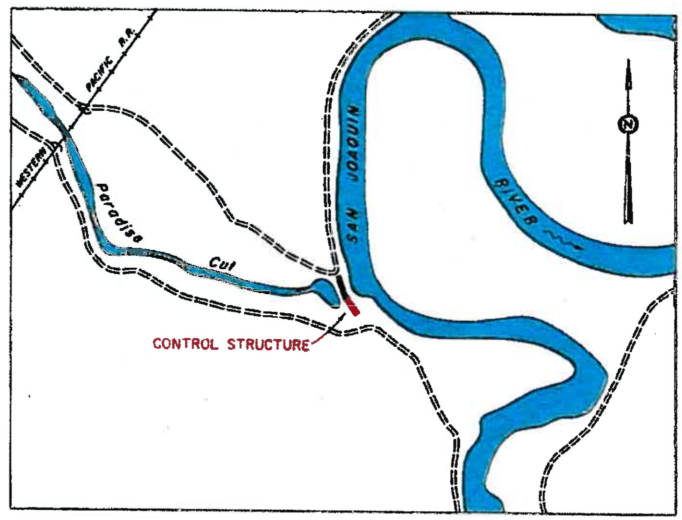
Estimates of the capital costs reflect 1960 construction costs, plus 15 percent for contingencies and 15 percent for engineering and overhead.

SUMMARY OF ESTIMATED CAPITAL COSTS
COMPREHENSIVE DELTA WATER PROJECT

Feature and date of construction	Capital cost
Steamboat Slough control structure (1968-70)	$2,943,000
Miner Slough closure (1970)	108,000
Ryde control structure, barge lock and fishway (1967-70)	5,653,000
Holland Cut control structure (1973-75)	2,761,000
Cross-Delta Canal headworks (1975-77)	1,998,000
Cross-Delta Canal fish screen (1968-70)	3,500,000
Old River and Middle River closures (1975)	258,000
Fishermans Cut closures (2) (1964)	133,000
Agricultural water facilities (1963-65)	2,520,000
Municipal and industrial water facilities (1968-71, 1980, 1995, 2010)	13,952,000
Channel dredging (1968-78)	8,950,000
Master levee system (small craft locks and portages, irrigation and drainage works)	
Isleton island-group (1964-80)	12,610,000
Lodi island-group (1964-81)	11,439,000
Holt island-group (1964-80)	13,810,000
Tracy island-group (1968-74)	4,722,000
Brentwood island-group (1964-79)	9,802,000
Sherman Island (1964-79)	2,030,000
Paradise Cut control structure (1969-71)	121,000
Bear Creek diversion (1967-70)	670,000
Kellogg Creek diversion (1971)	79,000
TOTAL CAPITAL COST, FIRST STAGE FEATURES	$98,059,000
TOTAL CAPITAL COST, SECOND STAGE FEATURES	$21,560,000



HOLLAND CUT STRUCTURE SITE



PARADISE CUT STRUCTURE SITE

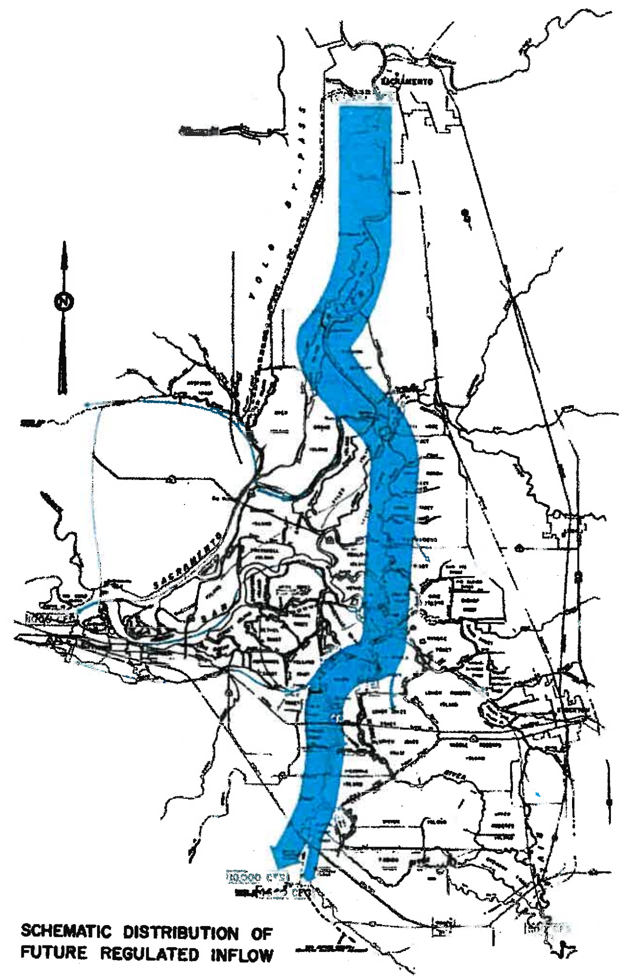
Comprehensive Delta Water Project—operation

Integrated operation of the multipurpose facilities of the Comprehensive Delta Water Project would enhance all principal phases of the Delta's economy, salvage water otherwise needed for salinity control, and provide very good quality water throughout the Delta. Although the project would have some adverse effects on certain segments of the Delta's economy, such as recreation and navigation, the multipurpose works would afford opportunity for enhancement of these same segments in other ways.

Operation of the water supply and transfer facilities during summer months would be similar to that described for the Single Purpose and Typical Alternative plans. Where representative districts or agencies are organized, the facilities could be locally operated and maintained, and appropriate adjustments in costs thereof could be made to achieve equitable distribution of costs to all beneficiaries.

Creation of interior and project channels in the southern portion of the Delta would separate irrigation water supplies from drainage water originating on lands east of the San Joaquin River. Good quality water from cross-Delta flows would be available throughout most of the southern Delta. Lands adjacent to the San Joaquin River upstream from Stockton would continue to divert from the river, but the quality of the water in this area could be improved by upstream flow in the San Joaquin River past Stockton induced by the pumping plants. A small net upstream flow occurs during summer months under present conditions. The quality of water in Paradise Cut could also be improved with circulation induced by pumping from the upper end into the San Joaquin River. Diversions from the river in this vicinity might be affected by operation of a San Joaquin Valley waste conduit. If current studies indicate that substitute supplies would then be necessary, or if further improvement of the quality of the supplies is desired even in the absence of adverse effects of a waste conduit, such supplies could be readily diverted from Delta channels without affecting works described herein.

Lands in the Holt island-group in the south central portion of the Delta range in elevation from several feet below sea level to a few feet above sea level. Irrigation water for the higher islands is pumped from the channels, while siphons are utilized for the lower islands. To achieve seepage control benefits for the lower islands, water



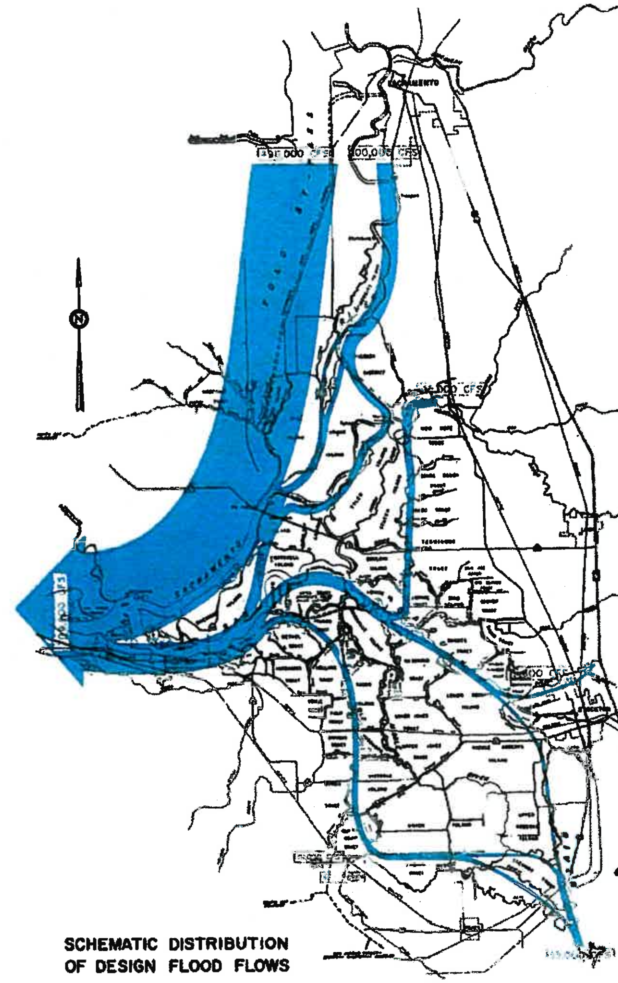
SCHEMATIC DISTRIBUTION OF FUTURE REGULATED INFLOW

levels in the channels could be lowered. This could be accomplished locally without detriment to the higher lands by constructing low dams with pumping plants in the channels and maintaining different water levels in the interior channel system.

Large volumes of small craft and fishing boats move between marinas and resorts in the Bethel Island area and Franks Tract or more distant points in the Delta and San Francisco Bay system. Peak small boat traffic would be served by three small craft portages on Piper Slough, and by one small craft lock on Sand Mound Slough. Lock or portage service for small craft would be provided at various other locations in the Delta when dictated by construction of channel closures. It should be recognized that subsequent developments and changes in patterns of use may necessitate revisions in the planned local service. While the lock and portages would cause some inconvenience to recreationists, creation of interior channels not subject to flood and tidal stages would benefit shore line installations. An expected great increase in boating in the future would intensify problems of patrolling and safety enforcement. Opportunities would be available to local public agencies to designate certain waterways for specific uses, and problems of regulation would be reduced under controlled access.

Master levees of the project in the southern half of the Delta would cause increased tidal amplitudes in the project channels. The maximum increase in the San Joaquin River system would be about one foot at Stockton. There would be no significant change in the mean water level. Some dredging in navigation channels would be necessary.

Tug and barge shipments into the southern Delta would be limited to the Cross-Delta Canal. Most of the present traffic involves beet shipments to a sugar refinery near Tracy, and the Holland Cut channel east of Franks Tract is generally used. The Cross-Delta Canal would be open to the San Joaquin River, and a barge lock at the Holland Cut control structure would not be economically justified. Although a slightly greater travel distance from northern and western Delta points would be involved under the project, the channel to the vicinity of the sugar refinery would be dredged. This would permit use of larger barges, which are presently precluded by shallow channel depths.



SCHEMATIC DISTRIBUTION OF DESIGN FLOOD FLOWS

Project Accomplishments—Delta water supply

Over 90 percent of the Delta lowlands now has adequate water supplies during summer months due in part to operation of the Central Valley Project. However, ten percent of the Delta in the western portion, including lands occupied by large water-using industries and municipalities, does not have adequate good quality water supplies at all times. Moreover, additional regulation and use of water in areas tributary to the Delta, exclusive of Delta exports, will lengthen the average period each year when salinity incursion from the Bay causes increased operating costs, plant shutdowns, and decreased farm production. The concentrations of dissolved minerals in water from the Contra Costa Canal now approach upper limits of acceptable quality during several months of most years, and significant sums of money are expended by industries for demineralization and water softening.

Under any of the foregoing projects, water of very good quality would continue to be supplied to about 90 percent of the Delta lowlands through existing facilities. It is estimated that the mineral quality of the supplies would generally range between about 15 to 80 parts of chlorides and between 100 and 350 parts of total dissolved solids per million parts water. The quality of water in the southern portion of the Delta would be improved.

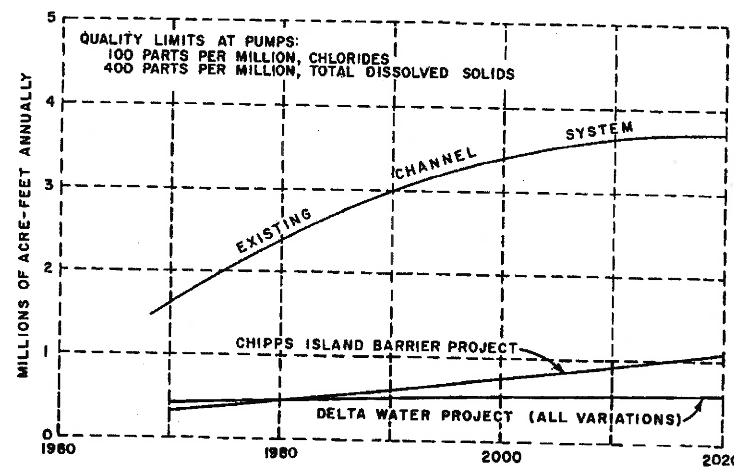
The quality of water in the Pittsburg-Antioch area with the Chipps Island Barrier Project in operation would be uncertain. Although downstream disposal of local municipal and industrial wastes and drainage from the San Joaquin Valley would eliminate the majority of the mineral pollutants, the effects of cooling water and mineral and organic wastes of the Delta might result in water supplies of questionable quality, particularly during critical dry periods. Elimination of the tidal effects in this area by construction of the barrier would also reduce the supply of dissolved oxygen in the water, which is now partly replenished from Suisun Bay.

All of the alternative plans for the Delta Water Project would involve dual water supplies with different water quality characteristics. While the concentrations of minerals in water in certain western channels would increase due to greater ocean salinity incursion, the quality of water from the Contra Costa Canal and from proposed water supply facilities would be excellent. It is estimated that substitute industrial water supplies would generally contain between 15 and 80 parts of chlorides per million parts of water. Similarly, the total dissolved solids would generally range between 125 and 300 parts per million. Irrigation water supplies would be of similar quality. The Contra Costa Canal would annually supply about 195,000 acre-feet of water, including some substitute water in northeastern Contra Costa County. All additionally required supplemental and substitute water would be supplied from the Montezuma Aqueduct. This annual quantity would amount to about 120,000 acre-feet in 1990 and 330,000 acre-feet in 2020. Brackish water supplies in the western Delta channels would vary in quality with location. The mean quality would be about 3,000 parts of chlorides per million parts water at Antioch during summer months. Water containing this much salinity is not necessarily damaging to cooling equipment involving alloy metals. A composite of several factors, most of which would not be modified by alternative plans for the Delta Water Project, controls the rate of corrosion of cooling equipment.

Project Accomplishments—water salvage

Unless physical works are constructed in the Delta to prevent salinity incursion from the Bay system, or to channelize fresh water directly across the Delta channels, it will be necessary to release increasingly greater amounts of fresh water from upstream storage to maintain satisfactory quality conditions. Greater rates of fresh water outflow will be necessary as the rate of export pumping from the Delta increases, and greater quantities of stored water will have to be released as the amount of surplus water for outflow is reduced by upstream depletions and export from the Delta. If Delta works are not constructed, the yield of other features of the State Water Facilities would be reduced and subsequent features for importation of water from north coastal sources would be needed at an earlier date. Any such modifications in the program would increase the cost of water in the Delta.

With any of the plans for the Delta water facilities, the amount of outflow from the Delta otherwise necessary for salinity control would be greatly reduced. It would still be necessary to dispose of municipal and industrial wastes from the western Delta, and drainage from the San Joaquin Valley, into channels downstream from points of usable good quality water. All of the plans are comparable in this respect, except that these wastes would aid in repulsion of ocean salinity incursion with any of the alternatives of the Delta Water Project. Fresh water required for operation of locks and the fishway would be lost with a barrier at Chipps Island, but would be available for use downstream of the control structures with any of the alternatives of the Delta Water Project. A small amount of conservation yield could be obtained from limited storage in Delta channels with a barrier at Chipps Island, but alternatives of the Delta Water Project would not provide conservation storage.



UPSTREAM STORAGE RELEASES FOR PROJECT OPERATION

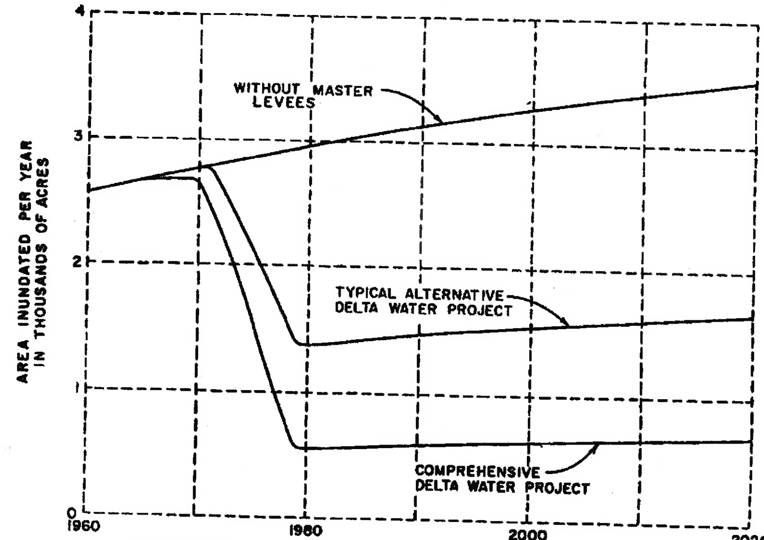
The amount of water otherwise necessary for salinity control which could be salvaged by Delta water facilities would vary with time, as indicated by the above graph. The amount of salvaged water would be the difference between demands on upstream storage for outflow without any works in the Delta, and demands with such works in operation. The estimated average annual salvage during the next 60 years would be 1,900,000 acre-feet with the Chipps Island Barrier Project, and 2,050,000 acre-feet with any of the alternative plans for the Delta Water Project.

Project Accomplishments—flood and seepage control

Only the Typical Alternative Delta Water Project and the Comprehensive Delta Water Project would provide flood and seepage control benefits to the Delta. However, all plans would include remedial works made necessary by adverse effects of flood or tidal water stages changed by project operation. These would be particularly necessary with the Chipps Island Barrier Project.

Project flood control benefits would result from reduction in the frequency of flooding, and from reductions in costs of maintaining Delta levees. It is emphasized that complete flood protection could not be assured, as the inflow to the Delta could exceed the designed capacity of the channels. Furthermore, although the stability of the master levees would be significantly greater than the stability of existing levees, the character of organic foundation soils is such that unforeseen stability problems might develop in some areas. For these reasons, emphasis should be given to zoning Delta lands lying below flood levels for uses involving low-value improvements such as farming, and precluding residential development. While complete flood protection for the Delta lands could not be assured under project conditions, there would be a marked improvement in protection over existing conditions which will worsen as land elevations in the Delta continue to subside.

About 103,000 acres would be benefited by master levees included in the Typical Alternative Delta Water Project, and about 143 miles of levees along interior channels would no longer require costly maintenance for high flood stages. The estimated average annual benefit of reduced flooding and operation and maintenance costs would be about $4.65 per acre. Master levees of the Comprehensive Delta Water Project would benefit about 252,000 acres and would reduce expensive maintenance on 295 miles of interior channel levees. The estimate of average annual flood control benefits is about $3.60 per acre.



PROJECTED AVERAGE ANNUAL AREA OF FLOODING

Seepage control benefits would be made available by lowering water levels in interior channels created by the Typical Alternative Delta Water Project or by the Comprehensive Delta Water Project. In addition, lower water levels would prolong the economic life of certain islands. These benefits and the extent of increased economic life would depend upon lowering average water levels in the interior channels. A general lowering of five feet could be made without adversely affecting depths for small craft, except in isolated locations, or the majority of water supply siphons. Based upon a five-foot lowering of water levels, seepage control benefits, averaging an estimated $0.50 per acre for 103,000 acres, would be available with the Typical Alternative Delta Water Project. The Comprehensive Delta Water Project would afford seepage benefits to 252,000 acres, and the estimated average annual benefit would be $0.45 per acre.

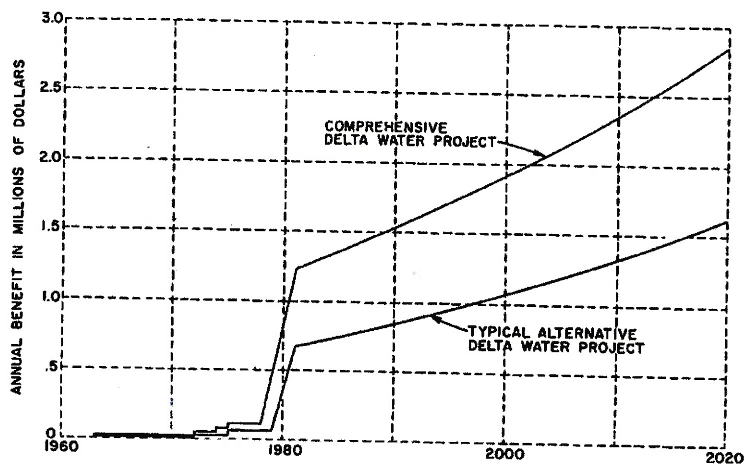
Project Accomplishments — vehicular transportation

The two basic problems of the existing road system in the Delta are (1) inadequate channel crossings and circuitous routes, with resultant excessive travel times, and (2) disproportionately high costs of maintenance. Projects involving master levees for flood control in the Delta would afford means for reducing both of these problems. However, the Chipps Island Barrier Project would provide no benefits to vehicular transportation, and the Single Purpose Delta Water Project would provide only incidental benefits of this kind.

The master levee system of the Typical Alternative Delta Water Project would include twenty-two channel closures upon which roads could be placed, and operation of four existing ferries could be terminated. The Comprehensive Delta Water Project would include thirty-nine channel closures providing new access and would eliminate the need for six ferries.

Roads on the landward berms of the master levees would be more stable and less difficult to maintain than existing roads on levee crowns. Driving on present levee roads is hazardous, as evidenced by frequent drownings when vehicles run off levees into adjacent channels. Passing clearance is often limited by parked vehicles. In addition to improved safety with roads on the levee berms, there would be ample width for parking off the roadways.

To realize the anticipated and needed development of recreation in the Delta, it will be necessary to greatly improve vehicular access. Realization of about 7,000,000 recreation-days each year by 1990, and almost 14,000,000 by 2020 will, in large degree, be dependent upon the improved vehicular access that could be provided by multipurpose use of the master flood control levees.



BENEFITS OF VEHICULAR TRANSPORTATION IMPROVEMENTS

The project benefits from enhancement of the road system would be a combination of savings in maintenance costs and savings in costs to Delta traffic associated with farming and to the recreationists. Savings to Delta interests reflect reduced costs of general travel and produce shipments through decreased travel times and distances. Savings to the recreationists were based upon projected recreation use and decreased travel times and distances.

Project Accomplishments—recreation

While some detriments to recreation are inherent in construction of any facilities in the Delta, substantial benefits would also be achieved. As has been stated, improvements in the road network would make more of the Delta accessible to recreationists. Land areas reclaimed by spoiling material from dredging of channels onto small islands would afford space for development of recreation service facilities and picnic areas. Project works at the head of the Cross-Delta Canal would be constructed to provide clearance for the majority of pleasure craft, thereby connecting the Sacramento and Mokelumne River systems. Elimination of flood and tidal effects from interior channels would make it possible to control water levels in those channels, reducing costs of maintaining waterfront recreation facilities. Furthermore, costs of new facilities would be less than for present conditions. The safety of the boating public is becoming a significant problem, and the incompatibility of high-speed boating, cruising, and skiing with fishing and swimming creates related safety problems. Local authorities will find it desirable and even necessary to designate certain Delta channels for specified types of recreation use. The interior project channels would lend themselves to this type of zoning and also to simplified enforcement.

Planning and construction of recreational developments in the Delta should involve local governmental agencies. Most project channel closures would not be constructed for eight or more years, and changing recreation patterns should be considered in future selection of remedial and enhancement facilities. Needs for small craft locks and boat portages should be re-evaluated at the time closures are constructed.

The most important form of recreation in the Delta is fishing. In terms of recreation-days, fishing is three times as important as the next most popular sport—cruising. A project which would cause a major reduction in fish populations might also cause very adverse effects on the recreation. In this connection the Chipps Island Barrier Project would result in losses of striped bass several times as great as those anticipated with any of the alternative plans for the Delta Water Project.

It is recognized that cruising, sailing, and water skiing are rapidly gaining in popularity in the Delta, and that construction of master flood control levees and channel closures would interfere with unrestricted boating access to certain channels. However, access would be provided through small craft locks or portage facilities at many of the channel closures, thus reducing the detriment primarily to short delays. Studies in other areas indicate that lockage delays are not too important to the majority of pleasure boatmen.

The following tabulation summarizes physical features of the several alternative projects which would affect recreational activity and growth in the Delta.

Item	Chipps Island Barrier Project	Single Purpose Delta Water Project	Typical Alternative Delta Water Project	Comprehensive Delta Water Project
Control structures	1	4	3	4
Channel closures	1	10	23	41
New master levees (miles)	0	0	90	185
Fishways	1	1	1	1
Principal fish screens	0	2	1	1
Barge locks	1	1	1	1
Small craft locks	0	0	2	5
Small craft portage facilities	0	0	5	17
Open navigable area (acres)	49,500	49,400	45,800	42,600
Navigable interior area (acres)	0	100	3,700	6,900
Open navigable channels (miles)	700	695	590	450
Navigable interior channels (miles)	0	5	110	250
Project roads (miles)				
Paved	0	0	33	70
Graveled	0	1	47	109
State and county levee roads (miles)	295	295	279	265
New inter-island accesses (closures)	0	6	22	39
New public waterfront land (acres)				
From master levees	0	0	1,900	3,600
From dredge spoils	0	1,900	1,900	2,300
Normal overhead clearance through Delta Cross Channel (feet)	6	16	16	16

Project Accomplishments—fish and wildlife

Any Delta water facilities would affect the habitat of fish in the Delta, but would have little effect, if any, on Delta wildlife. While it is known that the Delta plays an important role in the life cycle of migratory fish, and also supports resident sport fish, insufficient biological information is available with which to clearly define the potential effects of Delta water facilities. Nevertheless, relative comparisons of the alternative projects can be made.

Studies of effects of the Delta water facilities and export pumping plants were made by the California Department of Fish and Game in co-operation with the Department of Water Resources. Cooperative experiments with a full-scale vertical baffle fishway indicate that all migratory species would use this type of fishway. The conclusions of the Department of Fish and Game regarding the alternative projects are as follows:

"*Chipps Island Barrier*

"This project would be the most damaging of the four studied. It would probably cause a disastrous reduction of almost all species of fish found in the Delta. These losses would be brought about by the rapid salinity and temperature change across the barrier, loss of current in the fresh-water pool for migration direction, striped bass spawning eliminated due to lack of current behind the barrier, loss of important food items, and a threefold increase in pumping of water at Tracy. The amount of Sacramento River water being drawn around the tip of Sherman Island to the pumping plant would be greatly increased. Downstream migrants of the Sacramento River would be diverted to the pumps in large numbers. These fish would have to be screened at the pumps and returned to the river channel below the influence of this current. This condition would be a serious detriment to all fish using the Delta.

"*Single Purpose Delta Water Project*

"This project would be the least detrimental of the four projects studied. The reversal of flow around Sherman Island would be eliminated. Major fish screens would be installed at the Cross-Delta Canal headworks and at the head of Georgiana Slough. Therefore, downstream migrants in the Sacramento River would be guided down the western side of the Delta out of the influence of the pumps. In general, fish and eggs in the western portion of the Delta would no longer be affected by the pumps. The replacement of the hundreds of existing small irrigation siphons in the western Delta by screened irrigation supply systems would further reduce losses of small fish. In these respects conditions for fish in the Delta would be improved.

"Fish habitat would not be reduced in the Delta. The one channel that would be isolated under this project would be insignificant. An important effect of the project would be the increased reversal of flow in the San Joaquin River above the Cross-Delta Canal crossing. This reversal of flow would occur during an average of seven months of the year under full project operation. We were unable to evaluate the effect of the reversal. However, it could result in serious losses to salmon that now spawn in San Joaquin River tributaries south of the Mokelumne River. Most seriously affected would be upstream migrating salmon. The amount of water pumped from the Delta would be increased threefold. This increased withdrawal of water would divert proportionately more fish than is presently being diverted.

"*Typical Alternative Delta Water Project*

"This project would be the second least detrimental. Losses would be expected to be greater than the Single Purpose Project because of the reduction of 8 percent of the fish habitat through channel closures, and partial channelization of the Cross-Delta Canal. The channelization would cause a detriment by channeling the fish toward the pumps by a more direct route. Water diversions into isolated channels would be screened and loss of fish would be reduced. However, loss of eggs and fry would be unavoidable. Other project conditions would be the same as the Single Purpose Project.

"*Comprehensive Delta Water Project*

"This project would be the third least detrimental. It would cause greater loss than the Typical Alternative Project because of the reduction of 14 percent of the fish habitat, and the complete channelization of the Cross-Delta Canal. This would channel the fish directly to the pumps. Other project conditions would be the same as in the Single Purpose Project.

"From the foregoing, if one of the above-named projects is to be built in the Delta, the Department of Fish and Game would favor the Single Purpose Delta Water Project. However, all projects will cause serious fisheries problems and an intensive study would be required to solve these problems."

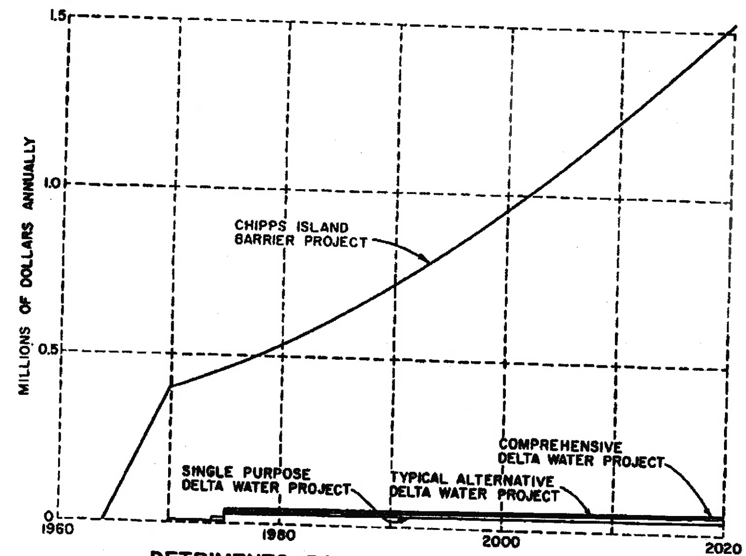
Formulation of project plans reflects comments and recommendations of the Department of Fish and Game. Fish screens would be installed at the heads of channels diverting water southward from the Sacramento River. Such screens would reduce the present rates of fish losses at the Tracy Pumping Plant and in numerous other diversions in the Delta. Project pumping plants would also be screened. Hundreds of diversion siphons and pumping plants in the Delta are not screened at this time. However, project diversions into interior channels would be screened, and the fish populations enhanced thereby.

Project Accomplishments—navigation

Commercial and military navigation in the Delta would be adversely affected in varying degrees by any Delta water facilities, but some potential benefits would also be realized through increases in channel depths and widths.

The Chipps Island Barrier Project would cause the greatest detrimental effect to navigation, since all traffic between the San Francisco Bay system and Delta points would have to pass through locks. At present, an average of about 570 deep-draft commercial vessels, and 10,300 tug and barge tows and small vessels pass Chipps Island each year. It is estimated the annual transits would increase to 2,800 and 40,000, respectively, by 2020. The volume of future military traffic cannot be realistically estimated, nor is it possible to place a reasonable value on its lost time. The increased tidal amplitude downstream from a barrier at Chipps Island would necessitate additional dredging in some areas to provide the required minimum navigation depth. This increased depth might cause additional maintenance dredging which frequently results from deepening navigation channels.

Completion of the Sacramento Deep Water Channel will divert most of the tug and barge traffic away from the Sacramento River between the vicinities of Rio Vista and Sacramento. The traffic which would pass the site of the Sacramento River control structure would generally be limited to that originating from or destined to points of call downstream from the vicinity of Freeport. It is anticipated that the volume of this traffic would increase from 600 transits per year after completion of the Sacramento Deep Water Channel to about 900 transits per year by 2020.



DETRIMENTS TO COMMERCIAL NAVIGATION

Construction of control structures and closures on channels south of the San Joaquin River in the heart of the Delta would increase time and distance for tug and barge travel to a sugar refinery near Tracy. However, channel improvements would permit use of larger barges, if shipping concerns should elect to do so. As this advantage would be subject to many factors in an operator's business which cannot be readily predicted, benefits were not claimed for possible use of larger barges.

Construction of a master levee system would necessitate relocation of some sugar beet loading docks in the Delta. However, improved roads would tend to compensate for increased hauls to relocated docks.

Economic Aspects—benefits, detriments, and costs

Only direct, tangible benefits and detriments to the initial recipient were evaluated for comparison with direct costs. However, it must be recognized that direct, intangible benefits and detriments would also result from project operation. The ratios of benefits to costs provide a guide to project selection, but consideration should also be given to the net benefits in making the final project selection. Although variations in benefit-cost ratios can result from different basic economic premises, the relative comparison of alternative projects would not change.

Certain significant benefits and detriments were not evaluated. All alternative plans would improve the quality of water exported to the San Joaquin Valley and reduce the drainage problems there. Only direct benefits of flood protection to agriculture were evaluated, but this protection would also benefit principal highways and urban developments. The estimated recreation benefits from land made available for development were considered to be equivalent to the value of the land. Intangible benefits would also accrue to recreation, and intangible detriments would result from reduced convenience of access into some channels. Only detriments to commercial fishing are shown, but intangible detriments to sport fishing would also accrue.

All estimates of benefits, detriments, and costs, including amortization, operation, and maintenance, reflect annual equivalent values for the period 1960-2020. An interest rate of four per cent per annum was used in the analysis.

Attention is invited to the net benefits of the Comprehensive Delta Water Project which are less than the net benefits of the Typical Alternative Delta Water Project. This condition results from inclusion of economically unjustified flood control for large areas south of the San Joaquin River wherein the direct benefits would be less than the costs. However, flood control for some of the critical areas south of the San Joaquin River warrants further study.

ESTIMATED ANNUAL BENEFITS, DETRIMENTS, AND COSTS

(In thousands of dollars)

Item	Chipps Island Barrier Project	Single Purpose Delta Water Project	Typical Alternative Delta Water Project	Comprehensive Delta Water Project
Benefits				
Water salvage (for export)	8,337	8,963	8,963	8,963
Improved water quality—municipal, industrial, and irrigation	880	880	880	880
Supplemental municipal and industrial water supply	503	1,343	1,343	1,343
Flood and seepage control	....	....	530	1,022
Vehicular transportation	....	....	410	734
Recreation	....	19	37	58
Total Benefits	9,720	11,205	12,163	13,000
Detriments				
Commercial navigation	617	18	24	27
Commercial fisheries	844	203	254	287
Total Detriments	1,461	221	278	314
BENEFITS MINUS DETRIMENTS	8,259	10,984	11,885	12,686
Costs				
Capital amortization	6,825	1,358	1,965	2,846
Annual operation and maintenance	2,077	691	884	1,136
Total Costs	8,902	2,049	2,849	3,982
NET BENEFITS	−643	8,935	9,036	8,704
BENEFIT–COST RATIO	0.93:1	5.36:1	4.17:1	3.19:1

Economic Aspects—allocation of costs

The capital and operational costs of each of the alternative projects were allocated among the project functions by the Separable Costs-Remaining Benefits method. In this method, all costs assignable to single functions are identified, and the remaining multipurpose costs are distributed among the functions in proportion to the benefits provided by the project, or in proportion to the lowest cost alternative means of providing equivalent benefits. The lowest value of either the benefits or alternative means is used as a limit.

The basic allocations were made in terms of present worth values (1960) of all costs and benefits. This procedure properly accounts for the time-value of money (interest) and the wide variation in dates of expenditure of money and realization of benefits. Allocations of the capital and operational costs in terms of actual expenditures, rather than present worth, are indicated in the accompanying tabulations to permit convenient comparisons with total amounts of these costs.

Attention is invited to the allocated costs of the Chipps Island Barrier Project. The costs which would be allocated to water salvage and western Delta water supply were limited by the lowest cost alternative means of providing equivalent benefits, which would be the Single Purpose Delta Water Project. The values

ALLOCATION OF ESTIMATED CAPITAL COSTS
(In thousands)

Item	Chipps Island Barrier Project	Single Purpose Delta Water Project	Typical Alternative Delta Water Project	Comprehensive Delta Water Project
Water salvage (for export)	$38,384	$38,444	$38,662	$41,655
Western Delta water supply [1]	8,098	8,111	8,156	8,788
Flood and seepage control	none	none	11,900	25,159
Vehicular transportation	none	none	8,132	18,083
Recreation land	none	none	681	1,429
Unassigned local costs	155,490	none	none	2,945
TOTALS	$201,972	$46,555	$67,531	$98,059

[1] For improvement in quality and supplemental water supplies. Allocated costs include portions properly attributable to upstream water users for future effects on the western Delta area due to increased water use in areas tributary to the Delta. Definite values attributable to upstream water users would be dependent upon resolution, negotiated or otherwise, of water rights problems.

shown for the Chipps Island Barrier Project are slightly less than those for the lowest cost alternative, since the funds for the former would be expended at an earlier date. The allocations to both projects in present worth values would be the same. As the costs which may be properly allocated to water salvage and western Delta water supply are less than the total cost, a portion of the costs of the Chipps Island Barrier Project are shown as unassigned local costs. If these costs are not repaid from sources other than water users, the Chipps Island Barrier Project would be financially infeasible.

Attention is also invited to the allocated costs of the Comprehensive Delta Water Project which indicate certain unassigned local costs. In this case the costs of flood and seepage control in areas south of the San Joaquin River exceed the direct benefits of flood and seepage control in these areas. Therefore, the allocation to flood and seepage control for these areas was limited to the benefits. These flood and seepage control features of the Comprehensive Delta Water Project are not economically justified.

After the costs were allocated to principal project functions, it was necessary to make suballocations among particular groups of beneficiaries. These suballocations, which are indicated on the following pages, were also made by the Separable Costs-Remaining Benefits method and were the basis for computing the average annual costs to beneficiaries throughout a 60-year period. In the adjoining tabulations the amounts allocated to vehicular transportation include some costs which would be suballocated to recreation access to reflect the benefits to the public for improved access to recreation areas of the Delta. It is estimated that about $7,075,000 of the capital costs and $92,000 of the annual operational costs for vehicular transportation under the Typical Alternative Delta Water Project would be suballocated to recreation access. Under the Comprehensive Delta Water Project these respective amounts would be $15,123,000 and $176,000. These foregoing amounts would be in addition to the basic allocation to recreation land, which reflects the value of lands made available for recreational development.

ALLOCATION OF ESTIMATED AVERAGE ANNUAL OPERATIONAL COSTS
(In thousands)

Item	Chipps Island Barrier Project	Single Purpose Delta Water Project	Typical Alternative Delta Water Project	Comprehensive Delta Water Project
Water salvage (for export)	$395	$571	$506	$483
Western Delta water supply [1]	83	120	107	102
Flood and seepage control	none	none	156	292
Vehicular transportation	none	none	106	210
Recreation land	none	none	9	16
Unassigned local costs	1,599	none	none	34
TOTALS	$2,077	$691	$884	$1,137

[1] For improvement in quality and supplemental water supplies. Allocated costs include portions properly attributable to upstream water users for future effects on the western Delta area due to increased water use in areas tributary to the Delta. Definite values attributable to upstream water users would be dependent upon resolution, negotiated or otherwise, of water rights problems.

Economic Aspects—costs of project services

It was assumed that all project costs not specifically declared nonreimbursable would be repaid by all beneficiaries of project functions. In accordance with the contracting principles established for water service under the State Water Resources Development System, the conservation features of the Delta water facilities will be financially integrated with other conservation features of the system. The cost of supplemental water required by Delta water users will include the Delta Water Charge and an allocated transportation charge.

Estimates of present and future costs of water supply in the western Delta area were predicated on continuation of current federal salinity control policy, which limits the minimum regulated outflow from the Delta to 1,500 second-feet, considered necessary to afford satisfactory quality control at the Central Valley Project pumping plants. Estimates of increased future costs without the State Water Facilities reflect continued upstream depletion of surplus water in the Delta, and represent average costs during the next 60 years. Estimates of costs shown for project conditions also reflect average costs during the next 60 years. It is emphasized that the estimates are comparative average annual *costs* during a 60-year period and do not reflect estimates of year by year *prices* which may be established.

The amounts allocated for repayment were limited by the lowest cost alternative means of accomplishing equivalent benefits. It may be noted that the costs of water supply in the western Delta area would be the same for the Chipps Island Barrier Project, Single Purpose Delta Water Project, and Comprehensive Delta Water Project. The Single Purpose Delta Water Project would be the lowest cost alternative means of providing water supplies and it limits the amount which may be allocated under the other two projects.

The costs of the Typical Alternative Delta Water Project allocated to water salvage would amount to an average of $0.64

COMPARATIVE SUMMARY OF ESTIMATED AVERAGE ANNUAL COSTS OF WATER SUPPLY IN WESTERN DELTA AREA WITH AND WITHOUT STATE WATER FACILITIES DURING 1960-2020 [1]

Item	Future cost without State Water Facilities	Chipps Island Barrier Project	Single Purpose Delta Water Project	Typical Alternative Delta Water Project	Comprehensive Delta Water Project
Contra Costa Canal service, $/acre-foot [2]	14.52 [3]	11.66	11.66	11.64	11.66
Substitute municipal and industrial water supply, $/acre-foot	[4]	[4]	3.45	3.33	3.45
Supplemental water supply [5]					
Contra Costa County, $/acre-foot	15.20	9.06	9.06	8.92	9.06
Solano County, $/acre-foot	17.00	8.82	8.82	8.68	8.82
Agricultural water supply, $/acre [6]	7.91 [7]	1.50	1.50	1.45	1.50

[1] Average of estimated costs during a 60-year period. Values do not necessarily reflect *prices* for project services.
[2] For all municipal and industrial water served from the Contra Costa Canal. All costs include $11 per acre-foot for water from the canal.
[3] Allocated costs reflect benefits from improved quality.
[3] Includes estimated excess water treatment due to salinity degradation.
[4] Estimated future cost of high quality water from Delta channels will vary between $2.00 and $5.00 per acre-foot, depending upon plant locations and operations.
[5] All supplemental project water available through operation of the Montezuma Aqueduct.
[6] Costs reflect average for about 34,000 acres in the western Delta lowlands.
[7] Cost expressed as loss per acre due to salinity incursion.

per acre-foot for all water exported from the Delta by the State Water Facilities. Similar costs with the other projects would be about $0.66 per acre-foot.

It is anticipated that a federal contribution would be provided for flood and seepage control. This contribution, tentatively estimated at $10,123,000 for the Typical Alternative Delta Water Project and $16,020,000 for the Comprehensive Delta Water Project, would probably reflect current federal policy for allocation of costs of levee improvements, and would be based on reduced flood damages and net savings from reduced levee maintenance costs. Local costs of maintaining existing levees incorporated in the master levee system probably would not be directly met by local districts. Maintenance would be included in the total project costs, and a portion of these costs would be allocated to local beneficiaries.

The total project costs allocated to vehicular transportation were suballocated to the benefited counties and to the general public. The allocation to the general public reflects enhancement of recreation, and was considered nonreimbursable.

COMPARATIVE SUMMARY OF ESTIMATED ANNUAL COSTS OF FLOOD AND SEEPAGE CONTROL WITH AND WITHOUT DELTA WATER FACILITIES DURING 1960-2020 [1]

(Per acre)

Item	Island-group					
	Isleton	Lodi	Holt	Tracy	Brentwood	Sherman
Present control cost	$8.00	$8.00	$7.50	$6.50	$7.50	$9.00
Future control cost without a project	10.85	10.29	9.16	7.50	8.83	13.10
Annual damage savings with a project	2.80	1.65	0.35	0.20	1.32	3.12
Typical Alternative Delta Water Project						
Allocated project cost	2.04	2.17				
Interior levees and pumping cost	7.96	7.34				
Total control cost	$10.00	$9.51				
Net savings	3.65	2.43				
Comprehensive Delta Water Project						
Allocated project cost	2.15	2.29	2.09	2.29	2.38	2.53
Interior levees and pumping cost	7.96	7.34	6.66	4.97	6.04	10.57
Total control cost	$10.11	$9.63	$8.75	$7.26	$8.42	$13.10
Net savings	3.54	2.31	0.76	0.44	1.73	3.12

[1] Average of estimated costs during a 60-year period. Values do not necessarily reflect prices for project services.

COMPARATIVE SUMMARY OF ESTIMATED ANNUAL COSTS AND SAVINGS WITH VEHICULAR TRANSPORTATION IMPROVEMENTS DURING 1960-2020 [1]

Item	Contra Costa County	San Joaquin County	Sacramento County
Typical Alternative Delta Water Project			
Allocated project cost	$—	$41,400	$4,500
Operational savings to present road system	—	38,500	1,100
Savings to road users	—	265,700	105,200
Net savings	—	268,800	101,800
Comprehensive Delta Water Project			
Allocated project cost	13,300	95,700	11,200
Operational savings to present road system	2,900	59,300	5,000
Savings to road users	82,000	465,600	119,700
Net savings	71,600	429,200	113,500

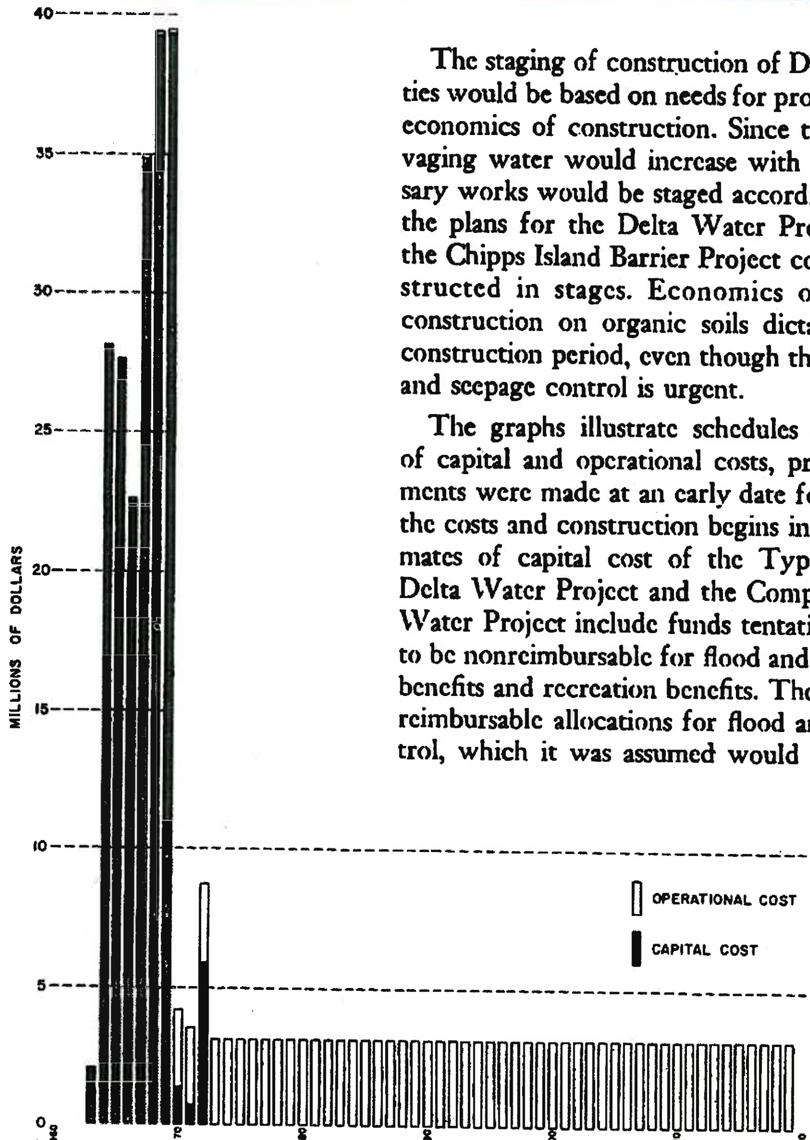
[1] Average of estimated costs during a 60-year period. Values do not necessarily reflect prices for project services.
NOTE: There would not be any vehicular transportation improvements in portions of other counties within the Delta.

Economic Aspects—repayment

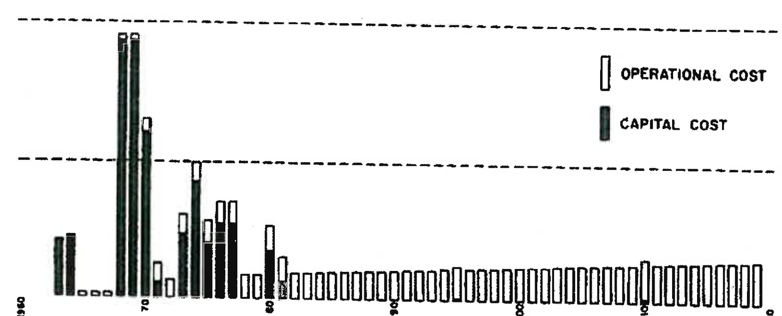
The staging of construction of Delta water facilities would be based on needs for project services and economics of construction. Since the need for salvaging water would increase with time, the necessary works would be staged accordingly for any of the plans for the Delta Water Project. However, the Chipps Island Barrier Project could not be constructed in stages. Economics of master levee construction on organic soils dictate an extended construction period, even though the need for flood and seepage control is urgent.

The graphs illustrate schedules of expenditures of capital and operational costs, provided arrangements were made at an early date for repayment of the costs and construction begins in 1963. The estimates of capital cost of the Typical Alternative Delta Water Project and the Comprehensive Delta Water Project include funds tentatively considered to be nonreimbursable for flood and seepage control benefits and recreation benefits. The estimated nonreimbursable allocations for flood and seepage control, which it was assumed would be provided by the Federal Government, amount to about $10,123,000 for the Typical Alternative Delta Water Project and $16,020,000 for the Comprehensive Delta Water Project. The estimated allocation of capital costs to recreation land and access would be $7,756,000 with the Typical Alternative Delta Water Project and $16,552,000 with the Comprehensive Delta Water Project. The corresponding allocations of annual operational costs would be $101,000 and $192,000, respectively. It was assumed that the allocated capital costs for recreation land and access would be nonreimbursable and be borne by the State of California. It was also assumed that the annual operational costs would be reimbursable from gas tax funds and nominal rental charges on land made available for recreation development.

The allocated reimbursable costs for water salvage and western Delta water supply would be repaid by water charges. The charges would be based on integrated repayment of other necessary State Water Facilities. The reimbursable costs of flood



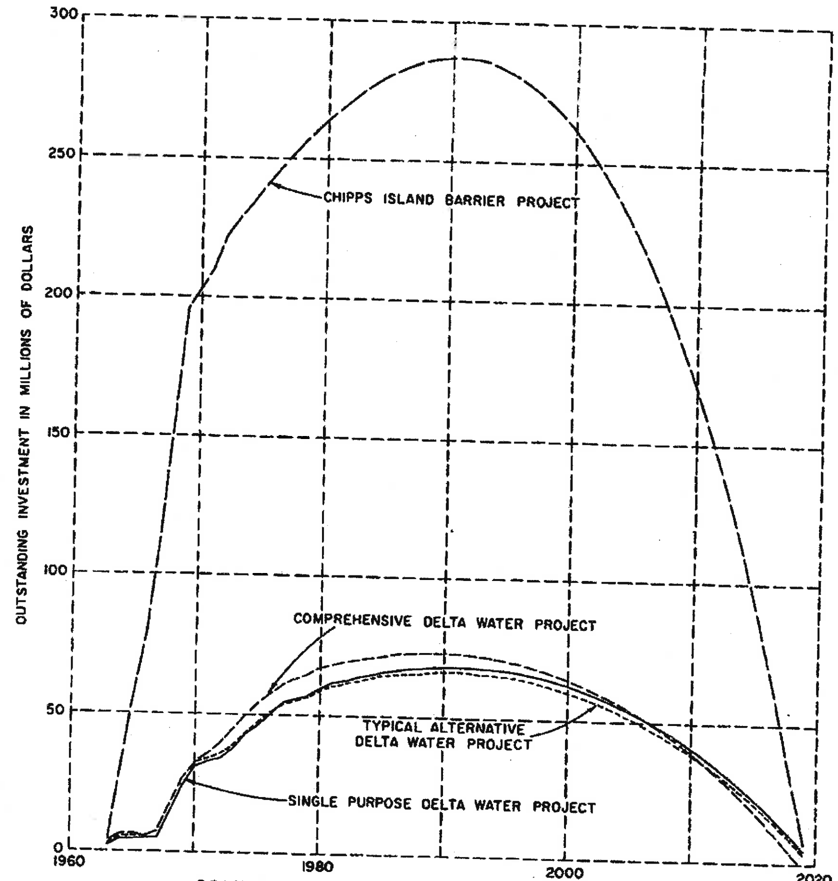
CHIPPS ISLAND BARRIER PROJECT



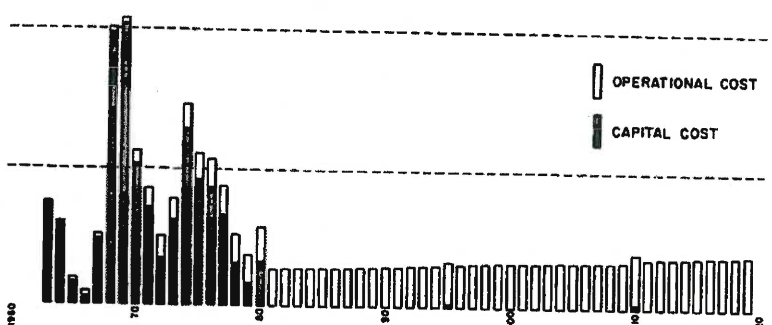
SINGLE PURPOSE DELTA WATER PROJECT

and seepage control and vehicular transportation improvements would be repaid by annual payments from the beneficiaries of flood and seepage control and from the counties, respectively. It was assumed that unassigned local costs of the Chipps Island Barrier Project would be recovered in annual payments in proportion to the projected industrial tax base. This assumed method of repayment would necessitate a rate of about $1.19 per $100 of assessed valuation throughout a 60-year period. It was also assumed that unassigned local costs of the Comprehensive Delta Water Project would be recovered in annual payments based upon the total acreage of land south of the San Joaquin River which would benefit from flood and seepage control. An annual payment of $0.86 per acre would be required.

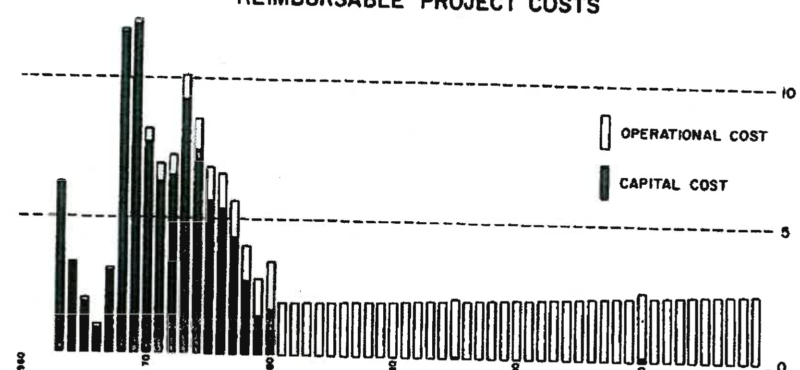
The comparative investment requirements for allocated reimbursable costs, including interest and operational costs, of the several projects are shown in the accompanying graph.



COMPARISON OF OUTSTANDING INVESTMENT REIMBURSABLE PROJECT COSTS



TYPICAL ALTERNATIVE DELTA WATER PROJECT



COMPREHENSIVE DELTA WATER PROJECT

Conclusions and Recommendations

CONCLUSIONS

GENERAL

The plans for Delta water facilities described in this report are consistent with and would accomplish the water development purposes embraced in the California Water Resources Development Bond Act approved on November 8, 1960. Additional features could be incorporated to provide flood and seepage control, transportation, and recreation benefits.

WATER SUPPLY

Problems of water quality in the western portion of the Delta necessitate early construction of facilities to provide suitable water supplies for present and future uses.

WATER SALVAGE

Without physical control works in the Delta, increasingly greater quantities of fresh water from upstream storage will be required to repel ocean salinity and maintain good quality water for use within and export from the Delta. Water salvage will be dependent upon coordinated operation of regulatory storage, export works, and Delta water facilities.

FLOOD AND SEEPAGE CONTROL

The magnitude of flood damage and the costs of flood and seepage control will become increasingly greater as the land surface of many Delta islands continues to subside. A master levee system would reduce these costs. Early initiation of construction is necessary to economically provide stable levees.

VEHICULAR TRANSPORTATION AND RECREATION

Improvements to the road system in the Delta are needed to reduce costs of vehicular shipment and to develop the recreation potential to accommodate an estimated 7,000,000 recreation-days in 1990, and 14,000,000 recreation-days in 2020.

DELTA WATER FACILITIES

1. The Chipps Island Barrier Project would be functionally feasible, would provide adequate water supplies of acceptable quality for the Delta, and would salvage water otherwise needed for salinity control amounting to an estimated annual average of 1,900,000 acre-feet based on a 60-year period. However, the net benefits would be less than the project costs in a ratio of 0.93:1. Therefore, the project would not be economically justified. The project would not be financially feasible, unless revenues could be obtained from local taxes in addition to revenues derived from water sales.

2. The alternative plans of the Delta Water Project would be functionally feasible, would permit export of full water demands on the State Water Facilities, and would provide adequate water supplies, both in quality and quantity, for the Delta. The project would salvage water otherwise needed for salinity control amounting to an estimated annual average of 2,050,000 acre-feet based on a 60-year period.

3. The Chipps Island Barrier Project would probably cause disastrous reductions in the fisheries resource of the Delta. The Single Purpose Delta Water Project would be the least detrimental of all projects and would reduce some losses of fish and

Advanced Planning, Design, and Operation Studies

It is anticipated that the results of the planning studies summarized in this bulletin and described in detail in the supporting office reports will be the basis for selection of a general plan for the Delta Water Project. However, it is recognized that definite plans, designs, and operation programs will be dependent upon further studies and negotiations on certain aspects of the project plans.

LOCAL ACTION

Early consideration should be given by local agencies to the extent of their interest in facilities which could be constructed to provide local benefits. Acute water supply problems in the western Delta, particularly in the agricultural lowlands, warrant early resolution of interest in plans for water supply facilities. Consideration should be given to creation of master districts to represent related areas of interest in flood and seepage control benefits.

UNITED STATES CORPS OF ENGINEERS

Studies for flood and seepage control benefits and estimates of the federal contribution were based on methods and preliminary studies of the Corps of Engineers. Conditions in the Delta do not precisely fit standard procedures, and it will be necessary for the Corps of Engineers to make a detailed review of these studies to determine the extent of federal interest.

UNITED STATES BUREAU OF RECLAMATION

The Delta Water Project would enhance the operation of the Federal Central Valley Project by improving and insuring the quality of water exported from the Delta and by providing good quality water in the western Delta area in lieu of salinity control. The extent of federal interest in these benefits should be jointly analyzed by the Bureau of Reclamation and the Department of Water Resources.

HIGHWAYS

The channel closures and wide landward berms of the master levee system offer excellent opportunities for enhancing the road network in the Delta. Studies should be made by the State Division of Highways and county highway departments of transportation enhancement features, such as better road surfacing and connecting roads, which might be incorporated in the project plans.

FISHERY RESOURCES

To more definitely predict the anticipated project effects on fisheries and to design the fish screens and other remedial measures, it will be necessary to study certain biological aspects of the Delta fisheries. Joint studies of the anticipated project effects should be undertaken by the Department of Fish and Game and the Department of Water Resources.

OTHER STUDIES

Advance planning studies of flow distribution, salinity incursion, water quality, and sedimentation should continue throughout the design and early operation phases of project construction.

Test levee construction now being conducted pursuant to legislative directives will be continued to determine the most economical and efficient means of construction to provide an adequate levee system.

A general plan for remedial recreation facilities and recreation enhancement has been developed. Specific plans for facilities and development of land which can be made available for recreation uses should be prepared by county agencies, the Department of Water Resources, and other appropriate state agencies.

Acknowledgments

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COOPERATIVE STUDIES

U. S. Corps of Engineers
Sacramento District––flood control and navigation aspects
San Francisco District––preliminary designs, Chipps Island Barrier Project

U. S. Coast and Geodetic Survey––subsidence surveying

California Department of Fish and Game––fish and game studies

Contra Costa County Water Agency––industrial water use studies

University of California
Berkeley––electric analog model of Delta channels
Davis––organic soil salination research

Stanford University––salinity incursion analyses

Parsons, Brinckerhoff, Hall and Macdonald––recreation studies

WESTERN DELTA ADVISORY COMMITTEE

A special Western Delta Advisory Committee was established at the suggestion of the Director of Water Resources to advise the department, primarily on studies of water requirements and plans in the western Delta. Committee membership, which has not endorsed all aspects of this report, included:

Contra Costa County

W. G. Buchanan, Chairman
Thomas M. Carlson
William J. O'Connell

Sacramento County

Arthur L. Kiefer
Jack Minge
Weber Rothwell, Secretary

San Joaquin County

L. H. Bradley
Clifford B. Bull, Vice-Chairman
Richard G. Salter

Solano County

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Albert M. Jongeneel
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U. S. Bureau of Reclamation

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U. S. Corps of Engineers

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STAFF

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Department of Water Resources
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Robert G. Potter
Sam I. Ito
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Lee H. Woodward
Edward F. Huntley
Philip T. Zwanck
Virgil D. Buechler
Howard W. Wolber

Table 3. Sacramento River Multiyear Droughts (reconstructed from tree rings prior to 1900)

Period	Length (in years)	Average Runoff (MAF)
1579–82	4	12.4
1593–95	3	9.3
1618–20	3	13.2
1651–55	5	12.3
1719–24	6	12.6
1735–37	3	12.2
1755–61	6	13.3
1776–78	3	12.1
1793–95	3	10.7
1839–41	3	12.9
1843–46	4	12.3
1918–20 (actual)	3	12.0
1929–34 (actual)	6	9.8
1959–62 (actual)	4	13.0
1987–92 (actual)	6	10.0

Exhibit "C"

CALIFORNIA DEPARTMENT OF WATER RESOURCES

NEWS FOR IMMEDIATE RELEASE

NEWS FOR IMMEDIATE RELEASE

March 10, 2014

Contacts:
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Severity of Past Droughts Quantified by New Streamflow Reconstructions

SACRAMENTO – As part of ongoing work to improve California's drought preparedness and better adapt to climate change, the Department of Water Resources (DWR) today released a report examining tree-ring data to help better understand historic periods of drought. The report helps develop long-term reconstructions of streamflow or precipitation for the Klamath, Sacramento, and San Joaquin river basins. The report, prepared for DWR by researchers at the University of Arizona, is available is available here. Funding for part of the Klamath Basin work was provided by the U.S. Bureau of Reclamation under its WaterSMART program.

Initial work on the reconstruction project began in 2010, at a time when California was just emerging from the 2007-09 drought. Completion of the final report coincides with a new three-year drought and a Water Year 2014 that so far is one of the driest years in the historical record.

California's roughly one hundred years of observed data are, however, only a small subset of the hydrologic record that can be reconstructed by measuring tree rings and calibrating them to observed data. The tree-ring measurements made for this project allowed development of reconstructions that begin in the year 900 for the Sacramento River and San Joaquin River systems, and in the 1500s for various sites in the Klamath Basin.

"Streamflow reconstruction from tree rings takes advantage of the great longevity and climate sensitivity of several tree species in California and Oregon," said lead author David Meko, a University of Arizona research professor of dendrochronology. "The tree-ring patterns record unusual climate events and modes of variability that occurred before the short period of gaged streamflow."

Exhibit "D"

Drought is a recurring part of California's climate. The report's reconstructions show numerous periods of four or more years when streamflows were below median conditions.

In addition, the report reveals that all three river basins share common major periods of extreme low flow conditions, although the degree of severity varies from river to river. The most severe shared periods were the 1100s (20 – 50 year sustained dry periods), 1570 to early 1580s (up to decades-long periods), and 1920s -1930s (up to 20-year periods). The Sacramento and San Joaquin basins shared 1580 as the single driest year of record. The driest single year for Klamath River streamflow was 1655 (1580 was 17th driest). The graphic below illustrates notable low-flow periods in the river basins. A tabulation listing all dry periods of four or more years is attached.

Paleoclimate information such as these reconstructed streamflows captures a broader range of hydrologic variability than provided in the historical record, thereby putting our short period of observed droughts in perspective.

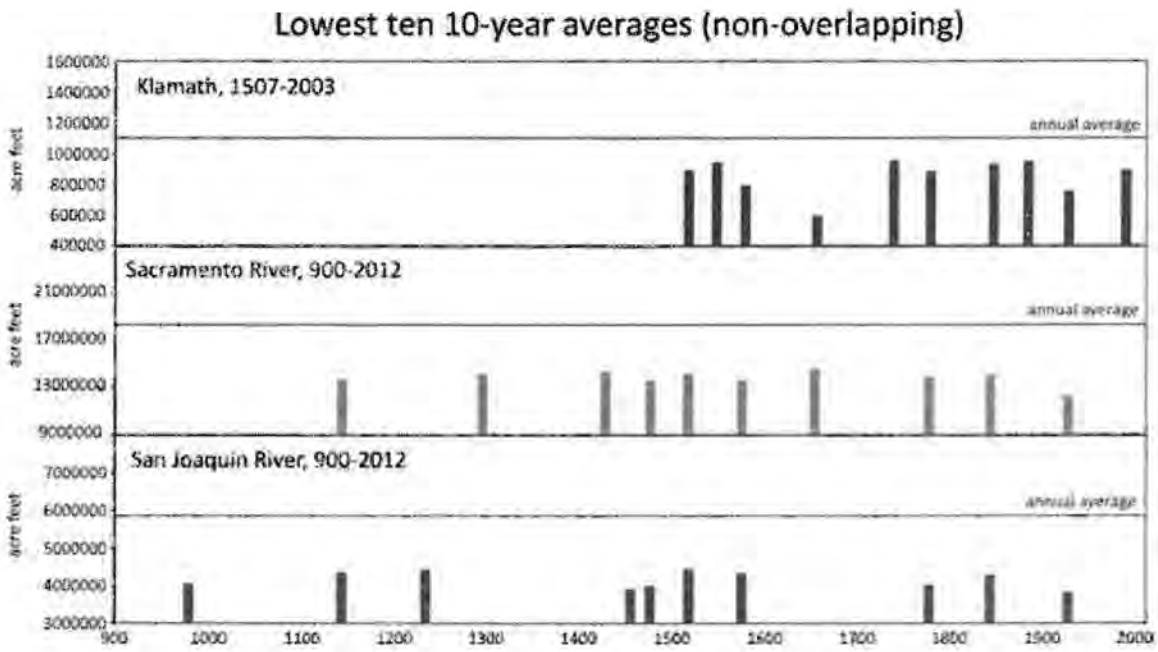
A repeat of the "Dustbowl Drought" of the 1920s and 1930s (our most severe historical event in terms of duration) with today's urban and agricultural development would sorely challenge California's infrastructure and institutional framework for water management. That challenge would pale in comparison to the time of the Medieval Climate Anomaly, when sustained severe drought gripped much of the western United States.

Paleoclimate information is useful in helping to understand and model natural variability in the climate system that may provide clues for improving drought prediction at the seasonal time scales important for water management.

Jeanine Jones of DWR said, "Drought prediction skillful enough to use for water management decision-making remains a research challenge for the science community. Having improved climate forecasting capabilities at time scales of months to a year in advance would provide great benefit for drought preparedness."

Looking into the future, the reconstructions also help provide context for expected impacts of climate change. The report compares drought durations seen in the paleoclimate record with those projected by downscaled global climate change models run to simulate conditions by the end of the century. The results indicate that the paleoclimate data may be useful for assessing future climate projections in the context of past centuries.

Report co-author Connie Woodhouse, professor and interim head of the University of Arizona School of Geography and Development, said, "These tree-ring records document the range of drought characteristics, including duration, that have occurred in the past, under natural climate variability. These droughts could occur in the future, but under warmer temperatures that will further exacerbate their impacts."



Klamath = Klamath River at Keno

Sacramento River = Sacramento River runoff

San Joaquin River = San Joaquin River runoff

Sacramento River runoff is the sum of unimpaired flow in million acre-feet at:
Sacramento River above Bend Bridge

Feather River at Oroville (aka inflow to Lake Oroville)
Yuba River near Smartville

American River below Folsom Lake

San Joaquin River Runoff is the sum of unimpaired flow in million acre-feet at:

Stanislaus River below Goodwin Reservoir (aka inflow to New Melones Res.)

Tuolumne River below La Grange (aka inflow to New Don Pedro Reservoir)

Merced River below Merced Falls (aka inflow to Lake McClure)

San Joaquin River inflow to Millerton Lake

Runs[a] with length ≥4 years in three flow reconstructions

Klamath[b]		Sacramento4c		San Joaquin4[d]	
Years	**N**	**Years**	**N**	**Years**	**N**
1515-1522	8	921- 924	4	946- 950	5
1540-1543	4	945- 950	6	977- 981	5
1547-1552	6	975- 981	7	1072-1075	4
1578-1582	5	1072-1075	4	1143-1148	6
1592-1597	6	1130-1136	7	1155-1158	4
1642-1646	5	1143-1148	6	1172-1177	6
1648-1668	21	1150-1158	9	1210-1213	4
1738-1744	7	1170-1177	8	1233-1239	7
1756-1761	6	1233-1239	7	1294-1301	8
1764-1767	4	1292-1301	10	1395-1402	8
1775-1779	5	1390-1393	4	1407-1410	4
1783-1787	5	1395-1400	6	1425-1428	4
1792-1798	7	1407-1410	4	1450-1461	12
1843-1846	4	1425-1432	8	1463-1466	4
1848-1852	5	1451-1457	7	1471-1483	13
1873-1876	4	1475-1483	9	1505-1508	4
1880-1884	5	1515-1521	7	1518-1523	6
1912-1915	4	1540-1543	4	1540-1545	6
1917-1920	4	1569-1572	4	1569-1572	4
1924-1935	12	1578-1582	5	1578-1582	5
1987-1992	6	1592-1595	4	1592-1595	4
		1636-1639	4	1629-1632	4
		1645-1648	4	1645-1648	4
		1652-1655	4	1652-1655	4
		1753-1760	8	1688-1691	4
		1780-1783	4	1753-1757	5
		1843-1846	4	1780-1783	4
		1856-1859	4	1793-1796	4
		1917-1922	6	1843-1846	4
		1926-1935	10	1855-1859	5
		1946-1951	6	1928-1931	4
		1959-1962	4	1946-1950	5
		1987-1992	6	1959-1962	4
				1987-1992	6
				2000-2004	5

[a] runs defined as consecutive years below median
[b] Klamath River at Keno, 1507-2003; median =1113 thousand acre-feet (TAF)
[c] Sacramento River runoff, 900-2012, median=17800 TAF
[d] San Joaquin River runoff, 900-2012, median=5598 TAF

With California facing one of the most severe droughts on record, Governor Brown declared a drought State of Emergency and directed state officials to take all necessary actions to prepare for water shortages. The Governor signed legislation to immediately help communities deal with the devastating dry conditions affecting our state and to provide funding to increase local water supplies after it was passed with bipartisan support in the legislature.

Governor Brown met with President Obama about crucial federal support during the ongoing drought, and the state continues to work with federal partners to ensure coordinated drought monitoring and response. Governor Brown and the administration have also expressed support for federal legislation introduced by Senators Feinstein and Boxer and Representatives Jim Costa, Tony Cárdenas and Sam Farr.

Across state government, action is being taken. The Department of General Services is leading water conservation efforts at state facilities, and the California State Architect has asked California school districts and Community Colleges to act on the Governor's call to reduce water usage. The Department of Transportation is cutting water usage along California's roadways by 50 percent. Caltrans has also launched a public awareness campaign, putting a water conservation message on their more than 700 electronic highway signs.
In January, the state took action to conserve water in numerous Northern California reservoirs to meet minimum needs for operations impacting the environment and the economy, and recently the Department of Water Resources and U.S. Bureau of Reclamation announced they would seek the authority to make water exchanges to deliver water to those who need it most. The State Water Resources Control Board announced it would work with hydropower generators and the Federal Energy Regulatory Commission to preserve water in California reservoirs, and the California Department of Fish and Wildlife and the California Fish and Game Commission restricted fishing on some waterways due to low water flows worsened by the drought.

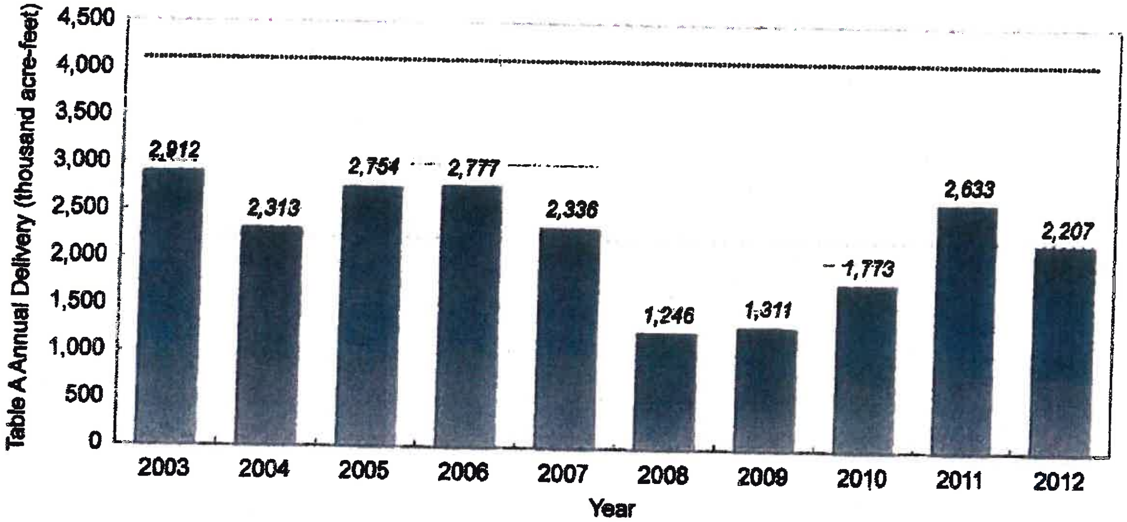
The state is working to protect local communities from the dangers of extreme drought. The California Department of Public Health identified and offered assistance to communities at risk of severe drinking water shortages and is working with other state and local agencies to develop solutions for vulnerable communities. CAL FIRE hired additional firefighters and is continuously adjusting staffing throughout the state to help address the increased fire threat due to drought conditions. The California Department of Food and Agriculture launched a drought website to help farmers, ranchers and farmworkers find resources and assistance programs that may be available to them during the drought.

Even as the state deals with the immediate impacts of the drought, it's also planning for the future. In 2013, the California Natural Resources Agency, the California Environmental Protection Agency and CDFA released the California Water Action Plan, which will guide state efforts to enhance water supply reliability, restore damaged and destroyed ecosystems and improve the resilience of our infrastructure.

Governor Brown has called on all Californians to voluntarily reduce their water usage by 20 percent, and the Save Our Water campaign launched four public service announcements encouraging residents to conserve and has resources available in Spanish. Last December, the Governor formed a Drought Task Force to review expected water allocations and California's preparedness for water scarcity. In May 2013, Governor Brown issued an Executive Order to direct state water officials to expedite the review and processing of voluntary transfers of water.

– 30 –

The Department of Water Resources operates and maintains the State Water Project, provides dam safety and flood control and inspection services, assists local water districts in water management and water conservation planning, and plans for future statewide water needs.

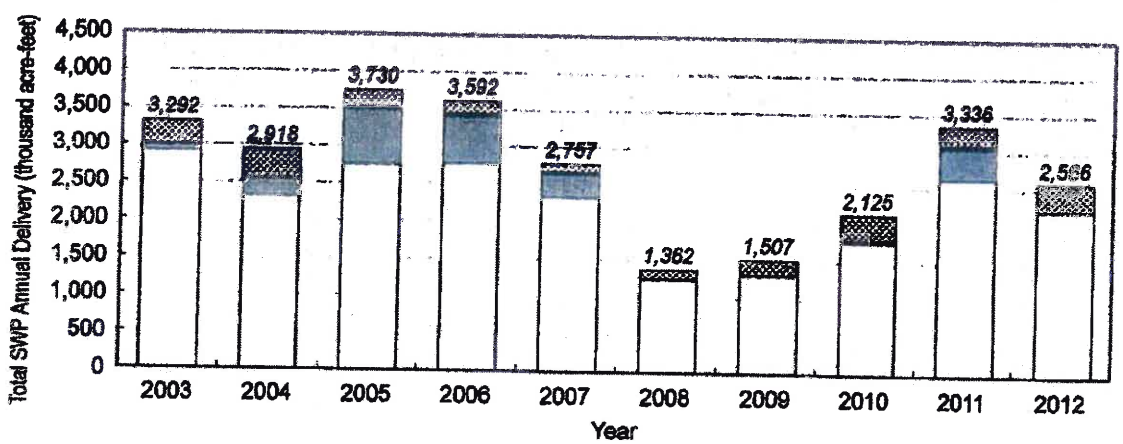


Maximum Possible SWP Table A Delivery (4,172 thousand acre-feet)

Long-term (10-year period) Average (2,226 thousand acre-feet)

Note: The differences in historical deliveries from the State Water Project Delivery Reliability Report 2011 are due to reclassification of the various components of water delivered to SWP contractors.

Figure 2-3. Historical Deliveries of SWP Table A Water, 2003-2012



	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Carryover	290	370	207	160	95	110	188	333	251	350
Turnback	30	17	38	34	16	3	2	11	31	8
Article 21	60	218	731	621	310	3	6	8	421	1
Table A	2,912	2,313	2,754	2,777	2,336	1,246	1,311	1,773	2,633	2,207

Note: The differences in historical deliveries from the State Water Project Delivery Reliability Report 2011 are due to reclassification of the various components of water delivered to SWP contractors.

Figure 2-4. Total Historical SWP Deliveries, 2003-2012 (by Delivery Type)

Exhibit "E"

Dry-Year Deliveries of SWP Table A Water under Future Conditions

Table 6-3 and Figure 6-3 present estimates of future SWP Table A water deliveries during possible drought conditions and compare these estimates with the corresponding delivery estimates calculated for the 2011 Report. Drought scenarios for future conditions are analyzed using the historical drought-period precipitation and runoff patterns from 1922–2003 as a reference, while accounting for future conditions (e.g., land use, climate change).

The results of modeling future conditions under potential drought-year scenarios provide an estimated range of Table A deliveries that can be expected during drought periods.

The 2-year drought period (1976–1977) shows significantly lower Table A deliveries in the 2013 Report than in the 2011 Report (see Figure 6-3), because of modeling refinements (see the technical addendum at http://baydeltaoffice.water.ca.gov/) and reclassification of 1975 into a wet year rather than an above-normal year, as was used in the 2011 Report (due to the change in the assumed climate change model). Because 1975 is now considered a wet year in this 2013 Report's model, there are higher fall X2 requirements to meet and more Delta outflow is required in September. This leads to lower reservoir levels at the start of the new water year and smaller deliveries during the upcoming 2-year dry period.

Table 6-3. Estimated Average and Dry-Period Deliveries of SWP Table A Water (Future Conditions, in taf/year) and Percent of Maximum SWP Table A Amount, 4,133 taf/year

	Long-term Average (1921-2003)		Single Dry Year (1977)		Dry Periods							
					2-Year Drought (1976-1977)		4-Year Drought (1931-1934)		6-Year Drought (1987-1992)		6-Year Drought (1929-1934)	
2011 Report	2,465	60%	441	11%	1,457	35%	1,401	34%	1,226	30%	1,365	33%
2013 Report	2,400	58%	453	11%	978	24%	1,263	31%	1,055	26%	1,251	30%

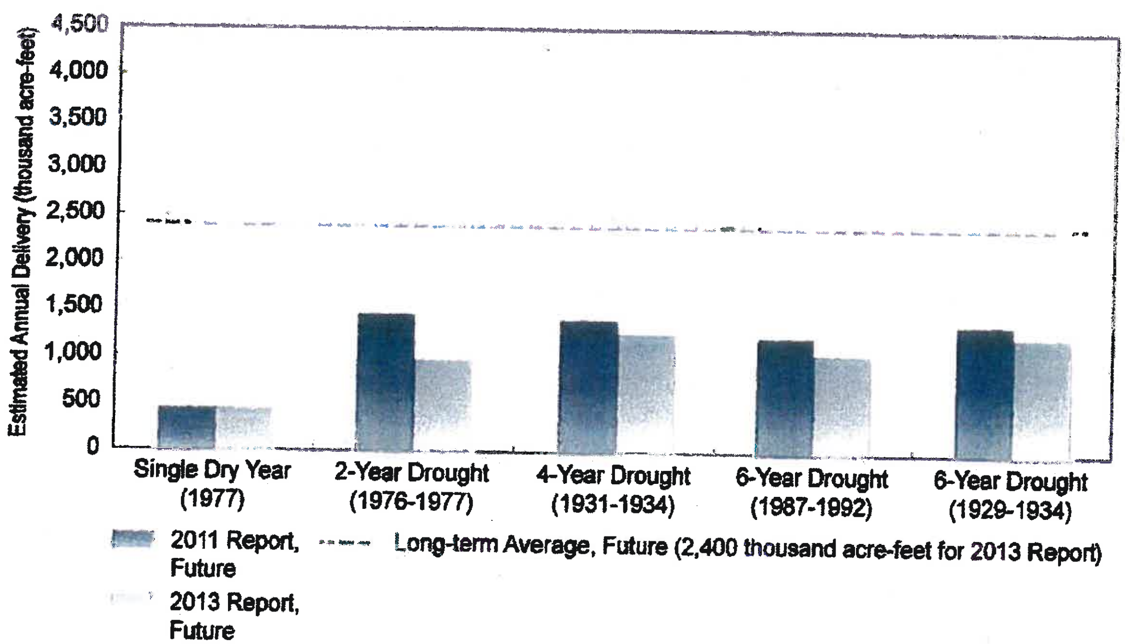


Figure 6-3. Estimated Dry-Period SWP Table A Water Deliveries (Future Conditions)

Title	**THE CALIFORNIA WATER RESOURCES DEVELOPMENT BOND ACT**
Year/Election	**1960 general**
Proposition type	bond (leg)
Popular vote	Yes: 3,008,328 (51.5%); No: 2,834,384 (48.5%)
Pass/Fail	Pass
Summary	This act provides for a bond issue of one billion, seven hundred fifty million dollars ($1,750,000,000) to be used by the Department of Water Resources for the development of the water resources of the State.

For

Argument in Favor of California Water Resources Development Bond Act

Your vote on this measure will decide whether California will continue to prosper.

This Act, if approved, will launch the statewide water development program which will meet present and future demands of all areas of California. The program will not be a burden on the taxpayer; no new state taxes are involved; the bonds are repaid from project revenues, through the sale of water and power. In other words, it will pay for itself. The bonds will be used over a period of many years and will involve an approximate annual expenditure averaging only $75 million, as compared, for example with $600 million a year we spend on highways.

Existing facilities for furnishing water for California's needs will soon be exhausted because of our rapid population growth and industrial and agricultural expansion. We now face a further critical loss in the Colorado River supply. Without the projects made possible by this Act, we face a major water crisis. We can stand no more delay.

If we fail to act <u>now</u> to provide new sources of water, land development in the great San Joaquin Valley will slow to a halt by 1965 and the return of cultivated areas to wasteland will begin. In southern California, the existing sources of water which have nourished its tremendous expansion will reach capacity by 1970 and further development must wholly cease. In northern California desperately needed flood control and water supplies for many local areas will be denied.

This Act will assure construction funds for new water development facilities to meet California's requirements now and in the future. No area will be deprived of water to meet the needs of another. Nor will any area be asked to pay for water delivered to another.

To meet questions which concerned, southern California, the bonds will finance completion of all facilities needed, as described in the Act. Contracts for delivery of water may not be altered by the Legislature. The tap will be open, and no amount of political maneuvering can shut it off.

Under this Act the water rights of northern California will remain securely protected. In addition, sufficient money is provided for construction of local projects to meet the pressing needs for flood control, recreation and water deliveries in the north.

A much needed drainage system and water supply will be provided in the San Joaquin Valley.

Construction here authorized will provide thousands of jobs. And the program will nourish tremendous industrial and farm and urban expansion which will develop an ever-growing source of employment and economic prosperity for Californians.

Our Legislature has appropriated millions of dollars for work in preparation, and construction is now underway. It would be tragic if this impressive start toward solution of our water problems were now abandoned.

If we fail to act <u>now</u> to insure completion of this constructive program, serious existing water shortages will only get worse. The success of our State is at stake. <u>Vote "Yes" for water for people, for progress, for prosperity!</u>

Exhibit "F"

Public Law 86-488

June 3, 1960
[S. 44]

AN ACT

To authorize the Secretary of the Interior to construct the San Luis unit of the Central Valley project, California, to enter into an agreement with the State of California with respect to the construction and operation of such unit, and for other purposes.

Central Valley Project, Calif. San Luis unit. Construction.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That (a) for the principal purpose of furnishing water for the irrigation of approximately five hundred thousand acres of land in Merced, Fresno, and Kings Counties, California, hereinafter referred to as the Federal San Luis unit service area, and as incidents thereto of furnishing water for municipal and domestic use and providing recreation and fish and wildlife benefits, the Secretary of the Interior (hereinafter referred to as the Secretary) is authorized to construct, operate, and maintain the San Luis unit as an integral part of the Central Valley project. The principal engineering features of said unit shall be a dam and reservoir at or near the San Luis site, a forebay and afterbay, the San Luis Canal, the Pleasant Valley Canal, and necessary pumping plants, distribution systems, drains, channels, levees, flood works, and related facilities, but no facilities shall be constructed for electric transmission or distribution service which the Secretary determines, on the basis of an offer of a firm fifty-year contract from a local public or private agency, can through such contract be obtained at less cost to the Federal Government than by construction and operation of Government facilities. The works (hereinafter referred to as joint-use facilities) for joint use with the State of California (hereinafter referred to as the State) shall be the dam and reservoir at or near the San Luis site, forebay and afterbay, pumping plants, and the San Luis Canal. The joint-use facilities consisting of the dam and reservoir shall be constructed, and other joint-use facilities may be constructed, so as to permit future expansion; or the joint-use facilities shall be constructed initially to the capacities necessary to serve both the Federal San Luis unit service area and the State's service area, as hereinafter provided. In constructing, operating, and maintaining the San Luis unit, the Secretary shall be governed by the Federal reclamation laws (Act of June 17, 1902 (32 Stat. 388), and Acts amendatory thereof or supplementary thereto). Construction of the San Luis unit shall not be commenced until the Secretary has (1) secured, or has satisfactory assurance of his ability to secure, all rights to the use of water which are necessary to carry out the purposes of the unit and the terms and conditions of this Act, and (2) received satisfactory assurance from the State of California that it will make provision for a master drainage outlet and disposal channel for the San Joaquin Valley, as generally outlined in the California water plan, Bulletin Numbered 3, of the California Department of Water Resources, which will adequately serve, by connection therewith, the drainage system for the San Luis unit or has made provision for constructing the San Luis interceptor drain to the delta designed to meet the drainage requirements of the San Luis unit as generally outlined in the report of the Department of the Interior, entitled "San Luis Unit, Central Valley Project," dated December 17, 1956.

43 USC 371 and note.
Preliminary measures.

Conditions.

(b) No water provided by the Federal San Luis unit shall be delivered in the Federal San Luis service area to any water user for the production on newly irrigated lands of any basic agricultural commodity, as defined in the Agricultural Act of 1949, or any amendment thereof, if the total supply of such commodity as estimated by the Secretary of Agriculture for the marketing year in which the bulk

63 Stat. 1051.
7 USC 1421 note.

Exhibit "G"

PL 99-546, October 27, 1986, 100 Stat 3050

UNITED STATES PUBLIC LAWS
99th Congress - Second Session
Convening January 21, 1986

DATA SUPPLIED BY THE U.S. DEPARTMENT OF JUSTICE. (SEE SCOPE)
Additions and Deletions are not identified in this document.

PL 99-546 (HR 3113)
October 27, 1986

An Act to implement the Coordinated Operations Agreement, the Suisun Marsh Preservation Agreement, and to amend the Small Reclamation Projects Act of 1956, as amended, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

TITLE I -- COORDINATED OPERATIONS
PROJECT OPERATION POLICY

SEC. 101. Section 2 of the Act of August 26, 1937 (50 Stat. 850) is amended by --

(a) inserting at the beginning "(a)"; and
(b) inserting the following new subsection:
"(b)(1) Unless the Secretary of the Interior determines that operation of the Central Valley project in conformity with State water quality standards for the San Francisco Bay/Sacramento-San Joaquin Delta and Estuary is not consistent with the congressional directives applicable to the project, the Secretary is authorized and directed to operate the project, in conjunction with the State of California water project, in conformity with such standards. Should the Secretary of the Interior so determine, then the Secretary shall promptly request the Attorney General to bring an action in the court of proper jurisdiction for the purposes of determining the applicability of such standards to the project.
"(2) The Secretary is further directed to operate the Central Valley project, in conjunction with the State water project, so that water supplied at the intake of the Contra Costa Canal is of a quality equal to the water quality standards contained in the Water Right Decision 1485 of the State of California Water Resources Control Board, dated August 16, 1978, except under drought emergency water conditions pursuant to a declaration by the Governor of California. Nothing in the previous sentence shall authorize or require the relocation of the Contra Costa Canal intake.".

REIMBURSABLE COSTS

SEC. 102. Section 2 of the Act of August 26, 1937 (50 Stat. 850) is amended by inserting the following new subsection:

"(c)(1) The costs associated with providing Central Valley project water supplies for the purpose of salinity control and for complying with State water quality standards identified in exhibit A of the 'Agreement Between the United States of America and the Department of Water Resources of the State of California for Coordinated Operation of the Central Valley Project and the State Water Project' dated May 20, 1985, shall be allocated among the project purposes and shall be reimbursed in accordance with existing Reclamation law and policy. The costs of providing water for salinity control and for complying with State water quality standards above those standards identified in the previous sentence shall be nonreimbursable.
"(2) The Secretary of the Interior is authorized and directed to undertake a cost allocation study of the Central Valley project, including the provisions of this Act, and to implement such allocations no later than January 1, 1988.".

COORDINATED OPERATIONS AGREEMENT

Exhibit "H"

SEC. 103. Section 2 of the Act of August 26, 1937 (50 Stat. 850) is amended by inserting the following new subsection:

"(d) The Secretary of the Interior is authorized and directed to execute and implement the 'Agreement Between the United States of America and the Department of Water Resources of the State of California for Coordinated Operation of the Central Valley Project and the State Water Project' dated May 20, 1985: Provided, That --
"(1) the contract with the State of California referred to in subarticle 10(h)(1) of the agreement referred to in this subsection for the conveyance and purchase of Central Valley project water shall become final only after an Act of Congress approving the execution of the contract by the Secretary of the Interior; and
"(2) the termination provisions of the agreement referred to in this subsection may only be exercised if the Secretary of the Interior or the State of California submits a report to Congress and sixty calendar days have elapsed (which sixty days, however, shall not include days on which either the House of Representatives or the Senate is not in session because of an adjournment of more than three days to a day certain) from the date on which said report has been submitted to the Speaker of the House of Representatives and the President of the Senate for reference to the Committee on Interior and Insular Affairs of the House of Representatives and the Committee on Energy and Natural Resources of the Senate. The report must outline the reasons for terminating the agreement and, in the case of the report by the Secretary of the Interior, include the views of the Administrator of the Environmental Protection Agency and the Governor of the State of California on the Secretary's decision.".

REFUGE WATER SUPPLY INVESTIGATION

SEC. 104. The Secretary of the Interior shall not contract for the delivery of more than 75 percent of the firm annual yield of the Central Valley project not currently committed under long-term contracts until one year after the Secretary has transmitted to the Congress a feasibility report, together with his recommendations, on the "Refuge Water Supply Investigations, Central Valley Basin, California.".

ADJUSTMENT OF RATES AND ABILITY TO PAY

SEC. 105. The Secretary of the Interior shall include in all new or amended contracts for the delivery of water from the Central Valley project a provision providing for the automatic adjustment of rates by the Secretary of the Interior if it is found that the rate in effect may not be adequate to recover the appropriate share of the existing Federal investment in the project by the year 2030. The contracts shall also include a provision authorizing the Secretary of the Interior to adjust determinations of ability to pay every five years.

OPERATION AND MAINTENANCE DEFICITS

SEC. 106. The Secretary of the Interior shall include in each new or amended contract for the delivery of water from the Central Valley project provisions ensuring that any annual deficit (outstanding or hereafter arising) incurred by a Central Valley project water contractor in the payment of operation and maintenance costs of the Central Valley project is repaid by such contractor under the terms of such new or amended contract, together with interest on any such deficit which arises on or after October 1, 1985, at a rate equal to the average market yields on outstanding marketable obligations of the United States with remaining periods to maturity comparable to the applicable reimbursement period of the project, adjusted to the nearest one-eighth of 1 percent.

TITLE II -- SUISUN MARSH PRESERVATION AGREEMENT
AUTHORITY TO ENTER AGREEMENT

SEC. 201. The Secretary of the Interior is authorized to execute and implement the agreement between the Department of the Interior, the State of California and the Suisun Resources Conservation District (dated November 1, 1985).

COST-SHARING PROVISIONS

(iii) evaluation of lower Mokelumne River floodway improvements.

(C) INTERTIES.—Activities under this subparagraph consist of—

(i) evaluation and construction of an intertie between the State Water Project California Aqueduct and the Central Valley Project Delta Mendota Canal, near the City of Tracy, as an operation and maintenance activity, except that the Secretary shall design and construct the intertie in a manner consistent with a possible future expansion of the intertie capacity (as described in subsection (f)(1)(B)); and

(ii) assessment of a connection of the Central Valley Project to the Clifton Court Forebay of the State Water Project, with a corresponding increase in the screened intake of the Forebay.

(D) PROGRAM TO MEET STANDARDS.—

Deadline.

(i) IN GENERAL.—Prior to increasing export limits from the Delta for the purposes of conveying water to south-of-Delta Central Valley Project contractors or increasing deliveries through an intertie, the Secretary shall, not later than 1 year after the date of enactment of this Act, in consultation with the Governor, develop and initiate implementation of a program to meet all existing water quality standards and objectives for which the Central Valley Project has responsibility.

(ii) MEASURES.—In developing and implementing the program, the Secretary shall include, to the maximum extent feasible, the measures described in clauses (iii) through (vii).

(iii) RECIRCULATION PROGRAM.—The Secretary shall incorporate into the program a recirculation program to provide flow, reduce salinity concentrations in the San Joaquin River, and reduce the reliance on the New Melones Reservoir for meeting water quality and fishery flow objectives through the use of excess capacity in export pumping and conveyance facilities.

(iv) BEST MANAGEMENT PRACTICES PLAN.—

(I) IN GENERAL.—The Secretary shall develop and implement, in coordination with the State's programs to improve water quality in the San Joaquin River, a best management practices plan to reduce the water quality impacts of the discharges from wildlife refuges that receive water from the Federal Government and discharge salt or other constituents into the San Joaquin River.

(II) COORDINATION WITH INTERESTED PARTIES.—The plan shall be developed in coordination with interested parties in the San Joaquin Valley and the Delta.

(III) COORDINATION WITH ENTITIES THAT DISCHARGE WATER.—The Secretary shall also coordinate activities under this clause with other entities that discharge water into the San Joaquin River to reduce salinity concentrations discharged into

Exhibit "I"

the River, including the timing of discharges to optimize their assimilation.

(v) ACQUISITION OF WATER.—The Secretary shall incorporate into the program the acquisition from willing sellers of water from streams tributary to the San Joaquin River or other sources to provide flow, dilute discharges of salt or other constituents, and to improve water quality in the San Joaquin River below the confluence of the Merced and San Joaquin Rivers, and to reduce the reliance on New Melones Reservoir for meeting water quality and fishery flow objectives.

(vi) PURPOSE.—The purpose of the authority and direction provided to the Secretary under this subparagraph is to provide greater flexibility in meeting the existing water quality standards and objectives for which the Central Valley Project has responsibility so as to reduce the demand on water from New Melones Reservoir used for that purpose and to assist the Secretary in meeting any obligations to Central Valley Project contractors from the New Melones Project.

(vii) UPDATING OF NEW MELONES OPERATING PLAN.—The Secretary shall update the New Melones operating plan to take into account, among other things, the actions described in this title that are designed to reduce the reliance on New Melones Reservoir for meeting water quality and fishery flow objectives, and to ensure that actions to enhance fisheries in the Stanislaus River are based on the best available science.

(3) WATER USE EFFICIENCY.—

(A) WATER CONSERVATION PROJECTS.—Activities under this paragraph include water conservation projects that provide water supply reliability, water quality, and ecosystem benefits to the California Bay-Delta system.

(B) TECHNICAL ASSISTANCE.—Activities under this paragraph include technical assistance for urban and agricultural water conservation projects.

(C) WATER RECYCLING AND DESALINATION PROJECTS.—Activities under this paragraph include water recycling and desalination projects, including groundwater remediation projects and projects identified in the Bay Area Water Plan and the Southern California Comprehensive Water Reclamation and Reuse Study and other projects, giving priority to projects that include regional solutions to benefit regional water supply and reliability needs.

(D) WATER MEASUREMENT AND TRANSFER ACTIONS.—Activities under this paragraph include water measurement and transfer actions.

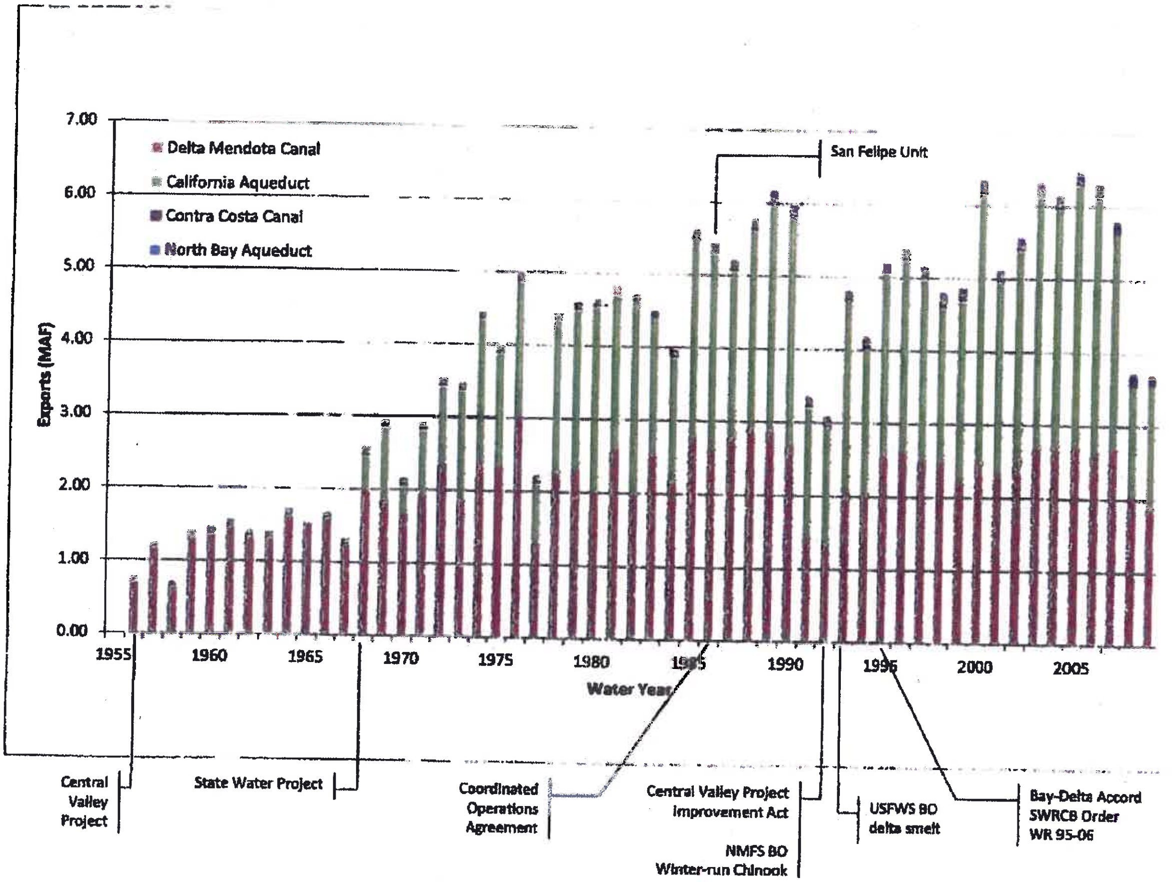
(E) URBAN WATER CONSERVATION.—Activities under this paragraph include implementation of best management practices for urban water conservation.

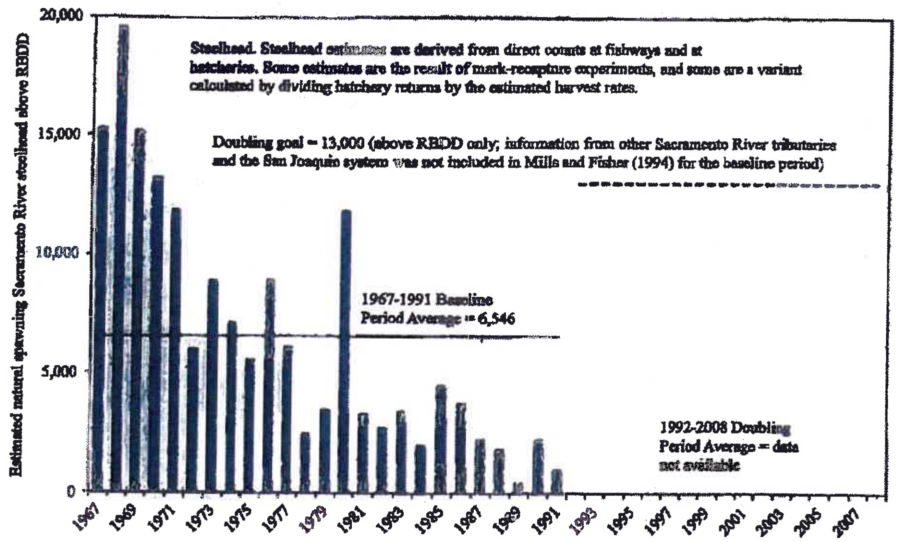
(F) RECLAMATION AND RECYCLING PROJECTS.—

Applicability.

(i) PROJECTS.—This subparagraph applies to—

(I) projects identified in the Southern California Comprehensive Water Reclamation and Reuse Study, dated April 2001 and authorized by


7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Exports (MAF)
Delta Mendota Canal
California Aqueduct
Contra Costa Canal
North Bay Aqueduct
San Felipe Unit
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Water Year
Central Valley Project
State Water Project
Coordinated Operations Agreement
Central Valley Project Improvement Act
NMFS BO Winter-run Chinook
USFWS BO delta smelt
Bay-Delta Accord SWRCB Order WR 95-06


Estimated natural spawning Sacramento River steelhead above RBDD
20,000
15,000
10,000
5,000
0
Steelhead. Steelhead estimates are derived from direct counts at fishways and at hatcheries. Some estimates are the result of mark-recapture experiments, and some are a variant calculated by dividing hatchery returns by the estimated harvest rates.
Doubling goal = 13,000 (above RBDD only; information from other Sacramento River tributaries and the San Joaquin system was not included in Mills and Fisher (1994) for the baseline period)
1967-1991 Baseline Period Average = 6,546
1992-2008 Doubling Period Average = data not available
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007

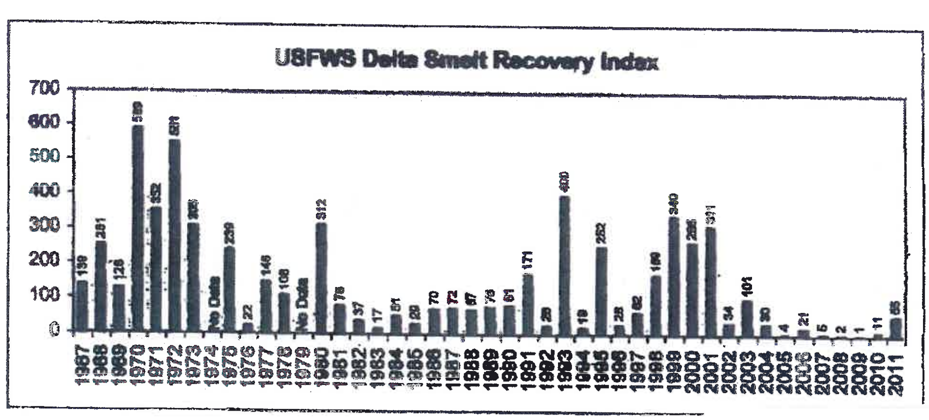

USFWS Delta Smelt Recovery Index
700
600
500
400
300
200
100
0

Exhibit “J”

2-1-13

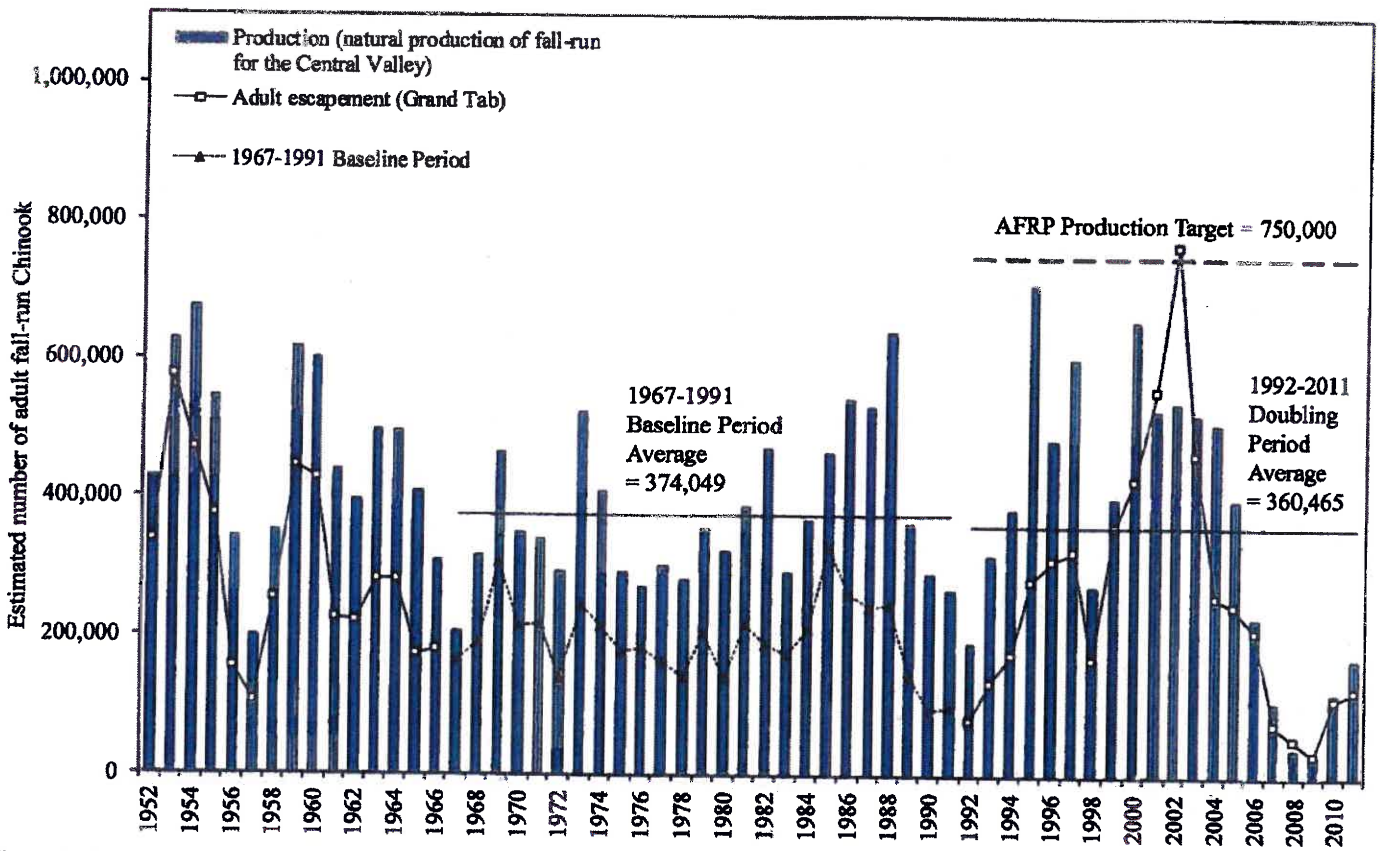


Figure 2. Estimated yearly natural production and in-river escapement of adult fall-run Chinook salmon in the Central Valley rivers and streams. 1952 - 1966 and 1992 - 2011 numbers are from CDFG Grand Tab (Apr 24, 2012). 1967-1991 Baseline Period numbers are from Mills and Fisher (CDFG, 1994).

Exhibit "K"

2-1-13

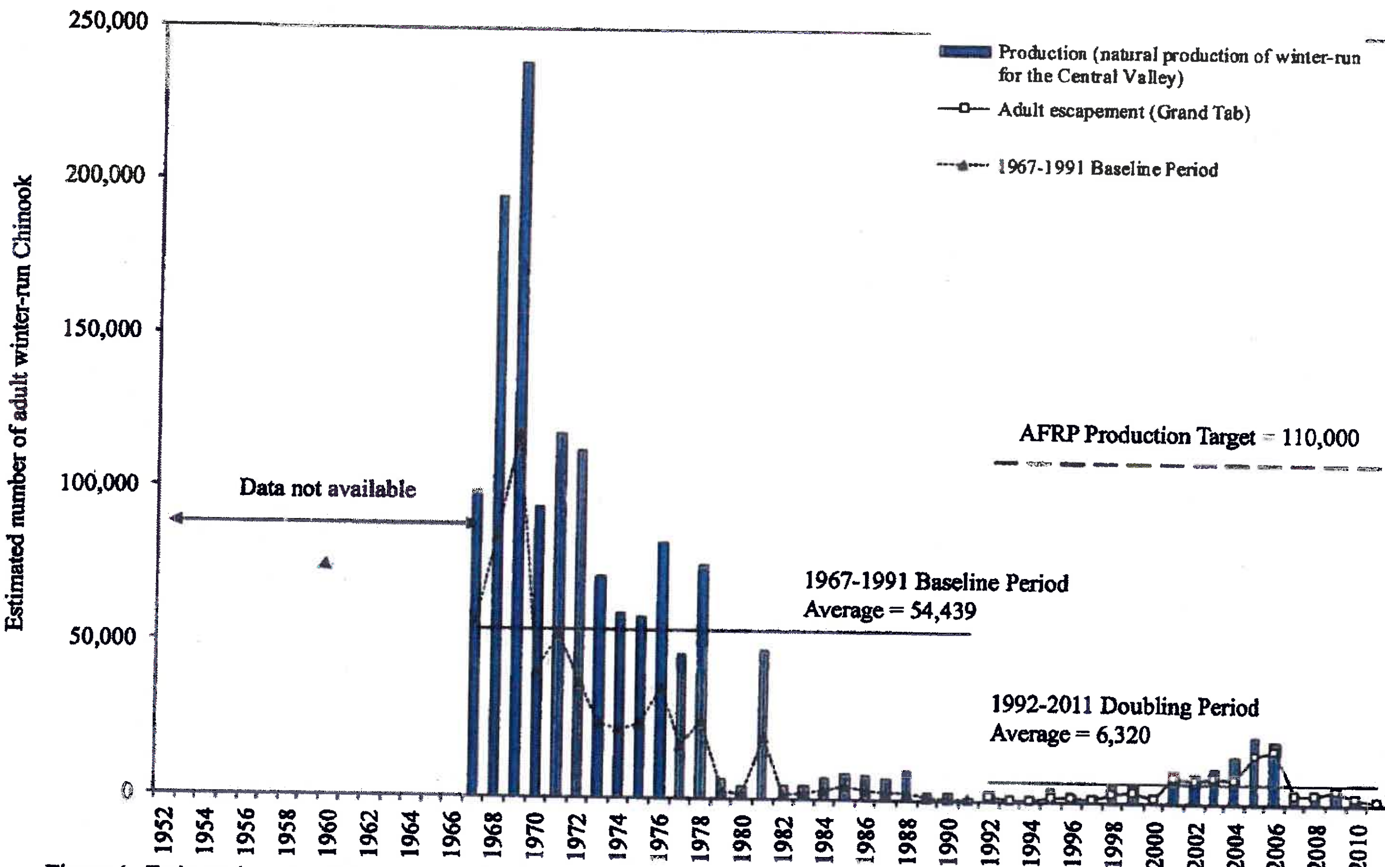


Figure 4. Estimated yearly adult natural production, and in river adult escapements of winter-run Chinook salmon in the Central Valley rivers and streams. 1992 - 2011 numbers are from CDFG Grand Tab (Apr 24, 2012). 1967-1991 Baseline Period numbers are from Mills and Fisher (CDFG, 1994).

Exhibit "L"

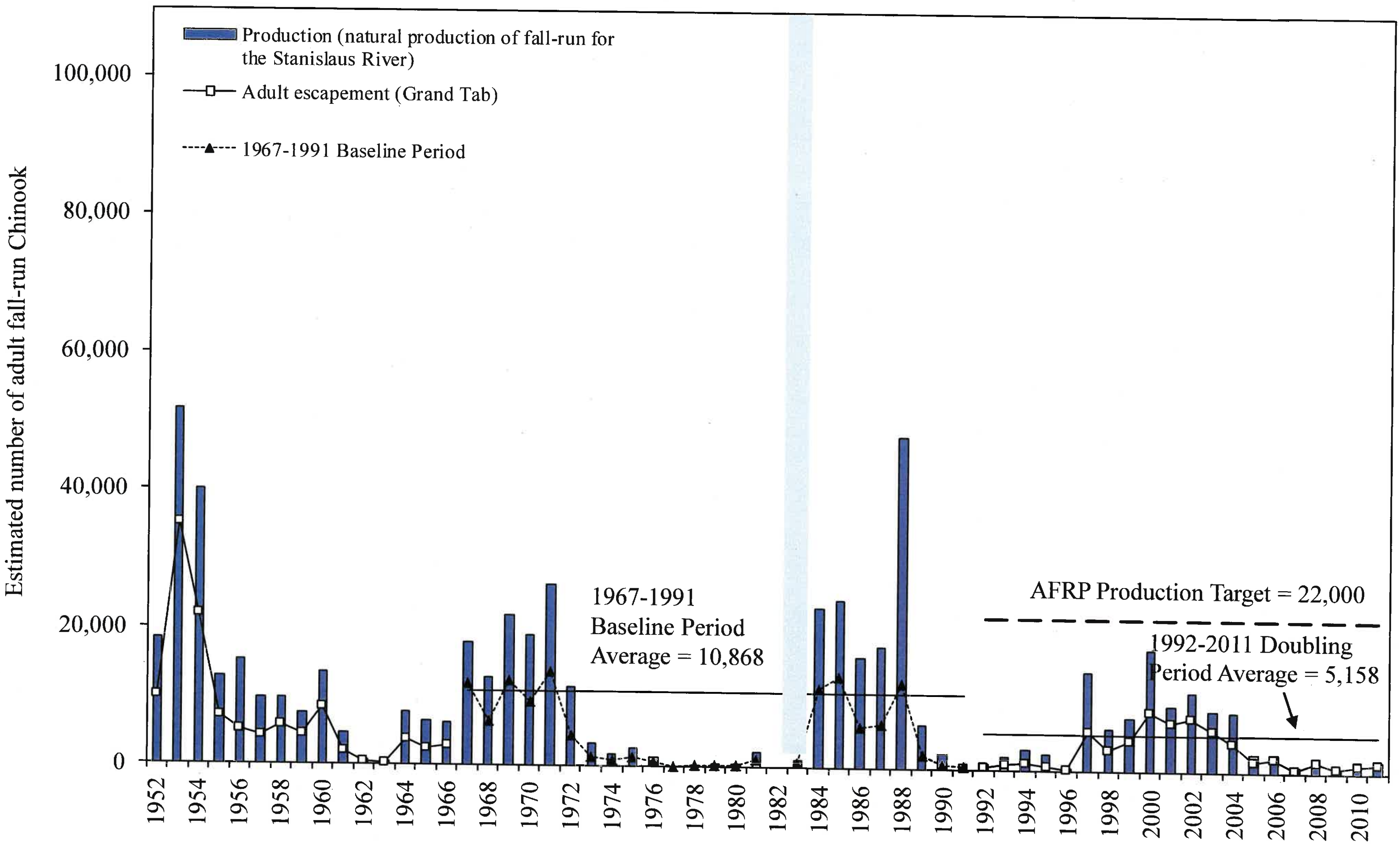


Figure 32. Estimated yearly natural production, and in river escapements of Stanislaus River adult fall-run Chinook salmon. 1952 – 1966, and 1992 - 2011 numbers are from CDFG Grand Tab (Apr 24, 2012). 1967-1991 Baseline Period numbers are from Mills and Fisher (CDFG, 1994). ▭ = data was not available for 1982.

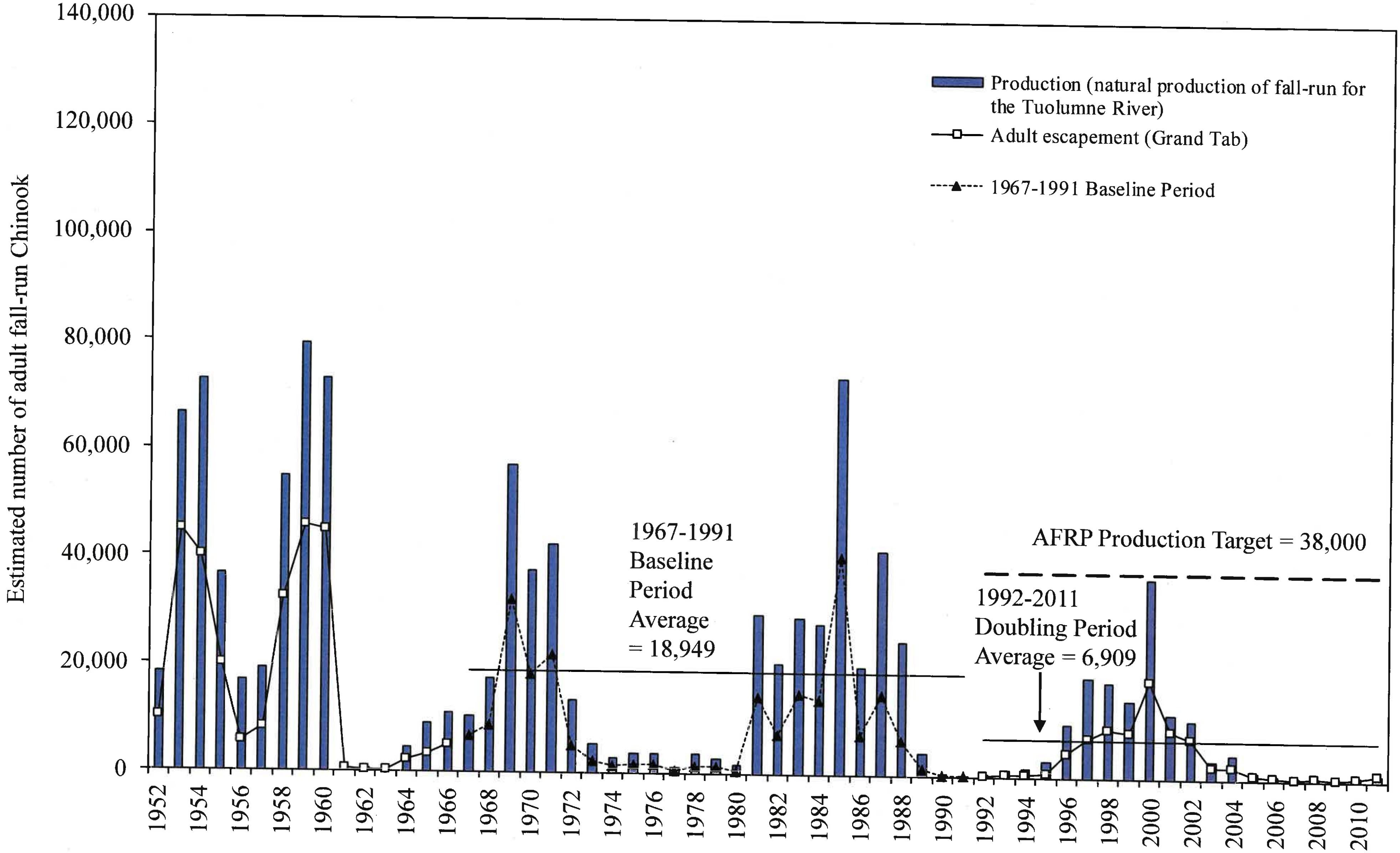


Figure 33. Estimated yearly natural production, and in river escapements of Tuolumne River adult fall-run Chinook salmon. 1952 - 1966, and 1992 - 2011 numbers are from CDFG Grand Tab (Apr 24, 2012). 1967-1991 Baseline Period numbers are from Mills and Fisher (CDFG, 1994).

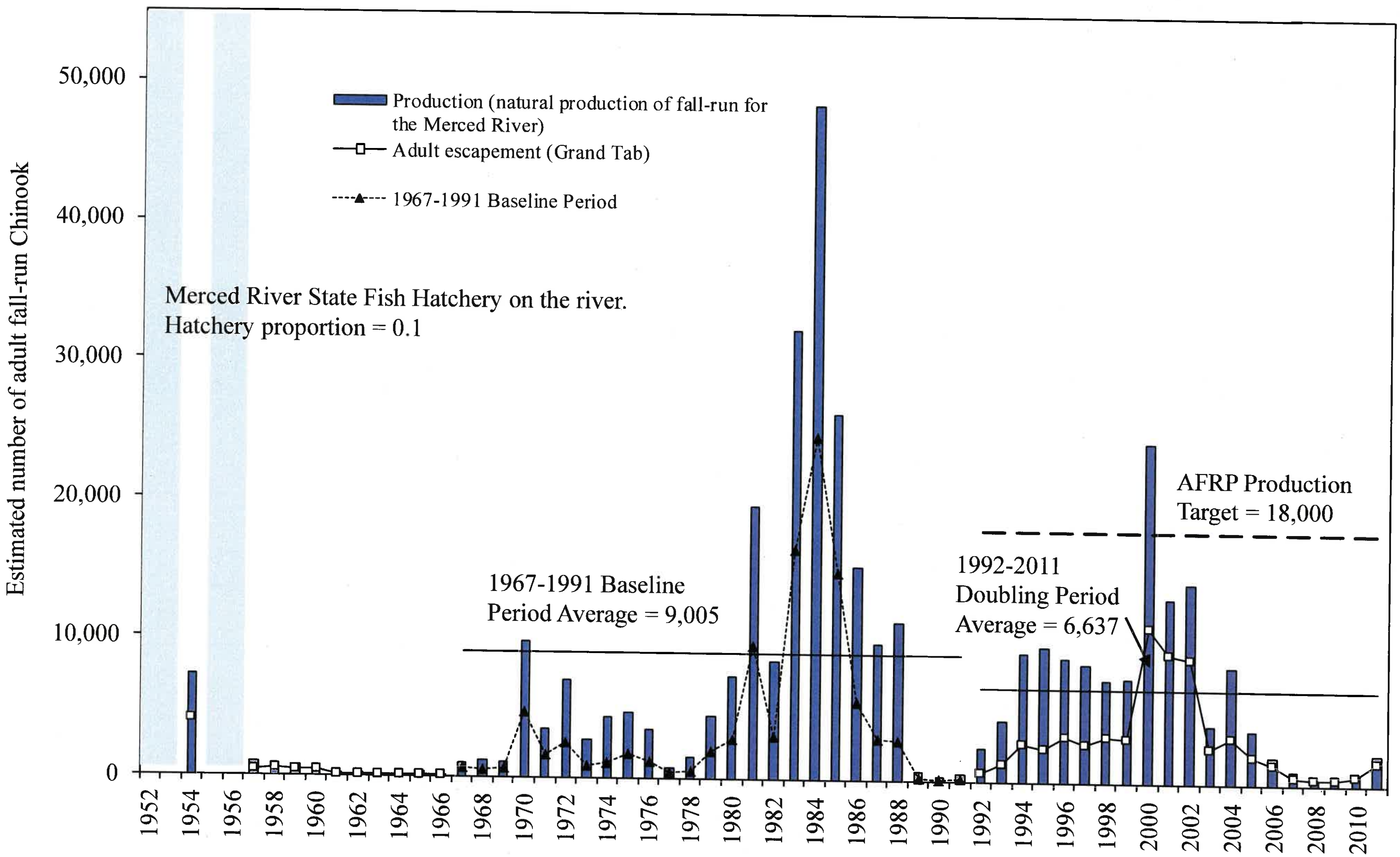


Figure 34. Estimated yearly natural production, and in river escapements of Merced River adult fall-run Chinook salmon. 1952 - 1966, and 1992 - 2011 numbers are from CDFG Grand Tab (Apr 24, 2012). ▭ data was not available for 1952 - 1953, and 1955 - 1956. 1967-1991 Baseline Period numbers are from Mills and Fisher (CDFG, 1994).

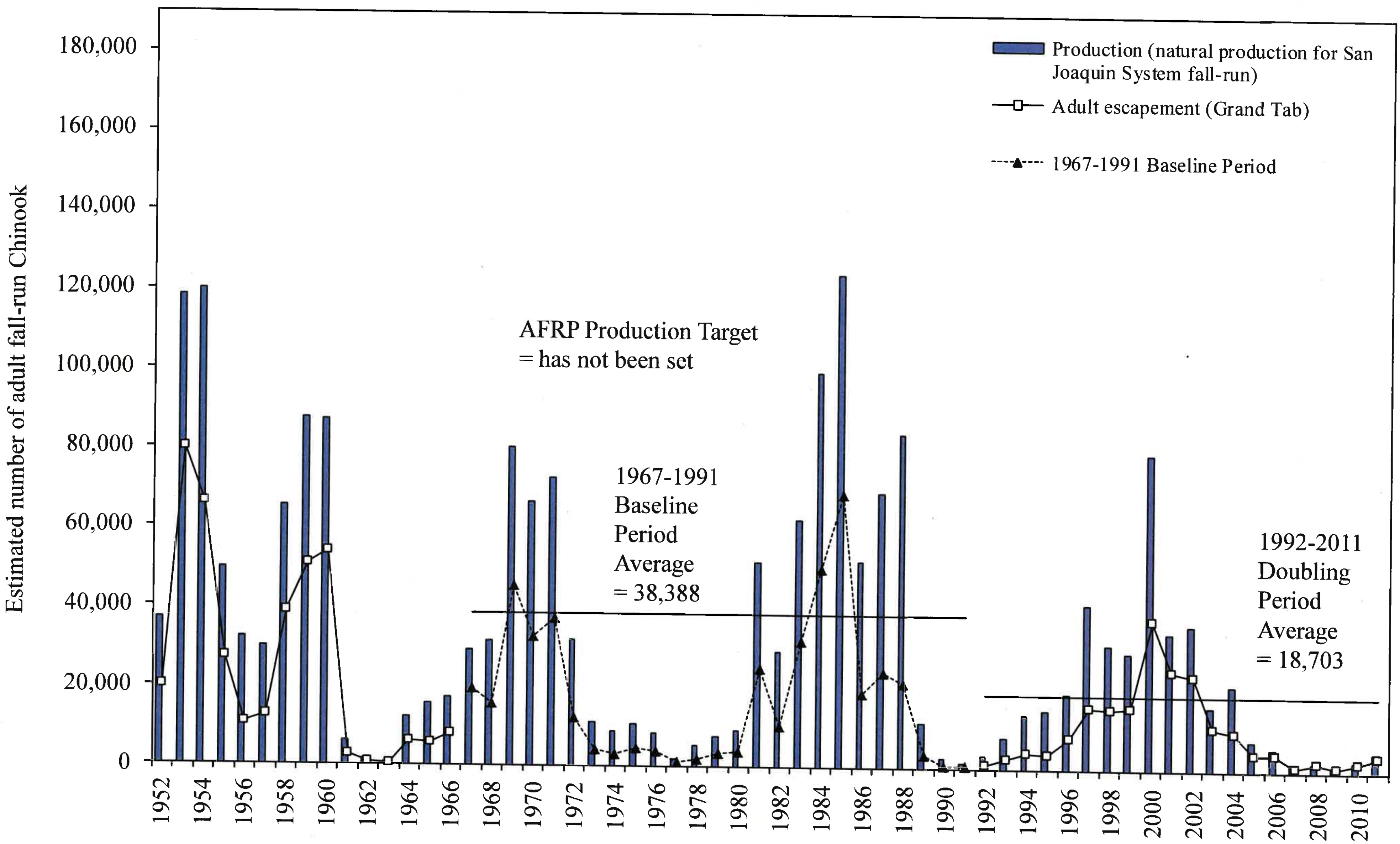
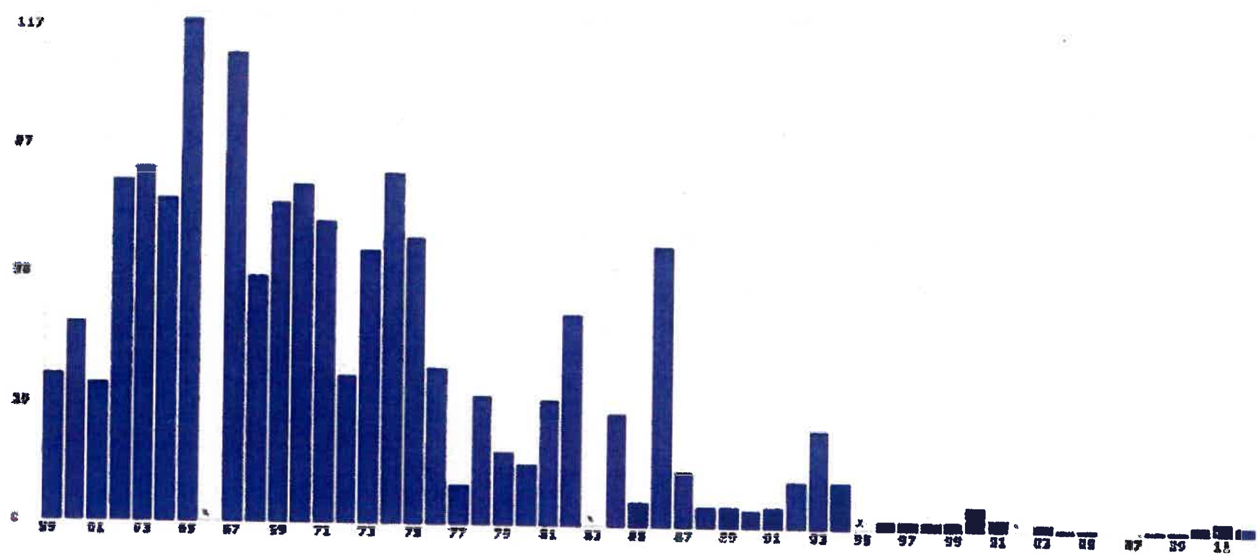


Figure 35. Estimated yearly natural production, and in river escapements of San Joaquin System adult fall-run Chinook salmon. The San Joaquin System is the sum of the Stanislaus, Tuolumne, and Merced Rivers. 1952 - 1966, and 1992 - 2011 numbers are from CDFG Grand Tab (Apr 24, 2012). 1967-1991 Baseline Period numbers are from Mills and Fisher (CDFG, 1994).

CALIFORNIA DEPARTMENT OF
FISH and WILDLIFE

Home » Regions » Bay Delta Region » Studies and Surveys » Summer Townet Survey » Striped Bass Indices

Striped Bass Indices



Striped Bass Indices

YEAR	INDEXDATE	DELTA INDEX	SUISUN BAY INDEX	TOTAL INDEX
1959	12-Jul	30.7	3.0	33.7
1960	16-Jul	32.0	13.6	45.6
1961	21-Jul	25.2	6.4	31.6
1962	26-Jul	46.8	32.1	78.9
1963	3-Aug	38.2	43.5	81.7
1964	1-Aug	54.7	20.7	75.4

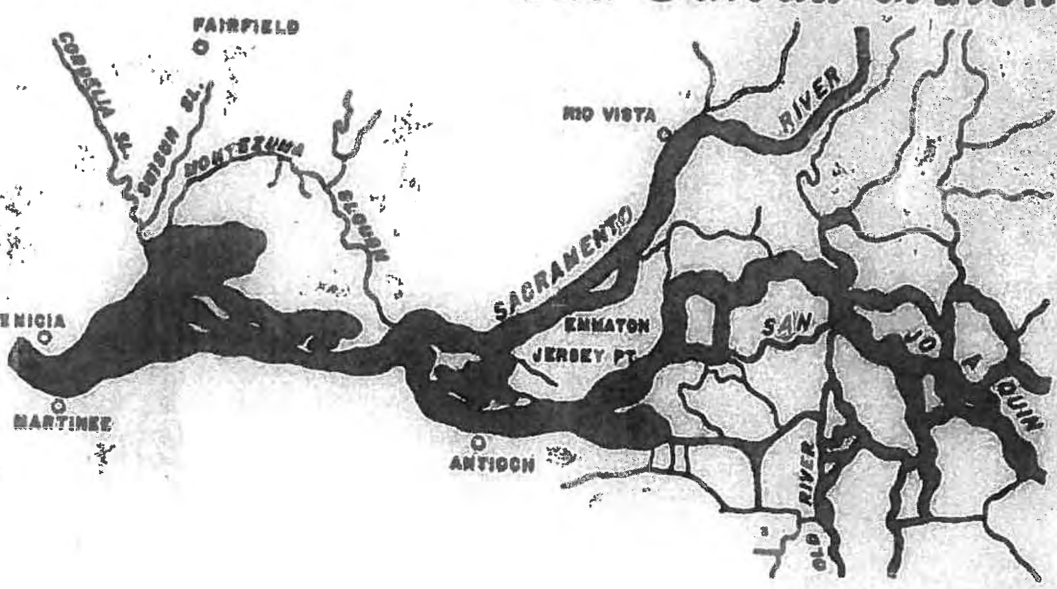
Exhibit “M”

Water Right Decision 1485

In the Matter of Permit 12720 (Application 5625) and Other Permits of United States Bureau of Reclamation for the Federal Central Valley Project and of California Department of Water Resources for the State Water Project.

DECISION IN FURTHERANCE OF JURISDICTION RESERVED IN DECISIONS D 893, D 990, D 1020, D 1250, D 1275, D 1291, D 1308, D 1356, and PERMIT ORDER 124

Sacramento-San Joaquin Delta and Suisun Marsh



August 1978

STATE WATER RESOURCES CONTROL BOARD

Exhibit "N"

executed. The criteria in the draft agreement were recommended by Fish and Game and endorsed by the Department, and were extensively analyzed by the Board staff. Based on our most current assessment, the fishery standards provide significantly higher protection than existing basin plans. The Striped Bass Index is a measure of young bass survival through their first summer. The Striped Bass Index would be 71 under without project conditions (i.e., theoretical conditions which would exist today in the Delta and Marsh in the absence of the CVP and SWP), 63 under the existing basin plans, and about 79[3/] under this decision.

D 1485
1978

While the standards in this decision approach without project levels of protection for striped bass, there are many other species, such as white catfish, shad and salmon, which would not be protected to this level. To provide full mitigation of project impacts on all fishery species now would require the virtual shutting down of the project export pumps. The level of protection provided under this decision is nonetheless a reasonable level of protection until final determinations are made concerning a cross-Delta transfer facility or other means to mitigate project impacts.

3/ There is some indication that factors other than those considered in the Board's analysis of without project levels may also affect striped bass survival. The effects of these factors are such that the without project levels would be greater than 71. However, the magnitude of this impact is unknown and cannot be quantified at this time.

NOT PROVIDED

Suisun Marsh. Full protection of Suisun Marsh now could be accomplished only by requiring up to 2 million acre-feet of freshwater outflow in dry and critical years in addition to that required to meet other standards. This requirement would result in a one-third reduction in combined firm exportable yield of State and federal projects. In theory, the existing Basin 5B Plan purports to provide full protection to the Marsh. However, during the 1976-77 drought when the basin plan was in effect, the Marsh received little if any protection because the system almost ran out of water and emergency regulations had to be imposed. This decision balances the limitations of available water supplies against the mitigation responsibility of the projects. This balance is based on the constitutional mandate "...that the water resources of the State be put to beneficial use to the fullest extent of which they are capable..." and that unreasonable use and unreasonable diversion be prevented (Article 10, Section 2, California Constitution).

The Bureau, the Department, Fish and Game, and U. S. Fish and Wildlife Service are working together to develop alternative water supplies for the Marsh. Such alternative supplies appear to represent a feasible and reasonable method for protection of the Marsh and mitigation of the adverse impacts of the projects. Under this decision the Department and Bureau are required, in cooperation with other agencies, to develop a plan for Suisun Marsh by July 1, 1979. The Suisun Marsh plan should ensure that the

Jeff Opperman
Final Report for Fellowship R/SF-4

My CALFED fellowship (R/SF-4) had three primary research areas: (1) how native fish use California floodplains; (2) developing a method to identify and quantify a particular type of floodplain in the Sacramento Valley; and (3) a white paper for CALFED that reviews, summarizes, and synthesizes research on floodplains generally, and Central Valley floodplains specifically.

1. Native fish and floodplains.
For this research I collaborated with Carson Jeffres, a graduate student at UC Davis (this research was his Master's thesis). We compared the growth rates of juvenile Chinook salmon between various floodplain and riverine habitats. This study built on previous work; (1) in the Yolo Bypass that found that juvenile Chinook grew faster in the flooded Bypass than in the nearby Sacramento River and; (2) in the Cosumnes Preserve which showed that native, wild juvenile Chinook salmon appeared to use the Cosumnes floodplain for rearing when it was inundated.

Juvenile salmon were obtained from a hatchery on the Mokelumne River and placed in enclosures within the Cosumnes River and floodplain (ten fish per enclosure). For two flood seasons (2004 and 2005), six enclosures were placed in each of three different habitat types in the floodplain and two locations in the river (30 enclosures total). Floodplain habitats included an ephemeral pond, flooded terrestrial herbaceous vegetation, and a pond that was permanent during the first year of the study and ephemeral during the second. The river locations were the river channel above the floodplain and the river channel below the floodplain.

The fish were measured at one week intervals, although measurement frequency declined during large flood events that made access difficult. In 2004 fish were measured three times over 4.5 weeks and in 2005 they were measured four times over 8 weeks. After the final measurement the fish were sacrificed and a sub-set were saved for a gut-content analysis.

In general, fish had faster growth rates in floodplain habitats than in the river. During periods of low, clear water, fish growth rates in the river site above the floodplain were comparable to those in the floodplain. However, during higher flows, with more turbid water, growth in the river above the floodplain was significantly lower than on the floodplain. Fish in the river below the floodplain, which was representative of intertidal delta habitat, were consistently low.

The main channel of the Cosumnes River, like those of many Central Valley rivers, is incised and lacks complexity. There are few side channels, backwaters, or accessible floodplain habitats (other than the Cosumnes Preserve). Thus, juvenile fish will tend to be displaced downstream during high flow events. In the Cosumnes, juvenile fish will be flushed downstream to either the intertidal delta or the floodplain. Among these two

Exhibit "O"

habitats, the floodplain appears to provide significantly better habitat for rearing (Figure 1).

Figure 1. Juvenile Chinook on the right were reared within an enclosure within the Cosumnes River floodplain while those on the left were reared within an enclosure in the river below the floodplain (intertidal Delta habitat).

This study confirms that juvenile Chinook benefit from access to floodplain habitats. While river habitats comparable to those above the floodplain can support similar growth rates as the floodplain, this habitat is more variable. During high flows the river offers poor habitat and fish living in this type of habitat will tend to be displaced downstream. The floodplain can provide optimal growing conditions during such floods and likely offers superior habitat conditions to the downstream Delta.

The risk of fish stranding on the floodplain merits further research. However, initial research on the Cosumnes suggests that native fish tend to respond to cues that facilitate emigration from the floodplain during draining and that primarily non-native fish become stranded. This work further supports the concept that floodplain restoration can be an important strategy for restoring Central Valley salmon populations.

This research is summarized in:

Jeffres, C., J. Opperman, and P. B. Moyle. *Submitted.* Ephemeral floodplain habitats provide best growth conditions for juvenile Chinook salmon in a California river. Submitted to Environmental Biology of Fishes.

This work has also been presented at the following conferences:

1. Floodplain Management Association 2005
2. Society for Ecological Restoration 2005
3. Riverine Hydroecology (Stirling, Scotland) 2006

2. Identifying and mapping the floodplain inundated by the Floodplain Activation Flood.

Working in collaboration with Phil Williams and Associates (PWA), we worked to define, identify, and quantify a particular type of floodplain: that which is inundated by a Floodplain Activation Flood (FAF). The FAF is a relatively frequent, long duration, spring-time flood that has particular value for native fish and food web productivity (see text on floodplain conceptual model below for further description of a Floodplain Activation Flood).

The FAF was defined as follows:

1. occurs in two out of three years (67% exceedance probability)
2. duration of at least one week
3. occurs between March 15 and May 15.

These criteria were applied to a series of paired gauges along the Sacramento River and within the Yolo Bypass. This process derived a flood stage elevation that corresponded to the FAF criteria. This flood stage was then used to develop a water surface that was applied to topography for the Sacramento River and surrounding floodplain (from US Army Corps of Engineers' Sacramento-San Joaquin Comprehensive Study), estimating the area of floodplain inundated during the FAF.

We found that there is very little floodplain area inundated by the FAF in the current Sacramento Valley. Nearly all floodplain that corresponds to the FAF is found within the Yolo Bypass.

This work is further described in:

Philip Williams & Associates, L., and J. J. Opperman. 2006. The frequently activated floodplain: quantifying a remnant landcape in the Sacramento Valley, San Francisco, CA.

Williams, P., J. Opperman, E. Andrews, S. Bozkurt, and P. Moyle. Quantifying activated floodplain on a lowland regulated river. *In preparation for* San Francisco Estuary and Watershed Science.

3. The Central Valley Floodplain White Paper
I am continuing to work on the floodplain white paper along with my co-author, Peter Moyle. A central part of the white paper is a conceptual model for Central Valley floodplains, briefly described below.

This work has been presented at the following conferences:
1. Floodplain Management Association, 2005
2. American Geophysical Union and the North American Benthological Society, 2005
3. Society for Ecological Restoration, 2005

4. State of the Estuary Conference, 2005
5. CALFED Science Conference, 2006
6. Riverine Hydroecology (Stirling, Scotland), 2006
7. State of Washington, the Ecological Value of High Flows, 2006

Brief overview of conceptual model:

Floodplains support high levels of biodiversity and are among the most productive ecosystems in the world. They provide a range of ecosystem services to human society, including storage and conveyance of flood flows, groundwater recharge, open space, recreational opportunities, and habitat for a diversity of species, many of them of economic importance. Among the world's ecosystem types, Costanza et al. (1997) ranked floodplains second only to estuaries in terms of the ecosystem services provided to society. In the Central Valley, the most important ecosystem services provided by floodplains include reduction of flood risk and habitat for numerous species, including commercially and recreationally valuable species (e.g., chinook salmon and waterfowl) and for endangered species. Recent research has demonstrated that floodplains provide necessary spawning habitat for the Sacramento splittail, an endemic minnow (Sommer et al. 1997) and that juvenile chinook salmon grow faster on floodplains than in main-stem river channels (Sommer et al. 2001b) (Figure 1). Productivity from floodplains can be exported to the Sacramento-San Joaquin Delta, where food limitation is likely one of the factors contributing to the decline of fish species (Jassby and Cloern 2000, Schemel et al. 2004). Further, in places such as the Yolo Bypass, ecologically valuable floodplains can be compatible with productive agriculture (Sommer et al. 2001a).

Recognizing these valuable services, state and federal agencies have expressed policy goals to restore floodplains in the Central Valley (CALFED Bay-Delta Program 2000). Further, flood management projects in the Central Valley now generally include a floodplain restoration component. To guide these restoration efforts, we convened a floodplain working group, composed of floodplain experts drawn from academia, agencies, NGOs, and the private sector, to define ecologically functional floodplains. This group described three primary components of ecologically functional floodplains:

- ***Connectivity*** between river and floodplain.
- ***Hydrological variability***
- ***Sufficient geographic scale*** for associated ecological benefits to be meaningful on a system- or population-scale.

We developed a conceptual model of floodplain processes based on the scientific literature, our collective experiences studying floodplains, and guidance from the floodplain working group (Figure 2). This conceptual model illustrates the linkages between physical and biological processes in floodplains and can be used to inform floodplain restoration projects.

Organization of the conceptual model.
A diverse range of flows influence floodplain geomorphic and ecological processes, ranging from flows below bankfull to large, rare, and highly erosive floods. Numerous aspects of these flows have geomorphic and ecological significance, including magnitude, frequency, duration, rates of change, and seasonality, as well as antecedent conditions on the floodplain. To simplify, our conceptual model focuses on three types of 'representative floods,' characterized by their frequency and magnitude, which are found in the blue boxes in the Hydrology portion of the model. These floods perform geomorphic work, described in the brown-outline boxes in the Geomorphology portion of the model. Hydrologic and geomorphic processes create the conditions for Ecosystem Responses and Processes to occur (green-outlined boxes). The Ecosystem Responses and Processes produce Ecological Benefits, the magnitudes of which are influenced by the geographic scale of floodplain. Two representative floods, the Floodplain Activation Flood and the Floodplain Reorganization Flood are illustrated in Figures 2 and 3 and described below.

Two representative floods
Floodplain Activation Flood. The floodplain activation flood (FAF) is a small-magnitude flood that occurs relatively frequently (e.g., almost every year) (Figure 3). The FAF can be further defined in terms of seasonality and duration—for example a flood that lasts at least one week and occurs in the Spring. The following article by Betty Andrews defines a FAF in terms of frequency, season, and duration and then describes a process to map the floodplain that corresponds to the FAF in the Sacramento Valley. A long duration flood produces characteristic ecological benefits such as habitat for native fish spawning and rearing (Figure 1) and food web productivity. The duration of the flood is important as these processes cannot occur during a short event. The seasonality of the flood also influences which ecological processes occur (see the temporal scale bar (Winter ▯ Late spring) in one of the ecological process boxes). The importance of duration and seasonality for a FAF is indicated by the question mark adjacent to the flood occurring in late January on the hydrograph in Figure 2 (a short, winter-time flood). Because floodplains can remain inundated for a period of time after the loss of direct connection with river flows, a series of short connections can also function as a floodplain activation flood.
Floodplain Reorganization Flood. The floodplain reorganization flood is a greater magnitude flood that occurs less frequently (Figure 3). This higher energy flood produces geomorphic work including extensive erosion and deposition on the floodplain which creates heterogeneous floodplain topography. In turn, these dynamic events and heterogeneous topography create a diverse ecosystem with vegetation patches of varying age, species composition and structure, and floodplain water bodies of varying successional stage and connectivity to the river. The ecosystem processes that occur during a Floodplain Activation Flood take place within the mosaic of habitat features created during Floodplain Reorganization Floods.

Conclusions
The model illustrates the importance of hydrological variability for an ecologically functional floodplain. For example, a floodplain that rarely is inundated by a Floodplain

Activation Flood will not produce the ecological benefits of food web productivity or spawning and rearing habitat for native fish. A floodplain that is not subject to Floodplain Reorganization Floods will not maintain the mosaic of habitats (e.g., vegetation and water bodies of varying successional stages) that help support floodplain biodiversity. Therefore, floodplain restoration projects should not only focus on reintroducing connectivity between rivers and floodplains. Floodplain managers should also ask the following questions about this connectivity: how often, for how long, in what season, and of what magnitude? The answers to these questions will strongly influence the range of ecological benefits that the restored floodplain can provide.

CALFED Bay-Delta Program. 2000. Ecosystem restoration program plan. Volume I: Ecological attributes of the San Francisco Bay-Delta watershed. Pages 532 pp. CALFED.

Costanza, R., R. dArge, R. deGroot, S. Farber, M. Grasso, B. Hannon, K. Limburg, S. Naeem, R. V. Oneill, J. Paruelo, R. G. Raskin, P. Sutton, and M. vandenBelt. 1997. The value of the world's ecosystem services and natural capital. *Nature* 387: 253-260.

Jassby, A. D., and J. E. Cloern. 2000. Organic matter sources and rehabilitation of the Sacramento - San Joaquin Delta (California, USA). *Aquatic Conservation: Marine and Freshwater Ecosystems* 10: 323-352.

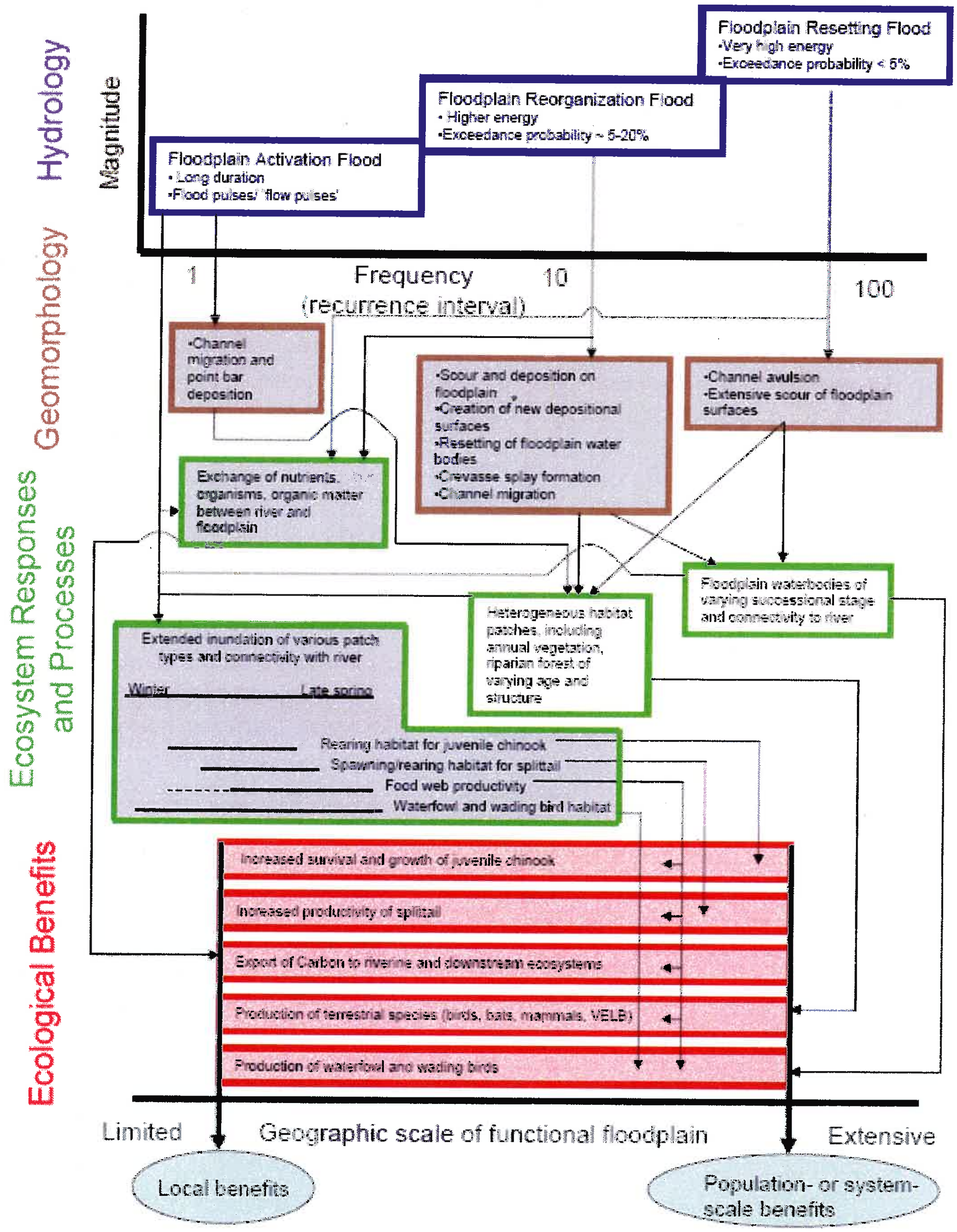
Schemel, L. E., T. R. Sommer, A. B. Muller-Solger, and W. C. Harrell. 2004. Hydrological variability, water chemistry, and phytoplankton biomass in a large floodplain of the Sacramento River, CA, USA. *Hydrobiologia* 513: 129-139.

Sommer, T., R. Baxter, and B. Herbold. 1997. Resilience of splittail in the Sacramento-San Joaquin estuary. *Trans. Am. Fish. Soc.* 126: 961-976.

Sommer, T., B. Harrell, M. Nobriga, R. Brown, P. Moyle, W. Kimmerer, and L. Schemel. 2001a. California's Yolo Bypass: evidence that flood control can be compatible with fisheries, wetlands, wildlife, and agriculture. *Fisheries* 26: 6-16.

Sommer, T. R., M. L. Nobriga, W. C. Harrell, W. Batham, and W. J. Kimmerer. 2001b. Floodplain rearing of juvenile chinook salmon: evidence of enhanced growth and survival. *Canadian Journal of Fisheries and Aquatic Sciences* 58: 325-333.

Figure 2. Floodplain Conceptual Model



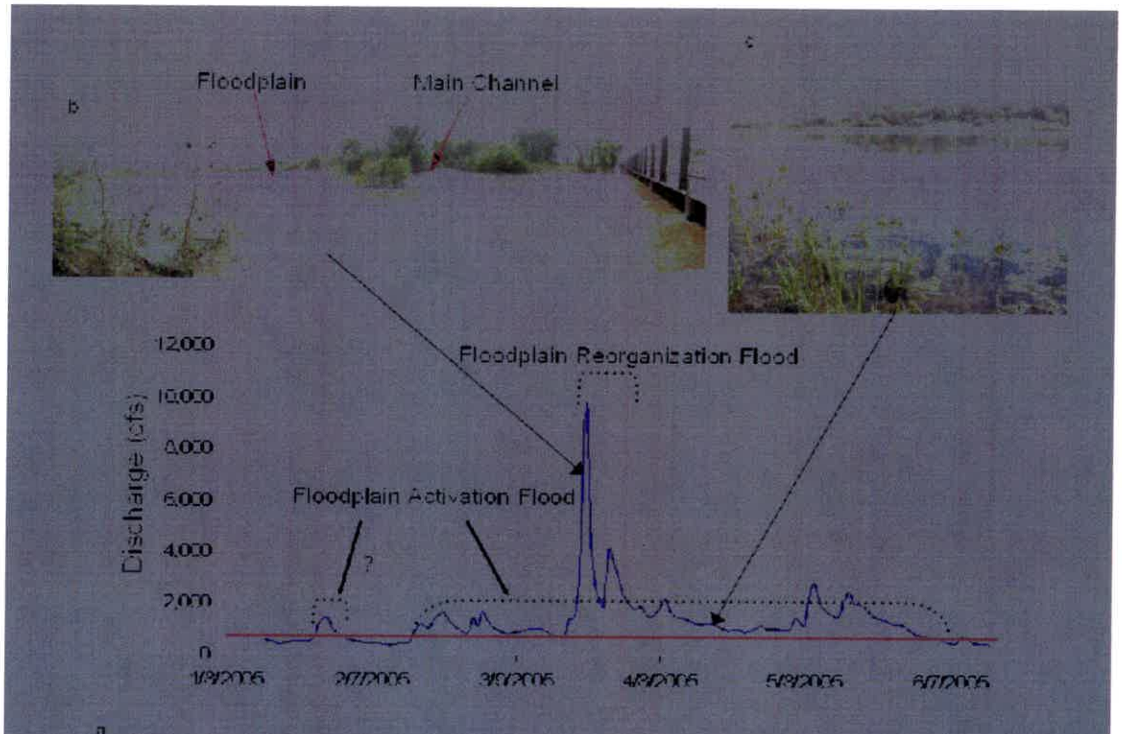


Figure 3. (a) Hydrograph from the Cosumnes River, winter and spring 2005. The red line indicates the approximate discharge at which the river and floodplain are connected. The importance of duration and seasonality for a floodplain activation flood (FAF) is indicated by the question mark adjacent to the flood occurring in late January (i.e., this short, winter-time flood may not provide the ecological benefits associated with a FAF); (b) A floodplain reorganization flood on the Cosumnes River floodplain, March 23, 2005; (c) A floodplain activation flood on the Cosumnes River floodplain, April 2005. Note the development of algal mats in the water and on the vegetation.

Floodplain rearing of juvenile chinook salmon: evidence of enhanced growth and survival

T.R. Sommer, M.L. Nobriga, W.C. Harrell, W. Batham, and W.J. Kimmerer

Abstract: In this study, we provide evidence that the Yolo Bypass, the primary floodplain of the lower Sacramento River (California, U.S.A.), provides better rearing and migration habitat for juvenile chinook salmon (*Oncorhynchus tshawytscha*) than adjacent river channels. During 1998 and 1999, salmon increased in size substantially faster in the seasonally inundated agricultural floodplain than in the river, suggesting better growth rates. Similarly, coded-wire-tagged juveniles released in the floodplain were significantly larger at recapture and had higher apparent growth rates than those concurrently released in the river. Improved growth rates in the floodplain were in part a result of significantly higher prey consumption, reflecting greater availability of drift invertebrates. Bioenergetic modeling suggested that feeding success was greater in the floodplain than in the river, despite increased metabolic costs of rearing in the significantly warmer floodplain. Survival indices for coded-wire-tagged groups were somewhat higher for those released in the floodplain than for those released in the river, but the differences were not statistically significant. Growth, survival, feeding success, and prey availability were higher in 1998 than in 1999, a year in which flow was more moderate, indicating that hydrology affects the quality of floodplain rearing habitat. These findings support the predictions of the flood pulse concept and provide new insight into the importance of the floodplain for salmon.

Résumé : Notre étude démontre que le canal de dérivation Yolo, la principale plaine d'inondation de la région aval de la rivière Sacramento (Californie, É.-U.), offre de meilleurs habitats pour l'alevinage et la migration des jeunes Saumons Quinnat (*Onchorhynchus tshawytscha*) que les bras adjacents de la rivière. En 1998 et 1999, la taille des saumons a augmenté plus rapidement dans la plaine d'inondation agricole, sujette aux débordements saisonniers de crue, que dans la rivière, ce qui laisse croire à de meilleurs taux de croissance. De plus, des jeunes saumons marqués à l'aide de fils de métal codés et relâchés dans la plaine d'inondation étaient plus gros au moment de leur recapture et avaient des taux de croissance apparente plus élevés que des poissons relâchés dans la rivière en même temps. L'amélioration des taux de croissance dans la plaine de débordement résultait en partie d'une consommation significativement plus importante de proies, le reflet d'une plus grande disponibilité des invertébrés de la dérive. Un modèle bioénergétique laisse croire que le succès de l'alimentation a été meilleur dans la plaine d'inondation que dans la rivière, en dépit du coût métabolique d'alevinage significativement plus grand dans les eaux plus chaudes de la plaine d'inondation. Les indices de survie des poissons marqués et relâchés dans la plaine d'inondation étaient quelque peu plus élevés que ceux des poissons de la rivière, mais les différences n'étaient pas statistiquement significatives. La croissance, la survie, le succès de l'alimentation et la disponibilité des proies étaient tous supérieurs en 1998 par comparaison avec 1999, une année à débit plus modéré, ce qui indique que l'hydrologie affecte la qualité des habitats d'alevinage dans la plaine d'inondation. Nos résultats appuient les prédictions du concept de pulsion de crue (flood pulse concept) et mettent en lumière l'importance de la plaine d'inondation pour le saumon.

[Traduit par la Rédaction]

Introduction

Although the trophic structure of large rivers is frequently dominated by upstream processes (Vannote et al. 1980), there is increasing recognition that floodplains plays a major role in the productivity and diversity of riverine communities (Bayley 1995). Based largely on observations from relatively undisturbed river–floodplain systems, Junk et al. (1989) proposed the flood pulse concept, which predicts that annual inundation is the principal force determining productivity and biotic interactions in river–floodplain systems. Floodplains can provide higher biotic diversity (Junk et al. 1989) and increased production of fish (Bayley 1991; Halyk and Balon 1983) and invertebrates (Gladden and Smock 1990). Potential mechanisms for floodplain effects include increased habitat diversity and area (Junk et al. 1989), large inputs of

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Exhibit "P"

 DOI: 10.1139/cjfas-58-2-325

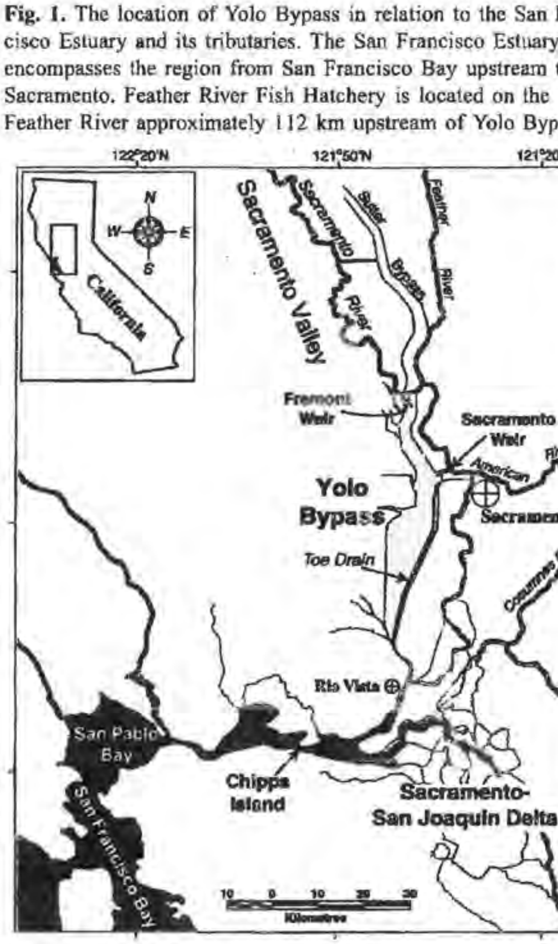
terrestrial material into the aquatic food web (Winemiller and Jepsen 1998), and decreased predation or competition due to intermediate levels of disturbance (Corti et al. 1997). Nonetheless, the degree to which floodplains support riverine ecosystems remains poorly understood, particularly in regulated and temperate rivers. Uncertainties about river–floodplain relationships are due, in large part, to the difficulty in separating the relative contribution of floodplain versus channel processes and sampling problems in seasonal habitats, which are frequently subject to extreme environmental variation.

In the this study, we examined the relative importance of floodplain and riverine habitat to juvenile chinook salmon (*Oncorhynchus tshawytscha*) in the Sacramento River (California, U.S.A.), a large regulated river (Fig. 1). The system is particularly well suited to a comparative study, because young salmon migrating down the lower Sacramento River to the San Francisco Estuary in wet years have two alternative paths: they may continue down the heavily channelized main river or they may pass through the Yolo Bypass, an agricultural floodplain bordered by levees. We had two reasons to believe that the floodplain might be important habitat for young salmon. First, years of high flow are known to enhance populations of a variety of species in the San Francisco Estuary (Jassby et al. 1995) and the survival of chinook salmon (Kjelson et al. 1982). However, the specific mechanisms for these benefits have not been established. Possible reasons for the positive effects of flow on fish include increased habitat availability, migration cues, food supply, larval transport, and reduced predation rates (Bennett and Moyle 1996). Floodplain inundation is one of the unique characteristics of wet years, during which the Yolo Bypass is likely to be a significant migration corridor for young chinook salmon in the Sacramento Valley. During high-flow events, the Yolo Bypass can convey >75% of the total flow from the Sacramento River basin, the major producer of salmon among tributaries of the San Francisco Estuary. Second, floodplains are known to be among the most important fish-rearing areas in a variety of river systems, yet in developed regions, the availability of this habitat has been greatly reduced by channelization and levee and dam construction (Rasmussen 1996). A high degree of habitat loss may greatly enhance the biological significance of remnant floodplains in heavily modified systems, such as the San Francisco Estuary and its tributaries.

This study tests the hypothesis that the agricultural floodplain provides better habitat quality than the adjacent river channel. For the purpose of this analysis, we focus on salmon growth, feeding success, and survival as indicators of habitat quality. Obviously, there are many other possible measures of habitat quality, such as reproductive output of adults or physiological indicators. However, we believe that the chosen suite of parameters is reasonably representative of habitat quality. For example, Gutreuter et al. (2000) successfully used growth as a factor to test the hypothesis that floodplain inundation had a major effect on fish production.

The San Francisco Estuary is one of the largest estuaries on the Pacific Coast (Fig. 1). The system includes downstream bays (San Pablo and San Francisco) and a delta, a broad network of tidally influenced channels that receive inflow from the Sacramento and San Joaquin rivers. The estuary and its tributaries have been heavily altered by levees, dams, land reclamation activities, and water diversions. The primary floodplain of the Sacramento River portion of the delta is the Yolo Bypass, a 24 000-ha leveed basin that conveys excess flow from the Sacramento Valley, including the Sacramento River, Feather River, American River, Sutter Bypass, and westside streams. The 61 km long floodplain floods seasonally in winter and spring in about 60% of years, and is designed to convey up to 14 000 $m^3 \cdot s^{-1}$. During a typical flooding event, water spills into the Yolo Bypass via the Fremont Weir when Sacramento Basin flows surpass approximately 2000 $m^3 \cdot s^{-1}$. Except during extremely high flow events, the mean depth of the floodplain is generally less than 2 m, creating broad shoal areas. During dry seasons, the Toe Drain channel, a permanent riparian corridor, remains inundated as a result of tidal action. At higher levels of Sacramento Basin flow (e.g., >5000 $m^3 \cdot s^{-1}$), the Sacramento Weir is also frequently operated. Agricultural fields are the dominant habitat type in Yolo Bypass, but approximately one-third of the floodplain area is natural vegetation, including riparian habitat, upland habitat, emergent marsh, and permanent ponds.

Fig. 1. The location of Yolo Bypass in relation to the San Francisco Estuary and its tributaries. The San Francisco Estuary encompasses the region from San Francisco Bay upstream to Sacramento. Feather River Fish Hatchery is located on the Feather River approximately 112 km upstream of Yolo Bypass.



There are four races of chinook salmon in the Sacramento Valley: winter, spring, late fall, and fall run (Yoshiyama et al. 2000). Historical data indicate that all races have decreased in abundance since the 1950s, but the spring, winter, and late-fall runs have shown the most pronounced declines. There are multiple causes for these long-term reductions, including habitat loss, habitat degradation, water diversions, and oceanic conditions. In the present study, we focused on the fall run, the numerically dominant race in the Sacramento Valley. The typical life-history pattern for these salmon is for young to migrate from the tributaries to the bay–delta area at the "fry" stage (Brandes and McLain 2001), when most individuals are approximately 35- to 70-mm fork length (FL). In low flow years, there may be substantial upstream rearing in the Sacramento River. Peak juvenile emigration from the tributaries occurs during winter and spring (Kjelson et al. 1982).

Materials and methods

Physical conditions

During 1998–1999, flow measurements in Yolo Bypass and the adjacent stretch of the Sacramento River were obtained from gauges operated by the U.S. Geological Survey (USGS). Daily water temperatures for each site were calculated as the mean of maximum and minimum daily measurements for single stations in the Sacramento River (USGS) and a temperature recorder (Onset Corp.) installed in the Yolo Bypass Toe Drain channel (Fig. 1). However, from 1 February to 26 March 1998, these data were not available for Yolo Bypass. During this period, before the recorder was installed, discrete measurements were taken at the same location, typically during mid or late morning.

Fish sampling

Salmon FL (mm) was measured during January–April in 1998 and 1999 on samples collected with 15-m beach seines (4.75-mm mesh). Samples were collected weekly at five core locations located around the perimeter of the Yolo Bypass, during periods when the basin was flooded. After the bypass drained, additional samples were collected at random locations around the perimeter of ponds near the core locations. Comparative data on salmon size in the adjacent reach of the Sacramento River were collected by the U.S. Fish and Wildlife Service (USFWS) at five beach-seine sites, using techniques similar to those used when the the bypass was flooded.

FLs of salmon obtained from beach-seine sampling were compared to determine whether there was evidence of major differences in salmon size between the Yolo Bypass and the Sacramento River. However, these data were not considered unambiguous evidence of growth differences, because the two systems were open to immigration and emigration during much of the study, and migrating salmon include multiple races of salmon that cannot be readily separated. We addressed this issue by using paired releases of coded-wire-tagged (CWT) juvenile salmon in Yolo Bypass and the Sacramento River. This approach allowed comparisons of growth among fish of similar origin and provided a relative estimate of migration time and survival. The salmon were produced and tagged at the Feather River Fish Hatchery and released on 2 March 1998 and 11 February 1999. The release sites were in Yolo Bypass below Fremont Weir (52 000 in 1998; 105 000 in 1999) and in the adjacent reach of the Sacramento River (53 000 in 1998; 105 000 in 1999). The fish had a mean FL of 57.5 ± 0.5 mm (SE) in 1998 and of 56.8 ± 0.4 mm (SE) in 1999. A small portion of each group was subsequently collected by trawling at the seaward margin of the delta at Chipps Island, which is located downstream of the confluence of the Yolo Bypass and the Sacramento River (Fig. 1). The USFWS Chipps Island survey samples a single channel location with a midwater trawl towed at the surface (Baker et al. 1995; Brandes and McLain 2001). Ten 20-min tows were made each day, except during March in 1998 and 1999, when sampling was conducted every other day. Data on migration time (days) and FL (mm) were recorded for fish recaptured from each release group. Apparent growth rate was also calculated for each fish, as: (FL of individual at Chipps Island – mean FL of CWT release group) × (migration time)$^{-1}$. Survival indices of the paired CWT releases were calculated by USFWS by dividing the number of fish recovered for each release group at Chipps Island by the number released, corrected for the fraction of time and channel width sampled (Brandes and McLain 2001).

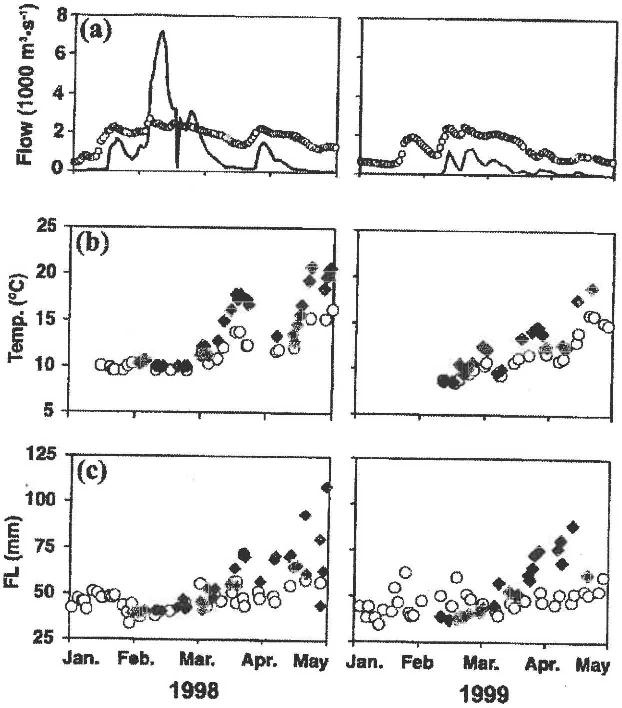
Diet

We performed diet comparisons on fall-run juvenile salmon (33–81 mm) collected in beach-seine samples during February–March of 1998 and 1999 from the Yolo Bypass (103 individuals) and the Sacramento River (109 individuals). Fish samples were tagged and stored individually in a deep freeze. After thawing, stomachs were removed from the fish and the contents were identified (using a dissecting microscope) to order (insects and arachnids), genus (crustaceans), or phylum (rarely eaten taxa such as oligochaetes). To develop average invertebrate length estimates, up to 10 individuals of each prey type encountered were measured. Prey dry weight estimates were calculated from average lengths, using regression equations for delta crustaceans obtained from J. Orsi (California Department of Fish and Game, Stockton, CA 95205, unpublished data) and from literature sources. Diet results were compared as an index of relative importance (IRI) (Shreffler et al. 1992) for each month. The index was calculated as: IRI = (% numeric composition + % weight composition) × % frequency of occurrence.

Prey availability

Invertebrates were sampled in February–March of 1998 and 1999, to examine prey availability in the Yolo Bypass and the Sacramento River. Sampling was not designed as a comprehensive evaluation of spatial and temporal variation of prey. Rather, it was intended to provide information on whether variation in salmon diets between the two locations was consistent with gross differences in prey type or relative abundance. We focused on Diptera (adults, pupae, and larvae) and crustacean zooplankton, which comprised over 90% of the diets of Yolo Bypass and Sacramento River juvenile salmon. Weekly drift samples were collected at fixed stations on the Yolo Bypass and the Sacramento River during periods when the floodplain was inundated. The sampling points were located away from overhanging vegetation and bank eddies, in water velocities of approximately 15–60 cm·s^{-1}, depending on flow. Net (500-μm mesh) dimensions were 0.46 × 0.3 m mouth and 0.91 m length. The nets were fished for approximately 30 min during mid-morning, to coincide with the time period when most fish-stomach samples were taken. Sample volume was calculated using a flowmeter (General Oceanics Model 2030R) and net dimensions. Drift samples were stored in ethanol or formaldehyde, then identified to family or order using a dissecting microscope. In 1998, zooplankton were collected in the Yolo Bypass at two fixed stations with battery-operated rotary-vane pumps with a mean flow rate of 17 L·min^{-1}. Samples were taken via pipes with outlets at multiple locations beneath the water surface. Discharge was directed into a 150 μm mesh net held in a basin on the bank. Flow rate was recorded at the beginning and end of the sample period, which varied from 1 to 6 h. No samples were taken in the Sacramento River during a comparable period in 1998. In 1999, zooplankton samples were taken with a Clarke–Bumpus net (160-μm mesh, diameter 0.13 m, length 0.76 m) placed in surface flow in the Yolo Bypass and Sacramento River. Sample volume was recorded as for the drift net. Zooplankton samples were concentrated and stored in 5%

Fig. 2. Chinook salmon size versus physical conditions in Yolo Bypass and the Sacramento River during winter and spring in 1998 and 1999. (*a*) Mean daily flow ($m^3 \cdot s^{-1}$) in Yolo Bypass (solid line) and the Sacramento River (circles). (*b*) Mean water temperature (°C) in Yolo Bypass (solid symbols) and the Sacramento River (open symbols). (*c*) Mean daily chinook salmon FL for Yolo Bypass (solid symbols) and Sacramento River (open symbols) beach-seine stations. For presentation purposes, only the daily mean FLs are shown; however, individual observations for February–March were used for statistical analyses.



formaldehyde, for later identification to genus using a dissecting microscope.

Bioenergetics

Feeding success was examined in two ways: (1) prey biomass estimated from stomach contents and (2) prey biomass estimated as a function of maximum theoretical consumption. For the first measure, we used the previously described stomach-content data to calculate total-prey biomass for individual fish.

A limitation of using prey biomass as a measure of feeding success between locations is that thermal history affects how consumption alters growth rate (Hewett and Kraft 1993). As will be discussed in further detail, water temperatures were significantly higher in the Yolo Bypass floodplain than in the Sacramento River. To correct for this problem, our second approach used bioenergetic modeling to incorporate the metabolic effects of water temperature. We used methods similar to those of Rand and Stewart (1998) to calculate a wet weight ration index, which uses prey biomass for each sampled individual as a proportion of the theoretical maximum daily consumption. The stomach-content data were used as our estimate of prey biomass for individual fish. The theoretical maximum daily consumption rate (C_{max}) was modeled using Fish Bioenergetics 3.0 (Hanson et al. 1997), using observed body size and water temperature at the time each beach-seine sample was collected. The model input also required fish mass, which we estimated from FL data, using length–weight relationships from Sacramento River juvenile salmon (Petrusso 1998). The caloric value of the prey was taken from weight conversion factors provided by Hanson et al. (1997). Model parameters were derived from those of Stewart and Ibarra (1991) for chinook salmon. The model was run for individual fish collected at each sampling location in 1998 and 1999.

Table 1. Robust regression statistics for Yolo Bypass and Sacramento River salmon FLs for 1998 and 1999.

	1998		1999	
	Parameter ± SEM	*t*	Parameter ± SEM	*t*
Intercept	29.4±0.6	46.8	23.5±0.5	43.7
Location	6.4±0.6	10.2	11.1±0.5	20.6
Day	0.3±0.01	34.5	0.3±0.01	48.5
Location:day	−0.14±0.01	−18.4	−0.21±0.01	−33.6

Note: The t values are all highly significant ($p < 0.0001$).

We emphasize that the second approach provides an *index*, rather than an *absolute* measure of feeding success. The wet weight ration index is conceptually analogous to "*P*" in Hanson et al. (1997), a model parameter that indicates what fraction of C_{max} is obtained over the course of the day. The major difference is that *P* is based on prey consumption over a 24-hour period, whereas our wet weight ration index is based on instantaneous measurements of stomach contents, which may not represent mean trends over the entire day. An additional limitation is that the Stewart and Ibarra (1991) model parameters were developed for adult salmon and we applied the model to juveniles. We did not have sufficient field or laboratory data to develop bioenergetic-model parameters specific to the earliest life stages. Nonetheless, other studies (Rand and Stewart 1998) have demonstrated that similar wet weight ration indices can provide an effective technique for comparing relative salmonid feeding success between seasons and years.

Statistical analysis

Overlapping temperature measurements from continuous recorders and the discrete measurements during 26 March – May 1998 were analyzed with Wilcoxon's matched-pairs test, to determine whether the two methods yielded different results. Mean water temperature for Yolo Bypass and the Sacramento River during the primary period of floodplain inundation (February–March) was analyzed with a generalized linear model with a variance function that increased with the mean squared, since variances were not homogeneous (Venables and Ripley 1997). Salmon FL measurements for Yolo Bypass and the Sacramento River during February–March of 1998 and 1999 were compared with a robust iteratively reweighted least squares regression procedure ("rlm"; Venables and Ripley 1997), because we detected substantial numbers of outliers in preliminary graphical evaluations of the data. Initial analyses revealed a substantial difference in the effects of location between years, so years were analyzed separately. Results from the CWT and bioenergetic studies were analyzed using a factorial-design analysis of variance, to evaluate the effects of location (Yolo Bypass, Sacramento River) and year (1998, 1999). Residuals from each model were examined graphically, to confirm that they met the assumption of normality and homogeneity of variance. Cochran and Levene's tests were also used, to test the assumption of homogeneity of variance. Logarithmic transformation was performed where necessary.

Results

Physical conditions

Yolo Bypass was inundated in 1998 and 1999 but the hydrology was substantially different in the two years (Fig. 2).

Table 2. Results of salmon collections at Chipps Island for 1998 and 1999 coded-wire-tagged groups released concurrently in Yolo Bypass and the Sacramento River.

	1998		1999	
	Yolo Bypass	Sacramento River	Yolo Bypass	Sacramento River
Fork length (mm)	93.7±2.0	85.7±1.4	89.0±2.6	82.1±1.7
Migration time (days)	46.2±2.3	55.4±3.5	58.2±2.8	58.6±4.1
Apparent growth rate (mm·day^{-1})	0.80±0.06	0.52±0.02	0.55±0.06	0.43±0.03
Survival index	0.16	0.09	0.09	0.07
Sample size	9	10	9	8

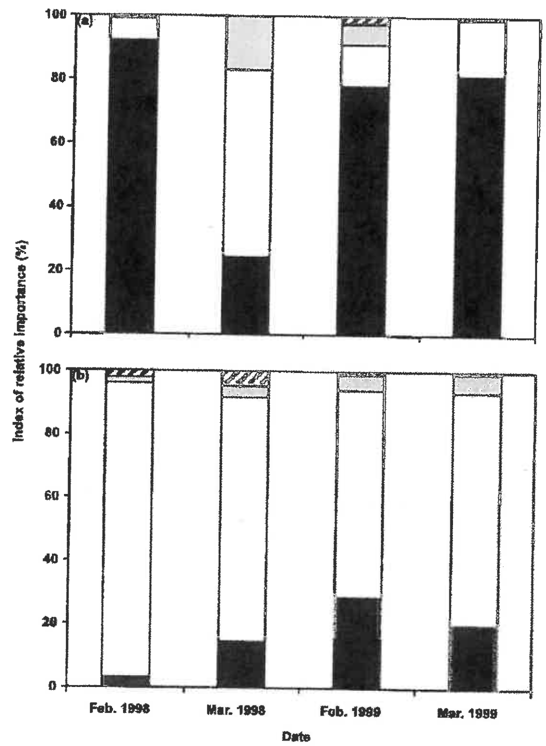
Note: Values for FL, migration time, and apparent growth rate are mean ± standard error (SEM).

The first year was extremely wet, with multiple flow pulses and a peak flow of 7200 $m^3 \cdot s^{-1}$. In 1999, floodplain hydrology was more moderate, with a peak of 1300 $m^3 \cdot s^{-1}$. Flows in the Sacramento River were much less variable than in the floodplain and generally remained at or below 2000 $m^3 \cdot s^{-1}$, a level within the design capacity (3100 $m^3 \cdot s^{-1}$) of the channel. Overlapping sampling between the continuous-temperature recorders and the discrete measurements during March–May 1998 showed a mean difference of 0.9°C between the two approaches, but this disparity was not statistically significant (Wilcoxon's matched-pairs test, $p > 0.25$). In 1998 and 1999, temperatures increased fairly steadily throughout the study period; however, in both years, temperature levels in Yolo Bypass were up to 5°C higher than those in the adjacent Sacramento River during the primary period of inundation, February–March. Temperature in the Yolo Bypass was described in 1998 by $T_y = -7.7 \pm 2.1 + (1.9 \pm 0.2)T_s$ and in 1999 by $T_y = -3.5 \pm 1.2 + (1.5 \pm 0.1)T_s$, where T_y is the temperature of the Yolo Bypass, T_s is the temperature of the Sacramento River, and the range for each value is the 95% confidence limit.

Fish growth, migration time, apparent growth rate, and survival

Salmon increased in size substantially faster in the Yolo Bypass than in the Sacramento River during each of the study years (Fig. 2). Robust regression results showed that the effect of location was highly significant ($p < 0.00001$) in each year (Table 1). This result is consistent with the CWT data (Table 2), which showed that the 1998 and 1999 Yolo Bypass CWT release groups had significantly larger mean length ($F = 14.34$, $p = 0.0006$) and higher apparent growth rates ($F = 20.67$, $p = 0.0007$) than the Sacramento River release groups. There was also a statistically significant effect of year: both release groups had larger mean sizes ($F = 4.42$, $p = 0.04$) and higher apparent growth rates ($F = 16.47$, $p = 0.0002$) in 1998 than in 1999. The 1998 Yolo Bypass CWT group showed the fastest migration time, arriving an average of at least 9 days ahead of any other release group. However, there was no statistically significant ($F = 2.22$, $p = 0.15$) effect of release location on migration time in the analysis of variance (ANOVA). As for fish size and apparent growth rate, mean migration time was slower in 1999 than in 1998 ($F = 5.60$, $p = 0.02$). There was no statistically significant interaction between location and year for salmon size ($F = 0.07$, $p = 0.78$), apparent growth rate ($F = 1.62$, $p = 0.21$), or migration time ($F = 1.8$, $p = 0.18$). The survival indices were somewhat higher for CWT groups released in the Yolo Bypass than for those released in the Sacramento River for both 1998 and 1999. However, the lowest coefficient of variation based on a Poisson distribution of the CWT recaptures is 32%, and the actual (unknown) distribution of counts is likely to have higher variance than a Poisson distribution. Clearly the confidence limits of the paired survival indices would overlap, so the differences are not statistically significant.

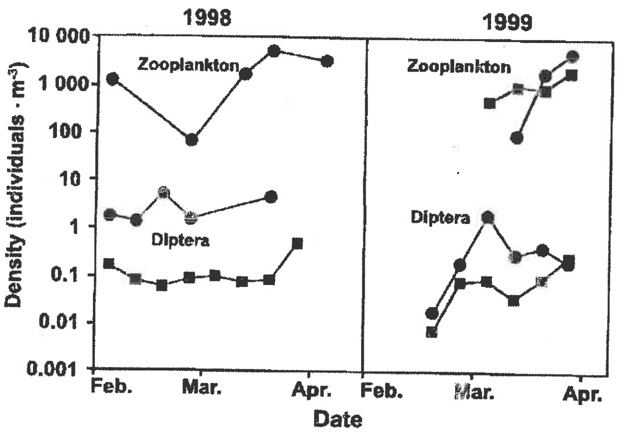
Fig. 3. Chinook salmon diet during February and March of 1998 and 1999 in Yolo Bypass (*a*) and the Sacramento River (*b*). The index of relative importance (*y*-axis) is defined in the text. Diptera (solid bars), zooplankton (open bars), other aquatic prey (shaded bars), and other terrestrial prey (striped bars) are shown for each month.



Diet

The diet of young salmon in the Yolo Bypass was dominated by dipterans, principally chironomid pupae and adults (Fig. 3). The second most common prey item was zooplank-

Fig. 4. Log_{10}-scaled weekly abundance (individuals·m^{-3}) of zooplankton and Diptera in Yolo Bypass (circles) and the Sacramento River (squares) during 1998 and 1999. Note that 1998 zooplankton data were not available for the Sacramento River.



ton, mostly cladocerans and copepods. Except for March 1998, zooplankton comprised less than 15% of the Yolo Bypass diets. Other aquatic (mainly amphipods and collembola) and terrestrial (mainly ants and arachnids) prey were relatively minor diet items. As for the floodplain samples, dipterans and zooplankton comprised over 90% of the diets of Sacramento River salmon; however, zooplankton were the dominant prey item in all months. Other aquatic (mostly amphipods, oligochaetes, and collembola) and terrestrial (mostly ants and other terrestrial insects) prey were consumed infrequently.

Prey availability

The drift samples contained many of the same taxa observed in the salmon diets, with Diptera (principally chironomids) as the major type at both sampling locations. However, the density of Diptera was much higher in the Yolo Bypass than in the Sacramento River (Fig. 4), particularly in 1998, when densities were consistently an order of magnitude higher. In general, dipteran drift densities were higher at each location in 1998 than in 1999. There was little difference in zooplankton density in the Yolo Bypass between 1998 and 1999 or between Yolo Bypass and the Sacramento River in 1999.

Bioenergetics

Young salmon from the Yolo Bypass had higher total-prey weights (F = 39.2, df = 1, p < 0.0001) than those from the Sacramento River (Fig. 5). The bioenergetic-modeling results showed that Yolo Bypass salmon also had higher wet weight ration indices than those from the Sacramento River (F = 19.3, df = 1, p < 0.0001). The interaction between location and year was significant for both the wet weight ration indices (F = 10.0, df = 1, p = 0.02) and the prey weights (F = 4.7, df = 1, p = 0.03).

Discussion

Chinook salmon that rear in the Yolo Bypass floodplain have higher apparent growth rates than those that remain in the adjacent Sacramento River channels. Mean length increased faster in the Yolo Bypass during each study year, and CWT fish released in the Yolo Bypass were larger and had higher apparent growth rates than those released in the Sacramento River. It is possible that these observations are due to higher mortality rates of smaller individuals in the Yolo Bypass or of larger individuals in the Sacramento River; however we have no data or reasonable mechanism to support this argument.

Apparent growth differences between the two areas are consistent with water temperature and stomach-content results. We found that the Yolo Bypass floodplain had significantly higher water temperatures and that young salmon from the floodplain ate significantly more prey than those from the Sacramento River. The wet weight ration indices calculated from bioenergetic modeling suggest that the increased prey availability in Yolo Bypass was sufficient to offset increased metabolic requirements from higher water temperatures. Higher water temperatures in the Yolo Bypass are expected as a result of the shallow depths on the broad floodplain. Increased feeding success in the Yolo Bypass is consistent with trends in prey availability. While Yolo Bypass and the Sacramento River had similar levels of zooplankton, Yolo Bypass had more dipteran prey in the drift, particularly in 1998. Studies of juvenile chinook salmon diets by Rondorf et al. (1990) showed that zooplankton were the least-favored prey items. Therefore, the dominance of zooplankton in the diets of Sacramento River salmon probably reflects a relatively low availability of other more energetically valuable prey items.

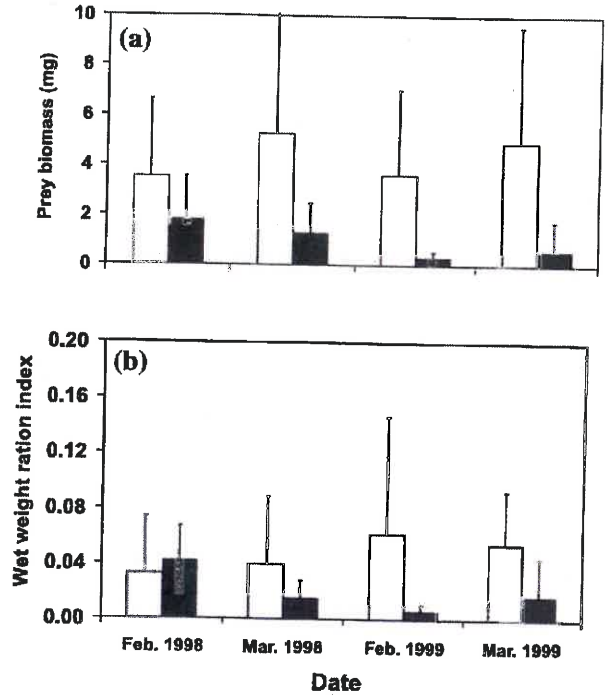
Recoveries of paired releases were too few to determine whether the higher survival indices for the Yolo Bypass release groups represent actual survival differences or random variation. Additional validation is needed from new release studies and from CWT recoveries in the adult ocean fishery and escapement. Nonetheless, the hypothesis that floodplain rearing could improve survival is substantiated by the growth data and bioenergetic modeling. Faster growth rates reflect improved habitat conditions, which would be expected to lead to improved survival, both during migration and later in the ocean. Elevated Yolo Bypass survival rates are also consistent with significantly faster migration rates in 1998, the likely result of which would be reduced exposure time to mortality risks in the delta, including predation and water diversions.

Improved survival is consistent with other habitat differences between the Yolo Bypass floodplain and the Sacramento River channel. We estimate that complete inundation of the Yolo Bypass creates a wetted area approximately 10 times larger than the reach of the Sacramento River we studied. This level of inundation is equivalent to a doubling of the wetted area of the entire delta portion of the San Francisco Estuary. Much of the floodplain habitat consists of broad shoals composed of soil and vegetation that are typical of the low-velocity conditions selected by young salmon (Everest and Chapman 1972). An increase in rearing area should reduce competition for food and space and perhaps reduce the probability of encountering a predator. In contrast, the Sacramento River channel is relatively narrow, with steep rock-reinforced banks and little shallow habitat. Migration through the Yolo Bypass corridor would also prevent fish from entering the channels of the central delta, in which there are various risks, including major water diversions (Brandes and McLain 2001). However, the Yolo Bypass is a less-stable environment, with stranding risks when flood waters recede. The relatively well-drained topography of the Yolo Bypass floodplain may help to reduce the magnitude of this problem. This is not to say, however, that access to floodplain rearing habitat represents the only mechanism to account for possible improvements in juvenile salmon survival in wetter years. Other covariates, such as reduced water temperature (Baker et al. 1995), reduced predation losses from higher turbidity (Gregory and Levings 1998), and reduced water diversion effects (Kjelson et al. 1982), also contribute to improved wet-year survival of salmon that migrate through the San Francisco Estuary.

The results from this study suggest that hydrology may affect salmon feeding success, migration, and survival in both floodplain and river habitat. The CWT results indicate that salmon grew faster, migrated faster, and may have had better survival rates in 1998 than in 1999. One clear difference between the years is that the flow pulses were higher and of longer duration in 1998 than in 1999. Higher flow could directly increase migration rates through higher water velocities and have multiple indirect effects on growth through factors such as food supply or water temperature. The abundance of Diptera in drift samples was substantially higher in 1998 than in 1999 in both locations. The significant interaction between location and year for both prey weights and the wet weight ration index indicates that the combined effects of diet and water temperature under 1998 hydrology should have resulted in higher growth rates. Higher growth rates and faster migration times in 1998 may, in turn, have improved survival by reducing predation risk. Higher-flow conditions in 1998 increased the quantity and duration of floodplain rearing area, perhaps reducing resource competition and predator encounter rates. Increased flow duration and magnitude in 1998 could also have improved survival on the floodplain by reducing stranding risks.

These results provide new insight into the significance of seasonal floodplain habitat for salmon rearing, which has been studied primarily in perennial waterways such as estuaries and rivers (Healey 1991; Kjelson et al. 1982). Indeed, this is the first study we are aware of demonstrating that off-channel floodplain provides major habitat for chinook salmon. We do not believe that the benefits of the floodplain to chinook salmon are unique to Yolo Bypass. Initial results from the Cosumnes River, an undammed watershed in the delta, show similar growth enhancements for juvenile chinook salmon that rear on the floodplain rather than in adjacent river channels (Peter Moyle, University of California, Davis, CA 95616, personal communication). Moreover, the benefits of the floodplain to salmon are consistent with findings for other fish species. Sommer et al. (1997) found that the Yolo Bypass provides major spawning, rearing, and foraging habitat for the native cyprinid Sacramento splittail (*Pogonichthys macrolepidotus*). The spawning and rearing of fish on floodplains has been reported in diverse locations that range from small streams (Halyk and Balon 1983; Ross and Baker 1983) to large rivers (Copp and Penaz 1988) in both temperate (Gehrke 1992; Turner et al. 1994) and tropical (Winemiller and Jepsen 1998) locations. The growth effects of floodplain habitat have been described for several tropical locations (Welcomme 1979); however, the present study and the results of Gutreuter et al. (2000) represent the only examples from temperate rivers of which we are aware.

Fig. 5. Feeding success results for Yolo Bypass (open bars) and Sacramento River (solid bars) juvenile salmon during 1998 and 1999. (*a*) Estimated prey weights in stomach contents. (*b*) Wet weight ration indices. Means and standard errors are shown.



Differences between the invertebrate communities in floodplains versus river channels have been reported by Castella et al. (1991). The exceptional production of drift invertebrates on the Yolo Bypass floodplain is consistent with the results of Gladden and Smock (1990), who found that invertebrate production was one to two orders of magnitude greater on the floodplain than in adjacent streams. Although we did not monitor benthic invertebrates, results from other studies of large rivers indicate that benthic biomass may be up to an order of magnitude higher in the floodplain (Junk et al. 1989). The Yolo Bypass drift invertebrate results contrast with the results for zooplankton, which were not particularly abundant on the floodplain. This finding is comparable with that of Welcomme (1979), who reported that densities of zooplankton in natural floodplains are frequently low, except for low-water periods and localized concentrations near habitat interfaces such as shorelines.

The mechanism for greater abundance of drift invertebrates in the Yolo Bypass remains unclear, but is unlikely to be an artifact of land use on the floodplain. Possible explanations for increased drift abundance include increased food supply (e.g., primary production or detritus), more habitat, and longer hydraulic residence times. For each of these mechanisms, Yolo Bypass probably provides functions similar to more "natural" floodplains. Improved food supply is supported by the work of Jassby and Cloern (2000), whose modeling studies suggest that the Yolo Bypass should have enhanced phytoplankton production as a result of its large surface area and shallow depth. Inputs of fertilizers from agriculture in the Yolo Bypass would not be important contributing factors, as nitrogen and phosphorous are rarely limiting to phytoplankton production in the delta (Ball and Arthur 1979). Like less-disturbed floodplains in other regions (Junk et al. 1989), invertebrate production in the Yolo Bypass may be stimulated by an increased availability of detritus in the food web. Alternatively, the trends in invertebrate abundance we observed may be a consequence of physical differences between floodplain and channel habitat. Inundation of the floodplain may increase the amount of habitat for benthic invertebrates, a major source of drift biomass. Given the larger surface area and lower velocities in Yolo Bypass, the floodplain probably has a much longer hydraulic residence time than the Sacramento River, reducing the rate at which drift invertebrates would be flushed out of the system. Increased habitat area and hydraulic residence time would also have been functional characteristics of the historical floodplain.

In the broader context, the results for salmon and drift invertebrates are consistent with the flood pulse concept, which predicts that floodplains should yield greater fish and invertebrate production than channel habitat (Junk et al. 1989). This finding is significant in that the flood pulse concept was developed primarily on the basis of relatively undisturbed rivers, whereas our study was conducted in a regulated river with a floodplain dominated by agricultural uses. Gutreuter et al. (2000) showed similar enhancements in fish growth from floodplain inundation in the Upper Mississippi River, another large regulated river. These studies suggest that floodplains can maintain important functional characteristics even in heavily modified rivers. In the case of the San Francisco Estuary and its tributaries, we do not claim that floodplain inundation is the primary factor regulating the productivity of the system. The Yolo Bypass floodplain may be seasonally more productive than the Sacramento River for some fish and invertebrates, but we have no data regarding its contribution during dry months or years. Nonetheless, the results of the present study and of Sommer et al. (1997) are sufficient to demonstrate that the floodplain represents one of the most biologically important habitat types in the region. We believe that proposed large-scale restoration activities in the San Francisco Estuary and its tributaries (Yoshiyama et al. 2000) that would increase the area and connectivity of the floodplain offer particular promise for native fish populations such as chinook salmon and Sacramento splittail.

Acknowledgements

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[Article]

Habitat Use and Stranding Risk of Juvenile Chinook Salmon on a Seasonal Floodplain

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Abstract.—Although juvenile Chinook salmon *Oncorhynchus tshawytscha* are known to use a variety of habitats, their use of seasonal floodplains, a highly variable and potentially risky habitat, has not been studied extensively. Particularly unclear is whether a seasonal floodplain is a net "source" or a net "sink" for salmonid production. To help address this issue, we studied salmon habitat use in the Yolo Bypass, a 24,000-ha floodplain of the Sacramento River, California. Juvenile salmon were present in the Yolo Bypass during winter–spring; fish were collected in all regions and substrates of the floodplain in diverse habitats. Experimental releases of tagged hatchery salmon suggest that the fish reared on the floodplain for extended periods (mean = 33 d in 1998, 56 d in 1999, and 30 d in 2000). Floodplain rearing and associated growth are also supported by the significantly larger size of wild salmon at the floodplain outlet than at the inlet during each of the study years. Several lines of evidence suggest that although the majority of young salmon successfully emigrated from the floodplain, areas with engineered water control structures had comparatively high rates of stranding. Adult ocean recoveries of tagged hatchery fish indicate that seasonal floodplains support survival at least comparable with that of adjacent perennial river channels. These results indicate that floodplains appear to be a viable rearing habitat for Chinook salmon, making floodplain restoration an important tool for enhancing salmon production.

A large downstream movement of fry to provide dispersal to rearing areas is typical of ocean-type Chinook salmon *Oncorhynchus tschawytcha* (Healey 1991). Rearing areas include channel and off-channel habitat in natal and nonnatal streams and their estuaries (Bjornn 1971; Kjelsen et al. 1982; Levy and Northcote 1982; Swales et al. 1986; Swales and Levings 1989; Healey 1991; Shreffler et al. 1992). Recently, Sommer et al. (2001b) observed that juvenile Chinook salmon also live on seasonal floodplains. Large rivers and streams typically have dynamic floodplains varying in size from several to thousands of hectares, unless their channels are heavily confined by topography (e.g., streams at high elevation or confined by canyons or levees). Floodplains are known to be of major importance to aquatic ecosystems in most regions; large rivers typically favor the development of a fauna adapted to colonize this habitat (Welcomme 1979; Junk et al. 1989; Sparks 1995). As a result, it is reasonable to expect dispersing salmonid fry show some ability to use seasonal habitat. In support of this hypothesis, Sommer et al. (2001b) reported that food resources and water temperatures on the seasonal floodplain of a large river were superior to those in an adjacent perennial channel, resulting in enhanced growth rates of young salmon. Despite some evidence that enhanced growth on the floodplain improved fry–smolt survival in the estuary, Sommer et al. (2001b) did not address any effects on adult production.

Intuitively, rearing in seasonal floodplains or intermittent streams seems risky because these habitats are among the most dynamic on earth (Power et al. 1995). It is still unknown whether seasonally dewatered habitats are a net "source" or a "sink" for salmonid production relative to production in permanent stream channels (Brown 2002). In particular, the high degree of seasonal flow fluctuation characteristic of floodplain habitat could cause major stranding events and increase mortality rates of young salmon (Bradford 1997; Brown 2002). For resident taxa in intermittent streams, the benefits of very large flow fluctuations appear to outweigh costs associated with a variable environment (Spranza and Stanley 2000). This issue continues to be a key concern for regulatory agencies that evaluate off-channel restoration projects or proposed flow fluctuations for possible effects on fishes (Brown 2002; Bruce Oppenheim, NOAA Fisheries, personal communication).

Here, we describe spatial and temporal trends in juvenile Chinook salmon habitat use and stranding in a large California river floodplain. Our study was conducted in the Yolo Bypass, the primary floodplain of the Sacramento River, the major pro-

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Exhibit "Q"

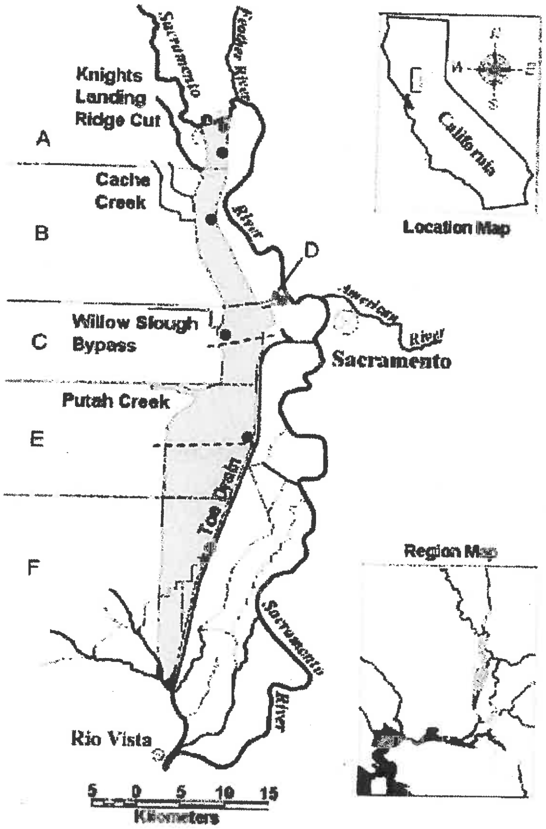

FIGURE 1.—Location of Yolo Bypass in relation to the San Francisco Bay–Delta and its tributaries. Fremont Weir is the upper (northern) edge of the Yolo Bypass. The major regions of the floodplain are delineated from north to south and correspond to the following codes: (A) Fremont Weir; (B) Cache Creek sinks; (C) Yolo Bypass Wildlife Area; (D) Sacramento Bypass; (E) Putah Creek Sinks; and (F) Liberty Island. The sampling locations are identified as follows: beach seine sites (solid circles); screw trap (star); and purse seine transects (dotted lines).

ducer of salmon in the San Francisco estuary (Figure 1). Because the Yolo Bypass can convey 75% or more of the total flow from the Sacramento River basin (Sommer et al. 2001a), this floodplain can be expected to be a migratory pathway for a substantial number of juvenile Chinook salmon. A major objective of our study was to collect basic information about the timing, duration, and habitat use of salmon on floodplains. We hoped that these data would provide insight into whether a floodplain is a net source (i.e., with rearing benefits) or a net sink (i.e., with high mortality because of stranding or predation) for salmon populations. The major hypotheses evaluated were as follows: (1) salmon occur in all major habitat types and geographic regions; (2) floodplains provide rearing habitat for salmon and are not simply a migration corridor; and (3) stranding of juvenile salmon does not have a major population-level effect on survival of the fish that use floodplain habitat. We addressed these hypotheses by sampling wild fish throughout the floodplain, experimentally releasing tagged fish, and using hydrologic modeling and measurements of physical conditions to describe how habitat varied over the study period.

Study Area

The San Francisco Estuary and its two component regions, Sacramento–San Joaquin Delta and downstream bays (Figure 1), make up one of the largest estuaries on the Pacific coast of North America. Major changes to the system have included diking and isolation of about 95% of the wetlands, introduction of exotic species, channelization, sediment inputs from hydraulic mining, and discharge of agricultural and urban chemicals (Nichols et al. 1986; Kimmerer 2002). The Estuary receives most freshwater via the Delta, which drains approximately 100,000 km^2. Most precipitation occurs upstream of the Delta during winter and spring, resulting in a greater than 10-fold seasonal range of daily freshwater flow into the estuary. However, the hydrograph is substantially altered by dams on each of the major rivers. Peak flow pulses typically occur during winter, but dam operations can reduce the magnitude of the pulses, particularly in dry years, when much of the inflow is captured behind reservoirs (Mount 1995; Kimmerer 2002). The historically prominent spring flow pulse from snowmelt is at present muted except during heavy, late-season storms. For the past several decades, much of the spring snowmelt has been stored in reservoirs and released during summer and autumn, periods of historically lower flow. As much as 65% of the net Delta flow during summer and autumn is diverted from the channels by two large water diversions (the State Water Project and the Central Valley Project); additional water is diverted by 2,200 pumps and siphons for irrigation (Kimmerer 2002).

The 24,000-ha Yolo Bypass is the primary floodplain of the Delta (Sommer et al. 2001a). The majority of the floodplain is leveed to protect surrounding cities from floodwaters, but levees confine flow through the bypass only under very high flow events. The Yolo Bypass currently floods an average of every other year, typically under high-flow periods in winter and spring. The Yolo Bypass has a complex hydrology, with inundation possible from several different sources. The floodplain typically has a peak inundation period during January–March but can flood as early as October and as late as June. The primary input to the Yolo Bypass is through Fremont Weir in the north, which conveys floodwaters from the Sacramento and Feather rivers. During major storm events (e.g., >5,000 m^3/s), additional water enters from the east via the Sacramento Weir, adding flow from the American and Sacramento rivers. Flow also enters the Yolo Bypass from several small streams on its western margin, including Knights Landing Ridge Cut, Cache Creek, and Putah Creek. During much of the winter, water-suspended sediment levels in the Yolo Bypass and Sacramento River are high, generally resulting in secchi depths of less than 0.25 m. However, hydraulic residence times are typically longer in the Yolo Bypass than in the Sacramento River (Sommer et al. 2004). Floodwaters recede from the northern and western portions of the bypass along relatively even elevation gradients of 0.09% west–east and 0.01% north–south into a perennial channel on the eastern edge of the Bypass; they then rejoin the Sacramento River near Rio Vista. The majority of the Yolo Bypass is at present managed for wildlife in a mosaic that includes riparian, wetland, upland, and perennial pond habitats; however, a dominant land use during the past two decades, agriculture has decreased in recent years because of habitat restoration activities.

Our data collection focused on the fall-run juvenile Chinook salmon, currently the numerically dominant race in the Sacramento Valley (Yoshiyama et al. 2000). There are four races of Chinook salmon in the Sacramento Valley: winter, spring, late-fall, and fall-run. Like many other native fish, Chinook salmon in the San Francisco estuary and its tributaries have been adversely affected by such factors as habitat loss, water diversions, and species introductions (Bennett and Moyle 1996); as a result, the Sacramento River winter and spring run Chinook salmon are protected under the Federal Endangered Species Act. The typical life history pattern is for young fall-run salmon fry (approximately 35–70 mm fork length) to migrate from the tributaries during winter and spring to the estuary (Brandes and McLain 2001).

Methods

Physical habitat.—Because seasonal hydrologic variability is a key characteristic of floodplain habitat, we reasoned that detailed data on changes in physical habitat would be necessary to evaluate the responses of young salmon. Daily flow data were obtained from gauging stations in the floodplain, and temperature data were collected using continuous temperature recorders (Sommer et al. 2001b). However, the vast area of Yolo Bypass made it impractical to directly measure other parameters, such as depth and surface area. As an alternative, we used a hydrologic model to estimate these parameters (Sommer et al. 2004). To summarize, the model treated Yolo Bypass as a "reservoir" described by (1) basin geometry and (2) flow and stage time series. The Yolo Bypass floodplain geometry was developed from 200 cross-sections with data collected at 300-m intervals by standard rod and level survey techniques. Mean daily stage and flow data were obtained from five gauging stations in the Yolo Bypass. For each date in the time series, we used linear interpolation between the gauging stations to estimate the stage at each cross-section. The estimated stage value was then used to calculate conveyance characteristics of each cross-section: area, width, and wetted perimeter. The daily results for each cross-section were used to estimate total surface area and mean depth. The large scale of the study reach did not allow validation of the depth estimates. As a partial validation of the model, Sommer et al. (2004) estimated total inundated area for the Yolo Bypass by using aerial photographs on days when the floodplain was inundated (February 8 and March 2, 1998) and when the floodplain was draining (April 28, 1998). To provide additional information about areas where fish stranding and consequent losses could occur, we estimated the portion of the area that was isolated ponds versus inundated area that was actively draining to the Delta (i.e., perennial channels and adjacent inundated area) on April 28, 1998.

Fish habitat use.—We used beach seine sampling to examine which regions and substrates of the floodplain were used by young salmon (hypothesis 1). During January through April of each year, a 15-m seine (3.2-mm mesh) was used to sample six regions of the Yolo Bypass (Figure 1). Fixed stations were used in each region during flooded periods. After floodplain drainage, samples were collected randomly within each region. For all periods, the primary substrate type of the habitat (sand, mud, gravel, pavement, or vegetation). fish species and size, and an estimate of the surface area swept by the seine were recorded. Habitat use during flood events was summarized in terms of the percentage of samples that contained salmon for each region and substrate type.

To provide additional information about habitat use, we conducted purse seine sampling along two transects (Figure 1). This sampling, performed in 1998 when the Yolo Bypass flow was relatively high (>850 m^3/s), used purse seines (30.5 m × 4.6 m, 4.75-mm mesh) set from a jet boat. Purse seining was conducted at 1–2 transects up to five times weekly, depending on hydrology. Hauls were made at random points in each of three habitat types (riparian, agricultural fields, and wetlands), the boundaries of which were established from aerial photographs taken before the Bypass was inundated. In the case of riparian habitat, hauls were made in clearings adjacent to trees to avoid snagging. We also recorded transect side (east or west half) for each haul because the western side of the Yolo Bypass was shallower and flow was dominated by inputs from westside streams rather than from Fremont or Sacramento weirs (Sommer et al. 2004). Most of these hauls were performed in areas exposed to at least a modest current. Additional limited paired sampling was conducted to examine possible differences between areas with and without velocity refuges. Low-velocity habitats sampled included downstream edges of levees, islands, and clusters of trees. Water velocities in randomly selected areas were approximately 0–0.05 m/s compared with greater than 0.33 m/s in adjacent exposed areas. Water depths were similar for each sampling pair. Differences in salmon densities for each habitat type were examined by using a Kruskal–Wallace test. A randomization *t*-test with 1,000 iterations (Haddon 2001) was used to compare salmon density on the east and west sides of the floodplain.

Migration trends.—To examine temporal trends in salmon migration through the floodplain (hypotheses 2 and 3), we operated a rotary screw trap (EG Solutions, Corvallis, Oregon) near the base of the Yolo Bypass during each study year. This technique was intended to provide an indication of the timing and duration of migration, rather than an absolute measure of the number of salmon emigrating the floodplain. During much of the sampling period the inundated width of the floodplain was 1–5 km, an area we considered too large for the traditional mark–recapture evaluations required to measure trap efficiency and total emigration (Roper and Scarnecchia 1996). A 1.5-m-diameter trap was used for the first 3 weeks of sampling in February 1998, after which a 2.4-m trap was used for all other sampling. We operated traps as often as 7 days each week, the daily effort varying from 1 to 24 h, depending on debris load and safety considerations. Fish number and size were recorded in all years. In 1998, young salmon were classified as fry (prominent parr marks) or transitional fish/smolts (faded parr marks, silver appearance).

Floodplain residence time and growth.—We used experimental releases of salmon with coded wire tags (CWTs) as our primary method to evaluate fish residence time on the floodplain (hypothesis 2). Fry (mean size = 57 mm fork length) from the Feather River Fish Hatchery (Figure 1) were tagged by using coded-wire half tags (Northwest Marine Technologies) and released in the Yolo Bypass below the Fremont Weir on March 2, 1998 (53,000 fry); February 11, 1999 (105,000 fry); and February 22, 2000 (55,000 fry). We assessed residence time in the Yolo Bypass from recoveries of tagged fish in the screw trap at the base of the floodplain.

We also examined, using the previously described beach seine data, whether there was evidence of long-term rearing of wild salmon in the floodplain. We compared the slopes of weekly fork length measurements for the two northern beach seine regions ("North") to the southernmost region ("South"), using a generalized linear model (GLM) with a Poisson distribution and log link variance function. We reasoned that major significant differences between the sizes of fish in the two areas provided evidence of extended rearing and growth of fish in the floodplain.

Salmon survival and stranding.—We used several independent data sources to examine whether salmon successfully emigrated from the floodplain (hypothesis 3). First, we compared survival of each of the Yolo Bypass CWT hatchery-reared salmon release groups with the survival of parallel CWT groups containing the same number of fish released into the Sacramento River (Sommer et al. 2001b). Recapture rates at the smolt stage of the 1998 and 1999 release groups had previously been analyzed by Sommer et al. (2001b); in the present study, we evaluated adult recoveries in the commercial and recreational ocean fisheries through 2003. Second, we examined stranding by using beach seine data (described previously) collected within a few weeks after the Sacramento River stopped flowing into the Yolo Bypass. Densities of salmon were compared with a randomization *t*-test (Haddon 2001) for (1) isolated earthen ponds (2) perennial channels, and any sites immediately adjacent to these water sources. The results for all years were pooled because of relatively low sample sizes for individual years. Data for each year

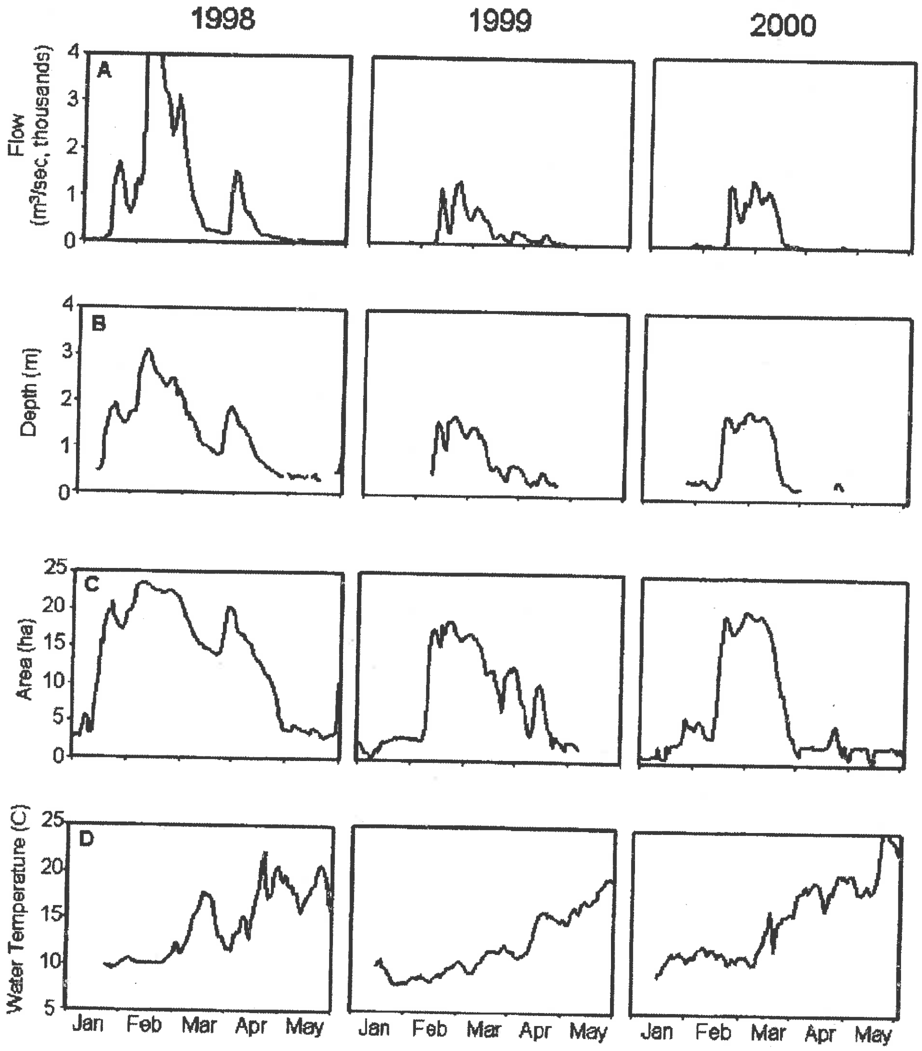

FIGURE 2.—Trends in physical variables for January–June 1998–2000: (A) mean daily flow in the Yolo Bypass; (B) simulated mean daily depth; (C) surface area; and (D) daily mean water temperature. The surface area data for 1998 and 2000 are from Sommer et al. (2004).

were first standardized for possible annual differences in abundance by conversion to z-scores; we then ran the randomization analysis using 1,000 iterations. We hypothesized that abundance of salmon would be equal in isolated ponds and contiguous water sources; that is, they would show no distinct "preferences." Our reasoning was that similar abundance levels would indicate successful emigration, because most of the water drains from the floodplain. To further understand factors that could affect stranding, we also used a randomization t-test to compare densities of fish in two types of isolated ponds: isolated earthen ponds and concrete weir scour ponds at Fremont and Sacramento weirs (Figure 1). Sampling effort was much greater in the isolated earthen ponds, so the randomization t-test was performed after randomly subsampling the earthen pond data from throughout the floodplain to provide equal sample sizes. We predicted that flood control structures would cause higher stranding than "natural" ponds. In addition, we examined trends in the catch of salmon in the screw trap data. We predicted that salmon catch would increase substantially during drainage because fish successfully emigrated the floodplain.

Results

Physical Habitat

The hydrographs varied substantially during the years of study (Figure 2A). In 1998 the hydrology was wet (4.4-year recurrence flood event) and the Yolo Bypass was inundated during mid-January through mid-April and again in early June. The flow was lower in the other 2 years, when inundation occurred between mid-February and mid-March, peak flood events being at the 1.7-year recurrence interval in 1999 and at the 2.4-year recurrence interval in 2000. Surface area in the Yolo Bypass closely followed the flow peaks, the amounts of inundated area being successively smaller in each of the study years (Figure 2C). For the April 28, 1998, photographs, the total surface area of 5,050 ha was slightly lower than the model estimate of 6,700 ha. Based on the aerial photographs, we estimated that only 600 ha of the 5,050 ha comprised isolated ponds, the remainder being water that drained to the Delta. For all but peak flood events, mean water depth remained less than 1 m (Figure 2B). During peak flood events, mean depths did not exceed 2 m except in February 1998. Water temperature showed gradual increases throughout each study year (Figure 2D).

Fish Habitat Use

We captured salmon in all regions of the floodplain and on all substrate types. During 1998–2000 flood events, salmon were captured in a high percentage of samples in each region (Figure 1) of the floodplain: (1) Fremont Weir (100%, n = 13 samples); (2) Cache Creek Sinks (50%, n = 16 samples); (3) Yolo Bypass Wildlife Area (77%, n = 22 samples); (4) Sacramento Bypass (100%, n = 7 samples); (5) Putah Creek Sinks (94%, n = 11 samples); and (6) Liberty Island (100%, n = 7 samples). Similarly, during 1998–2000 flood events we collected salmon on a high percentage of substrate types: (1) mud (70%, n = 47 samples); (2) sand (100%, n = 3 samples); (3) pavement (100%, n = 8 samples); (4) vegetation (97%, n = 32 samples); and 5) gravel (89%, n = 9 samples).

Salmon densities as estimated by purse seine sampling were not significantly different between riparian (mean abundance = 46.9/ha, SE = 10.4, n = 23), agricultural (mean abundance = 20.9/ha, SE = 6.1, n = 35), or natural vegetated habitat types (mean abundance = 27.5/ha, SE = 5.6, n = 31) based on a Kruskal–Wallis test (H = 4.38, df = 2, P = 0.112). There was also no statistically significant difference between the east (mean abundance = 29.5/ha, SE = 6.0, n = 53) and west (mean abundance = 29.9/ha, SE = 6.7, n = 36) sides of the Bypass as shown by a randomization t-test (P = 0.95). Salmon were collected in six hauls in low-velocity habitat (mean abundance = 189/ha, SE = 24/ha), but none were collected in adjacent areas exposed to a current.

Floodplain Migration Trends

Salmon migration as indicated by trends in screw trap catch was highly variable over the course of the study, but there were prominent peaks in Chinook salmon catch coincident with floodplain drainage during late March–April (Figure 3B). Additional smaller peaks in salmon catch also paralleled flow, mostly during February and March. The life history stage of salmon during 1998 was exclusively parr through the end of March, after which the majority showed signs of smoltification.

Floodplain Residence Time

Based on recoveries of tagged fish in the screw trap, the mean residence time of CWT salmon was 33 d (range, 16–46 d; n = 10) in 1998, 56 d (range, 4–76 d; n = 49) in 1999, and 30 d (range, 28–37 d; n = 25) in 2000. The size of fish was significantly larger (P<0.001; GLM) at the outlet of the floodplain than at the top (Figure 3C) during each of the study years.

Salmon Survival and Stranding

The numbers of CWT fish recovered for the Yolo Bypass were higher than in the Sacramento River in 1998, similar in 1999, and lower in 2000 (Table 1). Densities of wild Chinook salmon were highly variable during floodplain drainage events, with no statistically significant difference between densities in isolated earthen ponds and contiguous water sources (Table 2). However, densities of salmon were significantly higher (P < 0.0001; randomization t-test) in concrete weir scour ponds than in isolated earthen ponds (Table 3).

Discussion

Research on migratory fishes reveals that these species frequently have alternative life histories that may be influenced by habitat use at early life stages (Clark 1968; Secor 1999). Under Clark's (1968) "contingent hypothesis," migratory taxa have divergent migration pathways that could help the species deal with environmental variability and heterogeneity. This theory is consistent with our understanding of Chinook salmon, which are adapted to the extreme hydrologic variability in western North America and show a range of life histories (Healey 1991; Bottom et al. 2005). In this context, the use of multiple habitats—including natal and nonnatal streams (Bjornn 1971; Scriv-

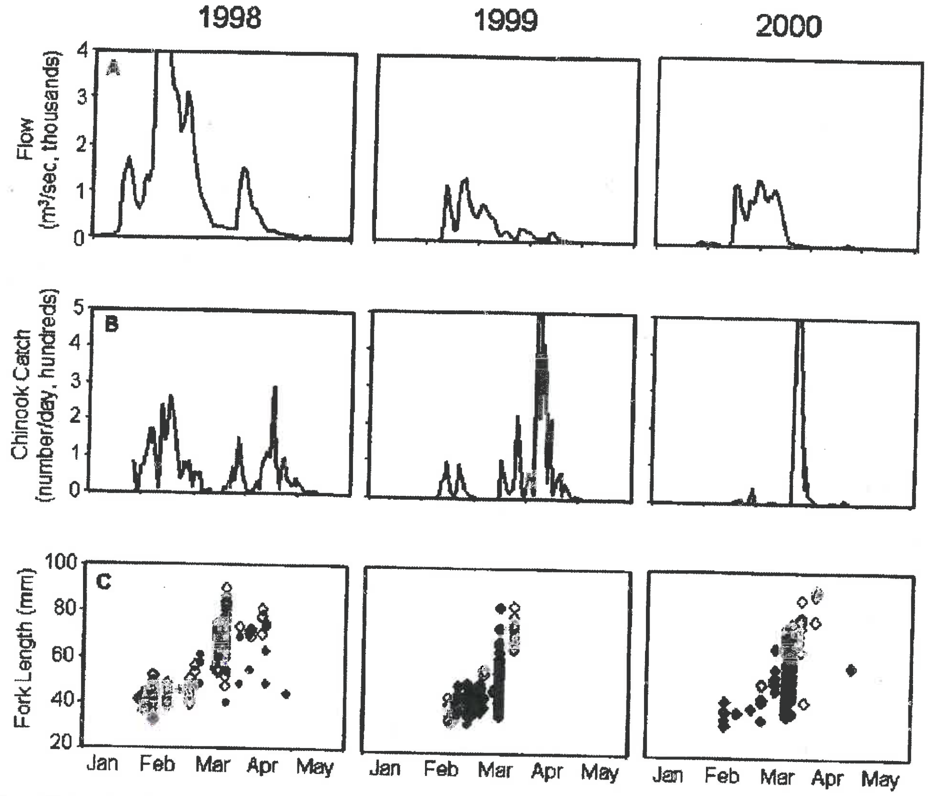

FIGURE 3.—Chinook salmon results during winter and spring 1998–2000: (A) mean daily flow; (B) salmon catch rates in screw trap sampling; and (C) salmon size for beach seine samples near the Yolo Bypass intake (solid symbols) and outlet (clear symbols).

ener et al. 1994), side channels and off-channel ponds (Swales et al. 1986; Swales and Levings 1989), low-elevation rivers (Kjelsen et al. 1982; Brown 2002), and estuaries (Healey 1991; Shreffler et al. 1992)—can be considered as part of an overall "bet-hedging" strategy that spreads risk across a variable environment. Despite the fact that seasonal floodplain represents perhaps the single most variable habitat available to salmon, our study suggests that floodplains are a viable rearing location for young fish.

TABLE 1.—Number of coded wire tags recovered in the ocean and commercial fisheries for Chinook salmon released in the Yolo Bypass and Sacramento River. The total number of tagged fish released in each location for each year is shown in parentheses. The survival ratio is calculated as the number of Yolo Bypass recoveries divided by the number of Sacramento River recoveries.

Release group	1998 (53,000)	1999 (105,000)	2000 (55,000)
Yolo Bypass	75	136	27
Sacramento River	35	138	47
Survival ratio	2.14	0.99	0.57

At the beginning of our study, our conceptual model for floodplain habitat use was that young salmon move into the floodplain during high-flow events and spread throughout the broad expanse of seasonally inundated habitat. Among the wide variety of suitable substrates and habitat types for rearing, young salmon appear to seek out low-velocity areas. Moreover, floodplain habitat apparently is not simply a migration corridor; many young salmon actively rear on the highly productive floodplain habitat for extended periods of time, resulting in high growth rates. Our findings suggest that salmon emigrate from the seasonally inundated habitat both during flood events and during drainage. Juvenile Chinook salmon do not appear to be especially prone to stranding mortality; indeed, survival may actually be enhanced by floodplain rearing in some years. Our conceptual model was supported by our results and has a variety of management implications.

Salmon were present in a broad range of habitat and substrate types and were collected in all regions and sides of the Yolo Bypass floodplain. The

TABLE 2.—Densities of Chinook salmon (number/ha ± SE, with sample size in parentheses) collected in beach seine sampling during drainage events in 1998–2000. The sample locations are divided into isolated earthen ponds and contiguous water sources. Density differences were not statistically significant between the two pond types based on a randomization t-test of the pooled data for all years ($P = 0.79$; $n = 43$ for isolated ponds; $n = 59$ for contiguous water sources).

Location type	1998	1999	2000
Isolated ponds.	206 ± 112 (30)	890 ± 491 (8)	126 ± 65 (5)
Contiguous water sources	167 ± 79 (33)	310 ± 104 (13)	463 ± 123 (13)

fact that they were present on the western half of the Bypass, where flows are dominated by Knights Landing Ridge Cut and Cache and Putah creeks, suggests that salmon spread throughout the floodplain after entering the basin by way of Fremont and Sacramento weirs. A few of these fish may have originated from a modest spawning population in Putah Creek (Marchetti and Moyle 2001). The fact that salmon were present in a wide range of habitat and substrate types and in different regions of the Yolo Bypass indicates that many areas of habitat were suitable, although this does not mean that there were no habitat preferences. Like many young fishes, much of the distribution of juvenile Chinook salmon can be explained by their association with shallow depths and low velocities (Everest and Chapman 1972; Roper et al. 1994; Bradford and Higgins 2001). The physical modeling indicated that mean depths were generally 1 m or less during all but peak flood periods, so much of the thousands of hectares of inundated habitat was probably within the shallow range typically preferred by young Chinook salmon (Everest and Chapman 1972). Our limited purse seine sampling suggested that young salmon were most abundant in low-velocity areas, which is consistent with previous studies in river and stream habitat (Everest and Chapman 1972; Roper et al. 1994; Bradford and Higgins 2001). We did not directly simulate water velocity in the present study; however, the relatively shallow water depth during flood events reflects the broad area of low-velocity rearing habitat created during flood events. We expect that this increase in rearing habitat in the Yolo Bypass provides foraging opportunities (Sommer et al. 2001b), reduced energy expenditure, and perhaps reduced probability of encounter with a predator (Ward and Stanford 1995).

Our results also suggest that fish rear in the system for extended periods rather than simply using it as a migration corridor. The mean residence time of 30–56 d for the 44-km reach between the floodplain release location and the screw trap is substantially longer than one would expect, given that (1) fingerlings are capable of migrating at rates of at least 6–24 km/d in low-elevation reaches of other large rivers (Healey 1991) and (2) one of our 1999 CWT fish was recovered just 4 days after being released, having traveled an estimated rate of 11 km/d. The fish were significantly larger at the base of the Yolo Bypass, suggesting that their period of residence in the floodplain was long enough to support substantial growth. Similarly, Sommer et al. (2001b) found that salmon showed higher growth rates in the Yolo Bypass than in the adjacent Sacramento River, primarily because of higher levels of invertebrate prey in the floodplain. A long period of rearing is also supported by the screw trap data, which showed that the densities of salmon were greatest during drainage of the floodplain. We believe that these peaks are a result of rearing salmon being forced off of the floodplain by receding flows. Temperature and salmon life history stage do not provide good alternative explanations for the emigration trends. In 1998, for example, water temperatures were relatively high by late March and salmon began smoltification shortly thereafter; yet the screw trap data indicate

TABLE 3.—Densities of Chinook salmon (number/ha ± SE, with sample size in parentheses) collected in beach seine sampling for earthen ponds and adjacent concrete weir ponds. Density differences were statistically significant between the two pond types based on a randomization t-test of the pooled data for all years ($P < 0.0001$; $n = 26$ for each pond type). Note that we used a randomly sampled subset of the earthen pond data to provide equal sample sizes for the comparison.

Location type	1998	1999	2000
Earthen ponds	186 ± 67 (63)	531 ± 200 (21)	369 ± 97 (18)
Concrete weir ponds	2,717 ± 1,115 (14)	14,208 ± 3,898 (12)	4,181 ± 1,275 (3)

that emigration did not peak until the end of April, when the floodplain drained. Perhaps the emigration trends are partially confounded by seasonal variation in salmon abundance. In the absence of trap efficiency data, we cannot estimate the proportion of the population that emigrated in winter versus spring events.

Several lines of evidence suggest that the majority of fish successfully emigrated from the floodplain. One important observation was that the area of isolated ponds was small relative to the overall area of the floodplain during both peak flood and drainage periods. As an example, in 1998, the wettest year we studied, the peak area of inundation was 24,000 ha, but the total inundated area dropped to 5,000 ha by late April. Of the 5,000 ha remaining at this point, our estimates from aerial photographs showed that isolated ponds took up only 600 ha. Put another way, isolated ponds represented just 12% of the wetted area in April and only 2.5% of the peak inundated area in winter. The same trend is evident in the area simulations for 1999 and 2000, when the peak area was 20,000 ha, but dropped to about 2,000 ha within a month. These results demonstrate that the Yolo Bypass drains fairly efficiently, leaving little isolated area where stranding can occur. This finding was somewhat unexpected, because many parts of the Yolo Bypass have natural topographic features or agricultural levees that could potentially impede drainage and fish emigration. Even if the area of isolated ponds is low, stranding could still be a substantial source of mortality if densities of fish in the remaining ponds were very high. However, we found no evidence that densities of fish stranded in isolated ponds were significantly higher than those in contiguous water sources that were draining to the Delta. The key point here is that most of the water drains from the floodplain and apparently the majority of the fish are leaving with the receding floodwaters. To help illustrate this issue, if we assume that mean densities of fish observed in Table 2 were representative of the entire wetted area of floodplain in April 1998, then the total number of fish in the 600 ha of isolated ponds would have been 123,600 salmon, lower than an estimate of 835,000 fish in the 5,000 ha of contiguous water sources. This conservative estimate also does not include the large numbers of fish that emigrated from the floodplain before April.

In addition to the beach seine and surface area data, we believe that trends in screw trap data support the hypothesis that stranding is not consistently a major problem on the floodplain. The screw trap data are somewhat ambiguous, because the large area of the floodplain makes it unreasonable to measure the efficiency of the trap. Therefore, we cannot accurately estimate the absolute number of salmon emigrating from the floodplain. However, we can at least examine the patterns of trap catch to evaluate likely mechanisms. Some of the possible patterns that we would expect to see for different factors are summarized in Figure 4. First, under the "trap efficiency" model, we would have expected dual peaks in the earliest and latest portions of flood events, when the screw trap would be sampling the highest portion of total flow (Figure 4A). If young salmon follow the "go with the flow" model, catch and flow peaks should be well-correlated (Figure 4B). Alternatively, if floodplains represent an important rearing habitat, we would expect catch trends to follow the "loitering" model, in which catch does not increase until drainage, when fish are forced from their rearing habitat by receding floodwaters (Figure 4C). Finally, if stranding were a major factor controlling catch trends, we would expect an early increase in catch as fish moved through the floodplain during inundation, but then catch should drop earlier than flow as young salmon became isolated from draining floodwaters (Figure 4D; "bathtub" model). Of these patterns, our data for the Yolo Bypass provide the strongest support for both the "go with the flow" and "loitering" models. In each year we saw obvious screw trap catch peaks associated with flow events, and additional prominent peaks associated with drainage. To summarize, apparently some of the fish move

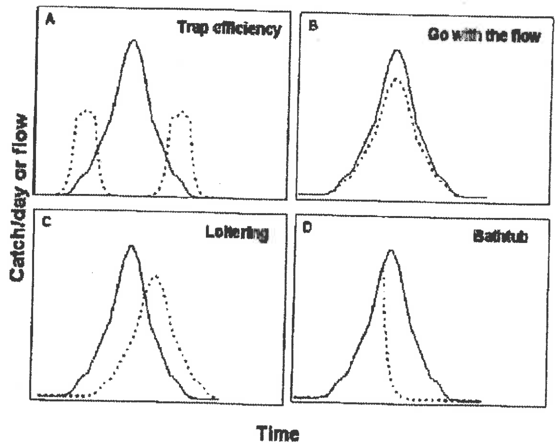

FIGURE 4.—Four conceptual models of expected screw trap catch (dotted line) relative to flow (solid line). See the Discussion for further details about each model.

through the floodplain in direct association with flow, whereas others remain as long as possible to rear on the floodplain. The screw trap trends show no evidence that stranding had a major influence on patterns of emigration.

Relatively low stranding rates on the Yolo Bypass floodplain are supported by observations from other seasonal floodplain habitat in the San Francisco estuary (Peter Moyle, University of California–Davis, personal communication) and other studies. Higgins and Bradford (1996) and Bradford (1997) report that juvenile salmonids are relatively mobile and that most avoid being stranded during moderate rates of stage change. Higgins and Bradford (1996) state that maximum recommended stage reduction levels for gravel bars of regulated rivers are typically 2.5–5 cm/h, much more than the 1 cm/h or less rates of change in mean water depth we observed during drainage in the present study. In his review of the ecology of fishes in floodplain rivers, Welcomme (1979) noted that the majority of fish emigrate from floodplain habitat during drainage.

Even if stranding is not a major source of mortality, this does not necessarily mean that floodplains are not sinks for salmon production. Of the possible sources of mortality, birds and piscivorous fishes may have benefited from stranded salmon (Brown 2002). As noted by Sommer et al. (2001a), major avian predation is unlikely because densities of wading birds are low relative to the thousands of hectares of rearing habitat available during flood events. We did not measure densities of fish predators, but believe that the creation of large areas of rearing habitat should create more refuges for young fish and decrease the probability of encounter with a predator.

Ultimately, it is survival data that allow us to differentiate source from sink habitat. The size and complexity of the San Francisco estuary made it very difficult to directly measure survival rates with statistical rigor (Newman and Rice 2002); however, our CWT release studies at least provide an indication of whether survival rates in the Yolo Bypass were substantially different from those in the Sacramento River, the adjacent migration corridor. The limited results suggest that fry–adult survival rates were at least comparable in the Yolo Bypass and the Sacramento River. Moreover, the 1998 results suggest that in some years, survival may actually be substantially higher for salmon that migrate through the floodplain. Although none of these CWT releases were replicated, the fact that Sommer et al. (2001b) reported similar results for fry-to-smolt survival for the same releases in 1998 and 1999 increases our confidence that the survival data are not spurious.

Our data indicate that floodplains are a viable rearing habitat for juvenile Chinook salmon. Hence, the most important management implication of our study is that seasonal habitat should be considered as part of restoration plans for this species. Despite frequent concerns that off-channel habitat could increase stranding mortality (Brown 2002; Bruce Oppenheim, NOAA Fisheries, personal communication), our results for a hydrologically variable seasonal floodplain suggest that one should be able to design restoration projects that do not create a population sink because of excessive mortality. This is not to say, however, that stranding mortality is never an issue on floodplain habitat. For example, in the Yolo Bypass we saw significantly higher stranding rates in the concrete weir scour ponds of Fremont and Sacramento weirs than in earthen ponds. This finding suggests that artificial water control structures can create unusual hydraulics that promote stranding. However, the total area of these concrete weir ponds was only 3 ha, much smaller than our estimate of 600 ha for total isolated pond area for April 1998 and insignificant compared with the peak inundated area of 24,000 ha area. Fixing the poor hydraulics at these water-control structures may, nonetheless, be an attractive option, particularly if the cost of the solution is relatively low or if it helps to address other fisheries issues such as adult fish passage. In the Yolo Bypass, the concrete weirs not only create stranding problems for juveniles but also frequently block upstream passage of adult salmon, sturgeon, and steelhead trout (Sommer et al. 2001a), thus creating an incentive to resolve both issues simultaneously.

Finally, we wish to acknowledge that even natural floodplain or well-designed restored floodplain habitat could at least occasionally be a population sink because of stranding or predation losses. Our study was conducted over 3 years for a single, large floodplain; we cannot rule out the possibility that floodplains may not have net benefits in other years or locations. As an example, fish densities in the Yolo Bypass were relatively low compared with those reported in some other studies (Levy and Northcote 1982; Swales et al. 1986; Swales and Levings 1989); perhaps young salmon behavior could be different at higher densities. However, the potential for such losses can still be consistent with effective management of salmon populations. Diverse life history strategies provide bet-hedging for salmon populations in the highly variable environment of coastal tributaries (Secor 1999; Bottom et al. 2005). We therefore expect that young salmon will not thrive in all habitats in every year. In the case of highly variable seasonal environments such as floodplains, stranding losses might cause excessive mortality in some years, but the risks may be offset by increased rearing habitat and food resources in other years (Sommer et al. 2001b; Brown 2002).

Acknowledgments

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Insights into the
Problems, Progress, and Potential Solutions
for Sacramento River Basin Native Anadromous Fish Restoration

Spring-Run Chinook Salmon in Mill Creek, California (Photo by Dave Vogel)

April 2011

Prepared for:

Northern California Water Association
and
Sacramento Valley Water Users

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Exhibit "R"

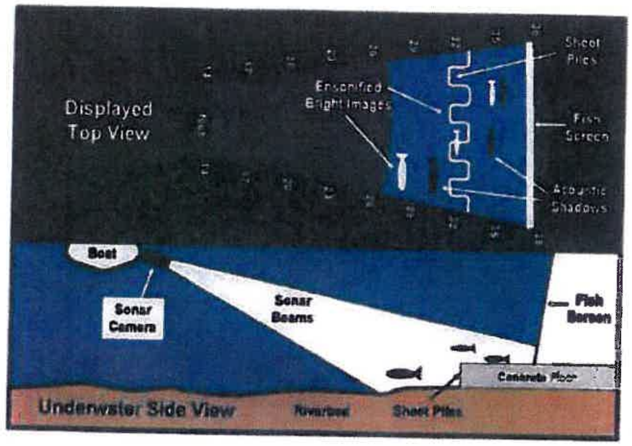


Figure 60. Schematics of DIDSON™ imaging at the base of a flat-plate fish screen. Bottom diagram shows orientation of sonar beams from the acoustic camera off the side of a boat and submerged objects at the fish screens. Top diagram shows the resultant corresponding sonar imaging of objects ensonified with acoustic shadows from the objects. (from Vogel 2008b)

From 1996 through 2010, Natural Resource Scientists, Inc. conducted 22 separate research projects on juvenile salmon (including four studies of predatory fish) in the Delta using acoustic or radio telemetry as a means to gain an improved understanding of fish movements and mortality (Vogel 2010a). The reason juvenile salmon telemetry studies were initiated in the Delta was to acquire detailed data on fish behavior, fish route selection through complex channels, and estimate fish survival in discrete reaches. Past efforts using traditional coded-wire tagging could not answer those critically important questions. Research findings from the telemetry investigations indicate that smolt survival assumptions and models must incorporate these new conclusions to avoid misinterpretation of data and improve quantitative estimates of fish survival and movements (Vogel 2010a).

The first successful use of telemetry on juvenile salmon in the Central Valley was conducted by Natural Resource Scientists, Inc. on behalf of EBMUD in 1996 and 1997. At that time, the specific behavior of juvenile salmon in the Delta was largely unknown. The initial studies quickly determined that the fish did not move as a school, but instead, dispersed, exhibiting a wide range in migratory behaviors in the complex Delta environment. Salmon moved many miles back and forth each day with the ebb and flood tides and the side channels (where flow was minimal) were largely unused. Site-specific hydrodynamic conditions present at flow splits when the fish arrived had a major affect in initial route selection. Importantly, some of the salmon were believed to have been preyed upon based on very unusual behavior patterns (Vogel 2010a).

Subsequent, additional juvenile salmon telemetry studies were conducted by Natural Resource Scientists Inc. on behalf of the USFWS and CALFED in the north Delta (Vogel 2001, Vogel 2004). Triangulating radio-tagged fish locations in real time (Figure 61) clearly demonstrated how juvenile salmon move long distances with the tides and were advected into regions with very large tidal prisms, such as upstream into Cache Slough and into the flooded Prospect and Liberty Islands (Figure 62). During the studies, it was determined that some radio-tagged salmon were eaten by predatory fish in northern Cache Slough, near the levee breaches into flooded islands (discussed below). Also, monitoring telemetered fish revealed that higher predation occurred in Georgiana Slough as compared to the lower Sacramento River (Figure 63). As discussed previously, past coded-wire tagging studies found that salmon released into northern Georgiana Slough were found to have a higher mortality rate than fish released downstream of the slough in the Sacramento River (Brandes and McLain 2001).

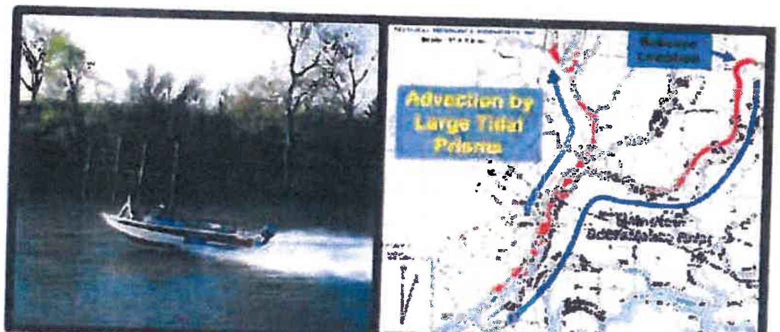


Figure 61. Left picture, mobile telemetry conducted in the north Delta. Photo by Dave Vogel.
Figure 62. Right picture, telemetered locations of approximately 100 radio-tagged salmon smolts released in the lower Sacramento River near Ryde (data from Vogel 2001 and Vogel 2004).

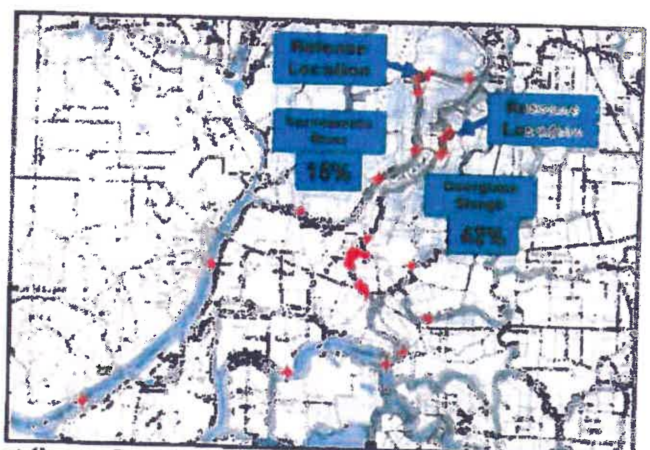
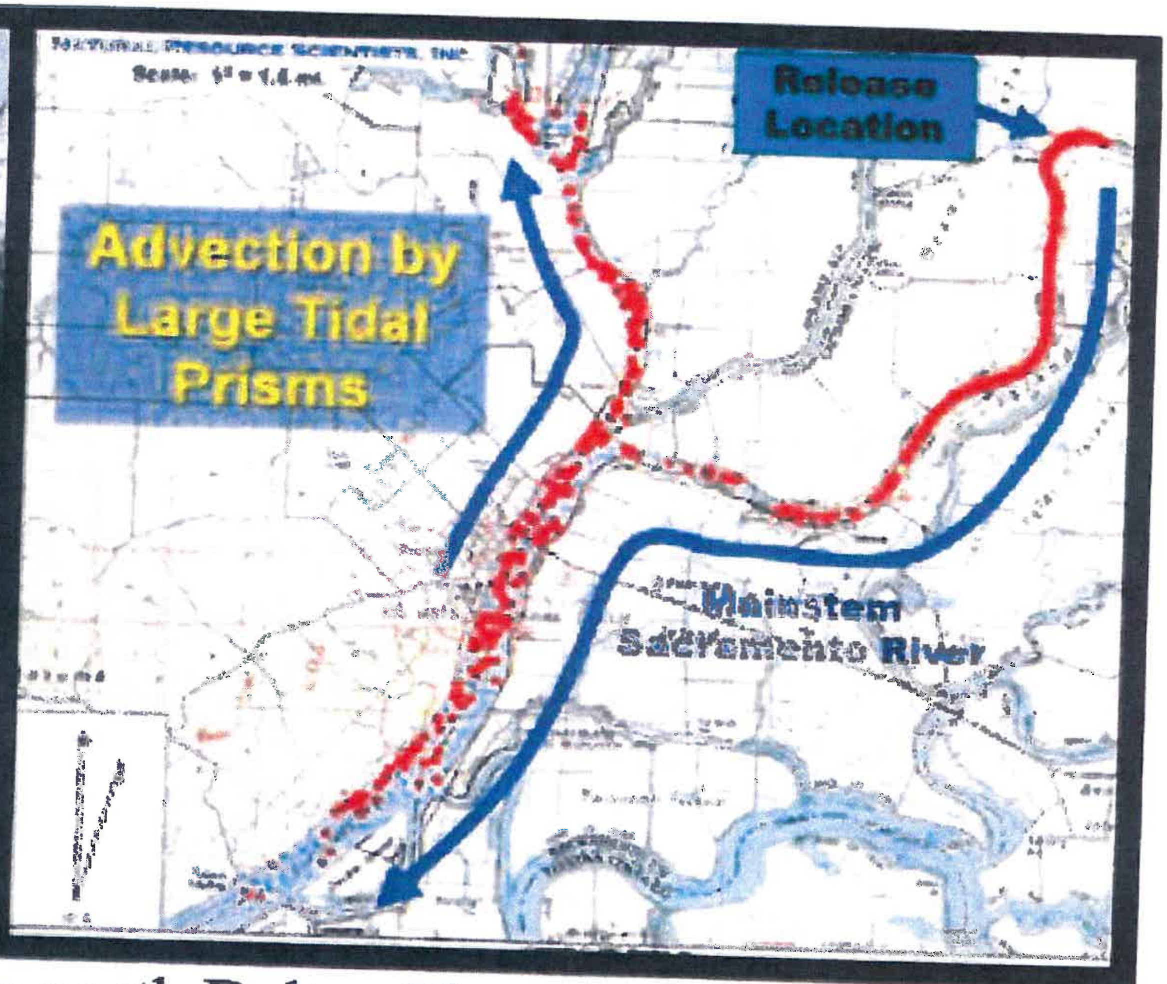


Figure 63. Estimated mortality rate for groups of radio-tagged salmon released at two locations in the north Delta and locations where radio-tagged salmon smolts were detected to have been preyed upon (Vogel 2001, Vogel 2004).

More recently, a 2007 study conducted by releasing acoustic-tagged juvenile salmon in the San Joaquin River found 116 motionless juvenile salmon transmitters in the lower San Joaquin River near the Stockton Waste Water Treatment Plant and a nearby bridge (Figure 64) (Vogel 2007b). This was an all-time record for the largest number of dead radio- or acoustic-telemetered juvenile



ducted in the north Delta. Photo by Dave Vogel.
ıs of approximately 100 radio-tagged salmon smolts released in the

vegetation at some sites in the Delta and water clarity. Increased water clarity for sight predators such as black bass and striped bass would presumably favor predatory fish over prey (*e.g.*, juvenile salmon). Fewer native fish species are found in *Egeria* stands compared to introduced fish species (Grimaldo and Hymanson 1999). Additionally, it has been hypothesized that high densities of *Egeria* in portions of the Delta may restrict juvenile salmon access to preferred habitats, forcing salmon to inhabit deep water or channel areas where predation risks may be higher (Grimaldo *et al.* 2000).

During recent years, there has been an emphasis to reclaim or create shallow, tidal wetlands to assist in re-recreating the form and function of ecosystem processes in the Delta with the intent of benefitting native fish species (Simenstad *et al.* 1999). Among a variety of measures to create such wetlands, Delta island levees either have been breached purposefully or have remained unrepaired so the islands became flooded. A recent example is the flooding of Prospect Island which was implemented under the auspices of creating shallow water habitat to benefit native fish species such as anadromous fish (Christophel *et al.* 1999). Initial fish sampling of the habitat created in Prospect Island suggested the expected benefits may not have been realized due to an apparent dominance of non-native fish (Christophel *et al.* 1999). Importantly, a marked reduction of sediment load to the Delta in the past century (Shvidchenko *et al.* 2004) has implications in the long-term viability of natural conversion of deep water habitats on flooded Delta islands into shallow, tidal wetlands. The very low rates of sediment accretion on flooded Delta islands indicate it would take many years to convert the present-day habitats to intertidal elevations which has potentially serious implications for fish restoration (Nobriga and Chotkowski (2000) due to likely favorable conditions for non-salmonid fish species that can prey on juvenile salmon. Studies of the shallow water habitats at flooded Delta islands showed that striped bass and largemouth bass represented 88 percent of the individuals among 20 fish species sampled (Nobriga *et al.* 2003).

There have likely been significant adverse, unintended consequences of breaching levees in the Delta. There is a high probability that site-specific conditions at the breaches have resulted in hazards for juvenile anadromous fish through the creation of favorable predator habitats. The breaches have changed the tidal prisms in the Delta and can change the degree in which juvenile fish are advected back and forth with the tides (Figure 61; previously discussed). Additionally, many of the breaches were narrow which have created deep scour holes favoring predatory fish. Sport anglers are often seen fishing at these sites during flood or ebb tides. Breaching the levees at Liberty Island is an example (Figure 72 and 73). Recent acoustic-tagging of striped bass in this vicinity confirmed a high presence of striped bass (Figure 74, D. Vogel, unpub. data).

Figure 72. Liberty Island in the north Delta before and after flooding.

Figure 73. Liberty Island in the north Delta before and after flooding showing locations of narrow breaches in the levee.

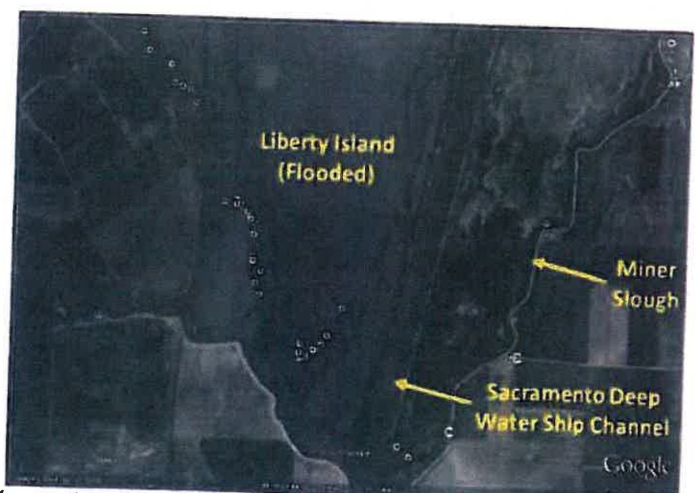


Figure 74. Locations (squares) where predatory striped bass were acoustic-tagged with transmitters during the winter of 2008 – 2009 in the north Delta near Liberty Island (D. Vogel, unpublished data).

STATE OF CALIFORNIA
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EDWARD HYATT, State Engineer

SACRAMENTO-SAN JOAQUIN WATER SUPERVISOR'S REPORT

FOR YEAR

1931

By
HARLOWE M. STAFFORD
Water Supervisor

Under the supervision of
HAROLD CONKLING
Deputy State Engineer

August, 1932

Exhibit "S"

TABLE 69

UNIT CONSUMPTIVE USE OF WATER IN SACRAMENTO-SAN JOAQUIN DELTA**
Acre-feet per Acre

Crop or Classification	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total Seasonal Use	Total Annual Use
Alfalfa	(.06)	(.08)	.10	.30	.40	.50	.65	.55	.50	.20	(.10)	(.07)	3.20	3.51
Asparagus	.05	.05	.05	.05	.08	.14	.40	.68	.55	.42	.12	.10	2.69	2.69
Beans	(.06)	(.08)	(.08)	(.16)	(.20)	.14	.24	.58	.37	(.09)	(.07)	(.05)	1.33	2.12
Beets	(.06)	(.08)	(.08)	.13	.32	.51	.61*	.53*	.20*	(.13)	(.10)	(.07)	2.30	2.82
Celery	(.04)	(.04)	(.04)	(.08)	(.10)	.10	.10	.20	.25	.30	.20	.05	1.20	1.50
Corn	(.04)	(.04)	(.04)	(.08)	(.10)	.24	.85	.84*	.40*	.10	(.10)	(.07)	2.43	2.90
Fruit	(.04)	(.04)	(.04)	.18	.32	.50	.57	.40	.23	.07	(.07)	(.05)	2.27	2.51
Grain and Hay	(.04)	(.04)	.07	.60	.83	.20	(.14)	(.23)	(.21)	(.14)	(.07)	(.05)	1.70	2.62
Onions	(.04)	(.04)	.08	.13	.27	.49	.43	.20	(.16)	(.13)	(.10)	(.07)	1.60	2.14
Pasture	.08	.10	.20	.25	.25	.25	.25	.25	.20	.15	.10	.08	2.16	2.16
Potatoes	(.06)	(.08)	(.08)	(.16)	.15	.38	.52	.30	.15	(.09)	(.07)	(.05)	1.50	2.09
Seed	(.06)	(.08)	(.08)	.10	.25	.50	.50	.50	.35	.10	(.10)	(.07)	2.30	2.69
Truck	(.06)	(.08)	.10	.10	.25	.50	.45	.45	.30	.15	.10	(.07)	2.40	2.61
Tules	.16	.09	.30	.74	1.10	1.28	1.53	1.32	1.18	.98	.59	.36	9.63	9.63
Willows	.05	.03	.09	.22	.33	.38	.46	.40	.35	.29	.18	.10	2.88	2.88
Bare Land	.04	.04	.04	.08	.10	.13	.14	.13	.11	.09	.07	.05	1.02	1.02
Idle Land with Weeds***	.06	.08	.08	.16	.20	.26	.28	.24	.16	.13	.10	.07	1.82	1.82
Open Water Surfaces	.08	.13	.23	.34	.60	.76	.84	.78	.60	.33	.14	.08	4.91	4.91

NOTE: Figures shown in brackets ( ) represent estimated consumptive use on cropped areas before planting and after harvest. (Evaporation from bare land, use by weeds, etc.).

* Includes estimated additional use by weeds during these months.

** These are the data as determined for and published in Bulletin No. 27 - "Variation and Control of Salinity in Sacramento-San Joaquin Delta and Upper San Francisco Bay" - Table 1.

*** Average for land below elevation 5.0 U.S.G.S. datum. Use on unirrigated lands above elevation 5.0 is considered zero.

STATE OF CALIFORNIA
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EDWARD HYATT, State Engineer

S A C R A M E N T O - S A N J O A Q U I N

W A T E R S U P E R V I S O R ' S

R E P O R T

FOR YEAR

1 9 3 1

By
HARLOWE M. STAFFORD
Water Supervisor

Under the supervision of
HAROLD CONKLING
Deputy State Engineer

August, 1932

Exhibit "T"

TABLE 74

USE OF WATER BY CAT-TAILS GROWN IN TANKS, NEAR CLARKSBURG,
RECLAMATION DISTRICT 999, 1931

TANK NO.	USE OF WATER — ACRE-FEET PER ACRE												
	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	YEAR
2	0.22	0.22	0.58	1.08	2.28	2.28	2.96	2.51	1.66	0.91	0.43	0.23	15.36
3	0.21	0.20	0.49	1.12	1.94	2.11	2.51	1.92	1.36	0.83	0.51	0.22	13.42
4	0.20	0.21	0.52	1.30	2.51	2.78	3.34	2.78	1.90	1.04	0.54	0.29	17.41
5	0.23	0.25	0.50	1.15	1.98	1.83	2.04	1.82	1.28	0.76	0.37	0.13	12.34
6	0.22	0.24	0.60	1.44	2.80	2.77	3.51	—UNDER TEST FOR LEAKAGE→					
MEANS	0.22	0.22	0.54	1.22	2.30	2.35	2.87	*2.26	*1.55	*0.94	*0.46	*0.22	*14.63

*MEAN OF FOUR TANKS

TABLE 75

USE OF WATER BY TULES GROWN IN TANKS, NEAR CLARKSBURG,
RECLAMATION DISTRICT 999, 1931

TANK NO.	USE OF WATER — ACRE-FEET PER ACRE												
	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	YEAR
7	0.21	0.23	0.54	1.32	3.02	2.88	4.35	—UNDER TEST FOR LEAKAGE—					
8	0.20	0.24	0.48	1.18	2.45	2.39	3.02	2.59	1.78	1.01	0.51	0.20	16.05
9	0.20	0.26	0.48	1.12	2.14	2.20	2.76	1.98	1.37	0.82	0.41	0.20	13.94
10	0.19	0.24	0.51	1.08	2.07	2.26	2.88	1.71	1.23	0.66	0.43	0.23	13.49
11	0.21	0.*9	0.40	0.90	1.84	1.65	1.63	1.32	1.16	0.72	0.39	0.19	10.60
12	0.20	0.20	0.25	0.84	1.75	1.26	2.75	2.36	1.72	1.09	0.61	0.27	13.30
MEANS	0.20	0.23	0.44	1.07	2.21	2.11	2.90	*1.99	*1.45	*0.86	*0.47	*0.22	*13.48

*MEAN OF FIVE TANKS

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS

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EDWARD HYATT, State Engineer

S A C R A M E N T O - S A N J O A Q U I N

W A T E R S U P E R V I S O R ' S

R E P O R T

FOR YEAR

1 9 3 1

By
HARLOWE M. STAFFORD
Water Supervisor

Under the supervision of
HAROLD CONKLING
Deputy State Engineer

August, 1932

Exhibit "U"

TABLE 77

USE OF WATER BY CAT-TAILS AND TULES GROWN IN TANKS AT CAMP 3, KING ISLAND
1931

TANK NUMBER	PLANT	WATER SURFACE ABOVE GROUND SURFACE FEET	USE OF WATER – ACRE-FEET PER ACRE													COMPARATIVE PLANT SIZE (2)
			JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC. (3)	YEAR (4)	
1	CAT-TAILS	0.0	0.14	0.13	0.25	0.52	0.52	0.31	0.33	0.18	0.13	0.15	0.07		2.8	UNDERSIZE
2	CAT-TAILS	1.0	– NO	USABLE	RECORD	–	(1)0.72	0.82	0.92	0.82	0.67	0.53	0.26		6.2	UNDERSIZE
3	TULES	1.0	– NO	USABLE	RECORD	–	(1)1.33	1.13	1.32	1.16	0.80	0.51	0.19		8.0	NORMAL
4	TULES	0.0	0.17	0.15	0.45	0.58	1.00	0.88	0.88	0.71	0.53	0.15	0.07		5.7	UNDERSIZE

(1) INCLUDES APRIL 29TH AND 30TH.
(2) THE COMPARISON FOR SIZE IS WITH SURROUNDING PATCH PLANTS OF THE SAME KIND. PLANTS IN TANKS NUMBERS 1 AND 2 WERE UNDERSIZE ALL SEASON. PLANTS IN TANK NUMBER 4 WERE NORMAL SIZE AT BEGINNING OF SEASON.
(3) HEAVY RAINS DERANGED CONDITIONS SO THAT NO RELIABLE RECORD FOR DECEMBER WAS OBTAINED.
(4) ESTIMATED. CLOSELY FOR TANKS NUMBERS 1 AND 4. ROUGHLY FOR TANKS NUMBERS 2 AND 3.

– – 0 – –

TABLE 78

USE OF WATER BY TULES GROWN IN TANKS AT SIMMONS ISLAND, NEAR BAY POINT, 1931

TANK NO.	WATER SURFACE ABOVE GROUND SURFACE FEET	USE OF WATER – ACRE-FEET PER ACRE													NUMBER OF STALKS IN JULY*
		JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.*	DEC.	YEAR (APPROX)	
1	1.0	0.11	0.15	0.23	0.28	0.38	0.48	0.61	0.48	0.43	0.21	0.11	(0.11)	3.58	11
2	0.0	(0.11)	(0.11)	(0.12)	0.14	0.94	0.80	0.69	0.52	0.36	0.22	0.11	(0.11)	4.23	19
3	1.0	(0.11)	(0.15)	(0.28)	0.34	1.01	0.87	0.84	0.67	0.60	0.46	0.29	(0.11)	5.73	35
4	0.0	(0.11)	(0.15)	(0.24)	0.29	0.96	0.89	0.78	0.59	0.54	(0.30)	0.14	(0.11)	5.10	30
MEANS		(0.11)	(0.14)	(0.22)	0.26	0.82	0.76	0.73	0.57	0.48	(0.30)	0.16	(0.11)	4.66	

NOTE: FIGURES IN PARENTHESES ARE ESTIMATED.
* THERE WERE SOME NEW SPROUTS IN ALL TANKS IN JULY.

Floodplain rearing of juvenile chinook salmon: evidence of enhanced growth and survival

T.R. Sommer, M.L. Nobriga, W.C. Harrell, W. Batham, and W.J. Kimmerer

Abstract: In this study, we provide evidence that the Yolo Bypass, the primary floodplain of the lower Sacramento River (California, U.S.A.), provides better rearing and migration habitat for juvenile chinook salmon (*Oncorhynchus tshawytscha*) than adjacent river channels. During 1998 and 1999, salmon increased in size substantially faster in the seasonally inundated agricultural floodplain than in the river, suggesting better growth rates. Similarly, coded-wire-tagged juveniles released in the floodplain were significantly larger at recapture and had higher apparent growth rates than those concurrently released in the river. Improved growth rates in the floodplain were in part a result of significantly higher prey consumption, reflecting greater availability of drift invertebrates. Bioenergetic modeling suggested that feeding success was greater in the floodplain than in the river, despite increased metabolic costs of rearing in the significantly warmer floodplain. Survival indices for coded-wire-tagged groups were somewhat higher for those released in the floodplain than for those released in the river, but the differences were not statistically significant. Growth, survival, feeding success, and prey availability were higher in 1998 than in 1999, a year in which flow was more moderate, indicating that hydrology affects the quality of floodplain rearing habitat. These findings support the predictions of the flood pulse concept and provide new insight into the importance of the floodplain for salmon.

Résumé : Notre étude démontre que le canal de dérivation Yolo, la principale plaine d'inondation de la région aval de la rivière Sacramento (Californie, É.-U.), offre de meilleurs habitats pour l'alevinage et la migration des jeunes Saumons Quinnat (*Onchorhynchus tshawytscha*) que les bras adjacents de la rivière. En 1998 et 1999, la taille des saumons a augmenté plus rapidement dans la plaine d'inondation agricole, sujette aux débordements saisonniers de crue, que dans la rivière, ce qui laisse croire à de meilleurs taux de croissance. De plus, des jeunes saumons marqués à l'aide de fils de métal codés et relâchés dans la plaine d'inondation étaient plus gros au moment de leur recapture et avaient des taux de croissance apparente plus élevés que des poissons relâchés dans la rivière en même temps. L'amélioration des taux de croissance dans la plaine de débordement résultait en partie d'une consommation significativement plus importante de proies, le reflet d'une plus grande disponibilité des invertébrés de la dérive. Un modèle bioénergétique laisse croire que le succès de l'alimentation a été meilleur dans la plaine d'inondation que dans la rivière, en dépit du coût métabolique d'alevinage significativement plus grand dans les eaux plus chaudes de la plaine d'inondation. Les indices de survie des poissons marqués et relâchés dans la plaine d'inondation étaient quelque peu plus élevés que ceux des poissons de la rivière, mais les différences n'étaient pas statistiquement significatives. La croissance, la survie, le succès de l'alimentation et la disponibilité des proies étaient tous supérieurs en 1998 par comparaison avec 1999, une année à débit plus modéré, ce qui indique que l'hydrologie affecte la qualité des habitats d'alevinage dans la plaine d'inondation. Nos résultats appuient les prédictions du concept de pulsion de crue (flood pulse concept) et mettent en lumière l'importance de la plaine d'inondation pour le saumon.

[Traduit par la Rédaction]

Introduction

Although the trophic structure of large rivers is frequently dominated by upstream processes (Vannote et al. 1980), there is increasing recognition that floodplains plays a major role in the productivity and diversity of riverine communities (Bayley 1995). Based largely on observations from relatively undisturbed river–floodplain systems, Junk et al. (1989) proposed the flood pulse concept, which predicts that annual inundation is the principal force determining productivity and biotic interactions in river–floodplain systems. Floodplains can provide higher biotic diversity (Junk et al. 1989) and increased production of fish (Bayley 1991; Halyk and Balon 1983) and invertebrates (Gladden and Smock 1990). Potential mechanisms for floodplain effects include increased habitat diversity and area (Junk et al. 1989), large inputs of

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Exhibit "P"

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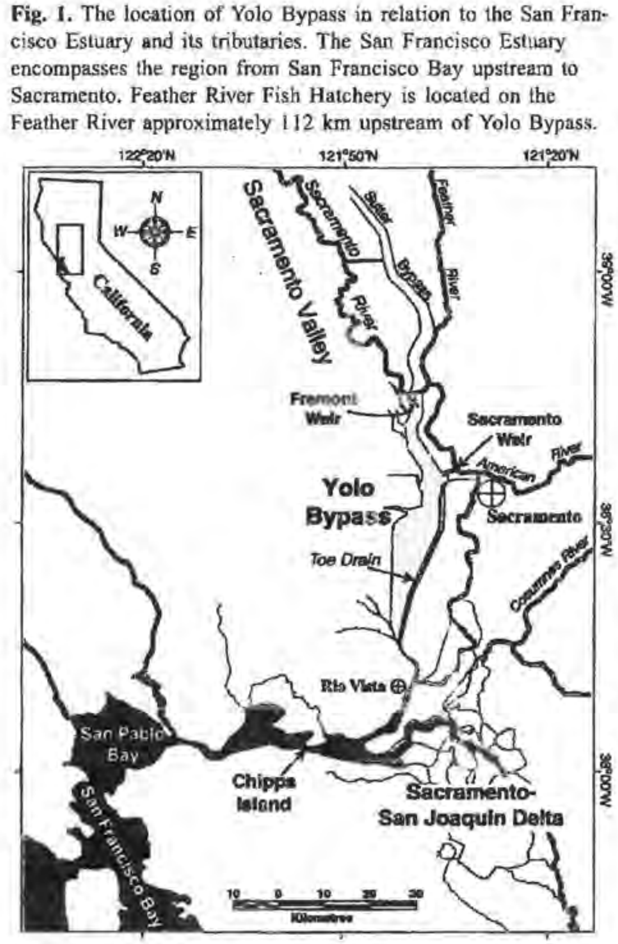
terrestrial material into the aquatic food web (Winemiller and Jepsen 1998), and decreased predation or competition due to intermediate levels of disturbance (Corti et al. 1997). Nonetheless, the degree to which floodplains support riverine ecosystems remains poorly understood, particularly in regulated and temperate rivers. Uncertainties about river–floodplain relationships are due, in large part, to the difficulty in separating the relative contribution of floodplain versus channel processes and sampling problems in seasonal habitats, which are frequently subject to extreme environmental variation.

In the this study, we examined the relative importance of floodplain and riverine habitat to juvenile chinook salmon (*Oncorhynchus tshawytscha*) in the Sacramento River (California, U.S.A.), a large regulated river (Fig. 1). The system is particularly well suited to a comparative study, because young salmon migrating down the lower Sacramento River to the San Francisco Estuary in wet years have two alternative paths: they may continue down the heavily channelized main river or they may pass through the Yolo Bypass, an agricultural floodplain bordered by levees. We had two reasons to believe that the floodplain might be important habitat for young salmon. First, years of high flow are known to enhance populations of a variety of species in the San Francisco Estuary (Jassby et al. 1995) and the survival of chinook salmon (Kjelson et al. 1982). However, the specific mechanisms for these benefits have not been established. Possible reasons for the positive effects of flow on fish include increased habitat availability, migration cues, food supply, larval transport, and reduced predation rates (Bennett and Moyle 1996). Floodplain inundation is one of the unique characteristics of wet years, during which the Yolo Bypass is likely to be a significant migration corridor for young chinook salmon in the Sacramento Valley. During high-flow events, the Yolo Bypass can convey >75% of the total flow from the Sacramento River basin, the major producer of salmon among tributaries of the San Francisco Estuary. Second, floodplains are known to be among the most important fish-rearing areas in a variety of river systems, yet in developed regions, the availability of this habitat has been greatly reduced by channelization and levee and dam construction (Rasmussen 1996). A high degree of habitat loss may greatly enhance the biological significance of remnant floodplains in heavily modified systems, such as the San Francisco Estuary and its tributaries.

This study tests the hypothesis that the agricultural floodplain provides better habitat quality than the adjacent river channel. For the purpose of this analysis, we focus on salmon growth, feeding success, and survival as indicators of habitat quality. Obviously, there are many other possible measures of habitat quality, such as reproductive output of adults or physiological indicators. However, we believe that the chosen suite of parameters is reasonably representative of habitat quality. For example, Gutreuter et al. (2000) successfully used growth as a factor to test the hypothesis that floodplain inundation had a major effect on fish production.

The San Francisco Estuary is one of the largest estuaries on the Pacific Coast (Fig. 1). The system includes downstream bays (San Pablo and San Francisco) and a delta, a broad network of tidally influenced channels that receive inflow from the Sacramento and San Joaquin rivers. The estuary and its tributaries have been heavily altered by levees, dams, land reclamation activities, and water diversions. The primary floodplain of the Sacramento River portion of the delta is the Yolo Bypass, a 24 000-ha leveed basin that conveys excess flow from the Sacramento Valley, including the Sacramento River, Feather River, American River, Sutter Bypass, and westside streams. The 61 km long floodplain floods seasonally in winter and spring in about 60% of years, and is designed to convey up to 14 000 $m^3 \cdot s^{-1}$. During a typical flooding event, water spills into the Yolo Bypass via the Fremont Weir when Sacramento Basin flows surpass approximately 2000 $m^3 \cdot s^{-1}$. Except during extremely high flow events, the mean depth of the floodplain is generally less than 2 m, creating broad shoal areas. During dry seasons, the Toe Drain channel, a permanent riparian corridor, remains inundated as a result of tidal action. At higher levels of Sacramento Basin flow (e.g., >5000 $m^3 \cdot s^{-1}$), the Sacramento Weir is also frequently operated. Agricultural fields are the dominant habitat type in Yolo Bypass, but approximately one-third of the floodplain area is natural vegetation, including riparian habitat, upland habitat, emergent marsh, and permanent ponds.

Fig. 1. The location of Yolo Bypass in relation to the San Francisco Estuary and its tributaries. The San Francisco Estuary encompasses the region from San Francisco Bay upstream to Sacramento. Feather River Fish Hatchery is located on the Feather River approximately 112 km upstream of Yolo Bypass.



There are four races of chinook salmon in the Sacramento Valley: winter, spring, late fall, and fall run (Yoshiyama et al. 2000). Historical data indicate that all races have decreased in abundance since the 1950s, but the spring, winter, and late-fall runs have shown the most pronounced declines. There are multiple causes for these long-term reductions, including habitat loss, habitat degradation, water diversions, and oceanic conditions. In the present study, we focused on the fall run, the numerically dominant race in the Sacramento Valley. The typical life-history pattern for these salmon is for young to migrate from the tributaries to the bay–delta area at the "fry" stage (Brandes and McLain 2001), when most individuals are approximately 35- to 70-mm fork length (FL). In low flow years, there may be substantial upstream rearing in the Sacramento River. Peak juvenile emigration from the tributaries occurs during winter and spring (Kjelson et al. 1982).

Materials and methods

Physical conditions

During 1998–1999, flow measurements in Yolo Bypass and the adjacent stretch of the Sacramento River were obtained from gauges operated by the U.S. Geological Survey (USGS). Daily water temperatures for each site were calculated as the mean of maximum and minimum daily measurements for single stations in the Sacramento River (USGS) and a temperature recorder (Onset Corp.) installed in the Yolo Bypass Toe Drain channel (Fig. 1). However, from 1 February to 26 March 1998, these data were not available for Yolo Bypass. During this period, before the recorder was installed, discrete measurements were taken at the same location, typically during mid or late morning.

Fish sampling

Salmon FL (mm) was measured during January–April in 1998 and 1999 on samples collected with 15-m beach seines (4.75-mm mesh). Samples were collected weekly at five core locations located around the perimeter of the Yolo Bypass, during periods when the basin was flooded. After the bypass drained, additional samples were collected at random locations around the perimeter of ponds near the core locations. Comparative data on salmon size in the adjacent reach of the Sacramento River were collected by the U.S. Fish and Wildlife Service (USFWS) at five beach-seine sites, using techniques similar to those used when the the bypass was flooded.

FLs of salmon obtained from beach-seine sampling were compared to determine whether there was evidence of major differences in salmon size between the Yolo Bypass and the Sacramento River. However, these data were not considered unambiguous evidence of growth differences, because the two systems were open to immigration and emigration during much of the study, and migrating salmon include multiple races of salmon that cannot be readily separated. We addressed this issue by using paired releases of coded-wire-tagged (CWT) juvenile salmon in Yolo Bypass and the Sacramento River. This approach allowed comparisons of growth among fish of similar origin and provided a relative estimate of migration time and survival. The salmon were produced and tagged at the Feather River Fish Hatchery and released on 2 March 1998 and 11 February 1999. The release sites were in Yolo Bypass below Fremont Weir (52 000 in 1998; 105 000 in 1999) and in the adjacent reach of the Sacramento River (53 000 in 1998; 105 000 in 1999). The fish had a mean FL of 57.5 ± 0.5 mm (SE) in 1998 and of 56.8 ± 0.4 mm (SE) in 1999. A small portion of each group was subsequently collected by trawling at the seaward margin of the delta at Chipps Island, which is located downstream of the confluence of the Yolo Bypass and the Sacramento River (Fig. 1). The USFWS Chipps Island survey samples a single channel location with a midwater trawl towed at the surface (Baker et al. 1995; Brandes and McLain 2001). Ten 20-min tows were made each day, except during March in 1998 and 1999, when sampling was conducted every other day. Data on migration time (days) and FL (mm) were recorded for fish recaptured from each release group. Apparent growth rate was also calculated for each fish, as: (FL of individual at Chipps Island – mean FL of CWT release group) × (migration time)$^{-1}$. Survival indices of the paired CWT releases were calculated by USFWS by dividing the number of fish recovered for each release group at Chipps Island by the number released, corrected for the fraction of time and channel width sampled (Brandes and McLain 2001).

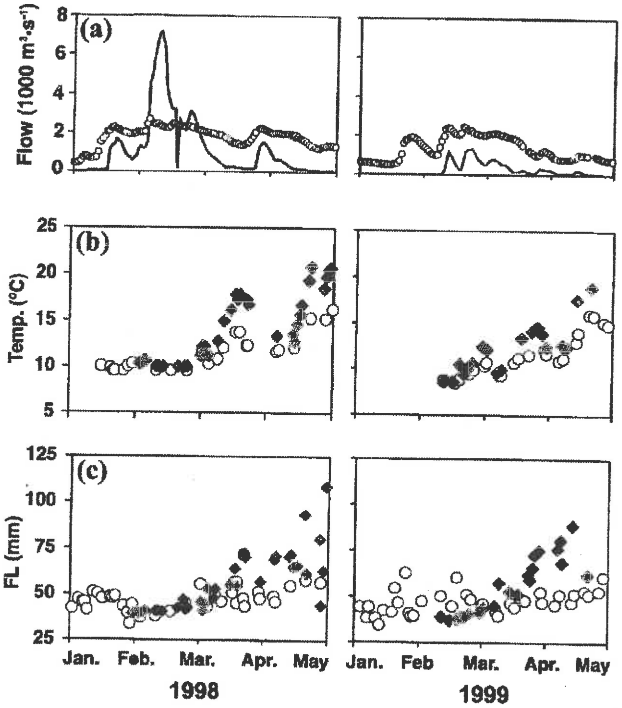
Diet

We performed diet comparisons on fall-run juvenile salmon (33–81 mm) collected in beach-seine samples during February–March of 1998 and 1999 from the Yolo Bypass (103 individuals) and the Sacramento River (109 individuals). Fish samples were tagged and stored individually in a deep freeze. After thawing, stomachs were removed from the fish and the contents were identified (using a dissecting microscope) to order (insects and arachnids), genus (crustaceans), or phylum (rarely eaten taxa such as oligochaetes). To develop average invertebrate length estimates, up to 10 individuals of each prey type encountered were measured. Prey dry weight estimates were calculated from average lengths, using regression equations for delta crustaceans obtained from J. Orsi (California Department of Fish and Game, Stockton, CA 95205, unpublished data) and from literature sources. Diet results were compared as an index of relative importance (IRI) (Shreffler et al. 1992) for each month. The index was calculated as: IRI = (% numeric composition + % weight composition) × % frequency of occurrence.

Prey availability

Invertebrates were sampled in February–March of 1998 and 1999, to examine prey availability in the Yolo Bypass and the Sacramento River. Sampling was not designed as a comprehensive evaluation of spatial and temporal variation of prey. Rather, it was intended to provide information on whether variation in salmon diets between the two locations was consistent with gross differences in prey type or relative abundance. We focused on Diptera (adults, pupae, and larvae) and crustacean zooplankton, which comprised over 90% of the diets of Yolo Bypass and Sacramento River juvenile salmon. Weekly drift samples were collected at fixed stations on the Yolo Bypass and the Sacramento River during periods when the floodplain was inundated. The sampling points were located away from overhanging vegetation and bank eddies, in water velocities of approximately 15–60 $cm \cdot s^{-1}$, depending on flow. Net (500-μm mesh) dimensions were 0.46×0.3 m mouth and 0.91 m length. The nets were fished for approximately 30 min during mid-morning, to coincide with the time period when most fish-stomach samples were taken. Sample volume was calculated using a flowmeter (General Oceanics Model 2030R) and net dimensions. Drift samples were stored in ethanol or formaldehyde, then identified to family or order using a dissecting microscope. In 1998, zooplankton were collected in the Yolo Bypass at two fixed stations with battery-operated rotary-vane pumps with a mean flow rate of 17 $L \cdot min^{-1}$. Samples were taken via pipes with outlets at multiple locations beneath the water surface. Discharge was directed into a 150 μm mesh net held in a basin on the bank. Flow rate was recorded at the beginning and end of the sample period, which varied from 1 to 6 h. No samples were taken in the Sacramento River during a comparable period in 1998. In 1999, zooplankton samples were taken with a Clarke–Bumpus net (160-μm mesh, diameter 0.13 m, length 0.76 m) placed in surface flow in the Yolo Bypass and Sacramento River. Sample volume was recorded as for the drift net. Zooplankton samples were concentrated and stored in 5%

Fig. 2. Chinook salmon size versus physical conditions in Yolo Bypass and the Sacramento River during winter and spring in 1998 and 1999. (*a*) Mean daily flow ($m^3 \cdot s^{-1}$) in Yolo Bypass (solid line) and the Sacramento River (circles). (*b*) Mean water temperature (°C) in Yolo Bypass (solid symbols) and the Sacramento River (open symbols). (*c*) Mean daily chinook salmon FL for Yolo Bypass (solid symbols) and Sacramento River (open symbols) beach-seine stations. For presentation purposes, only the daily mean FLs are shown; however, individual observations for February–March were used for statistical analyses.



formaldehyde, for later identification to genus using a dissecting microscope.

Bioenergetics

Feeding success was examined in two ways: (1) prey biomass estimated from stomach contents and (2) prey biomass estimated as a function of maximum theoretical consumption. For the first measure, we used the previously described stomach-content data to calculate total-prey biomass for individual fish.

A limitation of using prey biomass as a measure of feeding success between locations is that thermal history affects how consumption alters growth rate (Hewett and Kraft 1993). As will be discussed in further detail, water temperatures were significantly higher in the Yolo Bypass floodplain than in the Sacramento River. To correct for this problem, our second approach used bioenergetic modeling to incorporate the metabolic effects of water temperature. We used methods similar to those of Rand and Stewart (1998) to calculate a wet weight ration index, which uses prey biomass for each sampled individual as a proportion of the theoretical maximum daily consumption. The stomach-content data were used as our estimate of prey biomass for individual fish. The theoretical maximum daily consumption rate (C_{max}) was modeled using Fish Bioenergetics 3.0 (Hanson et al. 1997), using observed body size and water temperature at the time each beach-seine sample was collected. The model input also required fish mass, which we estimated from FL data, using length–weight relationships from Sacramento River juvenile salmon (Petrusso 1998). The caloric value of the prey was taken from weight conversion factors provided by Hanson et al. (1997). Model parameters were derived from those of Stewart and Ibarra (1991) for chinook salmon. The model was run for individual fish collected at each sampling location in 1998 and 1999.

Table 1. Robust regression statistics for Yolo Bypass and Sacramento River salmon FLs for 1998 and 1999.

	1998		1999	
	Parameter ± SEM	*t*	Parameter ± SEM	*t*
Intercept	29.4±0.6	46.8	23.5±0.5	43.7
Location	6.4±0.6	10.2	11.1±0.5	20.6
Day	0.3±0.01	34.5	0.3±0.01	48.5
Location:day	−0.14±0.01	−18.4	−0.21±0.01	−33.6

Note: The *t* values are all highly significant ($p < 0.0001$).

We emphasize that the second approach provides an *index*, rather than an *absolute* measure of feeding success. The wet weight ration index is conceptually analogous to "*P*" in Hanson et al. (1997), a model parameter that indicates what fraction of C_{max} is obtained over the course of the day. The major difference is that *P* is based on prey consumption over a 24-hour period, whereas our wet weight ration index is based on instantaneous measurements of stomach contents, which may not represent mean trends over the entire day. An additional limitation is that the Stewart and Ibarra (1991) model parameters were developed for adult salmon and we applied the model to juveniles. We did not have sufficient field or laboratory data to develop bioenergetic-model parameters specific to the earliest life stages. Nonetheless, other studies (Rand and Stewart 1998) have demonstrated that similar wet weight ration indices can provide an effective technique for comparing relative salmonid feeding success between seasons and years.

Statistical analysis

Overlapping temperature measurements from continuous recorders and the discrete measurements during 26 March – May 1998 were analyzed with Wilcoxon's matched-pairs test, to determine whether the two methods yielded different results. Mean water temperature for Yolo Bypass and the Sacramento River during the primary period of floodplain inundation (February–March) was analyzed with a generalized linear model with a variance function that increased with the mean squared, since variances were not homogeneous (Venables and Ripley 1997). Salmon FL measurements for Yolo Bypass and the Sacramento River during February–March of 1998 and 1999 were compared with a robust iteratively reweighted least squares regression procedure ("rlm"; Venables and Ripley 1997), because we detected substantial numbers of outliers in preliminary graphical evaluations of the data. Initial analyses revealed a substantial difference in the effects of location between years, so years were analyzed separately. Results from the CWT and bioenergetic studies were analyzed using a factorial-design analysis of variance, to evaluate the effects of location (Yolo Bypass, Sacramento River) and year (1998, 1999). Residuals from each model were examined graphically, to confirm that they met the assumption of normality and homogeneity of variance. Cochran and Levene's tests were also used, to test the assumption of homogeneity of variance. Logarithmic transformation was performed where necessary.

Results

Physical conditions

Yolo Bypass was inundated in 1998 and 1999 but the hydrology was substantially different in the two years (Fig. 2).

Table 2. Results of salmon collections at Chipps Island for 1998 and 1999 coded-wire-tagged groups released concurrently in Yolo Bypass and the Sacramento River.

	1998		1999	
	Yolo Bypass	Sacramento River	Yolo Bypass	Sacramento River
Fork length (mm)	93.7±2.0	85.7±1.4	89.0±2.6	82.1±1.7
Migration time (days)	46.2±2.3	55.4±3.5	58.2±2.8	58.6±4.1
Apparent growth rate (mm·day^{-1})	0.80±0.06	0.52±0.02	0.55±0.06	0.43±0.03
Survival index	0.16	0.09	0.09	0.07
Sample size	9	10	9	8

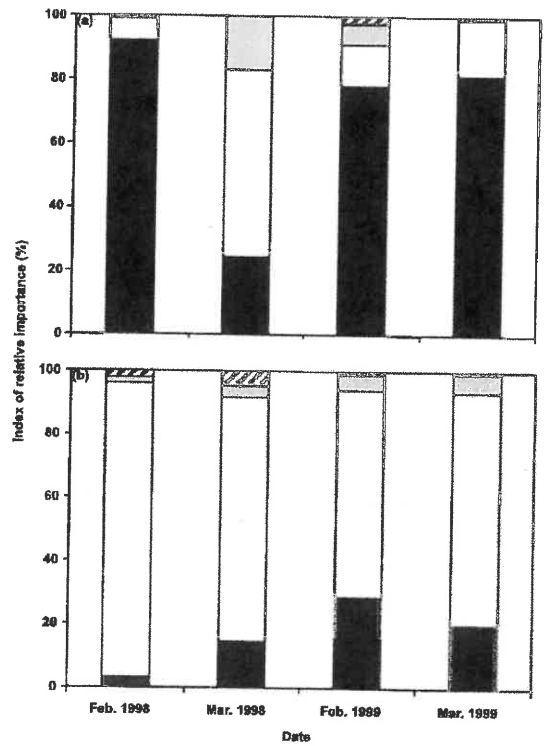
Note: Values for FL, migration time, and apparent growth rate are mean ± standard error (SEM).

The first year was extremely wet, with multiple flow pulses and a peak flow of 7200 $m^3 \cdot s^{-1}$. In 1999, floodplain hydrology was more moderate, with a peak of 1300 $m^3 \cdot s^{-1}$. Flows in the Sacramento River were much less variable than in the floodplain and generally remained at or below 2000 $m^3 \cdot s^{-1}$, a level within the design capacity (3100 $m^3 \cdot s^{-1}$) of the channel. Overlapping sampling between the continuous-temperature recorders and the discrete measurements during March–May 1998 showed a mean difference of 0.9°C between the two approaches, but this disparity was not statistically significant (Wilcoxon's matched-pairs test, $p > 0.25$). In 1998 and 1999, temperatures increased fairly steadily throughout the study period; however, in both years, temperature levels in Yolo Bypass were up to 5°C higher than those in the adjacent Sacramento River during the primary period of inundation, February–March. Temperature in the Yolo Bypass was described in 1998 by $T_y = -7.7 \pm 2.1 + (1.9 \pm 0.2)T_s$ and in 1999 by $T_y = -3.5 \pm 1.2 + (1.5 \pm 0.1)T_s$, where T_y is the temperature of the Yolo Bypass, T_s is the temperature of the Sacramento River, and the range for each value is the 95% confidence limit.

Fish growth, migration time, apparent growth rate, and survival

Salmon increased in size substantially faster in the Yolo Bypass than in the Sacramento River during each of the study years (Fig. 2). Robust regression results showed that the effect of location was highly significant ($p < 0.00001$) in each year (Table 1). This result is consistent with the CWT data (Table 2), which showed that the 1998 and 1999 Yolo Bypass CWT release groups had significantly larger mean length ($F = 14.34$, $p = 0.0006$) and higher apparent growth rates ($F = 20.67$, $p = 0.0007$) than the Sacramento River release groups. There was also a statistically significant effect of year: both release groups had larger mean sizes ($F = 4.42$, $p = 0.04$) and higher apparent growth rates ($F = 16.47$, $p = 0.0002$) in 1998 than in 1999. The 1998 Yolo Bypass CWT group showed the fastest migration time, arriving an average of at least 9 days ahead of any other release group. However, there was no statistically significant ($F = 2.22$, $p = 0.15$) effect of release location on migration time in the analysis of variance (ANOVA). As for fish size and apparent growth rate, mean migration time was slower in 1999 than in 1998 ($F = 5.60$, $p = 0.02$). There was no statistically significant interaction between location and year for salmon size ($F = 0.07$, $p = 0.78$), apparent growth rate ($F = 1.62$, $p = 0.21$), or migration time ($F = 1.8$, $p = 0.18$). The survival indices were somewhat higher for CWT groups released in the Yolo Bypass than for those released in the Sacramento River for both 1998 and 1999. However, the lowest coefficient of variation based on a Poisson distribution of the CWT recaptures is 32%, and the actual (unknown) distribution of counts is likely to have higher variance than a Poisson distribution. Clearly the confidence limits of the paired survival indices would overlap, so the differences are not statistically significant.

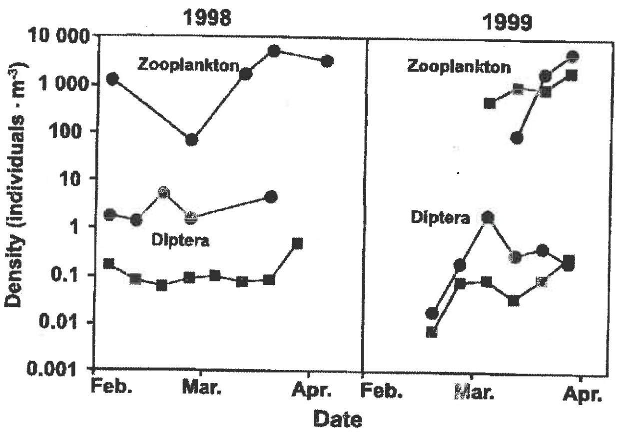
Fig. 3. Chinook salmon diet during February and March of 1998 and 1999 in Yolo Bypass (*a*) and the Sacramento River (*b*). The index of relative importance (*y*-axis) is defined in the text. Diptera (solid bars), zooplankton (open bars), other aquatic prey (shaded bars), and other terrestrial prey (striped bars) are shown for each month.



Diet

The diet of young salmon in the Yolo Bypass was dominated by dipterans, principally chironomid pupae and adults (Fig. 3). The second most common prey item was zooplank-

Fig. 4. Log_{10}-scaled weekly abundance (individuals·m^{-3}) of zooplankton and Diptera in Yolo Bypass (circles) and the Sacramento River (squares) during 1998 and 1999. Note that 1998 zooplankton data were not available for the Sacramento River.



ton, mostly cladocerans and copepods. Except for March 1998, zooplankton comprised less than 15% of the Yolo Bypass diets. Other aquatic (mainly amphipods and collembola) and terrestrial (mainly ants and arachnids) prey were relatively minor diet items. As for the floodplain samples, dipterans and zooplankton comprised over 90% of the diets of Sacramento River salmon; however, zooplankton were the dominant prey item in all months. Other aquatic (mostly amphipods, oligochaetes, and collembola) and terrestrial (mostly ants and other terrestrial insects) prey were consumed infrequently.

Prey availability

The drift samples contained many of the same taxa observed in the salmon diets, with Diptera (principally chironomids) as the major type at both sampling locations. However, the density of Diptera was much higher in the Yolo Bypass than in the Sacramento River (Fig. 4), particularly in 1998, when densities were consistently an order of magnitude higher. In general, dipteran drift densities were higher at each location in 1998 than in 1999. There was little difference in zooplankton density in the Yolo Bypass between 1998 and 1999 or between Yolo Bypass and the Sacramento River in 1999.

Bioenergetics

Young salmon from the Yolo Bypass had higher total-prey weights ($F = 39.2$, df = 1, $p < 0.0001$) than those from the Sacramento River (Fig. 5). The bioenergetic-modeling results showed that Yolo Bypass salmon also had higher wet weight ration indices than those from the Sacramento River ($F = 19.3$, df = 1, $p < 0.0001$). The interaction between location and year was significant for both the wet weight ration indices ($F = 10.0$, df = 1, $p = 0.02$) and the prey weights ($F = 4.7$, df = 1, $p = 0.03$).

Discussion

Chinook salmon that rear in the Yolo Bypass floodplain have higher apparent growth rates than those that remain in the adjacent Sacramento River channels. Mean length increased faster in the Yolo Bypass during each study year, and CWT fish released in the Yolo Bypass were larger and had higher apparent growth rates than those released in the Sacramento River. It is possible that these observations are due to higher mortality rates of smaller individuals in the Yolo Bypass or of larger individuals in the Sacramento River; however we have no data or reasonable mechanism to support this argument.

Apparent growth differences between the two areas are consistent with water temperature and stomach-content results. We found that the Yolo Bypass floodplain had significantly higher water temperatures and that young salmon from the floodplain ate significantly more prey than those from the Sacramento River. The wet weight ration indices calculated from bioenergetic modeling suggest that the increased prey availability in Yolo Bypass was sufficient to offset increased metabolic requirements from higher water temperatures. Higher water temperatures in the Yolo Bypass are expected as a result of the shallow depths on the broad floodplain. Increased feeding success in the Yolo Bypass is consistent with trends in prey availability. While Yolo Bypass and the Sacramento River had similar levels of zooplankton, Yolo Bypass had more dipteran prey in the drift, particularly in 1998. Studies of juvenile chinook salmon diets by Rondorf et al. (1990) showed that zooplankton were the least-favored prey items. Therefore, the dominance of zooplankton in the diets of Sacramento River salmon probably reflects a relatively low availability of other more energetically valuable prey items.

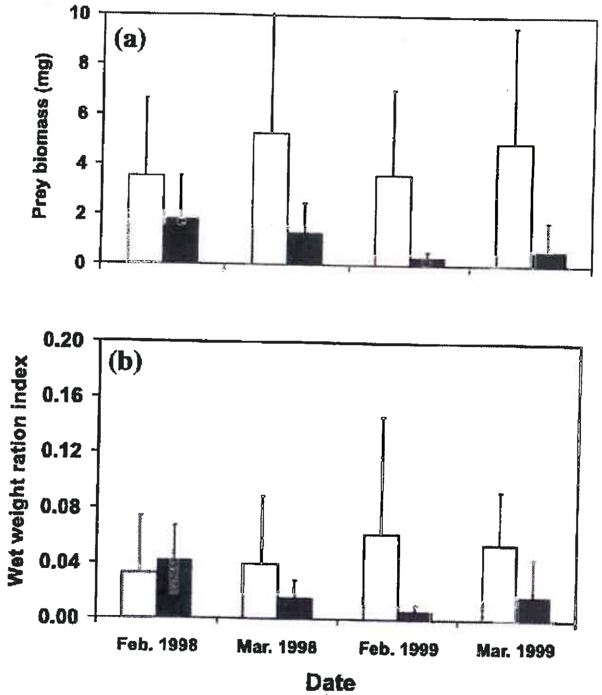
Recoveries of paired releases were too few to determine whether the higher survival indices for the Yolo Bypass release groups represent actual survival differences or random variation. Additional validation is needed from new release studies and from CWT recoveries in the adult ocean fishery and escapement. Nonetheless, the hypothesis that floodplain rearing could improve survival is substantiated by the growth data and bioenergetic modeling. Faster growth rates reflect improved habitat conditions, which would be expected to lead to improved survival, both during migration and later in the ocean. Elevated Yolo Bypass survival rates are also consistent with significantly faster migration rates in 1998, the likely result of which would be reduced exposure time to mortality risks in the delta, including predation and water diversions.

Improved survival is consistent with other habitat differences between the Yolo Bypass floodplain and the Sacramento River channel. We estimate that complete inundation of the Yolo Bypass creates a wetted area approximately 10 times larger than the reach of the Sacramento River we studied. This level of inundation is equivalent to a doubling of the wetted area of the entire delta portion of the San Francisco Estuary. Much of the floodplain habitat consists of broad shoals composed of soil and vegetation that are typical of the low-velocity conditions selected by young salmon (Everest and Chapman 1972). An increase in rearing area should reduce competition for food and space and perhaps reduce the probability of encountering a predator. In contrast, the Sacramento River channel is relatively narrow, with steep rock-reinforced banks and little shallow habitat. Migration through the Yolo Bypass corridor would also prevent fish from entering the channels of the central delta, in which there are various risks, including major water diversions (Brandes and McLain 2001). However, the Yolo Bypass is a less-stable environment, with stranding risks when flood waters recede. The relatively well-drained topography of the Yolo Bypass floodplain may help to reduce the magnitude of this problem. This is not to say, however, that access to floodplain rearing habitat represents the only mechanism to account for possible improvements in juvenile salmon survival in wetter years. Other covariates, such as reduced water temperature (Baker et al. 1995), reduced predation losses from higher turbidity (Gregory and Levings 1998), and reduced water diversion effects (Kjelson et al. 1982), also contribute to improved wet-year survival of salmon that migrate through the San Francisco Estuary.

The results from this study suggest that hydrology may affect salmon feeding success, migration, and survival in both floodplain and river habitat. The CWT results indicate that salmon grew faster, migrated faster, and may have had better survival rates in 1998 than in 1999. One clear difference between the years is that the flow pulses were higher and of longer duration in 1998 than in 1999. Higher flow could directly increase migration rates through higher water velocities and have multiple indirect effects on growth through factors such as food supply or water temperature. The abundance of Diptera in drift samples was substantially higher in 1998 than in 1999 in both locations. The significant interaction between location and year for both prey weights and the wet weight ration index indicates that the combined effects of diet and water temperature under 1998 hydrology should have resulted in higher growth rates. Higher growth rates and faster migration times in 1998 may, in turn, have improved survival by reducing predation risk. Higher-flow conditions in 1998 increased the quantity and duration of floodplain rearing area, perhaps reducing resource competition and predator encounter rates. Increased flow duration and magnitude in 1998 could also have improved survival on the floodplain by reducing stranding risks.

These results provide new insight into the significance of seasonal floodplain habitat for salmon rearing, which has been studied primarily in perennial waterways such as estuaries and rivers (Healey 1991; Kjelson et al. 1982). Indeed, this is the first study we are aware of demonstrating that off-channel floodplain provides major habitat for chinook salmon. We do not believe that the benefits of the floodplain to chinook salmon are unique to Yolo Bypass. Initial results from the Cosumnes River, an undammed watershed in the delta, show similar growth enhancements for juvenile chinook salmon that rear on the floodplain rather than in adjacent river channels (Peter Moyle, University of California, Davis, CA 95616, personal communication). Moreover, the benefits of the floodplain to salmon are consistent with findings for other fish species. Sommer et al. (1997) found that the Yolo Bypass provides major spawning, rearing, and foraging habitat for the native cyprinid Sacramento splittail (*Pogonichthys macrolepidotus*). The spawning and rearing of fish on floodplains has been reported in diverse locations that range from small streams (Halyk and Balon 1983; Ross and Baker 1983) to large rivers (Copp and Penaz 1988) in both temperate (Gehrke 1992; Turner et al. 1994) and tropical (Winemiller and Jepsen 1998) locations. The growth effects of floodplain habitat have been described for several tropical locations (Welcomme 1979); however, the present study and the results of Gutreuter et al. (2000) represent the only examples from temperate rivers of which we are aware.

Fig. 5. Feeding success results for Yolo Bypass (open bars) and Sacramento River (solid bars) juvenile salmon during 1998 and 1999. (*a*) Estimated prey weights in stomach contents. (*b*) Wet weight ration indices. Means and standard errors are shown.



Differences between the invertebrate communities in floodplains versus river channels have been reported by Castella et al. (1991). The exceptional production of drift invertebrates on the Yolo Bypass floodplain is consistent with the results of Gladden and Smock (1990), who found that invertebrate production was one to two orders of magnitude greater on the floodplain than in adjacent streams. Although we did not monitor benthic invertebrates, results from other studies of large rivers indicate that benthic biomass may be up to an order of magnitude higher in the floodplain (Junk et al. 1989). The Yolo Bypass drift invertebrate results contrast with the results for zooplankton, which were not particularly abundant on the floodplain. This finding is comparable with that of Welcomme (1979), who reported that densities of zooplankton in natural floodplains are frequently low, except for low-water periods and localized concentrations near habitat interfaces such as shorelines.

The mechanism for greater abundance of drift invertebrates in the Yolo Bypass remains unclear, but is unlikely to be an artifact of land use on the floodplain. Possible explanations for increased drift abundance include increased food supply (e.g., primary production or detritus), more habitat, and longer hydraulic residence times. For each of these mechanisms, Yolo Bypass probably provides functions similar to more "natural" floodplains. Improved food supply is supported by the work of Jassby and Cloern (2000), whose modeling studies suggest that the Yolo Bypass should have enhanced phytoplankton production as a result of its large surface area and shallow depth. Inputs of fertilizers from agriculture in the Yolo Bypass would not be important contributing factors, as nitrogen and phosphorous are rarely limiting to phytoplankton production in the delta (Ball and Arthur 1979). Like less-disturbed floodplains in other regions (Junk et al. 1989), invertebrate production in the Yolo Bypass may be stimulated by an increased availability of detritus in the food web. Alternatively, the trends in invertebrate abundance we observed may be a consequence of physical differences between floodplain and channel habitat. Inundation of the floodplain may increase the amount of habitat for benthic invertebrates, a major source of drift biomass. Given the larger surface area and lower velocities in Yolo Bypass, the floodplain probably has a much longer hydraulic residence time than the Sacramento River, reducing the rate at which drift invertebrates would be flushed out of the system. Increased habitat area and hydraulic residence time would also have been functional characteristics of the historical floodplain.

In the broader context, the results for salmon and drift invertebrates are consistent with the flood pulse concept, which predicts that floodplains should yield greater fish and invertebrate production than channel habitat (Junk et al. 1989). This finding is significant in that the flood pulse concept was developed primarily on the basis of relatively undisturbed rivers, whereas our study was conducted in a regulated river with a floodplain dominated by agricultural uses. Gutreuter et al. (2000) showed similar enhancements in fish growth from floodplain inundation in the Upper Mississippi River, another large regulated river. These studies suggest that floodplains can maintain important functional characteristics even in heavily modified rivers. In the case of the San Francisco Estuary and its tributaries, we do not claim that floodplain inundation is the primary factor regulating the productivity of the system. The Yolo Bypass floodplain may be seasonally more productive than the Sacramento River for some fish and invertebrates, but we have no data regarding its contribution during dry months or years. Nonetheless, the results of the present study and of Sommer et al. (1997) are sufficient to demonstrate that the floodplain represents one of the most biologically important habitat types in the region. We believe that proposed large-scale restoration activities in the San Francisco Estuary and its tributaries (Yoshiyama et al. 2000) that would increase the area and connectivity of the floodplain offer particular promise for native fish populations such as chinook salmon and Sacramento splittail.

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[Article]

Habitat Use and Stranding Risk of Juvenile Chinook Salmon on a Seasonal Floodplain

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Abstract.—Although juvenile Chinook salmon *Oncorhynchus tshawytscha* are known to use a variety of habitats, their use of seasonal floodplains, a highly variable and potentially risky habitat, has not been studied extensively. Particularly unclear is whether a seasonal floodplain is a net "source" or a net "sink" for salmonid production. To help address this issue, we studied salmon habitat use in the Yolo Bypass, a 24,000-ha floodplain of the Sacramento River, California. Juvenile salmon were present in the Yolo Bypass during winter–spring; fish were collected in all regions and substrates of the floodplain in diverse habitats. Experimental releases of tagged hatchery salmon suggest that the fish reared on the floodplain for extended periods (mean = 33 d in 1998, 56 d in 1999, and 30 d in 2000). Floodplain rearing and associated growth are also supported by the significantly larger size of wild salmon at the floodplain outlet than at the inlet during each of the study years. Several lines of evidence suggest that although the majority of young salmon successfully emigrated from the floodplain, areas with engineered water control structures had comparatively high rates of stranding. Adult ocean recoveries of tagged hatchery fish indicate that seasonal floodplains support survival at least comparable with that of adjacent perennial river channels. These results indicate that floodplains appear to be a viable rearing habitat for Chinook salmon, making floodplain restoration an important tool for enhancing salmon production.

A large downstream movement of fry to provide dispersal to rearing areas is typical of ocean-type Chinook salmon *Oncorhynchus tschawytcha* (Healey 1991). Rearing areas include channel and off-channel habitat in natal and nonnatal streams and their estuaries (Bjornn 1971; Kjelsen et al. 1982; Levy and Northcote 1982; Swales et al. 1986; Swales and Levings 1989; Healey 1991; Shreffler et al. 1992). Recently, Sommer et al. (2001b) observed that juvenile Chinook salmon also live on seasonal floodplains. Large rivers and streams typically have dynamic floodplains varying in size from several to thousands of hectares, unless their channels are heavily confined by topography (e.g., streams at high elevation or confined by canyons or levees). Floodplains are known to be of major importance to aquatic ecosystems in most regions; large rivers typically favor the development of a fauna adapted to colonize this habitat (Welcomme 1979; Junk et al. 1989; Sparks 1995). As a result, it is reasonable to expect dispersing salmonid fry show some ability to use seasonal habitat. In support of this hypothesis, Sommer et al. (2001b) reported that food resources and water temperatures on the seasonal floodplain of a large river were superior to those in an adjacent perennial channel, resulting in enhanced growth rates of young salmon. Despite some evidence that enhanced growth on the floodplain improved fry–smolt survival in the estuary, Sommer et al. (2001b) did not address any effects on adult production.

Intuitively, rearing in seasonal floodplains or intermittent streams seems risky because these habitats are among the most dynamic on earth (Power et al. 1995). It is still unknown whether seasonally dewatered habitats are a net "source" or a "sink" for salmonid production relative to production in permanent stream channels (Brown 2002). In particular, the high degree of seasonal flow fluctuation characteristic of floodplain habitat could cause major stranding events and increase mortality rates of young salmon (Bradford 1997; Brown 2002). For resident taxa in intermittent streams, the benefits of very large flow fluctuations appear to outweigh costs associated with a variable environment (Spranza and Stanley 2000). This issue continues to be a key concern for regulatory agencies that evaluate off-channel restoration projects or proposed flow fluctuations for possible effects on fishes (Brown 2002; Bruce Oppenheim, NOAA Fisheries, personal communication).

Here, we describe spatial and temporal trends in juvenile Chinook salmon habitat use and stranding in a large California river floodplain. Our study was conducted in the Yolo Bypass, the primary floodplain of the Sacramento River, the major pro-

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Exhibit "Q"

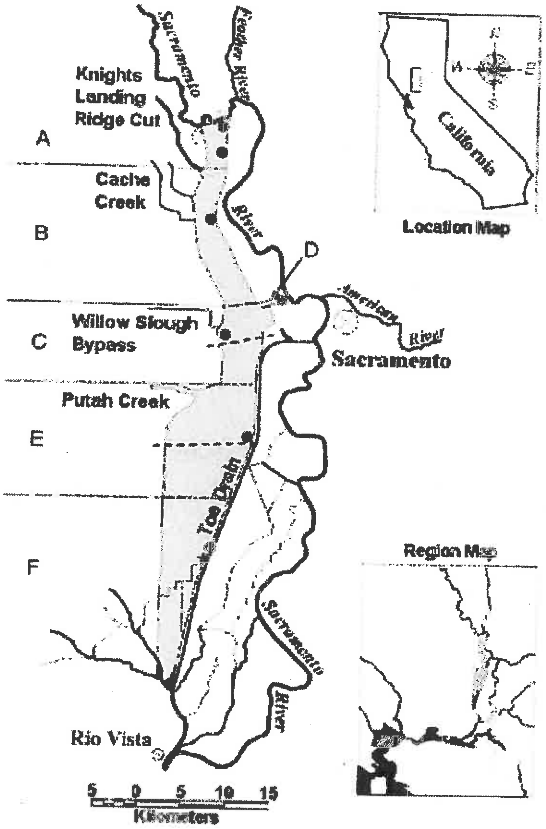

FIGURE 1.—Location of Yolo Bypass in relation to the San Francisco Bay–Delta and its tributaries. Fremont Weir is the upper (northern) edge of the Yolo Bypass. The major regions of the floodplain are delineated from north to south and correspond to the following codes: (A) Fremont Weir; (B) Cache Creek sinks; (C) Yolo Bypass Wildlife Area; (D) Sacramento Bypass; (E) Putah Creek Sinks; and (F) Liberty Island. The sampling locations are identified as follows: beach seine sites (solid circles); screw trap (star); and purse seine transects (dotted lines).

ducer of salmon in the San Francisco estuary (Figure 1). Because the Yolo Bypass can convey 75% or more of the total flow from the Sacramento River basin (Sommer et al. 2001a), this floodplain can be expected to be a migratory pathway for a substantial number of juvenile Chinook salmon. A major objective of our study was to collect basic information about the timing, duration, and habitat use of salmon on floodplains. We hoped that these data would provide insight into whether a floodplain is a net source (i.e., with rearing benefits) or a net sink (i.e., with high mortality because of stranding or predation) for salmon populations. The major hypotheses evaluated were as follows: (1) salmon occur in all major habitat types and geographic regions; (2) floodplains provide rearing habitat for salmon and are not simply a migration corridor; and (3) stranding of juvenile salmon does not have a major population-level effect on survival of the fish that use floodplain habitat. We addressed these hypotheses by sampling wild fish throughout the floodplain, experimentally releasing tagged fish, and using hydrologic modeling and measurements of physical conditions to describe how habitat varied over the study period.

Study Area

The San Francisco Estuary and its two component regions, Sacramento–San Joaquin Delta and downstream bays (Figure 1), make up one of the largest estuaries on the Pacific coast of North America. Major changes to the system have included diking and isolation of about 95% of the wetlands, introduction of exotic species, channelization, sediment inputs from hydraulic mining, and discharge of agricultural and urban chemicals (Nichols et al. 1986; Kimmerer 2002). The Estuary receives most freshwater via the Delta, which drains approximately 100,000 km^2. Most precipitation occurs upstream of the Delta during winter and spring, resulting in a greater than 10-fold seasonal range of daily freshwater flow into the estuary. However, the hydrograph is substantially altered by dams on each of the major rivers. Peak flow pulses typically occur during winter, but dam operations can reduce the magnitude of the pulses, particularly in dry years, when much of the inflow is captured behind reservoirs (Mount 1995; Kimmerer 2002). The historically prominent spring flow pulse from snowmelt is at present muted except during heavy, late-season storms. For the past several decades, much of the spring snowmelt has been stored in reservoirs and released during summer and autumn, periods of historically lower flow. As much as 65% of the net Delta flow during summer and autumn is diverted from the channels by two large water diversions (the State Water Project and the Central Valley Project); additional water is diverted by 2,200 pumps and siphons for irrigation (Kimmerer 2002).

The 24,000-ha Yolo Bypass is the primary floodplain of the Delta (Sommer et al. 2001a). The majority of the floodplain is leveed to protect surrounding cities from floodwaters, but levees confine flow through the bypass only under very high flow events. The Yolo Bypass currently floods an average of every other year, typically under high-flow periods in winter and spring. The Yolo Bypass has a complex hydrology, with inundation possible from several different sources. The floodplain typically has a peak inundation period during January–March but can flood as early as October and as late as June. The primary input to the Yolo Bypass is through Fremont Weir in the north, which conveys floodwaters from the Sacramento and Feather rivers. During major storm events (e.g., >5,000 m^3/s), additional water enters from the east via the Sacramento Weir, adding flow from the American and Sacramento rivers. Flow also enters the Yolo Bypass from several small streams on its western margin, including Knights Landing Ridge Cut, Cache Creek, and Putah Creek. During much of the winter, water-suspended sediment levels in the Yolo Bypass and Sacramento River are high, generally resulting in secchi depths of less than 0.25 m. However, hydraulic residence times are typically longer in the Yolo Bypass than in the Sacramento River (Sommer et al. 2004). Floodwaters recede from the northern and western portions of the bypass along relatively even elevation gradients of 0.09% west–east and 0.01% north–south into a perennial channel on the eastern edge of the Bypass; they then rejoin the Sacramento River near Rio Vista. The majority of the Yolo Bypass is at present managed for wildlife in a mosaic that includes riparian, wetland, upland, and perennial pond habitats; however, a dominant land use during the past two decades, agriculture has decreased in recent years because of habitat restoration activities.

Our data collection focused on the fall-run juvenile Chinook salmon, currently the numerically dominant race in the Sacramento Valley (Yoshiyama et al. 2000). There are four races of Chinook salmon in the Sacramento Valley: winter, spring, late-fall, and fall-run. Like many other native fish, Chinook salmon in the San Francisco estuary and its tributaries have been adversely affected by such factors as habitat loss, water diversions, and species introductions (Bennett and Moyle 1996); as a result, the Sacramento River winter and spring run Chinook salmon are protected under the Federal Endangered Species Act. The typical life history pattern is for young fall-run salmon fry (approximately 35–70 mm fork length) to migrate from the tributaries during winter and spring to the estuary (Brandes and McLain 2001).

Methods

Physical habitat.—Because seasonal hydrologic variability is a key characteristic of floodplain habitat, we reasoned that detailed data on changes in physical habitat would be necessary to evaluate the responses of young salmon. Daily flow data were obtained from gauging stations in the floodplain, and temperature data were collected using continuous temperature recorders (Sommer et al. 2001b). However, the vast area of Yolo Bypass made it impractical to directly measure other parameters, such as depth and surface area. As an alternative, we used a hydrologic model to estimate these parameters (Sommer et al. 2004). To summarize, the model treated Yolo Bypass as a "reservoir" described by (1) basin geometry and (2) flow and stage time series. The Yolo Bypass floodplain geometry was developed from 200 cross-sections with data collected at 300-m intervals by standard rod and level survey techniques. Mean daily stage and flow data were obtained from five gauging stations in the Yolo Bypass. For each date in the time series, we used linear interpolation between the gauging stations to estimate the stage at each cross-section. The estimated stage value was then used to calculate conveyance characteristics of each cross-section: area, width, and wetted perimeter. The daily results for each cross-section were used to estimate total surface area and mean depth. The large scale of the study reach did not allow validation of the depth estimates. As a partial validation of the model, Sommer et al. (2004) estimated total inundated area for the Yolo Bypass by using aerial photographs on days when the floodplain was inundated (February 8 and March 2, 1998) and when the floodplain was draining (April 28, 1998). To provide additional information about areas where fish stranding and consequent losses could occur, we estimated the portion of the area that was isolated ponds versus inundated area that was actively draining to the Delta (i.e., perennial channels and adjacent inundated area) on April 28, 1998.

Fish habitat use.—We used beach seine sampling to examine which regions and substrates of the floodplain were used by young salmon (hypothesis 1). During January through April of each year, a 15-m seine (3.2-mm mesh) was used to sample six regions of the Yolo Bypass (Figure 1). Fixed stations were used in each region during flooded periods. After floodplain drainage, samples were collected randomly within each region. For all periods, the primary substrate type of the habitat (sand, mud, gravel, pavement, or vegetation). fish species and size, and an estimate of the surface area swept by the seine were recorded. Habitat use during flood events was summarized in terms of the percentage of samples that contained salmon for each region and substrate type.

To provide additional information about habitat use, we conducted purse seine sampling along two transects (Figure 1). This sampling, performed in 1998 when the Yolo Bypass flow was relatively high (>850 m^3/s), used purse seines (30.5 m × 4.6 m, 4.75-mm mesh) set from a jet boat. Purse seining was conducted at 1–2 transects up to five times weekly, depending on hydrology. Hauls were made at random points in each of three habitat types (riparian, agricultural fields, and wetlands), the boundaries of which were established from aerial photographs taken before the Bypass was inundated. In the case of riparian habitat, hauls were made in clearings adjacent to trees to avoid snagging. We also recorded transect side (east or west half) for each haul because the western side of the Yolo Bypass was shallower and flow was dominated by inputs from westside streams rather than from Fremont or Sacramento weirs (Sommer et al. 2004). Most of these hauls were performed in areas exposed to at least a modest current. Additional limited paired sampling was conducted to examine possible differences between areas with and without velocity refuges. Low-velocity habitats sampled included downstream edges of levees, islands, and clusters of trees. Water velocities in randomly selected areas were approximately 0–0.05 m/s compared with greater than 0.33 m/s in adjacent exposed areas. Water depths were similar for each sampling pair. Differences in salmon densities for each habitat type were examined by using a Kruskal–Wallace test. A randomization *t*-test with 1,000 iterations (Haddon 2001) was used to compare salmon density on the east and west sides of the floodplain.

Migration trends.—To examine temporal trends in salmon migration through the floodplain (hypotheses 2 and 3), we operated a rotary screw trap (EG Solutions, Corvallis, Oregon) near the base of the Yolo Bypass during each study year. This technique was intended to provide an indication of the timing and duration of migration, rather than an absolute measure of the number of salmon emigrating the floodplain. During much of the sampling period the inundated width of the floodplain was 1–5 km, an area we considered too large for the traditional mark–recapture evaluations required to measure trap efficiency and total emigration (Roper and Scarnecchia 1996). A 1.5-m-diameter trap was used for the first 3 weeks of sampling in February 1998, after which a 2.4-m trap was used for all other sampling. We operated traps as often as 7 days each week, the daily effort varying from 1 to 24 h, depending on debris load and safety considerations. Fish number and size were recorded in all years. In 1998, young salmon were classified as fry (prominent parr marks) or transitional fish/smolts (faded parr marks, silver appearance).

Floodplain residence time and growth.—We used experimental releases of salmon with coded wire tags (CWTs) as our primary method to evaluate fish residence time on the floodplain (hypothesis 2). Fry (mean size = 57 mm fork length) from the Feather River Fish Hatchery (Figure 1) were tagged by using coded-wire half tags (Northwest Marine Technologies) and released in the Yolo Bypass below the Fremont Weir on March 2, 1998 (53,000 fry); February 11, 1999 (105,000 fry); and February 22, 2000 (55,000 fry). We assessed residence time in the Yolo Bypass from recoveries of tagged fish in the screw trap at the base of the floodplain.

We also examined, using the previously described beach seine data, whether there was evidence of long-term rearing of wild salmon in the floodplain. We compared the slopes of weekly fork length measurements for the two northern beach seine regions ("North") to the southernmost region ("South"), using a generalized linear model (GLM) with a Poisson distribution and log link variance function. We reasoned that major significant differences between the sizes of fish in the two areas provided evidence of extended rearing and growth of fish in the floodplain.

Salmon survival and stranding.—We used several independent data sources to examine whether salmon successfully emigrated from the floodplain (hypothesis 3). First, we compared survival of each of the Yolo Bypass CWT hatchery-reared salmon release groups with the survival of parallel CWT groups containing the same number of fish released into the Sacramento River (Sommer et al. 2001b). Recapture rates at the smolt stage of the 1998 and 1999 release groups had previously been analyzed by Sommer et al. (2001b); in the present study, we evaluated adult recoveries in the commercial and recreational ocean fisheries through 2003. Second, we examined stranding by using beach seine data (described previously) collected within a few weeks after the Sacramento River stopped flowing into the Yolo Bypass. Densities of salmon were compared with a randomization *t*-test (Haddon 2001) for (1) isolated earthen ponds (2) perennial channels, and any sites immediately adjacent to these water sources. The results for all years were pooled because of relatively low sample sizes for individual years. Data for each year

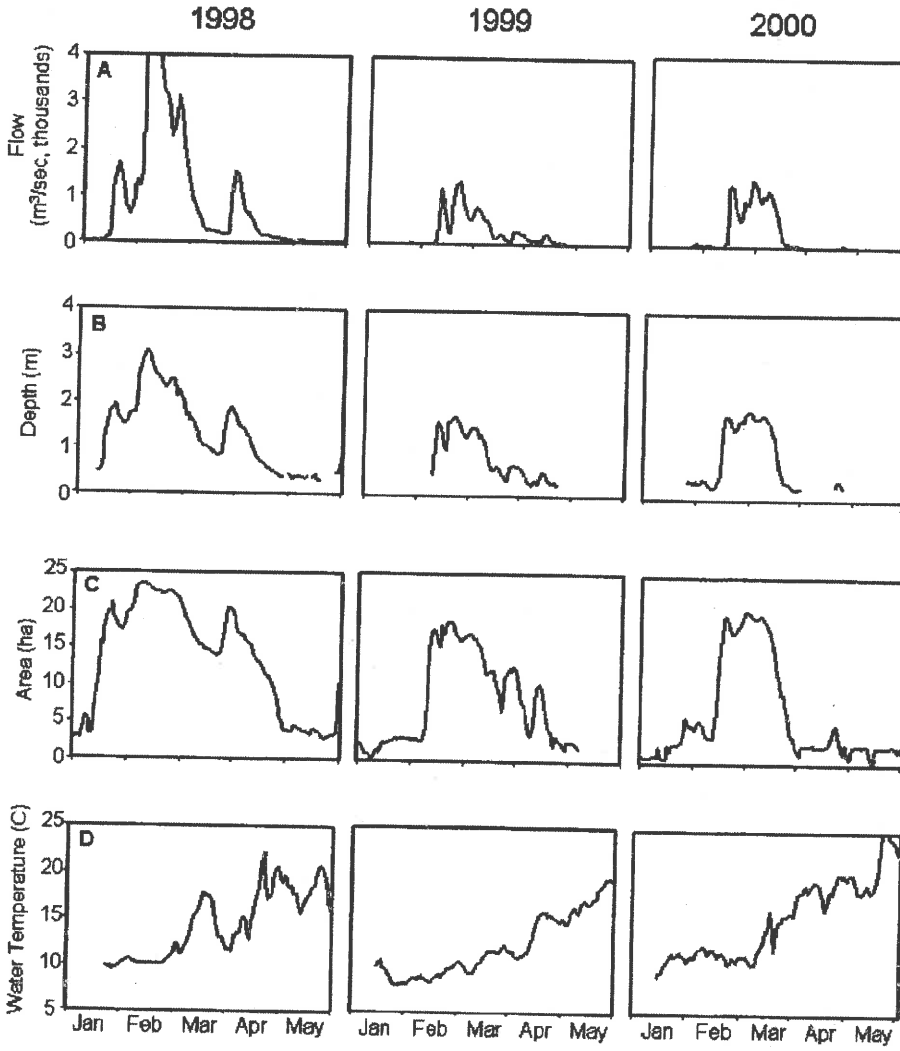

FIGURE 2.—Trends in physical variables for January–June 1998–2000: (A) mean daily flow in the Yolo Bypass; (B) simulated mean daily depth; (C) surface area; and (D) daily mean water temperature. The surface area data for 1998 and 2000 are from Sommer et al. (2004).

were first standardized for possible annual differences in abundance by conversion to z-scores; we then ran the randomization analysis using 1,000 iterations. We hypothesized that abundance of salmon would be equal in isolated ponds and contiguous water sources; that is, they would show no distinct "preferences." Our reasoning was that similar abundance levels would indicate successful emigration, because most of the water drains from the floodplain. To further understand factors that could affect stranding, we also used a randomization t-test to compare densities of fish in two types of isolated ponds: isolated earthen ponds and concrete weir scour ponds at Fremont and Sacramento weirs (Figure 1). Sampling effort was much greater in the isolated earthen ponds, so the randomization t-test was performed after randomly subsampling the earthen pond data from throughout the floodplain to provide equal sample sizes. We predicted that flood control structures would cause higher stranding than "natural" ponds. In addition, we examined trends in the catch of salmon in the screw trap data. We predicted that salmon catch would increase substantially during drainage because fish successfully emigrated the floodplain.

Results

Physical Habitat

The hydrographs varied substantially during the years of study (Figure 2A). In 1998 the hydrology was wet (4.4-year recurrence flood event) and the Yolo Bypass was inundated during mid-January through mid-April and again in early June. The flow was lower in the other 2 years, when inundation occurred between mid-February and mid-March, peak flood events being at the 1.7-year recurrence interval in 1999 and at the 2.4-year recurrence interval in 2000. Surface area in the Yolo Bypass closely followed the flow peaks, the amounts of inundated area being successively smaller in each of the study years (Figure 2C). For the April 28, 1998, photographs, the total surface area of 5,050 ha was slightly lower than the model estimate of 6,700 ha. Based on the aerial photographs, we estimated that only 600 ha of the 5,050 ha comprised isolated ponds, the remainder being water that drained to the Delta. For all but peak flood events, mean water depth remained less than 1 m (Figure 2B). During peak flood events, mean depths did not exceed 2 m except in February 1998. Water temperature showed gradual increases throughout each study year (Figure 2D).

Fish Habitat Use

We captured salmon in all regions of the floodplain and on all substrate types. During 1998–2000 flood events, salmon were captured in a high percentage of samples in each region (Figure 1) of the floodplain: (1) Fremont Weir (100%, n = 13 samples); (2) Cache Creek Sinks (50%, n = 16 samples); (3) Yolo Bypass Wildlife Area (77%, n = 22 samples); (4) Sacramento Bypass (100%, n = 7 samples); (5) Putah Creek Sinks (94%, n = 11 samples); and (6) Liberty Island (100%, n = 7 samples). Similarly, during 1998–2000 flood events we collected salmon on a high percentage of substrate types: (1) mud (70%, n = 47 samples); (2) sand (100%, n = 3 samples); (3) pavement (100%, n = 8 samples); (4) vegetation (97%, n = 32 samples); and 5) gravel (89%, n = 9 samples).

Salmon densities as estimated by purse seine sampling were not significantly different between riparian (mean abundance = 46.9/ha, SE = 10.4, n = 23), agricultural (mean abundance = 20.9/ha, SE = 6.1, n = 35), or natural vegetated habitat types (mean abundance = 27.5/ha, SE = 5.6, n = 31) based on a Kruskal–Wallis test (H = 4.38, df = 2, P = 0.112). There was also no statistically significant difference between the east (mean abundance = 29.5/ha, SE = 6.0, n = 53) and west (mean abundance = 29.9/ha, SE = 6.7, n = 36) sides of the Bypass as shown by a randomization t-test (P = 0.95). Salmon were collected in six hauls in low-velocity habitat (mean abundance = 189/ha, SE = 24/ha), but none were collected in adjacent areas exposed to a current.

Floodplain Migration Trends

Salmon migration as indicated by trends in screw trap catch was highly variable over the course of the study, but there were prominent peaks in Chinook salmon catch coincident with floodplain drainage during late March–April (Figure 3B). Additional smaller peaks in salmon catch also paralleled flow, mostly during February and March. The life history stage of salmon during 1998 was exclusively parr through the end of March, after which the majority showed signs of smoltification.

Floodplain Residence Time

Based on recoveries of tagged fish in the screw trap, the mean residence time of CWT salmon was 33 d (range, 16–46 d; n = 10) in 1998, 56 d (range, 4–76 d; n = 49) in 1999, and 30 d (range, 28–37 d; n = 25) in 2000. The size of fish was significantly larger (P<0.001; GLM) at the outlet of the floodplain than at the top (Figure 3C) during each of the study years.

Salmon Survival and Stranding

The numbers of CWT fish recovered for the Yolo Bypass were higher than in the Sacramento River in 1998, similar in 1999, and lower in 2000 (Table 1). Densities of wild Chinook salmon were highly variable during floodplain drainage events, with no statistically significant difference between densities in isolated earthen ponds and contiguous water sources (Table 2). However, densities of salmon were significantly higher (P < 0.0001; randomization t-test) in concrete weir scour ponds than in isolated earthen ponds (Table 3).

Discussion

Research on migratory fishes reveals that these species frequently have alternative life histories that may be influenced by habitat use at early life stages (Clark 1968; Secor 1999). Under Clark's (1968) "contingent hypothesis," migratory taxa have divergent migration pathways that could help the species deal with environmental variability and heterogeneity. This theory is consistent with our understanding of Chinook salmon, which are adapted to the extreme hydrologic variability in western North America and show a range of life histories (Healey 1991; Bottom et al. 2005). In this context, the use of multiple habitats—including natal and nonnatal streams (Bjornn 1971; Scriv-

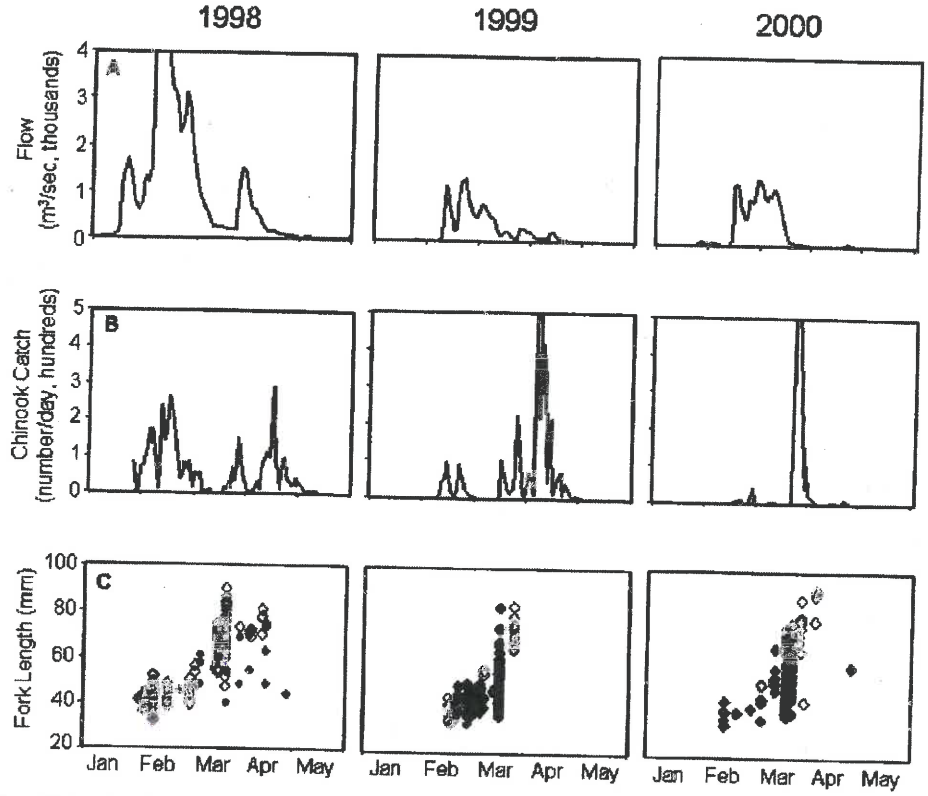

FIGURE 3.—Chinook salmon results during winter and spring 1998–2000: (A) mean daily flow; (B) salmon catch rates in screw trap sampling; and (C) salmon size for beach seine samples near the Yolo Bypass intake (solid symbols) and outlet (clear symbols).

ener et al. 1994), side channels and off-channel ponds (Swales et al. 1986; Swales and Levings 1989), low-elevation rivers (Kjelsen et al. 1982; Brown 2002), and estuaries (Healey 1991; Shreffler et al. 1992)—can be considered as part of an overall "bet-hedging" strategy that spreads risk across a variable environment. Despite the fact that seasonal floodplain represents perhaps the single most variable habitat available to salmon, our study suggests that floodplains are a viable rearing location for young fish.

TABLE 1.—Number of coded wire tags recovered in the ocean and commercial fisheries for Chinook salmon released in the Yolo Bypass and Sacramento River. The total number of tagged fish released in each location for each year is shown in parentheses. The survival ratio is calculated as the number of Yolo Bypass recoveries divided by the number of Sacramento River recoveries.

Release group	1998 (53,000)	1999 (105,000)	2000 (55,000)
Yolo Bypass	75	136	27
Sacramento River	35	138	47
Survival ratio	2.14	0.99	0.57

At the beginning of our study, our conceptual model for floodplain habitat use was that young salmon move into the floodplain during high-flow events and spread throughout the broad expanse of seasonally inundated habitat. Among the wide variety of suitable substrates and habitat types for rearing, young salmon appear to seek out low-velocity areas. Moreover, floodplain habitat apparently is not simply a migration corridor; many young salmon actively rear on the highly productive floodplain habitat for extended periods of time, resulting in high growth rates. Our findings suggest that salmon emigrate from the seasonally inundated habitat both during flood events and during drainage. Juvenile Chinook salmon do not appear to be especially prone to stranding mortality; indeed, survival may actually be enhanced by floodplain rearing in some years. Our conceptual model was supported by our results and has a variety of management implications.

Salmon were present in a broad range of habitat and substrate types and were collected in all regions and sides of the Yolo Bypass floodplain. The

TABLE 2.—Densities of Chinook salmon (number/ha ± SE, with sample size in parentheses) collected in beach seine sampling during drainage events in 1998–2000. The sample locations are divided into isolated earthen ponds and contiguous water sources. Density differences were not statistically significant between the two pond types based on a randomization t-test of the pooled data for all years ($P = 0.79$; $n = 43$ for isolated ponds; $n = 59$ for contiguous water sources).

Location type	1998	1999	2000
Isolated ponds.	206 ± 112 (30)	890 ± 491 (8)	126 ± 65 (5)
Contiguous water sources	167 ± 79 (33)	310 ± 104 (13)	463 ± 123 (13)

fact that they were present on the western half of the Bypass, where flows are dominated by Knights Landing Ridge Cut and Cache and Putah creeks, suggests that salmon spread throughout the floodplain after entering the basin by way of Fremont and Sacramento weirs. A few of these fish may have originated from a modest spawning population in Putah Creek (Marchetti and Moyle 2001). The fact that salmon were present in a wide range of habitat and substrate types and in different regions of the Yolo Bypass indicates that many areas of habitat were suitable, although this does not mean that there were no habitat preferences. Like many young fishes, much of the distribution of juvenile Chinook salmon can be explained by their association with shallow depths and low velocities (Everest and Chapman 1972; Roper et al. 1994; Bradford and Higgins 2001). The physical modeling indicated that mean depths were generally 1 m or less during all but peak flood periods, so much of the thousands of hectares of inundated habitat was probably within the shallow range typically preferred by young Chinook salmon (Everest and Chapman 1972). Our limited purse seine sampling suggested that young salmon were most abundant in low-velocity areas, which is consistent with previous studies in river and stream habitat (Everest and Chapman 1972; Roper et al. 1994; Bradford and Higgins 2001). We did not directly simulate water velocity in the present study; however, the relatively shallow water depth during flood events reflects the broad area of low-velocity rearing habitat created during flood events. We expect that this increase in rearing habitat in the Yolo Bypass provides foraging opportunities (Sommer et al. 2001b), reduced energy expenditure, and perhaps reduced probability of encounter with a predator (Ward and Stanford 1995).

Our results also suggest that fish rear in the system for extended periods rather than simply using it as a migration corridor. The mean residence time of 30–56 d for the 44-km reach between the floodplain release location and the screw trap is substantially longer than one would expect, given that (1) fingerlings are capable of migrating at rates of at least 6–24 km/d in low-elevation reaches of other large rivers (Healey 1991) and (2) one of our 1999 CWT fish was recovered just 4 days after being released, having traveled an estimated rate of 11 km/d. The fish were significantly larger at the base of the Yolo Bypass, suggesting that their period of residence in the floodplain was long enough to support substantial growth. Similarly, Sommer et al. (2001b) found that salmon showed higher growth rates in the Yolo Bypass than in the adjacent Sacramento River, primarily because of higher levels of invertebrate prey in the floodplain. A long period of rearing is also supported by the screw trap data, which showed that the densities of salmon were greatest during drainage of the floodplain. We believe that these peaks are a result of rearing salmon being forced off of the floodplain by receding flows. Temperature and salmon life history stage do not provide good alternative explanations for the emigration trends. In 1998, for example, water temperatures were relatively high by late March and salmon began smoltification shortly thereafter; yet the screw trap data indicate

TABLE 3.—Densities of Chinook salmon (number/ha ± SE, with sample size in parentheses) collected in beach seine sampling for earthen ponds and adjacent concrete weir ponds. Density differences were statistically significant between the two pond types based on a randomization t-test of the pooled data for all years ($P < 0.0001$; $n = 26$ for each pond type). Note that we used a randomly sampled subset of the earthen pond data to provide equal sample sizes for the comparison.

Location type	1998	1999	2000
Earthen ponds	186 ± 67 (63)	531 ± 200 (21)	369 ± 97 (18)
Concrete weir ponds	2,717 ± 1,115 (14)	14,208 ± 3,898 (12)	4,181 ± 1,275 (3)

that emigration did not peak until the end of April, when the floodplain drained. Perhaps the emigration trends are partially confounded by seasonal variation in salmon abundance. In the absence of trap efficiency data, we cannot estimate the proportion of the population that emigrated in winter versus spring events.

Several lines of evidence suggest that the majority of fish successfully emigrated from the floodplain. One important observation was that the area of isolated ponds was small relative to the overall area of the floodplain during both peak flood and drainage periods. As an example, in 1998, the wettest year we studied, the peak area of inundation was 24,000 ha, but the total inundated area dropped to 5,000 ha by late April. Of the 5,000 ha remaining at this point, our estimates from aerial photographs showed that isolated ponds took up only 600 ha. Put another way, isolated ponds represented just 12% of the wetted area in April and only 2.5% of the peak inundated area in winter. The same trend is evident in the area simulations for 1999 and 2000, when the peak area was 20,000 ha, but dropped to about 2,000 ha within a month. These results demonstrate that the Yolo Bypass drains fairly efficiently, leaving little isolated area where stranding can occur. This finding was somewhat unexpected, because many parts of the Yolo Bypass have natural topographic features or agricultural levees that could potentially impede drainage and fish emigration. Even if the area of isolated ponds is low, stranding could still be a substantial source of mortality if densities of fish in the remaining ponds were very high. However, we found no evidence that densities of fish stranded in isolated ponds were significantly higher than those in contiguous water sources that were draining to the Delta. The key point here is that most of the water drains from the floodplain and apparently the majority of the fish are leaving with the receding floodwaters. To help illustrate this issue, if we assume that mean densities of fish observed in Table 2 were representative of the entire wetted area of floodplain in April 1998, then the total number of fish in the 600 ha of isolated ponds would have been 123,600 salmon, lower than an estimate of 835,000 fish in the 5,000 ha of contiguous water sources. This conservative estimate also does not include the large numbers of fish that emigrated from the floodplain before April.

In addition to the beach seine and surface area data, we believe that trends in screw trap data support the hypothesis that stranding is not consistently a major problem on the floodplain. The screw trap data are somewhat ambiguous, because the large area of the floodplain makes it unreasonable to measure the efficiency of the trap. Therefore, we cannot accurately estimate the absolute number of salmon emigrating from the floodplain. However, we can at least examine the patterns of trap catch to evaluate likely mechanisms. Some of the possible patterns that we would expect to see for different factors are summarized in Figure 4. First, under the "trap efficiency" model, we would have expected dual peaks in the earliest and latest portions of flood events, when the screw trap would be sampling the highest portion of total flow (Figure 4A). If young salmon follow the "go with the flow" model, catch and flow peaks should be well-correlated (Figure 4B). Alternatively, if floodplains represent an important rearing habitat, we would expect catch trends to follow the "loitering" model, in which catch does not increase until drainage, when fish are forced from their rearing habitat by receding floodwaters (Figure 4C). Finally, if stranding were a major factor controlling catch trends, we would expect an early increase in catch as fish moved through the floodplain during inundation, but then catch should drop earlier than flow as young salmon became isolated from draining floodwaters (Figure 4D; "bathtub" model). Of these patterns, our data for the Yolo Bypass provide the strongest support for both the "go with the flow" and "loitering" models. In each year we saw obvious screw trap catch peaks associated with flow events, and additional prominent peaks associated with drainage. To summarize, apparently some of the fish move

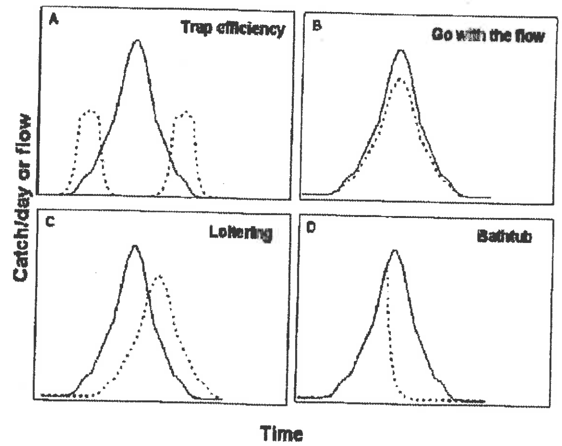

FIGURE 4.—Four conceptual models of expected screw trap catch (dotted line) relative to flow (solid line). See the Discussion for further details about each model.

through the floodplain in direct association with flow, whereas others remain as long as possible to rear on the floodplain. The screw trap trends show no evidence that stranding had a major influence on patterns of emigration.

Relatively low stranding rates on the Yolo Bypass floodplain are supported by observations from other seasonal floodplain habitat in the San Francisco estuary (Peter Moyle, University of California–Davis, personal communication) and other studies. Higgins and Bradford (1996) and Bradford (1997) report that juvenile salmonids are relatively mobile and that most avoid being stranded during moderate rates of stage change. Higgins and Bradford (1996) state that maximum recommended stage reduction levels for gravel bars of regulated rivers are typically 2.5–5 cm/h, much more than the 1 cm/h or less rates of change in mean water depth we observed during drainage in the present study. In his review of the ecology of fishes in floodplain rivers, Welcomme (1979) noted that the majority of fish emigrate from floodplain habitat during drainage.

Even if stranding is not a major source of mortality, this does not necessarily mean that floodplains are not sinks for salmon production. Of the possible sources of mortality, birds and piscivorous fishes may have benefited from stranded salmon (Brown 2002). As noted by Sommer et al. (2001a), major avian predation is unlikely because densities of wading birds are low relative to the thousands of hectares of rearing habitat available during flood events. We did not measure densities of fish predators, but believe that the creation of large areas of rearing habitat should create more refuges for young fish and decrease the probability of encounter with a predator.

Ultimately, it is survival data that allow us to differentiate source from sink habitat. The size and complexity of the San Francisco estuary made it very difficult to directly measure survival rates with statistical rigor (Newman and Rice 2002); however, our CWT release studies at least provide an indication of whether survival rates in the Yolo Bypass were substantially different from those in the Sacramento River, the adjacent migration corridor. The limited results suggest that fry–adult survival rates were at least comparable in the Yolo Bypass and the Sacramento River. Moreover, the 1998 results suggest that in some years, survival may actually be substantially higher for salmon that migrate through the floodplain. Although none of these CWT releases were replicated, the fact that Sommer et al. (2001b) reported similar results for fry-to-smolt survival for the same releases in 1998 and 1999 increases our confidence that the survival data are not spurious.

Our data indicate that floodplains are a viable rearing habitat for juvenile Chinook salmon. Hence, the most important management implication of our study is that seasonal habitat should be considered as part of restoration plans for this species. Despite frequent concerns that off-channel habitat could increase stranding mortality (Brown 2002; Bruce Oppenheim, NOAA Fisheries, personal communication), our results for a hydrologically variable seasonal floodplain suggest that one should be able to design restoration projects that do not create a population sink because of excessive mortality. This is not to say, however, that stranding mortality is never an issue on floodplain habitat. For example, in the Yolo Bypass we saw significantly higher stranding rates in the concrete weir scour ponds of Fremont and Sacramento weirs than in earthen ponds. This finding suggests that artificial water control structures can create unusual hydraulics that promote stranding. However, the total area of these concrete weir ponds was only 3 ha, much smaller than our estimate of 600 ha for total isolated pond area for April 1998 and insignificant compared with the peak inundated area of 24,000 ha area. Fixing the poor hydraulics at these water-control structures may, nonetheless, be an attractive option, particularly if the cost of the solution is relatively low or if it helps to address other fisheries issues such as adult fish passage. In the Yolo Bypass, the concrete weirs not only create stranding problems for juveniles but also frequently block upstream passage of adult salmon, sturgeon, and steelhead trout (Sommer et al. 2001a), thus creating an incentive to resolve both issues simultaneously.

Finally, we wish to acknowledge that even natural floodplain or well-designed restored floodplain habitat could at least occasionally be a population sink because of stranding or predation losses. Our study was conducted over 3 years for a single, large floodplain; we cannot rule out the possibility that floodplains may not have net benefits in other years or locations. As an example, fish densities in the Yolo Bypass were relatively low compared with those reported in some other studies (Levy and Northcote 1982; Swales et al. 1986; Swales and Levings 1989); perhaps young salmon behavior could be different at higher densities. However, the potential for such losses can still be consistent with effective management of salmon populations. Diverse life history strategies provide bet-hedging for salmon populations in the highly variable environment of coastal tributaries (Secor 1999; Bottom et al. 2005). We therefore expect that young salmon will not thrive in all habitats in every year. In the case of highly variable seasonal environments such as floodplains, stranding losses might cause excessive mortality in some years, but the risks may be offset by increased rearing habitat and food resources in other years (Sommer et al. 2001b; Brown 2002).

Acknowledgments

This study would not have been successful without the contributions of staff from the Interagency Ecological Program, which includes the California Department of Water Resources, California Department of Fish and Game, and U.S. Fish and Wildlife Service. The field assistance of W. Batham, R. Kurth, C. Messer, K. Malchow, F. Feyrer, and L. Grimaldo is gratefully acknowledged. This manuscript was substantially improved by the comments of P. Moyle, B. Herbold, F. Feyrer, T.G. Brown, and two anonymous reviewers. Funding was provided by the Interagency Ecological Program and CALFED.

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Insights into the
Problems, Progress, and Potential Solutions
for Sacramento River Basin Native Anadromous Fish Restoration

Spring-Run Chinook Salmon in Mill Creek, California (Photo by Dave Vogel)

April 2011

Prepared for:

Northern California Water Association
and
Sacramento Valley Water Users

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Exhibit "R"

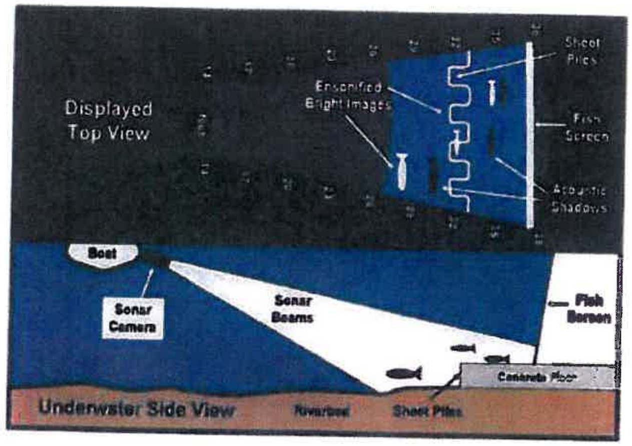


Figure 60. Schematics of DIDSON™ imaging at the base of a flat-plate fish screen. Bottom diagram shows orientation of sonar beams from the acoustic camera off the side of a boat and submerged objects at the fish screens. Top diagram shows the resultant corresponding sonar imaging of objects ensonified with acoustic shadows from the objects. (from Vogel 2008b)

From 1996 through 2010, Natural Resource Scientists, Inc. conducted 22 separate research projects on juvenile salmon (including four studies of predatory fish) in the Delta using acoustic or radio telemetry as a means to gain an improved understanding of fish movements and mortality (Vogel 2010a). The reason juvenile salmon telemetry studies were initiated in the Delta was to acquire detailed data on fish behavior, fish route selection through complex channels, and estimate fish survival in discrete reaches. Past efforts using traditional coded-wire tagging could not answer those critically important questions. Research findings from the telemetry investigations indicate that smolt survival assumptions and models must incorporate these new conclusions to avoid misinterpretation of data and improve quantitative estimates of fish survival and movements (Vogel 2010a).

The first successful use of telemetry on juvenile salmon in the Central Valley was conducted by Natural Resource Scientists, Inc. on behalf of EBMUD in 1996 and 1997. At that time, the specific behavior of juvenile salmon in the Delta was largely unknown. The initial studies quickly determined that the fish did not move as a school, but instead, dispersed, exhibiting a wide range in migratory behaviors in the complex Delta environment. Salmon moved many miles back and forth each day with the ebb and flood tides and the side channels (where flow was minimal) were largely unused. Site-specific hydrodynamic conditions present at flow splits when the fish arrived had a major affect in initial route selection. Importantly, some of the salmon were believed to have been preyed upon based on very unusual behavior patterns (Vogel 2010a).

Subsequent, additional juvenile salmon telemetry studies were conducted by Natural Resource Scientists Inc. on behalf of the USFWS and CALFED in the north Delta (Vogel 2001, Vogel 2004). Triangulating radio-tagged fish locations in real time (Figure 61) clearly demonstrated how juvenile salmon move long distances with the tides and were advected into regions with very large tidal prisms, such as upstream into Cache Slough and into the flooded Prospect and Liberty Islands (Figure 62). During the studies, it was determined that some radio-tagged salmon were eaten by predatory fish in northern Cache Slough, near the levee breaches into flooded islands (discussed below). Also, monitoring telemetered fish revealed that higher predation occurred in Georgiana Slough as compared to the lower Sacramento River (Figure 63). As discussed previously, past coded-wire tagging studies found that salmon released into northern Georgiana Slough were found to have a higher mortality rate than fish released downstream of the slough in the Sacramento River (Brandes and McLain 2001).

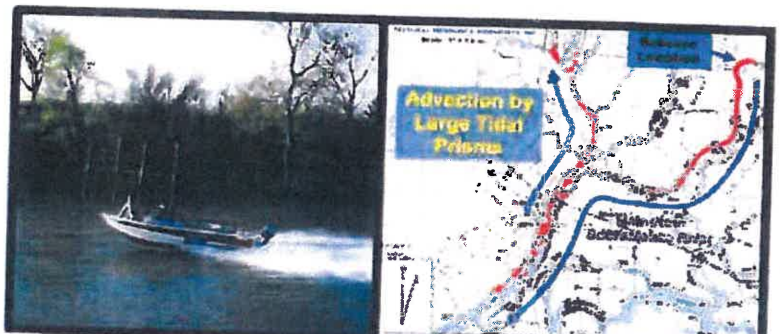


Figure 61. Left picture, mobile telemetry conducted in the north Delta. Photo by Dave Vogel.
Figure 62. Right picture, telemetered locations of approximately 100 radio-tagged salmon smolts released in the lower Sacramento River near Ryde (data from Vogel 2001 and Vogel 2004).

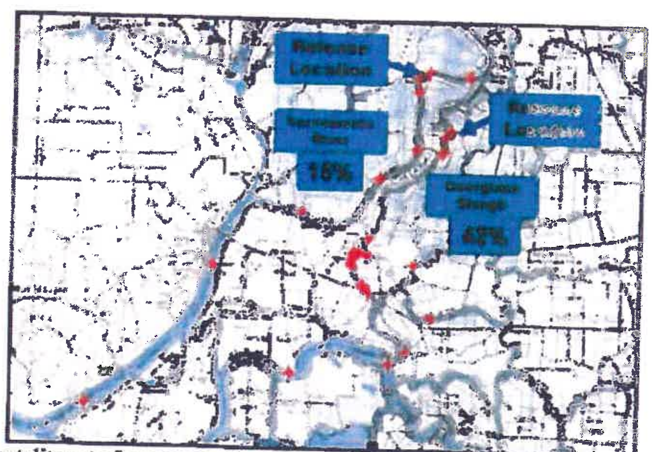
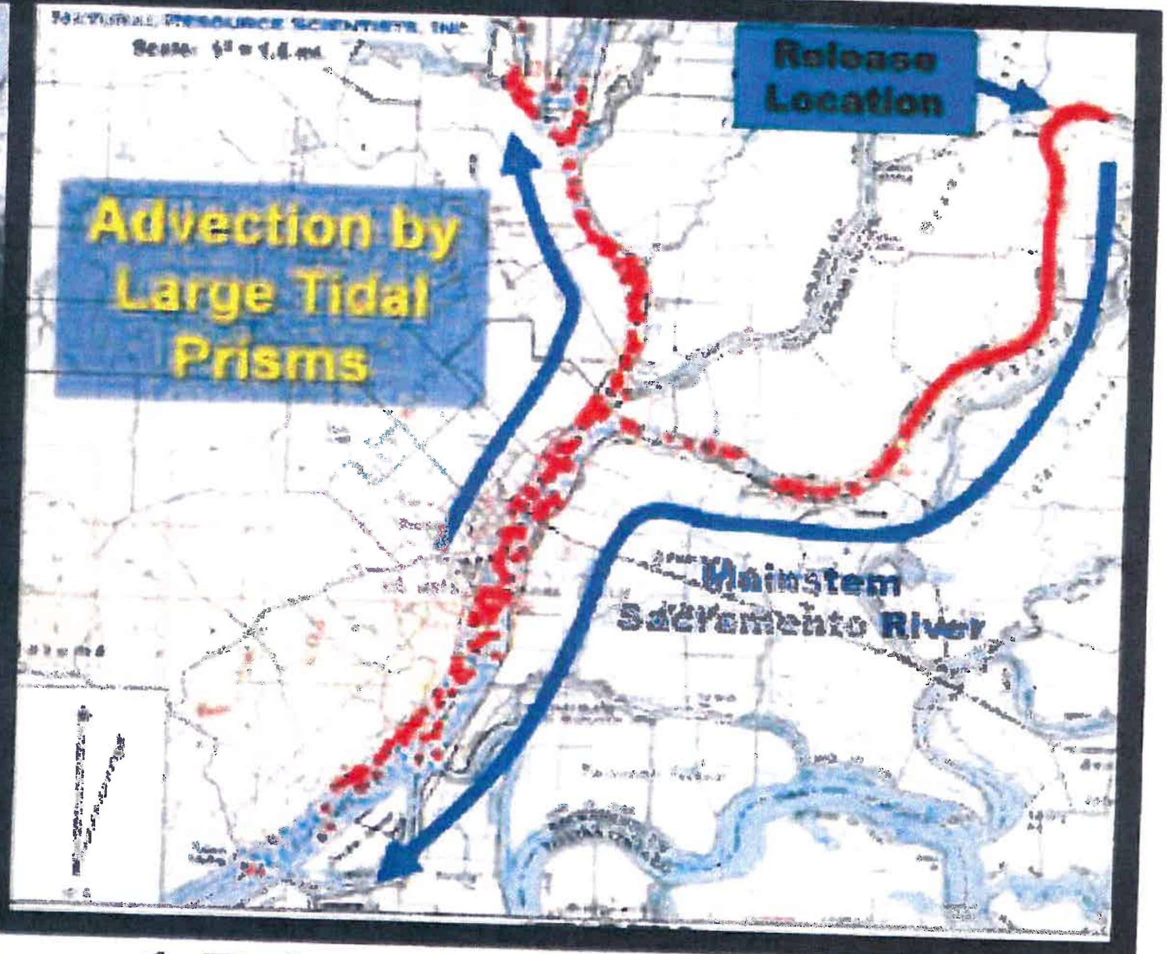


Figure 63. Estimated mortality rate for groups of radio-tagged salmon released at two locations in the north Delta and locations where radio-tagged salmon smolts were detected to have been preyed upon (Vogel 2001, Vogel 2004).

More recently, a 2007 study conducted by releasing acoustic-tagged juvenile salmon in the San Joaquin River found 116 motionless juvenile salmon transmitters in the lower San Joaquin River near the Stockton Waste Water Treatment Plant and a nearby bridge (Figure 64) (Vogel 2007b). This was an all-time record for the largest number of dead radio- or acoustic-telemetered juvenile



ducted in the north Delta. Photo by Dave Vogel.
ıs of approximately 100 radio-tagged salmon smolts released in the

vegetation at some sites in the Delta and water clarity. Increased water clarity for sight predators such as black bass and striped bass would presumably favor predatory fish over prey (*e.g.*, juvenile salmon). Fewer native fish species are found in *Egeria* stands compared to introduced fish species (Grimaldo and Hymanson 1999). Additionally, it has been hypothesized that high densities of *Egeria* in portions of the Delta may restrict juvenile salmon access to preferred habitats, forcing salmon to inhabit deep water or channel areas where predation risks may be higher (Grimaldo *et al.* 2000).

During recent years, there has been an emphasis to reclaim or create shallow, tidal wetlands to assist in re-recreating the form and function of ecosystem processes in the Delta with the intent of benefitting native fish species (Simenstad *et al.* 1999). Among a variety of measures to create such wetlands, Delta island levees either have been breached purposefully or have remained unrepaired so the islands became flooded. A recent example is the flooding of Prospect Island which was implemented under the auspices of creating shallow water habitat to benefit native fish species such as anadromous fish (Christophel *et al.* 1999). Initial fish sampling of the habitat created in Prospect Island suggested the expected benefits may not have been realized due to an apparent dominance of non-native fish (Christophel *et al.* 1999). Importantly, a marked reduction of sediment load to the Delta in the past century (Shvidchenko *et al.* 2004) has implications in the long-term viability of natural conversion of deep water habitats on flooded Delta islands into shallow, tidal wetlands. The very low rates of sediment accretion on flooded Delta islands indicate it would take many years to convert the present-day habitats to intertidal elevations which has potentially serious implications for fish restoration (Nobriga and Chotkowski (2000) due to likely favorable conditions for non-salmonid fish species that can prey on juvenile salmon. Studies of the shallow water habitats at flooded Delta islands showed that striped bass and largemouth bass represented 88 percent of the individuals among 20 fish species sampled (Nobriga *et al.* 2003).

There have likely been significant adverse, unintended consequences of breaching levees in the Delta. There is a high probability that site-specific conditions at the breaches have resulted in hazards for juvenile anadromous fish through the creation of favorable predator habitats. The breaches have changed the tidal prisms in the Delta and can change the degree in which juvenile fish are advected back and forth with the tides (Figure 61; previously discussed). Additionally, many of the breaches were narrow which have created deep scour holes favoring predatory fish. Sport anglers are often seen fishing at these sites during flood or ebb tides. Breaching the levees at Liberty Island is an example (Figure 72 and 73). Recent acoustic-tagging of striped bass in this vicinity confirmed a high presence of striped bass (Figure 74, D. Vogel, unpub. data).

Figure 72. Liberty Island in the north Delta before and after flooding.

Figure 73. Liberty Island in the north Delta before and after flooding showing locations of narrow breaches in the levee.

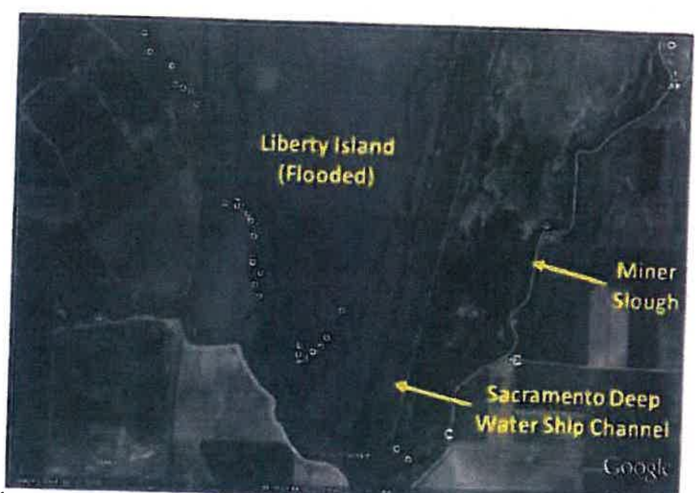


Figure 74. Locations (squares) where predatory striped bass were acoustic-tagged with transmitters during the winter of 2008 – 2009 in the north Delta near Liberty Island (D. Vogel, unpublished data).

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS

PUBLICATIONS OF THE
DIVISION OF WATER RESOURCES
EDWARD HYATT, State Engineer

SACRAMENTO-SAN JOAQUIN

WATER SUPERVISOR'S

REPORT

FOR YEAR

1931

By
HARLOWE M. STAFFORD
Water Supervisor

Under the supervision of
HAROLD CONKLING
Deputy State Engineer

August, 1932

Exhibit "S"

TABLE 69

UNIT CONSUMPTIVE USE OF WATER IN SACRAMENTO-SAN JOAQUIN DELTA**
Acre-feet per Acre

Crop or Classification	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total Seasonal Use	Total Annual Use
Alfalfa	(.06)	(.08)	.10	.30	.40	.50	.65	.55	.50	.20	(.10)	(.07)	3.20	3.91
Asparagus	.05	.05	.05	.05	.08	.14	.40	.68	.55	.42	.12	.10	2.69	2.69
Beans	(.06)	(.08)	(.08)	(.16)	(.20)	.14	.24	.58	.37	(.09)	(.07)	(.05)	1.33	2.12
Beets	(.06)	(.08)	(.08)	.13	.32	.51	.61*	.53*	.20*	(.13)	(.10)	(.07)	2.30	2.82
Celery	(.04)	(.04)	(.04)	(.08)	(.10)	.10	.10	.20	.25	.30	.20	.05	1.20	1.50
Corn	(.04)	(.04)	(.04)	(.08)	(.10)	.24	.85	.84*	.40*	.10	(.10)	(.07)	2.43	2.90
Fruit	(.04)	(.04)	(.04)	.18	.32	.50	.57	.40	.23	.07	(.07)	(.05)	2.27	2.91
Grain and Hay	(.04)	(.04)	.07	.60	.83	.20	(.24)	(.23)	(.21)	(.14)	(.07)	(.05)	1.70	2.62
Onions	(.04)	(.04)	.08	.13	.27	.49	.43	.20	(.16)	(.13)	(.10)	(.07)	1.60	2.14
Pasture	.08	.10	.20	.25	.25	.25	.25	.25	.20	.15	.10	.08	2.16	2.16
Potatoes	(.06)	(.08)	(.08)	(.16)	.15	.38	.52	.30	.15	(.09)	(.07)	(.05)	1.50	2.09
Seed	(.06)	(.08)	(.08)	.10	.25	.50	.50	.50	.35	.10	(.10)	(.07)	2.30	2.69
Truck	(.06)	(.08)	.10	.10	.25	.50	.45	.45	.30	.15	.10	(.07)	2.40	2.61
Tules	.16	.09	.30	.74	1.10	1.28	1.53	1.32	1.18	.98	.59	.36	9.63	9.63
Willows	.05	.03	.09	.22	.33	.38	.46	.40	.35	.29	.18	.10	2.88	2.88
Bare Land	.04	.04	.04	.08	.10	.13	.14	.13	.11	.09	.07	.05	1.02	1.02
Idle Land with Weeds***	.06	.08	.08	.16	.20	.26	.28	.24	.16	.13	.10	.07	1.82	1.82
Open Water Surfaces	.08	.13	.23	.34	.60	.76	.84	.78	.60	.33	.14	.08	4.91	4.91

NOTE: Figures shown in brackets ( ) represent estimated consumptive use on cropped areas before planting and after harvest. (Evaporation from bare land, use by weeds, etc.).

* Includes estimated additional use by weeds during these months.

** These are the data as determined for and published in Bulletin No. 27 - "Variation and Control of Salinity in Sacramento-San Joaquin Delta and Upper San Francisco Bay" - Table 1.

*** Average for land below elevation 5.0 U.S.G.S. datum. Use on unirrigated lands above elevation 5.0 is considered zero.

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS

PUBLICATIONS OF THE
DIVISION OF WATER RESOURCES
EDWARD HYATT, State Engineer

SACRAMENTO-SAN JOAQUIN WATER SUPERVISOR'S REPORT

FOR YEAR
1931

By
HARLOWE M. STAFFORD
Water Supervisor

Under the supervision of
HAROLD CONKLING
Deputy State Engineer

August, 1932

Exhibit "T"

TABLE 74

USE OF WATER BY CAT-TAILS GROWN IN TANKS, NEAR CLARKSBURG, RECLAMATION DISTRICT 999, 1931

TANK NO.	USE OF WATER – ACRE-FEET PER ACRE												
	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	YEAR
2	0.22	0.22	0.58	1.08	2.28	2.28	2.96	2.51	1.66	0.91	0.43	0.23	15.36
3	0.21	0.20	0.49	1.12	1.94	2.11	2.51	1.92	1.36	0.83	0.51	0.22	13.42
4	0.20	0.21	0.52	1.30	2.51	2.78	3.34	2.78	1.90	1.04	0.54	0.29	17.41
5	0.23	0.25	0.50	1.15	1.98	1.83	2.04	1.82	1.28	0.76	0.37	0.13	12.34
6	0.22	0.24	0.60	1.44	2.80	2.77	3.51	—UNDER TEST FOR LEAKAGE→					
MEANS	0.22	0.22	0.54	1.22	2.30	2.35	2.87	*2.26	*1.55	*0.94	*0.46	*0.22	*14.63

*MEAN OF FOUR TANKS

TABLE 75

USE OF WATER BY TULES GROWN IN TANKS, NEAR CLARKSBURG, RECLAMATION DISTRICT 999, 1931

TANK NO.	USE OF WATER – ACRE-FEET PER ACRE												
	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	YEAR
7	0.21	0.23	0.54	1.32	3.02	2.88	4.35	—UNDER TEST FOR LEAKAGE—					
8	0.20	0.24	0.48	1.18	2.45	2.39	3.02	2.59	1.78	1.01	0.51	0.20	16.05
9	0.20	0.26	0.48	1.12	2.14	2.20	2.76	1.98	1.37	0.82	0.41	0.20	13.94
10	0.19	0.24	0.51	1.08	2.07	2.26	2.88	1.71	1.23	0.66	0.43	0.23	13.49
11	0.21	0.19	0.40	0.90	1.84	1.65	1.63	1.32	1.16	0.72	0.39	0.19	10.60
12	0.20	0.20	0.25	0.84	1.75	1.26	2.75	2.36	1.72	1.09	0.61	0.27	13.30
MEANS	0.20	0.23	0.44	1.07	2.21	2.11	2.90	*1.99	*1.45	*0.86	*0.47	*0.22	*13.48

*MEAN OF FIVE TANKS

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS

PUBLICATIONS OF THE
DIVISION OF WATER RESOURCES
EDWARD HYATT, State Engineer

S A C R A M E N T O - S A N J O A Q U I N

W A T E R S U P E R V I S O R ' S

R E P O R T

FOR YEAR

1 9 3 1

By
HARLOWE M. STAFFORD
Water Supervisor

Under the supervision of
HAROLD CONKLING
Deputy State Engineer

August, 1932

Exhibit "U"

TABLE 77

USE OF WATER BY CAT-TAILS AND TULES GROWN IN TANKS AT CAMP 3, KING ISLAND
1931

TANK NUMBER	PLANT	WATER SURFACE ABOVE GROUND SURFACE FEET	USE OF WATER – ACRE-FEET PER ACRE													COMPARATIVE PLANT SIZE (2)
			JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC. (3)	YEAR (4)	
1	CAT-TAILS	0.0	0.14	0.13	0.25	0.52	0.52	0.31	0.33	0.18	0.13	0.15	0.07		2.8	UNDERSIZE
2	CAT-TAILS	1.0	– NO	USABLE	RECORD	–	(1)0.72	0.82	0.92	0.82	0.67	0.53	0.26		6.2	UNDERSIZE
3	TULES	1.0	– NO	USABLE	RECORD	–	(1)1.33	1.13	1.32	1.16	0.80	0.51	0.19		8.0	NORMAL
4	TULES	0.0	0.17	0.15	0.45	0.58	1.00	0.88	0.88	0.71	0.53	0.15	0.07		5.7	UNDERSIZE

(1) INCLUDES APRIL 29TH AND 30TH.
(2) THE COMPARISON FOR SIZE IS WITH SURROUNDING PATCH PLANTS OF THE SAME KIND. PLANTS IN TANKS NUMBERS 1 AND 2 WERE UNDERSIZE ALL SEASON. PLANTS IN TANK NUMBER 4 WERE NORMAL SIZE AT BEGINNING OF SEASON.
(3) HEAVY RAINS DERANGED CONDITIONS SO THAT NO RELIABLE RECORD FOR DECEMBER WAS OBTAINED.
(4) ESTIMATED. CLOSELY FOR TANKS NUMBERS 1 AND 4. ROUGHLY FOR TANKS NUMBERS 2 AND 3.

– – 0 – –

TABLE 78

USE OF WATER BY TULES GROWN IN TANKS AT SIMMONS ISLAND, NEAR BAY POINT, 1931

TANK NO.	WATER SURFACE ABOVE GROUND SURFACE FEET	USE OF WATER – ACRE-FEET PER ACRE													NUMBER OF STALKS IN JULY*
		JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.*	DEC.	YEAR (APPROX)	
1	1.0	0.11	0.15	0.23	0.28	0.38	0.48	0.61	0.48	0.43	0.21	0.11	(0.11)	3.58	11
2	0.0	(0.11)	(0.11)	(0.12)	0.14	0.94	0.80	0.69	0.52	0.36	0.22	0.11	(0.11)	4.23	19
3	1.0	(0.11)	(0.15)	(0.28)	0.34	1.01	0.87	0.84	0.67	0.60	0.46	0.29	(0.11)	5.73	35
4	0.0	(0.11)	(0.15)	(0.24)	0.29	0.96	0.89	0.78	0.59	0.54	(0.30)	0.14	(0.11)	5.10	30
MEANS		(0.11)	(0.14)	(0.22)	0.26	0.82	0.76	0.73	0.57	0.48	(0.30)	0.16	(0.11)	4.66	

NOTE: FIGURES IN PARENTHESES ARE ESTIMATED.
* THERE WERE SOME NEW SPROUTS IN ALL TANKS IN JULY.

1.C.2.2 Attachments to Comments of Oakdale Irrigation District, South San Joaquin Irrigation District, and Stockton East Water District

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ATTACHMENT A

The Bureau of Reclamation (BOR) has proposed to operate New Melones Reservoir to try to meet a water temperature target of 65°F (7 day average daily max; 7DADM) at Goodwin Dam from April 1, 2015 through October 31, 2015. This target would be in lieu of the water temperature objectives recommended by the BiOp. Flows downstream of Goodwin Dam would be those described in table 2e of the BiOP, and no additional water would be released for temperature management. Tri-Dam Project, OID, and SSJID are providing this memorandum and information in support of BOR's proposed operations.

Water temperatures downstream of Goodwin Dam were modeled based on BOR's proposed operating strategy and this information is provided as Attachment 1. Two scenarios were considered with regard to power generation. A base case run assumed all released water passes through the generators until power generation ceases when reservoir elevation falls below the power intake. In an alternate run, power generation is gradually bypassed as the water surface elevation in New Melones Reservoir approaches the elevation of the powerhouse inlet. This allows for blending of warmer surface water released through the powerhouse with cooler water released through the low level outlet.

The model runs predict that water temperatures at Goodwin Dam would reach approximately 70°F in early August under the base case, and would then abruptly drop to approximately 60°F when power generation ceases due to the reservoir elevation falling below the power intake. These extremes can be moderated by gradually bypassing power generation as simulated in the alternate run. Gradually bypassing power generation as the reservoir elevation approaches the elevation of the powerhouse inlet allows for blending of warm water released through the powerhouse with colder water released through the low level outlet. Bypassing power generation through the entire summer would quickly deplete the coolest water stored in the reservoir, resulting in higher water temperatures than the alternate run.

Under the alternate run which reduces temperature extremes by gradually bypassing power generation, BOR's proposed target of 65°F at Goodwin Dam is generally met from April through October[1]. End of September storage under this scenario is projected to be approximately 130,000 AF. A second set of base case and alternate power bypass runs were made assuming higher carryover storage of approximately 200,000 AF to explore the potential influence of higher carryover storage on release temperatures. Comparison of the two sets indicated no apparent improvement in temperature conditions during October with higher carryover storage.

What does this mean for fish?

BOR's proposal would target 65°F at Goodwin for spring outmigration, *O. mykiss* oversummering, and for adult upstream migration during the fall. Each of these periods is discussed in the following sections with regard to the BiOp water temperature objectives, projected temperature conditions, and potential impacts to fish.

[1] Projected water temperatures range from 65.2°F to 66.1°F during July 31 through August 13.

<u>*Spring outmigration conditions*</u>

The BiOp includes water temperature objectives of 52°F at Knights Ferry and 55°F at Orange Blossom Bridge (OBB) January 1 through May 31 for *O. mykiss* smoltification. Water temperature modeling in Attachment 1, and also reflected in Figure 1, demonstrate that these objectives cannot be met in 2015 since water temperatures at release from Goodwin Dam are expected to exceed the objectives. Modeled temperatures at Goodwin Dam are slightly cooler than observed temperatures during April and May 2014.

A pulse flow intended by the BiOp to provide outmigration flow cues to enhance likelihood of anadromy and for conveyance and maintenance of downstream migratory habitat quality, occurred during March 24 through April 2. No *O. mykiss* smolts were captured in the rotary screw traps and no untagged *O. mykiss* smolts were captured at the Mossdale trawl in response to the 1,500 cfs pulse flow. Similarly, there was no apparent response of Chinook salmon to the pulse flow, likely due to the timing being in the lull between fry and smolt migrations. A second pulse flow of larger volume is scheduled to occur April 7 through April 19 for the same purpose.

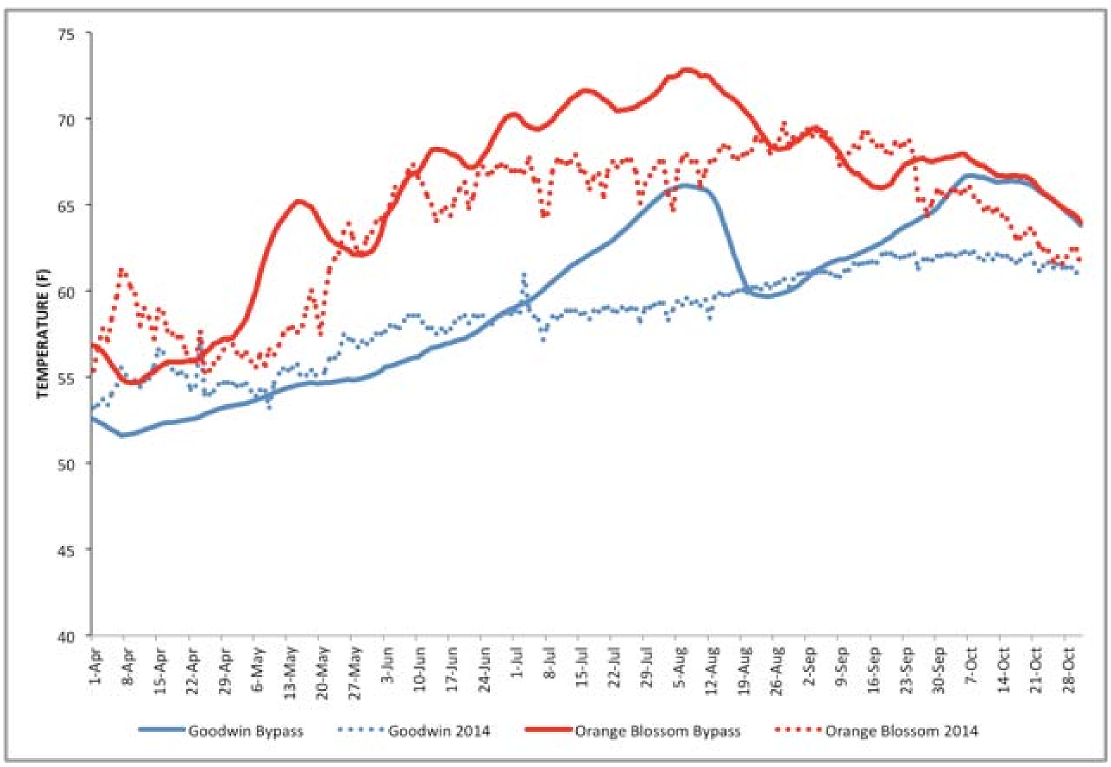


Figure 1. Projected 2015 7DADM water temperature and observed 2014 daily maximum water temperature at Goodwin Dam and OBB.

<u>*Oversummering conditions*</u>

The BiOp includes an oversummering water temperature objective of 65°F at OBB June 1 through September 30. This objective has consistently been exceeded during the past three years, and the objective was not met on a single day during 2014 (Figure 2). The Stanislaus River Operations Group (SOG) report showed that June-September 2014 maximum water temperatures at OBB approached, but did not exceed 70°F (SOG 2014).

Summer water temperatures during July and August 2015 are projected to be warmer than during 2014. Temperatures are expected to decrease during September to levels similar to 2014 as releases would be made entirely through the low level outlet. However, this reduction in temperature is short-lived as temperatures are projected to rise in October when cold water storage behind New Melones Dam is depleted. BOR's proposed target of 65°F at Goodwin is projected to generally be met during the oversummering period. Projected water temperatures range from 65.2°F to 66.1°F during July 31 through August 13.

Annual surveys of *O. mykiss* abundance and distribution conducted annually by the Districts since 2009 have documented a relatively stable population (Figure 3). River-wide abundance estimates from 2009 to 2014 have averaged just over 20,220 *O. mykiss* (all life stages combined) and have never been estimated to be less than about 14,000 (2009). High index densities of *O. mykiss* have been consistently observed in the Goodwin Canyon reach over the past six monitoring seasons. This reach can be generally classified as a high gradient reach that contains a higher relative amount of fast-water habitats (riffles and rapids). Relative to the lower reaches of the Stanislaus River, the Goodwin Canyon reach has more, smaller units (about 22 habitat units per mile). The number of habitat units in this reach may provide more habitat complexity than other reaches of the Stanislaus River. Key factors that may contribute to higher-than-average abundances on the Stanislaus (relative to other San Joaquin River tributaries) include high gradient reaches that are typically associated with higher amount of fast-water habitats, especially in Goodwin Canyon. Surveys planned for 2015 will provide data to detect any changes from baseline abundance and distribution that may occur in response to the ongoing drought.

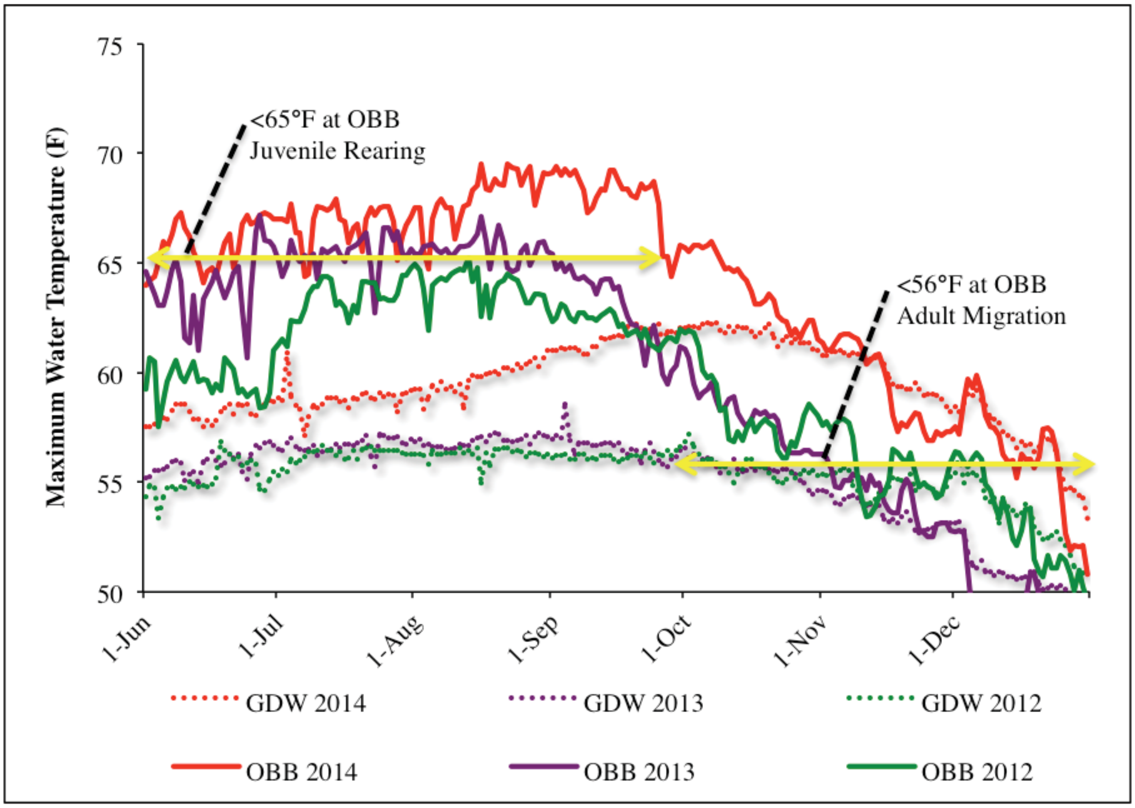


Figure 2. June 1 – December 31, 2012-2014 daily maximum water temperature at Orange Blossom Bridge and Goodwin Dam.

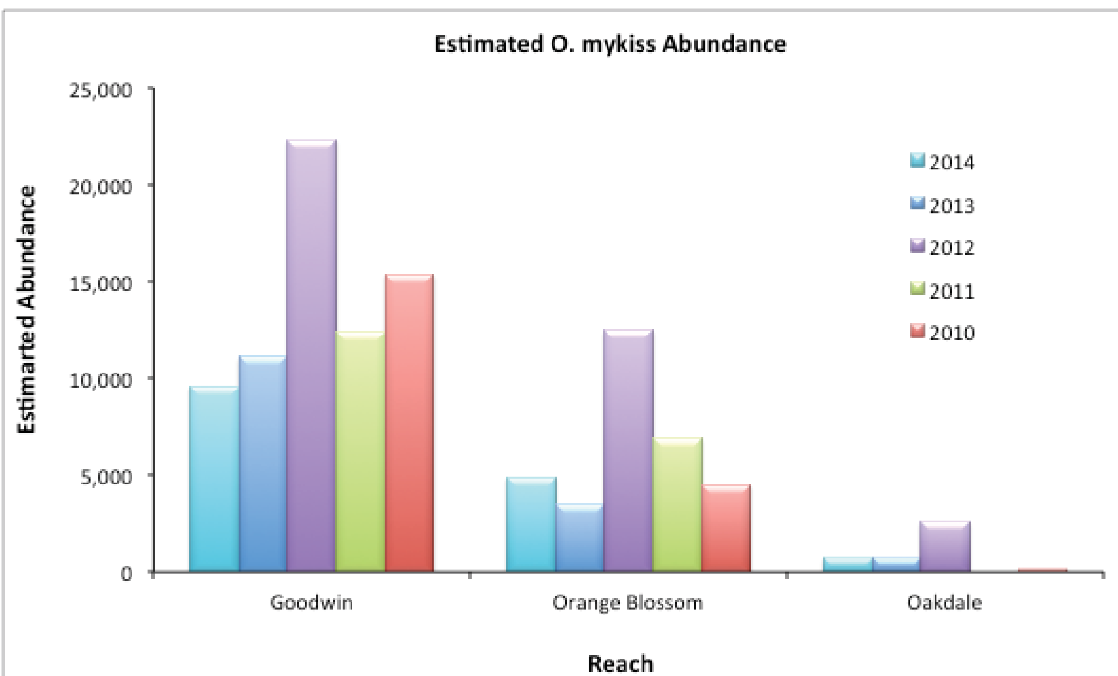


Figure 3. Distribution of *O. mykiss* in the Stanislaus River between Goodwin Dam and Oakdale during 2009-2014.

Fall conditions

The BiOp includes an adult *O. mykiss* migration water temperature objective of 56°F at OBB during October 1 through December 31. Release temperatures at Goodwin exceeded this objective until December during 2014 (Figure 2). Water temperatures are projected to be warmer during October 2015 than observed during October 2014 (Figure 1). BOR's proposed target of 65°F at Goodwin is projected to be met through October.

Any upstream migrating adult *O. mykiss* or Chinook salmon would have already migrated through much warmer water temperatures downstream in the San Joaquin River and Delta. October is also early for *O. mykiss* upstream migration. At the Stanislaus River weir, migration of *O. mykiss* > 16 inches has been observed as early as October 8 and median passage typically occurs during late December.

Fall-run Chinook salmon are not protected under the ESA, and there are currently no water temperature objectives for fall-run in the Stanislaus River. However, the fall pulse flows and water temperature objectives in the BiOp were largely based on the purported needs of fall-run Chinook as a proxy for *O. mykiss*. Based on redd surveys conducted by FISHBIO, peak spawning typically occurs in November with roughly 7% of spawning occurring prior to November 1. During late-September and early October, median redd location is typically near the upper end of Goodwin Canyon where temperatures are coolest (Attachment 2). By late October, spawning increases in downstream locations as water temperatures decrease due to decreasing ambient air temperatures, and median redd location is typically Knights Ferry. While the warm release temperatures at Goodwin Dam predicted by the model will decrease the incubation success of eggs deposited by any early arriving fall-run Chinook salmon that may spawn during October, this is a consequence of the unprecedented drought conditions which would have likely resulted in no flow under unimpaired conditions. During November as ambient air temperatures decrease, the stream begins to cool naturally as it flows downstream from Goodwin Dam. While this is expected to provide for greater success of fall-run Chinook salmon spawning in November and December relative to October, temperature impacts to incubating fall-run Chinook salmon during fall 2015 are now unavoidable.

Summary

There is a difficult management decision to be made at New Melones this year. BOR can operate in the traditional method through the powerhouse and water temperatures at Goodwin will exceed 65°F during the summer. If the powerhouse and bypass are blended 65°F at Goodwin can mostly be achieved during the summer. However, using the bypass in July or August depletes the coldwater mass behind New Melones resulting in elevated water temperatures for fall-run Chinook that arrive in the Stanislaus River before November 1. The amount of carryover storage in the two runs, 200,000AF and 115,000AF, indicate no apparent improvement in water temperatures in October.

ATTACHMENT 1

Stanislaus River Water Temperature Model Results

Stanislaus Temperature Modeling
2015 Proposed Operations

1. Objective

The objective of this work is to assess, using the HEC-5Q Model, the expected temperature conditions at discrete points along the Stanislaus River, given the currently proposed water release schedule from New Melones through the end of 2015.

2. Background

Review of snow pack data from several CDEC stations in or near the Stanislaus watershed indicates that the runoff this year will likely be the lowest of the past 30+ years (see Figure 3).

The Tri-Dam Project is estimating that the total inflow to New Melones from March 1 to September 30 of this year will be in the order of 90,000 acre-feet with the majority of the inflow occurring in March, April and May. For modeling purposes, it is also assumed that the inflow in October will be in the order of 3,000 acre-feet.

The closest historical hydrologic condition to the current year appears to be the dry year of 1987 and even then, the historical inflow to New Melones exceeded the current runoff projection.

3. Modeling Approach

The modeling approach under this scope of work is to use 1987 as an example year in terms of the climate conditions and pattern of runoff, yet to scale down the historical inflow to New Melones to match the 90,000 and 3,000 acre-feet projections, as follows:

			Historical inflow , AF	Ratio:Historical to 90 & 3 TAF
1-Mar	thru	30-Sep-1987	**295,412**	**0.305**
1-Oct	thru	31-Oct-1987	**12,175**	**0.246**

Figure 1: Scaling Factors from Historical Inflow to Projected Inflow

Then, set the New Melones storage to the current state (605,600 acre-feet on February 28), superimpose the release and diversion schedule that is currently being proposed (see Diversion and Release Schedule below), and operate the system accordingly.

This approach will enable estimating the temperature conditions that might be experienced at various locations along the Stanislaus (e.g., below Goodwin Dam, Knights Ferry, Orange Blossom Bridge and Oakdale) through the end of 2015.

It should be noted that given the extremely low water level in New Melones at the present time, it is probable that the old Melones Dam will be exposed, similar to what had happened in the drought of 1987-1992. The model will simulate the old-new dam interaction, including the switch from power plant flow to low-level outlet release and the ramification of this kind of operation on the temperature response below Goodwin Dam and downriver.

4. Diversion and Release Schedule

The proposed diversion schedule from the Goodwin Pool to OID and SSJID and the release to the river from Goodwin Dam, as obtained from the stakeholders, are as follows:

Month	Water Right Type	2014 Diversion to Storage (acre-feet)	2014 Direct Diversion acre-feet
January:	Riparian:		
	Pre1914:		
February:	Riparian:		
	Pre1914:		
March:	Riparian:		
	Pre1914:		28,209
April:	Riparian:		
	Pre1914:		40,666
May:	Riparian:		
	Pre1914:		58,906
June:	Riparian:		
	Pre1914:	2,972	73,314
July:	Riparian:		
	Pre1914:		75,030
August:	Riparian:		
	Pre1914:		67,925
September:	Riparian:		
	Pre1914:		42,338
October:	Riparian:		
	Pre1914:		8,111
November:	Riparian:		
	Pre1914:		
December:	Riparian:		
	Pre1914:		

(Note: Diversion to Storage is ignored)

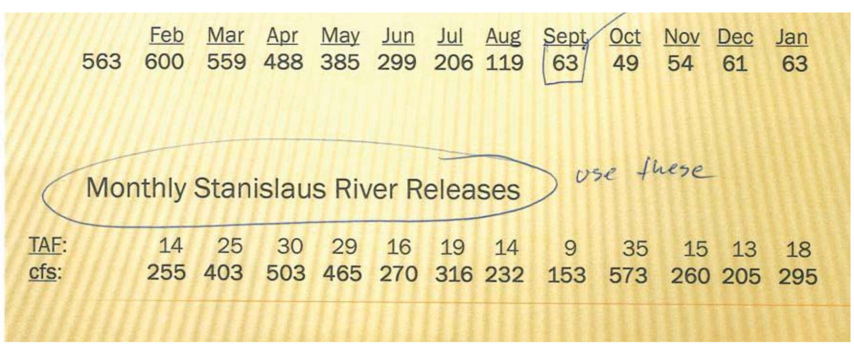


Figure 2: Proposed Diversion and Release Schedule

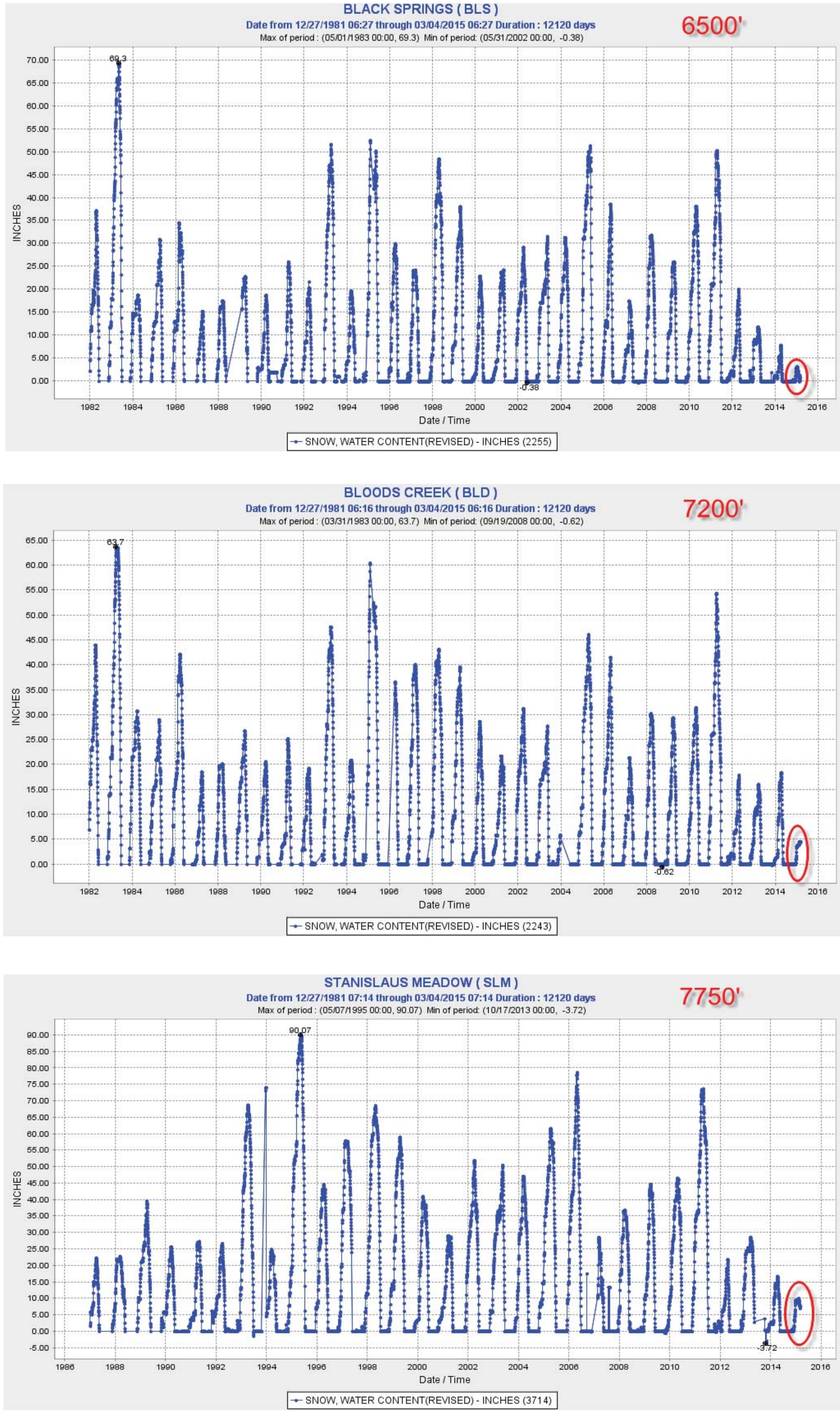


Figure 3: Snow Pack Data from Several CDEC Stations near the Stanislaus watershed

5. Tasks:

1. Set up the data to run a year similar to 1987:
   a. Process the hydrological and meteorological data.
   b. Define volume such that the storage at the end of February 28 is 605,600 acre-feet.
   c. Scale down the May - September flow & October flows by the ratios shown in Figure 1.
   d. Assume monthly average diversion and New Melones outflow, as specified the Diversion and Release Schedule in Figure 2.
   e. Prepare DSS inputs for the above.
2. Set up the model to run the modified 1987.
3. Run the model - generate output as directed.
4. QA/QC of results with emphasis on new-old dam interaction.
5. Analyze the results in terms of the expected temperatures at the specified locations along the Stanislaus River from day 1 of the simulation to end-of-year 2015.
6. Evaluate the merit of different strategies for switching from power plant flow to low-level outlet release from New Melones.
7. Compile a short write up about study findings.
8. Present results to the client.

Modeling, Analysis and Findings

1. Model Setup

The HEC-5Q was set to simulate a single year similar to 1987 in terms of the pattern of inflow to New Melones except that the rate of the inflow was scaled down in accordance with Figure 1 above. The meteorological conditions were also set to match the historical conditions in 1987.

In order to prime the model, the simulation started on January 1, 1987 where by New Melones storage was set in such a way that by February 28 the total volume of water in the reservoir would equal to the observed volume on that date, i.e., 605,600 acre-feet. The computed temperature profiles in New Melones and Tulloch were then compared with observed data near March 1 from other years (see Figure 4 below) to ensure that the boundary condition as far as the thermal structures in the reservoirs are reasonable (note that in Figure 4 the New Melones elevation is completely different, however the temperature ranges and profile shapes are similar in both reservoirs).

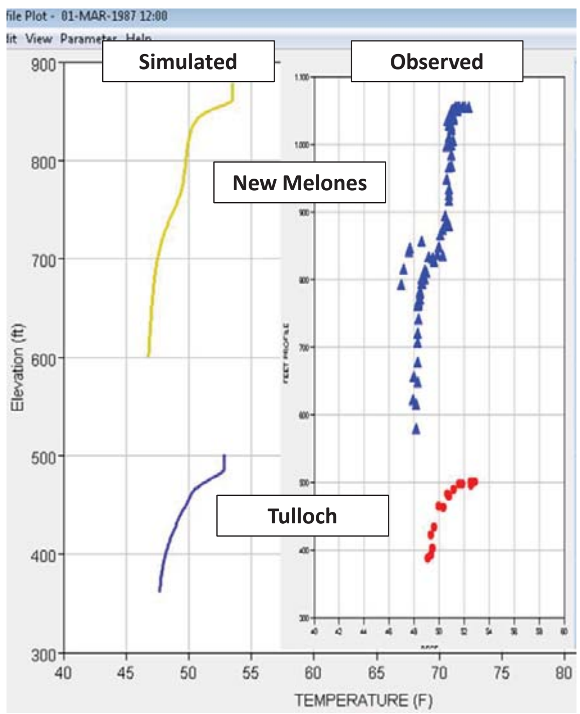


Figure 4: Computed and Observed Thermal Profiles in New Melones and Tulloch Reservoirs near March 1

2. Simulation Modes

The HEC-5Q was run in two modes:

a) No-Bypass Operation – under this mode, New Melones was operated in a way where the water is released through the power plant until the water level in the reservoir reaches the minimum power pool elevation.

b) Bypass Operation – under this mode, New Melones was operated in a way where the release is switched gradually from power release to low-level outlet release in advance of reaching minimum power pool elevation.

For the latter, several strategies for bypass operation were analyzed in terms of the starting date and the rate of transitioning from no-bypass to full-bypass operation, as explained below.

3. Projected New Melones Storage

The effect on New Melones Storage is essentially the same for the two operation modes described above. Mass-balance calculation on New Melones for the period March 1 through Oct 31, 2015 is shown in Figure 5 below:

	Release to River	**Diversion (OID & SSJID)**	**Total Outflow**	**NM Storage**	**NM Elev**
Beginning:	(CFS)	(CFS)	(TAF)	(TAF)	(FT)
Mar	200	459	41	605	879
Apr (1)	200	683	26		
Apr (16)	500	683	35		
May (1)	500	958	43		
May (16)	150	958	35		
Jun	150	1,232	82		
Jul	150	1,220	84		
Aug	150	1,105	77		
Sep	150	712	51		
Oct	175	132	19		
Nov				181	768
Total (TAF)	124	394	494		
Projected Inflow to NM			93		
Reduction in storage in NM (excluding evap and local runoff)			401		
Reduction in storage in NM (including evap and local runoff)			424		

Figure 5: Mass balance on New Melones for the period March 1 to October 31, 2015

The figure shows that the projected storage in New Melones on November 1 is 181 TAF corresponding to El. 768. This reduction in storage takes into consideration the net effect of New Melones and Tulloch evaporation, including local runoff to Tulloch (which was assumed to be similar to 1987).

The gradual decline of water levels in the reservoir from March through December is shown in Figure 6 below. The figure shows that given the assumed inflow to New

Melones and proposed outflow (diversion plus release to river), the water will probably not recede to the point where the submerged old Melones Dam will be exposed. However, the depressed water levels in the reservoir will greatly affect the water temperatures downstream as the warm water epilimnion (the top-most layer) will be discharged from the reservoir through the power intake. It should be noted that in both operation modes power flow will cease as the reservoir reaches the minimum power pool at El. 785 (usually around September 1) and water will be discharged at that point thorough the low-level outlet in New Melones Dam.

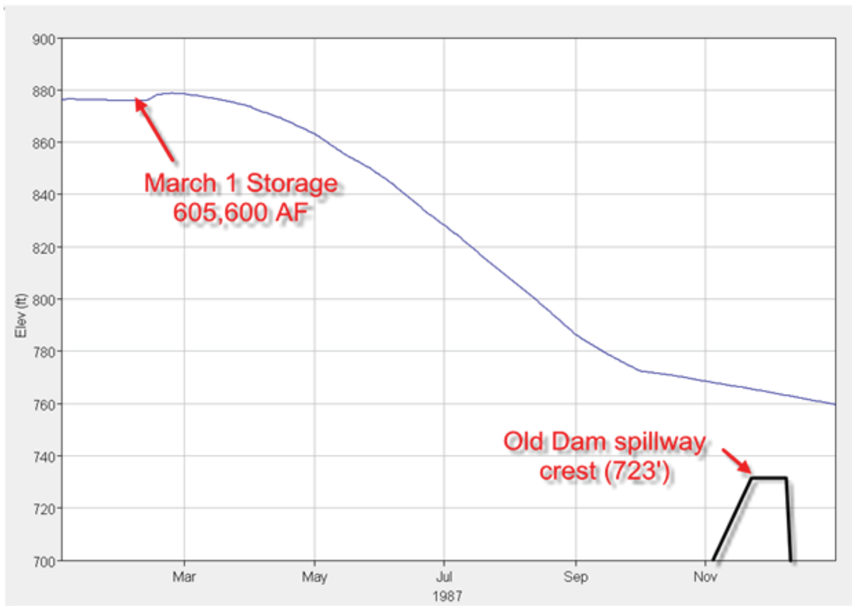


Figure 6: Projected New Melones Water Levels in 2015

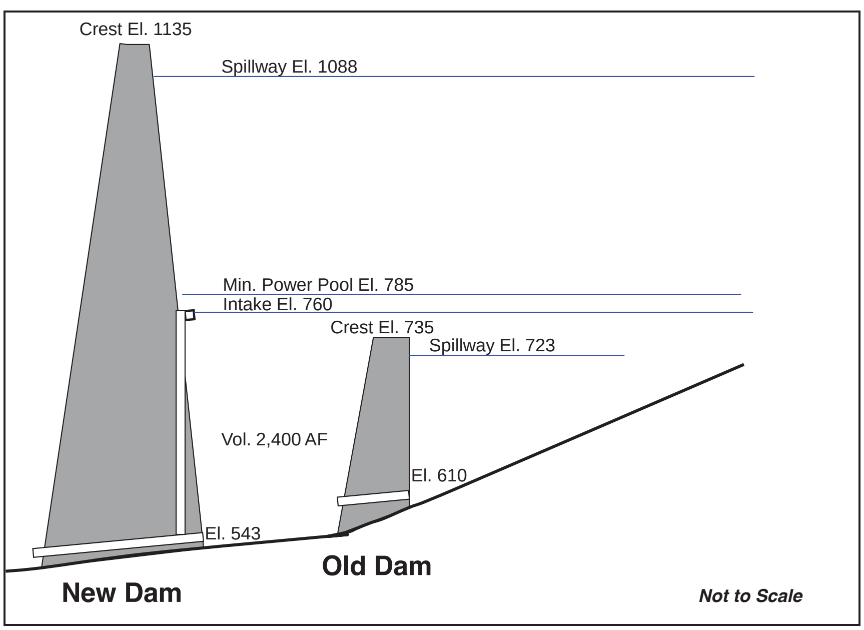


Figure 7: New-Old Dam Interaction

4. Projected Downriver Temperature Response – No-Bypass Operation

The following tables show the results for the temperature response at six discrete points along the Stanislaus River:

1) Below Goodwin Dam
2) Knights Ferry
3) Orange Blossom Bridge
4) Highway 120 Bridge (Oakdale)
5) Ripon Gage (Highway 99)
6) Above the confluence with the San Joaquin River

The results are presented in terms of the 7-Days Average of Daily Maximums (7DADM). In other words, each number in the table is the sum of the maximum daily temperatures in past seven days divided by 7. This term is consistent with EPA's recommended criterion for assessing fish viability.

Notice the precipitous drop of temperatures (almost 10 Deg-F below Goodwin Dam) from September on. This is due to the abrupt switch from no-bypass to full-bypass operation on September 1 (due to power constraints).

Table 1: Temperature Response – 7DADM
March-April, 2015

	BLW GOODWIN	KNIGHTS FERRY	ORANGE BLOSSOM	HYW 120 BRIDGE	RIPON GAGE	ABV SJR
	NO BYPASS	NO BYPASS	NO BYPASS	NO BYPASS	NO BYPASS	NO BYPASS
	7DADM	7DADM	7DADM	7DADM	7DADM	7DADM
	DEGF	DEGF	DEGF	DEGF	DEGF	DEGF
1-Mar	50.5	50.6	52.2	52.3	55.4	55.6
2-Mar	50.6	50.8	52.5	52.5	55.7	55.9
3-Mar	50.8	51.1	53.0	53.1	56.4	56.6
4-Mar	50.8	51.2	53.3	53.5	56.9	57.1
5-Mar	50.7	51.2	53.4	53.8	57.2	57.5
6-Mar	50.7	51.3	53.6	54.1	57.5	57.8
7-Mar	50.8	51.4	53.8	54.4	57.9	58.2
8-Mar	50.9	51.5	53.9	54.6	58.1	58.4
9-Mar	51.0	51.5	54.0	54.7	58.4	58.6
10-Mar	51.0	51.5	54.0	54.7	58.4	58.7
11-Mar	51.3	51.7	54.1	54.8	58.6	58.8
12-Mar	51.6	52.0	54.6	55.2	59.2	59.3
13-Mar	51.8	52.2	54.9	55.6	59.7	59.8
14-Mar	51.8	52.2	54.9	55.7	59.9	59.9
15-Mar	51.9	52.3	54.8	55.7	60.0	60.0
16-Mar	51.9	52.3	54.8	55.6	60.0	60.1
17-Mar	52.0	52.4	54.9	55.6	60.0	60.2
18-Mar	52.0	52.4	54.8	55.6	59.8	60.1
19-Mar	51.9	52.3	54.6	55.3	59.5	59.8
20-Mar	51.9	52.3	54.4	55.1	59.1	59.5
21-Mar	52.0	52.3	54.4	55.0	58.9	59.3
22-Mar	52.1	52.5	54.6	55.1	58.9	59.3
23-Mar	52.2	52.5	54.5	55.0	58.8	59.1
24-Mar	52.2	52.5	54.5	55.0	58.7	58.9
25-Mar	52.3	52.7	54.7	55.2	58.8	59.0
26-Mar	52.5	52.8	55.0	55.5	59.2	59.3
27-Mar	52.6	53.0	55.3	55.9	59.5	59.7
28-Mar	52.8	53.3	55.8	56.4	60.1	60.3
29-Mar	52.9	53.5	56.2	56.9	60.5	60.7
30-Mar	53.1	53.8	56.8	57.5	61.1	61.4
31-Mar	53.3	54.1	57.3	58.0	61.7	61.9
1-Apr	53.3	54.3	57.7	58.6	62.2	62.5
2-Apr	53.4	54.4	58.0	59.0	62.7	62.9
3-Apr	53.4	54.5	58.2	59.3	63.1	63.2
4-Apr	53.4	54.5	58.3	59.5	63.4	63.5
5-Apr	53.3	54.6	58.4	59.6	63.7	63.8
6-Apr	53.3	54.6	58.5	59.8	64.1	64.2
7-Apr	53.3	54.7	58.7	60.0	64.7	64.7
8-Apr	53.3	54.8	58.8	60.2	65.2	65.2
9-Apr	53.4	54.8	58.9	60.4	65.7	65.7
10-Apr	53.4	54.9	59.0	60.6	66.1	66.3
11-Apr	53.5	55.0	59.1	60.8	66.5	66.7
12-Apr	53.7	55.1	59.4	61.1	66.9	67.2
13-Apr	53.8	55.3	59.7	61.4	67.4	67.7
14-Apr	53.9	55.5	60.0	61.8	67.9	68.3
15-Apr	53.8	55.5	60.1	62.0	68.4	68.8
16-Apr	53.8	55.4	60.0	61.9	68.8	69.4
17-Apr	53.8	55.4	59.8	61.7	69.0	69.9
18-Apr	53.7	55.2	59.4	61.3	68.8	69.9
19-Apr	53.6	55.1	59.0	60.8	68.4	69.8
20-Apr	53.5	54.9	58.6	60.3	67.8	69.4
21-Apr	53.5	54.8	58.1	59.7	67.2	68.9
22-Apr	53.5	54.7	57.9	59.3	66.4	68.2
23-Apr	53.6	54.7	57.7	59.0	65.6	67.4
24-Apr	53.7	54.8	57.8	58.9	65.1	66.7
25-Apr	53.8	55.0	58.1	59.2	65.1	66.6
26-Apr	53.9	55.2	58.4	59.6	65.3	66.7
27-Apr	54.0	55.4	58.7	60.0	65.8	67.0
28-Apr	54.1	55.4	58.8	60.2	66.0	67.2
29-Apr	54.2	55.5	59.0	60.3	66.3	67.4
30-Apr	54.2	55.6	59.0	60.4	66.5	67.6

Table 2: Temperature Response – 7DADM
May-June, 2015

	BLW GOODWIN	KNIGHTS FERRY	ORANGE BLOSSOM	HYW 120 BRIDGE	RIPON GAGE	ABV SJR
	NO BYPASS	NO BYPASS	NO BYPASS	NO BYPASS	NO BYPASS	NO BYPASS
	7DADM	7DADM	7DADM	7DADM	7DADM	7DADM
	DEGF	DEGF	DEGF	DEGF	DEGF	DEGF
1-May	54.2	55.5	58.9	60.3	66.4	67.6
2-May	54.2	55.5	58.8	60.2	66.4	67.5
3-May	54.2	55.4	58.7	60.0	66.1	67.3
4-May	54.1	55.4	58.5	59.8	65.8	67.0
5-May	54.1	55.4	58.6	59.8	65.7	67.0
6-May	54.2	55.5	58.7	59.9	65.8	67.0
7-May	54.2	55.6	58.9	60.2	66.1	67.3
8-May	54.3	55.8	59.2	60.5	66.6	67.8
9-May	54.4	55.9	59.4	60.9	67.1	68.3
10-May	54.5	56.1	59.8	61.3	67.7	68.9
11-May	54.6	56.2	60.1	61.6	68.2	69.4
12-May	54.7	56.3	60.2	61.9	68.6	69.9
13-May	54.8	56.4	60.4	62.1	69.0	70.3
14-May	54.8	56.5	60.6	62.3	69.4	70.7
15-May	54.9	56.6	60.7	62.5	69.7	71.1
16-May	55.0	56.8	60.8	62.6	69.8	71.1
17-May	55.0	56.9	61.1	62.8	69.8	71.1
18-May	55.1	57.2	61.5	63.1	69.8	71.0
19-May	55.1	57.4	61.8	63.4	69.8	70.8
20-May	55.1	57.4	61.9	63.6	69.5	70.5
21-May	55.2	57.7	62.3	63.9	69.4	70.2
22-May	55.2	57.9	62.7	64.3	69.5	70.0
23-May	55.2	58.0	63.1	64.9	69.8	70.0
24-May	55.2	58.0	63.3	65.3	70.2	70.3
25-May	55.2	58.1	63.5	65.6	70.5	70.6
26-May	55.2	58.1	63.5	65.7	70.7	70.7
27-May	55.1	58.0	63.4	65.7	70.9	70.8
28-May	55.2	58.0	63.4	65.8	71.0	71.0
29-May	55.2	58.0	63.4	65.8	71.2	71.1
30-May	55.2	58.1	63.5	65.9	71.4	71.4
31-May	55.3	58.2	63.7	66.0	71.7	71.6
1-Jun	55.3	58.3	64.0	66.3	72.0	72.0
2-Jun	55.4	58.6	64.6	66.9	72.8	72.8
3-Jun	55.6	59.1	65.4	67.8	73.9	73.8
4-Jun	55.6	59.2	65.7	68.3	74.5	74.4
5-Jun	55.6	59.3	66.0	68.7	74.9	74.8
6-Jun	55.6	59.4	66.3	69.1	75.4	75.3
7-Jun	55.7	59.6	66.7	69.6	76.0	75.9
8-Jun	55.8	59.7	67.0	69.9	76.4	76.4
9-Jun	55.8	59.7	67.0	70.1	76.6	76.6
10-Jun	55.9	59.8	67.0	70.1	76.6	76.6
11-Jun	56.0	60.0	67.3	70.4	76.9	76.9
12-Jun	56.2	60.3	67.8	70.8	77.4	77.4
13-Jun	56.3	60.5	68.1	71.2	77.8	77.8
14-Jun	56.3	60.5	68.2	71.4	77.9	77.9
15-Jun	56.4	60.5	68.1	71.3	77.9	77.8
16-Jun	56.4	60.5	68.0	71.3	77.8	77.7
17-Jun	56.4	60.4	67.8	71.1	77.6	77.6
18-Jun	56.5	60.4	67.7	70.9	77.5	77.5
19-Jun	56.5	60.3	67.5	70.7	77.4	77.3
20-Jun	56.5	60.1	67.1	70.4	77.0	77.0
21-Jun	56.6	60.1	66.9	70.1	76.7	76.7
22-Jun	56.7	60.2	66.9	70.0	76.6	76.6
23-Jun	56.8	60.3	67.1	70.0	76.6	76.7
24-Jun	57.0	60.6	67.5	70.4	77.0	77.0
25-Jun	57.1	60.8	67.9	70.8	77.4	77.5
26-Jun	57.2	61.1	68.3	71.3	77.9	78.0
27-Jun	57.3	61.4	68.8	71.9	78.6	78.6
28-Jun	57.4	61.6	69.2	72.5	79.3	79.2
29-Jun	57.5	61.7	69.6	72.9	79.9	79.8
30-Jun	57.6	61.8	69.7	73.2	80.2	80.2

Table 3: Temperature Response – 7DADM
July-August, 2015

	BLW GOODWIN	KNIGHTS FERRY	ORANGE BLOSSOM	HYW 120 BRIDGE	RIPON GAGE	ABV SJR
	NO BYPASS	NO BYPASS	NO BYPASS	NO BYPASS	NO BYPASS	NO BYPASS
	7DADM	7DADM	7DADM	7DADM	7DADM	7DADM
	DEGF	DEGF	DEGF	DEGF	DEGF	DEGF
1-Jul	57.7	61.9	69.7	73.3	80.3	80.3
2-Jul	57.8	61.8	69.5	73.1	80.2	80.2
3-Jul	57.8	61.7	69.1	72.7	79.8	79.8
4-Jul	57.9	61.6	68.9	72.4	79.5	79.5
5-Jul	58.1	61.7	68.8	72.1	79.2	79.3
6-Jul	58.2	61.7	68.7	71.9	78.9	79.0
7-Jul	58.4	61.9	68.8	71.9	78.9	78.9
8-Jul	58.6	62.0	69.0	72.0	78.9	78.9
9-Jul	58.7	62.2	69.2	72.2	78.9	78.9
10-Jul	58.9	62.5	69.5	72.5	79.1	79.1
11-Jul	59.1	62.6	69.8	72.8	79.3	79.3
12-Jul	59.2	62.9	70.0	73.0	79.5	79.4
13-Jul	59.4	63.1	70.3	73.3	79.8	79.7
14-Jul	59.6	63.2	70.5	73.5	79.9	79.8
15-Jul	59.7	63.4	70.7	73.8	80.2	80.0
16-Jul	59.8	63.5	70.7	73.9	80.3	80.2
17-Jul	59.9	63.5	70.6	73.8	80.3	80.2
18-Jul	60.1	63.5	70.5	73.7	80.2	80.2
19-Jul	60.2	63.5	70.3	73.5	80.1	80.0
20-Jul	60.3	63.4	70.1	73.2	79.8	79.8
21-Jul	60.4	63.4	69.9	72.9	79.5	79.5
22-Jul	60.6	63.3	69.6	72.5	79.1	79.1
23-Jul	60.7	63.3	69.3	72.1	78.6	78.7
24-Jul	60.9	63.4	69.3	71.9	78.4	78.5
25-Jul	61.1	63.6	69.4	71.9	78.3	78.3
26-Jul	61.2	63.7	69.4	71.8	78.1	78.2
27-Jul	61.4	63.8	69.4	71.8	78.0	78.1
28-Jul	61.6	64.0	69.6	71.9	78.0	78.1
29-Jul	61.8	64.1	69.7	72.0	78.0	78.1
30-Jul	62.0	64.3	69.9	72.2	78.1	78.1
31-Jul	62.1	64.5	70.0	72.3	78.1	78.1
1-Aug	62.3	64.7	70.3	72.5	78.3	78.3
2-Aug	62.5	64.9	70.6	72.8	78.6	78.6
3-Aug	62.8	65.2	70.9	73.2	79.0	79.0
4-Aug	62.9	65.2	70.9	73.2	79.0	79.1
5-Aug	63.1	65.4	71.0	73.3	79.0	79.2
6-Aug	63.3	65.6	71.2	73.5	79.3	79.4
7-Aug	63.5	65.7	71.2	73.6	79.3	79.4
8-Aug	63.6	65.8	71.2	73.5	79.2	79.3
9-Aug	63.8	65.8	71.2	73.4	79.1	79.2
10-Aug	63.9	65.8	71.0	73.2	78.8	78.8
11-Aug	64.2	66.0	71.1	73.1	78.7	78.7
12-Aug	64.4	66.1	71.0	73.0	78.5	78.5
13-Aug	64.5	66.0	70.8	72.8	78.2	78.1
14-Aug	64.7	66.1	70.6	72.5	77.8	77.8
15-Aug	64.9	66.1	70.5	72.3	77.5	77.5
16-Aug	65.1	66.3	70.5	72.2	77.3	77.3
17-Aug	65.4	66.5	70.6	72.2	77.3	77.3
18-Aug	65.7	66.6	70.6	72.2	77.2	77.2
19-Aug	65.9	66.8	70.6	72.2	77.0	77.1
20-Aug	66.3	67.0	70.7	72.2	76.9	76.9
21-Aug	66.6	67.2	70.8	72.2	76.9	76.9
22-Aug	67.0	67.4	70.9	72.2	76.8	76.8
23-Aug	67.3	67.6	70.8	72.1	76.6	76.5
24-Aug	67.6	67.8	70.9	72.1	76.4	76.3
25-Aug	68.0	68.0	70.9	72.1	76.3	76.2
26-Aug	68.3	68.4	71.2	72.2	76.3	76.2
27-Aug	68.6	68.7	71.5	72.4	76.5	76.4
28-Aug	68.9	69.1	71.9	72.8	76.7	76.6
29-Aug	69.2	69.5	72.3	73.2	77.1	77.0
30-Aug	69.5	69.9	72.8	73.6	77.6	77.4
31-Aug	69.7	70.1	73.1	74.0	77.9	77.7

Table 4: Temperature Response – 7DADM
September-October, 2015

	BLW GOODWIN	KNIGHTS FERRY	ORANGE BLOSSOM	HYW 120 BRIDGE	RIPON GAGE	ABV SJR
	NO BYPASS	NO BYPASS	NO BYPASS	NO BYPASS	NO BYPASS	NO BYPASS
	7DADM	7DADM	7DADM	7DADM	7DADM	7DADM
	DEGF	DEGF	DEGF	DEGF	DEGF	DEGF
1-Sep	70.0	70.5	73.5	74.5	78.3	78.1
2-Sep	70.2	70.7	73.8	74.8	78.7	78.4
3-Sep	70.5	70.9	74.2	75.2	79.0	78.8
4-Sep	70.6	71.0	74.3	75.4	79.2	78.9
5-Sep	70.3	70.9	74.1	75.3	79.0	78.7
6-Sep	69.6	70.6	73.7	74.9	78.5	78.3
7-Sep	68.7	70.2	73.4	74.5	78.1	77.9
8-Sep	67.5	69.7	73.0	74.1	77.7	77.5
9-Sep	66.3	69.0	72.5	73.7	77.3	77.0
10-Sep	64.9	68.1	71.8	73.1	76.6	76.4
11-Sep	63.6	67.1	71.2	72.5	76.0	75.9
12-Sep	62.6	66.2	70.5	71.9	75.5	75.4
13-Sep	61.9	65.4	70.0	71.5	75.2	75.1
14-Sep	61.4	64.6	69.2	70.8	74.7	74.6
15-Sep	61.1	63.9	68.5	70.2	74.2	74.1
16-Sep	60.8	63.2	67.7	69.5	73.6	73.5
17-Sep	60.6	62.7	67.1	68.9	73.2	73.1
18-Sep	60.5	62.3	66.6	68.3	72.8	72.7
19-Sep	60.4	62.1	66.3	67.9	72.6	72.6
20-Sep	60.3	61.9	66.0	67.6	72.4	72.4
21-Sep	60.3	61.9	66.1	67.6	72.6	72.7
22-Sep	60.3	61.9	66.1	67.7	72.7	72.8
23-Sep	60.3	61.9	66.1	67.8	72.9	73.0
24-Sep	60.2	61.8	66.1	67.8	72.9	73.1
25-Sep	60.1	61.7	65.9	67.7	72.8	73.1
26-Sep	60.1	61.7	65.8	67.6	72.8	73.0
27-Sep	60.1	61.6	65.7	67.4	72.6	72.9
28-Sep	60.0	61.4	65.4	67.2	72.3	72.6
29-Sep	60.0	61.3	65.2	66.9	72.1	72.4
30-Sep	60.1	61.3	65.1	66.8	72.0	72.3
1-Oct	60.3	61.4	65.2	66.7	72.0	72.3
2-Oct	60.6	61.5	65.3	66.8	72.1	72.4
3-Oct	60.7	61.6	65.4	66.9	72.2	72.5
4-Oct	61.0	61.8	65.6	67.1	72.3	72.7
5-Oct	61.2	62.0	65.8	67.3	72.6	72.9
6-Oct	61.4	62.1	65.9	67.4	72.7	73.1
7-Oct	61.4	62.1	65.7	67.3	72.5	72.9
8-Oct	61.2	62.1	65.5	67.0	72.2	72.7
9-Oct	61.0	61.9	65.2	66.6	71.8	72.3
10-Oct	60.8	61.8	64.9	66.2	71.4	72.0
11-Oct	60.5	61.5	64.5	65.7	70.8	71.4
12-Oct	60.3	61.3	64.0	65.2	70.1	70.8
13-Oct	60.1	61.0	63.5	64.5	69.3	70.1
14-Oct	60.1	60.8	63.2	64.1	68.8	69.6
15-Oct	60.1	60.7	63.0	63.8	68.3	69.1
16-Oct	60.1	60.6	62.9	63.5	67.9	68.7
17-Oct	60.1	60.5	62.7	63.3	67.5	68.3
18-Oct	60.1	60.5	62.6	63.2	67.1	67.9
19-Oct	60.1	60.5	62.5	63.1	66.8	67.5
20-Oct	60.0	60.4	62.3	62.9	66.5	67.1
21-Oct	60.0	60.3	62.2	62.7	66.2	66.8
22-Oct	59.8	60.0	61.7	62.3	65.7	66.1
23-Oct	59.9	59.9	61.5	62.0	65.4	65.7
24-Oct	59.9	59.8	61.3	61.7	65.0	65.3
25-Oct	59.9	59.7	61.2	61.5	64.8	65.0
26-Oct	59.9	59.6	61.0	61.3	64.5	64.7
27-Oct	59.9	59.6	60.9	61.2	64.3	64.5
28-Oct	59.8	59.6	60.8	61.0	64.1	64.3
29-Oct	59.8	59.6	60.8	61.0	64.1	64.2
30-Oct	59.7	59.5	60.7	60.9	63.9	64.1
31-Oct	59.6	59.4	60.5	60.7	63.7	63.9

5. Projected Downriver Temperature Response – Bypass Operation

Bypass operation changes the thermal structure of both New Melones and Tulloch reservoirs and the temperature release below Goodwin, as such. The best way to explain this phenomenon is by way of example:

Figure 8 shows the computed temperature profiles in New Melones and Tulloch reservoirs on September 1 for two cases: A no-bypass case and a bypass case beginning on July 1.

- In the no-bypass case, warmer water outflow from New Melones resulting in little cool water remaining in Tulloch.
- In the bypass case, blending of colder water through the low-level outlet result in a larger warm water epilimnion in New Melones and cooler water in Tulloch (warm water remains in New Melones and not in the river below Goodwin).

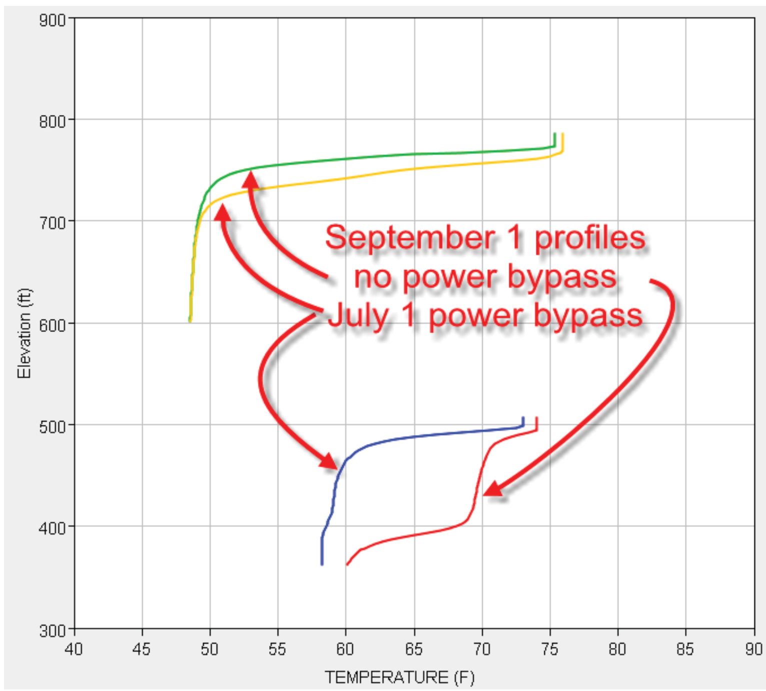


Figure 8: Temperature profiles in New Melones and Tulloch With and Without Bypass Operation

Four options for bypass operations have been considered:

1) Bypass starting July 1
2) Bypass starting July 15
3) Bypass starting August 1
4) Bypass starting August 15.

In all cases, the bypass operation was done gradually (assumed linear transition) from the specified starting date until full bypass by early September when New Melones reached its minimum power pool elevation.

The ramification of the bypass operation is a reduction in water temperature below Goodwin Dam (and downriver) in comparison with the no-bypass case, as illustrated in Figure 9 below:

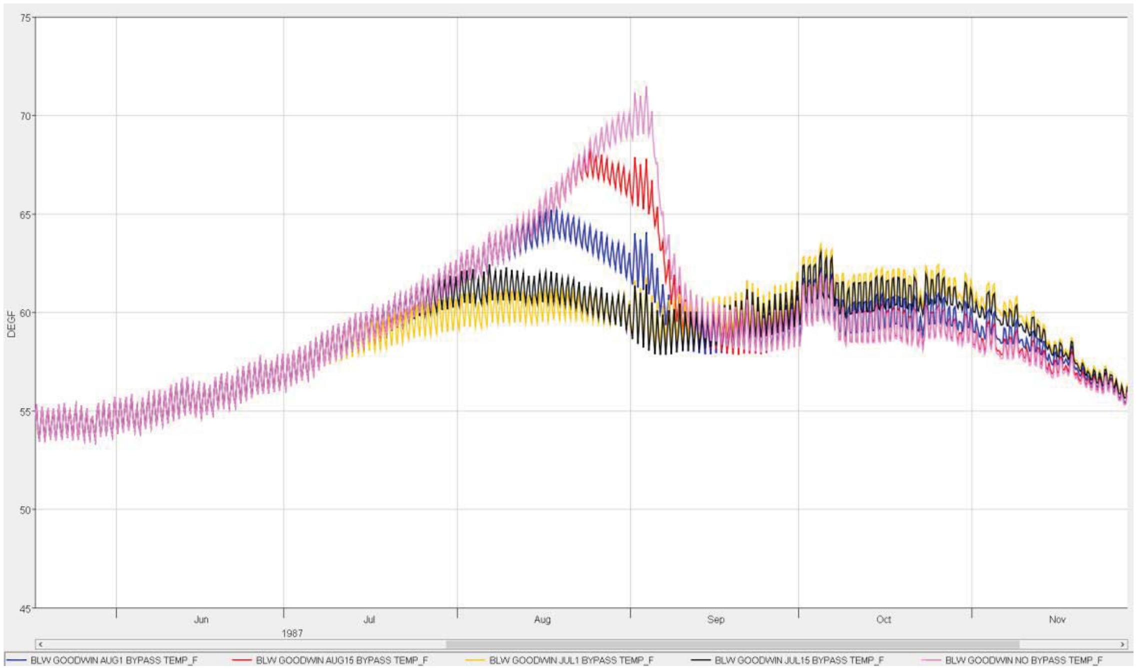


Figure 9: Effects of Power Bypass on Temperature Below Goodwin Dam

Figure 9 shows, that the most dramatic reduction in temperature in late August and early September could be achieved by starting the bypass operation on July 1. However, this type of operation would deplete cold water in New Melones, resulting in elevated water temperature in October. The question which of those bypass operation options provides the most thermal benefit should be dealt with in the context of impact on fish which is not the subject of this analysis.

In addition, the loss of energy production due to the power bypass should also be considered. A simplified power analysis related to this issue is provided below.

Based on visual inspection of the results, the July 15 bypass case was selected as the representative bypass case as it shows an overall moderation of temperatures throughout the bypass period. The results for this case in terms of 7DADM are presented in the following tables:

Table 5: Temperature Response – 7DADM
March-April, 2015

	BLW GOODWIN	KNIGHTS FERRY	ORANGE BLOSSOM	HYW 120 BRIDGE	RIPON GAGE	ABV SJR
	JUL15 BYPASS	JUL15 BYPASS	JUL15 BYPASS	JUL15 BYPASS	JUL15 BYPASS	JUL15 BYPASS
	7DADM	7DADM	7DADM	7DADM	7DADM	7DADM
	DEGF	DEGF	DEGF	DEGF	DEGF	DEGF
1-Mar	50.5	50.6	52.2	52.3	55.4	55.6
2-Mar	50.6	50.8	52.5	52.5	55.7	55.9
3-Mar	50.8	51.1	53.0	53.1	56.4	56.6
4-Mar	50.8	51.2	53.3	53.5	56.9	57.1
5-Mar	50.7	51.2	53.4	53.8	57.2	57.5
6-Mar	50.7	51.3	53.6	54.1	57.5	57.8
7-Mar	50.8	51.4	53.8	54.4	57.9	58.2
8-Mar	50.9	51.5	53.9	54.6	58.1	58.4
9-Mar	51.0	51.5	54.0	54.7	58.4	58.6
10-Mar	51.0	51.5	54.0	54.7	58.4	58.7
11-Mar	51.3	51.7	54.1	54.8	58.6	58.8
12-Mar	51.6	52.0	54.6	55.2	59.2	59.3
13-Mar	51.8	52.2	54.9	55.6	59.7	59.8
14-Mar	51.8	52.2	54.9	55.7	59.9	59.9
15-Mar	51.9	52.3	54.8	55.7	60.0	60.0
16-Mar	51.9	52.3	54.8	55.6	60.0	60.1
17-Mar	52.0	52.4	54.9	55.6	60.0	60.2
18-Mar	52.0	52.4	54.8	55.6	59.8	60.1
19-Mar	51.9	52.3	54.6	55.3	59.5	59.8
20-Mar	51.9	52.3	54.4	55.1	59.1	59.5
21-Mar	52.0	52.3	54.4	55.0	58.9	59.3
22-Mar	52.1	52.5	54.6	55.1	58.9	59.3
23-Mar	52.2	52.5	54.5	55.0	58.8	59.1
24-Mar	52.2	52.5	54.5	55.0	58.7	58.9
25-Mar	52.3	52.7	54.7	55.2	58.8	59.0
26-Mar	52.5	52.8	55.0	55.5	59.2	59.3
27-Mar	52.6	53.0	55.3	55.9	59.5	59.7
28-Mar	52.8	53.3	55.8	56.4	60.1	60.3
29-Mar	52.9	53.5	56.2	56.9	60.5	60.7
30-Mar	53.1	53.8	56.8	57.5	61.1	61.4
31-Mar	53.3	54.1	57.3	58.0	61.7	61.9
1-Apr	53.3	54.3	57.7	58.6	62.2	62.5
2-Apr	53.4	54.4	58.0	59.0	62.7	62.9
3-Apr	53.4	54.5	58.2	59.3	63.1	63.2
4-Apr	53.4	54.5	58.3	59.5	63.4	63.5
5-Apr	53.3	54.6	58.4	59.6	63.7	63.8
6-Apr	53.3	54.6	58.5	59.8	64.1	64.2
7-Apr	53.3	54.7	58.7	60.0	64.7	64.7
8-Apr	53.3	54.8	58.8	60.2	65.2	65.2
9-Apr	53.4	54.8	58.9	60.4	65.7	65.7
10-Apr	53.4	54.9	59.0	60.6	66.1	66.3
11-Apr	53.5	55.0	59.1	60.8	66.5	66.7
12-Apr	53.7	55.1	59.4	61.1	66.9	67.2
13-Apr	53.8	55.3	59.7	61.4	67.4	67.7
14-Apr	53.9	55.5	60.0	61.8	67.9	68.3
15-Apr	53.8	55.5	60.1	62.0	68.4	68.8
16-Apr	53.8	55.4	60.0	61.9	68.8	69.4
17-Apr	53.8	55.4	59.8	61.7	69.0	69.9
18-Apr	53.7	55.2	59.4	61.3	68.8	69.9
19-Apr	53.6	55.1	59.0	60.8	68.4	69.8
20-Apr	53.5	54.9	58.6	60.3	67.8	69.4
21-Apr	53.5	54.8	58.1	59.7	67.2	68.9
22-Apr	53.5	54.7	57.9	59.3	66.4	68.2
23-Apr	53.6	54.7	57.7	59.0	65.6	67.4
24-Apr	53.7	54.8	57.8	58.9	65.1	66.7
25-Apr	53.8	55.0	58.1	59.2	65.1	66.6
26-Apr	53.9	55.2	58.4	59.6	65.3	66.7
27-Apr	54.0	55.4	58.7	60.0	65.8	67.0
28-Apr	54.1	55.4	58.8	60.2	66.0	67.2
29-Apr	54.2	55.5	59.0	60.3	66.3	67.4
30-Apr	54.2	55.6	59.0	60.4	66.5	67.6

Table 6: Temperature Response – 7DADM
May-June, 2015

	BLW GOODWIN	KNIGHTS FERRY	ORANGE BLOSSOM	HYW 120 BRIDGE	RIPON GAGE	ABV SJR
	JUL15 BYPASS	JUL15 BYPASS	JUL15 BYPASS	JUL15 BYPASS	JUL15 BYPASS	JUL15 BYPASS
	7DADM	7DADM	7DADM	7DADM	7DADM	7DADM
	DEGF	DEGF	DEGF	DEGF	DEGF	DEGF
1-May	54.2	55.5	58.9	60.3	66.4	67.6
2-May	54.2	55.5	58.8	60.2	66.4	67.5
3-May	54.2	55.4	58.7	60.0	66.1	67.3
4-May	54.1	55.4	58.5	59.8	65.8	67.0
5-May	54.1	55.4	58.6	59.8	65.7	67.0
6-May	54.2	55.5	58.7	59.9	65.8	67.0
7-May	54.2	55.6	58.9	60.2	66.1	67.3
8-May	54.3	55.8	59.2	60.5	66.6	67.8
9-May	54.4	55.9	59.4	60.9	67.1	68.3
10-May	54.5	56.1	59.8	61.3	67.7	68.9
11-May	54.6	56.2	60.1	61.6	68.2	69.4
12-May	54.7	56.3	60.2	61.9	68.6	69.9
13-May	54.8	56.4	60.4	62.1	69.0	70.3
14-May	54.8	56.5	60.6	62.3	69.4	70.7
15-May	54.9	56.6	60.7	62.5	69.7	71.1
16-May	55.0	56.8	60.8	62.6	69.8	71.1
17-May	55.0	56.9	61.1	62.8	69.8	71.1
18-May	55.1	57.2	61.5	63.1	69.8	71.0
19-May	55.1	57.4	61.8	63.4	69.8	70.8
20-May	55.1	57.4	61.9	63.6	69.5	70.5
21-May	55.2	57.7	62.3	63.9	69.4	70.2
22-May	55.2	57.9	62.7	64.3	69.5	70.0
23-May	55.2	58.0	63.1	64.9	69.8	70.0
24-May	55.2	58.0	63.3	65.3	70.2	70.3
25-May	55.2	58.1	63.5	65.6	70.5	70.6
26-May	55.2	58.1	63.5	65.7	70.7	70.7
27-May	55.1	58.0	63.4	65.7	70.9	70.8
28-May	55.2	58.0	63.4	65.8	71.0	71.0
29-May	55.2	58.0	63.4	65.8	71.2	71.1
30-May	55.2	58.1	63.5	65.9	71.4	71.4
31-May	55.3	58.2	63.7	66.0	71.7	71.6
1-Jun	55.3	58.3	64.0	66.3	72.0	72.0
2-Jun	55.4	58.6	64.6	66.9	72.8	72.8
3-Jun	55.6	59.1	65.4	67.8	73.9	73.8
4-Jun	55.6	59.2	65.7	68.3	74.5	74.4
5-Jun	55.6	59.3	66.0	68.7	74.9	74.8
6-Jun	55.6	59.4	66.3	69.1	75.4	75.3
7-Jun	55.7	59.6	66.7	69.6	76.0	75.9
8-Jun	55.8	59.7	67.0	69.9	76.4	76.4
9-Jun	55.8	59.7	67.0	70.1	76.6	76.6
10-Jun	55.9	59.8	67.0	70.1	76.6	76.6
11-Jun	56.0	60.0	67.3	70.4	76.9	76.9
12-Jun	56.2	60.3	67.8	70.8	77.4	77.4
13-Jun	56.3	60.5	68.1	71.2	77.8	77.8
14-Jun	56.3	60.5	68.2	71.4	77.9	77.9
15-Jun	56.4	60.5	68.1	71.3	77.9	77.8
16-Jun	56.4	60.5	68.0	71.3	77.8	77.7
17-Jun	56.4	60.4	67.8	71.1	77.6	77.6
18-Jun	56.5	60.4	67.7	70.9	77.5	77.5
19-Jun	56.5	60.3	67.5	70.7	77.4	77.3
20-Jun	56.5	60.1	67.1	70.4	77.0	77.0
21-Jun	56.6	60.1	66.9	70.1	76.7	76.7
22-Jun	56.7	60.2	66.9	70.0	76.6	76.6
23-Jun	56.8	60.3	67.1	70.0	76.6	76.7
24-Jun	57.0	60.6	67.5	70.4	77.0	77.0
25-Jun	57.1	60.8	67.9	70.8	77.4	77.5
26-Jun	57.2	61.1	68.3	71.3	77.9	78.0
27-Jun	57.3	61.4	68.8	71.9	78.6	78.6
28-Jun	57.4	61.6	69.2	72.5	79.3	79.2
29-Jun	57.5	61.7	69.6	72.9	79.9	79.8
30-Jun	57.6	61.8	69.7	73.2	80.2	80.2

Table 7: Temperature Response – 7DADM
July-August, 2015

	BLW GOODWIN	KNIGHTS FERRY	ORANGE BLOSSOM	HYW 120 BRIDGE	RIPON GAGE	ABV SJR
	JUL15 BYPASS	JUL15 BYPASS	JUL15 BYPASS	JUL15 BYPASS	JUL15 BYPASS	JUL15 BYPASS
	7DADM	7DADM	7DADM	7DADM	7DADM	7DADM
	DEGF	DEGF	DEGF	DEGF	DEGF	DEGF
1-Jul	57.7	61.9	69.7	73.3	80.3	80.3
2-Jul	57.8	61.8	69.5	73.1	80.2	80.2
3-Jul	57.8	61.7	69.1	72.7	79.8	79.8
4-Jul	57.9	61.6	68.9	72.4	79.5	79.5
5-Jul	58.1	61.7	68.8	72.1	79.2	79.3
6-Jul	58.2	61.7	68.7	71.9	78.9	79.0
7-Jul	58.4	61.9	68.8	71.9	78.9	78.9
8-Jul	58.6	62.0	69.0	72.0	78.9	78.9
9-Jul	58.7	62.2	69.2	72.2	78.9	78.9
10-Jul	58.9	62.5	69.5	72.5	79.1	79.1
11-Jul	59.1	62.6	69.8	72.8	79.3	79.3
12-Jul	59.2	62.9	70.0	73.0	79.5	79.4
13-Jul	59.4	63.1	70.3	73.3	79.8	79.7
14-Jul	59.6	63.2	70.5	73.5	79.9	79.8
15-Jul	59.7	63.4	70.7	73.8	80.2	80.0
16-Jul	59.8	63.5	70.7	73.9	80.3	80.2
17-Jul	59.9	63.5	70.6	73.8	80.3	80.2
18-Jul	60.1	63.5	70.5	73.7	80.2	80.2
19-Jul	60.2	63.5	70.3	73.5	80.1	80.0
20-Jul	60.3	63.4	70.1	73.2	79.8	79.8
21-Jul	60.4	63.4	69.9	72.9	79.5	79.5
22-Jul	60.6	63.3	69.6	72.5	79.1	79.1
23-Jul	60.7	63.3	69.3	72.1	78.6	78.7
24-Jul	60.9	63.4	69.3	71.9	78.4	78.5
25-Jul	61.0	63.5	69.3	71.9	78.3	78.3
26-Jul	61.1	63.6	69.4	71.8	78.1	78.2
27-Jul	61.3	63.8	69.4	71.8	78.0	78.1
28-Jul	61.4	63.9	69.6	71.9	78.0	78.1
29-Jul	61.5	64.0	69.7	72.0	78.0	78.1
30-Jul	61.6	64.2	69.9	72.2	78.1	78.1
31-Jul	61.7	64.3	70.0	72.3	78.1	78.1
1-Aug	61.7	64.4	70.2	72.5	78.3	78.3
2-Aug	61.8	64.6	70.5	72.7	78.6	78.6
3-Aug	61.9	64.8	70.8	73.1	79.0	79.0
4-Aug	61.9	64.7	70.7	73.1	79.0	79.1
5-Aug	62.0	64.8	70.7	73.2	79.0	79.1
6-Aug	62.1	64.9	70.9	73.4	79.3	79.4
7-Aug	62.1	64.9	70.9	73.4	79.3	79.4
8-Aug	62.1	64.9	70.8	73.3	79.2	79.3
9-Aug	62.1	64.8	70.7	73.2	79.1	79.2
10-Aug	62.1	64.7	70.4	72.9	78.7	78.8
11-Aug	62.2	64.8	70.5	72.8	78.7	78.7
12-Aug	62.2	64.7	70.4	72.7	78.5	78.5
13-Aug	62.1	64.6	70.1	72.4	78.1	78.1
14-Aug	62.1	64.4	69.8	72.1	77.8	77.8
15-Aug	62.0	64.4	69.6	71.8	77.4	77.5
16-Aug	62.0	64.3	69.5	71.6	77.2	77.3
17-Aug	62.0	64.3	69.5	71.5	77.2	77.3
18-Aug	62.0	64.3	69.4	71.5	77.0	77.1
19-Aug	61.9	64.2	69.3	71.4	76.9	77.0
20-Aug	61.9	64.2	69.3	71.3	76.8	76.9
21-Aug	61.9	64.2	69.3	71.3	76.7	76.8
22-Aug	61.8	64.1	69.2	71.2	76.6	76.7
23-Aug	61.7	64.0	69.0	71.0	76.3	76.4
24-Aug	61.6	63.9	68.8	70.8	76.1	76.2
25-Aug	61.5	63.8	68.7	70.7	76.0	76.1
26-Aug	61.4	63.8	68.8	70.7	76.0	76.1
27-Aug	61.3	63.8	68.8	70.8	76.1	76.2
28-Aug	61.2	63.8	69.0	70.9	76.3	76.4
29-Aug	61.1	63.8	69.1	71.2	76.7	76.8
30-Aug	61.0	63.9	69.4	71.4	77.1	77.2
31-Aug	60.9	63.9	69.5	71.7	77.4	77.4

Table 8: Temperature Response – 7DADM
September-October, 2015

	BLW GOODWIN	KNIGHTS FERRY	ORANGE BLOSSOM	HYW 120 BRIDGE	RIPON GAGE	ABV SJR
	JUL15 BYPASS	JUL15 BYPASS	JUL15 BYPASS	JUL15 BYPASS	JUL15 BYPASS	JUL15 BYPASS
	7DADM	7DADM	7DADM	7DADM	7DADM	7DADM
	DEGF	DEGF	DEGF	DEGF	DEGF	DEGF
1-Sep	60.9	63.9	69.7	71.9	77.7	77.8
2-Sep	60.9	63.8	69.8	72.1	78.0	78.1
3-Sep	61.0	63.9	70.0	72.4	78.3	78.4
4-Sep	60.9	63.8	70.0	72.4	78.4	78.5
5-Sep	60.8	63.5	69.6	72.2	78.2	78.3
6-Sep	60.7	63.2	69.1	71.7	77.7	77.8
7-Sep	60.6	62.9	68.7	71.2	77.3	77.4
8-Sep	60.4	62.6	68.2	70.7	76.8	77.0
9-Sep	60.4	62.4	67.8	70.2	76.3	76.5
10-Sep	60.2	62.1	67.1	69.5	75.6	75.9
11-Sep	60.1	61.8	66.6	68.8	75.0	75.3
12-Sep	60.1	61.6	66.1	68.3	74.4	74.7
13-Sep	60.1	61.6	65.9	68.0	74.0	74.4
14-Sep	60.1	61.5	65.6	67.5	73.4	73.9
15-Sep	60.2	61.4	65.3	67.1	72.9	73.3
16-Sep	60.2	61.2	64.9	66.7	72.3	72.8
17-Sep	60.2	61.2	64.7	66.4	71.8	72.3
18-Sep	60.3	61.2	64.6	66.1	71.4	71.9
19-Sep	60.3	61.3	64.7	66.0	71.3	71.7
20-Sep	60.4	61.3	64.7	66.0	71.1	71.6
21-Sep	60.5	61.5	65.1	66.3	71.4	71.8
22-Sep	60.6	61.7	65.3	66.6	71.6	71.9
23-Sep	60.7	61.9	65.6	66.9	71.8	72.2
24-Sep	60.7	61.9	65.7	67.1	72.0	72.3
25-Sep	60.7	61.9	65.7	67.2	72.0	72.3
26-Sep	60.8	62.0	65.7	67.2	72.0	72.3
27-Sep	60.8	62.0	65.7	67.2	72.0	72.3
28-Sep	60.8	61.9	65.5	67.0	71.8	72.1
29-Sep	60.8	61.9	65.4	66.9	71.6	71.9
30-Sep	60.9	61.9	65.4	66.8	71.6	71.9
1-Oct	61.2	62.0	65.5	66.9	71.7	71.9
2-Oct	61.5	62.2	65.7	67.0	71.9	72.1
3-Oct	61.7	62.3	65.8	67.1	72.0	72.2
4-Oct	62.0	62.5	66.0	67.4	72.3	72.5
5-Oct	62.3	62.8	66.3	67.6	72.5	72.8
6-Oct	62.5	63.0	66.5	67.8	72.7	73.0
7-Oct	62.5	63.0	66.3	67.7	72.5	72.8
8-Oct	62.4	63.0	66.1	67.5	72.3	72.7
9-Oct	62.2	62.9	65.8	67.1	71.9	72.3
10-Oct	62.1	62.8	65.6	66.7	71.5	72.0
11-Oct	61.8	62.6	65.2	66.3	70.9	71.5
12-Oct	61.7	62.3	64.8	65.7	70.3	70.9
13-Oct	61.5	62.1	64.3	65.2	69.6	70.3
14-Oct	61.5	62.0	64.1	64.8	69.0	69.8
15-Oct	61.6	61.9	63.9	64.5	68.5	69.3
16-Oct	61.6	61.9	63.8	64.3	68.2	68.9
17-Oct	61.7	61.9	63.7	64.1	67.8	68.5
18-Oct	61.7	61.8	63.6	64.0	67.5	68.1
19-Oct	61.7	61.9	63.5	63.9	67.2	67.8
20-Oct	61.7	61.8	63.4	63.7	66.9	67.4
21-Oct	61.7	61.7	63.3	63.6	66.6	67.0
22-Oct	61.5	61.5	62.8	63.1	66.1	66.4
23-Oct	61.6	61.4	62.6	62.8	65.8	66.0
24-Oct	61.6	61.2	62.4	62.6	65.4	65.6
25-Oct	61.6	61.2	62.3	62.4	65.2	65.3
26-Oct	61.6	61.1	62.1	62.2	64.9	65.0
27-Oct	61.6	61.1	62.0	62.0	64.7	64.7
28-Oct	61.5	61.1	61.9	61.9	64.5	64.6
29-Oct	61.5	61.1	61.9	61.9	64.5	64.5
30-Oct	61.4	61.1	61.8	61.8	64.3	64.4
31-Oct	61.4	61.0	61.7	61.6	64.1	64.2

6. Projected Energy Loss Due to Bypass Operation

A simplified hydropower calculation was performed to estimate the energy loss due to the bypass operation. The no-bypass case was compared with the July 15 bypass case, as follows:

	No Bypass	July 15 Bypass	Energy Loss
	MWh	MWh	MWh
Jan			
Feb			
Mar	13,296	13,296	0
Apr	20,728	20,728	0
May	25,176	25,176	0
Jun	23,731	23,731	0
Jul	22,891	21,124	(1,768)
Aug	18,471	7,423	(11,047)
Sep	0	0	0
Oct	0	0	0
Nov	0	0	0
Dec	0	0	0
Total	134,546	121,731	(12,815)

Figure 10: Projected Energy Loss Due to Bypass Operation

Figure 10 shows that the energy loss during the bypass period, July 15 through August 31, 2015, will be in the order of 12,815 MWh. Based on PG&E SRAC (Short-Term Avoided Cost) for qualifying facilities, the cost per KWh in July and August of 2014 was approximately 5 cents. If we use the same price rate for this year, the loss of energy could amount to $640,747.

Stanislaus Temperature Modeling
2015 Proposed Operations
Water Allocation Schedule – March 25, 2015

General:

The objective of this work is to assess, using the HEC-5Q Model, the expected temperature conditions at discrete points along the Stanislaus River, given the most recent projections of inflow to New Melones Reservoir and the proposed water release schedule from March 25, 2015 through the December 31, 2015.

Tasks:

1. Set up the data to run a year similar to 1987:
   a. Prime the model by setting New Melones to the March 25 condition (storage and temperature profile wise).
   b. Disaggregate the estimated monthly NM inflow to daily (see the New Melones Inflow, Diversion and Release Schedule below).
   c. Assume monthly average diversion for OID/SSJID and for Goodwin release to river, as specified in the New Melones Inflow, Diversion and Release Schedule below.
   d. Prepare DSS inputs for the above.
2. Run the model in two modes:
   - No Hydro Bypass
   - Hydro Bypass starting July 15
3. Analyze the results in terms of the expected temperatures (7DADM) at the specified locations along the Stanislaus River from day 1 of the simulation to end-of-year 2015.
4. Estimate the energy loss due to Hydro Bypass operation

New Melones Inflow, Diversion and Release Schedule:

Beginning	NM Inflow	Goodwin OID/SSJID	Goodwin To River -2E
	TAF	TAF	CFS
March 1, 2015	31.3	16.4	200
March 26, 2015	5.0	4.8	200
April 1, 2015	9.0	26.1	677
April 15, 2015	9.0	29.8	709
May 1, 2015	8.7	37.6	200
May 16, 2015	9.3	40.1	200
June 1, 2015	12.0	77.3	150
July 1, 2015	12.0	82	150
August 1, 2015	11.0	78.4	150
September 1, 2015	11.0	48.8	150
October 1, 2015	3.0	0	577
November 1, 2015	1.1	0	200
December 1, 2015	1.3	0	200
December 31, 2015			

Figure 1: Estimated New Melones Inflow and Water Allocation in 2015

Modeling, Analysis and Findings

1. Priming the Mode

The HEC-5Q was set to simulate a single year similar to 1987 in terms of the pattern of inflow to New Melones except that the volume of the inflow was scaled down to match the monthly estimates specified in Figure 1 above. The meteorological conditions were also set to match the historical conditions in 1987.

In order to prime the model, the simulation started on January 1, 1987 where by New Melones storage was set in such a way that by March 25 the total volume of water in the reservoir equaled approximately to the observed volume on that date, i.e., 584,600 acre-feet. The computed temperature profiles in New Melones and Tulloch were also set to match typical conditions for these reservoirs during this time of the year.

2. Simulation Modes

The HEC-5Q was run in two modes:

a) No-Bypass Operation – under this mode, New Melones was operated in a way where the water was released through the power plant until the water level in the reservoir reached the minimum power pool elevation. At that point the release was switched to the low-level outlet in the dam.

b) Bypass Operation – under this mode, New Melones was operated in a way where the release was switched gradually from power release to low-level outlet release in advance of reaching the minimum power pool elevation.

3. Projected New Melones Storage

From the storage prospective, there is no difference between the two operations modes described above. Mass-balance calculation for New Melones for the period March 1 through December 31, 2015 is shown in Figure 2 below.

New Melones Ops - Projected Storage and Water Levels

Beginning	NM Inflow	Goodwin OID/SSJID	Goodwin To River -2E	NM Projected Storage	NM Projected Elevation
	TAF	TAF	CFS	TAF	FT
March 1, 2015	31.3	16.4	200	614	880
March 26, 2015	5.0	4.8	200	585	875
April 1, 2015	9.0	26.1	677	580	874
April 15, 2015	9.0	29.8	709	542	866
May 1, 2015	8.7	37.6	200	494	856
May 16, 2015	9.3	40.1	200	454	847
June 1, 2015	12.0	77.3	150	414	838
July 1, 2015	12.0	82	150	337	818
August 1, 2015	11.0	78.4	150	255	794
September 1, 2015	11.0	48.8	150	176	766
October 1, 2015	3.0	0	577	131	747
November 1, 2015	1.1	0	200	104	733
December 1, 2015	1.3	0	200	93	727
December 31, 2015				82	720

Figure 2: Mass balance for New Melones: March 1 to December 31, 2015

The figure shows that the projected storage in New Melones on November 1 is 104 TAF corresponding to El. 733. This reduction in storage takes into consideration the net effect of New Melones and Tulloch evaporation, including local runoff to Tulloch (which was assumed to be similar to 1987).

The gradual decline of water levels in the reservoir from March through December is shown in Figure 3 below. The figure shows that given the assumed inflow to New Melones and proposed outflow (diversion plus release to river), the water will probably recede to the point where the submerged old Melones Dam will emerge around December 19.

In addition, the depressed water levels in the reservoir will greatly affect the water temperatures downstream as the warm water epilimnion (the top-most layer) will be discharged from the reservoir through the power intake. It should be noted that in both operation modes power flow will cease as the reservoir reaches the minimum power pool at El. 785 (around end-of-day August 11) and water will be discharged at that point thorough the low-level outlet in the New Melones Dam.

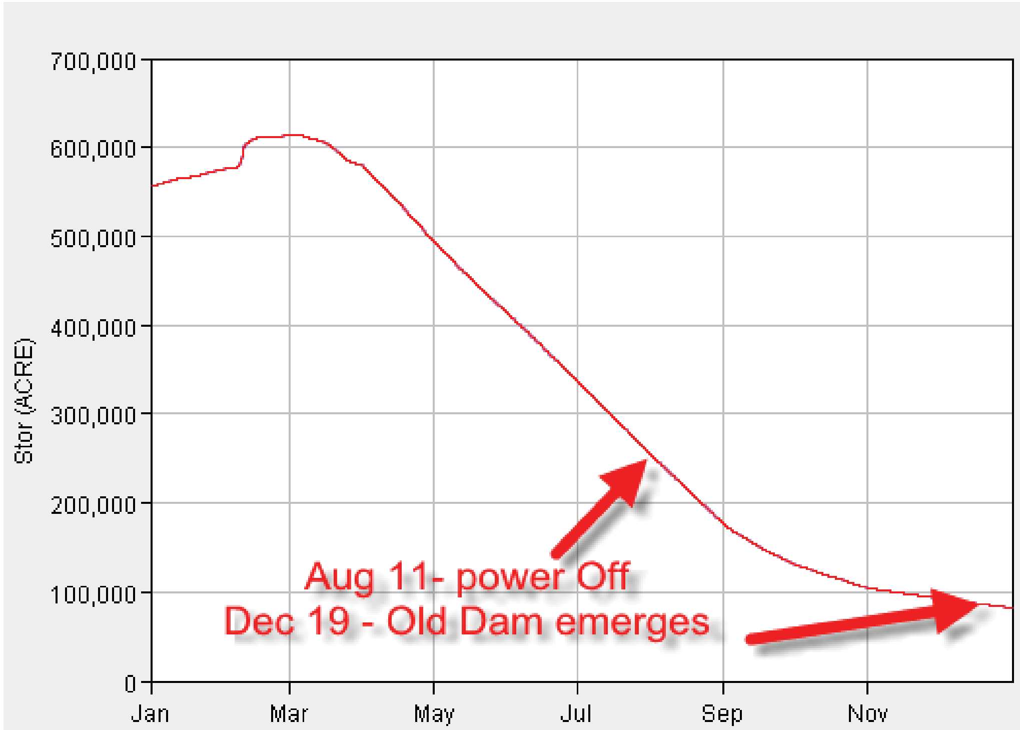


Figure 3: Projected New Melones Storage in 2015

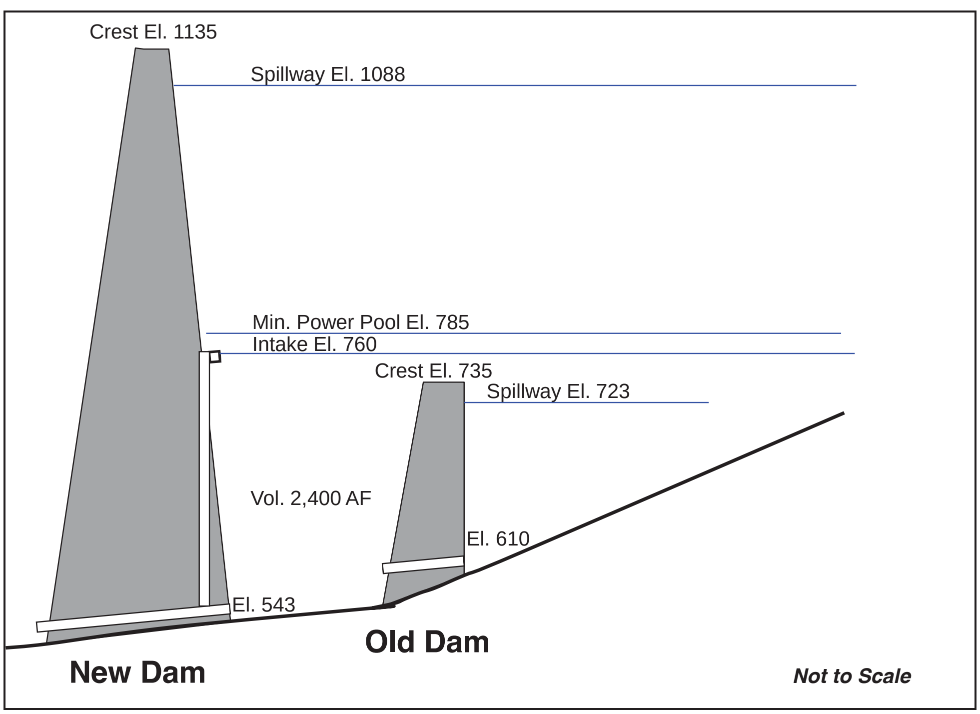


Figure 4: New-Old Dam Interaction

4. Projected Downriver Temperature Response – No-Bypass Operation

The following figures and tables show the results for the temperature response at six discrete points along the Stanislaus River:

1) Below Goodwin Dam
2) Knights Ferry
3) Orange Blossom Bridge
4) Highway 120 Bridge (Oakdale)
5) Ripon Gage (Highway 99)
6) Above the confluence with the San Joaquin River

The results are presented in two ways:

A. Graphical form - showing the daily maximum temperatures

B. Tabular form - showing the 7-Days Average of Daily Maximums (7DADM).

Notice the precipitous drop of temperatures (almost 10 Deg-F below Goodwin Dam) in mid-August under the No-Bypass mode. This is due to the abrupt switch from no-bypass to full-bypass operation on August 11 (due to power shutoff).

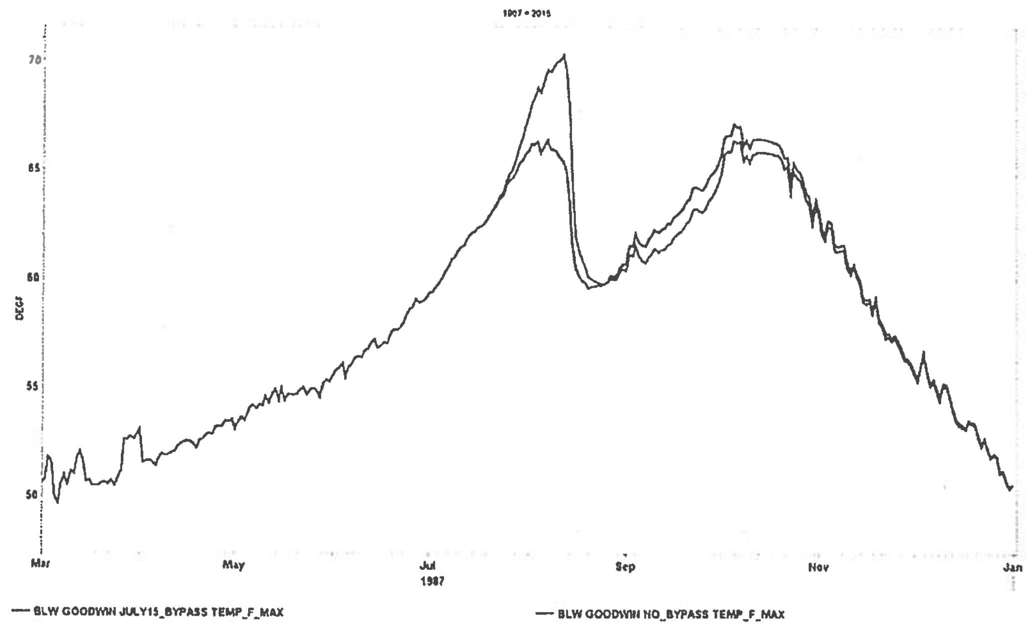


Figure 5 : Maximum Daily Temperatures below Goodwin Dam

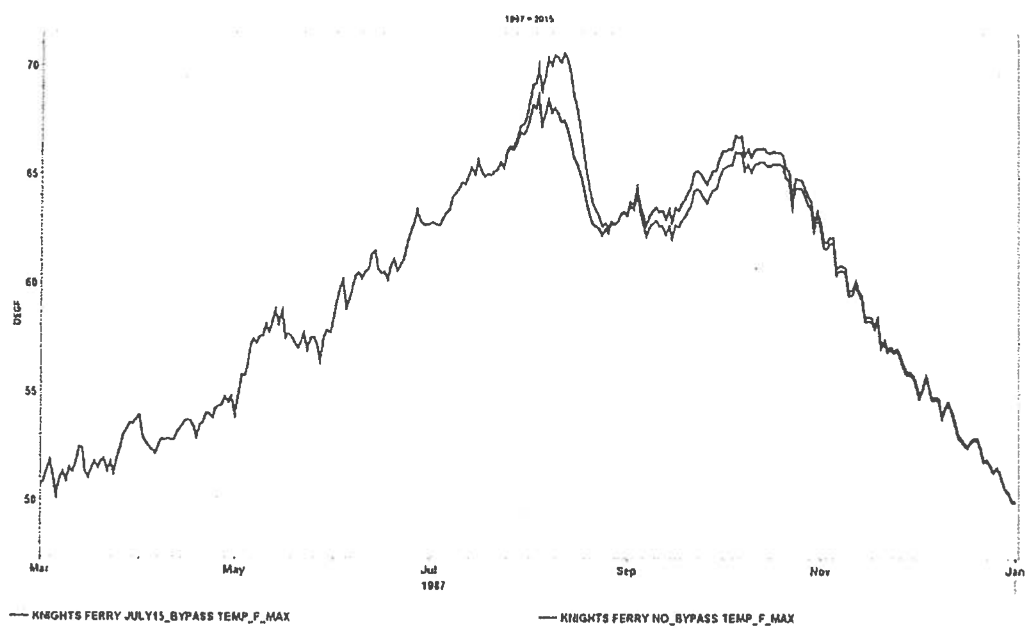


Figure 6 : Maximum Daily Temperatures at Knights Ferry

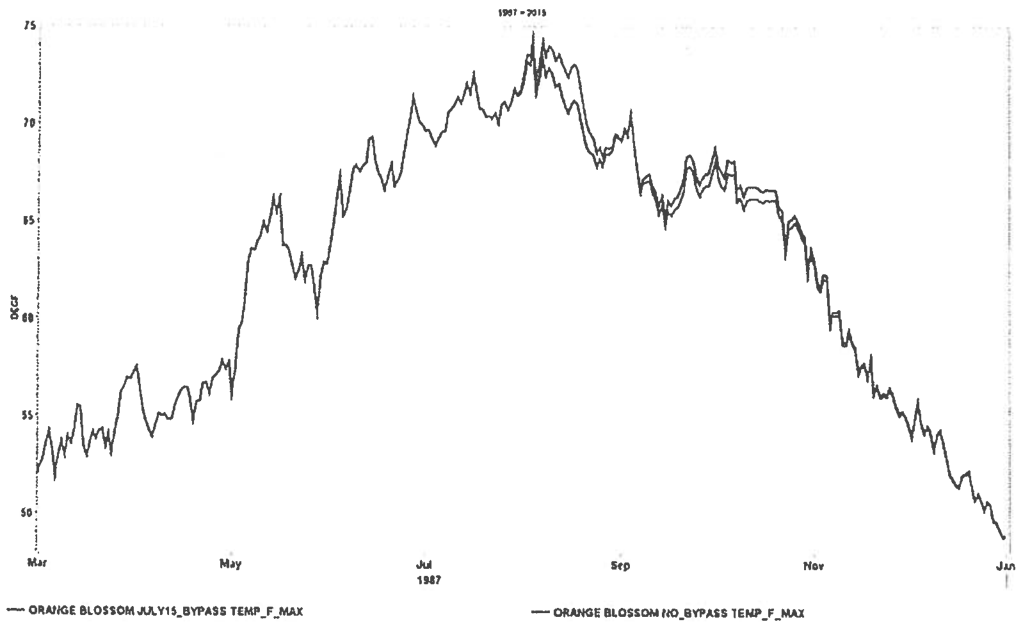


Figure 7 : Maximum Daily Temperatures at Orange Blossom Bridge

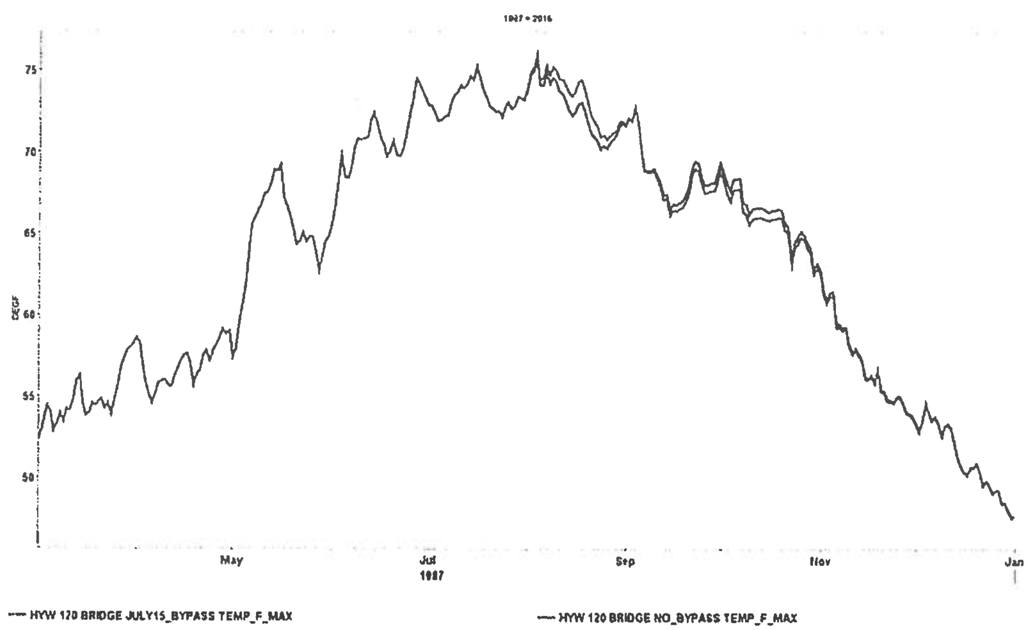


Figure 8 : Maximum Daily Temperatures below Highway 120 (Oakdale)

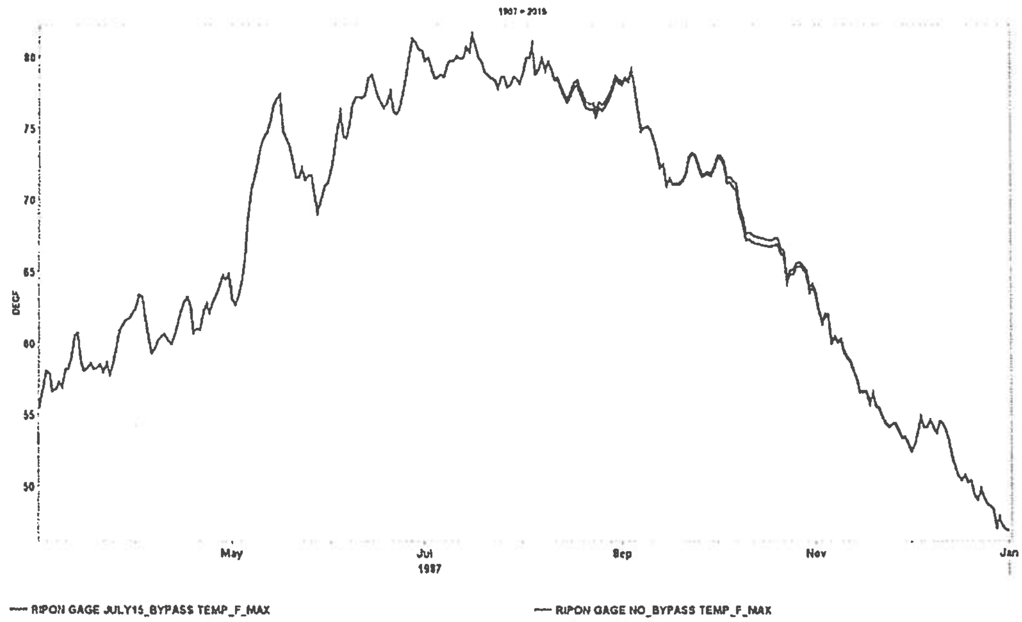


Figure 9 : Maximum Daily Temperatures at Ripon Gage (Highway 99)

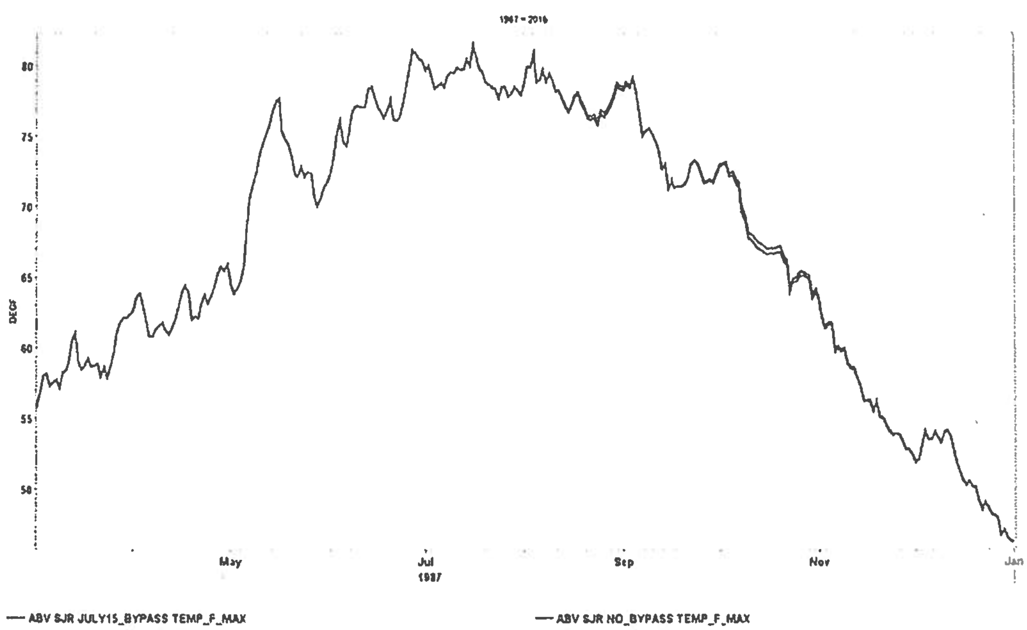


Figure 10 : Maximum Daily Temperatures above the Confluence with the San Joaquin River

Table 1: Temperature Response – 7DADM
March-April, 2015

	BLW GOODWIN	KNIGHTS FERRY	ORANGE BLOSSOM	HYW 120 BRIDGE	RIPON GAGE	ABV SJR
	NO_BYPASS	NO_BYPASS	NO_BYPASS	NO_BYPASS	NO_BYPASS	NO_BYPASS
	7DADM	7DADM	7DADM	7DADM	7DADM	7DADM
	DEGF	DEGF	DEGF	DEGF	DEGF	DEGF
1-Mar	50.2	50.1	51.5	51.5	54.2	54.5
2-Mar	50.4	50.3	51.9	51.9	54.7	54.9
3-Mar	50.8	50.7	52.4	52.4	55.4	55.6
4-Mar	50.8	50.9	52.8	52.9	56.0	56.2
5-Mar	50.7	50.9	52.8	53.1	56.4	56.6
6-Mar	50.7	51.0	53.0	53.3	56.7	57.0
7-Mar	50.7	51.1	53.2	53.6	57.0	57.3
8-Mar	50.7	51.1	53.2	53.7	57.2	57.5
9-Mar	50.6	51.1	53.3	53.8	57.4	57.7
10-Mar	50.5	51.0	53.2	53.7	57.4	57.8
11-Mar	50.8	51.1	53.3	53.8	57.5	57.9
12-Mar	51.1	51.4	53.8	54.2	58.1	58.3
13-Mar	51.2	51.6	54.2	54.7	58.7	58.8
14-Mar	51.2	51.6	54.2	54.8	58.9	59.0
15-Mar	51.2	51.7	54.1	54.8	59.0	59.2
16-Mar	51.1	51.7	54.1	54.8	59.0	59.3
17-Mar	51.1	51.7	54.2	54.8	59.1	59.4
18-Mar	50.9	51.7	54.1	54.8	59.0	59.4
19-Mar	50.7	51.6	53.9	54.6	58.7	59.1
20-Mar	50.6	51.5	53.8	54.4	58.4	58.8
21-Mar	50.5	51.5	53.8	54.4	58.3	58.6
22-Mar	50.5	51.6	53.9	54.5	58.3	58.7
23-Mar	50.5	51.6	53.9	54.5	58.3	58.6
24-Mar	50.6	51.6	53.9	54.5	58.3	58.5
25-Mar	50.7	51.7	54.1	54.7	58.4	58.6
26-Mar	51.0	51.9	54.3	54.9	58.8	59.0
27-Mar	51.3	52.1	54.7	55.3	59.2	59.4
28-Mar	51.6	52.4	55.2	55.8	59.7	60.0
29-Mar	51.8	52.7	55.6	56.3	60.2	60.5
30-Mar	52.2	53.0	56.2	56.9	60.8	61.1
31-Mar	52.5	53.3	56.6	57.5	61.3	61.7
1-Apr	52.5	53.4	56.8	57.8	61.9	62.2
2-Apr	52.4	53.3	56.7	57.9	62.2	62.6
3-Apr	52.3	53.2	56.5	57.7	62.3	62.8
4-Apr	52.1	53.1	56.1	57.3	62.1	62.7
5-Apr	51.9	52.9	55.7	56.8	61.8	62.5
6-Apr	51.8	52.7	55.3	56.4	61.4	62.3
7-Apr	51.6	52.5	54.9	56.0	61.1	62.1
8-Apr	51.7	52.5	54.7	55.6	60.7	61.8
9-Apr	51.7	52.6	54.7	55.5	60.3	61.5
10-Apr	51.8	52.6	54.7	55.5	60.1	61.3
11-Apr	51.8	52.7	54.7	55.6	60.0	61.2
12-Apr	51.9	52.8	55.0	55.8	60.2	61.3
13-Apr	52.0	52.9	55.1	56.0	60.4	61.5
14-Apr	52.1	53.0	55.3	56.2	60.7	61.7
15-Apr	52.2	53.2	55.5	56.4	61.1	62.1
16-Apr	52.3	53.3	55.7	56.7	61.4	62.4
17-Apr	52.4	53.4	55.9	56.9	61.8	62.8
18-Apr	52.4	53.4	55.9	56.9	61.9	63.0
19-Apr	52.4	53.4	55.9	56.9	61.9	63.1
20-Apr	52.5	53.5	55.9	56.9	61.9	63.1
21-Apr	52.5	53.5	55.9	56.9	61.9	63.1
22-Apr	52.6	53.6	56.0	57.0	61.9	63.1
23-Apr	52.6	53.6	55.9	56.9	61.7	62.9
24-Apr	52.7	53.7	56.1	57.0	61.7	62.8
25-Apr	52.8	53.9	56.4	57.4	62.1	63.2
26-Apr	52.9	54.0	56.6	57.7	62.5	63.6
27-Apr	53.1	54.2	56.9	58.0	63.1	64.1
28-Apr	53.1	54.3	57.0	58.2	63.4	64.5
29-Apr	53.2	54.4	57.2	58.4	63.7	64.8
30-Apr	53.3	54.4	57.2	58.4	63.9	65.0

Table 2: Temperature Response – 7DADM
May-June, 2015

	BLW GOODWIN	KNIGHTS FERRY	ORANGE BLOSSOM	HYW 120 BRIDGE	RIPON GAGE	ABV SJR
	NO_BYPASS	NO_BYPASS	NO_BYPASS	NO_BYPASS	NO_BYPASS	NO_BYPASS
	7DADM	7DADM	7DADM	7DADM	7DADM	7DADM
	DEGF	DEGF	DEGF	DEGF	DEGF	DEGF
1-May	53.3	54.5	57.3	58.4	63.6	65.0
2-May	53.4	54.7	57.6	58.6	63.9	65.0
3-May	53.4	54.9	58.0	58.9	63.9	64.9
4-May	53.5	55.1	58.4	59.3	64.1	64.9
5-May	53.5	55.5	59.2	60.1	64.7	65.4
6-May	53.6	55.9	60.0	61.0	65.5	66.0
7-May	53.8	56.3	61.0	62.2	66.7	67.1
8-May	53.9	56.7	62.0	63.5	68.2	68.3
9-May	54.0	57.0	62.7	64.5	69.6	69.6
10-May	54.1	57.3	63.4	65.5	71.1	71.1
11-May	54.2	57.5	63.9	66.3	72.3	72.4
12-May	54.3	57.7	64.3	66.9	73.3	73.4
13-May	54.4	57.9	64.6	67.3	74.1	74.2
14-May	54.4	58.0	64.9	67.7	74.9	75.1
15-May	54.5	58.2	65.2	68.1	75.6	75.8
16-May	54.6	58.2	65.2	68.2	75.7	76.0
17-May	54.6	58.1	65.0	68.1	75.7	76.1
18-May	54.7	58.1	64.8	67.9	75.6	76.0
19-May	54.6	57.9	64.5	67.5	75.2	75.7
20-May	54.6	57.7	63.9	66.8	74.5	75.0
21-May	54.7	57.6	63.5	66.2	73.7	74.3
22-May	54.7	57.4	63.0	65.6	73.0	73.6
23-May	54.7	57.3	62.8	65.2	72.5	73.1
24-May	54.8	57.3	62.6	64.9	72.1	72.8
25-May	54.8	57.3	62.5	64.8	71.8	72.5
26-May	54.8	57.3	62.4	64.6	71.5	72.2
27-May	54.8	57.2	62.1	64.3	71.1	71.8
28-May	54.9	57.2	62.1	64.2	70.9	71.6
29-May	54.9	57.2	62.1	64.1	70.7	71.4
30-May	55.0	57.3	62.2	64.2	70.7	71.4
31-May	55.1	57.5	62.3	64.3	70.7	71.4
1-Jun	55.2	57.7	62.6	64.6	70.9	71.5
2-Jun	55.4	58.1	63.3	65.2	71.6	72.2
3-Jun	55.6	58.6	64.3	66.2	72.6	73.0
4-Jun	55.6	58.8	64.7	66.9	73.2	73.6
5-Jun	55.7	59.0	65.1	67.5	73.7	74.0
6-Jun	55.8	59.3	65.7	68.1	74.3	74.5
7-Jun	55.9	59.6	66.2	68.8	74.9	75.1
8-Jun	56.0	59.8	66.7	69.4	75.5	75.6
9-Jun	56.1	59.9	66.8	69.7	75.8	75.9
10-Jun	56.2	59.9	66.9	69.8	76.0	76.0
11-Jun	56.4	60.2	67.3	70.2	76.4	76.4
12-Jun	56.5	60.5	67.8	70.7	77.0	77.0
13-Jun	56.7	60.7	68.2	71.2	77.5	77.4
14-Jun	56.8	60.8	68.2	71.4	77.7	77.6
15-Jun	56.8	60.8	68.2	71.4	77.7	77.6
16-Jun	56.9	60.8	68.1	71.3	77.7	77.5
17-Jun	57.0	60.7	68.0	71.2	77.6	77.4
18-Jun	57.1	60.8	67.9	71.0	77.5	77.4
19-Jun	57.2	60.7	67.7	70.9	77.3	77.3
20-Jun	57.2	60.6	67.3	70.5	77.0	76.9
21-Jun	57.3	60.6	67.2	70.2	76.7	76.7
22-Jun	57.5	60.7	67.2	70.1	76.6	76.6
23-Jun	57.7	60.9	67.4	70.2	76.6	76.7
24-Jun	57.9	61.2	67.8	70.5	77.0	77.0
25-Jun	58.1	61.5	68.2	71.0	77.4	77.5
26-Jun	58.3	61.8	68.7	71.5	78.0	78.0
27-Jun	58.5	62.1	69.2	72.2	78.7	78.6
28-Jun	58.6	62.4	69.7	72.8	79.3	79.3
29-Jun	58.8	62.6	70.0	73.2	79.9	79.8
30-Jun	58.9	62.8	70.2	73.5	80.2	80.2

Table 3: Temperature Response – 7DADM
July-August, 2015

	BLW GOODWIN	KNIGHTS FERRY	ORANGE BLOSSOM	HYW 120 BRIDGE	RIPON GAGE	ABV SJR
	NO_BYPASS	NO_BYPASS	NO_BYPASS	NO_BYPASS	NO_BYPASS	NO_BYPASS
	7DADM	7DADM	7DADM	7DADM	7DADM	7DADM
	DEGF	DEGF	DEGF	DEGF	DEGF	DEGF
1-Jul	59.0	62.8	70.2	73.6	80.4	80.4
2-Jul	59.2	62.8	70.1	73.5	80.3	80.3
3-Jul	59.3	62.7	69.7	73.1	79.9	79.9
4-Jul	59.4	62.7	69.5	72.8	79.6	79.6
5-Jul	59.6	62.8	69.4	72.6	79.3	79.3
6-Jul	59.8	62.9	69.4	72.4	79.0	79.0
7-Jul	60.0	63.1	69.5	72.4	79.0	79.0
8-Jul	60.3	63.3	69.7	72.5	79.0	78.9
9-Jul	60.5	63.5	69.9	72.7	79.0	79.0
10-Jul	60.8	63.8	70.3	73.0	79.3	79.2
11-Jul	61.0	64.0	70.5	73.3	79.4	79.3
12-Jul	61.2	64.3	70.8	73.5	79.6	79.5
13-Jul	61.4	64.5	71.2	73.9	79.9	79.8
14-Jul	61.6	64.7	71.3	74.1	80.0	79.8
15-Jul	61.8	64.9	71.6	74.4	80.3	80.1
16-Jul	62.0	65.0	71.7	74.5	80.4	80.3
17-Jul	62.1	65.1	71.6	74.5	80.4	80.3
18-Jul	62.3	65.2	71.5	74.4	80.4	80.2
19-Jul	62.4	65.2	71.4	74.2	80.2	80.1
20-Jul	62.6	65.1	71.1	73.9	80.0	79.9
21-Jul	62.8	65.2	70.9	73.6	79.7	79.6
22-Jul	63.0	65.2	70.7	73.2	79.3	79.2
23-Jul	63.2	65.2	70.4	72.9	78.8	78.8
24-Jul	63.5	65.3	70.5	72.7	78.6	78.6
25-Jul	63.8	65.5	70.5	72.7	78.5	78.5
26-Jul	64.1	65.7	70.6	72.7	78.4	78.3
27-Jul	64.4	65.9	70.7	72.7	78.3	78.2
28-Jul	64.8	66.2	70.9	72.8	78.3	78.2
29-Jul	65.2	66.5	71.0	72.9	78.3	78.2
30-Jul	65.6	66.8	71.3	73.1	78.3	78.2
31-Jul	66.0	67.1	71.5	73.2	78.4	78.3
1-Aug	66.5	67.5	71.8	73.5	78.6	78.5
2-Aug	67.0	67.9	72.2	73.9	78.9	78.8
3-Aug	67.4	68.4	72.7	74.3	79.3	79.2
4-Aug	67.8	68.6	72.8	74.5	79.3	79.2
5-Aug	68.2	69.0	73.0	74.6	79.4	79.4
6-Aug	68.6	69.4	73.4	74.9	79.6	79.6
7-Aug	68.8	69.6	73.5	75.1	79.7	79.6
8-Aug	69.1	69.8	73.6	75.1	79.6	79.6
9-Aug	69.3	70.0	73.6	75.1	79.5	79.4
10-Aug	69.5	70.0	73.4	74.9	79.2	79.0
11-Aug	69.7	70.2	73.6	74.9	79.2	79.0
12-Aug	69.8	70.4	73.6	74.8	79.0	78.8
13-Aug	69.5	70.3	73.4	74.6	78.6	78.4
14-Aug	68.8	70.1	73.3	74.4	78.4	78.1
15-Aug	67.7	69.7	73.1	74.2	78.0	77.8
16-Aug	66.5	69.3	73.0	74.1	77.9	77.7
17-Aug	65.2	68.7	72.9	74.1	77.9	77.6
18-Aug	63.8	68.0	72.7	74.0	77.8	77.5
19-Aug	62.4	67.1	72.3	73.8	77.7	77.4
20-Aug	61.3	66.2	71.9	73.6	77.6	77.3
21-Aug	60.7	65.5	71.5	73.4	77.5	77.3
22-Aug	60.4	64.7	71.0	73.1	77.4	77.2
23-Aug	60.1	64.1	70.3	72.6	77.2	76.9
24-Aug	60.0	63.6	69.8	72.1	76.9	76.7
25-Aug	59.9	63.2	69.3	71.7	76.8	76.6
26-Aug	59.9	63.0	69.0	71.4	76.7	76.6
27-Aug	59.9	62.9	68.8	71.2	76.8	76.7
28-Aug	59.9	62.8	68.7	71.2	77.0	76.9
29-Aug	59.9	62.8	68.8	71.2	77.2	77.3
30-Aug	60.0	62.9	68.9	71.3	77.5	77.6
31-Aug	60.1	63.0	68.9	71.4	77.7	77.8

Table 4: Temperature Response – 7DADM September-October, 2015

	BLW GOODWIN	KNIGHTS FERRY	ORANGE BLOSSOM	HYW 120 BRIDGE	RIPON GAGE	ABV SJR
	NO_BYPASS	NO_BYPASS	NO_BYPASS	NO_BYPASS	NO_BYPASS	NO_BYPASS
	7DADM	7DADM	7DADM	7DADM	7DADM	7DADM
	DEGF	DEGF	DEGF	DEGF	DEGF	DEGF
1-Sep	60.3	63.1	69.1	71.6	78.0	78.2
2-Sep	60.5	63.2	69.2	71.8	78.2	78.4
3-Sep	60.7	63.4	69.5	72.0	78.5	76.7
4-Sep	60.8	63.4	69.5	72.1	78.5	78.7
5-Sep	60.9	63.4	69.2	71.8	78.2	78.4
6-Sep	61.0	63.2	68.8	71.4	77.7	77.9
7-Sep	61.0	63.2	68.5	71.0	77.2	77.4
8-Sep	61.0	63.0	68.1	70.5	76.7	77.0
9-Sep	61.1	63.0	67.8	70.0	76.2	76.5
10-Sep	61.1	62.8	67.2	69.4	75.5	75.8
11-Sep	61.1	62.7	66.8	68.9	74.9	75.3
12-Sep	61.2	62.6	66.5	68.4	74.3	74.7
13-Sep	61.3	62.6	66.4	68.2	73.9	74.4
14-Sep	61.4	62.6	66.1	67.8	73.4	73.8
15-Sep	61.5	62.6	65.9	67.5	72.8	73.3
16-Sep	61.6	62.5	65.6	67.1	72.3	72.7
17-Sep	61.7	62.5	65.5	66.8	71.8	72.3
18-Sep	61.8	62.6	65.5	66.7	71.5	71.9
19-Sep	62.0	62.8	65.6	66.6	71.3	71.7
20-Sep	62.2	62.9	65.7	66.7	71.2	71.6
21-Sep	62.4	63.2	66.1	67.0	71.5	71.8
22-Sep	62.6	63.5	66.4	67.4	71.7	72.0
23-Sep	62.7	63.7	66.7	67.7	72.0	72.2
24-Sep	62.9	63.8	66.9	68.0	72.2	72.4
25-Sep	63.0	63.9	67.0	68.1	72.2	72.4
26-Sep	63.1	64.0	67.0	68.2	72.3	72.4
27-Sep	63.3	64.1	67.1	68.2	72.3	72.4
28-Sep	63.4	64.1	66.9	68.1	72.1	72.2
29-Sep	63.6	64.2	66.9	68.0	72.0	72.1
30-Sep	63.8	64.4	67.0	68.0	72.0	72.1
1-Oct	64.2	64.6	67.0	68.0	72.1	72.2
2-Oct	64.6	64.8	67.1	68.0	72.2	72.4
3-Oct	64.9	65.0	67.1	67.9	72.1	72.4
4-Oct	65.3	65.3	67.2	67.9	72.1	72.5
5-Oct	65.6	65.5	67.3	67.9	72.0	72.5
6-Oct	65.9	65.7	67.3	67.8	71.7	72.3
7-Oct	66.0	65.7	67.0	67.5	71.2	71.9
8-Oct	66.0	65.7	66.8	67.2	70.6	71.3
9-Oct	65.9	65.6	66.7	66.9	69.8	70.5
10-Oct	65.9	65.6	66.6	66.8	69.2	69.9
11-Oct	65.8	65.6	66.4	66.5	68.6	69.2
12-Oct	65.7	65.5	66.2	66.3	68.1	68.5
13-Oct	65.7	65.4	66.1	66.0	67.5	67.9
14-Oct	65.7	65.5	66.1	66.0	67.2	67.5
15-Oct	65.7	65.5	66.0	65.9	67.0	67.1
16-Oct	65.8	65.5	66.1	66.0	66.9	67.0
17-Oct	65.8	65.5	66.1	66.0	66.9	66.9
18-Oct	65.8	65.5	66.1	66.0	66.8	66.8
19-Oct	65.7	65.5	66.1	66.0	66.8	66.7
20-Oct	65.6	65.4	66.0	65.8	66.7	66.6
21-Oct	65.5	65.3	65.8	65.7	66.6	66.5
22-Oct	65.3	65.0	65.4	65.3	66.2	66.1
23-Oct	65.2	64.9	65.2	65.1	66.0	65.8
24-Oct	65.0	64.7	65.0	64.9	65.7	65.6
25-Oct	64.8	64.5	64.9	64.7	65.5	65.3
26-Oct	64.6	64.3	64.7	64.5	65.2	65.1
27-Oct	64.4	64.2	64.5	64.3	65.1	64.9
28-Oct	64.2	64.0	64.3	64.2	64.9	64.8
29-Oct	64.0	63.8	64.2	64.1	64.8	64.7
30-Oct	63.7	63.6	64.0	63.9	64.7	64.6
31-Oct	63.5	63.4	63.7	63.6	64.5	64.4

5. Projected Downriver Temperature Response – Bypass Operation

For the purpose of this analysis, the bypass operation started on July 15 and decreased at a rate of 1.0 percent per day, as illustrated in Figure 11 below:

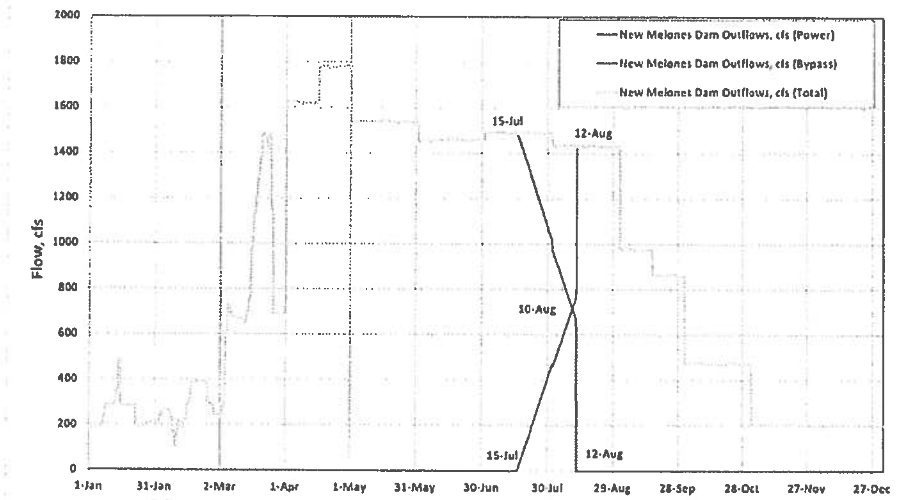


Figure 11: New Melones Power Bypass Operation

The rational for selecting 1.0 percent reduction of power flow per day when transitioning to bypass flow, is that it provides an overall moderation of temperatures throughout the bypass period. This would also keep the peak temperature in early August at approximately the same level as the peak temperature in early October, as illustrated in Figure 12 below:

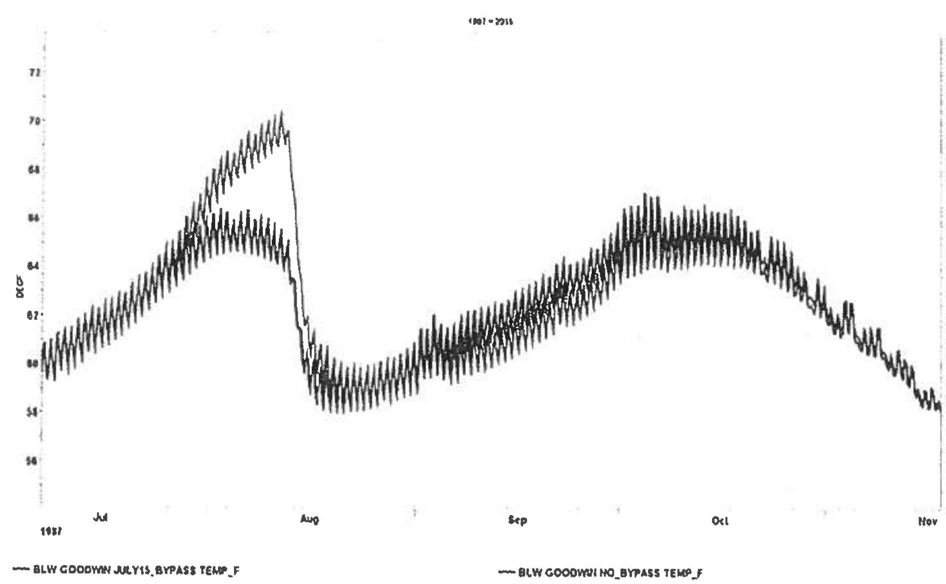


Figure 12: Effects of Power Bypass on Temperature Below Goodwin Dam

The results for the bypass case in terms of 7DADM are presented in the following tables:

Table 5: Temperature Response – 7DADM
March-April, 2015

	BLW GOODWIN	KNIGHTS FERRY	ORANGE BLOSSOM	HYW 120 BRIDGE	RIPON GAGE	ABV SJR
	JULY15_BYPASS	JULY15_BYPASS	JULY15_BYPASS	JULY15_BYPASS	JULY15_BYPASS	JULY15_BYPASS
	7DADM	7DADM	7DADM	7DADM	7DADM	7DADM
	DEGF	DEGF	DEGF	DEGF	DEGF	DEGF
1-Mar	50.2	50.1	51.5	51.5	54.2	54.5
2-Mar	50.4	50.3	51.9	51.9	54.7	54.9
3-Mar	50.8	50.7	52.4	52.4	55.4	55.6
4-Mar	50.8	50.9	52.8	52.9	56.0	56.2
5-Mar	50.7	50.9	52.8	53.1	56.4	56.6
6-Mar	50.7	51.0	53.0	53.3	56.7	57.0
7-Mar	50.7	51.1	53.2	53.6	57.0	57.3
8-Mar	50.7	51.1	53.2	53.7	57.2	57.5
9-Mar	50.6	51.1	53.3	53.8	57.4	57.7
10-Mar	50.5	51.0	53.2	53.7	57.4	57.8
11-Mar	50.8	51.1	53.3	53.8	57.5	57.9
12-Mar	51.1	51.4	53.8	54.2	58.1	58.3
13-Mar	51.2	51.6	54.2	54.7	58.7	58.8
14-Mar	51.2	51.6	54.2	54.8	58.9	59.0
15-Mar	51.2	51.7	54.1	54.8	59.0	59.2
16-Mar	51.1	51.7	54.1	54.8	59.0	59.3
17-Mar	51.1	51.7	54.2	54.8	59.1	59.4
18-Mar	50.9	51.7	54.1	54.8	59.0	59.4
19-Mar	50.7	51.6	53.9	54.6	58.7	59.1
20-Mar	50.6	51.5	53.8	54.4	58.4	58.8
21-Mar	50.5	51.5	53.8	54.4	58.3	58.6
22-Mar	50.5	51.6	53.9	54.5	58.3	58.7
23-Mar	50.5	51.6	53.9	54.5	58.3	58.6
24-Mar	50.6	51.6	53.9	54.5	58.3	58.5
25-Mar	50.7	51.7	54.1	54.7	58.4	58.6
26-Mar	51.0	51.9	54.3	54.9	58.8	59.0
27-Mar	51.3	52.1	54.7	55.3	59.2	59.4
28-Mar	51.6	52.4	55.2	55.8	59.7	60.0
29-Mar	51.8	52.7	55.6	56.3	60.2	60.5
30-Mar	52.2	53.0	56.2	56.9	60.8	61.1
31-Mar	52.5	53.3	56.6	57.5	61.3	61.7
1-Apr	52.5	53.4	56.8	57.8	61.9	62.2
2-Apr	52.4	53.3	56.7	57.9	62.2	62.6
3-Apr	52.3	53.2	56.5	57.7	62.3	62.8
4-Apr	52.1	53.1	56.1	57.3	62.1	62.7
5-Apr	51.9	52.9	55.7	56.8	61.8	62.5
6-Apr	51.8	52.7	55.3	56.4	61.4	62.3
7-Apr	51.6	52.5	54.9	56.0	61.1	62.1
8-Apr	51.7	52.5	54.7	55.6	60.7	61.8
9-Apr	51.7	52.6	54.7	55.5	60.3	61.5
10-Apr	51.8	52.6	54.7	55.5	60.1	61.3
11-Apr	51.8	52.7	54.7	55.6	60.0	61.2
12-Apr	51.9	52.8	55.0	55.8	60.2	61.3
13-Apr	52.0	52.9	55.1	56.0	60.4	61.5
14-Apr	52.1	53.0	55.3	56.2	60.7	61.7
15-Apr	52.2	53.2	55.5	56.4	61.1	62.1
16-Apr	52.3	53.3	55.7	56.7	61.4	62.4
17-Apr	52.4	53.4	55.9	56.9	61.8	62.8
18-Apr	52.4	53.4	55.9	56.9	61.9	63.0
19-Apr	52.4	53.4	55.9	56.9	61.9	63.1
20-Apr	52.5	53.5	55.9	56.9	61.9	63.1
21-Apr	52.5	53.5	55.9	56.9	61.9	63.1
22-Apr	52.6	53.6	56.0	57.0	61.9	63.1
23-Apr	52.6	53.6	55.9	56.9	61.7	62.9
24-Apr	52.7	53.7	56.1	57.0	61.7	62.8
25-Apr	52.8	53.9	56.4	57.4	62.1	63.2
26-Apr	52.9	54.0	56.6	57.7	62.5	63.6
27-Apr	53.1	54.2	56.9	58.0	63.1	64.1
28-Apr	53.1	54.3	57.0	58.2	63.4	64.5
29-Apr	53.2	54.4	57.2	58.4	63.7	64.8
30-Apr	53.3	54.4	57.2	58.4	63.9	65.0

Table 6: Temperature Response – 7DADM
May-June, 2015

	BLW GOODWIN	KNIGHTS FERRY	ORANGE BLOSSOM	HYW 120 BRIDGE	RIPON GAGE	ABV SJR
	JULY15_BYPASS	JULY15_BYPASS	JULY15_BYPASS	JULY15_BYPASS	JULY15_BYPASS	JULY15_BYPASS
	7DADM	7DADM	7DADM	7DADM	7DADM	7DADM
	DEGF	DEGF	DEGF	DEGF	DEGF	DEGF
1-May	53.3	54.5	57.3	58.4	63.8	65.0
2-May	53.4	54.7	57.6	58.6	63.9	65.0
3-May	53.4	54.9	58.0	58.9	63.9	64.9
4-May	53.5	55.1	58.4	59.3	64.1	64.9
5-May	53.5	55.5	59.2	60.1	64.7	65.4
6-May	53.6	55.9	60.0	61.0	65.5	66.0
7-May	53.8	56.3	61.0	62.2	66.7	67.1
8-May	53.9	56.7	62.0	63.5	68.2	68.3
9-May	54.0	57.0	62.7	64.5	69.6	69.6
10-May	54.1	57.3	63.4	65.5	71.1	71.1
11-May	54.2	57.5	63.9	66.3	72.3	72.4
12-May	54.3	57.7	64.3	66.9	73.3	73.4
13-May	54.4	57.9	64.6	67.3	74.1	74.2
14-May	54.4	58.0	64.9	67.7	74.9	75.1
15-May	54.5	58.2	65.2	68.1	75.6	75.8
16-May	54.6	58.2	65.2	68.2	75.7	76.0
17-May	54.6	58.1	65.0	68.1	75.7	76.1
18-May	54.7	58.1	64.8	67.9	75.6	76.0
19-May	54.6	57.9	64.5	67.5	75.2	75.7
20-May	54.6	57.7	63.9	66.8	74.5	75.0
21-May	54.7	57.6	63.5	66.2	73.7	74.3
22-May	54.7	57.4	63.0	65.6	73.0	73.6
23-May	54.7	57.3	62.6	65.2	72.5	73.1
24-May	54.8	57.3	62.6	64.9	72.1	72.8
25-May	54.8	57.3	62.5	64.8	71.8	72.5
26-May	54.8	57.3	62.4	64.6	71.5	72.2
27-May	54.8	57.2	62.1	64.3	71.1	71.8
28-May	54.9	57.2	62.1	64.2	70.9	71.6
29-May	54.9	57.2	62.1	64.1	70.7	71.4
30-May	55.0	57.3	62.2	64.2	70.7	71.4
31-May	55.1	57.5	62.3	64.3	70.7	71.4
1-Jun	55.2	57.7	62.6	64.6	70.9	71.5
2-Jun	55.4	58.1	63.3	65.2	71.6	72.2
3-Jun	55.6	58.6	64.3	66.2	72.6	73.0
4-Jun	55.6	58.8	64.7	66.9	73.2	73.6
5-Jun	55.7	59.0	65.1	67.5	73.7	74.0
6-Jun	55.8	59.3	65.7	68.1	74.3	74.5
7-Jun	55.9	59.6	66.2	68.8	74.9	75.1
8-Jun	56.0	59.8	66.7	69.4	75.5	75.6
9-Jun	56.1	59.9	66.8	69.7	75.8	75.9
10-Jun	56.2	59.9	66.9	69.8	76.0	76.0
11-Jun	56.4	60.2	67.3	70.2	76.4	76.4
12-Jun	56.5	60.5	67.6	70.7	77.0	77.0
13-Jun	56.7	60.7	68.2	71.2	77.5	77.4
14-Jun	56.8	60.8	68.2	71.4	77.7	77.6
15-Jun	56.8	60.8	68.2	71.4	77.7	77.6
16-Jun	56.9	60.8	68.1	71.3	77.7	77.5
17-Jun	57.0	60.7	68.0	71.2	77.6	77.4
18-Jun	57.1	60.8	67.9	71.0	77.5	77.4
19-Jun	57.2	60.7	67.7	70.9	77.3	77.3
20-Jun	57.2	60.6	67.3	70.5	77.0	76.9
21-Jun	57.3	60.6	67.2	70.2	76.7	76.7
22-Jun	57.5	60.7	67.2	70.1	76.6	76.6
23-Jun	57.7	60.9	67.4	70.2	76.6	76.7
24-Jun	57.9	61.2	67.8	70.5	77.0	77.0
25-Jun	58.1	61.5	68.2	71.0	77.4	77.5
26-Jun	58.3	61.8	68.7	71.5	78.0	78.0
27-Jun	58.5	62.1	69.2	72.2	78.7	76.6
28-Jun	58.6	62.4	69.7	72.8	79.3	79.3
29-Jun	58.8	62.6	70.0	73.2	79.9	79.8
30-Jun	58.9	62.6	70.2	73.5	80.2	80.2

Table 7: Temperature Response – 7DADM
July-August, 2015

	BLW GOODWIN	KNIGHTS FERRY	ORANGE BLOSSOM	HYW 120 BRIDGE	RIPON GAGE	ABV SJR
	JULY15_BYPASS	JULY15_BYPASS	JULY15_BYPASS	JULY15_BYPASS	JULY15_BYPASS	JULY15_BYPASS
	7DADM	7DADM	7DADM	7DADM	7DADM	7DADM
	DEGF	DEGF	DEGF	DEGF	DEGF	DEGF
1-Jul	59.0	62.8	70.2	73.6	80.4	80.4
2-Jul	59.2	62.8	70.1	73.5	80.3	80.3
3-Jul	59.3	62.7	69.7	73.1	79.9	79.9
4-Jul	59.4	62.7	69.5	72.8	79.6	79.6
5-Jul	59.6	62.8	69.4	72.6	79.3	79.3
6-Jul	59.8	62.9	69.4	72.4	79.0	79.0
7-Jul	60.0	63.1	69.5	72.4	79.0	79.0
8-Jul	60.3	63.3	69.7	72.5	79.0	78.9
9-Jul	60.5	63.5	69.9	72.7	79.0	79.0
10-Jul	60.8	63.8	70.3	73.0	79.3	79.2
11-Jul	61.0	64.0	70.5	73.3	79.4	79.3
12-Jul	61.2	64.3	70.8	73.5	79.6	79.5
13-Jul	61.4	64.5	71.2	73.9	79.9	79.8
14-Jul	61.6	64.7	71.3	74.1	80.0	79.8
15-Jul	61.8	64.9	71.6	74.4	80.3	80.1
16-Jul	62.0	65.0	71.7	74.5	80.4	80.3
17-Jul	62.1	65.1	71.6	74.5	80.4	80.3
18-Jul	62.3	65.2	71.5	74.4	80.4	80.2
19-Jul	62.4	65.2	71.4	74.2	80.2	80.1
20-Jul	62.6	65.1	71.1	73.9	80.0	79.9
21-Jul	62.8	65.2	70.9	73.6	79.7	79.6
22-Jul	63.0	65.1	70.7	73.2	79.3	79.2
23-Jul	63.2	65.2	70.4	72.9	78.8	78.8
24-Jul	63.4	65.3	70.5	72.7	78.6	78.6
25-Jul	63.7	65.5	70.5	72.7	76.5	78.5
26-Jul	63.9	65.7	70.6	72.7	78.4	78.3
27-Jul	64.2	65.8	70.7	72.7	78.3	78.2
26-Jul	64.4	66.1	70.9	72.8	78.3	78.2
29-Jul	64.7	66.3	71.0	72.9	78.3	78.2
30-Jul	64.9	66.5	71.2	73.1	78.3	78.2
31-Jul	65.2	66.7	71.4	73.2	78.4	78.3
1-Aug	65.4	67.0	71.7	73.4	78.6	78.5
2-Aug	65.6	67.3	72.0	73.8	78.9	78.8
3-Aug	65.8	67.6	72.4	74.2	79.2	79.2
4-Aug	65.9	67.7	72.4	74.3	79.3	79.2
5-Aug	66.0	67.6	72.5	74.4	79.4	79.3
6-Aug	66.1	68.0	72.8	74.7	79.6	79.6
7-Aug	66.1	68.1	72.6	74.7	79.6	79.6
8-Aug	66.1	68.0	72.8	74.7	79.6	79.5
9-Aug	66.0	68.0	72.7	74.6	79.5	79.4
10-Aug	65.9	67.8	72.4	74.3	79.1	79.0
11-Aug	65.9	67.9	72.5	74.2	79.1	78.9
12-Aug	65.7	67.8	72.4	74.1	78.9	78.7
13-Aug	65.3	67.5	72.0	73.8	78.5	78.4
14-Aug	64.7	67.2	71.8	73.5	78.2	78.1
15-Aug	63.9	66.8	71.5	73.2	77.9	77.7
16-Aug	63.1	66.4	71.3	73.0	77.7	77.6
17-Aug	62.3	66.0	71.2	72.9	77.6	77.5
18-Aug	61.5	65.5	70.9	72.7	77.5	77.4
19-Aug	60.7	64.9	70.6	72.6	77.4	77.3
20-Aug	60.2	64.4	70.3	72.4	77.3	77.2
21-Aug	59.9	63.9	70.0	72.2	77.2	77.1
22-Aug	59.8	63.5	69.6	71.9	77.1	77.0
23-Aug	59.7	63.1	69.2	71.5	76.8	76.7
24-Aug	59.7	62.8	68.8	71.2	76.5	76.5
25-Aug	59.7	62.6	68.4	70.8	76.4	76.4
26-Aug	59.8	62.5	68.3	70.6	76.3	76.3
27-Aug	59.8	62.5	68.2	70.6	76.4	76.4
28-Aug	59.9	62.6	68.3	70.6	76.6	76.7
29-Aug	60.0	62.7	68.4	70.7	76.9	77.0
30-Aug	60.1	62.8	68.6	71.0	77.2	77.3
31-Aug	60.3	62.9	68.7	71.1	77.4	77.6

Table 8: Temperature Response – 7DADM
September-October, 2015

	BLW GOODWIN	KNIGHTS FERRY	ORANGE BLOSSOM	HYW 120 BRIDGE	RIPON GAGE	ABV SJR
	JULY15_BYPASS	JULY15_BYPASS	JULY15_BYPASS	JULY15_BYPASS	JULY15_BYPASS	JULY15_BYPASS
	7DADM	7DADM	7DADM	7DADM	7DADM	7DADM
	DEGF	DEGF	DEGF	DEGF	DEGF	DEGF
1-Sep	60.5	63.1	69.0	71.4	77.7	77.9
2-Sep	60.7	63.3	69.1	71.6	78.0	78.2
3-Sep	61.0	63.5	69.4	71.9	78.3	78.5
4-Sep	61.2	63.6	69.5	72.0	78.3	78.5
5-Sep	61.4	63.6	69.3	71.8	78.0	78.2
6-Sep	61.5	63.5	68.9	71.4	77.5	77.7
7-Sep	61.7	63.5	68.6	71.0	77.1	77.3
8-Sep	61.7	63.4	68.3	70.5	76 6	76.9
9-Sep	61.8	63.4	66.0	70.1	76.2	76.4
10-Sep	61.8	63.3	67.5	69.5	75.5	75.8
11-Sep	61.9	63.2	67.1	69.0	74.8	75.2
12-Sep	62.0	63.2	66.8	68.6	74.3	74.6
13-Sep	62.2	63.3	66.8	68.4	73.9	74.4
14-Sep	62.3	63.3	66.5	68.0	73.4	73.8
15-Sep	62.4	63.3	66.3	67.7	72.8	73.3
16-Sep	62.5	63.2	66.1	67.4	72.3	72.7
17-Sep	62.7	63.3	66.0	67.2	71.9	72.3
18-Sep	62.8	63.4	66.0	67.0	71.5	71.9
19-Sep	63.0	63.5	66.1	67.0	71.4	71.7
20-Sep	63.1	63.7	66.2	67.1	71.3	71.6
21-Sep	63.4	64.0	66.6	67.4	71.6	71.9
22-Sep	63.6	64.3	67.0	67.8	71.9	72.1
23-Sep	63.7	64.5	67.3	68.2	72.1	72.3
24-Sep	63.9	64.7	67.5	68.4	72.3	72.5
25-Sep	64.0	64.8	67.6	68.6	72.4	72.5
26-Sep	64.2	64.9	67.6	68.6	72.5	72.5
27-Sep	64.3	65.0	67.7	68.7	72.5	72.5
28-Sep	64.4	65.0	67.6	68.6	72.3	72.3
29-Sep	64.6	65.1	67.5	68.4	72.2	72.2
30-Sep	64.8	65.2	67.6	68.4	72.2	72.2
1-Oct	65.1	65.4	67.7	68.5	72.3	72.3
2-Oct	65.5	65.6	67.8	68.5	72.4	72.5
3-Oct	65.8	65.8	67.8	68.4	72.4	72.6
4-Oct	66.1	66.1	67.9	68.4	72.3	72.6
5-Oct	66.4	66.3	67.9	68.5	72.2	72.7
6-Oct	66.6	66.4	67.9	68.4	72.1	72.6
7-Oct	66.7	66.4	67.6	68.1	71.6	72.1
8-Oct	66.7	66.4	67.5	67.8	70.9	71.6
9-Oct	66.6	66.4	67.3	67.5	70.2	70.9
10-Oct	66.6	66.3	67.3	67.4	69.7	70.3
11-Oct	66.5	66.3	67.1	67.1	69.1	69.6
12-Oct	66.4	66.2	66.9	66.9	68.6	68.9
13-Oct	66.3	66.1	66.7	66.6	68.0	68.3
14-Oct	66.4	66.1	66.7	66.6	67.7	67.9
15-Oct	66.4	66.1	66.6	66.5	67.5	67.6
16-Oct	66.4	66.1	66.7	66.5	67.4	67.4
17-Oct	66.4	66.1	66.7	66.5	67.3	67.3
18-Oct	66.3	66.1	66.7	66.5	67.3	67.2
19-Oct	66.3	66.1	66.6	66.5	67.3	67.2
20-Oct	66.1	65.9	66.5	66.4	67.2	67.0
21-Oct	66.0	65.8	66.3	66.2	67.0	66.9
22-Oct	65.8	65.5	65.9	65.8	66.6	66.5
23-Oct	65.6	65.3	65.7	65.5	66.3	66.2
24-Oct	65.4	65.2	65.5	65.3	66.0	65.9
25-Oct	65.3	65.0	65.3	65.1	65.8	65.6
26-Oct	65.0	64.7	65.0	64.9	65.6	65.4
27-Oct	64.8	64.6	64.9	64.7	65.4	65.2
28-Oct	64.6	64.4	64.7	64.5	65.2	65.0
29-Oct	64.3	64.2	64.5	64.4	65.1	65.0
30-Oct	64.1	64.0	64.3	64.2	65.0	64.9
31-Oct	63.8	63.7	64.0	63.9	64.7	64.6

6. Projected Energy Loss Due to Bypass Operation

A simplified hydropower calculation was performed to estimate the energy loss due to the bypass operation. The no-bypass case was compared with the July 15 bypass case, as follows:

	No Bypass	July 15 Bypass	Energy Loss
	MWh	MWh	MWh
Jan			
Feb			
Mar	16,497	16,497	0
Apr	31,130	31,130	0
May	27,797	27,797	0
Jun	24,097	24,097	0
Jul	23,811	21,969	(1,842)
Aug	5,625	3,419	(2,206)
Sep	0	0	0
Oct	0	0	0
Nov	0	0	0
Dec	0	0	0
Total	128,958	124,910	(4,048)

Figure 13: Projected Energy Loss Due to Bypass Operation

Figure 13 shows that the energy loss during the bypass period, July 15 through August 11, 2015, will be in the order of 4,048 MWh. Based on PG&E SRAC (Short-Term Avoided Cost) for qualifying facilities, the cost per KWh in July and August of 2014 was approximately 5 cents. If we use the same price rate for this year, the loss of energy could amount to $202,381.

ATTACHMENT 2

Fall-run Chinook salmon redd distribution and water temperatures in the Stanislaus River during 2009-2014.

Spatial distribution of fall-run Chinook salmon redds on the Stanislaus River

Methods

Annual redd surveys on the Stanislaus River have been conducted since 2007 to estimate the spawning distribution of fall-run Chinook salmon. In general, the entire spawning area is surveyed every other week (occasionally more frequently) to document the number of new redds. The results below represent preliminary data analyses to describe the relationship of redd deposition (a proxy for spawning activity) throughout the reproductive season (time) and by river location (river mile [RM]; space). For these particular analyses, six seasons of distribution data was used. Daily water temperatures throughout the Stanislaus River have been monitored concurrently, allowing an assessment of spawning distribution in relation to daily water temperatures. Water temperature recorders were located at seven stations, Goodwin Dam, Knights Ferry, Lover's Leap Restoration Area, Honolulu Bar, Orange Blossom Bridge, Oakdale, and at the Stanislaus River Weir.

We used a combination of graphical analyses and linear regression analyses to describe the spawning distributions of Chinook salmon from 2009 to 2014. For each season, the median location and downstream-most location of redds was summarized for each survey week. Water temperatures were often negatively related to the location of the water temperature logger (i.e. more upstream locations had cooler water temperatures with a predictable increase with increased distance downstream). However, this relationship occasionally did not remain constant or predictable throughout the spawning season. Therefore, we interpolated daily maximum water temperatures at the seven stations over the spawning season.

Results

As illustrated in Figure 1, spawning distribution was limited early in the season (i.e., redds only observed in the upper few river miles), but expanded to lower reaches as the spawning season progressed. Median locations of redd distribution decreased (in river mile [RM]) over the first five surveys during each year (Figure 1). During the late-September and early October, median locations were located near the upper end of Goodwin Canyon. However, by late October, median locations were typically centered around RM 54 (around Knights Ferry). Similarly, the downstream-most redd locations decreased in river mile over the first five surveys of each season. The decrease was more drastic than the decrease in median locations. New redds were typically observed as low as RM 32 (Riverbank) until early December. Results from linear regression analyses indicated statistically significant relationships between median locations and date (slope = -0.63; $P < 0.001$) *and* between downstream-most locations (slope = -2.64; $P \ll 0.001$; Figure 1).

Figures 2 through 7 each represent the interpolated daily maximum water temperatures at each station. The interpolations provide a general pattern in water temperatures across both time and space. The addition of the redd distributions show the timing and locations of spawning activity in relation to the water temperature regime during and prior each survey week. Overall daily maximum water temperatures were coolest during the 2011 spawning season (Figure 4) and were the warmest during 2014 (Figure 7). Spawning activity (i.e., new redds were observed) occurred from the 48 - 50°F range (late December 2011; Figure 4) to as high as 62 – 64°F range (mid October 2014; Figure 7). Most spawning activity during the other four seasons occurred between temperature ranges between 52°F and 56°F.

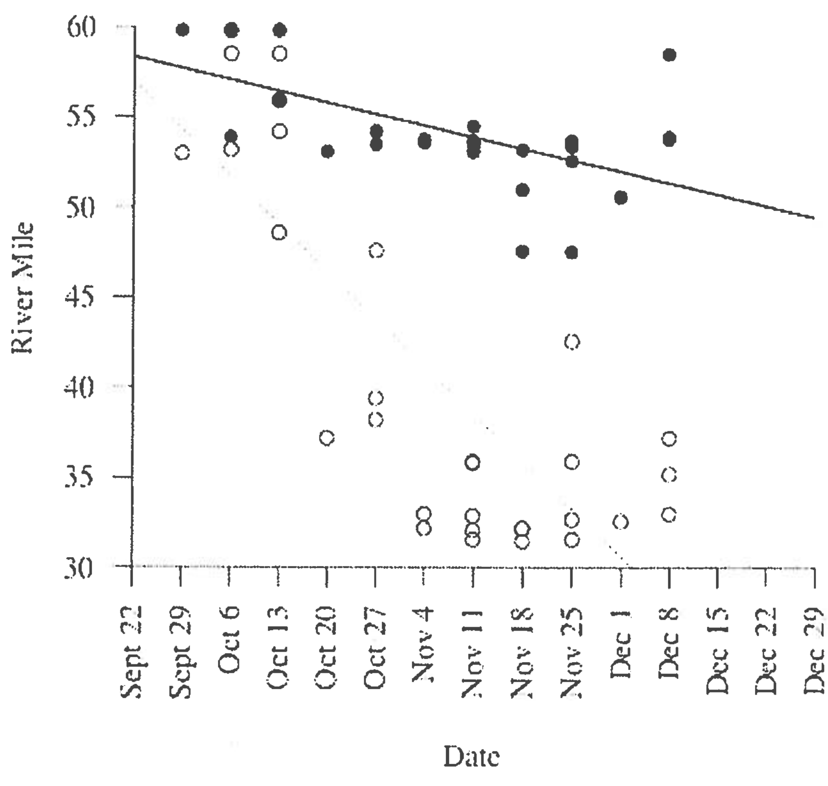


Figure 1. Relationship between median locations of Chinook redds (filled circles) and downstream-most locations (open circles) and date. Solid black line represents the best-fit line for the linear relationship between date and median locations (slope = -0.63; P < 0.001). Dotted line represents the best-fit line for the linear relationship between date and downstream-most locations (slope = -2.64; P << 0.001). For reference, Goodwin Dam is located at RM 60.

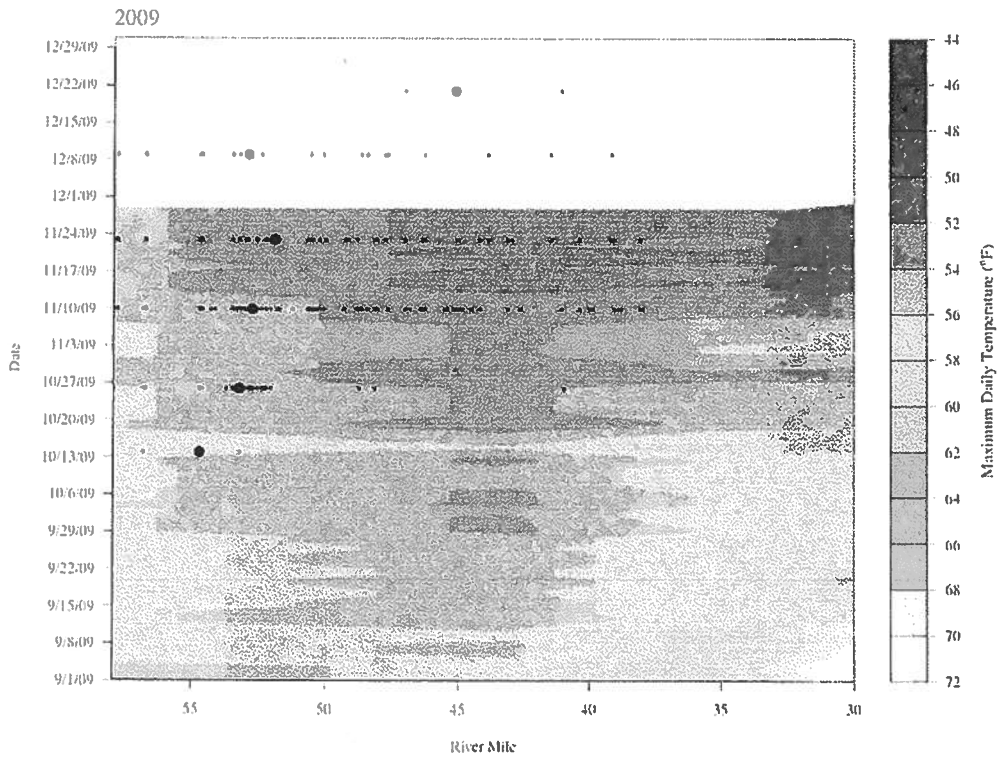


Figure 2. Interpolated daily maximum water temperatures from the Stanislaus River over the spawning season. Overall spatial distribution (small grey) and median location (larger filled circles) of observed Chinook salmon redds on the Stanislaus River by week during fall/winter 2009. Water year type in 2009 was below normal (BN). White areas on the graph indicate missing data or water temperatures outside the range of temperatures used.

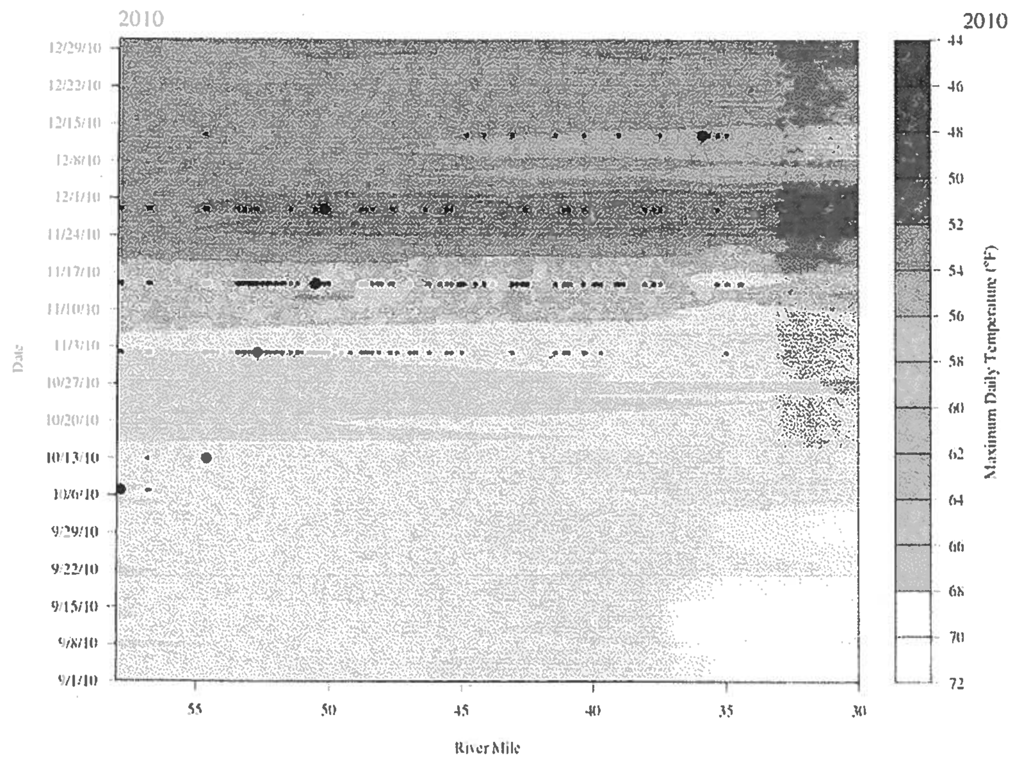


Figure 3. Interpolated daily maximum water temperatures from the Stanislaus River over the spawning season. Overall spatial distribution (small grey) and median location (larger filled circles) of observed Chinook salmon redds on the Stanislaus River by week during fall/winter 2010. Water year type in 2010 was above normal (AN). White areas on the graph indicate missing data or water temperatures outside the range of temperatures used.

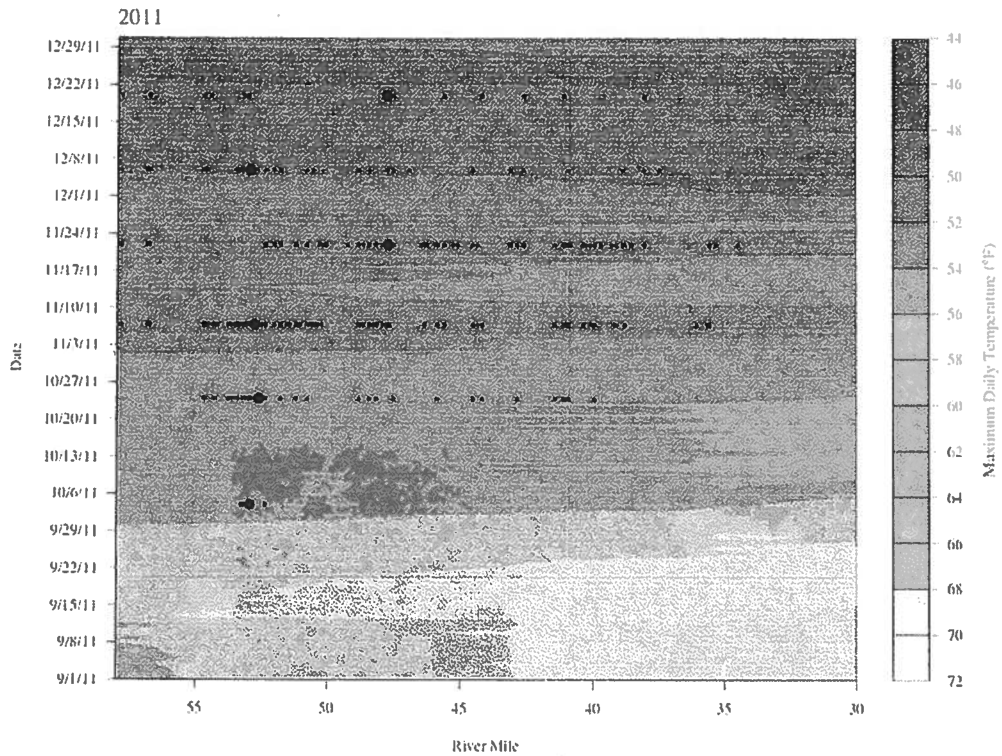


Figure 4. Interpolated daily maximum water temperatures from the Stanislaus River over the spawning season. Overall spatial distribution (small grey) and median location (larger filled circles) of observed Chinook salmon redds on the Stanislaus River by week during fall/winter 2011. Water year type in 2011 was wet (W). White areas on the graph indicate missing data or water temperatures outside the range of temperatures used.

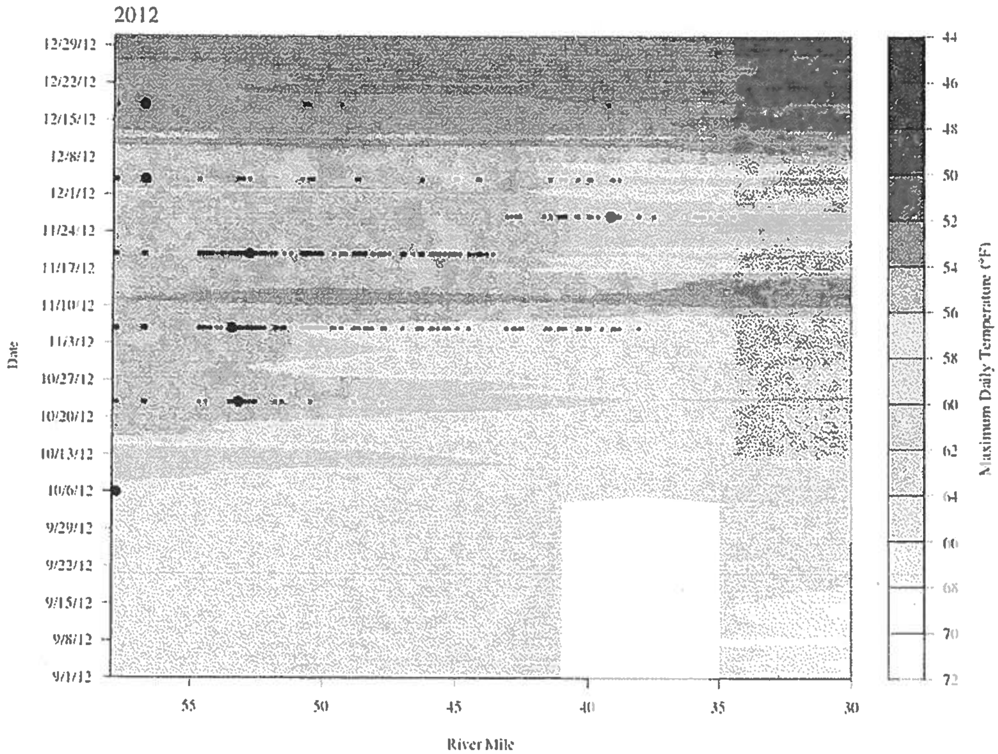


Figure 5. Interpolated daily maximum water temperatures from the Stanislaus River over the spawning season. Overall spatial distribution (small grey) and median location (larger filled circles) of observed Chinook salmon redds on the Stanislaus River by week during fall/winter 2012. Water year type in 2012 was dry (D). White areas on the graph indicate missing data or water temperatures outside the range of temperatures used.

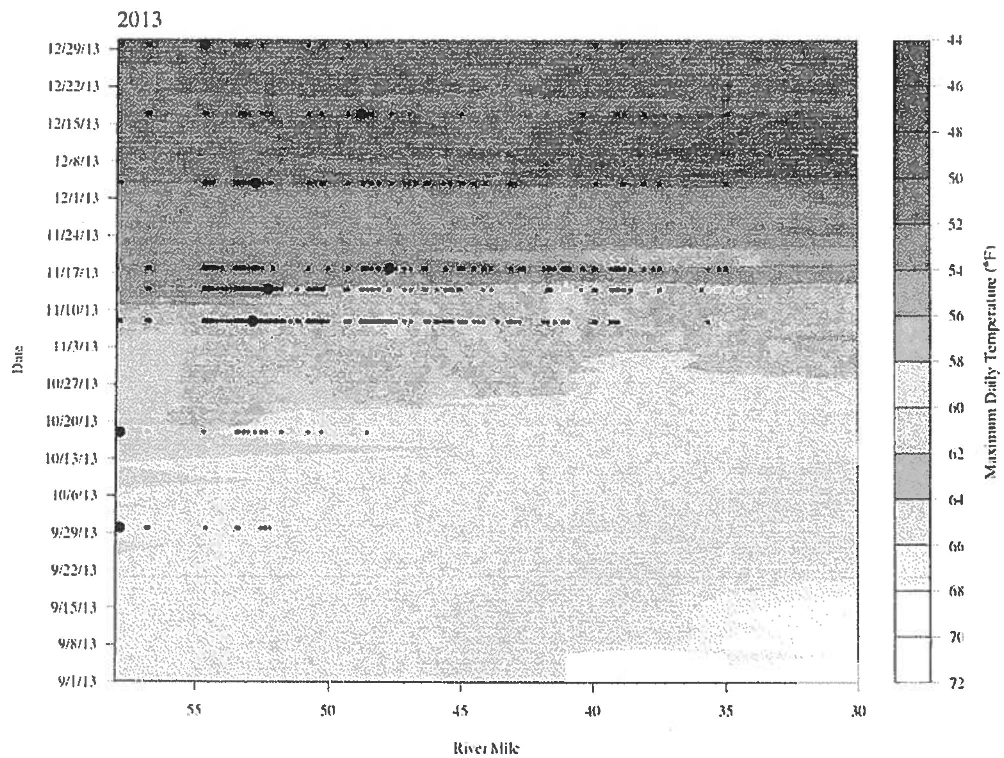


Figure 6. Interpolated daily maximum water temperatures from the Stanislaus River over the spawning season. Overall spatial distribution (small grey) and median location (larger filled circles) of observed Chinook salmon redds on the Stanislaus River by week during fall/winter 2013. Water year type in 2013 was critically dry (CD). White areas on the graph indicate missing data or water temperatures outside the range of temperatures used.

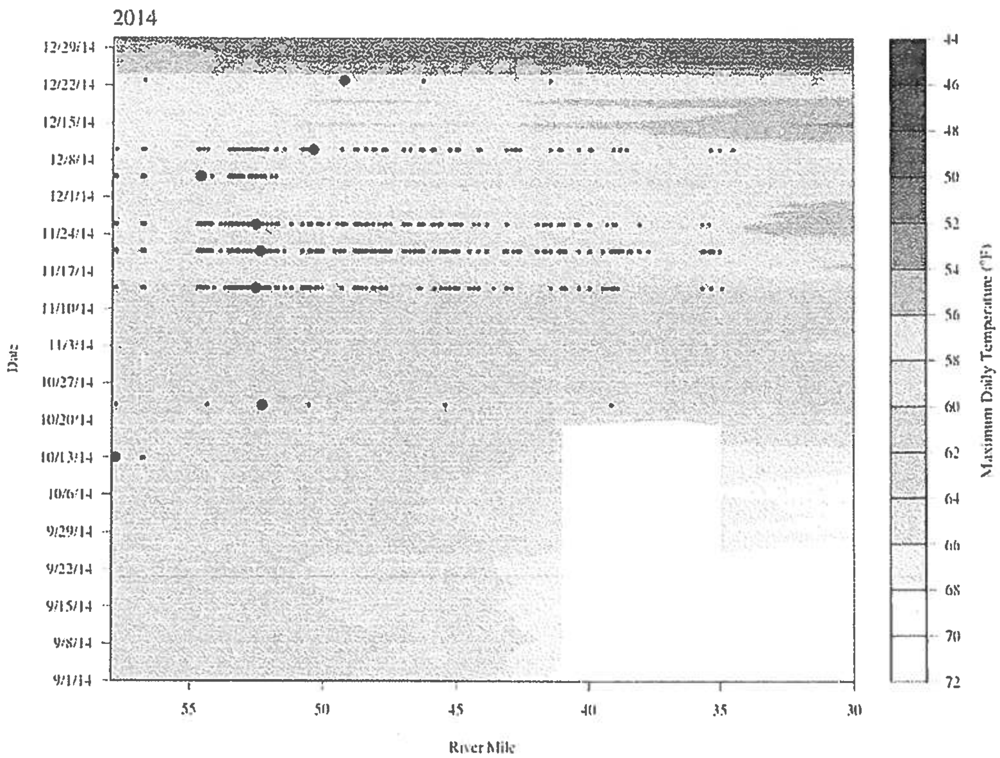
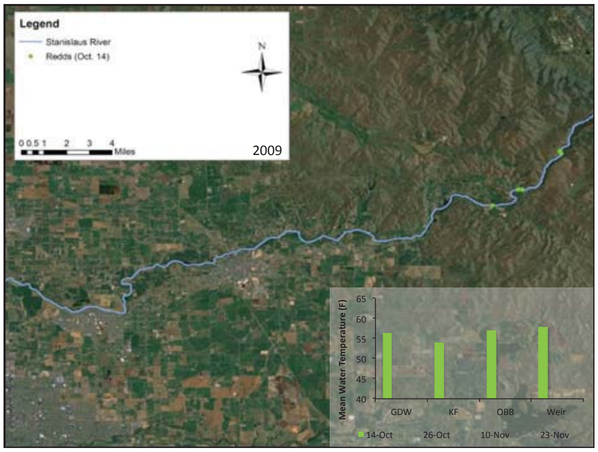
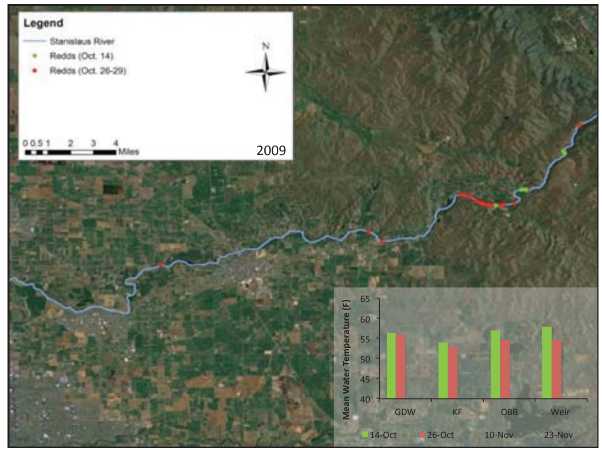
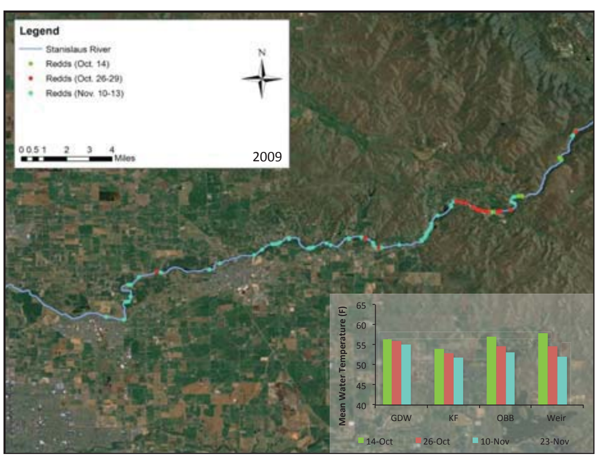
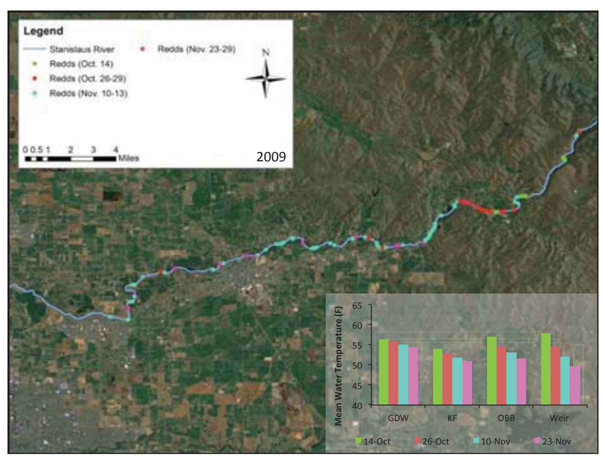


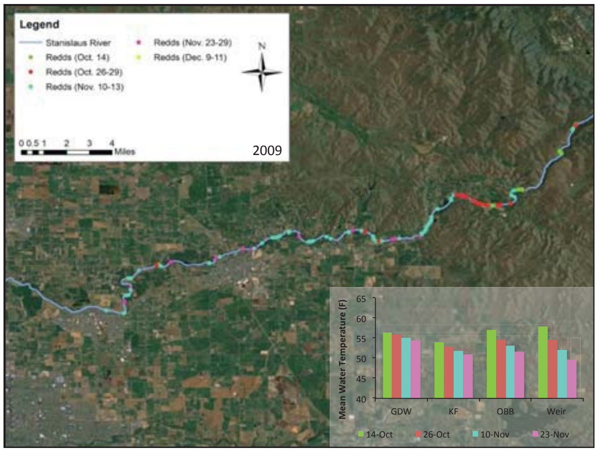
Figure 7. Interpolated daily maximum water temperatures from the Stanislaus River over the spawning season. Overall spatial distribution (small grey) and median location (larger filled circles) of observed Chinook salmon redds on the Stanislaus River by week during fall/winter 2014. Water year type in 2014 was critically dry (CD). White areas on the graph indicate missing data or water temperatures outside the range of temperatures used.

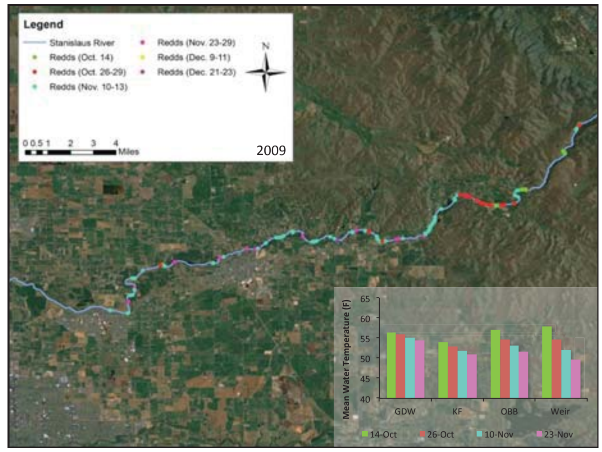

Legend
Stanislaus River
Redds (Oct. 14)
N
0 0.5 1 2 3 4 Miles
2009
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
14-Oct
26-Oct
10-Nov
23-Nov

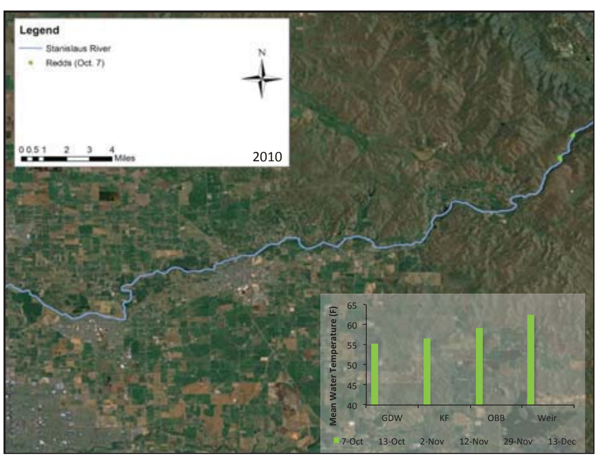

Legend
Stanislaus River
Redds (Oct. 14)
Redds (Oct. 26-29)
N
0 0.5 1 2 3 4 Miles
2009
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
14-Oct
26-Oct
10-Nov
23-Nov

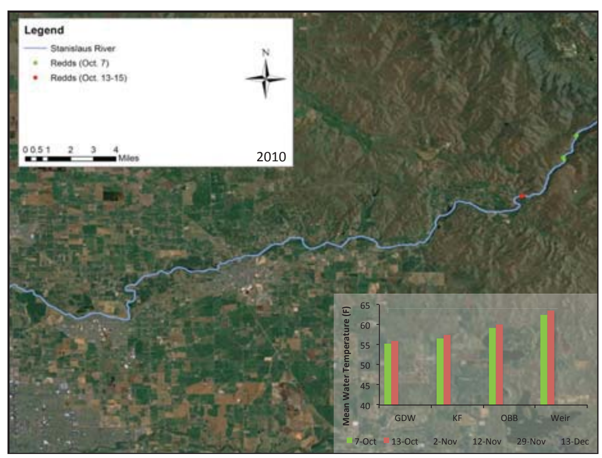

Legend
Stanislaus River
Redds (Oct. 14)
Redds (Oct. 26-29)
Redds (Nov. 10-13)
N
0 0.5 1 2 3 4 Miles
2009
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
14-Oct
26-Oct
10-Nov
23-Nov

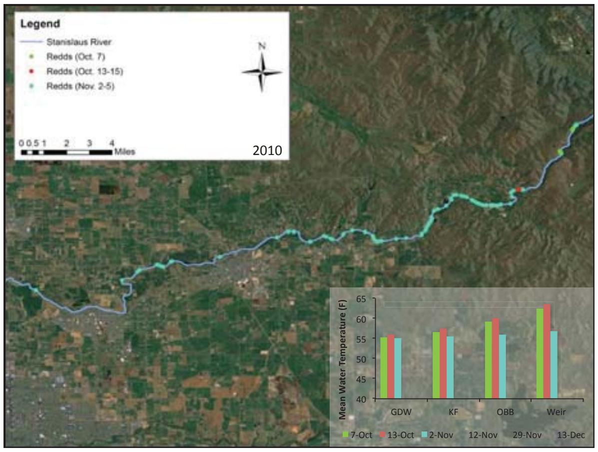

Legend
Stanislaus River
Redds (Nov. 23-29)
Redds (Oct. 14)
Redds (Oct. 26-29)
Redds (Nov. 10-13)
N
0 0.5 1 2 3 4 Miles
2009
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
14-Oct
26-Oct
10-Nov
23-Nov

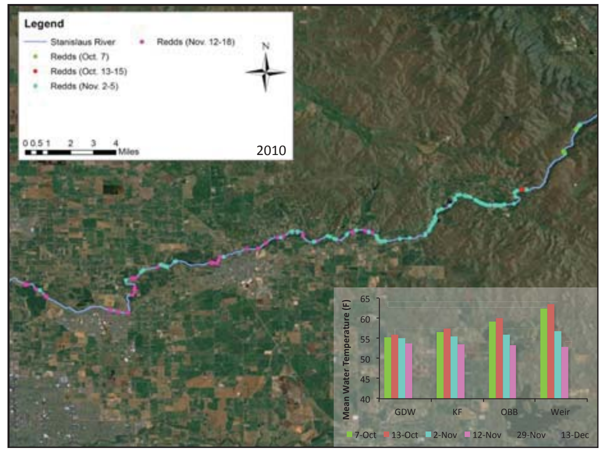

Legend
Stanislaus River
Redds (Oct. 14)
Redds (Oct. 26-29)
Redds (Nov. 10-13)
Redds (Nov. 23-29)
Redds (Dec. 9-11)
N
0 0.5 1 2 3 4 Miles
2009
Mean Water Temperature (F)
65 60 55 50 45 40
GDW KF OBB Weir
14-Oct 26-Oct 10-Nov 23-Nov

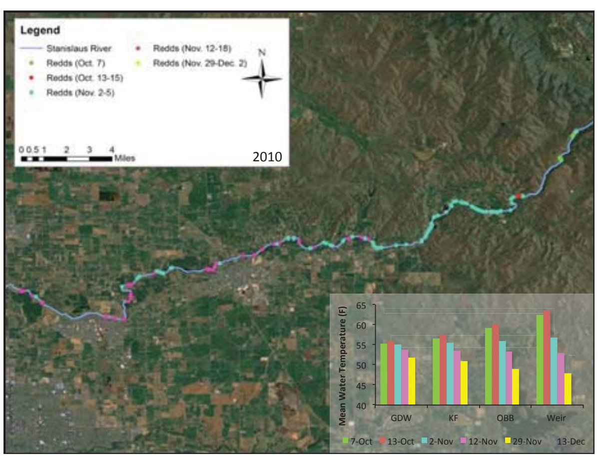

Legend
Stanislaus River
Redds (Oct. 14)
Redds (Oct. 26-29)
Redds (Nov. 10-13)
Redds (Nov. 23-29)
Redds (Dec. 9-11)
Redds (Dec. 21-23)
N
0 0.5 1 2 3 4 Miles
2009
Mean Water Temperature (F)
65 60 55 50 45 40
GDW KF OBB Weir
14-Oct 26-Oct 10-Nov 23-Nov

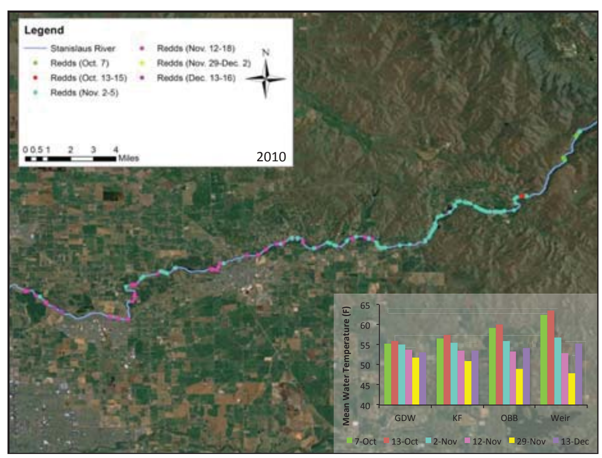

Legend
Stanislaus River
Redds (Oct. 7)
N
0 0.5 1 2 3 4 Miles
2010
Mean Water Temperature (F)
65 60 55 50 45 40
GDW KF OBB Weir
7-Oct 13-Oct 2-Nov 12-Nov 29-Nov 13-Dec

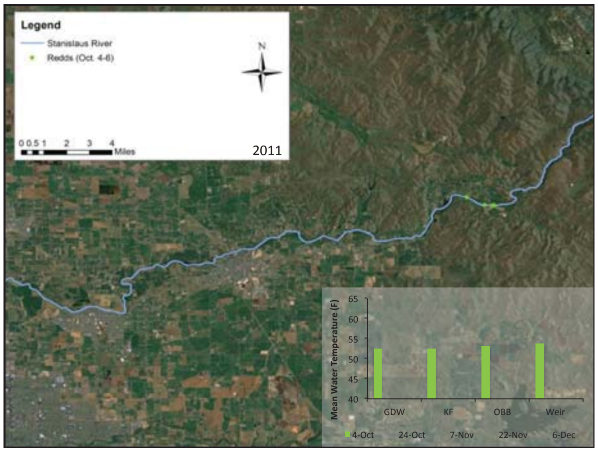

Legend
Stanislaus River
Redds (Oct. 7)
Redds (Oct. 13-15)
N
0 0.5 1 2 3 4 Miles
2010
Mean Water Temperature (F)
65 60 55 50 45 40
GDW KF OBB Weir
7-Oct 13-Oct 2-Nov 12-Nov 29-Nov 13-Dec


Legend
Stanislaus River
Redds (Oct. 7)
Redds (Oct. 13-15)
Redds (Nov. 2-5)
N
0 0.5 1 2 3 4 Miles
2010
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
7-Oct
13-Oct
2-Nov
12-Nov
29-Nov
13-Dec


Legend
Stanislaus River
Redds (Oct. 7)
Redds (Oct. 13-15)
Redds (Nov. 2-5)
Redds (Nov. 12-18)
N
0 0.5 1 2 3 4 Miles
2010
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
7-Oct
13-Oct
2-Nov
12-Nov
29-Nov
13-Dec


Legend
Stanislaus River
Redds (Oct. 7)
Redds (Oct. 13-15)
Redds (Nov. 2-5)
Redds (Nov. 12-18)
Redds (Nov. 29-Dec. 2)
N
0 0.5 1 2 3 4 Miles
2010
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
7-Oct
13-Oct
2-Nov
12-Nov
29-Nov
13-Dec


Legend
Stanislaus River
Redds (Oct. 7)
Redds (Oct. 13-15)
Redds (Nov. 2-5)
Redds (Nov. 12-18)
Redds (Nov. 29-Dec. 2)
Redds (Dec. 13-16)
N
0 0.5 1 2 3 4 Miles
2010
Mean Water Temperature (F)
65
60
55
50
45
40
GDW
KF
OBB
Weir
7-Oct
13-Oct
2-Nov
12-Nov
29-Nov
13-Dec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Redds (Oct. 4-6)
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Mean Water Temperature (F)
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4-Oct
24-Oct
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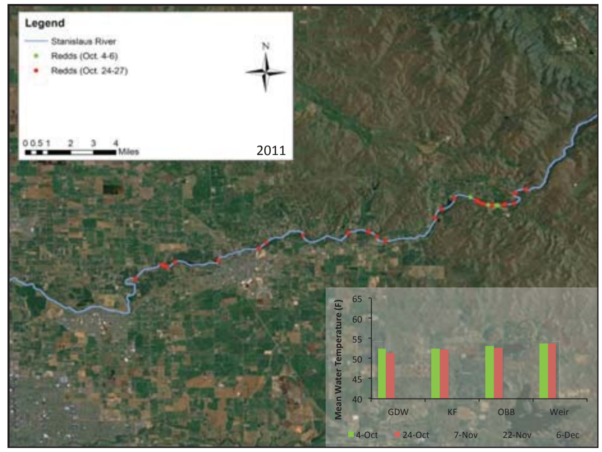
6-Dec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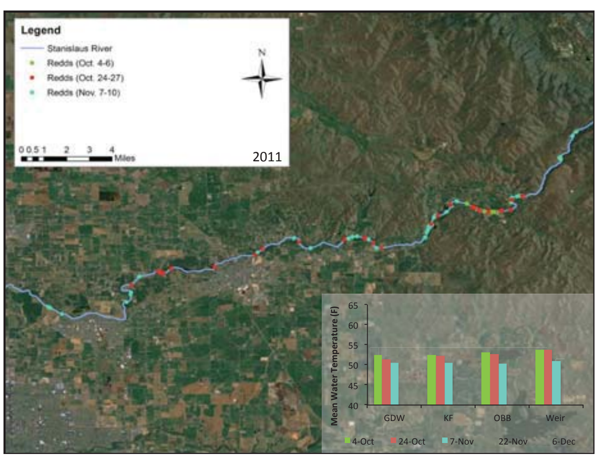
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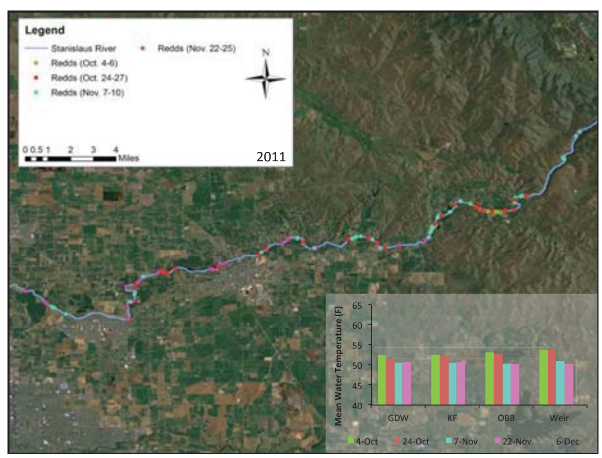
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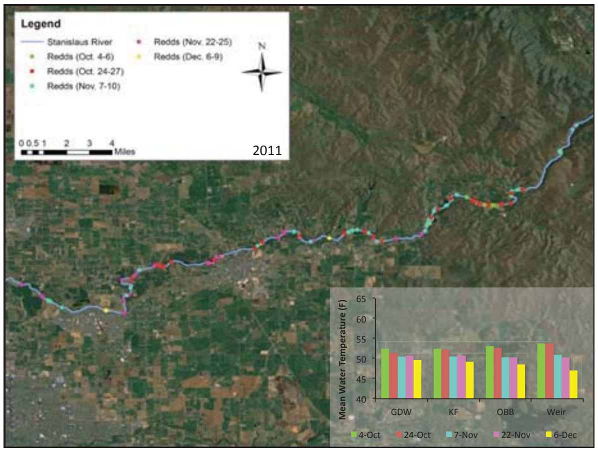
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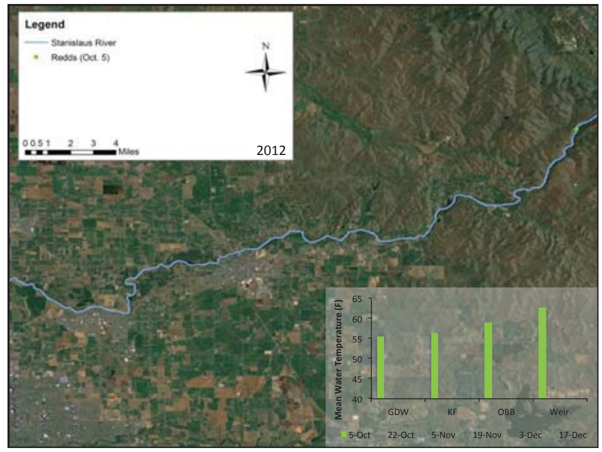
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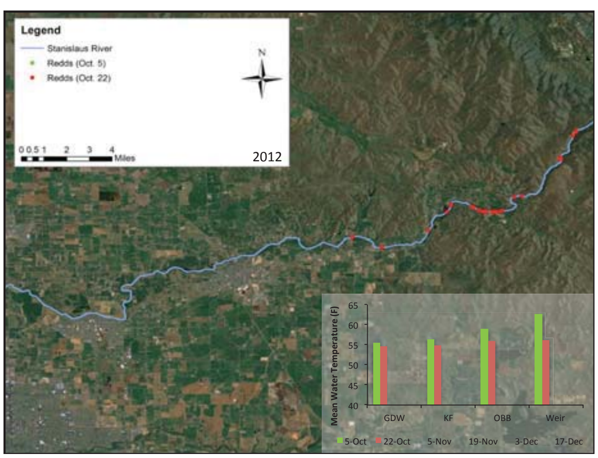
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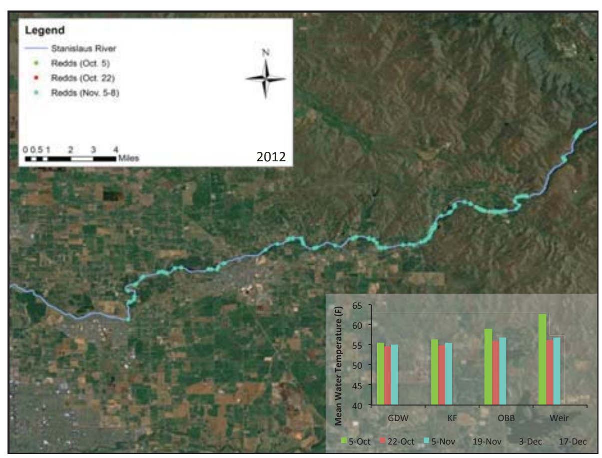
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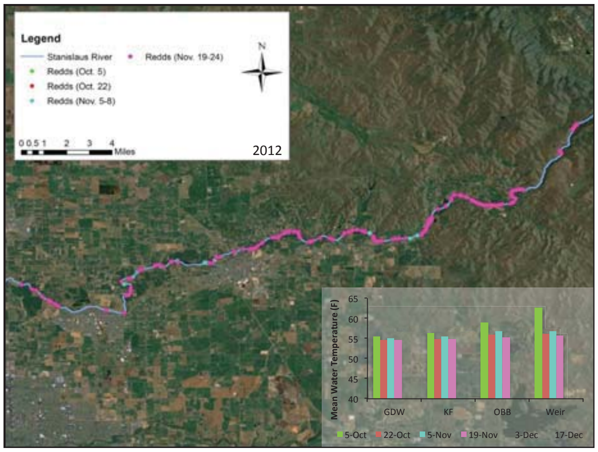
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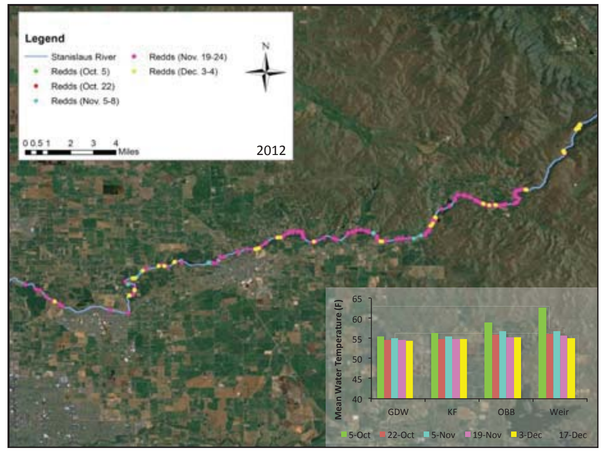
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Mean Water Temperature (F)
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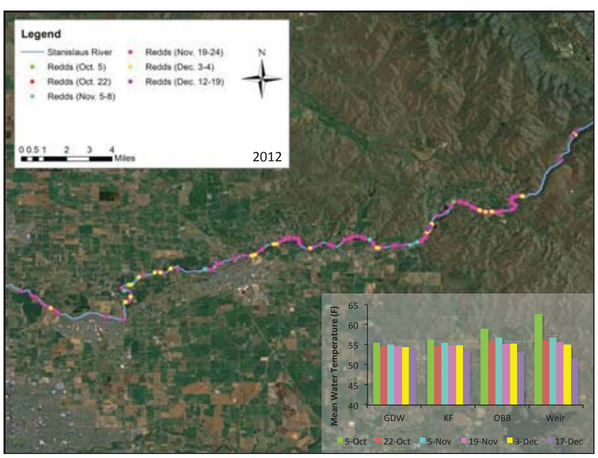
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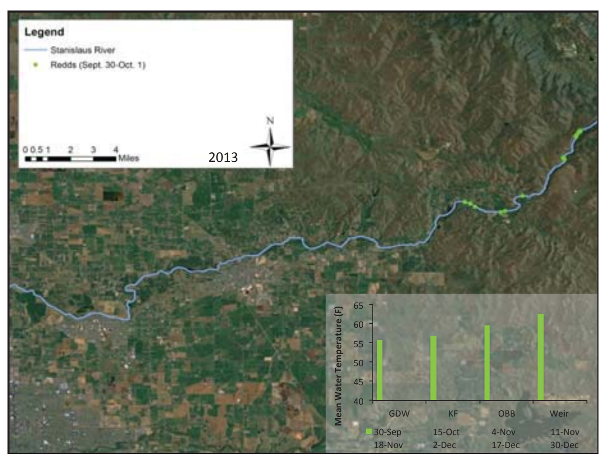
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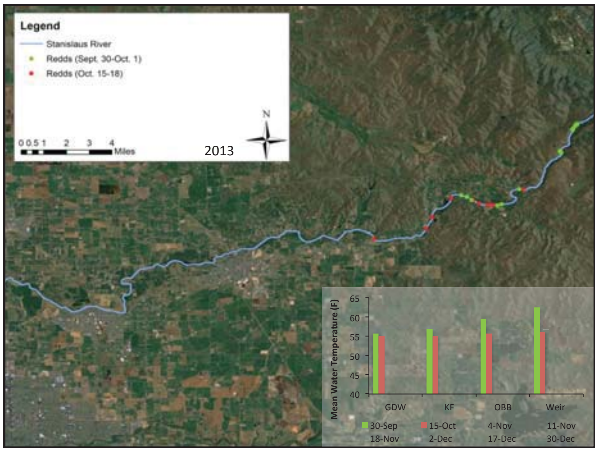
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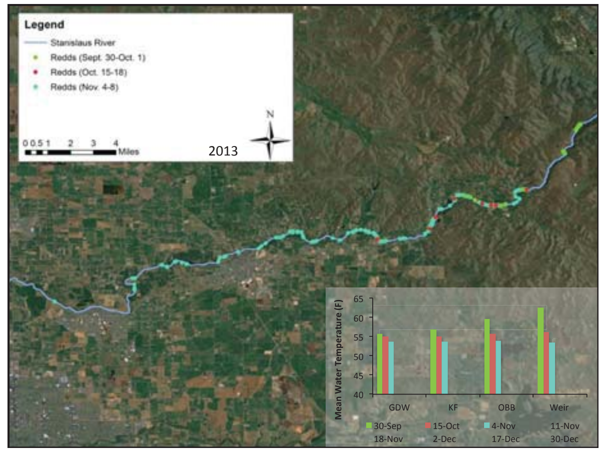
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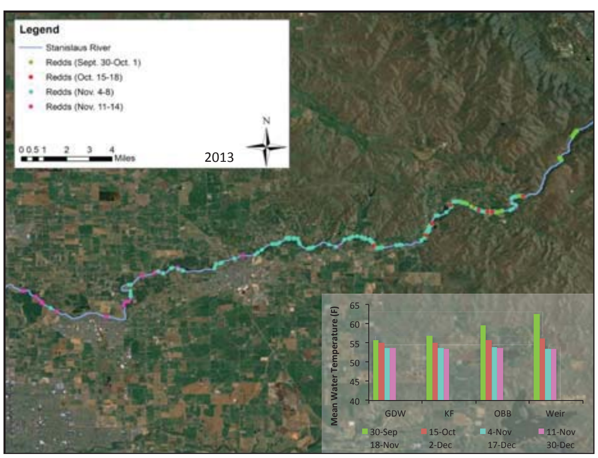
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2013
Mean Water Temperature (F)
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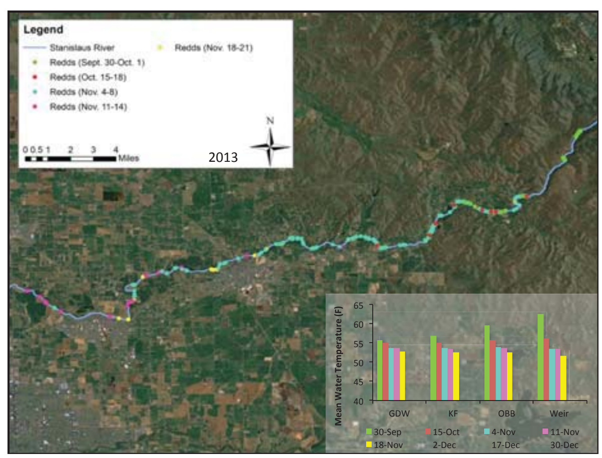
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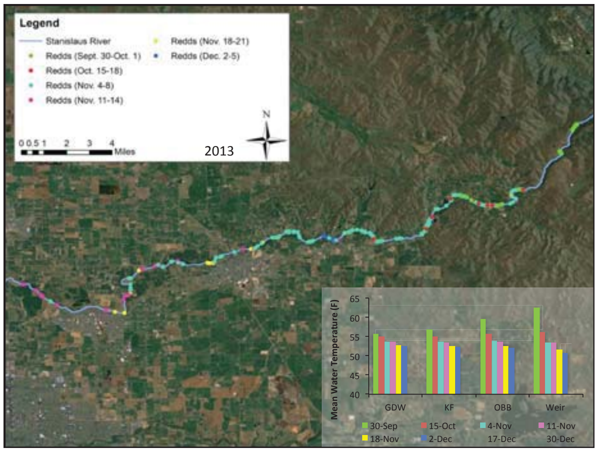
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Redds (Dec. 2-5)
Miles
2013
N
Mean Water Temperature (F)
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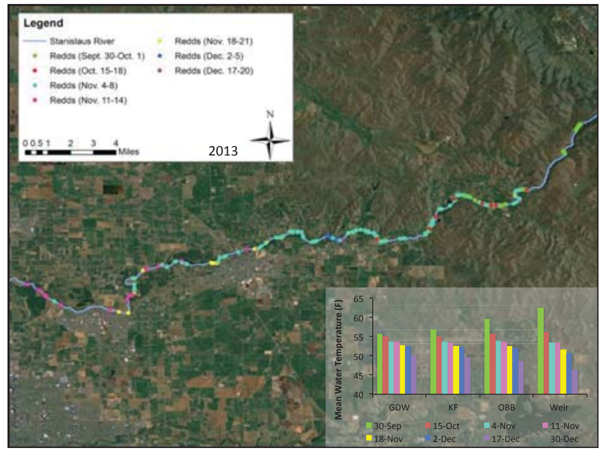
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Redds (Dec. 2-5)
Redds (Dec. 17-20)
Miles
2013
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Mean Water Temperature (F)
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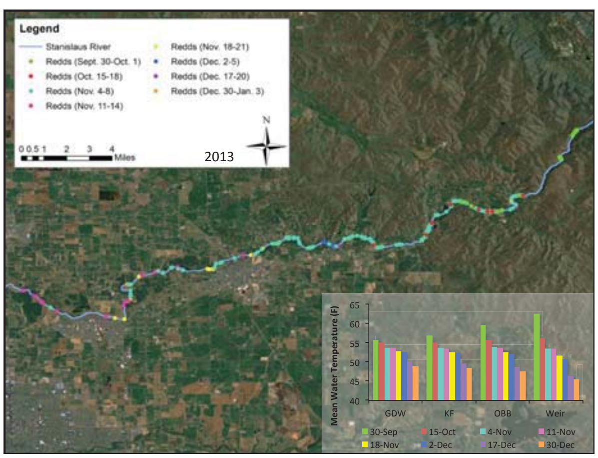
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Redds (Dec. 17-20)
Redds (Dec. 30-Jan. 3)
Miles
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Mean Water Temperature (F)
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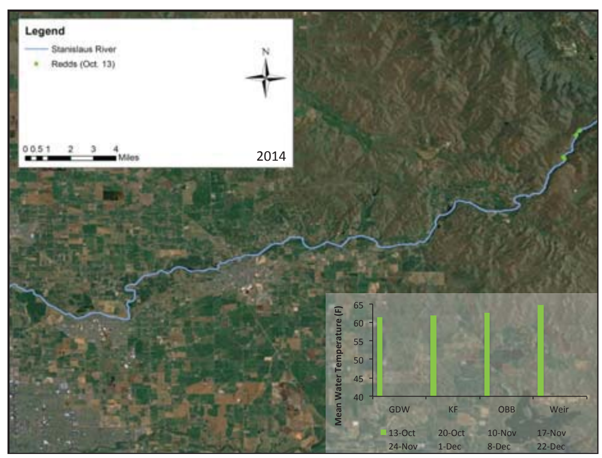
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Miles
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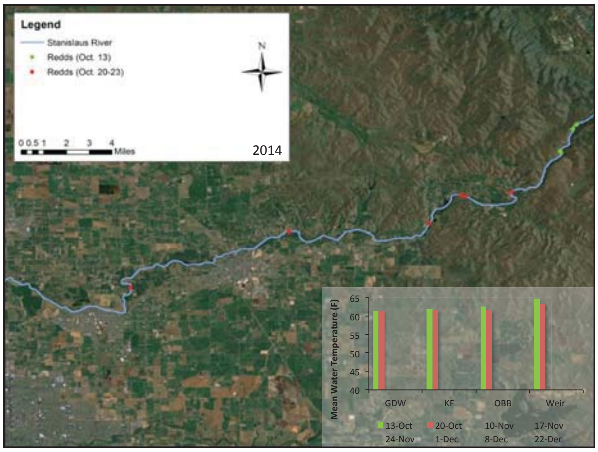
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2014
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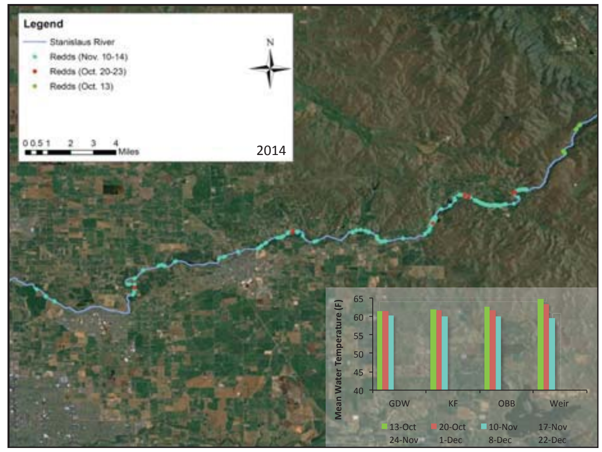
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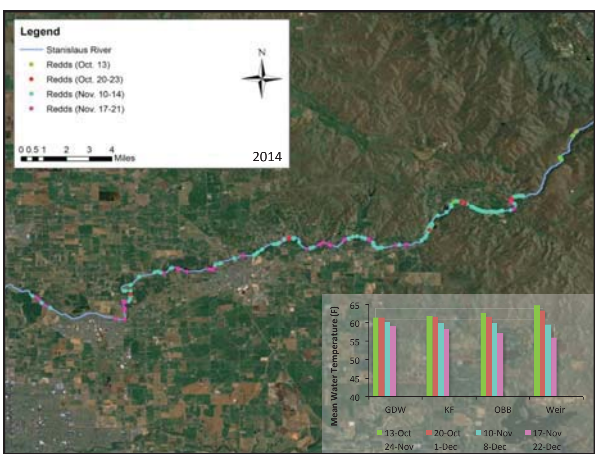
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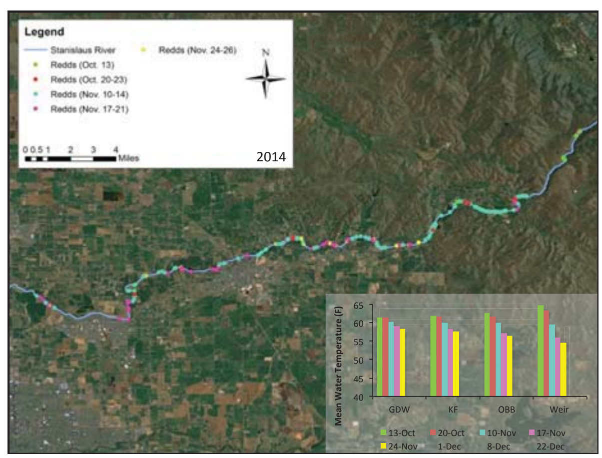
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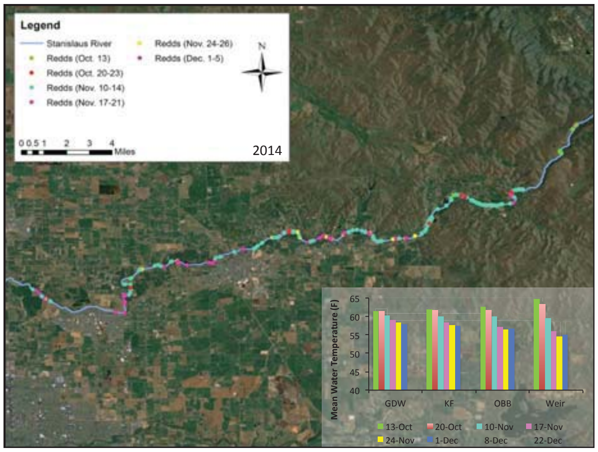
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2014
Mean Water Temperature (F)
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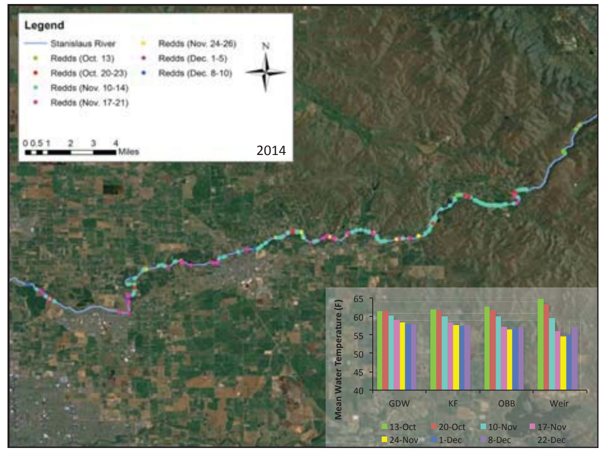
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2014
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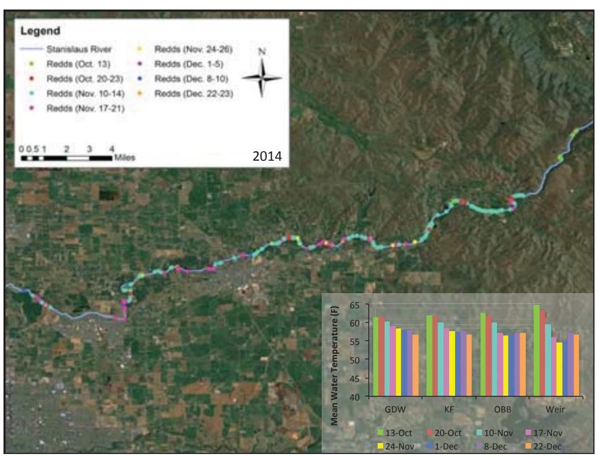
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Redds (Dec. 22-23)
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2014
Mean Water Temperature (F)
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13-Oct
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17-Nov
24-Nov
1-Dec
8-Dec
22-Dec

ATTACHMENT B

Summary of Scientific Certainty Regarding San Joaquin Basin Chinook Salmon

Prepared for State Water Resources Control Board
Phase II Comprehensive Review Workshops
Workshop 2, "Bay-Delta Fisheries" to be held October 1-2, 2012

Prepared by
Doug Demko, Michael Hellmair, Matt Peterson, Shaara Ainsley,
Michele Palmer, and Andrea Fuller

On behalf of the
San Joaquin Tributaries Authority

September 14, 2012

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SPRING FLOWS

Scientific Certainty: High

- ***High, unmanaged spring flood flows (above 18,000 cfs), can increase smolt survival through the Delta.***
- ***Without the Head of Old River [Physical] Barrier in place, no significant relationship exists between spring flows in the managed range (below 7,000 cfs) and smolt survival through the Delta.***
- ***Flow related science relied upon by the SWRCB's Technical Report (2012) are flawed, have been discredited, are not the best available science, and should not be used as primary justification to modify flow objectives.***

Key Supporting Science

Existing scientific evidence does not support the conclusion that late winter and spring flow (February to June) in the San Joaquin River is the "primary limiting factor" to smolt survival and subsequent abundance.

- The VAMP independent scientific review panel determined that "simply meeting certain flow objectives at Vernalis is unlikely to achieve consistent rates of smolt survival through the Delta" (Dauble et al., 2010).
- NMFS (2009) states that "flows below approximately 5,000 cfs have a high level of variability in the adult escapement returning 2.5 years later, indicating that factors other than flow may be responsible for the variable escapement returns. Flows above approximately 5,000 to 6,000 cfs begin to take on a linear form and adult escapement increase in relation to flow."
- Baker and Morhardt 2001 indicates that there are no data points between 11,000-18,000 cfs, so there is no ability to identify a linear trend beginning at 5,000 cfs. Also, Baker and Morhardt (2001) state "when only the data below 10,000 cfs are considered, there appears to be a negative relationship between flow and smolt survival."
- "The complexities of Delta hydraulics in a strongly tidal environment, and high and likely highly variable predation, appear to affect survival rates more than flow, by itself, and complicate the assessment of flow effects of on survival rates." (Dauble et al. 2010).
- Choice of emigration route may be more important to survival than flow (Perry et al. 2010).
- The VAMP Peer Review (Dauble et. al 2010) indicates that consideration should be given regarding the role of Delta survival for the smolt life stage in the larger context of the entire life cycle of the fall-run Chinook (i.e., life cycle model), including survival in the upper watershed, the Bay and the ocean and fry rearing in the Delta.

The SWRCB's Technical Report's (2012) conclusion that higher spring flows result in increased adult abundance is based almost exclusively on analyses that are flawed and have been discredited (e.g., DFG 2005, 2010a; Mesick et al 2007; Mesick 2009), as well as similar non-peer-reviewed analyses (e.g., various Mesick documents, AFRP 2005, TBI & NRDC 2010a-c).

- The DFG's San Joaquin River Fall-run Chinook Salmon Population Model (SJRFRCS Model) (DFG 2005, DFG 2010a) has been found to be flawed through both peer and professional reviews (Demko et. al 2010).
- Mesick, TBI & NRDC 2010a-c and AFRP 2005 references have not been peer-reviewed and their analyses are the same/similar to those used in DFG's SJRFRCS Model.
- At least two Mesick documents have been rejected previously by FERC (2009a-b) due to
    - the "fallacy of focusing entirely on flow" and failure to consider the influence of other possible limiting factors (Tuolumne River Limiting Factors Analysis; Mesick et al. 2007); and
    - failing to consider other Central Valley populations, the effects of hatchery introductions on Tuolumne River Chinook salmon, and other potential factors (Tuolumne River Risk of Extinction Analysis; Mesick 2009).
- No factors other than flow were investigated in a rigorous fashion in the models suggesting a causal relationship between spring flow and adult returns.
- Bay Delta Conservation Program and Delta Stewardship Council are not using these analyses and an independent review panel recently recommended that NMFS develop a life cycle model for CV salmonids to examine water management and Biological Opinion Reasonable and Prudent Actions (Rose et. al. 2011).

FLOODPLAIN

Scientific Certainty: High

- ***Floodplains with characteristics like those shown to provide benefits to Chinook salmon (i.e., large, continuous expanses of shallow-water habitat) cannot be created through managed flows in the San Joaquin Basin.***
- ***Juvenile steelhead are not are not likely to use floodplains and thus would not benefit from floodplain inundation, regardless of the season.***

Scientific Certainty: Deficient

- ***Benefits of floodplain habitat on Chinook abundance have not been quantified.***

Key Supporting Science

Floodplains in the San Joaquin Basin have different characteristics than the Yolo and Cosumnes and will not provide similar salmon growth and survival benefits.

- Floodplains in the Yolo and Cosumnes bypasses consist of virtually one large, continuous expanse of mostly shallow-water habitat; while the San Joaquin Basin consists of several disconnected, smaller areas of largely deep-water habitat (oxbow features). This deep-water habitat is similar to isolated pond habitats in the Yolo Bypass where alien fish dominate and no Chinook salmon were found (Feyrer et al. 2004).
- San Joaquin Basin inundation zones estimated by the cbec analysis (cbec 2010) represent the maximum area available under a range of flows, not the quality of that habitat for salmon (i.e., depth and velocities). Even though these estimates are a best-case scenario and include areas which would not be considered beneficial to rearing salmon (i.e., deep ox-bows), the total area is still dwarfed in comparison to the Yolo Bypass or Cosumnes Preserve.
- Growth differences between juveniles rearing in floodplains versus in-river were found after a two-week period (Jeffres et al. 2008). There is no data that supports the conclusion that similar benefits occur if rearing is less than a two-week inundation period.
- Increased growth on floodplains is likely related to several factors including warmer water temperatures resulting from shallower depths and greater surface area than found in-river, as well as lower velocities and better food sources (Sommer et al. 2001). Shallow water floodplain habitat is not prevalent in the San Joaquin Basin.

<u>Juvenile steelhead are not likely to use floodplains and thus would not benefit from floodplain inundation, regardless of the season.</u>

- Juvenile steelhead are not likely to use floodplains known to rear in floodplain habitats to any great degree at any time of year (Bustard and Narver 1975, Swales and Levings 1989, Keeley et al. 1996, Feyrer et al. 2006, Moyle et al. 2007).

<u>Floodplain rearing may help increase the size/weight of Chinook outmigrants, but has not been shown to increase the *abundance* of outmigrants or the *number of adult returns*.</u>

- No clear evidence that juvenile floodplain rearing increases adult recruitment.

<u>Floodplain inundation in the San Joaquin River tributaries only visually inferred from flow-area graphs by DFG (2010).</u>

- Wetted surface area increases more quickly between 3,000-5,000 cfs (Merced) and between 4,000-6,000 cfs (Tuolumne) indicating greater increases in width, which suggests bank overtopping or floodplain inundation; Stanislaus did not have a well-defined floodplain in the 100-10,000 cfs flow range examined (DFG 2010b, SWRCB Technical Report 2012).

<u>Tributary floodplain inundation thresholds exceed the SWRCB's Technical Report (2012) maximum monthly tributary target flows.</u>

- Maximum monthly target flows (i.e., median unimpaired) specified for each tributary in the SWRCB's Technical Report (2012) are 2,500 cfs for the Stanislaus River; 3,500 cfs for the Tuolumne River; and 2,000 cfs for the Merced River.
- Assuming minimum thresholds to begin inundating floodplains are 3,000 cfs for the Merced and Stanislaus Rivers, and 4,000 cfs for the Tuolumne River, all three of these minimums exceed the maximum flows proposed in the SWRCB's Technical Report (2012).

<u>SWRCB's Technical Report (2012) emphasizes the need for creating more floodplain in the San Joaquin Basin through higher flows, but "floodplain habitat" is not defined nor quantified for the San Joaquin Basin.</u>

- The attributes of "floodplain habitat," such as depth, velocity, cover, and water temperature, are not defined.
- No information/data is presented as to how much floodplain habitat exists in the San Joaquin Basin, how much could be gained at various flows, or what the benefit to Chinook salmon would be.

FLOW QUANTITY AND TIMING

<u>Scientific Certainty: High</u>

- ***Under specific conditions, salmon migration can be temporarily stimulated through flow management.***

<u>Scientific Certainty: Deficient</u>

- ***The benefit of temporary migratory stimulation on the survival of Chinook fry or smolts through the tributaries, lower San Joaquin River, and Delta is uncertain.***
- ***The importance of attraction flows to spawning migration and subsequent spawning success is uncertain.***

<u>Key Supporting Science</u>

<u>Juvenile Chinook migration out of the upper tributaries is ***temporarily*** stimulated by changes in flow, but long duration pulse flows do not "flush" fish out of the tributaries.</u>

- Juvenile Chinook migration can be stimulated by changes in flow, but the effect is short lived (few days) (Demko et al. 2001, 2000, 1996; Demko and Cramer 1995).

<u>Higher flows increase fry (but not necessarily parr or smolt) survival in the tributaries; benefits to adult escapement are uncertain.</u>

- Stanislaus River flows have a strong positive relationship with migration survival of Chinook fry, but weak associations with parr and smolt survival (Pyper and Justice 2006).
- Smolt survival (CWT) studies conducted by CDFG at flows ranging from 600 cfs to 1500 cfs and at 4,500 cfs have shown that smolt survival is highly variable and not improved by higher flows in the Stanislaus River (SRFG 2004; CDFG unpublished data).
- Smolt survival indices in the San Joaquin River from the Merced River downstream to Mossdale indicate little relationship to flow (TID/MID 2007).
- The contribution of fry emigrants (Feb/March) to total salmon production in the San Joaquin Basin is uncertain (Baker and Morhardt 2001; SRFG 2004; SJRGA 2008; Pyper and Justice 2006).

<u>Fall flow pulses ***temporarily*** stimulate upstream migration of Chinook salmon into San Joaquin Basin tributaries, but no evidence that attraction flows are needed.</u>

- Prolonged, high-volume fall pulse flows are not warranted, since equivalent stimulation of adult migration may be achieved through modest pulses (Pyper and others 2006).
    - Relatively modest pulse-flow event (increase of ~200 cfs for 3 days) was found to stimulate migration, but only for a short duration (increased for 2-3 days).
- Migration rate and timing are not dependent upon flows, exports, water temperature or dissolved oxygen concentrations (Mesick 2001; Pyper and others 2006).
- No evidence that low flows (1,000 to 1,500 cfs) in the San Joaquin River are an impediment to migration (Mesick 2001).

<u>Flow does not explain low Delta survival of juvenile Chinook observed since 2003, so more flow is not likely the solution.</u>

- Flood flows of approximately 10,000 cfs and 25,000 cfs during outmigration in 2005 and 2006 did not increase survival near levels when flows were moderately high (5,700 cfs) in 2000 (SJRGA 2007b).
- Since recent smolt survival has been far lower than it was historically, models based on historical data are not representative of recent conditions and should not be used to predict future scenarios (VAMP Technical Team 2009).

WATER TEMPERATURE

<u>**Scientific Certainty: High**</u>

- ***Water temperatures in the San Joaquin River and South Delta are controlled by air temperatures.***
- ***Releases from tributary reservoirs will not impact water temperatures in the San Joaquin River or South Delta.***
- ***San Joaquin River restoration flows will adversely affect water temperatures from the confluence of the Merced River downstream.***

Scientific Certainty: Deficient

- ***Salmon and steelhead survival benefits of releasing large quantities of water to decrease water temperatures in the tributaries are uncertain.***

Key Supporting Science

The dominant factor influencing water temperature is ambient air temperatures, not flow.

- Ambient air temperature is the primary factor affecting water temperature; by the end of May, water temperatures at Vernalis range between 65°F and 70°F regardless of flow levels between 3,000 cfs and 30,000 cfs. (SRFG 2004)

There is no evidence that water temperatures are unsuitable for adult Chinook upstream migration

- DFG demonstrated that pre-spawn mortality is quite low (i.e., 0%-4.5%) and appears to be density, not water temperature, dependent (Guignard 2005 through 2008).
- No associations between adult migration timing and conditions for water temperature, dissolved oxygen (DO), or turbidity (Pyper et. al 2006; Mesick 2001).
- San Francisco Bay water temperatures over 65°F in September when fish are migrating (CDEC; various stations) and water temperatures at Rough and Ready Island (RRI) are typically above 70°F during early migration season.

There is no evidence that water temperatures for juvenile rearing and migration need to be colder or maintained through June.

- Nearly all juvenile Chinook migrate prior to May 15, and <1% migrate after May 31, except in wet and above normal water years. 90-99% of non ad-clipped salvaged *O. mykiss* are encountered between January and May depending on water year type.
- Existing 7 Day Average Daily Maximum water temperatures are generally $\leq$68ºF (20°C) in the San Joaquin River and the eastside tributaries through May 15.

The restoration of the San Joaquin River upstream of the Merced River (San Joaquin River Restoration Program; SJRRP) will adversely affect water temperatures in the lower San Joaquin River during the spring and fall.

- The lower San Joaquin River downstream of the Merced River confluence is identified as temperature impaired (USEPA 2010). According to water temperature modeling conducted by AD Consultants, SJRRP flows will be the same as the ambient temperature (SJRGA 2007a).

Releases from tributary reservoirs will not impact water temperatures in the San Joaquin River or South Delta.

- Increasing flows from the tributaries will not decrease water temperatures in the mainstem San Joaquin River downstream of the Merced confluence (SJRGA 2007a).

DISSOLVED OXYGEN

Scientific Certainty: High

- ***Low dissolved oxygen concentrations are limited to the DWSC and are the result of anthropogenic manipulation of channel geometry.***
- ***Existing DO concentrations do not impact salmon and steelhead migration.***

Key Supporting Science

Low dissolved oxygen (DO) concentrations are limited to the Deep Water Ship Channel (DWSC), and are the result of anthropogenic manipulation of channel geometry.

- The eastside rivers (Tuolumne, Stanislaus and Merced) discharge high-quality Sierra Nevada water which has low planktonic algal content and oxygen demand, and are not a major source of oxygen demand contributing to the low DO problem in the DWSC (Lee and Jones-Lee 2003).
- DO concentrations in the DWSC can be ameliorated by installation of the Head of Old River Barrier (Brunell et al. 2010).

Existing DO concentrations do not impact salmon and steelhead migration.

- Contrary to Hallock et al. (1970) indicating adult migration is prevented under low DO, migration has been observed at DO < 5mg/L (Pyper and others 2006). Adult upstream migration rate and timing is not dependent on DO concentrations (Pyper and others 2006).
- Smolt survival experiments indicate that juvenile salmon survival is not correlated with existing DO concentrations (SRFG 2004; SJRGA 2002 and 2003). Salmon and steelhead migrate in the upper portion of the water column where DO concentrations are highest (Lee & Jones-Lee 2003).

FOOD

Scientific Certainty: High

- ***Salmon and steelhead are not impaired by food availability in the San Joaquin Basin.***
- ***Projected food production from inundated areas will be realized in short inundation periods.***

Key Supporting Science

Out-migrating Chinook smolts are not food-limited during their 3-15 day migration through the lower San Joaquin River below Vernalis and the South Delta.

- The SWRCB's Technical Report (2012) provides evidence that, in other systems, unregulated rivers have more and better food resources than regulated rivers. However, the report does not provide any evidence that increasing flows in an already highly degraded system has the capability to return primary and secondary production quantity and quality to its pre-regulated state.
- Based on acoustic VAMP studies in 2008, Holbrook et al. (2009) found that smolts took 3-15 days (median 6-9 days) for migration through the lower San Joaquin River and South Delta, therefore the demand for food production over such a short duration is questionable.
- Increases in primary and secondary production due to restoration or changes in management likely occur over longer periods of time, rather than by short-term pulse flows.

CONTAMINANTS

Scientific Certainty: Moderate

- ***Influence of higher flows on contaminant concentrations is variable; dilution may occur in some instances but increase in others.***
- ***Providing a percent of unimpaired flows may increase contaminant concentrations.***

Key Supporting Science

No evidence supports the idea that higher inflows reduce contaminant concentrations.

- The SWRCB's Technical Report (2012, p. 3-29) states, "Higher inflows also provide better water quality conditions by reducing temperatures, increasing dissolved oxygen levels, and ***reducing contaminant concentrations***" but does not provide any references or further discussion to support this statement.
- The SWRCB's Technical Report (2012) may infer that higher flows act to dilute suspended contaminants. However, the influence of higher flows on contaminant concentrations is variable; dilution may occur in some instances but increases may occur in others.

Unimpaired flows may increase contaminant concentrations.

- High flows can increase contaminant concentrations through resuspension of contaminants in sediments (McBain and Trush, Inc 2002). These resuspended contaminants can enter the food web and have longer residence times in rivers and estuaries than water (Bergamaschi et al. 1997).
- Pesticides and herbicides were found in every sample of surface water sites along the

San Joaquin River and in the Old River before, during and after the VAMP month-long pulse flow and some contaminants increased throughout these three periods (Orlando and Kuivila 2005).

- "Perhaps the greatest risks to potential restoration actions within the San Joaquin River study reaches relate to uncertainties regarding remobilization of past deposits of [...] pesticides, i.e., DDT and mercury" (McBain and Trush 2002).

TRANSPORT OF SEDIMENTS, BIOTA AND NUTRIENTS

Scientific Certainty: High

- ***Transport of sediment, biota, and nutrients benefits are closely linked to the availability and connectivity of floodplain habitat, and cannot be expected in a highly modified system such as the San Joaquin Basin.***

Key Supporting Science

Transport benefits from floodplain habitat are not realized in the South Delta and lower San Joaquin River because the majority of the floodplain in the lower San Joaquin River has been eliminated or is isolated behind levees.

- Transport of sediment, biota, and nutrients is directly related to the floodplains of a river-floodplain complex, which has nearly been eliminated from the lower San Joaquin River and its tributaries (cbec 2010; Williams 2006).
- "[F]ormer floodplains now behind manmade levees will remain isolated from the river, assuming no long-term changes in flood stages or flood protection policy" (Junk et al. 1989).
- "In unaltered large river systems with floodplains [...], the overwhelming bulk of the riverine animal biomass derives directly or indirectly from production within the floodplains and not from downstream transport of organic matter produced elsewhere in the basin" (Junk et al. 1989).
- The FPC focuses on the lateral exchange of water, nutrients and organisms between the river channel and the connected floodplain. The floodplain is considered as an integral part of the system (Junk and Wantzen 2003).

Transport of sediment, biota, and nutrients differs between the large river-floodplain systems described by Junk et al. (1989) and the anthropogenic, leveed river channels of the South Delta.

- Under natural conditions, sediments would be downstream from upper tributaries, but dams limit natural sediment inputs such as gravels (Schoellhamer et al. 2007).
- Human activities (mining, urbanization and agriculture) have increased erosion and the supply of fine river sediments (Schoellhamer et al. 2007).
- Schoellhamer et al. (2007) states that the present day modified system, "would tend to

transport more sediment to the Delta because 1) the flood basins were a sink for fine sediments, and 2) the leveed channels will experience greater bed shear stress because more flow is kept in the channel. . . It follows that levee setbacks and floodplain restoration would tend to decrease sediment supply to the Delta by promoting floodplain deposition along upstream reaches."

- Sediment inputs into the South Delta from the San Joaquin River are the result of increases in suspended sediments from run-off events and are generally not associated with managed flow pulses (SJRG 2004).

VELOCITY

Scientific Certainty: High

- ***No significant relationship exists between mean smolt migration time and San Joaquin River flow.***

Key Supporting Science

No evidence that higher spring flows "facilitate transport."

- The SWRCB's Technical Report (2012) did not define "facilitate transport so it is unclear by what mechanisms spring flows may facilitate transport of smolts, what the benefits are, and how the benefits may be influenced by factors such as flow level, duration, turbidity, etc. The SWRCB's Technical Report (2012) may be suggesting that increased flows result in increased ***velocity***, which may lead to decreased juvenile salmonid travel time through the region, thus 'facilitating transport'.

"It seems intuitively reasonable that increased flows entering the Delta from the San Joaquin River at Vernalis would decrease travel times and speed passage, with concomitant benefits to survival. The data, however, show otherwise" (Baker and Morhardt 2001).

- No significant relationships at the 95% confidence level between mean smolt migration times from three locations (one above and two below the HORB to Chipps Island) and San Joaquin River flow (average for the seven days following release), but
- Smolt migration rate increases with **size** of released smolts (Baker and Morhardt 2001).

Juvenile salmonids are actively swimming, rather than moving passively with the flow, as they migrate towards the ocean (Cramer Decl., Case 1:09-cv-01053-OWW-DLB Document 167, Peake McKinley 1998).

- Movements of juvenile salmonids depend on their species and size, water temperature and local hydrology, and many other factors (Cramer Decl., Case 1:09-cv-01053-OWW-DLB Document 167).

- Baker and Morhardt (2001) provide an example of a study which compared the speed of smolt passage to that of tracer particles (particle tracking model - PTM), "in which 80% of the smolts were estimated to have been recovered after two weeks, but only 0.55% of the tracer particles were recovered after two months."
- Chinook released at Mossdale traveled to Chipps Island 3.5 times faster than the modeled particles (Cramer Decl., Case 1:09-cv-01053-OWW-DLB Document 167).

<u>Results from VAMP studies (using acoustic tags) have generally shown short travel times between reaches, suggesting active swimming.</u>

- In 2009, mean travel times were reported for each reach, and all were under 2.5 days (SJRGA 2009).

<u>Increased flows may slightly increase velocity near the boundary of the Delta, but do not substantially increase velocity through the Delta.</u>

- Velocities at the Head of Old River may increase by about 1 ft/s with an additional 6,000 cfs San Joaquin River flow, but additional flow provides little to no change IN velocity (<0.5 ft/s) at other stations in the South Delta (Paulsen et al. 2008).

PHYSICAL HABITAT

<u>Scientific Certainty: High</u>

- ***Physical habitat has been substantially reduced by non-flow measures (e.g., land reclamation activities, levees).***
- ***Shallow water rearing habitat (important for almost all native fish), has virtually been eliminated from the Delta.***
- ***Restoring the Delta and mainstem San Joaquin River shallow water habitat cannot be accomplished through flow management.***
- ***Non-native species thrive in the highly altered San Joaquin Basin.***

<u>Key Supporting Science</u>

<u>Physical habitat for San Joaquin Basin and Delta native fishes has been substantially reduced and altered.</u>

- Diverse habitats historically available in the Delta have been simplified and reduced by development of the watershed (Lindley et al. 2009).
- Spawning and rearing habitat have been severely reduced, total abundance and salmon diversity reduced from past alterations (McEvoy, 1986; Yoshiyama et al., 1998, 2001; Williams 2006).
- Major change in system is loss of shallow rearing habitat (Lindley et al. 2009).
- 95% of wetlands/floodplains lost to levee construction and agricultural conversion since the mid 1800s (TBI 2003, Williams 2006).
- Only ~10% of historical riparian habitat remains, with half of the remaining acreage

disturbed or degraded (Katibah 1984).

- Shallow water habitats are essentially non-existent since the "current configuration of largely rip-rapped, trapezoidal channels in the Delta provides little habitat for covered species and contributes to a high degree of predation." (Essex 2009).

Levees and off-channel oxbows restrict ability to create shallow water habitat with increased flows.

- The primary purpose of levees is to provide flood protection and prevent high flows from entering adjacent floodplains. There are approximately 443 miles of levees in the lower San Joaquin River downstream of the Stanislaus River confluence and South Delta.
- Inundation of off-channel oxbows creates deep water instead of shallow water habitat.

Habitat alterations are linked with invasive species expansions.

- *Egeria densa* (Brazilian waterweed) expansion has increased habitat and abundance of largemouth bass and other invasive predators (Baxter et al. 2008).
- Current habitat structure benefits exotic predators more than natives (Brown 2003).

Habitat influences growth, survival and reproduction.

- Estuaries provide important rearing habitat for Chinook; salmon fry in Delta grew faster than in river (Healey 1991, Kjelson et al. 1982).
- Shallow water habitats support high growth of juvenile Chinook (Sommer et al. 2001; Jeffres et al. 2008; Maslin et al. 1997, 1998, 1999; Moore 1997). However, as mentioned above, there is little presently available.

Water quality aspect of habitat is highly variable.

- Variability in habitat likely causes regional differences in relationship between Delta smelt abundance and water quality (Baxter et al. 2008).
- Reduced pumping lowered salinity in Western Delta (as desired), but led (unexpected) result of increased salinity in Central Delta (Monsen et al. 2007).

Improving habitat for increased abundance of native fishes.

- Habitat quantity, quality, spatial distribution and diversity must be improved to promote life history diversity that will increase resilience and stability of salmon populations (Lindley et al. 2009).

GEOMORPHOLOGY

Scientific Certainty: High

- ***Managed flow range is insufficient to provide channel mobilizing flows in the San Joaquin River Basin.***
- ***In leveed systems, true channel mobilization flows are not possible because of flood control.***

Scientific Certainty: Deficient

- ***Releasing large quantities of water for channel mobilizing flows in the tributaries for uncertain benefits to salmon and steelhead.***

Key Supporting Science

Under natural conditions, channel formation and maintenance is directly influenced and modified by flow; however, the morphology of leveed rivers cannot be modified by flow (Jacobson and Galat 2006).

- The "five critical components of the ["natural," i.e., unaltered by humans] flow regime that regulate ecological processes in river ecosystems are the magnitude, frequency, duration, timing, and rate of change of hydrologic conditions (Poff et al. 1997, Poff and Ward 1989, Richter et al. 1996, Walker et al.1995).
- In [a highly modified] a system, flow-related factors like timing of floods, water temperature, and turbidity may be managed; but, in absence of a "naturalized morphology, or flow capable of maintaining channel-forming processes, the hydrologic pulses will not be realized in habitat availability."

Due to land use changes, higher flows do not necessarily provide the channel maintenance that would occur under natural conditions.

- In leveed systems, true channel mobilization flows are not possible because of flood control. In fact, higher flows can result in increased detrimental incision in upstream tributary areas (like the Stanislaus River) where existing riparian encroachment is armored and cannot be removed by high flow events, limiting "river migration and sediment transport processes" (Kondolf et al. 2001, page 39).
- Urban and agricultural developments have encroached down to the 8,000 cfs line, "effectively limiting the highest flows to no more than the allowable flood control" (i.e., 8,000 cfs, Kondolf et al. 2001).
- Where flood pulses are not available to provide maintenance of channel habitat, "mimicking certain geomorphic processes may provide some ecological benefits" (Poff et al. 1997) [e.g., gravel augmentation, stimulate recruitment of riparian trees like cottonwoods with irrigation].

In the absence of floodplain connectivity, the functions attributed to higher "pulse flows" cannot be achieved.

- Historically, the San Joaquin River was a channel connected with its floodplain. Flood pulses in the winter and spring would have provided the beneficial functions of floodplains identified by Junk et al. (1989) and by Junk and Wantzen (2003). However, anthropomorphic changes in the lower river (e.g., levees), particularly below Vernalis (the focus of the 2012 Technical Report), have substantially reduced this floodplain connectivity and the region can no longer be considered a "large river-floodplain system."

HEAD OF OLD RIVER BARRIER

Scientific Certainty: High

- ***Salmon smolt survival can be increased through installation of the Head of Old River Barrier (HORB).***

Key Supporting Science

Operation of a rock barrier at the Head of Old River improves salmon smolt survival through the Delta by 16-61% (Newman 2008).

- HORB reduces entrainment into Old River from more than 58% to less than 1.5%.
- Physical (rock) HORB increases San Joaquin River flow.
- Installation of the HORB doubles through-Delta survival by directing juvenile salmonids through the San Joaquin River mainstem (compared to the Old River route, NMFS 2012).

In the absence of a rock barrier at the Head of Old River, a statistically significant relationship between San Joaquin River flow and salmon survival does not exist (Newman 2008).

- HORB cannot be installed or operated during high flow events
    - Temporary rock barrier requires flows less than 5,000 cfs for installation and flows less than 7,000 cfs for operation (SJRTC 2008).

Head of Old River Barrier Predation and "Hot Spots".

- Mean predation rate at HORB was 27.5% in 2009 and 23.5% in 2010.
- 2007 telemetry tracking found that 20% of released fish were potentially consumed by predators at three "hot spots": Stockton Water Treatment Plant, Tracy Fish Facility trashracks and Old River / San Joaquin River split.

PREDATION

Scientific Certainty: High

- ***Predation by non-native species (especially striped bass)) is a major impediment to salmon smolt survival through the lower San Joaquin River and Delta more than river flow.***
- ***Evidence from other basins (i.e., Columbia) indicates that predation can be easily and cost-effectively reduced.***

Key Supporting Science

The VAMP review panel concluded that "high and likely highly variable impacts of predation appear to affect survival rates more than the river flow" (Dauble et al. 2010).

- All fishery agencies have acknowledged that striped bass are a major stressor on Chinook populations in the Central Valley and recovery will not occur without significant reduction in their populations and/or predation rates (DFG 2011).

Recent San Joaquin Basin VAMP studies conducted from 2006–2010 provide direct evidence of high predation rates on Chinook salmon in the lower San Joaquin River and South Delta.

- In 2007, 20% of released fish were potentially consumed by predators at three "hotspots" (Stockton Treatment Plant, Tracy Fish Facility trashracks, and the HOR).
- In 2009, mortality rates (likely due to predation) between Durham Ferry and the HOR ranged from 25.2% to 61.6% (mean 40.8%), and predation rates at HOR ranged from 11.8% to 40% (mean 27.5) (Bowen et al. 2009).
- In 2010, mortality rates (likely due to predation) between Durham Ferry and the HOR ranged from 2.8% to 20.5% (mean 7.8%) and predation rates at HOR ranged from 17% to 37% (mean 23.5%) (Bowen and Bark 2010).

Reducing striped bass predation on juvenile Chinook is the simplest, fastest, and most cost-effective means of increasing outmigration survival.

- High predation occurs at "hot spots," which can be the focus of a control program.
- Encouraging increased angling pressure on salmonid predators has successfully increased the number of adult returns in other basins on the West Coast (Radtke et al. 2004).
- Columbia River predator suppression program has cut predation on juvenile salmonids by 36% (Porter 2011).
- California Fish and Game Commission (CFGC 2012) rejected DFG's recommendation to amend striped bass sport fishing regulations, which included increasing bag limits and decreasing size limits.

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ATTACHMENT C

Review of Scientific Information Pertaining to SWRCB's February 2012 Technical Report on the Scientific Basis for Alternative San Joaquin River Flow Objectives

Prepared for State Water Resources Control Board
Phase II Comprehensive Review Workshops
Workshop 2, "Bay-Delta Fisheries" to be held October 1-2, 2012

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On behalf of the
San Joaquin Tributaries Authority

September 14, 2012

1. SPRING FLOWS

Overview

Increasing spring flows in the San Joaquin River (SJR) basin is one of the main goals in Section 3 of the February 2012 SJR Flow and Southern Delta Salinity Technical Report (SWRCB Technical Report 2012). Justifications for the increased flows are based on research conducted by Dr. Carl Mesick, California Department of Fish and Game (DFG; largely based on Mesick research), Anadromous Fish Restoration Program (AFRP; again largely based on Mesick research), The Bay Institute/ Natural Resources Defense Council (TBI/NRDC 2010a-c), and a variety of survival studies conducted from the early 1980s to 2010. Increased spring flows (occurring in the months of February through June) are thought to be the main factor influencing juvenile Chinook salmon (*Oncorhynchus tshawytscha*) survival and subsequent adult spawning abundance.

Research investigating the relationship between flows in the SJR, the Sacramento-San Joaquin Delta (Delta) and various aspects of Chinook salmon life history (e.g. smolt survival, escapement) has been conducted for nearly 35 years. Much of the research has been inconclusive and early studies are well summarized by Baker and Morhardt (2001) and more recently by the Vernalis Adaptive Management Program (VAMP) independent review panel (Dauble et al. 2010). Some key points from Dauble et al. (2010, pages 3 and 4) are:

- "Panel members are in agreement that simply meeting certain flow objectives at Vernalis is unlikely to achieve consistent rates of smolt survival through the Delta over time."
- "The complexities of Delta hydraulics in a strongly tidal environment, and high and likely highly variable impacts of predation, appear to affect survival rates more than the river flow, by itself, and greatly complicate the assessment of effects of flow on survival rates of smolts."
- "Apparent downstream migration survival of juvenile Chinook salmon was very poor during 2005 and 2006 even though Vernalis flows were unusually high (10,390 cfs and 26,020 cfs, respectively). These recent data serve as an important indicator that high Vernalis flow, *by itself*, cannot guarantee strong downstream migrant survival."
- "Although some positive statistical associations between San Joaquin River flow and salmon survival have been identified, there is also very large variation in the estimated survival rates at specific flow levels and there is a disturbing temporal trend to reduced survival rates at all flows. This large variability and associated temporal decline in survival rates strongly supports a conclusion that survival is a function of a complex set of factors, of which San Joaquin River flow at Vernalis is just one."

In addition, Baker and Morhardt (2001) and Dauble et al. (2010) both identify data gaps, experimental deficiencies, and high variability in survival rates for specific flows. Both reach some similar conclusions: that more research should be conducted, the variable of flow is likely not the only factor, and that a precise flow target set by management policies would likely not provide reliable survival rates on a year-to-year basis. These two documents were "buried" deep within section 3 of the SWRCB's Technical Report (2012; pages 3-32 for Baker and Morhardt [2001] and pages 3-38 and 3-39 for Dauble et al. [2010]).

These findings are in contrast with much of the literature cited in the SWRCB's Technical Report (2012) related to flow. Specifically, much of the cited material is based on analyses conducted by DFG (2005, 2010a) and Mesick (Mesick and Marston 2007, Mesick et. al 2007, Mesick 2009), as well as similar analyses by TBI and NRDC (2010a-c) and AFRP (2005), which all generally conclude that increased spring flows would increase both smolt survival and future escapement. These analyses do not adequately account for variables other than flow that could affect smolt survival or adult escapement, and rely on improper interpretations of simplistic linear regression relationships between complex variables. The linear relationships suffer from poor fits and violate many standard assumptions of linear regression analyses (see Attachment 1 and Demko et al. 2010 for more detailed reviews).

SWRCB's Technical Report (2012) Assertions Regarding Relationship Between San Joaquin River Flows and Salmon Survival

Bold statements below indicate the SWRCB's Technical Report (2012) assertions regarding the relationship between SJR flows and salmon survival, followed by supporting/contrary evidence, as follows:

SWRCB Assertion 1: The number of Chinook salmon spawners returning to the San Joaquin system are correlated with river flows during the February-June rearing and outmigration period 2 1/2 years earlier (pages 3-32 and 3-35).

- This flow/outmigration relationship was first mentioned during 1976 SWRCB proceedings by DFG (1976).
- Since 1976, this regression of flow and escapement 2.5 years later has been mentioned in numerous documents, which were cited throughout the SWRCB 2012 report. However, the statistical analyses used in these reports do not take into account the age composition of returning adults (made up of 2–5 year old adults). Instead, they lump all ages into age-3 adults, which are typically the dominant age group among returning adults in a given year. Therefore, simply grouping adult salmon of other ages into the escapement (the dependent variable in the relationship) is the incorrect way to conduct this type of analysis and adds additional uncertainty into the purported flow/outmigration relationship. For instance, using a simple example illustrating this issue, let us say that 1,000 adult salmon (made up of ages 2-5) return in 2011. For simplicity, let's also say that 10% of that escapement class is age-2 ("jacks"), 50% are age-3, 35% are age-4, and 5% are age-5. Using that age composition, there would be 100 age-2 salmon, 500 age-3 salmon, 350 age-4 salmon, and 50 age-5 salmon. Based on life history of fall-run Chinook salmon, that would mean that the 100 age-2 salmon that returned to spawn in Fall 2011 migrated to the ocean during the spring of approximately 1.5 years earlier, during the Spring of 2010. Similarly, the 500 age-

3 adult salmon entered the ocean approximately 2.5 years earlier (Spring of 2009), age-4 adult salmon entered approximately 3.5 years earlier (Spring of 2008), and age-5 adult salmon entered the ocean approximately 4.5 years earlier (Spring of 2007). The regression of flow and escapement 2.5 years later simply does not account for the well-known life history characteristics of fall-run Chinook salmon in the Central Valley (CV) and should not be used. A more appropriate cohort-specific analysis, would relate escapement of each age group with the conditions that each age group experienced in freshwater or during the outmigration period. Therefore, time-series data of escapement of age-2 salmon would need to be analyzed with the proper time-series data of outmigration conditions approximately 1.5 years earlier, not 2.5 years earlier. Similar corrections would need to be made with the older age groups as well. Due to this additional uncertainty, cohort-specific analyses and models (i.e., those that include age composition) should be used instead of the cited analyses. Flow management decisions should not be made using such potentially unreliable analyses.

SWRCB Assertion 2: In the SJR basin, it is recognized that the most critical life stage for salmonid populations is the spring juvenile rearing and migration period (DFG 2005, Mesick and Marston 2007, Mesick et al. 2007, and Mesick 2009) (pages 1-3 and 3-2).

- Most research from the Pacific Northwest suggests that the period after ocean entry is the most critical life stage for juvenile salmonids (i.e., where most of the mortality occurs) and largely determines year-class strength (or escapement, i.e., number of spawning adults in a given year) (Pearcy 1992, Gargett 1997, Beamish and Mahnken, 2001).
- The documents cited by SWRCB's Technical Report (2012) to support this claim are not peer reviewed and all based on work conducted by Mesick and others.

SWRCB Assertion 3: Analyses indicate that the primary limiting factor for salmon survival and subsequent abundance is reduced flows during the late winter and spring (February through June) when juveniles are completing the freshwater rearing phase of their life cycle and migrating from the SJR basin to the Delta (DFG 2005; Mesick and Marston 2007; Mesick et al. 2007; Mesick 2009) (page 3-28).

- The VAMP independent scientific review panel determined that "simply meeting certain flow objectives at Vernalis is unlikely to achieve consistent rates of smolt survival through the Delta" (Dauble et al., 2010).
- Based on Figure 11 from Baker and Morhardt (2001), NMFS (2009) states that "flows below approximately 5,000 cfs have a high level of variability in the adult escapement returning 2.5 years later, indicating that factors other than flow may be responsible for the variable escapement returns. Flows above approximately 5,000 to 6,000 cfs begin to take on a linear form and adult escapement increase in relation to flow."
    - However, Baker and Morhardt (2001) indicates that there are no data points between 11,000-18,000 cfs, so there is no ability to identify a linear trend beginning at 5,000 cfs. Also, Baker and Morhardt (2001) state,

    - "when only the data below 10,000 cfs are considered, there appears to be a negative relationship between flow and smolt survival."
- No factors other than flow (e.g., ocean conditions, predation, etc.) were investigated in a rigorous fashion in the models suggesting a causal relationship between spring flow and adult returns.
    - "The complexities of Delta hydraulics in a strongly tidal environment, and high and likely highly variable predation, appear to affect survival rates more than flow, by itself, and complicate the assessment of flow effects of on survival rates." (Dauble et al. 2010).
    - Choice of emigration route may be more important to survival than flow (Perry et al. 2010).
- The documents cited by the SWRCB's Technical Report (2012) to support this claim are not peer reviewed and all based on work conducted by Mesick and others.
- Bay Delta Conservation Program and Delta Stewardship Council are not using these analyses and an independent review panel recently recommended that NMFS develop a life cycle model for CV salmonids to examine water management and Biological Opinion Reasonable and Prudent Actions (Rose et. al. 2011).

Other Potential Factors That Influence Survival of Juvenile Salmon Not Accounted for in SWRCB's Technical Report (2012) or in Analyses Cited

Timing of outmigration:

- Survival of later-migrating juvenile Chinook smolts in the Columbia and Snake Rivers generally decreases compared to early-migrating smolts (Anderson 2003, Figures 10 and 24).
- Smolt-to-adult survival (cohort-specific) related to migration timing. Chinook smolts that migrated earlier in outmigration season are more likely to survive to adulthood (Scheurell et al. 2009).
- Snake River fall-run Chinook survival to Lower Granite Rapids Dam had the highest correlation with release date and water quality parameters (water temperature), which co-vary (Anderson et al. 2000, NMFS 2000a).

Route-Specific Migration Probabilities and Survival Probabilities:

- Perry et al. (2010) clearly shows the complicated nature of estimating survival in a highly complex, dendritic water body such as the Delta. Perry's work adds additional uncertainty to the survival estimates used by Mesick. The variation in survival estimates in years with high flows may be due to the route(s) that fish selected instead of the actual flows themselves. Higher survival rates could be due to a higher proportion of CWT-tagged salmon migrating into a route with a higher reach-specific survival rate.

Ocean Conditions:

- The SWRCB's Technical Report (2012) largely ignores the great influence that ocean conditions can have on survival and year-class strength of CV salmon. This reflects the reliance of the SWRCB's document on analyses that largely dismisses the role of ocean conditions (Mesick and Marston 2007, Mesick et. al 2007, Mesick 2009, TBI and NRDC 2010a-c, AFRP 2005).

- Lindley et al. (2007) states that a "broad body of evidence suggests that anomalous conditions in the coastal ocean in 2005 and 2006 resulted in unusually poor survival of the 2004 and 2005 broods of the SRFC (Sacramento River Fall-run Chinook)."
- Both the 2004 and 2005 broods entered the ocean during a period of weak upwelling, warm sea surface temperatures, and low densities of prey items (Lindley et al. 2009).

Accumulated Thermal Units (ATUs) – or Thermal Experience:

- In the Columbia River, migration patterns (onset of outmigration) of Chinook smolts were most associated with accumulated thermal units (a positive relationship); while increasing flow had a negative influence (Sykes et al. 2009). Thermal experience was found to have more influence on migration than daily mean water temperature.

Distance Traveled:

- Hatchery Chinook smolt survival varied inversely with the distance traveled to Lower Granite Rapids Dam (Muir et al. 2001).
- Smolt survival in the Columbia and Snake Rivers depends on distance traveled more than travel time (Anderson 2003, Bickford and Skalski, 2000) or migration velocity (Anderson et. al. 2005).

Additional Information regarding Flow and Juvenile Salmon Survival Relationships

Central Valley:

- Survival estimates for acoustically-tagged late-fall Chinook in a December release group were lower than for the January release group despite higher discharge and shorter travel times (Perry et al. 2010, p. 151). Some of this difference, however, was due to the proportion of each group that migrated between three different routes.

Outside Central Valley:

- No consistent relationship was found between years for either flow (study used a flow exposure index) or change in flow and Chinook smolt survival from Lower Granite Dam and McNary Dam (Smith et al. 2002). However, median travel times in each year decreased with increased flow exposure index (Smith et al. 2002). There was no relationship between median travel times and survival.
- No correlation present between daily flow and daily smolt survival probabilities (spring-run Chinook) through one reach of the Columbia River (Skalski 1998).
- On the Columbia River (spring-run Chinook) - Increased survival rates in the 1990s compared to the mid to late 1970s was not a function of flows. No significant differences were found between mean daily flows between the two periods (Williams et al., 2001).

- No relationship between fall-run Chinook survival and flow-travel time (Giorgi et al., 1994).
- No within-year flow-survival relationship for spring-run Chinook salmon smolts (Smith et al. 1997a).
- No within-year flow-survival relationship for fall-run Chinook salmon smolts (Giorgi et al. 1997, Smith et al. 1997b).
- No flow-survival relationship for Snake River spring-run Chinook smolts (NMFS 2000a).

2. FLOODPLAIN HABITAT

Overview

Creation of floodplains, one of the functions supported by spring flows according to the SWRCB's Technical Report (2012), has the potential to affect salmonid populations in various ways. While the ecology of floodplains in temperate regions, particularly on salmonid bearing streams, has been poorly studied, and some literature indicates that floodplain rearing increases growth and survival of Chinook salmon. In addition, floodplains provide important ephemeral spawning and rearing habitat to which native fish fauna has adapted.

While potential floodplain benefits to salmon fry are relatively undisputed, the main issue on the SJR and its tributaries appears to be the lack of low lying areas that can be regularly inundated by elevated discharge to provide productive floodplain habitat, which SWRCB's Technical Report (2012) fails to recognize. Inundation projections from modeling exercises often derive their floodplain estimates based solely on inundated surface area, without giving consideration to characteristics of inundated habitat (depths, substrate, vegetation, etc.).

Citations presented in the SWRCB's Technical Report (2012) illustrating the benefit of floodplain to rearing fishes are based on research conducted in river basins that are not directly comparable to the SJR and its tributaries (e.g., Mississippi River, neotropical and Southeast Asia systems). While there is some supporting evidence regarding the positive effects of frequent, long duration inundation of shallow floodplains on Chinook fry rearing in California (e.g., Sommer et al 2001, 2005; Moyle et al. 2007), such habitat is extremely limited in the SJR due to extensive habitat alteration and levee construction (Essex 2009). It follows that potential implied benefits of a more variable flow regime outlined in SWRCB's Technical Report (2012) may not be realized or will be severely curtailed in the SJR basin.

SWRCB's Technical Report (2012) Assertions regarding Floodplain Habitat

Bold statements below indicate the SWRCB's Technical Report (2012) assertions regarding floodplain habitat, followed by supporting/contrary evidence, as follows:

SWRCB Assertion 1. Warm, shallow-water floodplain habitats allow steelhead juveniles to grow faster (page 3-27).

- Juvenile steelhead are not known to rear in floodplain habitats to any great degree at any time of year (Bustard and Narver 1975, Swales and Levings 1989, Keeley et al. 1996, Feyrer et al. 2006, Moyle et al. 2007).
- Based on multi-year studies in the Cosumnes River, Moyle et al. (2007) concluded that steelhead were not adapted for floodplain use and the few steelhead observed were inadvertent floodplain users (i.e., uncommon and highly erratic in occurrence) that were "presumably…carried on to the floodplain by accident."

SWRCB Assertion 2. Successful Chinook salmon rearing is often associated with connectivity between river channel and riparian and floodplain habitat (page 3-19).

- Juvenile Chinook salmon are known to use floodplains, when available, for rearing. They benefit from floodplain use during the rearing phase through higher growth and greater feeding success (e.g. Sommer et al. 2001, Moyle et al. 2007).
- Chinook salmon have been documented to utilize the floodplain habitat in the Sutter Bypass, Yolo Bypass, and in the Cosumnes River (Feyrer et al. 2006, Sommer et al. 2001, Sommer et al. 2005, Moyle 2007).
    - In the Cosumnes River (annual floodplain inundation ranged from 6 to 158 days), Moyle et al. (2007) found that Chinook salmon were the most abundant species found in February and March. Likewise, Feyrer et al. (2006) found that juvenile Chinook salmon were common in the Sutter Bypass from January through May, but were relatively rare in June; on the Yolo Bypass they occurred primarily in March.

SWRCB Assertion 3. Floodplain rearing increases growth and survival in Chinook salmon (page 3-19).

- Chinook salmon that rear on floodplains have been shown to grow more rapidly than those rearing in the main river channel (Sommer et al. 2001).
- "1998 results *suggest* that in *some* years, survival *may* actually be substantially higher for salmon that migrate through the floodplain" (Sommer et al. 2005). However, clear conclusions regarding survival effects of juvenile floodplain use on adult recruitment are not available, and increased survival of these fish is often based on the inference that increased size at outmigration reduces mortality.

SWRCB Assertion 4. Floodplain inundation in the spring may benefit native species (pages 3-41 to 3-42).

- Historically, floodplains were important spawning and rearing habitats for at least some native fishes (e.g., obligate floodplain spawners, such as splittail), but their importance to river-spawners and slough residents (sucker and blackfish, respectively) is not well understood (Crain et. al 2004).
- "Today, floodplains appear important to native fishes mainly early in the season (February– April)" (Crain et. al 2004, page 15).
- Non-native species dominate the floodplain community later in the season (April-July) particularly permanent residents of ponds, ditches, and sloughs on the

floodplain) due to warmer water temperatures and lower flows (Crain et. al 2004). This is of special importance to floodplain management in the SJR Basin, as high abundances of non-native predators may benefit from floodplain inundation during proposed period, predominantly from April-June.

SWRCB Assertion 5. Shallow-water floodplain habitat provides rearing Chinook with refuge from predatory species (page 3-44).

- Shallow-water floodplains in the Sacramento River provide a refuge from large pelagic (i.e., open water) predators (e.g., Sacramento pikeminnow and striped bass) that, due to their pelagic nature, are unlikely to invade shallow, cover-rich habitats such as inundated fields of the Yolo Bypass.
- Much of the inundated floodplain habitat in the SJR that could be provided in the managed flow range are associated with oxbow features (cbec 2010), which are unlikely to provide predator refuge benefits because predation, particularly by ambush predators (e.g., largemouth bass), is expected to increase in such habitats (Saiki 1984, Brown 2000, Grimaldo et al. 2000, Feyrer & Healey 2003). These predators have been shown to be more efficient at capturing prey in complex habitat and in turbid conditions than pelagic piscivores (Greenberg et al. 1995, Nobriga & Feyrer 2007).
- The presence of high densities of exotic piscivorous fish in the perennial oxbows would likely result in heavy mortality of juvenile salmonids that entered the flooded oxbow areas.

SWRCB Assertion 6. "Floodplain inundation provides flood peak attenuation and promotes exchange of nutrients, organic matter, organisms, sediment, and energy between the terrestrial and aquatic systems" (SWRCB 2012, page 3-43).

- This is contradictory to the content of section 3.7.6 of the SWRCB's Technical Report (2012), which lists nutrients as a main factor contributing to poor water quality in the SJR and concludes that higher flows would serve to dilute this and other constituents of water quality:

> "Eutrophication from the dissolution of natural minerals from soil or geologic formations (e.g., phosphates and iron), fertilizer application (e.g., ammonia and organic nitrogen), effluent from sewage-treatment plants (e.g., nitrate and organic nitrogen), and atmospheric precipitation of nitrogen oxides may cause chronic stress to fish (McBain and Trush 2002). Algae and plant growth under eutrophic (high nutrient) conditions, along with their subsequent decomposition in the water column, lead to increase oxygen consumption and decreased dissolved oxygen conditions, reduced light penetration and reduced visibility. These conditions may render areas unsuitable for salmonid species, and favor other species (e.g., sucker, blackfish, carp, and shad)" (SWRCB 2012, page 3-49).

Clearly, the explanation of proposed benefits of changes to the flow regime with regards to nutrient supplementation (or dilution) is in need of refinement, and a more detailed evaluation of the relationship between proposed flow alterations and food web benefits is required.

SWRCB Assertion 7. Floodplain inundation provides benefits to downstream reaches in the form of nutrient supply (page 3-43).

- This assertion is erroneously attributed to Mesick (2009) by SWRCB's Technical Report (2012). Mesick (2009) did not study floodplains and their relationship to increased smolt survival, and did not investigate nutrient flow in the Tuolumne River.
- Levels of dissolved nutrients are seldom limiting factors for primary production in the main channel of rivers (Junk et al. 1989).
- The role of floodplains in nutrient cycling has not been extensively studied in California, but studies from other parts of the world indicate that floodplains can be both sources and sinks for nutrients, depending on geology, inundation duration, riverine nutrient loading, and many other factors (Junk et. al 1989). A study from the Cosumnes River suggests that floodplain inundation can reduce the amount of nitrate transported to downstream reaches (Sheibley et al. 2002).

Additional Information regarding Floodplain Inundation and Rearing of Juvenile Chinook in the SJR Basin

Floodplain conditions in the SJR Basin differ greatly from those in other river systems.

- Floodplains in the Yolo and Cosumnes bypasses consist of virtually one, large continuous expanse of mostly shallow-water habitat; while the San Joaquin Basin consists of several disconnected, smaller areas of largely deep-water habitat (oxbow features). This deep-water habitat is similar to isolated pond habitats in the Yolo Bypass where alien fish dominate and no Chinook salmon were found (Feyrer et al. 2004).
- Floodplains consisting of large expanses of shallow (mostly <1 m), slow velocity (mostly <0.3 mps) water have shown increased productivity of food organisms for fish and increased growth of juvenile Chinook salmon (Sommer et al. 2001). Limited studies in the Cosumnes River Preserve found that growth of juvenile Chinook was slower in isolated pond areas than in adjacent flooded pastures and woodlands (Jeffries et al. 2008).
- San Joaquin Basin inundation zones estimated by the cbec analysis (cbec 2010) only indicate the amount of maximum floodplain area available under a range of flows, but do not indicate the proportion of that habitat that could be used by salmon since they did not identify habitat quality (i.e., depth and velocities).
- Growth differences between juveniles rearing in floodplains versus in-river were found after a two-week period (Jeffres et al. 2008): expecting same benefits after less than two-week inundation period not warranted.
- Increased growth on floodplains is likely related to several factors including warmer water temperatures resulting from shallower depths and greater surface area than found in-river, as well as lower velocities and better food sources (Sommer et al. 2001).

Stranding risk associated with floodplain draining.

- Sommer et al. (2005) suggests that the majority of fish successfully emigrated from the Yolo Bypass because this particular floodplain drains fairly efficiently due to the low percentage of isolated pond area under both peak flood and draining periods; yet over 120,000 Chinook may have been stranded during that study (Sommer et al. 2005).
- Compared to the Yolo Bypass, where ponds are relatively rare and the Bypass is gradually sloped into a parallel toe drain, oxbow channel features characteristic of the lower SJR may not provide ideal rearing habitat for outmigrating salmonids and flooded oxbows are likely to result in significant stranding of juvenile salmon.

Achieving floodplain inundation is questionable under the maximum monthly target flows identified for each tributary by SWRCB (2012).

- DFG (2010c) visually inferred floodplain inundation from graphs of flow-area relationships
    - Wetted surface area increases on the graphs more quickly between 3,000-5,000 cfs (Merced) and between 4,000-6,000 cfs (Tuolumne) indicating greater increases in width, which suggests bank overtopping or floodplain inundation
    - The Stanislaus River channel did not appear to have a well-defined floodplain within the 100 to 10,000 cfs flow range examined (SWRCB 2012, DFG 2010); note: other unpublished studies of a small portion of the Stanislaus River (5.7 miles) indicates that a minimum of 3,000 cfs would be required for this portion of the river.
    - Therefore, minimum floodplain thresholds considered 3,000 cfs for the Merced and Stanislaus Rivers, and 4,000 cfs for the Tuolumne River.
- Assuming minimum floodplain thresholds above (i.e., 3,000 cfs for the Merced and Stanislaus Rivers, and 4,000 cfs for the Tuolumne River), all three minima exceed the maximum monthly target flows as specified for each tributary by the SWRCB's Technical Report (2012)(i.e., 2,500 cfs for the Stanislaus River; 3,500 cfs for the Tuolumne River; and 2,000 cfs for the Merced River). It is unknown at this time how the SWRCB's Technical Report (2012) intends that these maximum flow targets would be achieved (i.e., maximum daily amounts per month, or maximum average daily amounts per month), but if the SWRCB intends for these to be maximum daily targets, then floodplain inundation thresholds (3,000-4,000 cfs) exceed all targets.

Brief floodplain inundation (< two weeks) has not shown benefit.

- Assuming that floodplain does begin to inundate at these minimum floodplain inundation threshold flows identified above (i.e., 3,000-4,000 cfs, which is questionable), it remains to be discerned whether inundation periods <two-weeks are of sufficient duration to provide measurable benefits to rearing salmonids. Growth differences between floodplain-reared and in-river juveniles have been found after a two-week growth period in the Cosumnes River (Jeffres et al. 2008),

yet expecting similar growth increases in San Joaquin River floodplains after <2-week inundation periods is not warranted. Furthermore, Sommer et al. (2001) indicated that characteristics that possibly accounted for an increased growth rate on floodplain habitats included warmer water temperatures than in-river resulting from shallower depths and greater surface area, as well as lower velocities and better food sources (Sommer et al. 2001). Warmer water temperatures did not become apparent until ambient air temperatures began to increase, beginning in March. As mentioned previously, shallow water floodplain habitat is not prevalent in the San Joaquin Basin.

Late spring floodplain inundation.

- Increasing air temperatures in late spring (late May and June) are expected to lead to warmer water on the floodplains than in the river channels. According to Feyrer et al. (2006), the water temperatures on the Sutter and Yolo bypasses rose to about 24°C by June 2002 and 2004. These temperatures are approaching the chronic upper lethal limit for CV Chinook salmon (approximately 25°C) and according to Myrick and Cech (2001), juvenile Chinook salmon reared at water temperatures between 21 and 24°C were more vulnerable to striped bass predation than those reared at lower water temperatures.

SWRCB's Technical Report (2012) emphasizes the need for creating more floodplain in the San Joaquin Basin through higher flows, but "floodplain habitat" is not defined nor quantified for the San Joaquin Basin.

- The attributes of "floodplain habitat," such as depth, velocity, cover, and water temperature, are not defined.
- No information/data is presented as to how much floodplain habitat exists in the San Joaquin Basin, how much could be gained at various flows, or what the benefit to Chinook would be.

Recent Information Not Previously Available to the SWRCB

USBR technical feedback committee meeting SJRPP, July 2012.

Recent presentations at the USBR technical feedback committee meeting for the San Joaquin River Restoration Program (SJRRP) (USBR 2012), while summarizing the current state of salmon restoration science in the SJR, clearly illustrated the lack of specific information that is required for sound decision making.

Estimates of in-river habitat (including floodplain) requirements for successful rearing of enough juvenile salmon to meet management goals currently rely on many unrealistic assumptions, and are based on "territory size" required by juvenile salmonids at various developmental stages (e.g., fry require less "territory" than smolts). It should be noted that available suitable habitat (ASH) does not directly correspond to total habitat requirements, as it doesn't take into consideration the amount of river channel, riparian vegetation, sediment input, etc. needed to support the ASH.

Survival simulations indicate that, under current estimated mortality rates (based on other watersheds), the production goal of 44,000-1.6 million (spring run) and 63,000 – 750,000 (fall run) successful juvenile outmigrants would require 121 million spring-run and 173 million fall-run fry hatched at the spawning grounds. As juveniles move downstream and their sizes increase (and abundance decreases), territory size requirements are applied to abundance modeling based on a length-territory size relationship for salmonids from Grant and Kramer (1990). Preliminary estimates for maximum required suitable rearing habitat (in acres) are summarized in the table below:

Reach	Spring-Run	Fall-Run	Both Runs
Lower 1B	73	158	231
2A	121	276	397
3	59	183	242
4A	13	88	101
4B1	14	40	54
4B2	6	10	16
5	7	5	12
Total	**365**	**861**	**1226**

As SJR tributaries are deficient in shallow-water floodplain habitat, higher flows are proposed to reduce available habitat requirements, as fish are moved out of the system in a conveyor belt like fashion (Dr. Merz) and will therefore spend less time rearing in-river. However, note that data from other rivers in both the northern and southern CV are used to inform simulations for the SJR, which may not be applicable or sound. In addition, the model was purposely kept simple, and many potentially important habitat characteristics (variable flow timing) were not included in the simulations.

Available floodplain modeling for the SJR is also still in its infancy, and so far only three water year scenarios have been examined (dry, normal, wet), and overall results were far too variable to draw clear conclusions:

- Overall available habitat results varied wildly depending on levee alignment;
- For each different levee alignment, the results varied drastically dependent on flow;
- Results also varied dependent on vegetative cover options;
- Some scenarios resulted in a small surplus of adequate floodplain habitat; others resulted in a deficiency of thousands of acres.

Furthermore, definitions of vegetative cover are not sufficiently refined, as shrub cover (which perhaps comprises most of the available habitat) is not included in the model since it cannot be estimated from aerial photography.

Current results from physical and biological model integration were not presented, but will be made available on the SJRRP website in the near future.

Stanislaus River Floodplain Versus Flow Relationships- USFWS results March 7, 2012.

A brief description of Stanislaus Floodplain modeling was provided in a March 2012 report (USFWS 2012) and presented at a Stanislaus Operations Group (SOG) meeting in May 2012 (SOG 2012). The goal was to develop a two-dimensional hydraulic model to quantify the relationship between floodplain area and flow for the Ripon to Jacob Myers reach of the Stanislaus River (RM 17.2 to 34.7), for flows ranging from 250 to 5,000 cfs.

Floodplain was defined based on a modeled wetted area versus flow relationship. First, a graph of total wetted area versus flow was examined to determine the flow at which floodplain inundation begins, as indicated by an inflection point in the graph (the wetted area vs. flow graph from which the inflection point was determined is the figure supplied as part of the meeting notes, inundation begins at ~1250 cfs). Then, the total wetted area at higher flows is subtracted from the total wetted area at which floodplain inundation begins to determine the inundated floodplain area at each flow (meaning that floodplain is essentially considered 0 at ~1,250 and then accrues as flows increase above this amount). Based on this standard methodology, floodplain inundation is expected to encompass low flow channels since the inflection point is likely not observed until other areas also become inundated.

No floodplain depths were specified in the graph provided in the meeting notes. However, in the report, there is one figure that provides depths of floodplain (red) expected at 1,500 cfs, which ranged from 0-2 meters deep (0-6 feet). Due to the color codes used, it is difficult to ascertain whether these depths are closer to zero or closer to 6 feet, which would affect whether these inundated areas would provide good rearing habitat. USFWS is only interested in total floodplain area (macrohabitat level), so indicated that wouldn't be providing any additional depth related figures, nor will velocities and water temperatures (microhabitat level) be incorporated into the floodplain model since the floodplain analysis is being done on a macrohabitat basis and there is no consideration of microhabitat variability (e.g., velocity or water temperature). In addition, the model used is not suitable for microhabitat level analysis given its coarse spatial scale resolution, so any efforts to look at those variables would require a different model.

USFWS' results for the Orange Blossom Bridge to Knight's Ferry reach (7.4 miles) indicate that 35 acres of floodplain accrue between flows of 1,500 cfs to 3,000 cfs with an additional 32.1 acres between 3,000 cfs and 5,000 cfs.

USFWS' future plans include conducting hydraulic models for additional reaches (Jacob Myers to Orange Blossom Bridge and Ripon to SJR confluence), and the results for all four reaches probably won't be presented in a report until February or March of 2013.

3. FLOW QUANTITY AND TIMING

Overview

Managed flow pulses are frequently used to stimulate migration of salmonids in the San Joaquin Basin. Under specific conditions, migration of returning spawners, as well as emigrating juveniles, can be temporarily stimulated through increases in discharge. However, there is no evidence that such flows are required for successful adult migration or that they can reduce straying rates of natural-origin fish.

Higher flows increase fry survival in the tributaries, but not necessarily true for parr and smolts; and the benefits to adult escapement are uncertain. Fry migrants from SJR tributaries exhibit higher survival during periods of higher flows; however, our understanding of the contribution of fry to adult recruitment is quite limited. Since 2003, survival through the South Delta has been very low, and high flow events have failed to increase survival to levels observed when flows ranged between 5,000 and 6,000 cfs, despite flood flows of up to 25,000 cfs during the juvenile emigration period.

Relevant Information Regarding Flow Quantity and Timing

Juvenile Chinook migration out of the tributaries is *temporarily* stimulated by changes in flow, but long duration pulse flows do not "flush" fish out of the tributaries.

- Juvenile Chinook migration can be temporarily stimulated by changes in flow, but the stimulatory effect is short lived (few days) and only affects fish that are ready to migrate (Demko and Cramer 1995; Demko et al. 1996, 2000, 2001).
- Juvenile migration from the tributaries typically begins in January and nearly all juveniles migrate out of the tributaries by May 15 (SJRGA 2008).
- Except in wet and above normal years, 0.7% or less of total juvenile salmon (i.e., fry, parr, and smolts), and 0.8% or less of salmon smolt outmigrate during June.

Higher flows increase fry survival in the tributaries, but not necessarily true for parr and smolts; benefits to adult escapement are uncertain.

- Over a decade of rotary screw trap monitoring in the Stanislaus River shows that flow has a strong positive relationship with migration survival of Chinook fry (Pyper et al. 2006).
- Smolt survival (CWT) studies conducted by CDFG at flows ranging from 600 cfs to 1500 cfs and at 4,500 cfs have shown that smolt survival is highly variable and not improved by higher flows in the Stanislaus River (SRFG 2004; CDFG unpublished data).
- Similarly, analyses of rotary screw trap data found that abundance ratios for parr and smolts were only weakly correlated with flows (Pyper and Justice 2006).
- Smolt survival indices in the San Joaquin River from the Merced River downstream to Mossdale indicate little relationship to flow (TID/MID 2007).
- The contribution of fry emigrants (Feb/March) to total salmon production in the San Joaquin Basin is unknown (Baker and Morhardt 2001; SRFG 2004; SJRGA 2008; Pyper and Justice 2006).
    - However, a sample (n=100) of Central Valley fall-run Chinook salmon (unknown tributary origins) captured in the 2006 ocean fisheries were comprised of an average 20.1% (± 5.4%) individuals that emigrated as fry in 2003 and 2004 (Miller et al. 2010).

A flow regime based upon 60% (or lower) of unimpaired flows in February or in June is not likely to provide the potential benefits that the SWRCB's Technical Report (2012) identified, and providing such flows in February and June is not

consistent with the States's policy to "achieve the highest water quality consistent with maximum benefit to the people of the state."

- See Palmer et. al (2012) and Fuller et. al (2012) for details.

Flow does not explain the low Delta survival of juvenile Chinook observed since 2003, so more flow is unlikely the solution.

- South Delta survival has been low since 2003. During this period, flood flows of approximately 10,000 cfs and 25,000 cfs during outmigration in two years (2005 and 2006) did not increase survival near levels when flows were moderately high (5,700 cfs) in 2000. It is unclear why smolt survival between 2003 and 2006 has been so low (SJRGA 2007b).
- Smolt survival during 2003-2006 was unexpectedly far lower than it was historically. Models based on historical data that do not accurately represent recent conditions (e.g., Newman 2008 and others) should not be used to predict future scenarios (VAMP Tech. Team 2009).

Fall flow pulses *temporarily* stimulate upstream migration of adult Chinook salmon into San Joaquin Basin tributaries, but no evidence that attraction flows benefit the species.

- Prolonged, high volume pulse flows in the fall are not warranted. Equivalent stimulation of adult migration may be achieved through relatively modest pulse flows (Pyper et. al 2006).
    - Relatively modest pulse-flow event (an increase of roughly 200 cfs for 3 days) was found to stimulate migration.
    - Stimulatory effect of both pulse-flow and attraction flows were short in duration (migration increased for 2-3 days).
- Adult migration rate and timing is not dependent upon water temperature or dissolved oxygen concentrations (Pyper et. al 2006).
    - No evidence that low flows (1,000 to 1,500 cfs) in the SJR are an impediment to migration.
- Migration appears to be stimulated by pulse flows, but no evidence that natural origin fish would stray or not migrate to San Joaquin tributaries if no pulse.
    - "Consistent movement patterns [Klamath fall Chinook migrants] with or without pulse flows is compelling evidence that these flows did not trigger upriver movement or otherwise substantially alter migration behavior" (Strange 2007).
    - No clear relationship between increased water flow and stimulated Atlantic salmon migration was found in River Mandalselva (southern Norway) (Thorstad and Heggberget 1998).
    - To attract adult Atlantic salmon migration into rivers, flows must occur in conjunction with other cues such as cooler weather or natural freshets (Mills 1991).
- Fall pulse flows may attract out-of-basin hatchery fish.
    - The Constant Fractional Marking Program, which began in 2007, is just now providing more complete information regarding straying rates, and

results indicate that hatchery straying may be substantial in the SJR Basin. In 2010, fall-run spawners in the Stanislaus River were 50% hatchery-origin despite the lack of a hatchery on the river; of those the majority came from either Nimbus Fish Hatchery fall-run net pen releases (31%), Mokelumne River Hatchery fall-run net pen releases (26%), or the Mokelumne River Hatchery fall-run trucked releases without net pen acclimation (23%)(Kormos et al. 2012).

4. WATER TEMPERATURE

Overview

The temperature tolerances of CV salmon stocks are likely distinct from those of other stocks in the Pacific Northwest, and the applicability of laboratory derived tolerance values to stocks that have evolved in (and are adapted to) habitats at the southernmost extent of the species' range is questionable. High growth and survival of natural Chinook stocks in the CV at temperatures considered higher than optimal for most stocks (based on data from northern stocks) indicate high thermal tolerance of these stocks. There is no clear evidence that San Joaquin Basin stocks are adversely impacted by the current temperature regime. Neither adult nor juvenile migration appear impeded by temperatures observed under current flow management, as indicated by the absence of high pre-spawn mortality or temperature dependent migration timing of adults. Furthermore, the vast majority of juveniles emigrate prior to increases in water temperature resulting from warming air temperatures (the main factor influencing water temperatures) in late spring.

Relevant Information Regarding Water Temperature

The dominant factor influencing water temperature is ambient air temperature.

- Ambient air temperature is the primary factor affecting water temperature.
- By the end of May, water temperatures at Vernalis range between 18 and 21°C (65°F and 70°F) regardless of flow levels between 3,000 cfs and 30,000 cfs (SRFG 2004).
  - On average, maximum daily water temperatures are at or above 20°C (68°F) at Vernalis, Mossdale, and RRI after May 15, and by June 16-30, even the coolest year on record (2005) was only slightly below 20°C at Vernalis, at 20°C at Mossdale, and above 20°C RRI.
- Based on data from the Western Regional Climate Center for Stockton during 1948-2006 (station 048558 WSO; http://www.wrcc.dri.edu), the average daily air temperature at Stockton during June is 22.6°C (72.7°F), and therefore the guideline used by the EPA, which is nearly 3°C cooler, will never be met during June.

Water temperature criteria from Pacific Northwest stocks do not apply to San Joaquin salmon and steelhead; and little is known about the responses of Central Valley species to in-river water temperatures.

- The SJR represents the southernmost extent of the current range of Chinook salmon. Southernmost stocks have evolved under much warmer and drier meteorological conditions than stocks in the Northwest; therefore, criteria based on northern stocks are not directly applicable.
- The applicability of thermal criteria derived from the laboratory has long been debated, and there has been no validation of the growth vs. water temperature relationship for any of the listed species in the CV to assess if laboratory results are transferable to these southern stocks (Myrick and Cech 2004).
- Wild Chinook salmon in the Central Valley often experience water temperatures higher than "optimal" (as based on northern stock data) yet still have high growth and survival. It is this flexibility that has made Chinook salmon so successful in the CV and able to thrive where less temperature tolerant salmonids cannot (Moyle 2005).
- Juvenile Chinook can survive exposure to water temperatures of 24ºC (75.2ºF), depending on their thermal history, availability of refuges in cooler water, and night-time water temperatures (Moyle 2005).
- While much information is available on lifestage-specific water temperature ranges of Chinook salmon and steelhead in the Pacific Northwest, little is known about the specific responses of CV species to water temperature (Williams et al. 2007).
- Water temperature standards are often based on a seven-day average of the daily maximums (7DADM) not to be exceeded; this approach does not reflect the duration of exposure and the range of temperatures that fish may experience. It is possible for Chinook salmon to maintain populations even when they experience periods of suboptimal or even near-lethal conditions. For example, the most productive spring-run Chinook salmon stream in California (i.e., Butte Creek) can experience daily maxima up to 24ºC (75.2ºF) with minima of 18-20ºC (64.4-68.0ºF) for short periods of time in pools where juveniles are rearing and adults are holding (Ward et al. 2003).
- Anecdotal evidence suggests that some species of CV salmonids are heat tolerant: "the high temperature tolerance of San Joaquin River fall run salmon, which survived temperatures of 80°F (26.7ºC), inspired interest in introducing those salmon into the warm rivers of the eastern and southern US (Yoshiyama 1996)."
- Historically, the San Joaquin Basin has had higher water temperatures than all the other rivers that support Chinook salmon and so it is possible that the San Joaquin race has evolved to withstand higher temperatures than 18.3ºC (65°F) (CALFED 1999).
- Additionally, southern steelhead stocks of the CV may have greater thermal tolerance than those in the Pacific Northwest (Myrick and Cech 2004).
- The optimum growth temperature for American River steelhead was nearly 3ºC (5ºF) warmer than the optimum growth temperature for more northern stocks (Wurtsbaugh and Davis 1977; Myrick and Cech 2004; Myrick and Cech 2001).

There is no evidence that temperatures are unsuitable for adult fall-run Chinook upstream migration in the San Joaquin Basin.

- Adult migration timing was unrelated to temperature, dissolved oxygen (DO), or turbidity conditions (Pyper et. al 2006).
- Although temperatures were exceptionally cool during September 2006, salmon did not migrate earlier than during 2003-2005. During September 2006, temperatures were as much as 3ºC (5ºF) cooler in the SJR at Rough and Ready Island (RM 37.9), Mossdale (RM 56.3), and Vernalis (RM 72.3), and as much as 5ºC (9°F) cooler in the Stanislaus River at Ripon (RM 15.7) as compared to monthly average temperatures at the same locations during 2003-2005. September flows in the Stanislaus and SJR exceeded average unimpaired flow conditions during all of these years (CDEC; Ripon gauge).
- Temperatures at Rough and Ready Island (RRI) typically above 21ºC (70°F) during early migration season; larger fraction of early migrants traveled under higher temperatures in 2003 than other years (Pyper et. al 2006).
- Managed flows in the San Joaquin Basin during September are higher than historic unimpaired (computed natural) flows. Natural SJR flows were lowest during September and flows were extremely low or nonexistent in dry years. During 1922-1992, the average unimpaired flows during September were 117 cfs in the Stanislaus River, 185 cfs in the Tuolumne River, 84 cfs in the Merced River, and 808 cfs in the SJR (CDWR 1994). Elevated discharge levels of cool water from reservoir storage actually increase flow and decreases temperature during these time intervals.
- If temperatures were a problem for adult migrants in the SJR Basin, high pre-spawn mortality would be expected. However, studies conducted by DFG demonstrated that the incidence of pre-spawn mortality is quite low (i.e., 0%-4.5%) and appears to be density, not temperature, dependent (Guignard 2005 through 2008).
- Bay temperatures over 18ºC (65°F) in September when fish are migrating (CDEC; various stations).

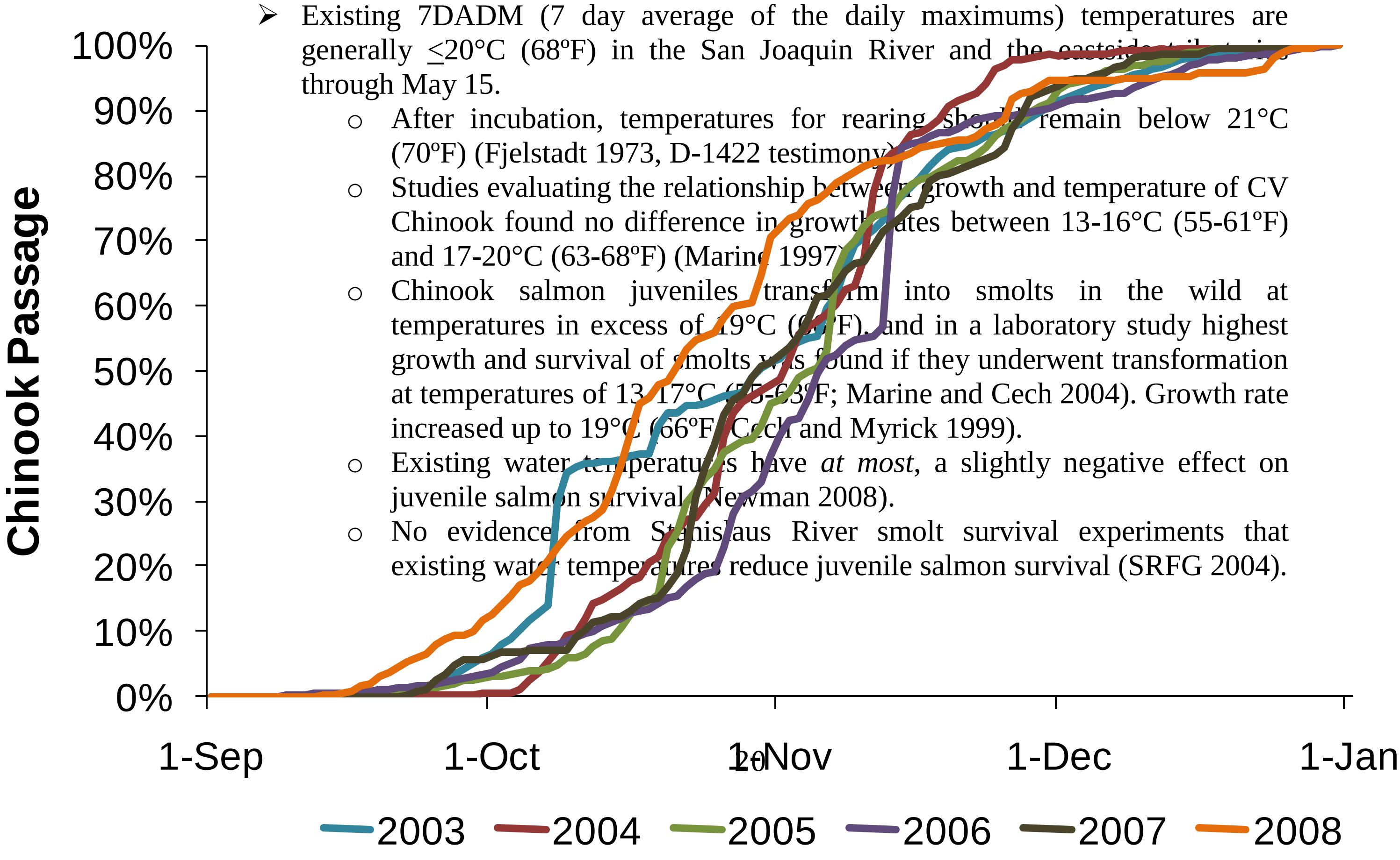

Figure 1. Cumulative upstream passage at the Stanislaus River Weir during 2003-2008 (FISHBIO 2009).

There is no evidence that temperatures for juvenile rearing and migration need to be colder than existing conditions or maintained through June 15.

- Nearly all juvenile Chinook migrate prior to May 15, and <1% migrate after May, except in wet and above normal water years. Also, 90-99% of non ad-clipped salvaged *O.mykiss* are encountered between January and May depending on water year type.
- Existing 7DADM (7 day average of the daily maximums) temperatures are generally ≤20°C (68ºF) in the San Joaquin River and the eastside tributaries through May 15.
  - After incubation, temperatures for rearing should remain below 21°C (70ºF) (Fjelstadt 1973, D-1422 testimony).
  - Studies evaluating the relationship between growth and temperature of CV Chinook found no difference in growth rates between 13-16°C (55-61ºF) and 17-20°C (63-68ºF) (Marine 1997).
  - Chinook salmon juveniles transform into smolts in the wild at temperatures in excess of 19°C (66ºF), and in a laboratory study highest growth and survival of smolts was found if they underwent transformation at temperatures of 13-17°C (55-63ºF; Marine and Cech 2004). Growth rate increased up to 19°C (66ºF; Cech and Myrick 1999).
  - Existing water temperatures have *at most*, a slightly negative effect on juvenile salmon survival (Newman 2008).
  - No evidence from Stanislaus River smolt survival experiments that existing water temperatures reduce juvenile salmon survival (SRFG 2004).

The restoration of the SJR upstream of the Merced River (San Joaquin River Restoration Program; SJRRP) will adversely affect water temperatures in the lower SJR during the spring and fall.

- The lower SJR downstream of the Merced River confluence is identified as temperature impaired (USEPA 2010). According to water temperature modeling conducted by AD Consultants (SJRGA 2007a), although the SJRRP flows will add more water in this reach, the travel time is such that when the new water reaches the Merced River confluence, it approaches equilibrium with ambient temperature. Even though it is anticipated that the water temperature at the confluence of the Merced and San Joaquin Rivers will be the same with and without the anticipated SJRRP flows, the SJRRP flows themselves are of such a large volume that it would take a comparatively large volume of water from the Merced River to reduce temperatures in the lower San Joaquin River downstream of the Merced confluence. Given the storage capacity of Lake McClure, it is not possible to provide the volume of releases that would be necessary to reduce these water temperatures without quickly exhausting the available water supply.

Releases from tributary reservoirs will not impact water temperatures in the San Joaquin River or South Delta.

- Increasing flows from the tributaries will not decrease water temperatures in the mainstem SJR (SJRGA 2007a).

5. DISSOLVED OXYGEN

Overview

Low dissolved oxygen (DO) levels have been measured in the SJR, in particular in the Deep Water Ship Channel from the Port of Stockton seven miles downstream to Turner Cut. These conditions are the result of increased residence time of water combined with high oxygen demand in the anthropogenically modified channel, which leads to DO depletion, particularly near the sediment-water interface. Despite these conditions, salmon and steelhead migration are not adversely impacted, and has been observed at concentrations as low as 5 mg/L. In addition, salmonids migrate in the upper portions of the water column where DO concentrations are highest.

It has been shown that low DO conditions in the SJR can be ameliorated through installation of the Head of the Old River Barrier (which increases SJR flow and juvenile salmonid survival by preventing fish from entering the Old River and subsequent entrainment), but there is no basis for requiring year-round DO objectives for SJR tributaries (e.g., Stanislaus at Ripon), as fish and aquatic habitat that could benefit from these DO levels are located far upstream of the SJR confluence during the summer months.

Relevant Information regarding Dissolved Oxygen

Low dissolved oxygen concentrations are limited to the Deep Water Ship Channel (DWSC), and are the result of anthropogenic manipulation of channel geometry.

- The eastside rivers (Tuolumne, Stanislaus and Merced) discharge high-quality Sierra Nevada water to the SJR which has low planktonic algal content and oxygen demand, and are not a major source of oxygen demand contributing to the low DO problem in the DWSC (Lee and Jones-Lee 2003).
- The DWSC, starting at the Port of Stockton where the SJR drops from 8-10 feet deep to 35-40 feet deep, is a major factor in DO depletion below the water quality objective. If the DWSC did not exist, there would be few, if any, low DO problems in the channel.
- The critical reach of the SJR DWSC for low DO problems is approximately the seven miles just downstream of the Port to Turner Cut (Lee and Jones-Lee 2003).

Dissolved oxygen concentrations in the DWSC are influenced by Delta exports, but can be ameliorated by installation of the Head of Old River Barrier (Brunell et al. 2010).

- Delta export pumping artificially changes the flows in the South Delta, which results in more of the SJR going through Old River. Water diverted through Old River can significantly reduce the SJR flow through the DWSC, thereby directly contributing to low DO in the DWSC.
- The physical (rock) HORB is installed to improve DO levels in fall.

Existing dissolved oxygen concentrations do not impact salmon and steelhead migration.

- Migration rate and timing is not dependent upon existing dissolved oxygen concentrations.
    - Contrary to the often cited Hallock et al. (1970) report that indicates adult migration was impeded under low dissolved oxygen, migration has been observed at DO less than 5mg/L (Pyper et. al 2006).
- Salmon and steelhead migrate in the upper portion of the water column where DO concentrations are highest due to photosynthesis and atmospheric surface aeration (Lee and Jones-Lee 2003).
- Smolt survival experiments indicate that juvenile salmon survival is not correlated with existing DO concentrations (SRFG 2004; SJRGA 2002 and 2003).

DO objective for DWSC is inconsistent with U.S. EPA national standard.

- The current U.S. EPA national water quality criterion for DO allows for averaging and for low DO concentrations to occur near the sediment-water interface. Central Valley Regional Water Quality Control Board Basin Plan DO water quality objective does not include these adjustments (Lee and Jones-Lee 2003).
- DO concentrations near the bottom in the DWSC waters are sometimes 1-2 mg/L lower than those found in the surface waters (Lee and Jones-Lee 2003).

DO objective on the Stanislaus River at Ripon is not needed year round to protect the salmon or steelhead fishery.

- While the Stanislaus River contains native fish and aquatic habitat that benefit from a minimum DO concentration of 7.0 mg/L, such fish and aquatic habitat are located more than 30 miles upstream of the Ripon compliance point during the summer months.
- Salmonids migrate through the area during late September though May. Neither salmon nor steelhead are typically located anywhere in the Stanislaus River downstream of Orange Blossom Bridge from June through August each year.

Species	Stage	Timing	Geographic Location
Fall-run Chinook salmon			
	Adult Migration	Late September - December	Goodwin Dam to confluence
	Spawning	October – December	Goodwin Dam to Riverbank
	Egg Incubation	October – March	Goodwin Dam to Riverbank
	Juvenile Rearing	Mid December – May	Goodwin Dam to Riverbank
		June – mid December	Goodwin Dam to Orange Blossom Bridge
	Juvenile Migration	January – May	Goodwin Dam to confluence
Steelhead			
	Adult Migration	Late September - March	Goodwin Dam to confluence
	Spawning	December – March	Goodwin Dam to Riverbank
	Egg Incubation	December – July	Goodwin Dam to Riverbank
	Juvenile Rearing	Year-round	Goodwin Dam to Riverbank
	Juvenile Migration	February – May	Goodwin Dam to confluence

6. FOOD

Overview

The SWRCB's Technical Report (2012) purports that increased flows in the early spring will improve food production for early spring salmon rearing (page 3-29): "These flows may also provide for increased and improved edge habitat (generally inundated areas with vegetation) in addition to increased food production for the remainder of salmon that are rearing in-river.". Juvenile salmonids depend on a healthy aquatic food web to survive and grow rapidly. The SWRCB's Technical Report (2012; page 3-42 to 3-43) makes the case that a more natural flow regime would shift the benthic macroinvertebrate community in favor of more palatable prey for fish. While they do not provide any evidence that salmonids are food limited in the SJR and South Delta, they provide evidence that in unregulated streams there are generally more beneficial algae and diatoms, and high winter flows reduce predator-resistant invertebrates. In contrast, the benthic communities of the regulated streams are species-poor, impaired, and with higher relative abundance of predator-resistant invertebrates. However, the report does not provide any support to show that increasing flows in an already highly degraded system has the capability to return primary and secondary production quantity and quality to its pre-regulated state. Furthermore, the Technical Report (2012) does not explain the temporal and spatial scales under consideration for food production.

Relevant Information Regarding Food

Outmigrating Chinook smolts are not food limited during their 3-15 day migration through the lower SJR below Vernalis and the South Delta.

- The SWRCB's Technical Report (2012, page 3-42) provides evidence that, in northern California (unspecified location), ***unregulated*** rivers have more and better food resources than regulated rivers. However, the report does not provide any evidence that increasing flows in an already highly degraded system has the capability to return primary and secondary production quantity and quality to its pre-regulated state.
  - Furthermore, the SWRCB's Technical Report (2012) does not define how it would measure changes in food production (quality or quantity) or the mechanisms thought to drive food production in response to short-term increases in flow.
- The SWRCB's Technical Report (2012) also does not explain temporal and spatial scales under consideration for food production.
  - Based on acoustic VAMP studies in 2008, Holbrook et al. (2009) found that smolts took 3-15 days (median 6-9 days) for migration through the lower San Joaquin River and South Delta; demand for food production over such a short duration is questionable.
  - Increases in primary and secondary production that occur due to restoration or changes in management likely occur over longer periods of time, rather than that targeted by short-term pulse flows.
  - Spatial scale is important too, as impacts to food resources are generated at different rates and via different processes depending on where they are located in the river continuum.

7. CONTAMINANTS

Overview

According to the SWRCB's Technical Report (2012), contaminants are one of several "stressors" or "other factors" in the SJR Basin. One of the functions supported by spring flows according to the SWRCB's Technical Report (2012) is that higher inflows provide better water quality conditions by reducing contaminant concentrations. The influence of higher flows on contaminant concentrations in the SJR is variable and not well understood; dilution may occur in some instances but increases may occur in others (Orlando and Kuivila 2005). Dissolved contaminants and suspended contaminants respond differently to changes in flow. While higher flows may dilute some contaminants, such as selenium, mercury and DDT, contaminants in the bottom sediments of the SJR could also be remobilized during higher flows (McBain and Trush, Inc 2002). Citations were not presented in the SWRCB's Technical Report (2012) in support of the statement that higher inflows reduce contaminant concentrations.

The SWRCB's Technical Report (2012) also states that higher spring flows will reduce travel time and exposure of smolts to contaminants. Despite concerns over the threat contaminants may pose to threatened and endangered salmonid species, little is known regarding the effects of these contaminants on the health and survival of juvenile Chinook salmon in the Delta and its tributaries (Orlando et al. 2005). More studies are needed to determine the potential effects of short-term exposure to contaminants for outmigrating Chinook smolts, which pass through the South Delta relatively quickly.

Relevant Information Regarding Contaminants

No evidence or citations were provided to support the idea that higher inflows reduce contaminant concentrations.

- The SWRCB's Technical Report (2012; 3-29) states, "Higher inflows also provide better water quality conditions by reducing temperatures, increasing dissolved oxygen levels, and ***reducing contaminant concentrations***" (Emphasis added; pages 48 & 49); however, the report does not provide any references or further discussion to support this statement.
- The SWRCB's Technical Report (2012) may be inferring that higher flows would act to dilute already suspended contaminants. However, the influence of higher flows on contaminant concentrations is variable; dilution may occur in some instances but increases may occur in others.

SWRCB failed to consider that higher flows may also lead to increased suspended contaminant concentrations.

- High flows can also lead to increases in contaminant concentrations resulting from the resuspension of contaminants located in riverbed sediments. Contaminants in suspended sediments may affect the ecosystem differently from dissolved contaminants, since filter feeding organisms consume suspended sediments and organic material (allowing the contaminants in the sediments to enter into the food web) and may have longer residence times in the rivers and estuaries in comparison with water (Bergamaschi et al. 1997).

- Research has begun to focus on the relationship between freshwater flow and contaminant transport to and through the Delta. Although increased flows can result in reduced dissolved or suspended sediment concentrations of some contaminants, they can also lead to increased pesticide loading.
- In a study conducted just downstream of Vernalis, the U.S. Geological Survey (USGS) examined the concentrations of organic contaminants in surface water sites along the SJR and in the Old River before, during and after the VAMP month-long pulse flow (Orlando and Kuivila 2005).
    - Of the 13 total pesticides detected, diazinon and three herbicides (metolachlor, simazine, and trifluralin) were found in every sample.
    - Although it might be expected that the higher flows would dilute the contaminants, the results were mixed. Diazinon and simazine were highest at SJR and OR sites before VAMP (4/2/01 and 4/6/01), showed intermediate values during the VAMP period (5/14/01 and 5/18/01) and then reached lowest values during the post-VAMP period (5/31/01 and 6/4/01). Metolachlor showed the opposite trend at SJR and OR sites and increased throughout the three periods. Trifluralin showed a peak during the VAMP period for most sites. Suspended sediments were highest in the SJR during VAMP; however, the opposite was true for the Old River, suspended sediments were lower during VAMP compared to just before and after the VAMP period. This was likely influenced by the operations of the Head of the Old River Barrier (HORB), which was installed during the 2001 VAMP period. All six culvert slide gates were open from April 26 to May 26, allowing some water to pass into the Old River. Suspended sediment concentrations generally increase with increasing streamflow, but there are likely nonlinear relationships between streamflow, suspended sediment concentration, and contaminant concentration.
    - Limited conclusions can be drawn from a study with such a narrow spatial and temporal scope, however it is clear that increased flows do not necessarily lead to reduced contaminant concentrations. Undoubtedly, more research is needed to clarify this process.
- Furthermore, the relationship between flow and contaminants is not obvious upstream of Vernalis. As summarized in the Background Report for the San Joaquin River Restoration Study (McBain and Trush, Inc 2002), while higher flows may dilute some contaminants, such as selenium, mercury and DDT, contaminants in the bottom sediments of the SJR could also be remobilized during higher flows.
    - McBain and Trush (2002) found that "although water quality conditions on the SJR relating to conservative ions, (e.g., salt and boron), and some nutrients are likely to improve under increased flow conditions, it is unclear how these and other potential restoration actions will impact many of the current TMDL programs and existing contaminant load estimates. This is most true of constituents with complex oxidation reduction chemistry, and sediment/water/biota compartmentalization (e.g.,

pesticides, trace metals). Perhaps the greatest risks to potential restoration actions within the San Joaquin River study reaches relate to uncertainties regarding remobilization of past deposits of organochlorine pesticides, i.e., DDT and mercury."

It remains unknown whether, or to what extent, migrating salmonids may be affected by suspended contaminants.

- It is generally recognized that contaminants can have a negative effect on aquatic ecosystems, however despite the extensive studies conducted in the field of toxicology, the direct ('acute toxicity' leading to death; or 'chronic' or 'sublethal toxicity' leading to decreased physical health; NMFS 2009a) and indirect effects (reduction of invertebrate prey sources, reducing energetically favorable prey species relative to less energetically profitable or palatable prey; Macneale et al. 2010) of pollutants on salmon in the wild are not well understood.
- Despite concerns over the threat contaminants may pose to threatened and endangered salmonid species, little is known regarding the effects of these contaminants on the health and survival of juvenile Chinook salmon in the Delta and its tributaries (Orlando et al. 2005).
- In a small scale, pilot study of contaminant concentrations in fish from the Delta and lower SJR, resident species were tested for some of the contaminants listed above; however, no salmonid species were tested (Davis et al. 2000).
    - The study found that 11 out of 19 adult largemouth bass sampled exceeded the mercury screening values, with a general pattern of lower concentrations downstream in the SJR toward the central Delta. DDT concentrations were exceeded in 6 of 11 white catfish, but only 1 of 19 largemouth bass. All samples above the DDT screening value were obtained from the South Delta or lower SJR watershed, indicating that the South Delta is still influenced by historic DDT use in the SJR basin. Two of the listed organophosphate pesticides were measured; diazinon was not detected in any sample and chlorpyrifos was detected in 11 of 47 samples analyzed, but at concentrations well below the screening value.
    - With regards to salmonids, however, it is important to consider that resident fish may experience chronic exposure to these chemicals, while outmigrating Chinook smolts pass through the South Delta in a relatively short period of time.
- A study by Meador et al. (2002) focused on estimating threshold PCB concentrations for juvenile Chinook salmon migrating through urban estuaries. PCBs were a concern because they had been shown to alter thyroid hormones important for the process of smoltification. During smoltification, salmonids tend to show declines in muscle lipids, the main lipid storage organ for salmonids, causing the PCBs to be redistributed to, and concentrated in, other organs (Meador et al. 2002).
    - Results of this study indicate that tissue concentrations below 2.4 mg PCB g-1 lipid should protect juvenile salmon migrating through urban estuaries from adverse effects specifically due to PCB exposure. This does not take

into account any effects of other contaminants likely to also be in estuarine waters such as the Delta.

Bioaccumulation, rather than exposure to dissolved contaminants, is likely the main concern for migrating juvenile Chinook.

- Pesticides in the water column may be dissolved contaminants or they may accumulate in suspended sediments associated with organic matter.
  - Dissolved contaminants can be absorbed through the gills or skin and this uptake may show more variability than the other exposure routes depending on concentrations, temperature and stress (Meador et al. 2002).
  - Contaminants that accumulate in riverbed sediments may be resuspended (Pereira et al. 1996), and enter the food chain through filter-feeding benthic or pelagic organisms, such as Corbicula clams. In turn, bottom feeder fish species (e.g., carp and catfish) consume filter-feeding invertebrates (Brown 1997). This process leads to bioaccumulation of the contaminants up the food chain.
  - Bioaccumulation, rather than exposure to dissolved contaminants, is likely the main concern for migrating juvenile Chinook (Meadnor et al. 2002). Factors that affect bioaccumulation include: variable uptake and elimination rates, reduced bioavailability, reduced exposure, and insufficient time for sediment–water partitioning or tissue steady state can affect (Meador et al. 2002).

8. VELOCITY

Overview

According to the SWRCB Technical Report (2012; page 3-29), higher spring flows “facilitate transfer of fish downstream” and “provide improved transport”. The term “facilitate transport” is undefined and is too vague to evaluate adequately. Although the SWRCB’s Technical Report (2012) cites DOI’s comments to the State Water Board (DOI 2010) regarding this function, there is no reference to “facilitate transport” anywhere in the DOI (2010) text. Therefore, it is unclear by what mechanisms spring flows facilitate transport of smolts, what the benefits are, and how the benefits may be influenced by factors such as flow level and duration.

Nonetheless, the SWRCB’s Technical Report (2012) may be suggesting that increased flows result in increased ***velocity***, which may lead to decreased juvenile salmonid travel time through the region, thus ‘facilitating transport’. Modeling suggests that velocities at the Head of Old River may increase by about 1 ft/s with an additional 6,000 cfs SJR flow, but the model predicts little to no change in velocity at other stations in the South Delta (Paulsen et al. 2008). Thus, increased flows may increase velocity near the boundary of the Delta, but do not substantially increase velocity through the Delta.

SWRCB's Technical Report (2012) Assertions Regarding Relationship Between San Joaquin River Flows and Velocity (Transport)

Bold statements below indicate the SWRCB's Technical Report (2012) assertions regarding relationship between SJR flows and transport, followed by supporting/contrary evidence, as follows:

SWRCB Assertion 1. In the late winter and spring, increased flows provide or facilitate improved transport of fish downstream (page 3-29).

- No evidence is provided that higher spring flows "facilitate transport," or present any potential mechanisms by which "facilitation" could be measured.
- The term "facilitate transport" is undefined in the SWRCB's Technical Report (2012) and it is unclear by what mechanisms spring flows facilitate transport of smolts, what the benefits are, and how the benefits may be influenced by factors such as flow level, duration, turbidity, etc.
  - The SWRCB's Technical Report (2012) cites an early USFWS exhibit submitted to the SWRCB (USFWS 1987) in support of the hypothesis that increased SJR flows are positively related to smolt migration rates, "with smolt migration rates more than doubling as inflow increased from 2,000 to 7,000 cfs." However, the original reference does not specify how and when these data were gathered and analyzed.
  - Presumably, these data (USFWS 1987) are part of the work conducted by the USFWS as part of the Interagency Ecological Program for the Sacramento-San Joaquin Delta (IEP). As in other documents related to IEP and other early studies, data have often been misinterpreted, or there were factors not considered such as the potential for different sized fish to be released (different sized fish behave differently giving the appearance that migration rates were influenced by flows).
- In 2001, these hypotheses regarding flow and migration rates were already in question as evidenced by Baker and Morhardt (2001), which stated that "initially it seems intuitively reasonable that increased flows entering the Delta from the SJR at Vernalis would decrease travel times and speed passage, with concomitant benefits to survival. The data, however, show otherwise."
  - Baker and Morhardt (2001) examined the relationship between mean smolt migration times from three locations (one above and two below the Head of the Old River to Chipps Island) and San Joaquin flow (average for the seven days following release) and found no significant relationships at the 95% confidence level, and a significant relationship at the 90% confidence level for only Old River releases.
  - Although flows were not found to facilitate transport, there was evidence of an increase in smolt migration rate with increasing size of released smolts (Baker and Morhardt 2001), which again highlights the limitation of the "black box approach" and emphasizes a need for a better understanding of the mechanisms underlying the relationship of survival and flow. This increase in migration rate with increasing size may be explained by the one factor that definitely helps facilitate the transport of salmon through the Delta: the

salmon itself. Juvenile salmonids are actively swimming, rather than moving passively with the flow, as they migrate towards the ocean (Cramer Decl., Case 1:09-cv-01053-OWW-DLB Document 167, Peake McKinley 1998), and the movements of juvenile salmonids depend on their species and size, water temperature, local hydrology, and many other factors (Cramer Decl., Case 1:09-cv-01053-OWW-DLB Document 167).

- Baker and Morhardt (2001) provide an example of a study which compared the speed of smolt passage to that of tracer particles (particle tracking model - PTM), "in which 80% of the smolts were estimated to have been recovered after two weeks, but only 0.55% of the tracer particles were recovered after two months." According to documents filed in the Consolidated Salmon Cases (Cramer Decl., Case 1:09-cv-01053-OWW-DLB Document 167), simulations of PTM were compared to actual mark and recapture CWT data for Chinook salmon released at Mossdale on the SJR, and it was found that smolts traveled to Chipps Island 3.5 times faster than the modeled particles, with a significant difference in the time to first arrival ($df=76$, $T=9.92$, $p<0.001$).

- In recent years, VAMP has used acoustic tags to monitor smolt outmigration survival, therefore more detailed travel times have been estimated for the various SJR and South Delta reaches.
  - Results have generally shown short travel times between reaches, suggesting active swimming. In 2009, the average travel times were reported for each reach, and all were under 2.5 days (SJRGA 2010). For example, the average travel time between Lathrop and Stockton was only 2.29 days.
- Juvenile salmonids are actively swimming, rather than moving passively with the flow, as they migrate towards the ocean (Cramer Decl., Case 1:09-cv-01053-OWW-DLB Document 167, Peake McKinley 1998).
  - Movements of juvenile salmonids depend on their species, size, water temperature, local hydrology, and many other factors (Cramer Decl., Case 1:09-cv-01053-OWW-DLB Document 167).
  - Recall the Baker and Morhardt (2001 example of a study, which compared the speed of smolt passage to that of tracer particles (i.e., PTM), discussed above.
  - Chinook released at Mossdale traveled to Chipps Island 3.5 times faster than the modeled particles (Cramer Decl., Case 1:09-cv-01053-OWW-DLB Document 167).
- Increased flows may slightly increase velocity near the boundary of the Delta, but do not substantially increase velocity through the Delta.
  - Modeling suggests that velocities at the Head of Old River may increase by about 1 ft/s with an additional 6,000 cfs SJR flow; however, the model predicts little to no change in velocity (<0.5 ft/s) at other stations in the South Delta (Paulsen et al. 2008).

9. PHYSICAL HABITAT

Overview

The historically diverse SJR and South Delta aquatic habitats have been substantially reduced, simplified and altered by development. One of the major changes in the system is the loss of shallow rearing habitat behind levees. Furthermore, aquatic vegetation growth and expansion over the past 20 years has increased water clarity by trapping suspended solids, affecting the composition of the fish communities (Nobriga et al. 2005). The current habitat structure now benefits introduced predators (Brown 2003).

The SWRCB's Technical Report (2012) maintains that the flow regime is the "master variable" that regulates the ecology of rivers, and the other habitat factors affecting community structure (e.g., temperature, water chemistry, physical habitat complexity), "are to some extent determined by flow (Moyle et al. 2011)." The report often refers to increases in physical habitat associated with increasing flow, however it lacks recognition of the limitations due to the substantially altered physical habitat. Much of the lower SJR and South Delta are banked by steep levees (about 443 miles downstream of Stanislaus River; Figure 2), limiting access to floodplain habitat and restricting true channel mobilization flows. For additional information see the discussions in the chapters "Floodplain Habitat" and "Geomorphology".

Relevant Information Regarding Physical Habitat

The physical habitat for native San Joaquin Basin and South Delta fishes has been substantially reduced and altered.

- Diverse habitats historically available in the Delta have been simplified and reduced by development of the watershed (Lindley et al. 2009).
- Spawning and rearing habitat have been severely reduced, salmon total abundance is down, and salmon diversity is reduced (McEvoy, 1986; Yoshiyama et al., 1998, 2001; Williams 2006).
- Major change in system is the loss of shallow rearing habitat (Lindley et al. 2009).
- An estimated 95% of wetlands/floodplains lost to levee construction and agricultural conversion since the mid 1800s (TBI 1998, Simenstad and Bollens 2003, Williams 2006).
- Only ~10% of historical riparian habitat remains, with half of the remaining acreage disturbed or degraded (Katibah 1984).
- Reduction in suitable physical habitat for delta smelt has reduced carrying capacity (Feyrer et al. 2007).

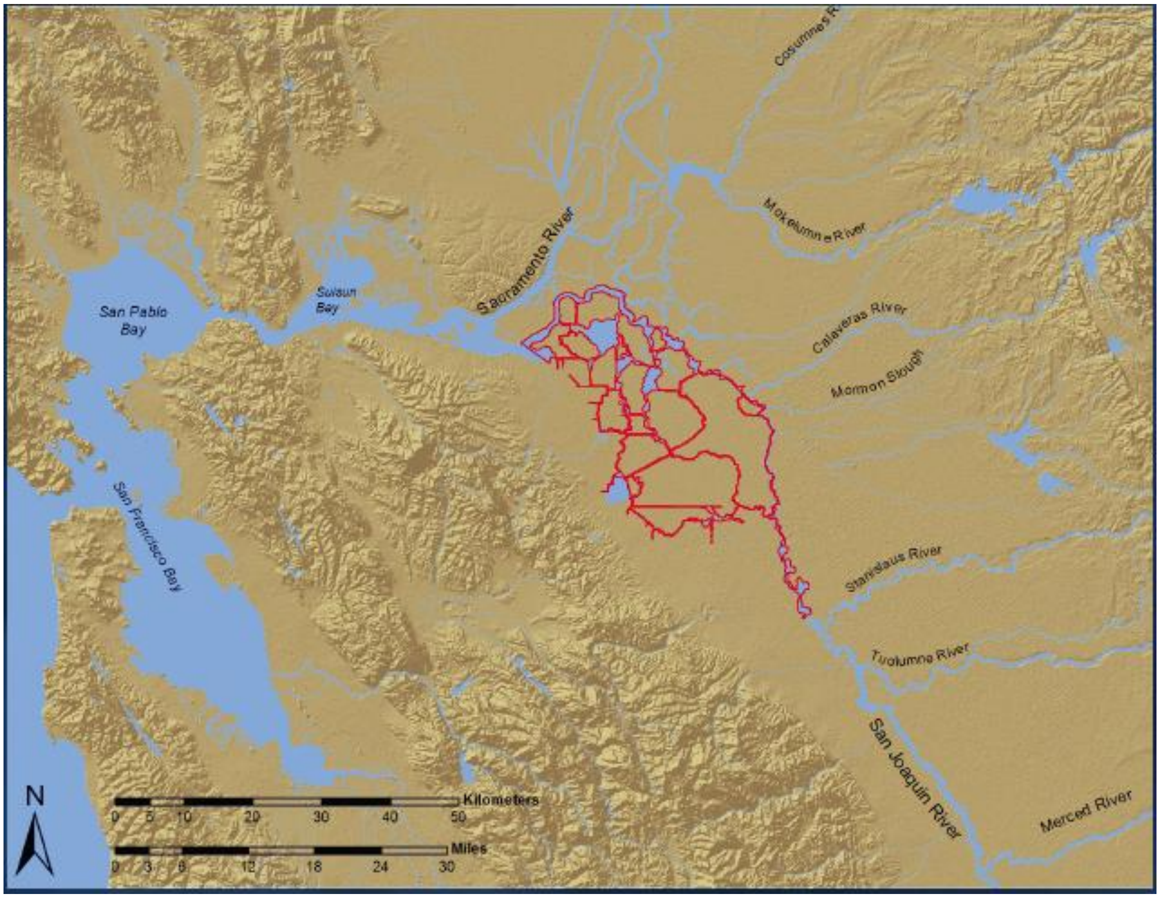

Figure 2. Levees in the South Delta and lower San Joaquin River downstream of the Stanislaus River confluence.

Habitat alterations are linked with invasive species expansions.

- *Egeria densa* (Brazilian waterweed) expansion has increased habitat and abundance of largemouth bass and other invasive predators (Baxter et al. 2008).
- The area near the CVP intake has significant amounts of *E. densa* (Baxter et al. 2008).

- Current habitat structure benefits introduced predators more than natives (Brown 2003).
- *Egeria* has strong influence on results of habitat alterations as different fish communities are found in its presence (Brown 2003).

Habitat influences growth, survival and reproduction through biological and physical mechanisms.

- Estuaries provide important rearing habitat for Chinook; salmon fry in Delta grew faster than in river (Healey 1991, Kjelson et al. 1982).
- Shallow water habitats support high growth in CV; juvenile Chinook had higher growth rates in small tributaries of Sacramento River than in the main Sacramento (Sommer et al. 2001; Jeffres et al. 2008; Maslin et al. 1997, 1998, 1999; Moore 1997).

Water quality aspect of habitat is highly variable.

- Aquatic vegetation increase, especially *E. densa*, over the past 20 years has increased water clarity by trapping suspended solids, with measurable effects on fish communities (Nobriga et al. 2005).
- Variability in habitat likely causes regional differences in the relationship between Delta smelt abundance and water quality (Baxter et al. 2008).
- Reduced pumping from the SWP in October of 2001 lowered salinity in western Delta (as desired), but led to opposite and unexpected result of increased salinity in central Delta (Monsen et al. 2007).

Improving habitat for increased abundance of native fishes.

- Increase productive capacity with access to floodplains, streams, and shallow wetlands (Lindley et al. 2009).
- Habitat quantity, quality, spatial distribution and diversity must be improved to promote life history diversity that will increase resilience and stability of salmon populations (Lindley et al. 2009).

10. GEOMORPHOLOGY

According to the SWRCB's Technical Report (2012), a more natural flow regime will improve geomorphic processes including scour and bed mobilization and will increase the number of turbidity events.

SWRCB's Technical Report (2012) Assertions Regarding Effects of Implementing a More Natural Flow Regime on Geomorphic Processes

Bold statements below indicate the SWRCB's Technical Report (2012) assertions regarding effects of implementing a more natural flow regime on geomorphic processes, followed by supporting/contrary evidence, as follows:

Assertion 1. A more natural flow regime will improve bed scour and mobilization and provide associated benefits such as creating a "less homogenous channel with

structures that are important for fish habitat, such as meanders, pools, riffles, overhanging banks, and gravel substrates of appropriate sizes…and rejuvenate riparian forests and clean gravel for salmon…" (SWRCB Technical Report 2012; page 3-48).

The natural flow paradigm assumes that channel formation and maintenance is directly influenced and modified by flow, which is generally true under natural conditions; however, leveed rivers can be nearly independent of flow. Poff et al. (1997, page 770), identify "five critical components of the ["natural," i.e., unaltered by humans] flow regime that regulate ecological processes in river ecosystems: the magnitude, frequency, duration, timing, and rate of change of hydrologic conditions (Poff and Ward 1989, Richter et al. 1996, Walker et al.1995)." The authors also recognize that most rivers are highly modified and allude to the possibility that restoration of a natural flow regime may be limited "depending on the present extent of human intervention and flow alteration affecting a particular river (Poff et al. 1997, Page 780)." The natural flow paradigm assumes that channel form is directly influenced and modified by flow, which is generally true under natural conditions (a potential exception being a bedrock controlled channel); however, the morphology of a highly engineered river (e.g., levees) can be practically independent of flow (Jacobson and Galat 2006). In such a system, flow-related factors like timing of floods, water temperature, and turbidity may be managed; but, in absence of a "naturalized morphology, or flow capable of maintaining channel-forming processes, the hydrologic pulses will not be realized in habitat availability" (Jacobson and Galat 2006, page 250).

With minimal floodplains remaining in the San Joaquin Basin due to land use changes, higher flows do not necessarily provide the channel maintenance that would occur under natural conditions. In leveed systems such as the San Joaquin Basin, true channel mobilization flows are not possible because of flood control. In some instances, higher flows can actually result in increased detrimental incision in upstream tributary areas like the Stanislaus River where existing riparian encroachment is armored and cannot be removed by high flow events, which limits "river migration and sediment transport processes" (Kondolf et al. 2001, page 39). In addition, the ability to provide a more natural flow regime is hampered by "urban and agricultural developments that have encroached down to the 8,000 cfs line," which effectively limit the highest flows to no more than the allowable flood control (i.e., 8,000 cfs) (Kondolf et al. 2001, page 46). Also, in the case of the Stanislaus River, there is limited opportunity to provide mechanical restoration of floodplains due to private landowners and flood control. In instances where flood pulses can no longer provide functions such as ***maintenance of channel habitat***, Poff et al. (1997) states, "mimicking certain geomorphic processes may provide some ecological benefits [e.g., gravel augmentation, stimulate recruitment of riparian trees like cottonwoods with irrigation]."

In the absence of floodplain connectivity, the functions attributed to higher "pulse flows" cannot be achieved as described by the Flood Pulse Concept (FPC) (Junk et al. 1989; Junk and Wantzen 2003). Under natural conditions, the SJR was a river channel connected with its floodplain. Flood pulses in the winter and spring would have provided the functions identified by Junk et al. (1989) and by Junk and Wantzen (2003). However, anthropomorphic changes in the lower river (e.g., levees), particularly below Vernalis (the focus of the SWRCB's Technical Report 2012), have substantially reduced this floodplain connectivity and the region can no longer be considered a "large river-floodplain system." In fact, the extent of inundated floodplain in the SJR between the confluence of the Stanislaus River and Mossdale only exceeds 2,000 acres at the maximum modeled flow of 25,000 cfs (cbec 2010). In comparison, the Yolo Bypass is approximately 59,000-acres (Sommer et. al 2005) and the Cosumnes floodplain is about 1,200 acres (Swenson et al. 2003).

11. HEAD OF OLD RIVER BARRIER

Overview

Although the SWRCB's Technical Report (2012) mentions the Head of Old River Barrier (HORB) in several contexts, there is no cohesive discussion about the substantial impact that the HORB has on juvenile salmon survival through the lower SJR and South Delta.

Relevant Information Regarding Head of Old River Barrier

Operation of a rock barrier at the Head of Old River improves salmon smolt survival through the Delta by 16-61% (Newman 2008).

- HORB reduces entrainment into Old River from more than 58% to less than 1.5%.
- Survival appears to be lower in the Old River than it is in the main stem San Joaquin River (Newman, 2008).
- Physical (rock) HORB increases SJR flow.
- Installation of the HORB doubles through-Delta survival by directing juvenile salmonids through the SJR mainstem (compared to the Old River route, NMFS 2012).

Absence of Head of Old River Barrier

- In the absence of the physical (rock) HORB, a statistically significant relationship between flow and survival does not exist (Newman 2008); therefore there is no justification for increasing flows when the barrier is not in operation.
    - The temporary HORB rock barrier requires flows less than 5,000 cfs for installation and flows less than 7,000 cfs for operation (SJRTC 2008).

Head of Old River Barrier Timeline.

- Initiated as a part of the South Delta Temporary Barriers Project in 1991 to be a temporary rock-fill physical barrier to prevent juvenile Chinook salmon from entering Old River at the Head of the Old River (HOR).
- Installation of the HORB had been utilized each spring (except in high water years) from 1992-2007 (see status table below).
- Between 2008 and 2011, installation of the physical barrier was prohibited by a Federal Court decision by U.S. District Court Judge Wanger due to concerns for delta smelt.
- In 2009 and 2010, a non-physical barrier (Bio-Acoustic Fish Fence; BAFF) was installed to replace the spring time HORB.

- In 2012, the physical barrier was installed as a part of a Joint Stipulation order by US District Court Judge O'Neil.
- Installation status of HORB each spring since 1992 includes:

YEAR	Type of HORB Installed	Reason
2012	Rock	Court ruling (Joint stipulation)
2011	Not installed	High Flows
2010	BAFF	VAMP/BOR study
2009	BAFF	VAMP/BOR study
2008	Not installed	Court Ruling
1992-2007	Rock installed annually with exception of high flow years	Not installed 1993, 1995, 1998, 1999, 2005, and 2006 due to high flows

Salmon versus Delta smelt.

- The HORB physical barrier in spring stops the juvenile Chinook salmon from entering the Old River, avoiding entrainment in the state and federal pumps. But, USFWS has taken the position that the physical barrier causes a negative flow to occur in the Middle and Old Rivers (OMR), which creates a situation that elevates Delta smelt entrainment.
- USFWS contends that negative OMR flows up to 1,250 cfs do not increase entrainment of Delta smelt, but negative OMR flows greater than 1,250 cfs do.
- A Joint Stipulation issued by Judge O'Neil regarding the 2012 CVP and SWP operations includes flow restrictions for OMR flows in April between -1,250 and -3,500 cfs; in May between -1,250 and -5,000 cfs.

Head of Old River Bio-Acoustic Fish Fence (BAFF; Bowen et. al 2008, 2009a-b, 2010).

- Beginning in the Spring of 2009, a three-year study was initiated by the U.S. Bureau of Reclamation (USBR) to install and monitor the effectiveness of a non-physical barrier at the head of Old River called a Bio-Acoustic Fish Fence (BAFF). The BAFF was installed in 2009 and 2010, but was not installed in 2011 because of high water.
- The BAFF consisted of three parts: a sound emitting device, a bubble curtain and a light system of strobe hi-intensity LEDs.
- In 2009, when the BAFF was on it was over 80% efficient at deterring tagged salmon smolts from entering Old River. When the BAFF was off, only 25% of tagged salmon smolts did not enter Old River.
- In 2010, the alignment of the BAFF was changed; it was set out further in the channel, lengthened to 136 m, the angle changed to 30 degrees and the downstream end of the BAFF changed from a straight layout to a "hockey stick" configuration.
- It was thought that the 2009 alignment, while being efficient in deterring acoustically tagged smolts from entering Old River, may have guided them into or near the large scour hole immediately down the SJR of the HOR. Later, the USBR

biologists attributed the high mortality of the tagged smolt to low flows in 2009, stating that the low flow consolidated the smolt path "So, prey may have been forced into a smaller volume of water with predator*s*", thus increasing predation (Bowen 2009).

Comparison of HORB BAFF efficiencies in 2009 and 2010

	2009 Range (%)	2009 Mean (%)	2010 Range (%)	2010 Mean (%)
Mortality rates between Durham Ferry and HORB	25.2 to 61.6	40.8	2.8 to 20.5	7.8
Predation rates at HORB	11.8 to 40	27.5	17 to 37	23.5
Deterrence rate of Barrier		81.4 total		23.0 total
Protection Efficiency	14 to 62	31	31 to 60	43.1

Head of Old River Barrier Predation and "Hot Spots."

- Predation Rate at HORB
  - 2009 11.8 – 40% (mean 27.5%)
  - 2010 17 – 37% (mean 23.5%)

Head of Old River Flow conditions during VAMP releases and tracking period.

- 2009 – 75/25% split in flows; with 75% heading into Old River, 25% into the mainstem San Joaquin (dates of operation: 4/22 – 6/13/2009)
- 2010 – 58/42% split; with 58% heading into Old River 42% into the mainstem San Joaquin (dates of operation: 4/25 – 6/25/2010)

12. PREDATION

Overview

Numerous studies have found that striped bass and other piscivorous fish prey on outmigrating salmon (Shapovalov 1936, Stevens 1966, Thomas 1967, Pickard et al. 1982, Merz 2003, Gingras 1997, Tucker et al. 1998). While striped bass are likely the most significant predator of Chinook salmon and Delta smelt (Nobriga and Feyrer 2007), several other invasive predators occur in the Delta and may also contribute to the predation losses including white catfish, black crappie, smallmouth bass, and spotted bass. The predation appears to be patchy both seasonally and spatially, with higher levels of predation documented in the spring, in areas of anthropogenic influence such as near water diversion structures and dams (Gingras 1997, Tucker et al. 1998, Merz 2003, Clark et al. 2009). In recent years it has become clear that predation on salmon may significantly limit salmon recovery efforts (NMFS 2009b; Dauble et al., 2010). The NMFS Draft Recovery Plan (2009b) for Chinook salmon and CV steelhead considered "predation on juveniles" one of the most important specific stressors.

The SWRCB's Technical Report (2012) indicates that flow can operate indirectly through other factors that directly influence survival, including predation. The report makes several statements regarding the relationship between flows and predation, asserting that increased flows will reduce the impacts of predation on outmigrating salmonids.

Relevant Information Regarding Predation

The VAMP review panel concluded that "high and likely highly variable impacts of predation, appear to affect survival rates more than the river flow" (Dauble et al. 2010).

- All fishery agencies have acknowledged that striped bass are a major stressor on Chinook populations in the CV and recovery will not occur without significant reduction in their populations and/or predation rates (DFG 2011).

Striped bass prey on juvenile Chinook.

- Many studies have found that striped bass eat salmon (Shapovalov 1936, Stevens 1966, Thomas 1967, Pickard et al. 1982, Merz 2003, Gingras 1997, Tucker et al. 1998).
- Striped bass stomachs have been collected with juvenile Chinook composing up to 65% (by volume) of the total contents (Thomas 1967).
- Waddell Creek stomach contents in April of 1935 found that large striped bass fed heavily on young salmon and trout (30.8% by number of occurrence) (Shapovalov 1936).
- In the Mokelumne River, 11 to 51% of the estimated salmon smolts were lost to striped bass predation in the Woodbridge Dam afterbay in 1993. Chinook were 24% (by volume) of juvenile bass stomach content in the spring in the Mokelumne River (Stevens 1966).
- Below Red Bluff Diversion Dam juvenile salmon outweighed other food types in striped bass stomach samples by a three to one margin (Tucker et al. 1998).
- Almost any fish occurring in the same habitat as striped bass will appear in the bass diet (Moyle 2002).
- There are roughly 1 million adult striped bass in the Delta and their abundance remains relatively high despite curtailment of a stocking program in 1992 (CDFG 2009).
- Recent concerns about the survival of endangered winter-run Chinook salmon in the Sacramento River have focused on the impacts of striped bass predation on outmigrants and the effects of striped bass population enhancement on winter-run Chinook population viability (Lindley and Mohr 1999). It was estimated that at a population of 765,000 striped bass adults, 6% of Sacramento River winter Chinook salmon outmigrants would be eaten each year (Lindley and Mohr 1999, 2003).

- "CDFG documented in their 2002 annual report to NMFS that an adult striped bass (420 mm) collected in May 2002 at Miller Ferry Bridge had 39 juvenile salmonids in its stomach (DFG022703)." (Hanson 2009).

Striped bass in the San Joaquin River and South Delta prey on juvenile Chinook to such an extent that they significantly reduce the number of Chinook returning to the San Joaquin Basin.

- High predation losses at the State Water Project (SWP) are particularly detrimental to SJR Chinook salmon populations since over 50% of juvenile salmon from the SJR travel through Old River on their way to the ocean, exposing them to predation at Clifton Court Forebay (CCF) and causing substantially reduced survival.
- Predation rates in CCF are as high as 66-99% of salmon smolts (Gingras 1997; Buell 2003; Kimmerer and Brown 2006).
- Striped bass are generally associated with the bulk of predation in CCF since their estimated populations have ranged between 30,000 and 905,000 (Healey 1997; Cohen and Moyle 2004); however, studies indicate that six additional invasive predators occur in the CCF (i.e., white catfish, black crappie, largemouth bass, smallmouth bass, spotted bass, redeye bass) with white catfish being the most numerous, having estimated populations of 67,000 to 246,000 (Kano 1990).
- Yoshiyama et al. (1998) noted that "[S]uch heavy predation, if it extends over large portions of the Delta and lower rivers, may call into question current plans to restore striped bass to the high population levels of previous decades, particularly if the numerical restoration goal for striped bass (2.5 to 3 million adults; USFWS 1995; CALFED 1997) is more than double the number of all naturally produced CV Chinook salmon (990,000 adults, all runs combined; USFWS 1995)."
- Hanson (2005) conducted a pilot investigation of predation on acoustically tagged steelhead ranging from 221-275mm, and estimated that 22 of 30 (73%) were preyed upon.
- Nobriga and Feyrer (2007) state: "Striped bass likely remains the most significant predator of Chinook salmon, *Oncorhyncus tschawytscha* (Lindley and Mohr 2003), and threatened Delta smelt, *Hypomesus transpacificus* (Stevens 1966), due to its ubiquitous distribution in the Estuary and its tendency to aggregate around water diversion structures where these fishes are frequently entrained (Brown et al. 1996)."

Recent San Joaquin Basin VAMP studies conducted from 2006–2010 provide direct evidence of high predation rates on Chinook salmon in the lower San Joaquin River and South Delta.

- An acoustic tag monitoring study was conducted from 2006 – 2010 to evaluate survival of salmon smolts emigrating from the SJR through the Delta (SJRGA 2011).
  - In 2006, results indicated that without the, "Head of Old River Barrier in place and during high-flow conditions many (half or more) of the acoustic-tagged fish, released near Mossdale, migrated into Old River."

- In 2007, a total of 970 juvenile salmon were tagged with acoustic transmitters and were detected by a combination of receivers:
  - Mobile tracking found that 20% of released fish (n=192) were potentially consumed by predators at three “hotspots” located near Stockton Treatment Plant (n=116), just upstream of the Tracy Fish Facility trashracks (n=57), and at the head of Old River flow split downstream of Mossdale (n=19).
  - Stationary detections indicate an average 45% loss, potentially attributable to predation, which does not account for losses at the largest “hotspot” at Stockton Treatment Plant, nor in the greater Delta past Stockton and Hwy 4.
- In 2008, the only tagged fish entering Old River to survive were fish collected (salvaged) at two large water conveyance projects and transported through the Delta by truck (Holbrook et al. 2009).
- In 2009, the combined loss rate from Durham Ferry to the HORB and the loss rate in the vicinity of the HORB (BAFF in) combined to show a loss rate between 60 -76% of the seven groups released at Durham Ferry (SJRGA 2010).
  - Mortality rates (likely due to predation) between Durham Ferry and the BAFF ranged from 25.2% to 61.6% (mean 40.8%) (Bowen et al. 2009).
  - Predation rates near the BAFF ranged from 11.8% to 40% (mean 27.5) (Bowen et al. 2009).
- In 2010, Old River supplemental smolt releases concluded of 162 of 247 (65.6%) tags were classified as coming from a predator rather than a smolt (SJRGA 2011).
  - Mortality rates (likely due to predation) between Durham Ferry and the BAFF ranged from 2.8% to 20.5% (mean 7.8%) (Bowen and Bark 2010).
  - Predation rates near the BAFF ranged from 17% to 37% (mean 23.5%) (Bowen and Bark 2010).

Significant predation losses are also occurring in the San Joaquin Basin tributaries due to non-native predators.

- Radio tracking studies conducted during May and June of 1998 and 1999, respectively (Demko et. al 1998; FISHBIO unpublished data), indicated that the survival of large, naturally produced and hatchery juveniles (105 to 150 mm fork length) was less than 10% in the Stanislaus River downstream of the Orange Blossom Bridge.
- Individual based, spatially explicit model – Piscivores consume an estimated 13-57% of fall-run Chinook in Tuolumne River (Jager et al. 1997).
- Significant numbers of striped bass migrate into the Stanislaus River each spring, as detected at the weir (Anderson et. al 2007; FISHBIO unpublished data), and are thought to prey heavily on outmigrating Chinook smolts.

The overwhelming majority of predation on juvenile Chinook is the result of non-native predators that were intentionally stocked by CDFG, and whose abundance can be reduced to minimize the impacts on Chinook.

- Most of the non-native fish species (69%) in California, including major predators, were intentionally stocked by CDFG for recreation and consumption beginning in the 1870s. All of the top predators responsible for preying on native fish are currently managed to maintain or increase their abundance. Historically, the Delta consisted of approximately 29 native fish species, none of which were significant predators. Today, 12 of these original species are either eliminated from the Delta or threatened with extinction, and the Delta and lower tributaries are full of large non-native predators such as striped bass that feed "voraciously" throughout long annual freshwater stays (McGinnis 2006).
    - Lee (2000) found a remarkable increase in the number of black bass tournaments and angler effort devoted to catching bass in the Delta over the last 15 years.
    - According to Nobriga and Feyrer (2007), "largemouth bass likely have the highest per capita impact on nearshore fishes, including native fishes," and concludes that "shallow water piscivores are widespread in the Delta and generally respond in a density-dependent manner to seasonal changes in prey availability."
    - "In recent years, both spotted bass (*Micropterus punctulatus*) and redeye bass (*M. coosae*) have invaded the Delta. While their impact in the Delta has not yet been determined, the redeye bass has devastated the native fish fauna of the Cosumnes River Basin, a Delta tributary" (Moyle *et al.* 2003 as cited by Cohen and Moyle 2004).
    - Black crappie were responsible for a high level of predation during a 1966/67 CDFG study (Stevens 1966). As many as 87 recognizable fish were removed from the stomach of one crappie, and counts of 40 to 50 were common. Most of the fish were undigested, hence not in the stomachs for very long.
- A lawsuit by the Coalition for a Sustainable Delta against DFG was settled in April 2011. Under the settlement, a comprehensive proposal to address striped bass predation in the Delta must be developed by state and federal fishery management agencies. As part of the settlement DFG must make appropriate changes to the bag limit and size limit regulations to reduce striped bass predation on the listed species, develop an adaptive management plan to research and monitor the overall effects on striped bass abundance, and create a $1 million research program focused on predation of protected species.
    - DFG (2011) proposed changing striped bass regulations to include raising the daily bag limit for striped bass from 2 to 6 fish with a possession limit of 12, and lowering the minimum size for striped bass from 18 to 12 inches. Proposed regulations included a "hot spot" for striped bass fishing at Clifton Court Forebay with a daily bag limit of 20 fish, a possession limit of 40 fish and no size limit. Fishing the hot spot would require a report card to be filled out and deposited in an iron ranger or similar receptacle.
    - With significant pressure from striped bass fishing groups, the California Fish and Game Commission denied the changes proposed by agency biologists in favor of keeping striped bass protections (CFGC 2012).
- According to NMFS (2009b), Priority Recovery Actions (1.5.4) Implement programs and measures designed to control non-native predatory fish (e.g., striped

> bass, largemouth bass, and smallmouth bass), including harvest management techniques, non-native vegetation management, and minimizing structural barriers in the Delta, which attract non-native predators and/or that delay or inhibit migration.

Reducing striped bass predation on juvenile Chinook is the simplest, fastest, and most cost-effective means of increasing outmigration survival.
High predation likely occurs at specific "hot spots", which can be the focus of a control program. The predation on salmonids appears to be patchy both seasonally and spatially, with higher levels of predation documented in the spring, in areas of anthropogenic influence such as near water diversion structures and dams (Gingras 1997, Tucker et al. 1998, Merz 2003, Clark et al. 2009). Stevens (1966) reported a "highly localized" situation at the Paintersville Bridge; in June he found some of the highest predations rates for the region, when 90.7% of all bass with food in their stomachs had consumed Chinook salmon (198 salmon in 97 stomachs). In 1993, a diet study estimated that 11 to 28% of the natural production of salmon smolts in the Mokelumne River was lost to striped bass predation in the Woodbridge Dam afterbay (Merz 2003). Likewise, below Red Bluff Diversion Dam on the Sacramento River juvenile salmon were found in high numbers in the stomachs of striped bass (Tucker et al. 1998). In addition, striped bass are generally associated with the bulk of predation in Clifton Court Forebay, where pre-screen loss rate (attributed to predation) was estimated at 63-99% for juvenile Chinook salmon and 78-82% for steelhead migrating through the Clifton Court Forebay (Gingras 1997, Clark et al. 2009). Furthermore, during a study of predation on salvaged fish (that had already survived the Forebay) the researchers noted a lack of predators at the non-release, control sites, suggesting "that the salvaged fish releases at the release sites were the principal attractants of predators as opposed to some other factor such as the presence of a man-made structure" (Miranda et al. 2010).

The predatory fishes such as striped bass and largemouth bass prey on covered fish species and can be locally abundant at predation hot spots. Adult striped bass are pelagic predators that often congregate near screened diversions, underwater structures, and salvage release sites to feed on concentrations of small fish, especially salmon. Striped bass are a major cause of mortality of juvenile salmon and steelhead near the SWP south Delta diversions (Clark et al. 2009). Largemouth bass are nearshore predators associated with beds of invasive aquatic vegetation (BDCP 2012).

Targeted predator removal at hot spots would reduce local predator abundance, thus reducing localized predation mortality of covered fish species. Predator hot spots include submerged structures, scour holes, riprap, and pilings. Removal methods will include electrofishing, gill netting, seining, and hook and line (BDCP 2012).

Altered Delta habitat has benefited non-native predator species and increased the vulnerability of outmigration juvenile salmonids.

> "The structure of the Delta, particularly in the central and southern Delta, has been significantly altered by construction of manmade channels and dredging, for shipping traffic and water conveyance. Intentional and unintentional

introductions of non-native plant and animal species have greatly altered the Delta ecosystem. Large predatory fish such as striped bass and largemouth bass have increased the vulnerability of emigrating juveniles and smolts to predation, while infestations of aquatic weeds such as *Egeria densa* have diminished the useable near- shore, shallow water habitat needed by emigrating salmonids for rearing (NMFS 2011)."

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Attachment A

Technical Memorandum

Review regarding use of select references by SWRCB in their Draft and Final *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives* (SWRCB 2010 and 2011) and DFG in their *Quantifiable Biological Objectives and Flow Criteria for Aquatic and Terrestrial Species of Concern Dependent on the Delta* report (DFG 2010)

TO: Tim O'Laughlin

FROM: Doug Demko, Michele Palmer, Andrea Fuller

DATE: January 30, 2012

SUBJECT: Review regarding use of select references by SWRCB in their Draft and Final *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives* (SWRCB 2010 and 2011) and DFG in their *Quantifiable Biological Objectives and Flow Criteria for Aquatic and Terrestrial Species of Concern Dependent on the Delta* report (DFG 2010)

This memorandum has been developed to present results of a review regarding use of select references by SWRCB in their Draft and Final *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives* (SWRCB 2010 and 2011) and DFG in their *Quantifiable Biological Objectives and Flow Criteria for Aquatic and Terrestrial Species of Concern Dependent on the Delta* report (DFG 2010). We focused our review on those references that were used in one or both documents to support the position that inadequate spring (Feb-Jun) flows are the primary cause of salmon decline including, in chronological order, Kjelson et al. 1981, Kjelson and Brandes 1989, AFRP 1995, Baker and Mohardt 2001, Brandes and McLain 2001, Mesick 2001, DFG 2005a, DFG 2009, Mesick and Marston 2007, Mesick et al. 2007, Mesick 2008, Mesick 2009, Mesick 2010a-e, and USDOI 2010. In addition, we examined peer reviews conducted on the SWRCB (2011) and DFG (2010) documents (Quinn et al. 2011 and Gross et al. 2010, respectively). A summary of key points is provided below followed by a detailed discussion of the findings of our review.

Summary of Key Points

- **References used by the SWRCB and DFG to support their position that inadequate spring (Feb-Jun) flows are the primary cause of salmon decline are NOT the best available science for evaluating current flow/survival relationships due to a variety of reasons including:**
    - All references prior to 2008 (i.e., Kjelson et al. 1981, Kjelson and Brandes 1989, AFRP 1995, Baker and Mohardt 2001, Brandes and McLain 2001, Mesick 2001, Mesick and Marston 2007, Mesick et al. 2007) are outdated and lack recent data reflecting major anthropogenic changes to the Delta ecosystem resulting in a regime shift in about 2000-2001; and are also statistically limited and have been superseded by superior Bayesian analyses conducted by Newman (2008)[1].

[1] In 2008, a more robust Bayesian analysis was designed and conducted by Newman using data from 1985 through 2006 (Newman 2008) to address the limitations of all the previous coded wire tag data analyses presented in pre-2008 reports.

- The DFG's San Joaquin River Fall-run Chinook Salmon Population Model (SJRFRCS Model) (DFG 2005a, DFG 2009) has been found to be flawed through both peer and professional reviews, as identified in previous comments submitted to the SWRCB (Demko et. al 2010).
- Mesick references have not been peer-reviewed and their analyses are the same/similar to those used in DFG's SJRFRCS Model.
- At least two Mesick documents have been rejected previously by FERC because the authors
  - presented a "fallacy of focusing entirely on flow" and did not consider the influence of other possible limiting factors (Tuolumne River Limiting Factors Analysis; Mesick et al. 2007); and
  - improperly analyzed the Tuolumne River in isolation of other Central Valley populations, did not consider effects of hatchery introductions on Tuolumne River Chinook salmon, and discounted other potential factors (Tuolumne River Risk of Extinction Analysis; Mesick 2009).
- Additionally, Mesick 2009 and supporting references (Mesick et al. 2009 a, b) have apparently been rejected for publication.

- **Currently, the best available science that should be used to evaluate potential flow/survival relationships, which were mentioned in the SWRCB technical reports but were inappropriately applied, include the following:**
  - Newman 2008 has been subject to extensive peer-review and is a published work (unlike Mesick documents); and uses higher quality information (paired releases versus non-paired releases used in other Mesick analyses).
  - VAMP Peer Review indicates that consideration should be given regarding the role of Delta survival for the smolt life stage in the larger context of the entire life cycle of the fall-run Chinook, including survival in the upper watershed, the Bay and the ocean and fry rearing in the Delta.
- **Peer review of SWRCB's final technical report indicates several areas for improvement, which are consistent with our previously and presently submitted comments and peer review comments are also applicable to the DFG QBO report:**
  - Due to limited review time, it is likely that Peer reviewers for the SWRCB's final technical report were not aware of previous findings regarding DFG's SJRFRCS Model or of this model's similarity to the Mesick analyses, which may have affected their comments.

- Nonetheless, even with limited information and review time, Peer reviewers found several areas for improvement including, but not limited to:
    - Implausibly high linkage of higher spring flows to adult escapement;
    - Other processes besides flow have likely contributed to declines, and will continue to hinder salmon recovery;
    - Holistic view (considering other factors besides flow) would be more tenable;
    - Contradictory statements regarding influence of ocean conditions;
    - Relies too heavily on secondary sources;
    - Several figures are not clear and could be better expressed with different analyses, or some figures do not support statements.

- **Peer review of DFG's QBO report indicates several areas for improvement, which are consistent with our previously and presently submitted comments, and peer review comments are also applicable to the SWRCB's technical reports:**
    - Using the best available science means:
        - Agencies may not manipulate their decisions by unreasonably relying on some sources to the exclusion of others.
        - Agencies may not disregard scientifically superior evidence.
    - Many concerns about the use (or lack of use) of citations.
        - Citations are to support an argument, not establish a fact.
        - References must be accurately and clearly cited.
        - Peer-reviewed literature preferred.
        - Frequent use of some references to exclusion of scientifically superior sources.
    - Uncertainties and assumptions are not provided.
    - Assumption that flow alone will restore fish populations is poorly founded.
    - Salmon objectives do not distinguish between hatchery and naturally produced fish.

REVIEW OF FINDINGS

1. References used by the SWRCB and DFG to support their position that inadequate spring (Feb-Jun) flows are the primary cause of salmon decline are NOT the best available science for evaluating current flow/survival relationships due to a variety of reasons including:

- **All studies prior to 2008 (i.e., Kjelson et al. 1981, Kjelson and Brandes 1989, AFRP 1995, Baker and Mohardt 2001, Brandes and McLain 2001, Mesick 2001, Mesick and Marston 2007, Mesick et al. 2007) are outdated and lack recent data reflecting major anthropogenic changes to the Delta ecosystem resulting in a regime shift in**

about 2000-2001; and are also statistically limited and have been superseded by superior Bayesian analyses conducted by Newman (2008)[2].

Three of the references cited prior to 2001 (Kjelson et al 1981, Kjelson and Brandes 1989, AFRP 1995) present regressions of spring flow at Vernalis vs. escapement 2.5 years later, and it is hypothesized from these regressions that smolt survival is positively correlated with river flow. Since smolt survival in the San Joaquin River was not measured, the influence of river flow on smolt survival could not be assessed.

In 2001, the first multi-year analyses of smolt survival data from mark-recapture studies was conducted to estimate salmon survival relative to flow at Vernalis were conducted by Baker and Morhardt (2001) and Brandes and McLain (2001). While Brandes and McLain (2001) identified a statistically significant relationship between smolt survival from Dos Reis to Chipps Island and river flow at Stockton, Baker and Morhardt (2001) concluded that "smolt survival through the Delta may be influenced to some extent by the magnitude of flows from the San Joaquin River, but this relationship has not been well quantified yet, especially in the range of flows for which such quantification would be most useful." Baker and Morhardt (2001) noted several weaknesses in the available data including low recapture numbers which generated imprecise estimates of survival, a lack of control of flow and export conditions during individual experiments, and lack of a statistical design in combinations of flows and exports.

The Vernalis Adaptive Management Plan (VAMP) studies were designed to address these weaknesses in previous CWT data and provided additional data through 2006. CWT data continued to be analyzed in piecemeal fashion through 2006 and the analyses were eventually superseded in 2008 by superior Bayesian analyses conducted by Newman (2008).[1] During the VAMP studies an abrupt, downward shift in smolt survival was documented.

- **The DFG's San Joaquin River Fall-run Chinook Salmon Population Model (SJRFRCS Model) (DFG 2005a, DFG 2009) has been found to be flawed through both peer and professional reviews, as identified in previous comments submitted to the SWRCB (Demko et. al 2010).**

Both the SWRCB and DFG refer to the SJRFRCS Model to support the idea that more spring flows are necessary to create more Chinook salmon in the San Joaquin Basin. As identified in our previous comments (Demko et al. 2010), which the SWRCB has not incorporated into their final technical report, the SJRFRCS Model uses inappropriate statistical models that do not represent the best available science; two versions of the SJRFRCS Model have been reviewed and found to contain substantial flaws (DFG 2005a version reviewed by Deas et al. 2006 and Pyper et al. 2006, and DFG 2009 version reviewed by Lorden and Bartoff 2010).

Demko et al. (2010) stated that

> The most recent version of the DFG [SJRFRCS] model (DFG 2009) is still considered inappropriate for use by the SWRCB for a number of reasons, including the previously mentioned incomplete revisions and the lack of peer-review. Our comments, highlighting the problems with the statistical validity of the current DFG model, are summarized under the next 12 issue statements. Details regarding these statements are provided in Attachment 1 [of Demko et.al. 2010].

- DFG Model Issue 1. It is clear that in order to have a statistically sound model for escapement, one needs to incorporate environmental variables other than, or in addition to flow, such as dissolved oxygen, exports, and water temperature.
- DFG Model Issue 2. The proposed simple linear regression model of escapement versus flow is inconsistent with the most recent data from 1999-2009, which shows a negative correlation between flow and escapement.
- DFG Model Issue 3. The proposed model is inconsistent over different flow ranges. For example, when dividing the range of flow observations into 4 equally sized bins, one of the bins shows a negative correlation between flow and escapement.
- DFG Model Issue 4. There are a small number of overly influential observations in the flow versus escapement data. For example, if one selects a moderately sized subset of these paired observations at random, the model fit varies widely and one frequently observes a negative correlation between flow and escapement.
- DFG Model Issue 5. The Ecological Fallacy: The well-known phenomenon that averaging over subgroups (as has been done with the flow data) falsely inflates the strength of a linear relationship.
- DFG Model Issue 6. Outliers are present in the flow versus escapement data.
- DFG Model Issue 7. The residuals from the flow versus escapement model exhibit non-normality.
- DFG Model Issue 8. Heteroscedasticity: The estimated errors in the flow versus escapement model exhibit a non-constant error rate.
- DFG Model Issue 9. Nonlinearity is observed in the flow versus escapement data.
- DFG Model Issue 10. The estimated errors in the flow versus escapement model exhibit dependence.
- DFG Model Issue 11. The flow versus escapement model has a low R_2 value of around 0.27.
- DFG Model Issue 12. The Regression Fallacy: That correlation implies causation.

- **Mesick references have not been peer-reviewed and their analyses are the same/similar to those used in DFG's SJRFRCS Model. Not peer-reviewed/similar analyses to DFG's SJRFRCS Model**. The SWRCB and DFG rely on several Mesick documents to support the position that inadequate spring (Feb-Jun) flows are the primary cause of salmon decline (i.e., both rely on Mesick 2009; Mesick et al. 2007; SWRCB also relies on Mesick 2001 and Mesick 2010a-e; and DFG also relies on Mesick 2008 and Marston 2007) as well as the SJRFRCS Model (DFG 2005, 2008, and 2009. Mesick documents have not been peer-reviewed, and their analyses are the same/similar to those used in DFG's SJRFRCS Model (DFG 2005a, DFG 2009).

Peer-reviewed literature is preferred since supporting evidence for an argument or position is stronger as a result of independent experts critical reviews of the papers; while citations to agency reports (e.g., Mesick documents) frequently provide weaker supporting evidence because they have not been independently reviewed by recognized experts (Gross et al. 2010).

As indicated in the previous section, DFG's SJRFRCS Model (DFG 2005a, DFG 2009) has been found to be flawed through peer (Deas et al. 2006) and professional (Pyper et al. 2006, Lorden and Bartoff 2010) reviews. Mesick references are largely based on the same linear regression approach used in DFG's SJRFRCS Model, and this approach continues to be re-packaged with slight variations by Mesick, as well as by DFG (2005a, 2009), and the U.S. Fish and Wildlife Service's (USFWS) Anadromous Fish Restoration Program (AFRP 2005). Although the regressions indicate a correlation between flow at Vernalis and escapement 2 ½ years later, the use of linear regressions to assess these effects is too simple an approach particularly given the fact that all authors include violations of simple linear regression; inadequate inclusion of other environmental factors (e.g., temperature) that are clearly important (e.g., predation, temperature); and the tendency for other factors to be correlated with each other (Lorden and Bartroff 2010). Some of the major problems with the linear regression approaches used by all of these authors include:

- Averaging (such as over months of flows) reduces variation that may exist (masking biologically important variations in flow) and has potential to falsely inflate the strength of linear relationship or make one appear when there is a more complex relationship or none at all. Authors have a responsibility to show that the variation lost in averaging does not affect the inferred relationship.
- Lack of robustness in the linear regression model fit does not support a cause-effect relationship between flow and escapement.
- Small number of data points overly influence and inflate the linear relationship between escapement and flows.
- Analysis assumes that escapement is normally distributed, but it is been shown to be non-normally distributed.
- Assumes that escapement is subject to random variations whose scale is constant and which averages out to zero; however, residual plots indicate both a bias (non-zero average) and non-constant scale of variations. Also, there are outliers contributing to the bias.
- Correlation does not imply causation (Lorden and Bartroff 2010).

Therefore, although linear regression relationship results suggest that flow may affect juvenile survival, the results do not imply a direct cause-effect relationship between juvenile salmon survival and flow, or that increasing flow will cause juvenile salmon survival to increase.

- **At least two Mesick documents have previously been rejected by FERC because the authors**
    - **presented a "fallacy of focusing entirely on flow" and did not consider the influence of other possible limiting factors (Tuolumne River Limiting Factors Analysis; Mesick et al. 2007); and**
    - **improperly analyzed the Tuolumne River in isolation of other Central Valley populations, did not consider effects of hatchery introductions on Tuolumne River Chinook salmon, and discounted other potential factors (Tuolumne River Risk of Extinction Analysis; Mesick 2009).**

Tuolumne River Limiting Factors Analysis (Mesick et al. 2007) Rejected by FERC. During recent FERC proceedings (FERC 2009a) regarding the operation of the New Don Pedro Project on the Tuolumne River, FERC rejected the findings of the Limiting Factors Analysis conducted as part of the Tuolumne River Management Conceptual Model by Mesick et al. (2007) because the authors presented a "fallacy of focusing entirely on flow" and did not consider the influence of other possible limiting factors (e.g., Delta exports, ocean conditions, and unscreened diversions). Key points made by FERC in a FERC Order issued July 16, 2009 (FERC 2009a) regarding the problems associated with Mesick et al. (2007) analyses include the following:

- Page 20, ¶70. Mesick et al. (2007) identifies Tuolumne River flows as having the greatest impact on juvenile Chinook salmon survival… however, they do not include any studies to ascertain the influence of other possible limiting factors, such as pumping at the state and federal water projects in the San Francisco Bay Delta, ocean conditions, and unscreened diversions in the Tuolumne River and in the Delta. In response to these concerns, we find that it may be inappropriate to focus on flow-related studies to the exclusion of other, possibly significant, limiting factors.
- Page 29, ¶74. Our review of the Limiting Factor Analysis does not suggest that the recent collapse of the Tuolumne River fall-run Chinook salmon can be attributed to the Article 37 flow regime. Rather, the analysis simply shows that, up to a point, higher flows produce more fish. This is not surprising. However, no significant increase in run size could occur if conditions outside the river system are unfavorable. Because fall-run Chinook salmon failed in the entire Sacramento and San Joaquin River system, it seems likely that one or more factors common to all of these runs may have caused the collapse. Further, we note that in recent Congressional testimony, NMFS agreed with this conclusion, stating that "the cause of the decline is likely a survival factor common to salmon runs from different rivers and consistent with the poor ocean conditions hypothesis being the major causative factor.
- Page 29, ¶75. The Limiting Factor Analysis states that Tuolumne River spring flows in excess of 3,000 cfs are necessary to ensure successful Chinook returns. However, the fallacy of focusing entirely on flows is illustrated by the fact that

the average spring flow in 2006 and 2007 (from February 1 through May 31) exceeded 3,500 cfs, yet the returns of both jack and adult fall-run Chinook salmon in 2008 and 2009 were extremely low.

- Page 31, ¶78. The Limiting Factor Analysis also discounts the effects of ocean conditions on the Tuolumne River stock. A report by the National Oceanic and Atmospheric Administration in 2006 and a recent report prepared for the Pacific Fishery Management Council in 2009 document that poor ocean conditions in 2005 and 2006 were the primary cause for the collapse of the Sacramento River Basin fall-run Chinook salmon.

Tuolumne River Risk of Extinction Analysis (Mesick 2009) Rejected by FERC. Mesick (2009) was originally submitted to FERC as Exhibit No. FWS-50 and was reviewed by Noah Hume (Senior Aquatic Ecologist at Stillwater Sciences, a scientific consulting firm). Hume testified that Mesick's (2009) risk of extinction analysis was improperly applied and pointed out that San Joaquin salmon populations have dropped well below the minimums necessary to maintain genetic viability in several periods in the past but have rebounded within a few years. Although Hume indicated that he did not have enough time to thoroughly review Mesick's document, he pointed out the following: (1) analyzing the population demographics and trends of the Tuolumne River population in isolation of other San Joaquin and Sacramento basin populations is suspect because the Tuolumne River population is not recognized as a distinct population segment (DPS) but is part of the Central Valley faIl/late fall-run Chinook evolutionary significant unit (ESU), which is not listed as endangered or threatened [status: Species of Special Concern]; (2) no consideration was given regarding the effects of hatchery introductions on Tuolumne Chinook salmon and the influence of inbreeding; and (3) no basis was given for discounting the influence of other factors (e.g., Delta and ocean conditions).

Based on Hume's testimony and corroborating testimony from Dr. Peter Moyle (professor at the University of California, Davis), FERC found

> the Tuolumne Chinook salmon population may be subject to extirpation, but is not at risk of extinction pending relicensing. Recent declines in Chinook salmon escapement levels are comparable to those occurring in other San Joaquin River tributaries and based on past patterns of high and low spawning returns, escapement levels in the Tuolumne River and other tributaries, are likely to rebound. More monitoring is needed to determine what factors, in addition to instream flows, are adversely impacting the salmon. (FERC 2009b, ¶275)

These findings are also applicable to other San Joaquin basin populations (i.e., Stanislaus and Merced).

- **Additionally, Mesick 2009 and supporting references (Mesick et al. 2009 a, b) have apparently been rejected for publication.**

  According to Carl Mesick's Curriculum Vitae (CSPA_exh8 Carl Mesick CV), he submitted several reports to the *California Fish and Game Scientific Journal* for publication in October 2009 (i.e., Mesick 2009 and Mesick et al. 2009a, b). However, none of these papers has been published in this journal as of their Summer 2011 issue, which indicates that these papers were not adequate for publication.

  Despite being rejected for publication and by FERC, these papers were used directly (i.e., Mesick 2009) or as sub-references to other Mesick documents within the SWRCB technical report including:
  1. Mesick et al. 2009a, b, were used as basis for risk of extinction analyses in Mesick 2009;
  2. Mesick 2009 used as supporting evidence for the risk of extinction of Tuolumne River salmon in Mesick 2010d;
  3. Mesick et al. 2009a used as the basis for analyses regarding the relationship of flow, temperature and exports with adult recovery rates in Mesick 2010c; and
  4. Mesick 2009 and Mesick et al. 2009a, b used in a synthesis of these analyses in Mesick 2010a, e.

2. Currently, the best available science that should be used to identify flow/survival relationships, which were mentioned in the SWRCB technical reports but were inappropriately applied, include the following:

- **Newman 2008.** Various analyses (e.g., Mesick 2010c, Baker and Mohardt 2001, Brandes and McLain 2001, Mesick 2001, Mesick and Marston 2007, Mesick et al. 2007) regarding smolt survival through the San Joaquin River Delta are used instead of superior analyses (i.e., Newman 2008). As an example, there are several reasons why the analyses presented in Mesick 2010c are inferior to Newman 2008, including the following:

  - Newman 2008 was subject to extensive peer-review and is a published work; unlike Mesick 2010c, which has not been peer-reviewed.
  - Mesick's approach does not use paired releases to address the effects of differences in sampling effort or the influence of conditions beyond the San Joaquin Delta. The quality of the information from the 35 paired releases used by Newman is superior to the 158 non-paired releases used by Mesick.
  - There are several problems with the way the Mesick 2010c analysis is presented including:
    - Basic statistics to describe the fit or significance of trend lines shown for each regression are noticeably absent from Mesick 2010c. For instance, there are no r^2 values reported for what appear to be very poor fits.
    - It is not clear whether the 13 instances of zero recoveries shown in Table 1 were included the analyses.

- The y-axis scale of 0-3% used for the graphs is an attempt to exaggerate the purported influence of flow and water temperature on recovery rates. This is an extremely narrow range, particularly when one considers expected noise in the data, and the potential effects of sampling effort.

Besides being inferior to Newman (2008), Mesick 2010c does not support the statement on pages 3-26 and 3-51 that "numerous studies indicate the primary limiting factor for FRCS tributary abundances is reduced spring flow, and that populations on the tributaries are highly correlated with tributary, Vernalis, and Delta flows". Mesick 2010c does not support the first part of this statement because in order to identify a primary limiting factor for FRCS tributary abundances, one would need to explore the relative impacts of all factors affecting each lifestage of FRCS in the tributaries, the San Joaquin River Delta, and in the ocean. For instance, Mesick 2010c did not explore whether survival during smolt outmigration is more limiting than ocean harvest. This analysis also did not explore whether river flow is the primary factor influencing smolt survival through the San Joaquin River Delta, since the recovery rates used were inclusive of smolt survival beyond Chipps Island and adult survival.

Similarly, Mesick 2010c also does not support the statement that "populations on the tributaries are highly correlated with tributary, Vernalis, and Delta flows". This analysis did not explore how population abundance, presumably escapement, may be correlated with flow. The analysis attempted to focus on the influence of San Joaquin River Delta flow on adult return rates, however the method used did not isolate smolt survival through the Delta from survival in the Bay, the Ocean, and during adult upstream migration.

- **Vamp Peer Review.** While the Technical Report discusses findings of a peer review of the VAMP conducted in 2010 (Dauble et al. 2010), an important recommendation to the SWRCB was omitted, which provides context for interpretation of the flow and survival relationships in terms of revision to the flow objectives. Specifically, the Panel was asked "*How can the results from the VAMP to date be used to inform the SWRCB's current efforts to review and potentially revise the San Joaquin River flow objectives and their implementation?*" The first part of their response, which was not included in the SWRCB's Technical Report, states that "In our answer to question 1, we attempted to summarize the scientific information obtained from the VAMP studies related to salmon survival through the Delta and the three factors of flow, exports, and the HORB. For several reasons, it is not straightforward to use that information to inform the Board's current efforts to review and revise San Joaquin River flow objectives. Because our review focused on the survival and passage of salmon smolts through the Delta, we did not evaluate other factors that may be limiting future salmon production. In setting flow objectives, we believe the Board **should consider the role of Delta survival for the smolt life stage in the larger context of the entire life cycle of the fall-run Chinook, including survival in the upper watershed, the Bay and the ocean and fry rearing in the Delta** [emphasis added] (SJRTC 2008)." The Technical Report fails to address this recommendation.

3. Peer review of SWRCB's final technical report indicates several areas for improvement, which are consistent with our previously and presently submitted comments and are also applicable to the DFG QBO report:

Peer reviewers were given a short time frame (30 days) to review the SWRCB's final technical report and were likely not aware of previous findings regarding DFG's SJRFRCS Model (i.e., peer review by Deas et al. 2006, Pyper et al 2006, Lorden and Bartroff 2010); or of the model's similarity to the Mesick analyses, which may have affected their comments.

Even in absence of this background material, peer reviewers for SWRCB's final technical report found areas for improvement including:

- Relies too heavily on secondary sources.
- Several figures are not clear, could be better expressed with different analyses, or do not support statements.
- Implausibly high linkage of higher spring flows to adult escapement.
- Other processes besides flow have likely contribute to declines, and will continue hinder their recovery.
- Holistic view (considering other factors besides flow) would be more tenable.
- Contradictory statements regarding influence of ocean conditions.

Relevant excerpts from peer reviewers are provided in Attachment 1.

4. Peer review of DFG's QBO indicates several areas for improvement, which are consistent with our previously and presently submitted comments, and are applicable to the SWRCB's technical reports:

- "Using the best available scientific information" means (page 3):
  - Agencies may not manipulate their decisions by unreasonably relying on some sources to the exclusion of others.
  - Agencies may not disregard scientifically superior evidence.
- Many concerns about the use (or lack of use) of citations.
  - Citations are to support an argument, not establish a fact. "Citations, even to the peer-reviewed literature, are not like theorems in mathematics, and do not establish validity."(page 3)
  - References must be accurately and clearly cited.
  - "Whenever possible, references should be to peer-reviewed literature, not internal technical reports or testimony." (page 6)
  - "Frequently relies on some sources to the exclusion of scientifically superior sources… it cites outdated analyses by Kjelson and Brandes instead of superior analyses (Newman and Rice 2002; Newman 2003)… It relies on an unpublished work by Marston [i.e., Marston 2007] and ignores superior studies by Newman [i.e., Newman 2008] and others involved with VAMP, and by Terry Speed (1993). It fails to cite many relevant, more recent papers (Appendix A3), including a long review on

Central Valley Chinook and steelhead (Williams 2006) that would have drawn DFG's attention to the superior sources just noted." (page 6)

- "Does not acknowledge the uncertainty associated with most of the modeling work referred to in the Draft." (page 6)
- "Critical assumptions and areas of major uncertainty are not described." (page 6)
- "assum[tion] that flow alone will restore natural processes and restore/reconnect critical habitats for [many] species… is poorly founded." (page 7)
- "objectives for salmon fail to distinguish hatchery and naturally produced fish" (page 9)

Relevant excerpts from peer reviewers are provided in Attachment 1.

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ATTACHMENT 1

EXCERPTS FROM A PEER REVIEW OF THE STATE WATER RESOURCES CONTROL BOARD'S FINAL TECHNICAL REPORT ON THE SCIENTIFIC BASIS FOR ALTERNATIVE SAN JOAQUIN RIVER FLOW AND SOUTHERN DELTA SALINITY OBJECTIVES

[Quinn, T., J.D. Olden, and M.E. Grismer]. 2011. External Peer Review of: State Water Resources Control Board California Environmental Protection Agency "Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives"

Quinn, Page 5
In general the report relies too heavily on secondary sources (e.g., Moyle 2002; NMFS 2009a, 2009b; Williams 2006). There is nothing wrong with these references *per se* but their use compels the reader to get that reference and find the relevant place in it. In cases where the secondary source is lengthy or not readily available, this is no small task. In addition, the referencing of work outside the basin and outside California is limited. I understand that the report has a sharp focus on the San Joaquin River but there are a number of places where work done elsewhere would be relevant.

In terms of conclusions, the report makes a strong case that the shortages of salmon and steelhead are in large part related to the heavy modification of this river system. The mean flows and variances in flow that are normal in rivers of this region and for which the fish evolved have been radically altered (see more detailed comments below). It seems likely, however, that other processes have played a role over the years in the decline of these fishes, and will continue to hinder their recovery. Some of these processes may be synergistic with flows such as, perhaps, chemical contaminants or predation in streams, whereas other may operate independently such as fisheries management, ocean conditions, predation by marine mammals, etc.

Quinn, Page 7
The use of olfaction to locate natal streams deserves better citations than (NMFS 2009a, DFG 2010a). It would be better to cite Hasler and Scholz (1983) or perhaps Dittman and Quinn (1996).

[TR] P. 70 The statement "However, if natal streams have low flows and salmon cannot perceive the scent of their natal stream, straying rates to other streams typically increases." demands more details. There should be information on this important feature of the adult phase and appropriate references. I was surprised to find that there have been no tracking studies on the movements and travel rate of salmon in this system. Can this be true, and if so, why have none been done? This is off-the-shelf technology and clearly important to inform

management in many ways.
I also have some sense (though I confess to not being sure precisely where I learned it) that there are much higher straying rates from the SJR than are considered normal, and that these result from transportation of hatchery juveniles downstream, and also from the difficulties that returning adults experience in detecting odors, given the altered flow regimes. Forgive me if I am mistaken in this regard but if there is any truth to the statement that straying is more prevalent than is normal, this certainly merits more attention in the report. There should be coded wire tagging data from the main hatcheries, I would think, and the analysis of them should be simple.

Quinn, Page 8
The statement that "streamflow alteration, dictated by the dams on the major SJR tributaries, affect [sic] the distribution and quantity of spawning habitat " seems to call for more information. Presumably, the dams have reduced the sediment transport patterns but some detail and references to this would be helpful, or at least an explanation of the processes. The peak flows will play a role in these kinds of sediment transport processes. Is there a loss of intermediate gravel sizes, leaving cobbles and silt? Has the gravel become embedded and so less suitable?

Figure 3.1, which seems to be copied from the NMFS BiOp, needs a proper caption; as is, it is hard to interpret.

Figure 3.2 is quite interesting. Are there similar data for other years, and if so, perhaps a summary table or figure could be produced. Are the redd counts referring to new redds, or all that were counted on each survey? Were they flagged, and so how does the total redd count relate to the number of live fish? Were there tagging studies of stream life and generation of "area-under-the-curve" estimates? In general, I find myself wanting more detail about this kind of data.

Quinn, Page 9
"... since 1952, the average escapement of fall-run Chinook salmon has shown a steady decline. "
This statement is contradicted by the figure (3.5) associated with it. There is no obvious trend downward but rather there are a series of pronounced peaks (a pair of peaks around 1954 and 1960, then discrete ones around 1970, 1985, and 2003). Each of the peaks lasted about 8 years, with distinct "troughs" in between. I think the conclusion that this was a "steady decline" is not supported. Can there be some more sophisticated analyses? What we have seems like a visual examination. What can we make of these peaks and troughs?

Quinn, Page 11
[TR] Page 80 "The limited data that do exist indicate that the steelhead populations in the SJR basin continue to decline (Good et al. 2005) and that none of the populations are [sic] viable at this time (Lindley et al. 2007)."

This latter is a very strong statement and could use some elaboration. Presumably, the implication is that only exchange with resident trout maintains the steelhead phenotype. This should be stated more explicitly, and the biological basis for this exchange merits discussion. I am surprised that the interesting recent papers on California *O. mykiss* were not cited (e.g., those by Satterthwaite, Mangel and co-authors), nor relevant papers from elsewhere (e.g., Narum and Heath). This is not merely a matter of getting some additional references but it is fundamental to the status and recovery prospects for these fish. If the anadromous life history is latent in the resident trout then changes in environmental conditions may allow it to express itself, whereas if the forms are very discrete, as is the case with sockeye salmon and kokanee (the anadromous and non-anadromous forms of *O. nerka*: e.g., Taylor et al. 1996), then the loss of one form is likely more permanent. This extent of plasticity is directly relevant to the efforts to address the chronic environmental changes to which these fishes have been subjected, and the prospects for recovery.

It is also worth noting that the migratory behavior of steelhead differs markedly from that of sub- yearling Chinook salmon. Sub-yearlings spend a lot more time in estuaries and littoral areas whereas steelhead seem to migrate more rapidly (as individuals), exit estuaries quicker (as a population), and occupy offshore waters to a much greater extent. There was extensive sampling in the Columbia River system by Dawley, McCabe and co-workers showing this, and many references to the use of estuaries.

The summary of the importance of spring flows for Chinook salmon seems very reasonable but it would be good to actually see more of the data on which these statements are based. What relationship might there be to pre-spawning mortality or incomplete spawning of adults, or egg- fry survival?

Quinn, Page 12
Figure 3.8 would be better expressed after adjustment for the size of the parent escapement and some density-dependence. Plotting numbers of smolts vs. flow suggests a connection but I would think that multi-variate relationships should be explored.

[TR] Page 84-85. "In a 1989 paper, Kjelson and Brandes once again reported a strong long term correlation (*R2* of 0.82) between flows at Vernalis during the smolt outmigration period of April through June and resulting SJR basin fall-run Chinook salmon escapement (2.5 year lag) (Kjelson and Brandes 1989).

This relationship should be easy to update and I would like to see the recent data. Frankly, I find this correlation implausibly high. There are so many factors affecting marine survival that even a perfect estimate of the number of smolts migrating to sea will not have an R2 of 0.82 with total adult return, much less with escapement (including both process and measurement error). I do not doubt that higher flows make for speedier passage and higher survival, but to link them so closely with adult escapement is stretching it. Indeed, it would seem that NMFS (2009) came to a similar conclusion. After acknowledging the shortcomings in this approach, it seems odd to see Figure 3.10, which is a time-series with flow during the smolt period and lagged escapement. If we much have escapement as the metric rather than smolt survival, can we not at least plot flow on the x-axis rather than date, and some form of density-adjusted recruit per spawner metric on the y-axis? I find it very difficult to see the relationship when plotted as time series.

Figure 3.12. This figure is a poor quality reproduction, and the y-axis is not defined. What is CDRR? (It is not in the list of acronyms). This report is pretty dense in terms of jargon and acronyms and abbreviation, so any effort to state things in plain English will be appreciated.

The text on the Importance of Flow Regime (3.7) is very sensible. It would be helpful to know what sources of the salmon mortality are most directly affected by flow reduction but, given the obvious data gaps, this seems unlikely. Thus overall correlations with survival and basic ecological principles have to carry the day. The text on fish communities, however, is rather confusing. I expected to see information of species composition, comparative tolerances to warm and cool water by various native and non-native fishes, ecological roles with respect to salmon, etc. However, there was a shift to population structure and importance of genetic and life history diversity for the success of salmon. This text (which would benefit from basic references such as Hilborn et al. 2003 for sockeye salmon, and the more recent papers by Moore and by Carlson on salmon in areas more extensively affected by humans) is fine but the reference to variable ocean conditions and marine survival seems to contradict the earlier statements that only smolt number going to sea really matter. Overall, I think this holistic view is more tenable than one only emphasizing the link between flow and smolt production. There is no question that marine survival varies from year to year but all you can ask from a river is that it produce juvenile salmon.

With respect to water temperature, the relationships between physical factors (local air temperature, water depth, solar radiation, groundwater, and heat loss, etc.) are quite well understood so it should be possible to hind-cast the thermal regime that would have occurred in the SJR and its tributaries had the dams and diversions not taken place.

Quinn, Page 13
Delta Flow Criteria
"Finally, the relationship between smolts at Chipps Island and returning adults to Chipps Island was not significant, suggesting that perhaps ocean conditions or other factors are responsible for mortality during the adult ocean phase. " This statement, referring to DFG data, also seems to contradict the earlier statements that marine conditions do not matter and that flow is all that matters. It would seem more correct to state that flow is the most important, among the things under our control.

On Table 3.15, it would be very helpful to present the status quo, so we can see the difference between the flows that DFG concluded are needed to double smolt production from present levels.

[TR] Page 105 "State Water Board determined that approximately 60 percent of unimpaired flow during the February through June period would be protective of fish and wildlife beneficial uses in the SJR. It should be noted that the State Water Board acknowledged that these flow criteria are not exact, but instead represent the general timing and magnitude of flow conditions that were found to be protective of fish and wildlife beneficial uses when considering flow alone."

This would seem to be a critical, overall conclusion: Higher and more variable flows are needed, and can be ca. 60% of unimpaired flows. This is logical and well supported by basic ecological principles, as these flows would provide benefits specific to salmon at several life history stages, and broader ecosystem benefits a well. The various exceedance plots (Figures 3.15 to 3.20) indicate that there is substantial improvement from flow at the 60% level whereas 20% and 40% achieve much less in the important late winter and early spring periods. As the report correctly notes, this is inevitably a bit arbitrary (why 60% - might 59% not do just as well?). Just as with agriculture and wildlife, fish production depends on complex interactions among a number of factors, of which flow is very important but not the only one. Extrapolation from lab studies to the field, where so many things go on at once and where history cannot be played back in a different scenario. So, one can pick at this value, just as one might pick at any specific value, and ask whether the fish can get by with a little less overall, or at some time of the year. Likewise, how much water do crops really need? Can we give the farmers less without hurting production? Obviously, that would depend on soil, temperature, distribution of the water, insects (beneficial and otherwise), and many other factors too. I think that this value (60%) is well- supported, given these kinds of uncertainties.

Olden, Page 4
Time series for fall-run Chinook salmon escapement exceed 50 years in length, highlighting steady declines since 1952 (Figure 3.5), and evidence is presented that hatchery-produced fish constitute a majority of the natural fall-run spawners in the Central Valley (Figure 3.6). The Technical Report and scientific papers discussed within collectively highlight the decadal long declines in Chinook salmon and steelhead trout (albeit limited data in the latter case) in the San Joaquin River basin. The Technical Report also correctly emphasizes that escapement numbers for the three tributaries are comparable in many years, thus suggesting the importance of coordinating flow management across the tributary systems. Indeed, discrete contributions from different tributaries may provide a portfolio effect by decreasing inter-annual variation in salmon runs across the entire system, thus stabilizing the derived ecosystem services (*sensu* Schindler et al. 2010, but within basins).

Olden, Page 6
The benefits of flow restoration may be enhanced if riverine thermal regimes are also considered. One example supporting this notion is in the lower Mississippi River where research has shown that growth and abundance of juvenile fishes are only linked to floodplain inundation when water temperatures are greater than a particular threshold. Schramm and Eggleton (2006) reported that the growth of catfishes (*Ictaluridae* spp.) was significantly related to the extent of floodplain inundation only when water temperature exceeded 15°C; a threshold temperature for active feeding and growth by catfishes. Under the current hydrographic conditions in the lower Mississippi River, the authors report that the duration of floodplain inundation when water temperature exceeds the threshold is only about 1 month per year) on average. Such a brief period of time is believed to be insufficient for

floodplain-foraging catfishes to achieve a detectable energetic benefit (Schramm and Eggleton 2006). These results are consistent with the 'thermal coupling' hypothesis offered by Junk et al. (1989) whereby the concordance of both hydrologic and thermal cycles is required for maximum ecological benefit.

Grismer, Page 2

Overall, this subject is difficult scientifically in terms of appropriate data collection and analyses. For example, the curve in Figure 3.8 on p.3-27 is practically meaningless given the few points available; perhaps this why no R2 value is provided. I suggest simply eliminating the curve. In Figure 3.10, there is extremely low fish "escapement" from the Merced River during 1950-1968 that would seem to "skew" results. Is there any explanation for this dearth of salmon in this period? Is it real or an artifact of sampling? In Figure 3.11, there is clearly an increase in recovered salmon as a function of the number released as might be expected, but the statistical interpretation is strained. Basically, averaging the 2-3 data points per number released indicates that approximately 2.5% salmon 'recovery' at releases of ~50,000 and 2.8% 'recovery' at releases twice as great (~100,000), leading to the possible observation that for releases up to ~100,000 fish recoveries between 2.5-3% might be expected. The single point at large value release (~128,000) suggests a greater recovery fraction (~5%), but it is only one point. Given the wide variability in the recovery numbers, I suspect that these recovery fractions are not statistically different. Perhaps a different analysis is more appropriate here.

ATTACHMENT 2

EXCERPTS FROM A PEER REVIEW OF THE CALIFORNIA DEPARTMENT OF FISH AND GAME'S QUANTIFIABLE BIOLOGICAL OBJECTIVES AND FLOW CRITERIA FOR AQUATIC AND TERRESTRIAL SPECIES OF CONCERN DEPENDENT ON THE DELTA

Gross, W.S., G.F. Lee, C.A. Simenstad, M. Stacey, and J.G. Williams. 2010. Panel Review of the CA Department of Fish and Game's Quantifiable Biological Objectives and Flow Criteria for Aquatic and Terrestrial Species of Concern Dependent on the Delta.

Gross et al. 2010, Page 3

We interpreted "using the best available scientific information" in terms of the following statements (from NRC 2004-a):

1) The agencies may not manipulate their decisions by unreasonably relying on some sources
to the exclusion of others;
2) The agencies may not disregard scientifically superior evidence;
3) Relatively minor flaws in scientific data do not render the data unreliable;
4) The agencies must use the best data available, not the best data possible;
5) The agencies must rely on even inconclusive or uncertain information is that is the best available at the time of the decision;
6) The agencies cannot insist on conclusive data to make a decision;
7) The agencies are not required to conduct independent research to improve the pool of available data.

…citation is supporting an argument, not establishing a fact. Citations, even to the peer-reviewed literature, are not like theorems in mathematics, and do not establish validity. For example, Stevens and Miller (1983) is in a peer-reviewed journal, but commits an elementary statistical error that vitiates its findings about the effects of Delta inflows on juvenile Chinook salmon (probably the authors and the reviewers missed the error because it was masked by the use of an index).

Gross et al. 2010, Page 4

Thinking of citations as supporting an argument explains why citations to the peer-reviewed literature are preferred. They provide stronger support for an argument because independent people thought to be qualified are supposed to have read the papers carefully. Citations to agency reports provide weaker support, even if the reports are conceptually and technically sound, because they are not independently reviewed. Citations to personal communications generally provide even weaker support, unless the person cited is a recognized authority, etc.

Gross et al. 2010, Page 6

- References must be accurately cited. It is the responsibility of the authors to ensure that they are correctly citing facts, results or conclusions from particular references and attributing them correctly. There are a number of examples in the Draft (discussed below in section 4.4.1) where a conclusion or fact is attributed incorrectly to a particular reference, which leaves the statement without a scientific basis.
- References must be clearly cited. Relying on references that are "personal communication" or obscurely cited ("NMFS 3 in SWRCB 2010") makes it difficult to evaluate the underlying science.
- Whenever possible, references should be to peer-reviewed literature, not internal technical reports or testimony. In many cases, this will require that the authors trace back through the literature to determine the original source of the information, but that is part of providing BAS.
- The Draft frequently relies on some sources to the exclusion of scientifically superior sources. As three examples, it cites outdated analyses by Kjelson and Brandes instead of superior analyses (Newman and Rice 2002; Newman 2003). It cites an outdated study by Brett (1952) and a consulting report and testimony by Alice Rich on the temperature tolerance of juvenile salmon instead of scientifically superior studies by Myrick and Cech (2001, 2002, 2004) and Marine and Cech (2004). It relies on an unpublished work by Marston and ignores superior studies by Newman2 and others involved with VAMP, and by Terry Speed (1993). It fails to cite many relevant, more recent papers (Appendix A3), including a long review on Central Valley Chinook and steelhead (Williams 2006) that would have drawn DFG's attention to the superior sources just noted.
- The Draft refers to a vague source (DFG 2010a) on key points, such as "Random rare and unpredictable poor ocean conditions may cause stochastic high mortality of juvenile salmon entering the ocean, but the overwhelming evidence is that more spring flow results in higher smolt abundance, and higher smolt abundance equates to higher adult production (DFG 2010a)" at p. 47. This sentence is also misleading; it is true that rare ocean conditions can cause high mortality of juvenile salmon entering the ocean, but so can more common conditions. This claim seems to be an attempt to defend the Marston results from the criticism that fitting models to smolt-adult survival data without taking variable ocean survival into account will give misleading results (a claim that is dubious to start with, but even more so without a supporting reference).

Gross et al. 2010, Page 7

- For many species, the Draft seems to assume that flow alone will restore natural processes and restore/reconnect critical habitats for these species. This assumption is poorly founded.
- Similarly, hypothesized responses by species and species assemblages should have been placed in context of DRERIP conceptual models (see: http://science.calwater.ca.gov/drerip/drerip_index.html for peer-reviewed models and documentation; these models are being prepared for future publication in *San Francisco Estuary and Watershed Science*).

Gross et al. 2010, Page 8

- The basic (not necessarily the Delta-specific) information on coastal wetland requirements and use by juvenile Chinook salmon is relatively parochial and out of date. There has been considerable information emerging over the past decade that continues to validate at least two relevant aspects of their life history:
  - Life history diversity of Chinook salmon, whether genetic or tactical, is influenced by habitat diversity and opportunity and is considered important to population resilience; and,
  - Several life history types express strong fidelity toward prolonged estuarine wetland occupancy, fidelity toward particularly geomorphic habitat features and specific locations, and selectivity toward particular estuarine food web pathways. Miller et al. (2010) provide evidence that a substantial proportion of juvenile Central Valley fall Chinook leave fresh water at <56 mm fork length. Given that most Central Valley fall Chinook are hatchery fish, as shown by Barnett-Johnson et al. (2005) and the proportion of marked fish observed in the 2009 carcass surveys, and that fish leaving fresh water at < 56 mm are unlikely to be hatchery fish, juveniles that leave fresh water before they reach "smolt" size may be the dominant part of the naturally produced fraction of the run. The objectives in the Draft ignore these fish.

Gross et al. 2010, Page 9

- The objectives for salmon fail to distinguish hatchery and naturally produced fish. The objectives refer to the salmon protection water quality objective, which seems to be: "Water quality conditions shall be maintained, together with other measures in the watershed, sufficient to achieve a doubling of natural production of Chinook salmon from the average production of 1967-1991, consistent with the provisions of State and federal law." There is a key phrase in this language, "natural production," that is defined in the CVPIA. This excludes hatchery-reared salmon. The Draft does not deal with the difference between hatchery and natural production of salmon and steelhead.
- The first three objectives embody the notion that river flows "transport salmon smolts through the Delta." As discussed in Ch. 6 of Williams (2006), the migration of juvenile salmon is much more complicated than this and for most juvenile Chinook life history types cannot, and should not, be separated from rearing in the Delta.

Gross et al. 2010, Page 10

Year-to-year variability to meet biological objectives is missing, or is based on water year type. If we are to use functional flows, then the water year type should not be a factor – the biological requirements should be independent of the hydrology. If there is a need for year-to-year variability, then this should be stated as such (this is something that Fleenor et al. (2010) did very well). The biological objectives and required flows should not depend on the specific realization of hydrologic flows. To be clear, if we have 10 straight wet years, or 10 straight dry years, the required flows for meeting the biological objectives will be incorrect. It is possible that the DFG was using criteria based on water year type to create year-to-year variability, but the scientific basis for this approach is not established. To built this up scientifically, the authors would need to (a) define what degree of year-to-year variability in flows benefits the species (not done in the Draft); (b) establish the temporal variability of year types in the historical record (also not done here, but analysis exists); and (c) develop projections of the frequency of water year types for future conditions (the CASCaDE project the USGS has been pursuing may inform this).

Gross et al. 2010, Page 12

- The connection between Delta water temperatures and river flows is not established in the literature. The criterion proposed here (flows >5000 cfs in April-May keep Delta water temperatures below 65 F) does not have any scientific citation associated with it (in the Draft this criterion is based on testimony from the Bay Institute). Exploration of temperature in the Delta and the connection to flows has been pursued in a fundamental sense by Monismith et al. (2008) and in view of the effects of climate change in a paper that is in review by Wagner et al. (part of the USGS CASCaDE project).

Gross et al. 2010, Page 13-14

The use of testimony (unavailable for review – or at least difficult to track down) or another unreviewed technical report (SWRCB 2010) is not enough to justify conclusions. In one case (for the flow requirement to prevent flow reversal at Georgiana Slough), a fact is attributed to the SWRCB report, but in that report the fact is referenced to "personal communication" or to some testimony that is unavailable for review. Other examples include references to Snider and Titus (DFG technical reports), Allen and Titus (which is actually a proposal!) and testimony from groups like American Rivers or the Natural Heritage Institute. To ensure scientific transparency, references should be given to their original source. Otherwise, a personal communication or a proposal begins to have the appearance of a reviewed scientific reference.

Gross et al. 2010, Page 14

- Statements without scientific references are sprinkled throughout the Draft. One example lies in the statement that as natural flows have been reduced, flow conditions have become more favorable to non-native species. While this might be true, the inclusion of the modifier "flow" on "conditions" makes it a more specific statement than is likely to be defensible scientifically (i.e., the more vague statement "…as natural flows have been reduced, conditions have become more favorable to non-native species" is probably better established in the literature). As a second example, the discussion of the decline in San Joaquin River Chinook from 26000 to 13000 states "Flow related conditions are likely to be a major cause of this decline," but there is no reference to support the statement. Further, the use of non-peer-reviewed information undermines much of the results presented. The flows required to prevent salmon entrainment at Georgiana Slough, for example, are referenced from Perry et al. 2008 and 2009, but these are just technical reports, and have not been peer-reviewed; at least some of this work has been published and that should be cited.
- In most cases the report does not clarify the degree of scientific certainty/uncertainty associated with individual flow objectives. Therefore it is not clear to what extent each individual objective is supported scientifically.
- Minimal detail of relevant modeling studies has been provided. In any case where flow criteria have been based in part upon modeling studies, the modeling studies should be

briefly described in the Draft. Direct references of relevant papers and reports should be provided.

- There are a number of cases where the actual sources of a piece of information are inaccurately referenced – at times in ways that are quite deceiving. For example, the Draft attributes population declines since 1985 to flows based on Fleenor et al. (2010). Fleenor et al. (2010) do not make that statement. (It is bad enough that such a fundamental point to this whole process is being based on an unreviewed document.). They do compare 1949-1968 ('when fish were doing better') to 1986-2005 ('when fish were doing poorer') and note that the flows have changed – but they do ***not*** conclude that this is causative.
- In the first paragraph of page 75, an entrainment loss estimate of up to 40% was attributed to "PTM results" by Kimmerer (2008). The bulk of the entrainment losses estimated in Kimmerer (2008) were estimated based on survey observations, flow observations and several assumptions. Figure 16 and a small part of the text discuss particle tracking model results which estimate percent loss to the population. However, it should be noted that this is assuming no natural mortality. Kimmerer (2008) also estimates population losses by a more complete method which does take account of natural mortality but does not utilize any particle tracking results. These (lower) estimates are more appropriate to cite, preferably noting that the estimated error bounds for the calculated population losses are quite large.
- It is not entirely clear in which cases the Biological Objectives and Flow Criteria have been directly adopted from other documents such as the ERP Plan or OCAP (NMFS 2008). This should be clarified for each Biological Objective and Flow Criteria.
- The report commonly references SWRCB 2010 and DFG 2010a. SWRCB 2010 refers to the State Water Resources Control Board document. Some of the information in that document is associated with an information proceeding. This document summarizes existing information and scientific understanding. DFG 2010a refers to the participation of CDFG in the State Water Resources Control Board Informational Proceeding. Whenever possible original scientific literature should be cited as opposed to summary documents.

Gross et al. 2010, Page 15

- Fleenor et al. (2010) is referenced frequently when the citation should have been to the original scientific source material, especially when this was a peer-reviewed journal publication.
- The Draft misinterprets several important references. For example, at p. 40: "Based on the mainly oceantype life history observed (*i.e.*, fall-run), MacFarlane and Norton (2002) concluded that unlike other salmonid populations in the Pacific Northwest, Central Valley Chinook salmon show little estuarine dependence and may benefit from expedited ocean entry." The first clause in this sentence is incorrect; MacFarlane and Norton (2002) were contrasting their results with those from other ocean-type populations of Chinook. Moreover, MacFarlane and Norton (2002) defined the estuary in terms of salinity, rather than tidal influence, so their study applies only to the bays, not to the Delta. Further, their data collection did not begin until late spring, whereas most naturally produced fall

Chinook move into the Delta in winter or early spring.

- A large section of text regarding salmon (pp 36-39) that contain errors and poor scholarship, including the misreading just discussed, was taken from the 2009 OCAP BO without attribution. The Draft does note that "Much of this section is excerpted and adapted from DFG (2010a, 2010b) and SWRCB (2010)," and indeed much of the language also appears in SWRCB (2010). It does not seem, however, that the language was original with DFG, as suggested by the reference to DFG (2010a; 2010b), which were submissions to the process resulting in SWRCB (2010). We realize that Section 85084.5 directs DFG to develop its recommendations to the SWRCB in consultation with NMFS, but this is carrying consultation too far, and violates ordinary standards for scientific writing.

ATTACHMENT D

UNITED STATES BUREAU OF RECLAMATION
NEW MELONES RESERVOIR – WATER RIGHT PERMITS 16597, 16600, 20245
(APPLICATIONS 14858, 19304, 14858B)

PETITION TO CHANGE STANISLAUS RIVER DISSOLVED OXYGEN (DO) COMPLIANCE POINT

- OID/SSJID and SEWD prepared this petition for Reclamation to request the State Water Board change the compliance point for dissolved oxygen on the Stanislaus River in Reclamation water right permits for New Melones Reservoir.
- Petition contains a summary of the water right process leading up to issuance of the permits, including testimony regarding the fishery needs on the Stanislaus River.
- Monitoring of fishery resources in the Stanislaus River, as well as a review of the temperature data, indicates that fish are not rearing at Ripon as temperatures exceed what is needed for the fish.
- Petition requests the State Water Board exercise its reserved jurisdiction to move the Stanislaus River DO compliance point from Ripon (River Mile 16) to Orange Blossom Bridge (River Mile 46.9) from June 1 through August 31.

UNITED STATES BUREAU OF RECLAMATION
NEW MELONES RESERVOIR – WATER RIGHT PERMITS 16597, 16600, 20245
(APPLICATIONS 14858, 19304, 14858B)

PETITION TO CHANGE STANISLAUS RIVER DISSOLVED OXYGEN COMPLIANCE POINT

I. INTRODUCTION.

Pursuant to the requirements of State Water Resources Control Board ("SWRCB") Decision 1422 ("D-1422), Decision 1616 ("D-1616"), Decision 1641 ("D-1641") and the Water Quality Control Plan, Central Valley Region, Fourth Edition, for the Sacramento River Basin (5A) and San Joaquin River Basin (5B) ("2004 CRWQCB Basin Plan"), the United States Bureau of Reclamation ("USBR") is required to release stored water from New Melones Reservoir to maintain a dissolved oxygen ("DO") concentration of 7.0 mg/L in the Stanislaus River as measured at Ripon.

The establishment of the 7.0 mg/L DO concentration is intended to preserve or enhance aquatic habitats, and spawning and rearing of salmon and steelhead. While the Stanislaus River contains fish and aquatic habitat that benefit from a minimum DO concentration of 7.0 mg/L, such fish and aquatic habitat are located far upstream of the Ripon compliance point during the summer months. As such, the USBR contends that the SWRCB should exercise its reserved jurisdiction to move the Stanislaus River DO compliance point from Ripon (River Mile 16) to Orange Blossom Bridge (River Mile 46.9) from June 1 through August 31.

II. BACKGROUND.

A. D-1422

In D-1422, the SWRCB required the USBR to release conserved water from New Melones Reservoir for water quality control purposes, including DO in the Stanislaus River. (D-1422, Condition 8). The SWRCB did not identify the DO concentration that the USBR would need to achieve in D-1422, but rather required the USBR to meet whatever DO concentration was required by any current and applicable Water Quality Control Plan. (Id.). Although no DO concentration requirement was established, D-1422 did establish that any Stanislaus River DO concentration requirement was to be met at Ripon, unless an alternative compliance location was approved by the SWRCB. (Id.).

The express purpose of the original request that a DO concentration in the Stanislaus River be met was "to protect the salmon fishery." (D-1422, p. 12, citing RT 526). However, it is unclear from the hearing transcripts and written testimony considered at the hearings which culminated in D-1422 how the DO requirement would protect the salmon fishery generally, or why the compliance point was established at Ripon.

Mr. Maurice Fjelstad authored a large portion of Chapter 2 of the California Department of Fish and Game's ("CDFG") "Report to the California State Water Resources Control Board On Effects of the New Melones Project on Fish and Wildlife Resources of the Stanislaus River and Sacramento-San Joaquin Delta ("1972 CDFG Report") which dealt with the predicted impact of the New Melones Project on the existing fishery resources of the Stanislaus River. (RT 520). His testimony is cited by the SWRCB in D-1422 in that the DO concentration is necessary to protect the salmon fishery of the Stanislaus River. (D-1422, p. 12). However, the citation relied upon by the SWRCB is of little specific assistance as to the importance of the DO concentration to salmon as it was just one part of a general answer given by Mr. Fjelstad in response to the question "Could you tell the board the specifics of – well, what the salmon need to survive?" Mr. Fjelstad responded to this question as follows:

> "Well,..., the salmon's primary requirement is water at the right time and at the right place. They require suitable water temperature. Fifty to fifty-two degrees is ideal for spawning. The temperature during spawning should be below 58 degrees. After spawning, after incubation, the temperatures should remain below 70 degrees. They require suitable dissolved oxygen which should be no less than seven parts per million. And, as I said before, they require adequate flows for upstream migration, spawning, incubation of the eggs, and downstream migration." (RT 526).

While Mr. Fjelstad further testified in detail about the specific needs of the various life-stages of salmon, as was also provided in Chapter 2 of the 1972 CDFG Report, neither Mr. Fjelstad nor the 1972 CDFG Report provide any further detail as to the what particular life stages of salmon require a minimum DO concentration.

This lack of a discussion about how DO affects any or all of the salmon life stages is critical, as virtually all of the other proposed requirements are associated with a specific life stage. For example, CDFG recommended a minimum flow of 200 cfs from Goodwin Dam to the confluence with the San Joaquin River between October and December for purposes of allowing upstream migration and spawning and incubation of eggs. (1972 CDFG Report, p. 2-11, 2-12 and Errata Sheet).CDFG recommended a minimum flow of 150 cfs from January 1 through February 28 between Goodwin Dam and the confluence with the San Joaquin River for incubation and a variety of flows between Goodwin Dam and Ripon during the January through June migration period. (1972 CDFG Report, p. 2-12 – 2-17 and Errata Sheet). CDFG further recommended a flow of 100 cfs between Goodwin Dam and the confluence with the San Joaquin River during July, August and September to control vegetative encroachment on spawning gravels, maintain suitable temperature and maintain suitable DO. (1972 CDFG Report, p. 2-17).

While there is a specific reference to DO during the summer months, this reference is particularly vague when compared to the other recommendations. In fact, it is not at all clear whether or not the reference to DO in the summer months has anything to do with fall run salmon at all. CDFG specifically stated

> "Summer flows are essential...in maintaining suitable dissolved oxygen and temperature levels for resident fishes and any steelhead and spring-run salmon populations which might develop in the Stanislaus River and will sustain juvenile salmon that stay in fresh water for one year."
> (1972 CDFG Report, p. 2-17).

From the construction of the sentence, CDFG is certainly stating that DO will assist resident fish and any steelhead or spring-run salmon, but it is not clear if CDFG is stating that DO is needed by juvenile salmon, or if the recommended summer *flows* will "sustain" such fish. Indeed, given that Mr. Paul Jensen, testifying on behalf of CDFG, stated that "juvenile fall run king salmon would not normally be expected to be in the river much beyond June," (RT 620) and that therefore summer temperatures were not a concern or limiting factor for salmon, it seems that the statement on page 2-17 of the 1972 CDFG Report must be read to state that DO in the summer is only important for steelhead and spring-run salmon if such populations might develop. This conclusion is bolstered further by Mr. Jensen's testimony that "[i]n July, August and September the salmon are gone." (RT 635).

A complete review of the evidence and testimony submitted to the SWRCB does not resolve the ambiguity. Clearly, at least as a general matter, the CDFG is recommending that a DO requirement is needed to protect the salmon fishery in the Stanislaus River. However, since there is no specific discussion as to the specific life stage or stages that the DO requirement is to protect or promote, there is no geographic area at which such DO requirement must be met. As noted above, the specific purpose that the other recommended conditions – such as flow or temperature – was to promote or protect determined where, in a geographic sense, such condition would be applicable. Thus, flows recommended for upstream migration were applicable throughout the Stanislaus River, whereas other flow recommendations were applicable primarily between Goodwin Dam and Ripon.

Despite the lack of specificity as to the purpose of the DO requirement requested by CDFG (beyond the general "for the protection of the salmon fishery") and therefore the lack of geographic location(s) at which such requirement must be met, the SWRCB nonetheless agreed to condition the USBR's permits on, among other things, the requirement that the USBR make releases of conserved water from New Melones for the purpose of meeting DO. (D-1422, p. 31, Condition 5). Additionally, although there is apparently no discussion as to the purpose of the DO requirement, and therefore no geographic area of compliance, the SWRCB nonetheless established the DO compliance point at Ripon. (Id.).[1]

B. D-1616

D-1422 dealt with the USBR's request for permits to divert water into New Melones for storage. In D-1616, the SWRCB considered the USBR's request for permits for direct diversion at New Melones.

While granting the permits requested by the USBR, the SWRCB prohibited any direct diversion for consumptive use if the DO concentration, as measured at Ripon, is less than that specified in the April 1975 version of the SWRCB's Water Quality Control Plan, San Joaquin River Basin 5C. (D-1616, Condition 12 and 13). As in D-1422, the SWRCB left open the possibility that it would consider and approve an alternate location for measuring compliance with the Stanislaus River DO concentration requirement. (D-1616, Condition 13).

CDFG did initially protest the USBR's permit application, but the protest was resolved before the conclusion of D-1616 through an agreement between the USBR and CDFG. As such, the SWRCB made no specific statements or findings regarding either the purpose of the continued DO concentration requirement or the continued use of Ripon as the compliance point of such requirement.

C. Current Permit Conditions

The USBR's permits for the New Melones Project were modified by the SWRCB in D-1641. These modifications were minor and still require the USBR to release stored water and/or refrain from directly diverting water unless and until the DO concentration at Ripon is met. (D-1641, p. 160 and 162).

The DO concentration requirement itself has changed over time since it was first required in D-1422. Now, the DO concentration requirement at Ripon is that specified in the 2004 CRWQCB Basin Plan. According to this plan, DO objectives are established based upon general needs of the fishery resource specific to a particular river or stream in the basin. That is, as a general matter, streams are designated as "WARM," meaning the fishery resources of that water body are rely primarily on warm water habitat (such as sunfish or catfish), "COLD," meaning the fishery resources of that water body rely primarily on cold water habitat (such as rainbow trout or sculpins) and "SPWN," meaning the fishery resources of that water body utilize the water body for reproduction and early development (such as salmon or steelhead trout), and a general DO

[1] In a personal communication with Mr. John Renning of the USBR in 2004, he suggested that Ripon was chosen as the compliance point not because of salmon, but rather due to the existence of numerous canneries in Ripon. These canneries had discharges of effluent that were high in biological or chemical oxygen demand. Mr. Renning's suggestion makes sense, as the SWRCB noted in D-1422 that the then-applicable water quality control plan included a requirement in the Stanislaus River for DO "as a result of waste discharges..." (D-1422, p. 12).

concentration is established for each of these fishery purposes. Unless an exception is made that requires either less or more stringent concentrations, water bodies designated as WARM shall not have DO concentrations that fall below 5.0 mg/L and water bodies designated as COLD or SPWN shall not have DO concentrations fall below 7.0 mg/L. (2004 CRWQCB Basin Plan, page III-5.00).

Since the Stanislaus River is designated COLD and SPWN, the DO concentration requirement is 7.0 mg/L. (2004 CRWQCB Basin Plan, p. II-8.00). Although the 2004 CRWQCB Basin Plan does not establish compliance points, the DO concentration of 7.0 mg/L must be met at Ripon as required by the USBR's permits for the New Melones Project.

III. DO CONCENTRATION COMPLAINCE POINT AT RIPON IS NOT NEEDED YEAR ROUND TO PROTECT THE SALMON OR STEELHEAD FISHERY.

The CDFG originally recommended a DO concentration requirement in the Stanislaus River "to protect the salmon fishery." (D-1422, p. 12, citing RT 526). Similarly, the current DO concentration requirement established by the CWRQCB is designed to protect the cold-water fishery and spawning fishes, which in the Stanislaus are primarily salmon and steelhead. While it is undisputed that salmon and steelhead exist in the Stanislaus River and that a DO concentration in the Stanislaus River for the protection of such fishery is appropriate, the compliance point of Ripon is not always appropriate for the protection of such fishery.

Geographically, the Stanislaus River extends approximately 60 miles from Goodwin Dam to the confluence with the San Joaquin River. Ripon is located approximately 44 miles downstream of Goodwin Dam, and approximately 16 miles upstream from the confluence of the Stanislaus and San Joaquin Rivers. As noted earlier, many requirements regarding flow, temperature, water quality, gravel size and other items are designed and intended to support, enhance or protect certain specific salmonid life stages. Salmon and steelhead in the Stanislaus River have five basic life stages: adult migration, spawning, egg incubation, juvenile rearing, and juvenile migration. By examining the timing and locations of these five life stages of salmon utilizing the Stanislaus River, it can be seen that the DO concentration requirement is not needed at Ripon on a year-round basis.

A. Fishery Resources

1. Fall-Run Chinook Salmon

a. Adult Fall-Run Chinook Migration

In 1972, the CDFG reported that adult salmon migrated up the Stanislaus River between early October and late December, with migration reaching a peak in Late October and early November. (1972 CDFG Report, p. 2-4). Although this description of migration timing is over 30 years old, it remains fairly accurate. Since 1972, data collected by private fishery consultants, non-profit organizations, and the CDFG demonstrate the majority of adults migrate upstream from late September through December with peak migration occurring from late October through early November (Table 1, Cramer Fish Sciences [CFS] unpublished data; Fishery Foundation of California [FFC] unpublished data; CDFG annual spawning survey reports). Yet, some adult migration has been observed as early as September and as late as January (Table 1).

In terms of location, adult migration in the Stanislaus River extends upstream from the river's confluence with the San Joaquin River to the spawning grounds located between Riverbank (River Mile 33) and Goodwin Dam (River Mile 58.4).

Table 1. Generalized upstream migration timing pattern observed at the Stanislaus River Weir near Riverbank (River Mile 31.2) during 2003-2005.

Date	***% Adult Chinook***
Sep 1-15	0.02%
Sep 16-30	2.72%
Oct 1-15	18.35%
Oct 16-31	26.60%
Nov 1-15	32.69%
Nov 16-30	12.68%
Dec 1-15	5.60%
Dec 16-31	1.16%
Jan 1-15	0.15%
Jan 16-31	0.02%

b. Fall-Run Chinook Spawning

Adult fall-run Chinook salmon spawn soon after they complete their upstream migration and arrive at the spawning grounds. For Stanislaus River salmon, spawning generally takes place between October and December based on spawning surveys (Table 2). However, there is evidence from spawning surveys (Table 2) that indicates a small amount (i.e., 1.2%) of spawning activity may occur as early as September or as late as January. In addition, juvenile outmigration studies (CFS unpublished data) indicate that spawning activity can occur as late as February based on estimated incubation requirements (i.e., 40 to 60 days) and the presence of newly emerged fry observed in late April.

According to the Stanislaus River Fish Group's (SRFG) "A summary of fisheries research in the lower Stanislaus River" ("SRFG 2004"), the spawning reach is about 25 miles long and extends from Goodwin Dam (River Mile 58.4) downstream to Riverbank (River Mile 33).

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Table 2. Generalized timing pattern of spawning in the Stanislaus River based on redd counts from CDFG spawning surveys conducted 1998 to 2005. (CDFG annual reports).

Date	***% redds observed***
Before Oct 1	0.1%
Oct 1-15	1.5%
Oct 16-31	10.5%
Nov 1-15	29.4%
Nov 16-30	29.4%
Dec 1-15	19.0%
Dec 16-31	9.0%
Jan 1-15	1.1%

c. Fall-Run Chinook Egg Incubation

The duration of salmon egg incubation varies significantly with water temperature, and Chinook salmon eggs require the accumulation of 888 Fahrenheit degree days (e.g., 1°F above freezing for one day) from the time that they are deposited by spawning adults until juveniles hatch and emerge from the gravel. (Piper and others 1982). Temperatures vary between years, within years, and by location, but based on typical fall/winter temperatures in the Stanislaus this translates to an incubation period of approximately 40 to 60 days. Based on documented spawn timing (CDFG annual reports) and the estimated number of days until hatching and emergence based on degree days, egg incubation generally extends from October through March.

Incubation occurs within the 25 mile spawning reach that extends from Goodwin Dam (River Mile 58.4) downstream to Riverbank (River Mile 33).(SRFG 2004).

d. Fall-Run Chinook Juvenile Rearing

Juvenile Chinook rearing in the Stanislaus River primarily occurs from mid December through May between Goodwin and Riverbank. However, some rearing may occur at different times and locations. For instance, some rearing may occur throughout the lower river below Riverbank from mid December through May when temperatures in the lower river are within tolerable ranges. However, the number of juveniles rearing in this lower reach is anticipated to be small based on abundance trends, migration timing, and fish size observed between Oakdale and Caswell; and any rearing that occurs below Orange Blossom Bridge is generally believed to be associated with fish migration or with displacement during pulse flows or flood control events

In addition, although most rearing juveniles migrate prior to June, some juveniles may continue to rear in the river above Orange Blossom Bridge (River Mile 46.9) throughout the summer and fall where temperatures are within tolerable ranges. However, based on snorkel surveys and outmigration data, it appears that very few juvenile salmon oversummer in the river. For instance, relatively low salmon densities are observed within the river after mid September (FFC unpublished data) and very few juveniles are observed migrating the following winter (i.e., three to 29 individuals captured annually at Oakdale and Caswell combined; CFS unpublished data).

e. Fall-Run Chinook Juvenile Migration

For over a decade, rotary screw traps located at Caswell (River Mile 8.6) have collected data on out-migrating juvenile salmon. Rotary screw trap data indicate that about 99% of salmon juveniles migrate out of the Stanislaus River from January through May. (SRFG 2004). Fry migration generally occurs from January through March, followed by smolt migration from April through May. However, some juveniles have been captured at Caswell as early as December 22 (<1% migrating prior to January) and as late as July 3 (<1% migrating after May). (CFS unpublished data reports).

In the Stanislaus River, out-migration of juvenile salmon extends from rearing areas below Goodwin Dam (River Mile 58.4) to the river's confluence with the San Joaquin River (River Mile 0.0).

f. Summary Fall-run Chinook Salmon Life Stage Timing and Geographic Location

From the above information, fall-run Chinook salmon life stage timing and geographic location within the Stanislaus River can be generalized as follows:

Stage	Timing	Geographic Location
Adult Migration	Late September - December	Goodwin Dam to confluence
Spawning	October – December	Goodwin Dam to Riverbank
Egg Incubation	October – March	Goodwin Dam to Riverbank
Juvenile Rearing	mid December – May	Goodwin Dam to Riverbank
	June – mid December	Goodwin Dam to Orange Blossom Bridge
Juvenile Migration	January – May	Goodwin Dam to confluence

2. Steelhead

a. Steelhead Adult Migration

Steelhead adults typically migrate from the ocean and into tributaries to spawn. However, unlike salmon, some adult steelhead may repeat their migration downstream out of the river after spawning to return to the ocean. (Shapovalov and Taft 1954; McEwan 2001).

In the Stanislaus River, there is little data regarding the migration patterns of adult steelhead since adults generally migrate during periods when river flows and turbidity are high making fish difficult to observe with standard adult monitoring techniques. A counting weir has been operated on the Stanislaus River from September to March in 2003-2004, September to April in 2004-2005, and September to December in 2005. Only two adult steelhead upstream migrants have been observed during these three years of monitoring. Of these two adult upstream migrants, one was observed in early January 2005 and the other during mid October 2005. Based upon this very limited data, it appears that adult steelhead may migrate into the Stanislaus River from at least October through January (CFS unpublished data). On the neighboring Mokelumne River, a longer time series of data (i.e., 12 years) exists to describe adult steelhead migration timing in the San Joaquin Basin. Results from the Mokelumne River study suggest that 97.7% of adult steelhead migration occurs from late September through March, although some fish have been observed as early as August 16 (Table 3; East Bay Municipal Utilities District unpublished data).

Limited data exists to describe the timing and frequency of occurrence of downstream migration after spawning. During three years of weir monitoring, nine spawned out adults that may have been migrating downstream out of the river to return to the ocean have been observed as early as December 27 and as late as March 18. It is generally believed that downstream migration of spawned out adults occurs soon after they have spawned. Based on this coupled with the few observations at the weir, adult downstream migration may occur from December through March.

Adult migration takes place in the Stanislaus River between the confluence with the San Joaquin River (River Mile 0.0) and Goodwin Dam (River Mile 58.4).

Table 3. Generalized adult steelhead upstream migration timing pattern observed on the Mokelumne River at Woodbridge Dam during 1990-2001. Source: East Bay Municipal Utility District unpublished data.

Date	***% Adult Steelhead***
Aug 1-15	0.0%
Aug 16-31	1.1%
Sep 1-15	1.1%
Sep 16-30	4.6%
Oct 1-15	7.4%
Oct 16-31	8.3%
Nov 1-15	14.0%
Nov 16-30	8.3%
Dec 1-15	9.5%
Dec 16-31	10.9%
Jan 1-15	7.2%
Jan 16-31	10.3%
Feb 1-15	8.9%
Feb 16-28	3.2%

Mar 1-15	3.4%
Mar 15-31	1.7%

b. Steelhead Spawning

As a result of poor visibility from high flows and turbid water conditions, there is little hard data regarding the spawning of steelhead in the Stanislaus River. However, based upon observations in the nearby Sacramento Basin (Hallock and others 1961) and limited data from the Stanislaus River (i.e., CFS unpublished weir and juvenile migration data), it is believed that steelhead spawn primarily between December and March.

During three years of weir monitoring, spawned out steelhead kelts have been observed as early as December 27 and as late as March 18 suggesting that spawning extends from at least late December through mid March (Table 4). Fry emergence is also an indicator of spawn timing and typically occurs 47 to 122 days after spawning (Barnhart 1986; Shapovalov and Taft 1954). Newly emerged rainbow/steelhead trout fry (i.e., ≤45 mm) are typically observed in the Oakdale screw trap from March through May, and have been captured as early as January 24. Similarly, young rainbow/steelhead trout have been observed during snorkel surveys conducted by the FFC beginning in April. (Kennedy and Cannon 2002). These fry observations corroborate that spawning may extend from late December through mid March.

Table 4. Monthly observations of steelhead kelts at the Stanislaus River weir during three seasons of monitoring.

	2003-2004	2004-2005	2005-2006
December	1	0	0
January	2	1	No sample
February	2	0	No sample
March	1	2	No sample

Although no steelhead spawning surveys have been conducted in the Stanislaus River, it is believed that steelhead spawning primarily takes place between Goodwin Dam and Orange Blossom Bridge. (SRFG 2004).

c. Steelhead Egg Incubation

Steelhead egg incubation occurs from the time that eggs are deposited by spawning adults until they hatch and juveniles emerge. Length of time required for eggs to develop and hatch is dependant on water temperature and is quite variable; hatching varies from about 19 days at an average temperature of 60EF to about 80 days at an average of 42EF. (Barnhart 1986) After hatching, pre-emergent fry remain in the gravel living on yolk-sac reserves for another four to six weeks. (Shapovalov and Taft 1954); thus, incubation (i.e., deposition to emergence) may extend from 47 to 122 days. Based on estimated spawn timing, typical incubation temperatures, and emergent fry observations (CFS unpublished juvenile migration data and FFC unpublished snorkel survey data observations), incubation in the Stanislaus River may occur from December through June.

d. Steelhead Juvenile Rearing

Juvenile rainbow/steelhead trout rearing in the Stanislaus River occurs year-round primarily between Goodwin Dam (River Mile 58.4) and Orange Blossom Bridge (River Mile 46.9). (CFS unpublished data; Kennedy and Cannon 2002). However, some rearing may occur at different times and locations. For instance, snorkel surveys by FFC indicate that the majority of steelhead rearing in the summer months takes place upstream of Orange Blossom Bridge, with the greatest abundance observed at Goodwin (River Mile 57.5) and Two-Mile Bar (River Mile 56.6). (Kennedy and Cannon 2002). In addition, some rearing may occur throughout the lower river below Orange Blossom Bridge during the winter months when temperatures in the lower river are within tolerable ranges. However, the number of juveniles rearing in this lower reach is anticipated to be small based on habitat suitability, angler observations, and limited snorkel survey data; and any rearing that occurs below Orange Blossom Bridge is generally believed to be associated with fish migration or with displacement during pulse flows or flood control events.

e. Steelhead Juvenile Migration

Over the past decade, the rotary screw traps at Caswell have typically been operated from January through June and the data indicates that steelhead outmigrate primarily from February through May (i.e., 95%). However, migration can begin as early as January and extend into June (CFS unpublished data reports).

The migration timing suggested by the Caswell data is also corroborated by observations made downstream at Mossdale on the San Joaquin River and in the neighboring Sacramento River Basin. To monitor emigration from the San Joaquin Basin, CDFG and the U.S. Fish and Wildlife Service (USFWS) operate a Kodiak trawl on the San Joaquin River near Mossdale on more of a year-round schedule and the trawl is believed to be more effective than rotary screw traps in capturing steelhead smolts. Similar to the timing suggested by catches at Caswell, steelhead were only captured from February through early June and 95% of the catch occurred from mid-March through May (USFWS unpublished data; Table 5). Additionally, Hallock and others (1961) found that juvenile steelhead in the Sacramento Basin migrated downstream during most months of the year, but the peak period of emigration occurred in the spring.

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Table 5. Generalized timing pattern of steelhead outmigration from the San Joaquin Basin developed from Mossdale trawl catch data collected by CDFG and the USFWS from 1996 to 2004.

Date	***% Juvenile Steelhead***
Feb 1-15	1.6%

Feb 16-29	0.0%
Mar 1-15	1.6%
Mar 16-31	3.1%
Apr 1-15	21.9%
Apr 16-30	29.7%
May 1-15	29.7%
May 16-31	10.9%
Jun 1-15	1.6%
Jun 16-30	0.0%

In the Stanislaus River, out-migration of juvenile steelhead extends from rearing areas below Goodwin Dam (River Mile 58.4) to the river's confluence with the San Joaquin River (River Mile 0.0).

f. Summary Steelhead Life Stage Timing and Geographic Location

From the above, steelhead life stage timing and geographic location within the Stanislaus River can be expressed as follows:

Stage	Timing	Geographic Location
Adult Migration	Late September – March	Goodwin Dam to confluence
Spawning	December - March	Goodwin Dam to Orange Blossom Bridge
Egg Incubation	December – July	Goodwin Dam to Orange Blossom Bridge
Juvenile Rearing	Year-round	Goodwin Dam to Orange Blossom Bridge
Juvenile Migration	February – May	Goodwin Dam to confluence

B. Change in DO Compliance Point is Appropriate

The above information shows that neither salmon nor steelhead are located anywhere in the Stanislaus River downstream of Orange Blossom Bridge from June through August each year. Orange Blossom Bridge is located 31 miles upstream of Ripon. Yet, even though no salmon or steelhead are located between downstream of Orange Blossom Bridge from June through August, the current USBR permits require the DO concentration objective of 7.0 mg/L to be met at Ripon during this time period. Since the express purpose of the DO concentration requirement in the Stanislaus River is to support, protect and enhance the river's salmon and steelhead fishery, it does not make any sense to require the USBR to continue to meet the DO concentration requirement at

Ripon during times of the year when there are no salmon or steelhead to benefit from such concentration.[2] In order to continue to protect the salmon and steelhead fishery while maximizing the available New Melones water for other beneficial uses,[3] the DO concentration compliance point for the period between June 1 and August 31 each year should be changed from Ripon to Orange Blossom Bridge.

Such a change is not unprecedented. Currently, there are four locations where more stringent DO concentration requirements than the general requirements established by the CRWQCB apply during certain specific times of the year. In the Sacramento River, the DO concentration between Keswick Dam and Hamilton City is 9.0 mg/L from June 1 through August 31. (2004 CRWQCB Basin Plan, p. III-5.00). In the Feather River, the DO concentration between Fish Barrier Dam to Honcut Creek is 8.0 mg/L from September 1 to the following May 31. (Id.). In the Merced River, the DO concentration is 8.0 mg/L all year from Cressy to New Exchequer Dam. (Id.). Finally, in the Tuolumne River, the DO concentration from Waterford to La Grange is 8.0 mg/L from October 15 to the following June 15. (Id.). Except for these specified times and locations, the general DO concentration limits established by the CRWQCB apply.

In each of these four instances, while it is not entirely clear as to the rationale behind the establishment of the more stringent DO concentration requirements for these specific reaches of river,[4] it appears that the reaches themselves constitute the primary spawning and rearing areas for salmon and/or steelhead. (*See* S.P. Cramer & Associates for Tuolumne and Merced Rivers; "Factors Affecting Chinook Salmon Spawning in the Lower Feather River (Fish Bulletin 179; Vol. 1 (2001)) p. 272 for Feather River, and NMFS (1997) for Sacramento River [winter run Chinook salmon]). That is, the DO concentration selected was then applied only to that portion of the river necessary to achieve the goal associated with the establishment of the DO concentration in the first place.

The same type of analysis should apply in the Stanislaus River. There are no salmon or steelhead downstream of Orange Blossom Bridge between June 1 and August 31 of each year. As such, the establishment and maintenance of the 7.0 mg/L DO concentration for some 31 miles between Orange Blossom Bridge and Ripon does not provide any benefit to either the salmon or steelhead fishery. The SWRCB should exercise the jurisdiction it has expressly reserved itself and change the DO concentration

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[2] The DO concentration of 7.0 mg/L requirement adopted by the CRWQCB is far in excess of what is needed by non-salmonid fishery resources. According to the E.P.A., DO concentrations in excess of 6.5 mg/L have no negative impact on non-salmonid fish at any life stage. (USEPA 1986).

[3] It must be remembered that the USBR's permits require it to "release" water from water stored by the New Melones project to meet and maintain the DO concentration at Ripon. Since Orange Blossom Bridge is significantly closer to New Melones than is Ripon, it is expected that changing the compliance point will result in significant water savings during the critical summer months that could be made available for other beneficial uses consistent with the enumerated purposes of the New Melones project and the CVP.

[4] At least for the more stringent DO concentrations on the Tuolumne and Merced Rivers, there are no written records explaining how or why the reaches were chosen or the more stringent DO concentrations selected. (Personal communication between S.P. Cramer & Associates and Betty Yee of the CRWQCB, 2005).

compliance point between June 1 and August 31 of each year from Ripon to Orange Blossom Bridge.

IV. CONCLUSION

The over-riding legal and policy consideration regarding the development and use of water is to avoid waste and to maximize the reasonable and beneficial use of the scarce resource. In the case of the Stanislaus River salmon and steelhead fishery, the existing requirement that the DO concentration level be met year-round at Ripon is not in accordance with the overall policy of reasonable use. The needs of the salmon and steelhead fishery, for which the DO concentration level was specifically adopted, demonstrate that the compliance point for the DO concentration can be changed to Orange Blossom Bridge from June 1 through August 31 of each year. By so doing, the salmon and steelhead fisheries in the Stanislaus River will continue to be protected, and valuable water in New Melones reservoir can be applied to other beneficial uses that are not presently being met in full.

The USBR strongly urges the SWRCB to amend its permits for both storage at New Melones and direct diversion from the Stanislaus River at New Melones to change the DO compliance point from Ripon to Orange Blossom Bridge between June 1 and August 31 of each year.

Dated: October 1, 2006

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COUNSEL IDENTIFICATION AT END

IN THE UNITED STATES DISTRICT COURT

FOR THE EASTERN DISTRICT OF CALIFORNIA

CONSOLIDATED SALMON CASES	LEAD CASE NO: 1:09-cv-1053 OWW-DLB
SAN LUIS & DELTA-MENDOTA WATER AUTHORITY, et al. v. LOCKE, et al.	Consolidated Cases: 1:09-cv-1090 OWW-DLB 1:09-cv-1378 OWW-DLB 1:09-cv-1520 OWW-SMS 1:09-cv-1580 OWW-DLB 1:09-cv-1625 OWW-SMS
STOCKTON EAST WATER DISTRICT v. NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, et al.	**DECLARATION OF AVRY DOTAN IN SUPPORT OF STANISLAUS RIVER PLAINTIFFS' MOTION FOR SUMMARY JUDGMENT**
STATE WATER CONTRACTORS v. LOCKE, et al.,	
KERN COUNTY WATER AGENCY, et al. v. U.S. DEPARTMENT OF COMMERCE, et al.	Date: November 18-19, 2010 Time: 9:00 A.M. Courtroom: 3 Judge; Hon. Oliver W. Wanger
OAKDALE IRRIGATION DISTRICT, et al. v. U.S. DEPARTMENT OF COMMERCE, et al.	
THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA v. NATIONAL MARINE FISHERIES, et al.	

Declaration of Avry Dotan

1. I, Avry Dotan, declare that the facts set forth below are true and correct based on my own personal knowledge and I could and would testify to them if called to do so.
2. I am a hydrologist and the owner and sole principal of AD Consultants, 15 Sullivan Drive, Moraga, CA 94556.
3. I have over 25 years experience in modeling for water resources, environmental and hydroelectric projects. I am specializing in computer modeling of complex water supply projects, hydrology analysis, water temperature modeling, project operations, feasibility and economic studies, and FERC licensing and re-licensing.
4. Since 1999 I have been the acting project manager and co-developer of the Stanislaus River Water Temperature Model, Stanislaus-Lower SJR Temperature Model (CALFED ERP-02-P28) and the San Joaquin River Basin-wide Water Temperature Model (CALFED ERP-06D-S20).
5. I have developed these models in association with my sub-consultants Resource Management Associates, Inc. (RMA) and Watercourse Engineering, Inc.

DEVELOPMENT OF STANISLAUS RIVER TEMPERATURE MODEL

6. Water temperature modeling of the San Joaquin River basin started as a grass-root project in December 1999 when a group of Stanislaus river stakeholders decided to analyze the relationship between operational alternatives, water temperature regimes and fish mortality in the Stanislaus River. These stakeholders included the United States Bureau of Reclamation ("USBR"), United States Fish and Wildlife Service ("FWS"), California Department of Fish and Game ("CDFG"), Oakdale Irrigation District ("OID"), South San Joaquin Irrigation District ("SSJID"), and Stockton East Water District ("SEWD") (collectively the "Stanislaus Stakeholders"). The Stanislaus Stakeholders decided to join resources and fund the development of a high resolution reservoir operation - water temperature computer model built on the HEC-5Q computer program.
7. The HEC-5Q is a generalized water quality computer program (software) designed by the US Army Corps of Engineers that can be configured for any reservoir-river system. The HEC-5Q

is public domain software and can be obtained at no cost from the US Army Corps of Engineers.

8. The HEC-5Q is widely accepted software that has been applied to numerous reservoir-river systems in the US and worldwide. Examples of application of the HEC-5Q in the State of California in recent years (other than the Stanislaus and San Joaquin River) are: Russian River (Sonoma County Water Agency), Sacramento River (US Bureau of Reclamation) and the reach below Friant Dam in the upper San Joaquin River (US Bureau of Reclamation). The latter was subsequently connected to the San Joaquin Basin Wide Model, as discussed further.

9. The HEC-5Q allows assessing temperature and a conservative water quality constituent (such as dissolved oxygen and electrical conductivity) in basin-scale planning and management decision-making. For the Stanislaus (and later the San Joaquin River), however, only water temperature was considered.

10. The steps necessary to apply the HEC-5Q to a given system include: representation of the physical system (e.g, characteristics of reservoirs, water conveyers, rivers geometry, etc.), assembling hydrological and meteorological data (e.g., flows and weather data) and defining operating rules (e.g., flood control rules, diversions, in-stream flow requirements).

11. Once all of the above is implemented, the model is then calibrated. Calibration is a process in which various parameters are adjusted (e.g, heat exchange coefficients for air-water and sediment-water interface, stream bed roughness coefficients, etc.) until a good-fit of observed vs. simulated conditions (e.g, temperature profile in the reservoirs and temperatures along the stream) is obtained.

12. Model set up and calibration is usually the most labor intensive effort in the implementation of the HEC-5Q. Once the model is calibrated, running hypothetical scenarios are usually straight forward tasks as they involved replacing the historical data sets with new data sets that are usually defined outside the model itself (e.g, hypothetical diversions and in-stream flow scenarios). For example, some of the scenarios that we studied for the Stanislaus Stakeholders during the course of the work for the group were based on output from the

CALSIM II model.

13. For the Stanislaus Water Temperature Model, physical representation of the system included the characteristics of New Melones Reservoir, Tulloch Reservoir, Goodwin Pool and approximately 60 miles downstream to the confluence of the San Joaquin River.

14. In addition, special code was added to the model to accommodate several unique attributes, including complex geometry of the submerged (old) dam in New Melones Reservoir and the short residence time and unique diversion characteristics of Goodwin Pool

15. The old-new dam interaction came into play during the 1992 drought when New Melones was drawn down to almost dead-storage levels. Fortunately (modeling wise), extensive flow and temperature data were collected during that period that allowed us to calibrate the model for those critical conditions and ensure that this special code is properly implemented in the model. The old-new dam interaction is especially important when operating the system more aggressively as appears to be the case when operating for temperature control per Action III.1.2 of the BO.

16. The Stanislaus Water Temperature Model was calibrated for temperature data collected during the 1990 - 1999 historical period. The simulation period (i.e., the period for which the model conducted operations studies) was 1980 to 1999. This period was selected because it covered the full period since New Melones started filling up after the construction of the new Dam to the study date at the time. The simulation period was subsequently extended as the model evolved over the years.

17. The simulation period could have been extended to years prior to 1980, similar to the period modeled with CALSIM II, relatively easily using pre-processor tools already developed by RMA for this purpose. However, the Stanislaus Stakeholders agreed that the proposed study period 1980 to 1999 covers sufficient range of hydrologic condition (wet, normal, dry and critically dry), as well as filling and emptying cycle of New Melones, to provide the insight for temperature response in the system under hypothetical operational scenarios.

18. Furthermore, when modeling water temperature in a reservoir-stream system, the level of resolution of the model is by far more important than the length of the simulation period

itself. In the case of the Stanislaus River temperature modeling, the need to compute the temperature variation and extremes was very important as they are directly related to fish habitat conditions (i.e, egg development, fish survival and growth, out-migration, in-migration, etc.).

19. Once the Stanislaus Water Temperature was completed in 2001, the model was used by the Stanislaus Stakeholders to evaluate water temperature objectives at critical points in the river system that would enhance habitat conditions for fall-run Chinook salmon and Steelhead rainbow trout. This was done by running the model for different operational scenarios proposed, primarily, by the irrigation districts and CDFG (objectives were examined for each fish species individually, and then combined into one envelope of conditions for the two).

20. The HEC-5Q can simulate temperature conditions at any specified time interval resolution. For the Stanislaus Water Temperature Model, a 6-hour time interval was selected as it provided an adequate balance between run time (the shorter the time step the longer it takes to execute a run) and the level of resolution needed in order to capture the diurnal temperature variability in the stream (6-hour interval captures the minimum daily temperature, usually around 6:00 AM, and maximum daily temperature usually around 6:00 PM). This "sub-daily" modeling is very important factor when studying temperature response in streams as temperatures could fluctuate significantly throughout the day as function of travel time and meteorological conditions (the farther the water travels from the source the closer it gets to ambient conditions). Sub-daily modeling is especially important when temperature objectives are also defined on a sub-daily basis. Modeling that would have coarse time steps (e.g., daily, weekly and monthly) tend to be biased towards the average and underestimate the extremes. **As a rule, modelers should employ time steps that are compatible with the level of resolution by which the results are tested**. This rationale was one of the primary reasons why the Stanislaus Water Temperature Model was developed, as the Stanislaus Stakeholders realized the need to evaluate the temperature regime in the basin on a sub-daily basis.

21. The Stanislaus Water Temperature Model was peer reviewed by Dr. Michael Deas, a

consultant retained by the Stanislaus Stakeholders to evaluate the suitability of the model for its intended purpose. After Dr. Deas submitted the peer review report in 2002 the model was unanimously accepted by the Stanislaus Stakeholders and adopted as the primary water temperature planning tool for the Stanislaus River. The Stanislaus River Water temperature Model has since been used by/on behalf the irrigation districts, CDFG and USBR.

FIRST EXPANSION OF THE MODEL

22. Upon reviewing modeling results, the Stanislaus Stakeholders recognized the need to extend the model to the Lower San Joaquin River thus enabling it to study the relationship between Stanislaus River operations and the temperature regime in the lower San Joaquin River as it flows to the Bay-Delta.

23. Due to limited funding available to the group, the Stanislaus Stakeholders asked me to submit a proposal to CALFED for the extension of the model.

24. In 2003, CALFED decided to fund the extension of the Stanislaus River Water Temperature Model to include the lower San Joaquin River (CALFED ERP-02-P28). A principal priority of this CALFED sponsored project was to develop a model capable of evaluating a wide range of alternatives for flow and water temperature management in the Stanislaus River and lower San Joaquin River. The project team was expanded and included Watercourse Engineering, Inc. and a peer review panel was assigned to assist in developing temperature criteria for the evaluation of model alternatives.

25. Once the model expansion was completed, the Stanislaus Stakeholders authorized the model to be used again to simulate different Stanislaus River operation scenarios, using water temperature objectives at critical points developed by CDFG, to estimate the magnitude and duration of water temperature conditions at critical points in the river and the effect on water supply and storage at New Melones. In 2006 I submitted a draft report to the Stanislaus Stakeholders describing the expanded model, the simulations conducted, and identifying the results of each simulation. In 2007 I submitted the final report to CALFED and released the final version of the model to the Stanislaus Stakeholders.

SECOND EXPANSION OF THE MODEL

26. The success of the Stanislaus work and the interest in this model expressed by the stakeholders from adjacent tributaries to the San Joaquin River (e.g. Tuolumne and Merced rivers), prompted CALFED to amend our existing contact and fund a second expansion of the model in 2004 (the work was done in parallel to finalizing our project report for the Stanislaus – Lower San Joaquin River Model). This extended the model to the entire San Joaquin River Basin below Stevinson (see the model extent on the map below). A beta version of the extended model, called the San Joaquin River Water Temperature Model ("SJRWTM") was completed in 2006, peer reviewed by a group of scientists selected by CALFED, and approved by CALFED as a Directed Action (CALFED ERP-06D-S20) for further refinement and completion.

27. Through this second expansion, the Stanislaus Water Temperature Model became one component of the overall SJRWTM (the model can be run separately for each San Joaquin River tributary or for the entire San Joaquin River Basin as a whole).

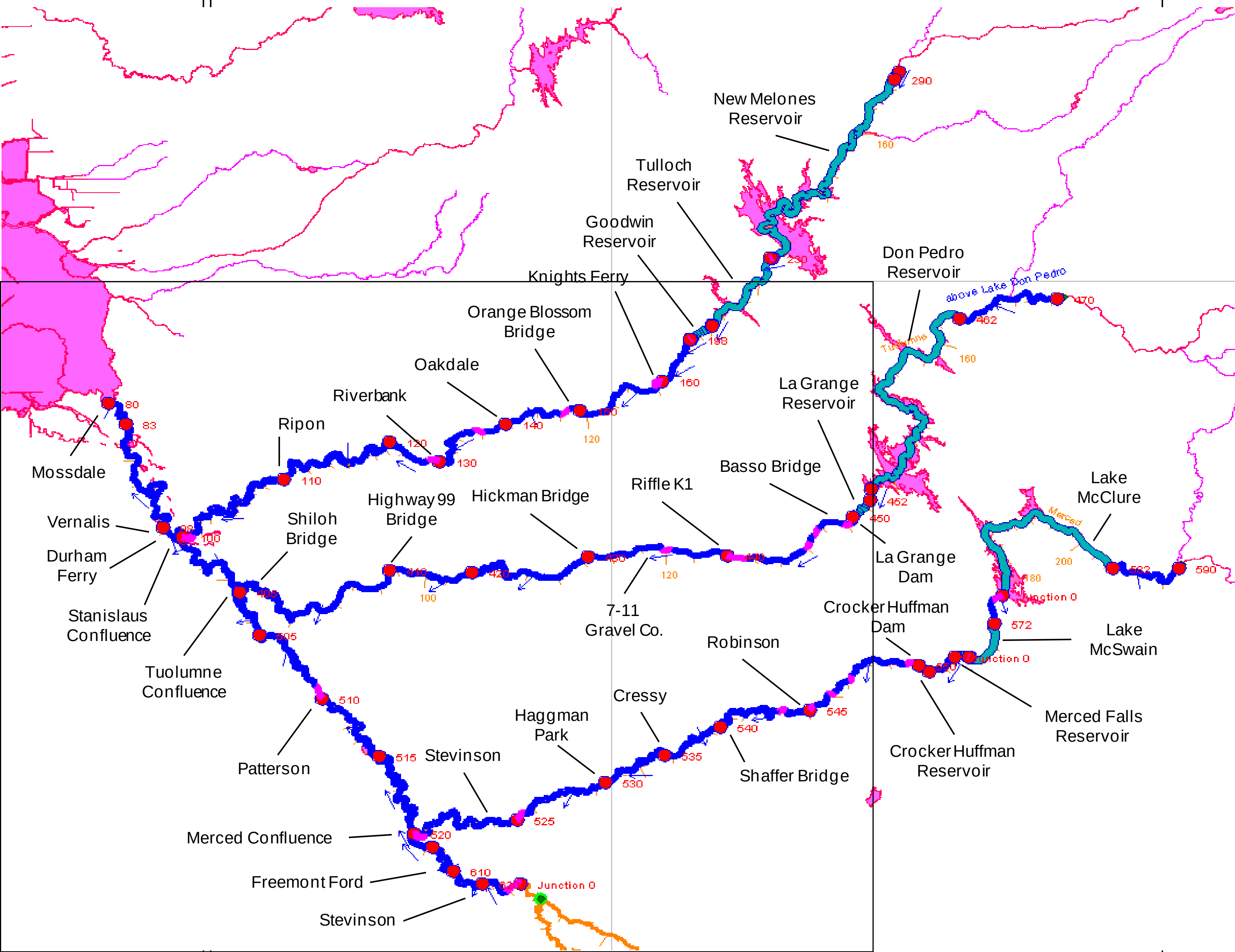
28. As such, any references from now on in my declaration to the Stanislaus River Water Temperature Model imply the model developed for the Stanislaus River prior to the implementation of SJRWTM. Any references in my declaration to the SJRWTM imply the Stanislaus component within the SJRWTM.

29. As part of the development of SJRWTM, the simulation period was also extended through December 2007 and the model was re-calibrated given the additional data collected over this time period (hydrological, meteorological and observed temperature in reservoirs and streams).

30. In addition, more features were coded into the model to automate the computation process. Until then, the model was designed to compute the temperature response downstream to the reservoirs given prescribed release schedule. This so-called "top-down" approach is the classical way by which the original HEC-5Q operates. The new features used the "bottom-up" approach where target temperatures at compliance points are identified (could be at multiple locations and times in the year) and the model computes how much water should be

released from the reservoirs and when (taking into account travel time) in an attempt to meet the target temperature. Special constraints are imposed to ensure that the model's proposed releases are compatible with the physical system as well as with the operator's ability to manage those releases (e.g., ramping rates, channel capacity, maximum volume of water available to managers to mitigate temperature violations, etc.).

31. Upon finalizing the model, the HEC-5Q representation of the Friant reach, a separate model developed by the USBR under a contract with my sub-contractor RMA, was added to the model, thus making it a full San Joaquin Basin-wide model.



testing phase of the model, the model was used to perform three broad categories of modeling studies: historical operations, alternative operations, and temperature target specification scenarios.

- Historical operations scenario – utilized historical hydrology and operations to form a baseline for comparative analysis with the other scenarios.
- Alternative operations scenario – focused primarily on the Stanislaus, where a set of prescriptive operations, such as instream flows, water allocations, and structural and/or operational changes, were implemented into the model.
- Temperature target specification scenarios – applied to the four-river model (all basins); temperature at key locations was specified and the system was re-operated to achieve those values.

33. The SJRWTM has already been used in several proceedings, including: analyses related to instream/temperature studies for the Stanislaus River, Friant Restoration Project, presentations for the SWRCB [303(d)/305(b)] workshop in 2007 (studies performed by the San Joaquin River Group Authority and CDFG), USBR Delta-Mendota Canal Recirculation Project, Tuolumne instream studies, and Tuolumne and Merced hydropower relicensing.

34. It is my understanding that the SJRWTM is intended to be the primary modeling and decision support tool for water temperature management in the San Joaquin River basin in the future.

OUTREACH, COLLABORATION AND TRAINING

35. Since both the Stanislaus Water Temperature Model (including the expansion to include the lower San Joaquin River) and the SJRWTM were developed collaboratively by a variety of stakeholders, and beginning in 2002 with grant funding from CALFED, regular meetings were held by and among the stakeholders to discuss refinement, development, calibration and use of the two models.

36. Regarding the Stanislaus River Water Temperature Model, a standing committee known as the "Technical Advisory Committee" ("TAC") was created. The TAC included representatives from the USBR and FWS.

37. On September 25, 2001, as part of the meetings of the TAC, we conducted a training session at the offices of OID in Oakdale and on how to run and use the Stanislaus River Water Temperature Model. Participants were asked to bring their individual laptops. During the training session the model was installed on their computers. Donald Smith, my sub-contractor from RMA presented an overview of the model's graphical user interface (GUI) which allows users to view modeling results, and then showed the steps needed to perform an actual run of the model. The model remained in the possession of the participants, and they were encouraged to continue to practice running the model after the training session. Two of the attendees at this training session were Randi Field of the USBR and Cesar Blanco of FWS. (See attendance sheet attached hereto as Exhibit A).

38. Regarding the SJRWTM, a kick-off meeting was held on April 22, 2005 at my office in Moraga, California. Representatives from NMFS, USBR and FWS all attended. The USBR attendee, Chief of Planning Lloyd Peterson, stated that the USBR was very pleased with their experience in using the HEC-5Q for the Sacramento River developed by exclusively for the USBR by RMA. He also mentioned the fact that the USBR is in the process of constructing a further extension of the model that would cover the area between Stevinson and Friant Dam on the upper San Joaquin River. The attendee from NMFS, Mr. Jeff McClain, indicated that one of NMFS' goals for the SJRWTM was to have a tool that would assess temperature on a sub-daily time step. (See Meeting Notes for April 22, 2005 meeting, attached hereto as Exhibit B).

39. During the April 22, 2005 kick-off meeting for the SJRWTM, a standing committee known as the "Super TAC" was established. The purpose of the Super TAC was to oversee implementation of the SJRWTM and development of alternatives to be evaluated with the SRJWTM. The Super TAC was expected to meet 4-5 times per year, and included representatives from the USBR, FWS and NMFS. (Also in Exhibit B).

40. Since 2000, there have been numerous TAC, Super TAC and other stakeholder meetings regarding the Stanislaus Water Temperature Model and the SJRWTM. Attendees have included Jack Rowel, Lloyd Peterson, Dave Robinson, Bill Green, Brian Deason, John

Hannon, Randi Field, Ken Yokoyama, Michael Tansey, Peggy Manza, Rick Johnson, Meri Moore, Lenore Thomas, Claire Hsu and Russ Yaworsky from the USBR, Madelyn Martinez, Jeff Mclain, Dennis Smith, Craig Anderson, and Erin Strange from NMFS, and Derek Hilts, Joseph Terry, Craig Fleming, Scott Spaulding, Carl Mesick, Cesar Blanco, J.D. Wikert and Andrew Hamilton from FWS. (See various sign-up sheets, attached hereto as Exhibit C).

41. On October 30, 2007, we conducted another training session, this time for SJRWTM. The training session took place at the offices of Modesto Irrigation District in Modesto. The training was in the form of a presentation using a computer and projector by Donald Smith of RMA, and included step by step instruction on how to run the SJRWTM and view results. All the participants already had the SJRWTM installed on their laptop computer (the model itself and instructions how to install the model, run it, and view results were provided to the stakeholders several weeks in advance). During the presentation, a staff member of RMA and I walked around the room and provided assistance to people who struggled with keeping up with the pace of the training. Once again, the model loaded onto the participants' laptops remained in their possession and the participants were encouraged to continue practice using the model. Attendees at this training session included, among other stakeholders, Claire Hsu, David Mooney and John Hannon from the USBR, and Joseph Terry from FWS. (See attendance sheet attached hereto as Exhibit D).

42. On November 19, 2008, I sent again an email to all of the stakeholders for the SJRWTM, including the USBR, FWS and NMFS, which provided links to ftp site where the most recent version SJRWTM could be downloaded and detailed instructions for installing and running the model. (See, eg., AR 00089085-00089086). This was essentially the official pre-release of the SJRWTM with the intent to provide access to the model to stakeholders other than those who participated in the training session a year earlier.

43. On October 2009, I submitted the final project report to CALFED along with the final version of the model. Although the 2009 version was almost identical in terms of its functionality to the 2008 one, I have encouraged the stakeholders to use the latest version of the model as the best and final to eliminate any confusion about the various versions.

REVIEW AND EVALUATION OF TEMPERATURE MODELING DONE FOR BO

44. I was asked by the Stanislaus River Plaintiffs to review and evaluate the temperature modeling for the June 2009 Biological Opinion (BO), as it relates to the Stanislaus River. Based on this review, I have formed the following opinions:

45. **Opinion 1 - The absence in the record of the actual temperature modeling tool used by Reclamation and NMFS limits the ability to assess whether the temperature modeling performed by the agencies provides any support for the Temperature Requirements of Action III.1.2**

46. On Wednesday, July 7, 2010, counsel for Stanislaus River Plaintiffs sent to me via e-mail one (1) Excel spreadsheet file, identified by the title "Field attached file – OCAP_2008_WaterTemp_Stanislaus_FWSFlows_042109.xls." ("Federal Defendants' Stanislaus Temperature Results"). This file contains the results of a model run by the USBR regarding the impacts to temperature under one of the draft RPAs developed in 2009, but not of the RPA actually contained in the final BO. Counsel also forwarded to me, on the same day, a .pdf version of an e-mail from the NMFS administrative record, identified as NMFS AR 00211982. This email identifies the specific CALSIM II simulation that was the subject of the temperature run. On July 14, 2010 I received from counsel for Stanislaus River Plaintiffs a DVD which contained the specific CALSIM II simulation identified in NMFS AR 00211982, including all of the assumptions, inputs and other related materials. These materials can be found in the AR in the modeling DVD provided by the USBR.

47. In May 2010, and again in July 2010, I reviewed Appendix H of the August 2008 OCAP Biological Assessment which generally describes what is variously identified as either the "Reclamation Temperature Model" or "USBR Temperature Model." According to information provided to me by counsel for Stanislaus River Plaintiffs, the USBR Temperature Model" described in Exhibit H of the August 2008 OCAP BA is the model used to generate the results contained in the Federal Defendants' Stanislaus River Temperature Results.

48. Appendix H to the 2008 OCAP BA does not contain a copy of the USBR Temperature

Model. It directs readers to look at three reports, written by Rowell in 1979, 1990 and 1997, for a more detailed explanation of the USBR Temperature Model. I was not able to find any of those reports on-line, nor are they in the administrative record for this case.

49. Since the actual USBR Temperature Model that was used by Reclamation and NMFS was not made available in the administrative record for this case I was not able to evaluate its code to determine exactly how it works or to verify the results that are reported in the record. Moreover, without the actual model source code and/or its documentation, especially model calibration results, I was unable to determine whether the results it yields are valid or not. Thus, my review of the temperature modeling performed by the agencies relies on the limited information about the model that is in the record.

50. It is my understanding, and as explained in Appendix H to the 2008 OCAP BA, that "No formal process documented the quality assurance and data quality of the Reclamation Temperature Model. This model was developed at a time where specific documentation requirements were less stringent. A peer review of the Reclamation Temperature model has not been performed".

51. Moreover, in absence of model calibration results, the agency modelers should have at least performed quality assurance (QA) checks for the USBR Temperature Model as part of the documentation of the BO itself. This could have been accomplished by simply simulating with the model the historical conditions in the river (e.g., a period for which water temperature data have been recorded) and comparing the simulated results with the observed data. I have not found any evidence in the record that the agency modelers performed these QA checks with the USBR Temperature Model in connection with the development of the BO.

52. **Opinion 2 – Mean Monthly Water Temperature data provide meaningless information regarding the temperature regime in the Stanislaus River in the context of meeting the temperature requirements of Action III.1.2.**

53. The BO specifies that compliance with the Stanislaus River temperature criteria set forth in Action III.1.2 "shall be measured based on a seven-day average daily maximum

temperature." (BO, p. 621). The 7DADM is computed at the end of each day by adding the maximum temperature of the past seven consecutive days and dividing by seven. In practicality, this means that water managers must: a) keep track of the maximum temperature observed at the compliance point in the river every day and b) operate the system in any given day (i.e., make the appropriate release from Goodwin Dam for temperature control at the compliance location) in a way where the maximum temperature in that day added to the maximum temperature in the past six days and divided by seven, would not exceed the temperature required per Action III.1.2.

54. The fundamental question that a reasonably prudent temperature modeler must address, before even dealing with which is the appropriate computer model to be used in connection with the BO is how does the temperature in the river vary throughout the day and month and what level of resolution will provide meaningful information to assess temperature compliance per Action III.1.2.

55. To answer that question, I examined the observed water temperature at Orange Blossom Bridge (OBB), as recorded by the California Data Exchange Center (CDEC) maintained by the California Department of Water Resources (DWR). Figure 1 shows temperature variation in March 2010 at OBB. The figure shows that temperature could vary over 4˚ Fahrenheit (F) per day and over 8˚ F, from approximately 50˚ F to 58˚ F, throughout the month. The Mean Monthly Temperature in this case is 54˚ F, which is approximately 4˚ F below the monthly maximum and 4˚ F above the monthly minimum.

56. Figure 2 shows the computed 7DADM per the specification of Action III.1.2. The figure clearly shows that if the target temperature for the month is 55˚ F (which happened to be the temperature requirements for the month of March), then a Mean Monthly Temperature measurement would have shown 100% compliance with this requirements. However, if the measure for compliance is 7DADM, rather than a monthly mean, then approximately 50% of the time temperature would exceed the target and be out of compliance.

57. The USBR Temperature Model results provided by Federal Defendants, and which I reviewed, present temperature solely on a Mean Monthly basis with no mention to daily

maximums and/or 7DADM. From the description of the Reclamation Temperature Model in the record, this is the only type of temperature measurement that this model was capable of producing.

58. No reasonably prudent modeler could conclude that using a model that is only capable of assessing Mean Monthly Temperature should be used to predict compliance with respect to Action III.1.2, which requires compliance using the much finer 7DADM temperature measurement.

59. **Opinion 3 – The USBR Temperature Model is Too Coarse to Simulate, Predict or Evaluate the Feasibility of or the Impacts Associated With Meeting the Stanislaus River Temperature Requirements of Action III.1.2.**

60. To verify my Opinion 2, I sought to duplicate the analysis that Reclamation performed with the USBR Temperature Model with the SJRWTM to determine if there was a substantial difference in the results. Given that the record did not contain the USBR Temperature Model or any documentation about the methodology and assumptions embedded in the model to simulate temperatures in the Stanislaus River system, I had to evaluate the merit of the model as a modeling tool in the context of establishing the Stanislaus River Temperature Requirements per Action III.2.1, by reviewing the model results provided by the Federal Defendants. The evaluation process involved three steps:

61. First – I ran the SJRWTM for one case study produced by the Federal Defendants, as explained below.

62. Second – I compared the temperature variability at OBB, one of two compliance locations per Action III.1.2, as computed by the SJRWTM and the USBR Temperature Model.

63. Third – I evaluated the results of the two models in relation to the Temperature Requirements of Action III.1.2.

64. The case study that I have selected was labeled “Study 8.0 w/FWS Flows”. This case was identified to me by the Stanislaus River Plaintiff’s Counsel as the most conservative case upon which Action III.1.2 was ultimately based.

65. In order to produce the run with the SJRWTM, I had to match the total diversions at

Goodwin Dam and total release from Goodwin Dam to the Stanislaus River with those obtained from the CALSIM II results for this case. The CALSIM II results were extracted from the file: "20090409_OCAP_Future_Study8_wQ4WQCPvnsQreqts_&_StanRPAw98\CONV\DSS\2020D09EDV.DSS". This file was given to me by Mr. Dan Steiner, a consultant to the Stanislaus River Plaintiff's Counsel. Mr. Steiner told me that this run contains the input hydrology that was used to run the USBR Temperature Model for the "Study 8.0 w/FWS Flows" case.

66. For quality assurance I have compared the New Melones storage as computed by the two models, as shown in Figure 3. The figure shows an overall good match between the two runs with minor mismatches in 1980 and early 2000. These mismatches are attributed to different boundary conditions in the two runs (CALSIM II starts at 1922 while the SJRWTM starts from the flood control rule curve in 1980) and probably slight differences in flood control rules between the two models. However, these mismatches are insignificant, in my opinion, as far as temperature outflow from New Melones is concerned.

67. My conclusion from the quality control check is that if there are discrepancies between the temperatures computed with the SJRWTM and the USBR Temperature Model, they must be attributed to the accuracy of the models themselves and not to the mass-balance calculations (i.e., inflow to New Melones, Goodwin diversion, Goodwin release, and the resulting storage in New Melones).

68. Next, I have examined the temperature at OBB as computed by the SJRWTM and the USBR Temperature Model. As shown in the example in Figure 4, temperature at OBB varies on an hourly basis within the day and on a daily basis within the month. While the SJRWTM computes the temperature variation throughout at 6-hour intervals and thus captures the daily maximums (and minimums), the USBR Temperature Model assumes constant temperature for the entire month.

69. Like with the previous example (observed data for the month of March 2010), the Mean Monthly Temperature as computed by the USBR Temperature Model, erroneously predicts

100% compliance with respect to the target, as shown in Figure 5. The SJRWTM, however, uses the 7DADM as a measure for compliance and shows a violation approximately 50% of the time, as also shown in Figure 5.

70. Figure 6 shows more examples where the Mean Monthly Temperature computed by the USBR Temperature Model predicts compliance with regard to the target while the SJRWTM that uses the 7DADM as a measure for compliance shows a violation.

71. It should be emphasized that none of results produced with the USBR Temperature Model that I was able to find in my review of the model discussed the relationship between the Mean Monthly Temperature and 7DADM which is the governing criterion for compliance.

72. In conclusion - the results generated by the USBR Temperature Model were so inaccurate that no reasonably prudent modeler could conclude that the USBR Temperature Model could serve as a useful tool for predicting compliance based upon a 7DADM compliance criterion.

73. **Opinion 4 – Even with the inaccuracy of the USBR Temperature Model, the modeling results demonstrate that the temperature requirements per Action III.1.2 are not attainable a significant percent of the time. This observation is even more pronounced using the SJRWTM.**

74. Figure 7 is a summary showing frequencies of meeting temperature targets (and violation of targets) specified for OBB per Action III.1.2. The case study again is "Study 8.0 w/FWS Flows". The table in Figure 7 shows two columns for each month. One for modeling results produced by the SJRWTM (labeled "5Q") and one produced by the USBR Temperature Model (labeled "NMFS").

75. As shown in Figure 7, the NMFS' results underestimate violations of the target 8 months out of the year (February to September). The NMFS violations are higher for October and November.

76. Given the above mentioned observation it is not clear to me what the rationale was for the temperature requirements set forth in Action III.1.2 as it is quite apparent that those objectives are not attainable a significant amount of the time even using the USBR Temperature Model as a predictive tool.

77. In conclusion – had the Federal Defendants used the SJRWTM to simulate the temperature condition under "Study 8.0 w/FWS Flows", it would have been apparent that the temperature requirements under Action III.1.2 are not attainable even more often than estimated with the USBR Temperature Model.

78. **Opinion 5 – The USBR Temperature Model is deficient because it failed to evaluate the impact on New Melones storage when Action III.1.2 would be in place and therefore the feasibility of this proposed action.**

79. To analyze the feasibility of Action III.1.2, modeling wise, requires a two-step approach: First – minimum instream flow below Goodwin Dam is imposed on the system. Instream flow is the required minimum releases from Goodwin Dam downstream to the Stanislaus River as defined in Table 2E of the BO (Action III.1.3). Second – the temperature response to the minimum instream flow at the compliance locations is computed. If the 7DADM at the compliance location exceeds the target set forth in Action III.1.2 (temperature violation) there is a need to augment the minimum flow until the target is met. This type of analysis could be done either by a trial and error (probably the only option available when using the USBR Temperature Model) or by activating the "bottom up" feature in the SJRWTM as described above.

80. I have already discussed the fact that the USBR Temperature Model is not capable of assessing the 7DADM but rather is using Mean Monthly Temperature. But even at this coarse level of resolution, there is nothing in the record that indicates that the federal agencies took the second step and tried to quantify how much water is needed over and above the minimum flows specified in Table 2E (Action III.1.3) to prevent violations of the new temperature restrictions in Action III.1.2. Without this analysis, agency staff could not determine the additional impact on water system storage of imposing Action III.1.2.

81. The SJRWTM on the other hand, was available and could have been used to perform exactly this analysis. To illustrate the impact of Action III.1.2, I did so. I ran the SJRWTM in the two modes explained earlier: "top-down" mode where instream flows per Table 2E were imposed and "bottom-up" where minimum flows prescribed in Table 2E were augmented to

mitigate temperature violations at the compliance location (OBB in case). The difference between the two runs: 2E and Augmented 2E (labeled as case 2EA) provided the answers to key questions: 1) What would be the impact of the augmentation for temperature on New Melones storage, 2) To what extent the augmentation succeed to mitigate temperature violation, and 3) Are there any consequences for this type of operation (i.e., would aggressive operation for temperature in some years cause unmitigated conditions the following years, especially in dry and critically dry years).

82. It should be noted that one of the assumptions used in this analysis is that in any given month, only up to 1000 cfs could be used for temperature control (i.e., augmenting the amounts specified in Table 2E by up to 1000 additional cfs). The logic was to set a limit on the total release to prevent from draining the reservoir indefinitely.

83. The need to define this limit raises another fundamental question regarding the concepts associated with the development of the terms and conditions set forth in Action III.1.2. Modeling of reservoir-river system is essentially mathematical representation of the physical system and the rules by which it operates. When simulating system operation, models are design to mimic as close as possible a real-life decision making of water managers and facility operators by employing a set of rules and considerations for system limits and constraints. In the case of temperature control, rules and considerations could include: Are there ramping rates (how fast to increase or decrease releases from the dam when operating for temperature control)? How much water should be released before operators' give-up the ability to lower temperature to meet the target? Should releases for temperature control be made at all if the temperature outflow from the dam already exceed the target (but yet could improve temperature conditions at the target)? Should a minimum storage volume in the reservoirs be defined as a threshold for ceasing temperature control?

84. To the best of my knowledge, none of the above mentioned rules and considerations are mentioned as part of Action III.1.2, only temperature targets and the fact the water should be released to meet those targets. To me it appears that there is disconnect between Action III.1.2 and the practical aspects of this action, or, at best, that Action III.1.2 is simply

incomplete

85. Figures 8 to 12 show the results for the above-mentioned analysis, as follows:

86. Figure 8 shows the New Melones storage under cases 2E and 2EA. The figure shows that New Melones storage would be depleted by as much as 717 TAF during the 1987-1995.

87. Figure 9 shows the amount of water needed on a monthly and annual basis for temperature control. The figure shows that the annual amount would vary between 22 TAF and 190 TAF with average amount equal to almost 84 TAF.

88. Figure 10 shows the effectiveness of the temperature control: In the summer, temperature at OBB could be reduced down to the target levels as measured using the 7DADM criterion. However, the model shows that an additional 1000 cfs would not be sufficient to lower the temperature to the target in the spring and fall.

89. Figure 11 shows that successive operation for temperature would eventually cease to be effective as New Melones' cold pool of water would be depleted. In other words, conserving water in New Melones by limiting releases in the spring and fall, when the ability to reduce the temperature to the target is questionable, could be a more effective way for temperature control in the long run.

90. Figure 12 shows that even after operating for temperature control (from 2E to 2EA), there are still significant violations of the target temperatures.

91. **In conclusion – The USBR Temperature Model failed to provide the level of analysis necessary to allow the regulatory agencies to realize all the impacts associated with imposing the terms and conditions set forth in Action III.1.2.**

92. **In contrast, the SJRWTM is the most advanced temperature model that has ever been developed for the Stanislaus and the San Joaquin River, as whole. The SJRWTM was designed to directly address all the implications associated with temperature response to flow and storage in the system thus providing a realistic check about what can and cannot be achieved as far as temperature control is concerned. Also, the SJRWTP has a built-in logic to model the old-new dam interaction. This unique feature is especially important when operating the system more aggressively, as appears to be the case when**

operating for temperature control per Action III.1.2 of the BO, because as the water level in New Melones approaches the crest of the old dam, the cold pool of water behind the old dam is isolated and cannot be released for temperature control. Instead, warmer water is skimmed of the top layer of the pool behind the old dam, which exacerbates the thermal condition downstream. Based on the information in the record describing the USBR Temperature Model, there is nothing to suggest that the USBR Temperature Model has the capability to address this issue.

93. **It should be noted that in 2006, in the peer review report of the OCAP, the panel addressed the weaknesses of monthly time-step models when applied to the needs of anadromous fish. The panel also identified the Stanislaus River Temperature Model as the preferred model for this task.**

94. **The Stanislaus River Temperature Model and then the SJRWTP were available to the Federal Defendants for almost six years. Unfortunately, they have not been used by the very same people who funded, supported and actively participated in their development since their infancy. Instead, the Federal Defendants have chosen an inferior model that raises more doubts about the validity of the results then insightful information that could lead to making informed decisions.**

95. **Beyond my conclusion that temperature targets are not attainable a significant amount of time, Action III.1.2 also has number of deficiencies that surfaced during my water temperature investigation and modeling. Action III.1.2 lacks in my opinion, basic rules, guidelines and constraints as to how the system should be operated for temperature control. There is disconnect between Action III.1.2 and the practical aspects of this action, or at best, Action III.1.2 is simply incomplete.**

Executed this 5th of August, 2010 in Moraga, California.

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OAKDALE IRRIGATION DISTRICT and
SOUTH SAN JOAQUIN IRRIGATION DISTRICT

MODELING DEMONSTRATES THAT NEW MELONES IS INCAPABLE OF REALSING SUFFICIENT WATER TO MEET THE REQUIREMENTS OF RPA ACTION III.1.2

Action III.1.2 requires USBR to make cold water releases from New Melones to provide suitable temperatures for CV steelhead. (BO, p. 621). The compliance point is at Orange Blossom Bridge (OBB) downstream of Goodwin Dam, and temperature compliance shall be measured based on a seven (7) day average daily maximum temperature (7DADM). (BO, p. 622).

1. USBR used the Reclamation Temperature Model (not provided in the AR, described in Appendix H to the 2008 OCAP BA) to evaluate feasibility of meeting the temperature criteria.
   a. The Reclamation model was not peer reviewed. (H-6)
   b. The Reclamation model present temperature on a mean monthly basis, and cannot depict daily maximums or 7DADM. (H-9; Milligan Decl., ¶ 12)
   c. The Reclamation model does not capture diurnal temperature variability. (Milligan Decl., ¶ 12).
   d. Reclamation model cannot simulate actual operations strategies used to meet temperature objectives. (Milligan Decl., ¶ 12).
   e. No modeling was done to assess potential impacts on storage due to flows released for temperature compliance. (Reed Decl., ¶ 30).
   f. NMFS/USBR did not quantify how much water would need to be released to meet temperature. (Reed Decl., ¶ 31).

2. Modeling performed using the Reclamation model showed that there will be temperature exceedances. (BO, p. 622; US Reply Br., p. 132; Reed Decl. ¶ 25).

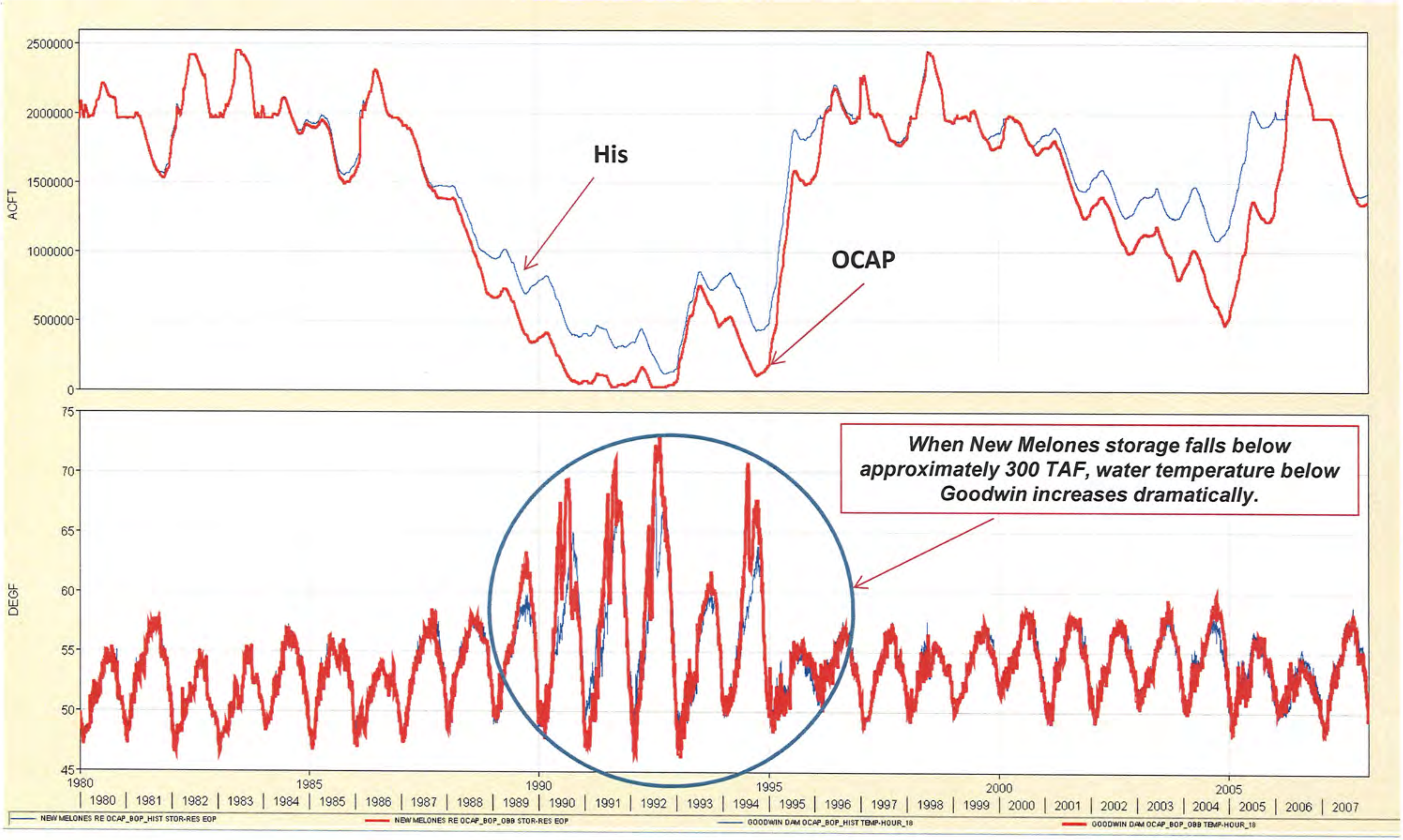
3. Dotan replicated the use of the Reclamation model using the San Joaquin River Water Temperature Model (SJRWTM). (Dotan Decl., ¶ ¶ 60-77).
   a. The model run shows that there are temperature exceedances in every month except December, January and February, exceedances occur more than 25% of the time in the months of May, July, October and November, and 92% of the time in October. (Dotan Decl., ¶¶ 73-77, Fig. 7).
   b. Dotan ran same data using the SJRWTM, which has a 6 hour timestep. Those runs found exceedances in all months except December and January, exceedances occur more than 18% of the time in the months of March, April, May, June, July, August, September, October and November, and exceedances of more than 40% of the time occur in the months of April, May, July, and October. (Dotan Decl., Fig. 7).

4. Dotan used the SJRWTM to model impacts to New Melones storage in releasing water to meet temperature requirement. Dotan modeled the required Appendix 2E flows, and ordered the model to use up to an additional 1,000 cfs to meet temperature. (Dotan Decl., ¶ 82).
   a. In the period 1987-1995, New Melones storage would need to be depleted by as much as 717,000 AF when compared with required 2E releases to meet temperature. (Dotan Decl., ¶ 86, Fig. 8).
   b. Even using up to an additional 1000 cfs does not result in 100% compliance. Still exceedances occur in every month except January, with exceedances occurring

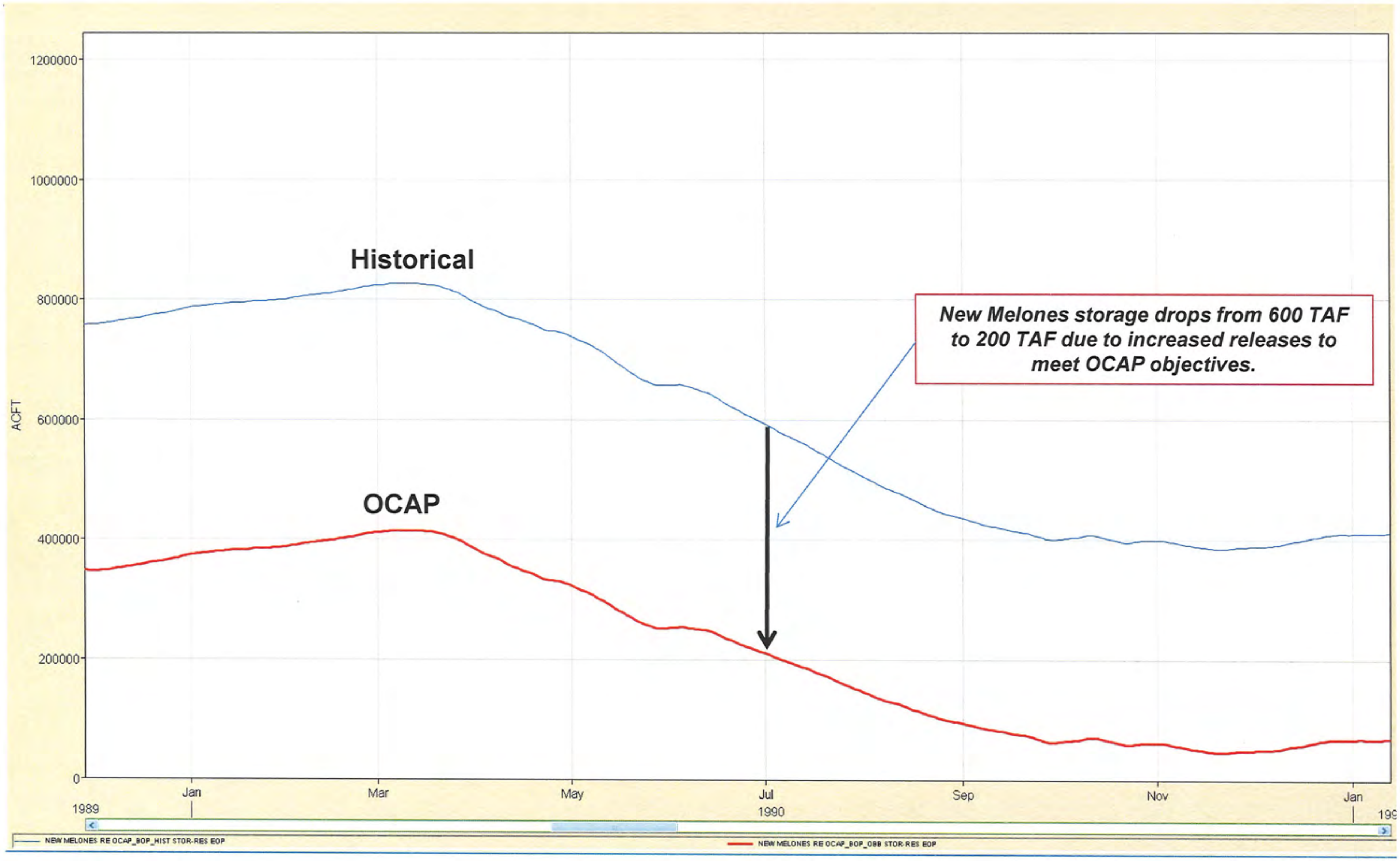
25% of the time or more in March, April, May, June, July, August, and October. (Dotan Decl., ¶ 90, Fig. 12).

c. Successive operation to meet temperature will eventually deplete cold water pool. (Dotan Decl., ¶ 89, Fig. 11).

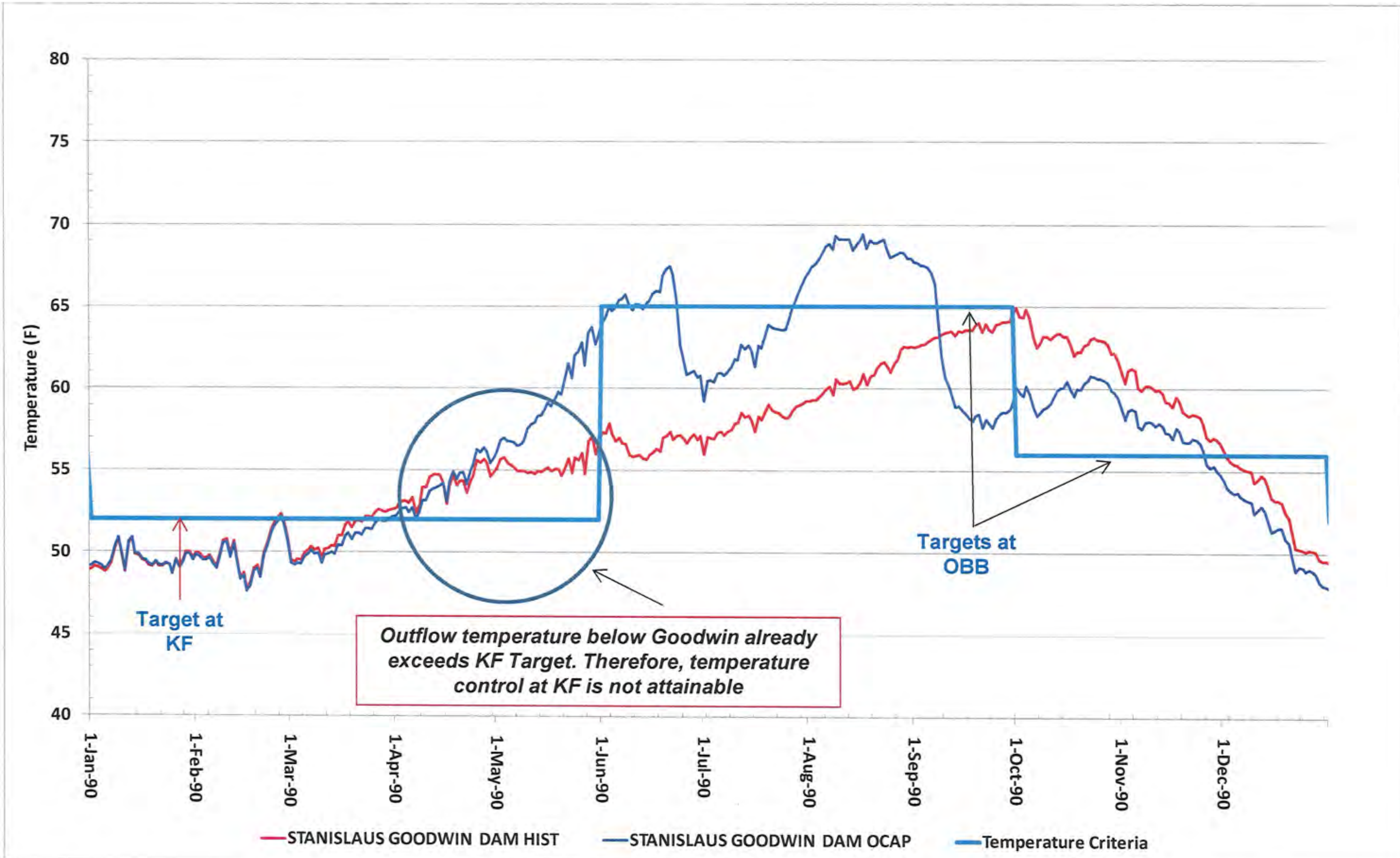
New Melones Storage is depleted due to increased releases above Historical to meet OCAP Temperature Targets (1980-2007)



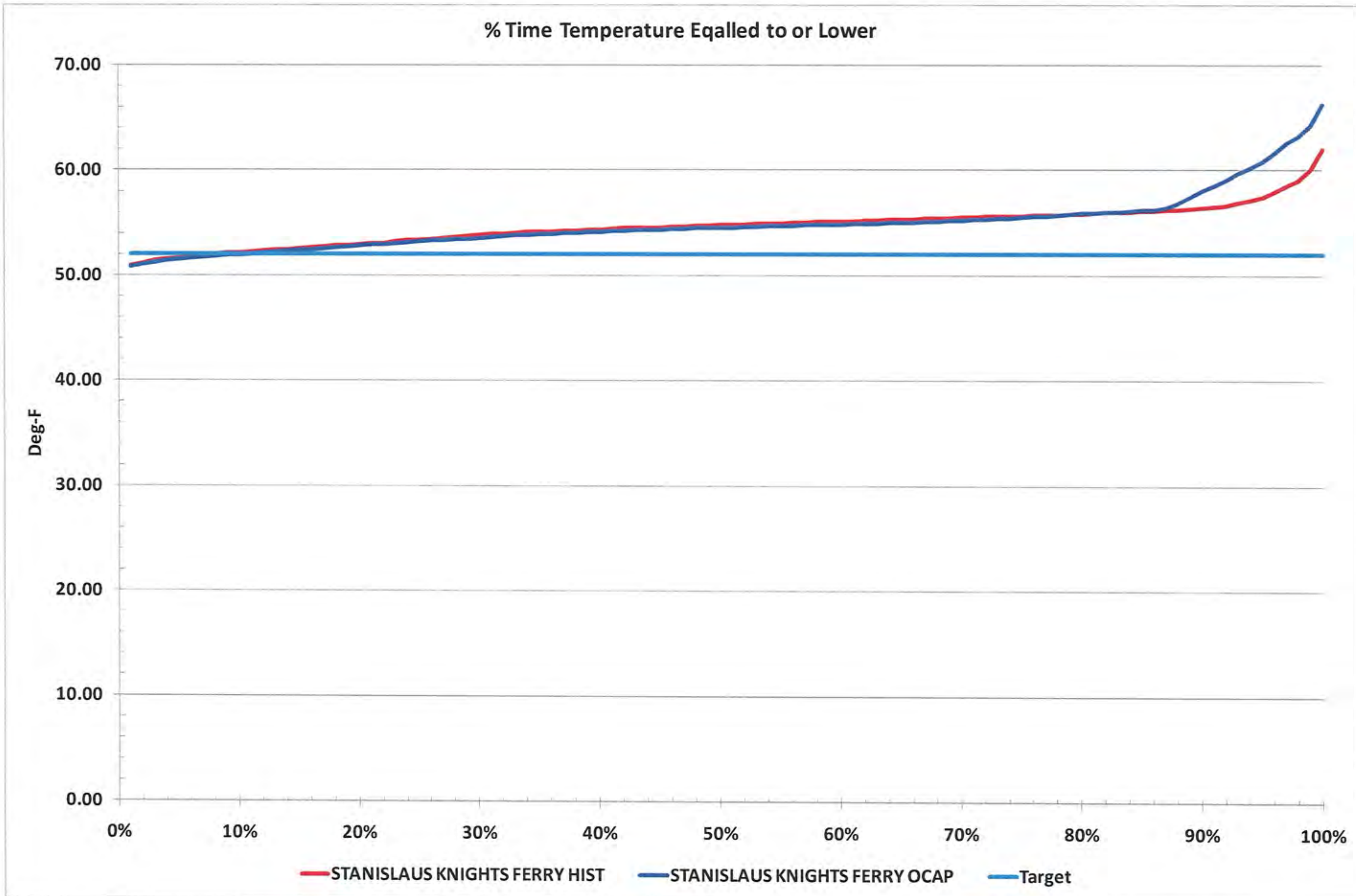
New Melones Storage - Critical Year 1990



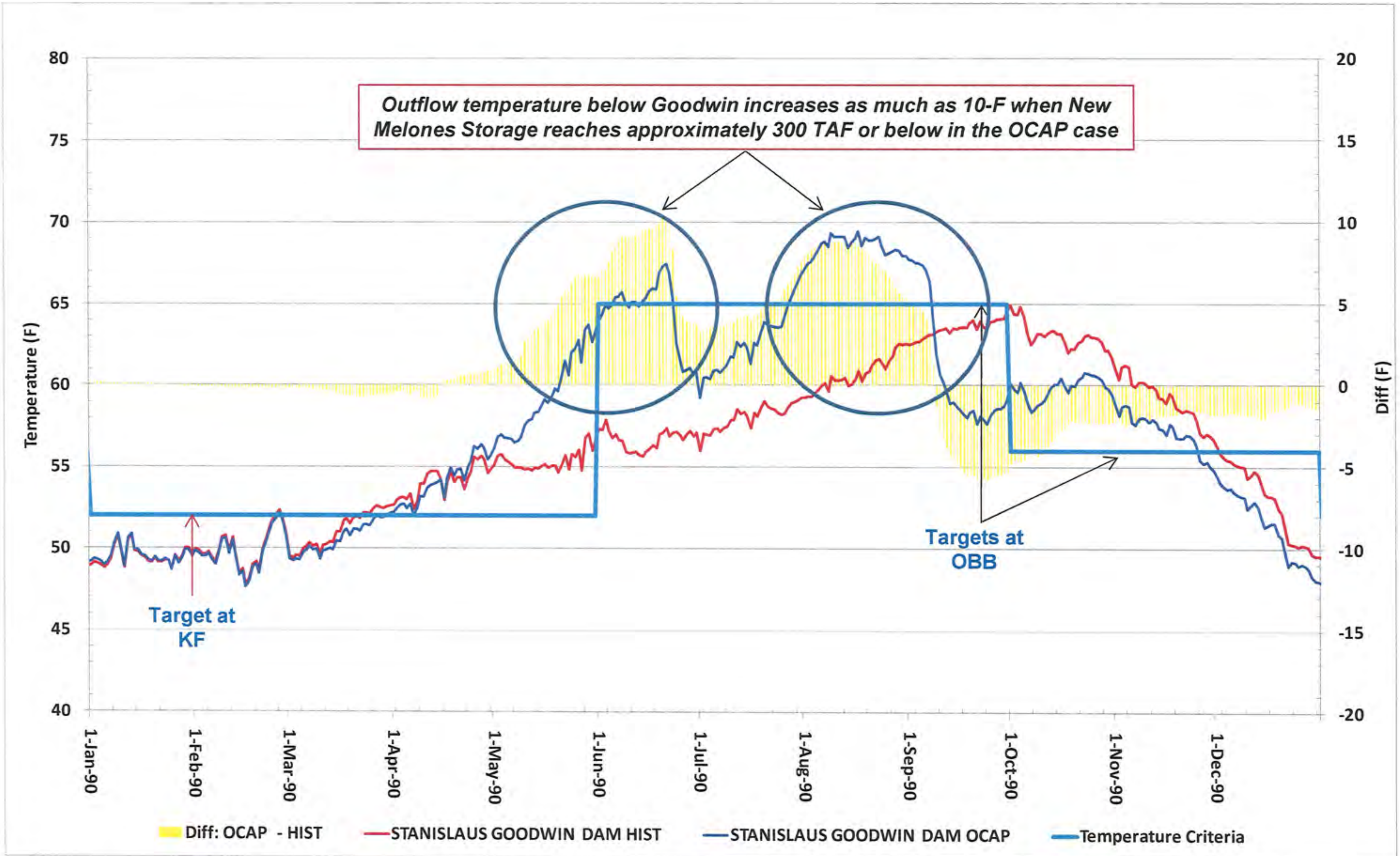
Temperature Below Goodwin Dam in Relation to Target Temperature at Knights Ferry (KF) and Orange Blossom Bridge (OBB)
Example: 1990 (similar phenomenon would occur 90% of the time)



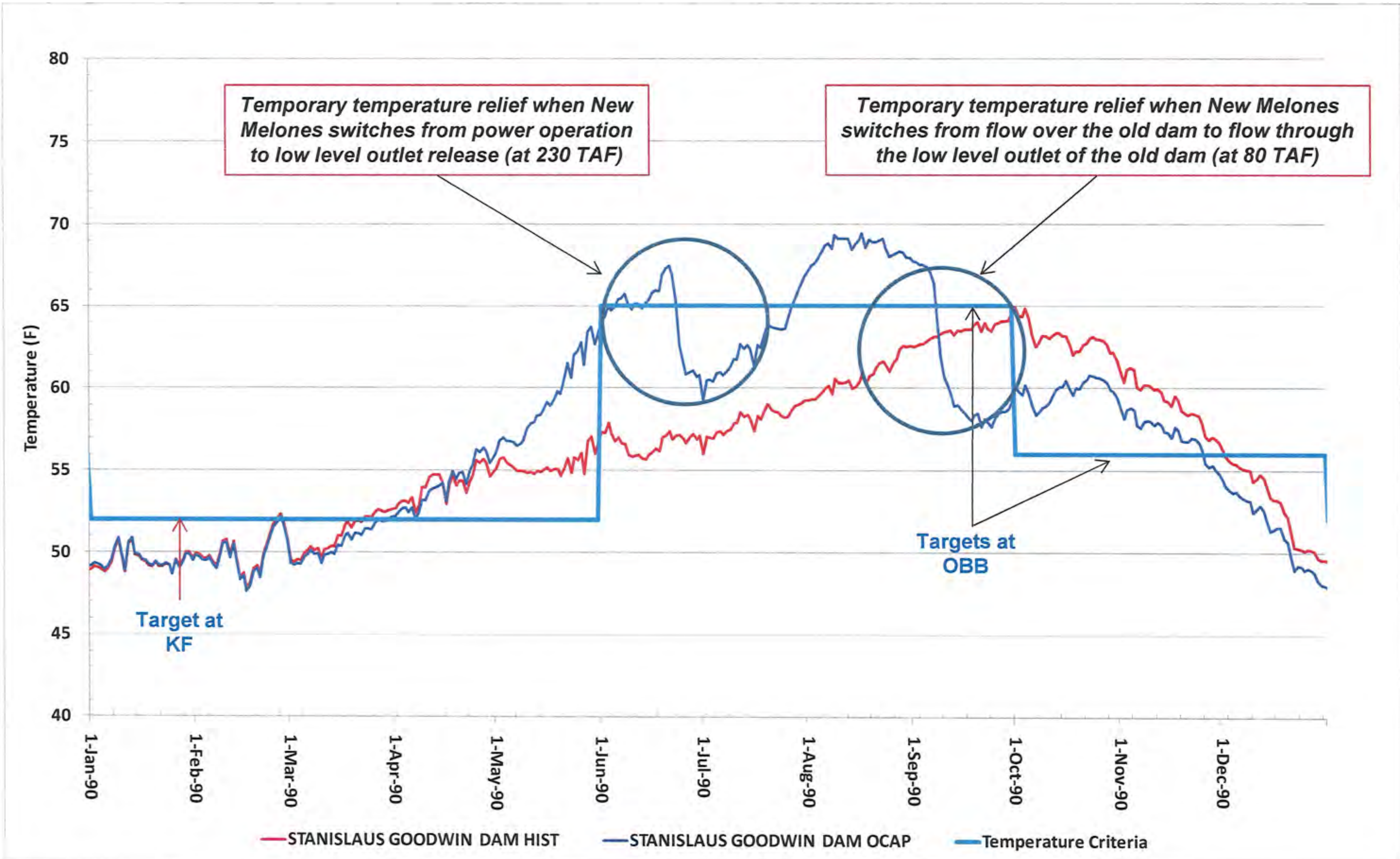
Target temperature at Knights Ferry can be met only about 10% of the time in the month of May with or without flow augmentation



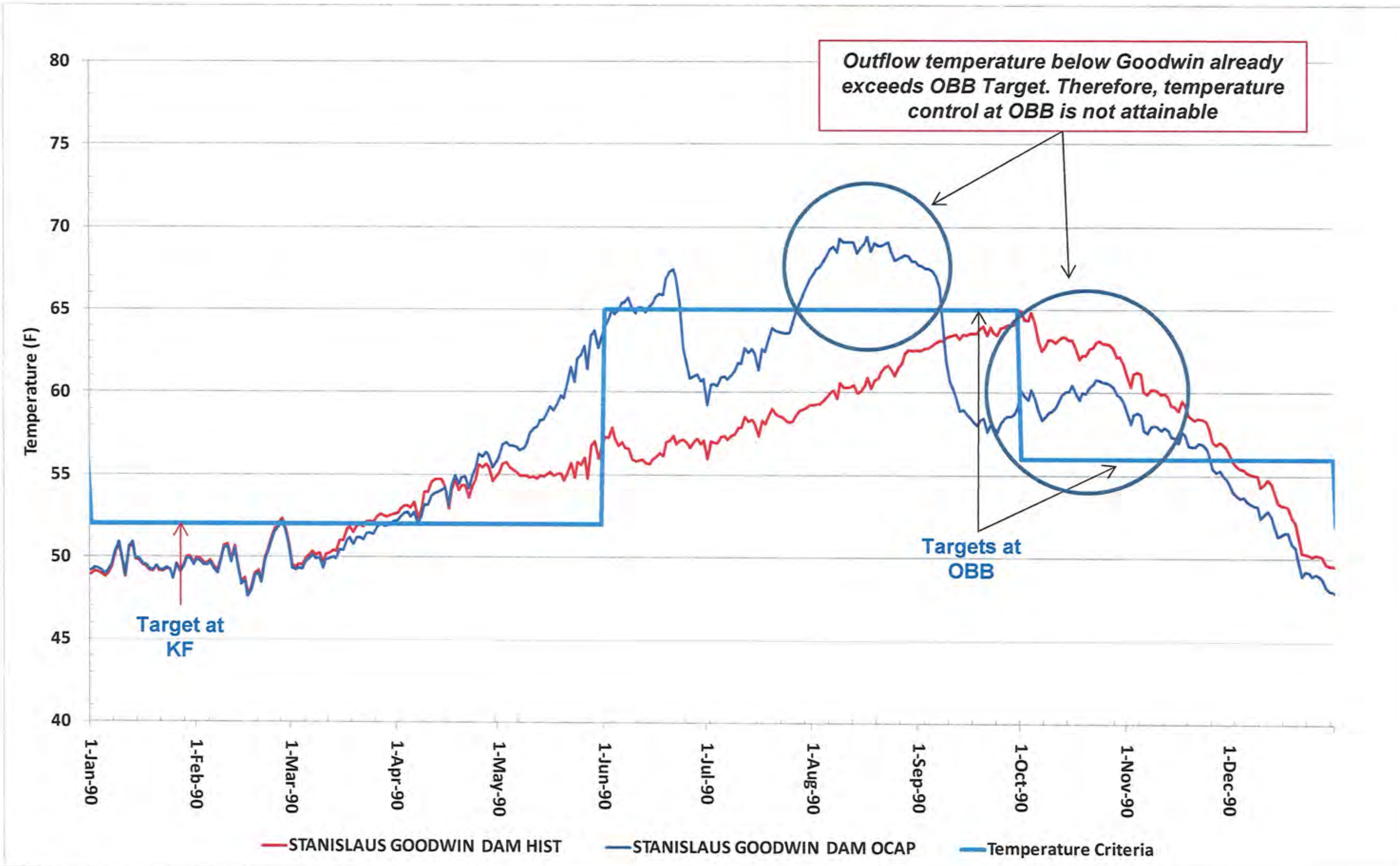
Temperature Below Goodwin Dam in Relation to Target Temperature at Knights Ferry (KF) and Orange Blossom Bridge (OBB) Example: 1990



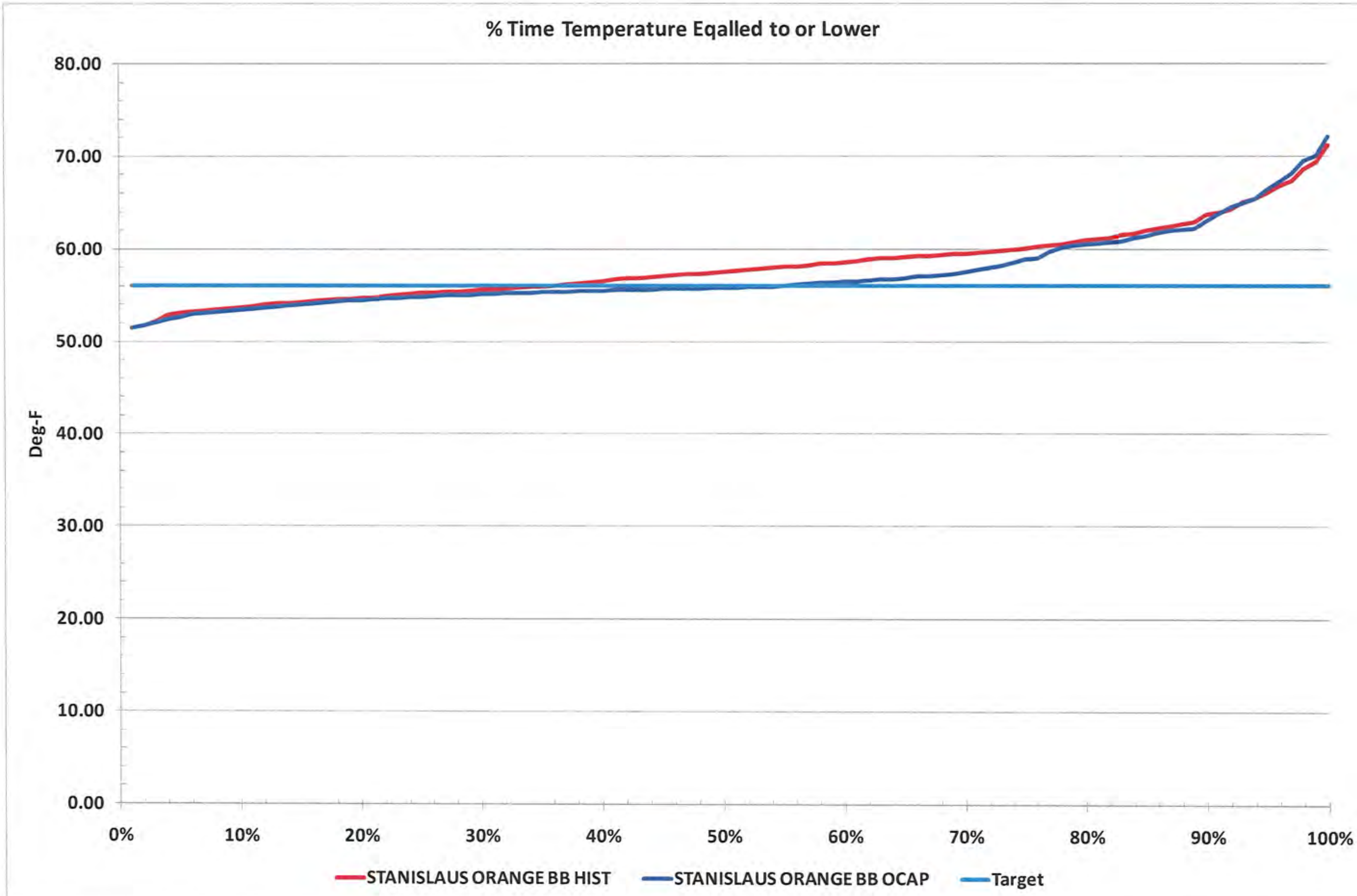
Temperature Below Goodwin Dam in Relation to Target Temperature at Knights Ferry (KF) and Orange Blossom Bridge (OBB) Example: 1990



Temperature Below Goodwin Dam in Relation to Target Temperature at Knights Ferry (KF) and Orange Blossom Bridge (OBB) Example: 1990



Target temperature at Orange Blossom Bridge can be met only about 50% of the time in the month of October even after flow augmentation (about 15% increase over Historical)

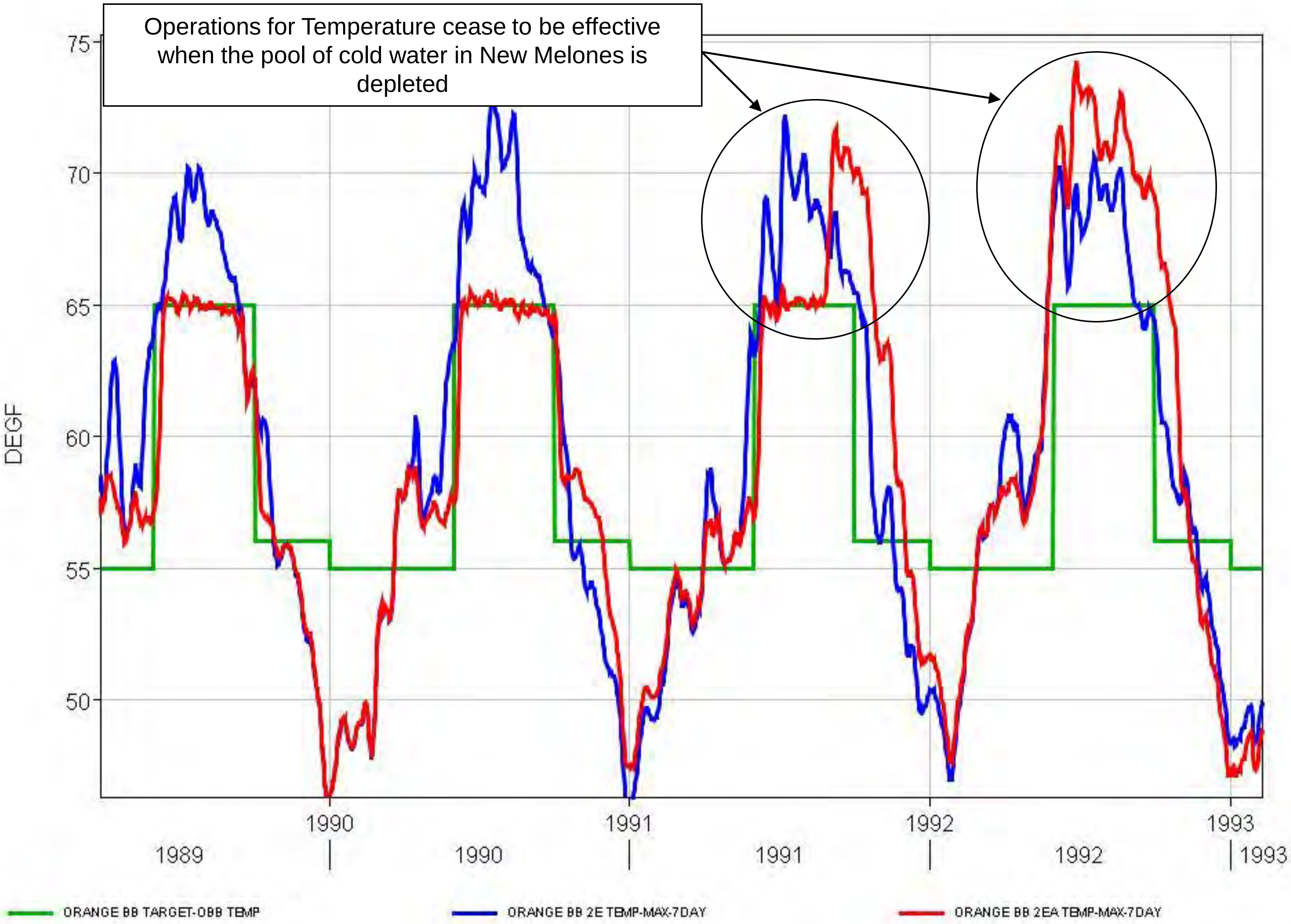


16%	47.5	46.3	49.1	47.3	50.9	49.5	51.8	48.8	53.3	50.7	55.2	54.5	60.7	60.6	60.4	61.2	58.0	58.7	54.4	57.8	52.3	53
18%	47.6	46.3	49.2	48.6	51.2	49.7	52.0	49.3	53.5	50.9	55.5	54.6	61.1	61.8	60.7	61.2	58.7	60.2	54.6	57.8	52.5	53
20%	47.7	46.3	49.3	48.6	51.3	49.7	52.2	49.3	53.6	50.9	55.7	54.6	61.5	61.8	61.0	61.2	59.0	60.2	54.7	58.1	52.6	55
22%	47.8	46.4	49.4	48.7	51.4	49.7	52.5	49.5	53.7	51.9	55.8	55.5	61.9	62.0	61.3	62.0	59.3	60.9	54.8	58.1	52.7	55
24%	47.9	46.4	49.6	48.7	51.6	49.7	52.7	49.5	54.1	51.9	56.1	55.8	62.2	62.0	61.5	62.0	59.5	60.9	55.0	58.1	53.0	55
26%	48.0	46.4	49.6	48.8	51.7	49.7	52.9	49.5	54.3	52.0	56.5	55.9	62.5	62.0	61.8	62.1	59.8	61.1	55.1	58.1	53.2	55
28%	48.1	47.1	49.7	48.8	51.9	50.1	53.1	49.7	54.4	53.0	56.8	56.3	62.6	62.3	61.9	62.8	60.1	62.2	55.2	58.7	53.4	55
30%	48.2	47.1	49.8	48.8	52.0	50.1	53.3	49.7	54.6	53.0	57.1	56.3	62.7	62.3	62.1	62.8	60.3	62.2	55.3	58.7	53.5	55
32%	48.3	47.5	49.9	48.9	52.2	50.4	53.4	50.1	54.8	53.1	57.3	57.1	62.9	62.6	62.2	63.2	60.4	62.4	55.4	58.9	53.7	55
34%	48.4	47.5	49.9	48.9	52.3	50.4	53.6	50.1	54.9	53.1	57.5	57.1	63.0	62.6	62.4	63.2	60.6	62.4	55.6	58.9	53.8	55
36%	48.5	47.8	50.0	49.2	52.4	50.8	53.7	50.5	55.1	53.7	57.6	57.9	63.2	62.6	62.5	63.2	60.8	62.8	55.7	58.9	53.9	55
38%	48.6	47.8	50.1	49.2	52.5	50.8	53.8	50.5	55.3	53.7	57.9	57.9	63.5	62.6	62.6	63.2	60.9	62.8	55.8	59.2	54.1	55
40%	48.6	48.1	50.2	49.6	52.6	51.0	54.0	50.6	55.4	54.2	58.0	58.6	63.8	62.8	62.8	63.2	61.0	62.9	56.0	59.2	54.2	55
42%	48.7	48.1	50.3	49.6	52.7	51.0	54.1	50.6	55.6	54.2	58.2	58.6	63.9	62.8	62.9	63.2	61.1	62.9	56.2	59.2	54.3	55
44%	48.8	48.1	50.5	49.8	52.8	51.4	54.2	51.6	55.7	55.5	58.4	58.7	64.1	63.1	63.1	63.3	61.2	63.0	56.3	59.2	54.5	55
46%	48.9	48.1	50.5	49.8	52.9	51.4	54.3	51.6	55.9	55.5	58.8	58.7	64.3	63.1	63.3	63.3	61.3	63.0	56.4	59.2	54.5	55
48%	49.0	48.1	50.6	50.1	53.0	51.5	54.5	51.9	56.0	55.5	59.6	61.5	64.4	63.2	63.4	63.3	61.5	63.3	56.6	59.2	54.6	55
50%	49.0	48.1	50.7	50.1	53.2	51.5	54.6	51.9	56.2	55.5	60.2	61.5	64.6	63.2	63.6	63.3	61.7	63.3	56.7	59.4	54.7	56
52%	49.1	48.1	50.8	50.2	53.3	51.5	54.8	51.9	56.3	55.5	60.9	61.5	64.7	63.2	63.7	63.3	61.7	63.3	56.8	59.5	54.8	56
54%	49.2	48.2	51.0	50.2	53.4	51.7	54.9	53.2	56.5	55.9	61.6	61.7	64.9	63.4	63.9	63.8	61.9	63.7	57.0	59.5	54.9	56
56%	49.3	48.2	51.1	50.2	53.5	51.7	55.0	53.2	56.6	55.9	62.1	61.7	65.0	63.4	63.9	63.8	62.1	63.7	57.2	59.6	54.9	56
58%	49.3	48.2	51.3	50.5	53.6	52.3	55.1	53.2	56.8	56.2	62.4	61.8	65.1	63.7	64.1	63.9	62.3	63.9	57.3	59.6	55.1	56
60%	49.4	48.2	51.3	50.5	53.8	52.3	55.2	53.2	56.9	56.2	62.8	61.8	65.1	63.7	64.2	63.9	62.4	63.9	57.5	59.7	55.2	56
62%	49.5	48.6	51.4	50.6	54.0	52.4	55.3	53.2	57.1	56.6	63.1	62.0	65.3	64.7	64.3	64.0	62.5	64.2	57.8	59.7	55.3	56
64%	49.6	48.6	51.6	50.6	54.1	52.4	55.5	53.2	57.3	56.6	63.4	62.0	65.4	64.7	64.5	64.0	62.7	64.2	57.9	59.7	55.4	56
66%	49.7	48.8	51.7	50.8	54.2	52.8	55.6	53.5	57.4	56.8	63.7	62.9	65.5	64.7	64.6	64.2	62.8	64.4	58.1	59.7	55.6	56
68%	49.8	48.8	51.8	50.8	54.4	52.8	55.8	53.5	57.6	56.8	64.0	62.9	65.6	64.7	64.7	64.2	63.0	64.4	58.3	59.7	55.8	56
70%	49.9	49.2	51.9	51.5	54.6	53.3	55.9	53.8	57.8	57.3	64.2	63.1	65.7	65.1	64.8	64.3	63.2	64.4	58.6	60.3	55.9	56
72%	50.0	49.2	52.0	51.5	54.7	53.3	56.1	53.8	58.0	57.3	64.4	63.1	65.9	65.1	64.9	64.3	63.4	64.4	59.0	60.3	56.1	56
74%	50.1	49.2	52.2	51.6	54.8	53.6	56.3	54.4	58.2	57.4	64.5	63.9	66.0	65.3	65.1	64.5	63.7	64.7	60.0	60.7	56.3	56
76%	50.2	49.4	52.3	51.6	55.0	53.6	56.5	54.5	58.4	57.4	64.7	64.0	66.2	65.3	65.1	64.5	64.1	64.7	60.3	60.7	56.4	56
78%	50.3	49.4	52.4	51.6	55.1	53.6	56.6	54.5	58.6	57.4	64.9	64.0	66.4	65.3	65.3	64.5	64.3	64.7	60.6	61.1	56.7	57
80%	50.5	49.7	52.5	51.7	55.4	54.1	56.8	54.6	58.8	57.5	65.1	64.0	66.5	65.6	65.5	64.8	64.8	64.7	60.9	61.1	56.9	57
82%	50.7	49.7	52.7	51.7	55.6	54.1	57.1	54.6	59.0	57.5	65.3	64.0	66.7	65.6	65.7	64.8	65.1	64.7	61.3	61.8	57.1	57
84%	50.8	49.8	53.0	51.9	55.9	54.2	57.3	54.8	59.3	57.6	65.5	64.1	66.9	65.8	66.0	65.3	65.6	65.0	61.8	61.8	57.4	57
86%	51.0	49.8	53.1	51.9	56.1	54.2	57.6	54.8	59.5	57.6	65.8	64.1	67.2	65.8	66.4	65.3	66.2	65.0	62.0	61.8	57.6	57
88%	51.2	50.3	53.3	51.9	56.3	54.4	57.8	55.8	59.7	58.6	66.0	64.3	67.5	66.0	67.1	65.3	68.2	65.5	63.0	62.1	58.0	57
90%	51.5	50.3	53.6	51.9	56.6	54.4	58.0	55.8	60.1	58.6	66.3	64.3	67.8	66.0	67.8	65.3	68.6	65.5	64.0	62.1	58.3	57
92%	51.7	50.9	54.0	53.1	57.0	54.7	58.3	56.2	60.5	58.8	66.6	65.5	68.3	66.1	69.1	66.0	68.9	66.6	65.2	64.5	58.6	58
94%	52.0	50.9	54.3	53.1	57.4	54.7	58.5	56.2	61.1	58.8	67.0	65.5	69.4	66.1	69.8	66.0	69.2	66.6	66.2	64.5	59.1	58
96%	52.4	52.1	54.8	54.0	58.2	56.6	58.9	57.5	63.4	61.6	67.4	65.8	70.1	68.3	70.7	66.2	69.5	68.3	66.8	65.9	60.2	59
98%	53.2	52.1	55.1	54.0	59.0	56.6	60.0	57.5	65.4	61.6	68.0	65.8	70.9	68.3	71.6	66.2	69.9	68.3	67.4	65.9	61.9	59
100%	53.9	52.1	58.4	54.0	60.8	56.6	63.9	57.5	67.6	61.6	69.6	65.8	74.0	68.3	73.1	66.2	71.0	68.3	69.7	65.9	63.3	59
Case	5Q	NMFS	5Q	NMFS	5Q	NMFS	5Q	NMFS	5Q	NMFS	5Q	NMFS	5Q	NMFS	5Q	NMFS	5Q	NMFS	5Q	NMFS	5Q	NM
Target	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	56.0	56.0	56.0	56

Above target   Below Target

Figure - 11

Augmentation for Temperature from 2E to 2EA

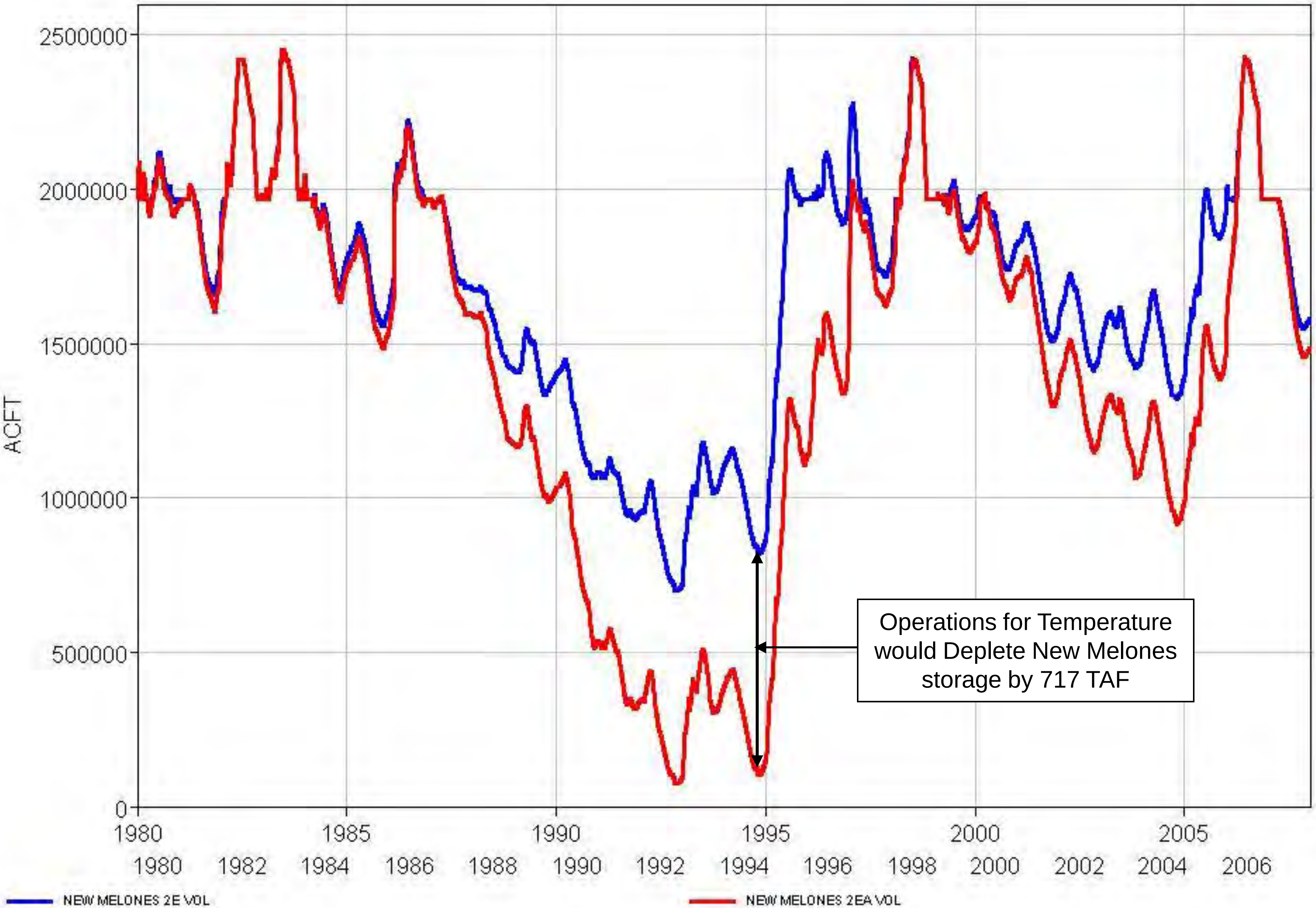


16%	47.6	47.5	49.2	49.1	50.8	50.5	52.5	52.2	54.3	54.1	55.7	55.6	60.8	60.3	60.9	60.9	58.8	58.9	54.0	53.7	51.8	51
18%	47.8	47.7	49.4	49.2	51.0	50.7	52.7	52.4	54.5	54.3	56.0	55.8	61.0	60.6	61.1	61.0	59.0	59.0	54.1	54.0	51.9	52
20%	47.9	47.8	49.4	49.3	51.2	51.0	52.9	52.6	54.6	54.4	56.3	56.2	61.4	61.1	61.2	61.2	59.3	59.3	54.3	54.3	52.1	52
22%	48.1	47.9	49.5	49.4	51.4	51.1	[illegible]	52.7	54.8	54.6	56.6	56.4	61.6	61.4	60.4	61.4	[illegible]	59.4	54.4	54.5	52.2	52
24%	48.2	48.1	49.7	49.5	51.6	51.3	53.3	52.9	54.9	54.7	56.8	56.6	61.9	61.9	61.5	61.5	59.6	59.7	54.6	54.7	52.3	52
26%	48.3	48.2	49.8	49.5	51.7	51.5	53.4	53.1	55.0	54.8	57.0	56.7	62.2	62.2	61.7	61.8	59.7	59.9	54.8	54.9	52.5	52
28%	48.4	48.3	49.9	49.6	51.9	51.6	53.6	53.3	55.2	54.9	57.2	57.0	62.5	62.4	61.9	62.1	59.8	60.1	55.0	55.0	52.6	52
30%	48.5	48.4	50.0	49.8	52.1	51.8	53.8	53.5	55.4	55.1	57.4	57.2	62.7	62.7	62.1	62.3	60.0	60.3	55.2	55.2	52.8	52
32%	48.6	48.4	50.1	49.9	52.2	52.0	54.0	53.7	55.5	55.2	57.6	57.4	63.0	63.0	62.3	62.5	60.1	60.5	55.3	55.3	52.9	53
34%	48.6	48.5	50.1	50.0	52.3	52.1	54.1	53.8	55.6	55.3	57.8	57.6	63.2	63.2	62.4	62.7	60.3	60.7	55.5	55.4	53.1	53
36%	48.7	48.6	50.2	50.1	52.4	52.3	54.3	54.0	55.7	55.4	58.0	57.8	63.4	63.5	62.6	62.9	60.5	60.9	55.6	55.5	53.1	53
38%	48.8	48.7	50.3	50.2	52.5	52.4	54.4	54.2	55.8	55.5	58.2	58.0	63.7	63.7	62.9	63.2	60.7	61.0	55.8	55.6	53.3	53
40%	48.9	48.8	50.4	50.3	52.6	52.6	54.5	54.3	55.9	55.7	58.4	58.1	63.9	64.0	63.1	63.4	60.9	61.2	55.9	55.6	53.4	53
42%	48.9	48.8	50.5	50.4	52.8	52.7	54.7	54.4	56.0	55.8	58.6	58.3	64.2	64.2	63.4	63.7	61.0	61.4	56.0	55.7	53.5	53
44%	49.0	48.9	50.6	50.6	52.9	52.8	54.8	54.6	56.0	55.9	58.9	58.6	64.6	64.4	63.6	63.8	61.2	61.5	56.1	55.8	53.6	53
46%	49.0	49.0	50.7	50.7	53.0	53.0	55.0	54.8	56.2	56.0	59.6	58.9	65.0	64.6	63.8	64.0	61.4	61.6	56.2	55.9	53.7	53
48%	49.1	49.0	50.8	50.7	53.1	53.1	55.2	55.1	56.4	56.1	60.5	59.4	65.3	64.7	64.1	64.2	61.5	61.8	56.4	55.9	53.8	53
50%	49.1	49.1	50.9	50.8	53.3	53.3	55.3	55.2	56.5	56.2	61.5	60.0	65.9	64.7	64.3	64.3	61.6	61.9	56.5	56.0	53.9	54
52%	49.2	49.2	51.0	51.0	53.4	53.4	55.5	55.4	56.7	56.3	62.9	60.5	66.3	64.8	64.5	64.4	61.8	62.0	56.7	56.0	54.0	54
54%	49.3	49.3	51.1	51.1	53.5	53.5	55.6	55.5	56.8	56.4	63.9	61.0	66.5	64.8	64.6	64.5	61.9	62.2	56.9	56.1	54.1	54
56%	49.3	49.3	51.2	51.2	53.7	53.7	55.7	55.7	56.9	56.5	64.3	61.5	66.8	64.9	64.9	64.6	62.1	62.4	57.0	56.2	54.2	54
58%	49.4	49.4	51.3	51.3	53.8	53.9	55.9	55.8	57.1	56.6	64.6	62.6	67.1	64.9	65.1	64.6	62.2	62.5	57.1	56.3	54.3	54
60%	49.5	49.5	51.4	51.4	54.0	54.0	56.0	56.0	57.2	56.7	64.9	63.4	67.2	65.0	65.3	64.7	62.4	62.7	57.2	56.4	54.4	54
62%	49.5	49.6	51.4	51.5	54.2	54.2	56.2	56.0	57.5	56.8	65.2	64.0	67.4	65.0	65.5	64.7	62.6	62.9	57.3	56.6	54.4	54
64%	49.7	49.7	51.5	51.5	54.5	54.4	56.4	56.1	57.7	56.9	65.5	64.3	67.5	65.0	65.7	64.8	62.8	63.1	57.7	56.7	54.5	54
66%	49.7	49.8	51.6	51.7	54.7	54.7	56.5	56.3	57.8	56.9	65.8	64.6	67.7	65.1	66.0	64.8	62.9	63.2	57.8	56.8	54.5	55
68%	49.8	49.9	51.7	51.8	55.0	55.0	56.7	56.4	58.1	57.0	66.0	64.7	67.9	65.1	66.1	64.9	63.1	63.4	58.0	56.9	54.6	55
70%	49.9	50.0	51.9	51.9	55.3	55.2	56.8	56.6	58.3	57.1	66.2	64.8	68.1	65.1	66.3	64.9	63.3	63.7	58.2	57.1	54.7	55
72%	50.0	50.1	52.1	52.1	55.5	55.5	57.0	56.7	58.6	57.1	66.4	64.9	68.3	65.2	66.5	65.0	63.5	63.9	58.5	57.2	54.8	55
74%	50.2	50.2	52.2	52.2	55.9	55.9	57.2	56.8	58.8	57.2	66.7	65.0	68.5	65.2	66.7	65.0	63.7	64.1	58.7	57.4	54.8	55
76%	50.2	50.3	52.3	52.4	56.3	56.2	57.4	56.9	59.2	57.3	67.0	65.0	68.8	65.2	66.9	65.0	64.0	64.3	59.0	57.7	55.0	55
78%	50.3	50.4	52.5	52.6	56.6	56.5	57.6	57.0	59.6	57.4	67.2	65.1	69.0	65.3	67.1	65.1	64.2	64.5	59.2	57.9	55.1	55
80%	50.5	50.5	52.7	52.9	56.9	56.7	57.8	57.1	60.3	57.5	67.4	65.2	69.2	65.3	67.3	65.1	64.4	64.7	59.5	58.3	55.2	55
82%	50.6	50.6	52.8	53.1	57.2	56.9	58.1	57.4	61.3	57.6	67.7	65.3	69.4	65.4	67.6	65.1	64.6	64.9	59.6	58.7	55.5	55
84%	50.7	50.8	53.0	53.4	57.4	57.2	58.5	57.5	62.0	57.7	68.0	65.4	69.6	65.4	67.9	65.2	64.8	65.0	59.8	59.2	55.6	56
86%	50.9	50.9	53.2	53.5	57.7	57.4	58.9	57.8	62.5	57.8	68.1	65.5	69.8	65.5	68.1	65.3	65.0	65.8	60.1	61.4	55.8	56
88%	51.1	51.1	53.4	53.8	57.9	57.7	59.2	58.0	63.0	57.9	68.4	65.6	70.1	65.6	68.2	65.3	65.2	66.7	60.3	62.7	56.2	56
90%	51.2	51.3	53.6	53.9	58.2	57.8	59.6	58.3	63.4	58.0	68.8	65.7	70.4	65.7	68.4	65.5	65.5	68.1	60.5	63.5	56.5	57
92%	51.4	51.6	54.0	54.2	58.4	58.0	59.8	58.5	64.0	58.1	69.2	66.0	70.7	65.9	68.7	65.8	65.9	68.9	60.8	64.5	56.7	57
94%	51.6	51.8	54.3	54.5	58.8	58.3	60.3	58.8	64.4	58.4	69.5	68.3	71.1	71.2	69.0	69.5	66.2	69.6	61.2	65.4	56.9	57
96%	52.0	52.2	54.6	54.8	59.3	58.6	60.8	59.0	65.4	59.5	69.8	70.0	71.5	73.2	69.4	70.5	66.5	69.9	62.1	66.5	57.3	58
98%	52.5	52.9	55.0	55.2	60.0	59.0	61.6	59.3	67.1	66.2	70.3	71.9	72.0	74.6	70.1	71.8	68.0	70.6	63.7	68.3	57.8	61
100%	54.0	54.0	56.6	56.7	60.8	59.7	63.3	60.0	69.9	71.1	71.0	74.9	74.0	75.9	73.0	73.6	70.2	72.5	65.6	70.5	59.3	63
Case	2E	2EA	2E	2EA	2E	2EA	2E	2EA	2E	2EA	2E	2EA	2E	2EA	2E	2EA	2E	2EA	2E	2EA	2E	2E
Target	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	56.0	56.0	56.0	56

Above target   Below Target

Figure - 8

New Melones Storage: 2E vs. 2EA



Summary of Floodplain Modeling and Geomorphic Flows

cbec conducted modeling (SRH-2D) for a 5.7 mile reach extending from Orange Blossom Bridge (OBB; RM 46.9) to Lovers Leap (RM 52.6). This reach was selected because LiDAR and bathymetry data was available and the reach represents much of the primary juvenile salmon rearing habitat. The model was developed with the intent to (1) identify the presence, or lack thereof, of floodplain habitat along the Lower Stanislaus River that would be available for salmon rearing, and (2) understand the behavior of geomorphically significant flows in forming and maintaining the channel and transporting sediment.

Floodplain inundation modeling results indicate the following:

- Total floodplain inundation area in the modeled reach was essentially 0 acres at <3,000 cfs. A total of 35 acres was available at 5,000 cfs, and 82 acres at 8,000 cfs.
- It would take (1) at least a 2-year post-dam flow to begin to inundate some fraction of the 35 acres of near-channel floodplain; (2) at least a 5-year post-dam flow to inundate some fraction of an additional 47 acres of overflow channel floodplain; and (3) a post-dam 100-year base flood (approximately 8,000 cfs) to inundate the entire 82 acres of available floodplain. It would be expected that floodplain areas below and above 5,000 cfs would be inundated on average 19 days and 6 days, respectively, in a given year.
- Based on extrapolations, the total acreage for the entire primary rearing reach is estimated to be 85 acres at 5,000 cfs and 200 acres at 8,000 cfs. As such, the flow release schedule stated in the National Marine Fisheries Service (NMFS 2009) Biological Opinion would result in very little floodplain inundation, which will provide little benefit to salmonids, particularly in the case of steelhead since floodplain is probably "not important to steelhead… given that there is little evidence of their extensive use of floodplain habitat in California" (Moyle 2009), and their preference for mid-channel and margin habitat as observed in the Stanislaus River (FISHBIO, personal observations).
- Based on this study, much larger pulse flows (than 8,000 cfs) would be required and/or topographic manipulation (e.g., Honolulu Bar Floodplain Enhancement Project- see description below) to reconnect floodplains to the present day river.

Channel forming and maintenance flows results indicate the following:

- Based on assumption that channel maintenance flows refer to mobilization of d_{50}-sized particles and greater, flows in the 3,000-5000 cfs range may provide some limited mobilization since modeled depth-averaged shear stresses were sufficient to mobilize d50 in this range at 43% of sites (i.e., 3 of 7) analyzed.
- Based on the assumption that channel forming flows refer to mobilization of d_{84}-sized particles and greater (which is our best assumption for total mobility of the channel bed, although not necessarily indicative of channel forming flows), channel forming flows will not be achieved under existing flood control limitations (i.e., no flows greater than 8,000 cfs released). At no modeled flow (i.e., 3,000 to 8,000) was the depth-averaged shear stress above that required to mobilize d_{84}-sized material. Channel forming flows would realistically require a minimum of a 5-year pre-dam flow, and as determined by Kondolf et al. (2001), the 5-year pre-dam flow that was partially responsible for forming the river prior to gravel mining and flow regulation was 19,100 cfs.
- Mobilization of spawning gravels may actually be detrimental to existing and restored

gravel supplies within the river channel. For instance, flows in the 5,000 to 6,000 range have been observed to displace gravel from restored gravel augmentation sites below Goodwin Dam into deep, downstream pools (FISHBIO personal observations) where it is of no use to spawning and rearing fish. Due to the severe gravel deficit and existence of several deep pools in the canyon, restored gravels can be expected to be lost to these mined areas at flows greater than 5,000 cfs.

Honolulu Bar Floodplain Enhancement Project

The Honolulu Bar Floodplain Enhancement Project (RM 49 to RM 50.5) was recently completed (end of September 2012; Figure 1). It was designed to restore several aquatic and riparian habitat elements in the Stanislaus River including 2.4 acres of floodplain habitat on the inside edge of a mid-channel island, 0.7 acres of floodplain bench in the south side of the river upstream of the mid-channel island, 0.4 acres of spawning riffle in the river adjacent to the mid-channel island, 3.85+ acres of native vegetation, and increased frequency and duration of flow connectivity in one mile of side channel habitat (Figure 2). Objectives of the Project include (1) restoring seasonally inundated floodplain habitat, (2) restoring year-round rearing habitat, (3) addressing an existing adult stranding issue, (4) increasing usable spawning habitat area, (5) increasing hiding cover, velocity refugia, habitat complexity, and instream habitat types, and (6) restoring native vegetation.

Figure 1. Side channel and restored floodplain looking northeast. Approximately 4.5-6 feet of materials were removed to lower gradient to increase amount of juvenile salmon rearing habitat over a wider range of flows.

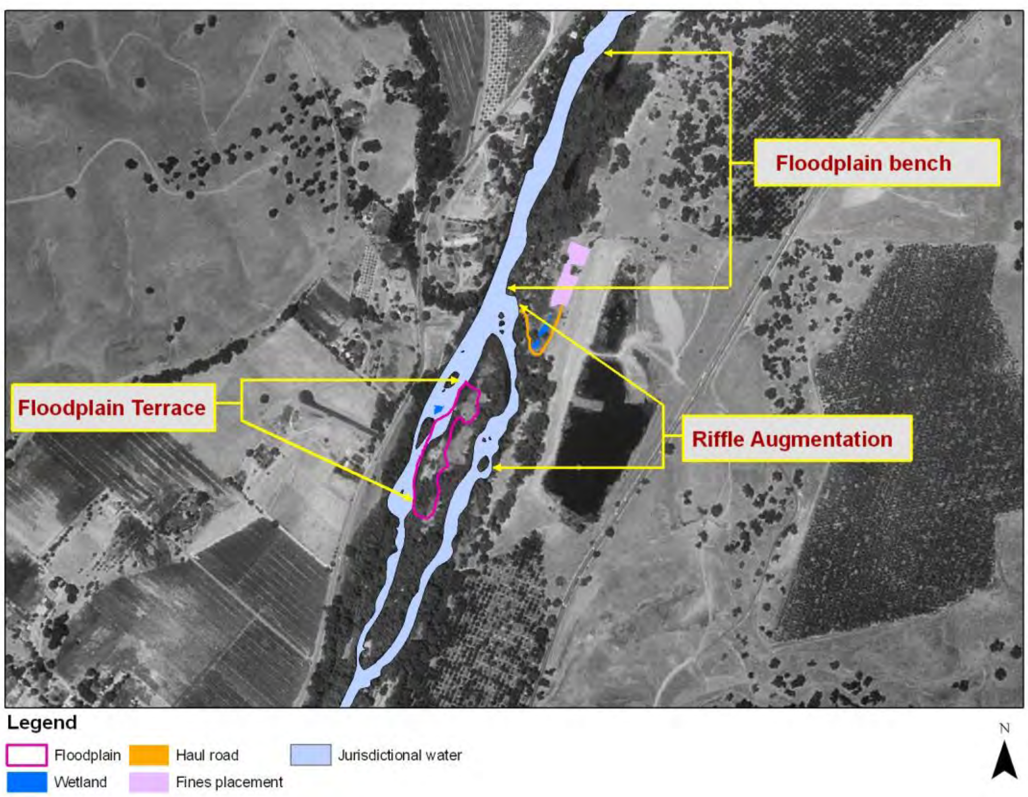


Figure 2. Honolulu Bar Floodplain Enhancement Project general footprints.

Summary of Key Findings from Stanislaus River Studies

Juvenile Migration Timing

- Juvenile Chinook migration can be temporarily stimulated by changes in flow, but the effect is short lived (few days) (Demko et al. 2001, 2000, 1996; Demko and Cramer 1995).
- Juvenile salmon migration typically begins in January and most juveniles migrate by May 15 (Table 1).
- Except in wet and above normal years, 0.7% or less of total juvenile salmon (i.e., fry, parr, and smolts), and 0.8% or less of salmon smolts outmigrate during June.
- Juvenile *O. mykiss* may be found migrating downstream throughout the year, but the majority of outmigration to the ocean occurs episodically between March and May. Based on Caswell RST catches, the majority of juvenile *O. mykiss* outmigrate by mid to late May (Table 2).

Juvenile Outmigrant Survival

- Over a decade of rotary screw trap monitoring in the Stanislaus River shows that
  - flow has a strong positive relationship with migration survival of Chinook fry (Pyper et al. 2006). Benefits to adult escapement of increased fry survival in the Stanislaus are uncertain (Baker and Morhardt 2001; SRFG 2004; SJRGA 2008; Pyper and Justice 2006).
  - abundance ratios for parr and smolts were only weakly correlated with flows (Pyper and Justice 2006).
- Smolt survival (CWT) studies conducted by CDFG at flows ranging from 600 cfs to 1,500 cfs and at 4,500 cfs have shown that smolt survival is highly variable and not improved by higher flows in the Stanislaus River (SRFG 2004; CDFG unpublished data), which is consistent with Pyper and Justice (2006) results above.

Adult upstream migration timing

- Operations at the Stanislaus River Weir (2003-2011) indicate that more than 97% of adult FRCS migrate after October 1 (Figure 1).
- Adult FRCS migration rate and timing are not dependent upon flows, water temperature or dissolved oxygen concentrations (Pyper and others 2006).
- Prolonged, high-volume fall pulse flows are not warranted, since equivalent stimulation of adult migration may be achieved through modest pulses (Pyper and others 2006). Relatively modest pulse-flow events (increase of ~200 cfs for 3 days) were found to stimulate migration for a short duration (2-3 day migration); while longer duration high-volume pulses did not substantially increase migration duration or magnitude (3-4 day migration).

Spawn timing and distribution

- The majority (98%) of Chinook salmon spawning occurs between October 15 and December 31.
- Historically, the spawning reach of the Stanislaus was described by G.H. Clark in the 1920s as extending from Knights Ferry to Oakdale, and this continues to be the reach where most spawning activity occurs. A small proportion of late-season spawning

(less than 5%) occurs down to Riverbank, and 95% of this activity occurs after November 30.

O. mykiss Abundance and Distribution

- Snorkel surveys conducted since 2002 have provided the most extensive data set on the distribution and between-year abundance of adult and juvenile *O. mykiss*. Surveys are performed bi-weekly at seven sample reaches between Goodwin Dam (RM 58.4) and Valley Oak (RM 41). Data indicate O. *mykiss* distribution is highest in the first four miles of river below Goodwin Dam–which consists primarily of high gradient canyon environment–with over 80% of the *O. mykiss* population inhabiting this reach of river.
- Summer population estimates calculated from intensive snorkel surveys between Goodwin Dam and Oakdale during 2009-2011 indicate that abundance is relatively stable across years, ranging from approximately 13,000-17,000 individuals.

Table 1. Stanislaus River juvenile Chinook salmon outmigration timing at Caswell (RM 8.6; 1998-2005).

		Wet (n=2)	Above Normal (n=2)	Below Normal (n=1)	Dry (n=3)	Critical (n=0)
Fry	Jan 1-15	0.7%	0.0%	0.0%	0.0%	-
	Jan 16-31	22.5%	12.4%	39.3%	0.1%	-
	Feb 1-15	22.6%	26.0%	3.3%	0.4%	-
	Feb 16-28	11.8%	27.4%	1.4%	14.4%	-
	Mar 1-15	8.8%	8.9%	2.9%	17.6%	-
	Mar 16-31	7.9%	7.7%	8.3%	5.3%	-
Smolt	Apr 1- 15	3.9%	4.5%	4.5%	16.3%	-
	Apr 16-30	3.9%	5.1%	26.5%	21.0%	-
	May 1-15	8.6%	3.5%	11.3%	17.8%	-
	May 16-31	7.0%	3.3%	2.5%	6.4%	-
	Jun 1- 15	2.1%	1.0%	0.1%	0.7%	-
	Jun 16-30	0.3%	0.2%	0.0%	0.0%	-

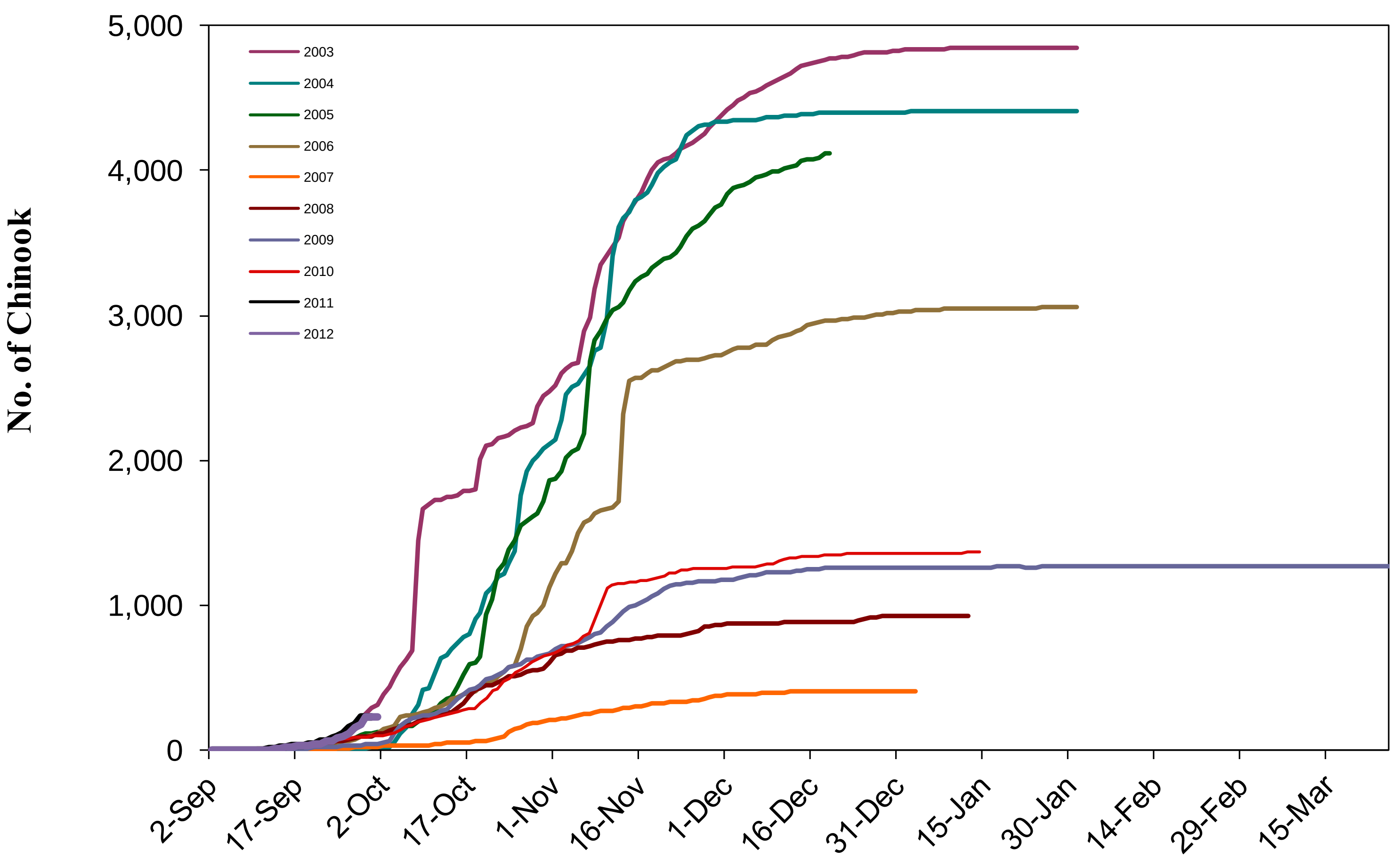
Table 2. Stanislaus River juvenile *O. mykiss* outmigration timing by water year type at Caswell (RM 8.6; 1995-2011).

	Wet (n=7)	Above Normal (n=3)	Below Normal (n=2)	Dry (n=3)	Critical (n=2)
J[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
J[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
F[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
F[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Mar 1-15	2.6%	2.8%	37.7%	27.0%	0.0%
Mar 16-31	17.2%	5.0%	7.7%	9.2%	6.5%
Apr 1- 15	16.8%	8.3%	0.0%	5.3%	8.7%
Apr 16-30	15.8%	13.9%	23.1%	12.0%	4.3%
May 1-15	2.6%	38.3%	3.8%	16.1%	54.3%
May 16-31	10.0%	5.0%	0.0%	3.7%	8.7%
Jun 1- 15	17.9%	2.8%	0.0%	0.0%	6.5%
Jun 16-30	0.0%	5.0%	0.0%	0.0%	0.0%

Table 3. Geographic and temporal distribution of spawning in the Stanislaus, 2000-2005.

STANISLAUS RIVER					
		Distribution of Redds[2]			
Date	%Redds Observed[1]	Goodwin	Knights Ferry to Horseshoe	Horseshoe to Oakdale	Oakdale to Riverbank
Before Oct 1	0.1%	100.0%	0.0%	0.0%	0.0%
Oct 1-15	1.5%	32.1%	61.3%	4.8%	1.8%
Oct 16-31	10.5%	17.5%	55.0%	24.5%	3.0%
Nov 1-15	29.4%	15.1%	51.4%	31.1%	2.5%
Nov 16-30	29.4%	13.6%	49.5%	33.6%	3.3%
Dec 1-15	19.0%	19.7%	38.9%	33.2%	8.2%
Dec 16-31	9.0%	14.5%	44.6%	34.3%	6.6%
Jan 1-15	1.1%	0.0%	46.5%	43.9%	9.7%

Cumulative Chinook Passage at the Stanislaus River Weir



Three Settings:

- 1997 IOP – Current SJR
- Current River – RPA
- September 2012 District Proposal

General Assumptions:

- Upstream San Joaquin River (above Stanislaus River Confluence)
  - Existing FERC and other Tributary instream flow requirements
  - Pre-SJRRP Friant
  - No SJRA/VAMP
- "Add Water" incorporated when necessary to maintain New Melones Storage > 150 TAF during 1986-1992 drought sequence.

New Melones

- 1997 IOP – Current SJR
  - OID/SSJID: Formula Water, occasionally not fully used according to land use and commitments calculation.
  - Vernalis flow requirement (February-June, including pulse) per D1641, using forecasted 75% exceedence parameters.

New Melones Forecast and Allocations

Annual Volume in 1,000 acre-feet

New Melones Forecast Index equals end-of-February storage plus March through September inflow

New Melones Forecast Index	Instream Fish	SEWD	CSJWCD	Vernalis Water Quality	Vernalis Flow Objective
0	1	2	3	4	5
0	0	0	0	0	0
1400	98	0	0	70	0
2000	125	0	0	80	0
2499.99	345	10	49	175	0
2500	345	10	80	175	1000
3000	467	10	80	250	1000
6000	467	10	80	250	1000
7000	467	10	80	250	1000
8000	467	10	80	250	1000
Form of lookup between indices:	Interpolate	Interpolate	Interpolate	Interpolate	Lookup
Threshold cutoff for interpolation:	NA	0	0	0	1400

Spreadsheet Canal

Upstream VAMP flo

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Initial Allocations

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New Melones Stor

Stanislaus Instream Fish Flow Requirement Monthly Distribution

Flow in CFS

Days	Lookup Period	Month	Lookup Reference	Breakpoints of Flow Distribution Schedules - 1,000 Acre-f and Period Schedules - CFS				
			0	0.0	98.4	243.3	253.8	310.3
15	10_1	Oct	1	0	110	200	250	250
16	10_2	Oct	2	0	110	200	250	250
15	11_1	Nov	3	0	200	250	275	300
15	11_2	Nov	4	0	200	250	275	300
15	12_1	Dec	5	0	200	250	275	300
16	12_2	Dec	6	0	200	250	275	300
15	1_1	Jan	7	0	125	250	275	300
16	1_2	Jan	8	0	125	250	275	300
15	2_1	Feb	9	0	125	250	275	300
13	2_2	Feb	10	0	125	250	275	300
15	3_1	Mar	11	0	125	250	275	300
16	3_2	Mar	12	0	125	250	275	300
14	4_1	Apr	13	0	250	300	300	900
16	4_2	Apr	14	0	500	1500	1500	1500
15	5_1	May	15	0	500	1500	1500	1500
16	5_2	May	16	0	250	300	300	900
15	6_1	Jun	17	0	0	200	200	250
15	6_2	Jun	18	0	0	200	200	250
15	7_1	Jul	19	0	0	200	200	250
16	7_2	Jul	20	0	0	200	200	250
15	8_1	Aug	21	0	0	200	200	250
16	8_2	Aug	22	0	0	200	200	250
15	9_1	Sep	23	0	0	200	200	250
15	9_2	Sep	24	0	0	200	200	250
Do not copy into this row	Equivalent Volume 1,000 Acre-feet:			0.0	98.9	245.7	256.2	311.5

New Melones Forecast and Allocations

Annual Volume in 1,000 acre-feet

Spreadsheet Canal

- Current River – RPA
  - OID/SSJID: Formula water, occasionally not fully used according to land use and commitments calculation.
  - Vernalis flow requirement (February-June, including pulse) per D1641, using forecasted 75% exceedence parameters.
  - Additional critical year RPA schedule (98.4 TAF) added for years when NMI < 1,400 TAF consistent with BO modeling. Such schedule is not included in Table 2E. Flow schedules do not include releases for BO temperature requirements.
  - Allocation for CVP Contractors is arbitrary but contributes to viable operation during all periods except during 1987-1992 drought.

	New Melones Forecast Index	Instream Fish	SEWD	CSJWCD	Vernalis Water Quality	Vernalis Flow Objective
	0	1	2	3	4	5
New Melones Forecast Index	0	98.4	10	0	400	0
equals end-of-February	1000	98.4	10	0	400	0
storage plus March through	1000.1	98.4	10	0	400	0
September inflow	1399.9	98.4	10	0	400	0
	1400	185.3	10	49	400	99999
	1724.9	185.3	10	49	400	99999
	1725	234.1	10	49	400	99999
	2177.9	234.1	10	49	400	99999
	2178	346.7	75	80	400	99999
	2386.9	346.7	75	80	400	99999
	2387	461.7	75	80	400	99999
	2500	461.7	75	80	400	99999
	2761.9	461.7	75	80	400	99999
	2762	589	75	80	400	99999
	3000	589	75	80	400	99999
	6000	589	75	80	400	99999
Form of lookup between indices:		Interpolate	Interpolate	Interpolate	Interpolate	Lookup
Threshold cutoff for interpolation:		NA	0	0	0	1400

Upstream VAMP flo

Release for Vernalis

Release for Vernalis
Vernalis water qualit

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Initial Allocations
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New Melones Stor

Stanislaus Instream Fish Flow Requirement Monthly Distribution

Flow in CFS

Breakpoints of Flow Distribution Schedules - 1,000 Acre-f and Period Schedules - CFS

Days	Lookup Period	Month	Lookup Reference	0.0	98.9	185.3	234.2	346.7
			0	0.0	98.9	185.3	234.2	346.7
15	10_1	Oct	1	0	110	577	636	774
16	10_2	Oct	2	0	110	577	636	774
15	11_1	Nov	3	0	200	200	200	200
15	11_2	Nov	4	0	200	200	200	200
15	12_1	Dec	5	0	200	200	200	200
16	12_2	Dec	6	0	200	200	200	200
15	1_1	Jan	7	0	125	213	219	226
16	1_2	Jan	8	0	125	213	219	226
15	2_1	Feb	9	0	125	214	221	229
13	2_2	Feb	10	0	125	214	221	229
15	3_1	Mar	11	0	125	200	200	200
16	3_2	Mar	12	0	125	200	200	200
14	4_1	Apr	13	0	250	200	500	1471
16	4_2	Apr	14	0	500	677	1000	1548
15	5_1	May	15	0	500	677	1000	1548
16	5_2	May	16	0	250	150	284	1031
15	6_1	Jun	17	0	0	150	200	363
15	6_2	Jun	18	0	0	150	200	363
15	7_1	Jul	19	0	0	150	200	250
16	7_2	Jul	20	0	0	150	200	250
15	8_1	Aug	21	0	0	150	200	250
16	8_2	Aug	22	0	0	150	200	250
15	9_1	Sep	23	0	0	150	200	250
15	9_2	Sep	24	0	0	150	200	250
Do not copy into this row	Equivalent Volume 1,000 Acre-feet:			0.0	98.9	185.3	234.2	346.7

- September 2012 District Proposal
  - OID/SSJID: Formula water, occasionally not fully used according to land use and commitments calculation.
  - No Vernalis flow requirement (assumed satisfied with tributary contributions)
  - Stanislaus River DO requirements modified – non-controlling.
  - Instream flow requirement:
    - Proposed schedule (monthly schedule providing the following annual total)

New Melones Storage Plus Inflow From	To	Fishery (TAF)
0	1,800	174
1,800	2,500	235
2,500	6,000	318

  - CVP Contractors annual allocation

New Melones Storage Plus Inflow From	To	Contractors (TAF)
0	1,400	10 (SEWD)
1,400	1,800	59 (10 SEWD)
1,800	6,000	155

New Melones Forecast and Allocations

Annual Volume in 1,000 acre-feet

	New Melones Forecast Index	Instream Fish	SEWD	CSJWCD	Vernalis Water Quality	Vernalis Flow Objective
	0	1	2	3	4	5
New Melones Forecast Index	0	9999	10	0	100	0
equals end-of-February	1299.999	9999	10	0	100	0
storage plus March through	1400	9999	10	0	100	0
September inflow	1401	9999	10	49	100	0
	1800	9999	10	49	100	0
	1801	99999	75	80	100	0
	2500	99999	75	80	100	0
	2501	999999	75	80	100	0
	7000	999999	75	80	100	0
	8000	999999	75	80	100	0
Form of lookup between indices:		Interpolate	Interpolate	Interpolate	Interpolate	Lookup
Threshold cutoff for interpolation:		NA	0	0	0	0

Spreadsheet Canal

Upstream VAMP flo

Release for Vernalis

Release for Vernalis
Vernalis water qualit

Stanislaus River Fis
Stanislaus fish patte
Off, uses NMI ba

Release for DO Req
Critical Year DO Re

Max Goodwin Releas

Initial Allocations
NM Index (Oct 192

New Melones Stor

Stanislaus Instream Fish Flow Requirement Monthly Distribution

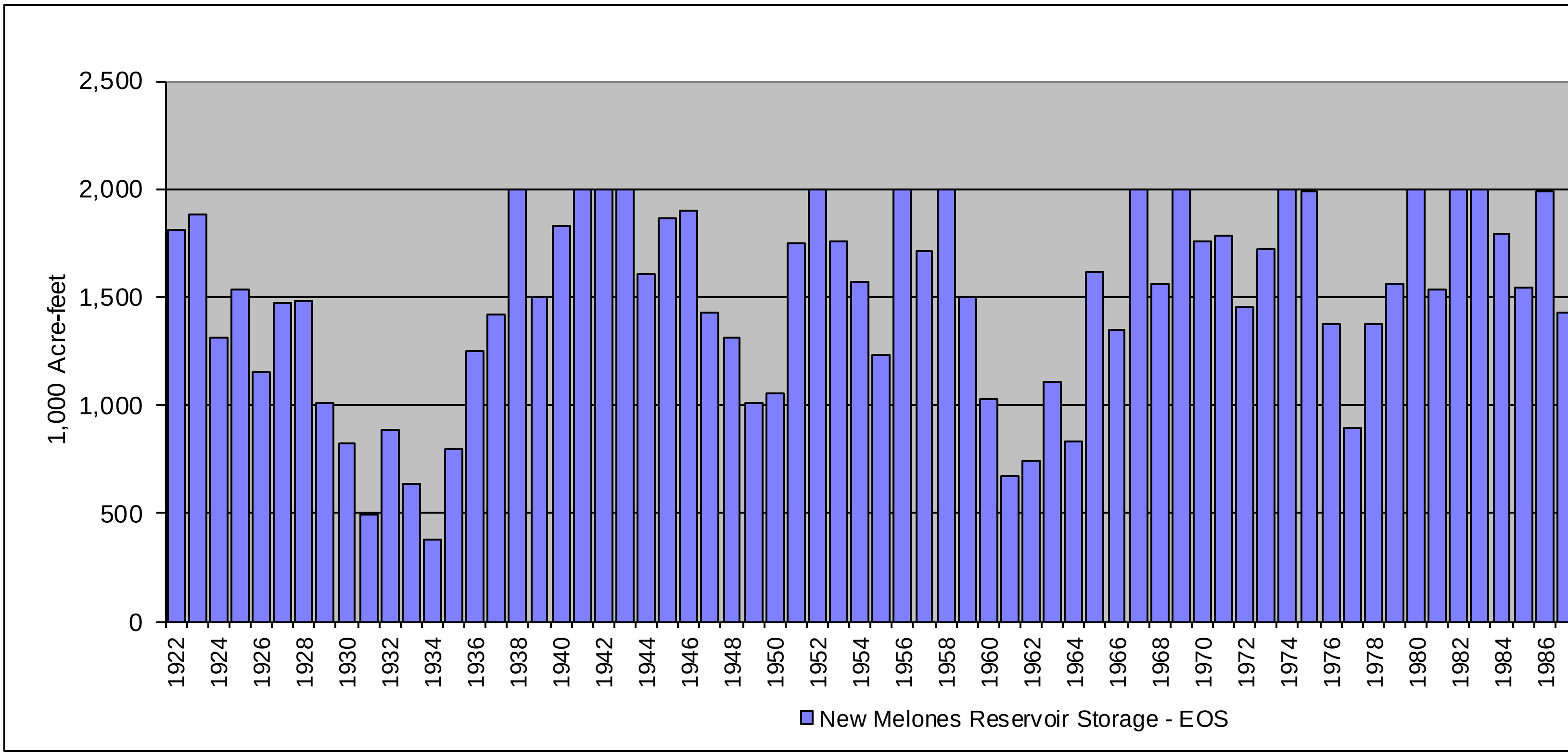
Flow in CFS

	Lookup Period	Month	Lookup Reference	Breakpoints of Flow Distribution Schedules - 1,000 Acre-f and Period Schedules - CFS				
Days			0	0.0	98.9	185.3	234.2	346.7
15	10_1	Oct	1	0	110	577	636	774
16	10_2	Oct	2	0	110	577	636	774
15	11_1	Nov	3	0	200	200	200	200
15	11_2	Nov	4	0	200	200	200	200
15	12_1	Dec	5	0	200	200	200	200
16	12_2	Dec	6	0	200	200	200	200
15	1_1	Jan	7	0	125	213	219	226
16	1_2	Jan	8	0	125	213	219	226
15	2_1	Feb	9	0	125	214	221	229
13	2_2	Feb	10	0	125	214	221	229
15	3_1	Mar	11	0	125	200	200	200
16	3_2	Mar	12	0	125	200	200	200
14	4_1	Apr	13	0	250	200	500	1471
16	4_2	Apr	14	0	500	677	1000	1548
15	5_1	May	15	0	500	677	1000	1548
16	5_2	May	16	0	250	150	284	1031
15	6_1	Jun	17	0	0	150	200	363
15	6_2	Jun	18	0	0	150	200	363
15	7_1	Jul	19	0	0	150	200	250
16	7_2	Jul	20	0	0	150	200	250
15	8_1	Aug	21	0	0	150	200	250
16	8_2	Aug	22	0	0	150	200	250
15	9_1	Sep	23	0	0	150	200	250
15	9_2	Sep	24	0	0	150	200	250
Do not copy into this row	Equivalent Volume 1,000 Acre-feet:			0.0	98.9	185.3	234.2	346.7

New Melones End-of-September Reservoir Storage

1997 IOP – Adapted to Current SJR

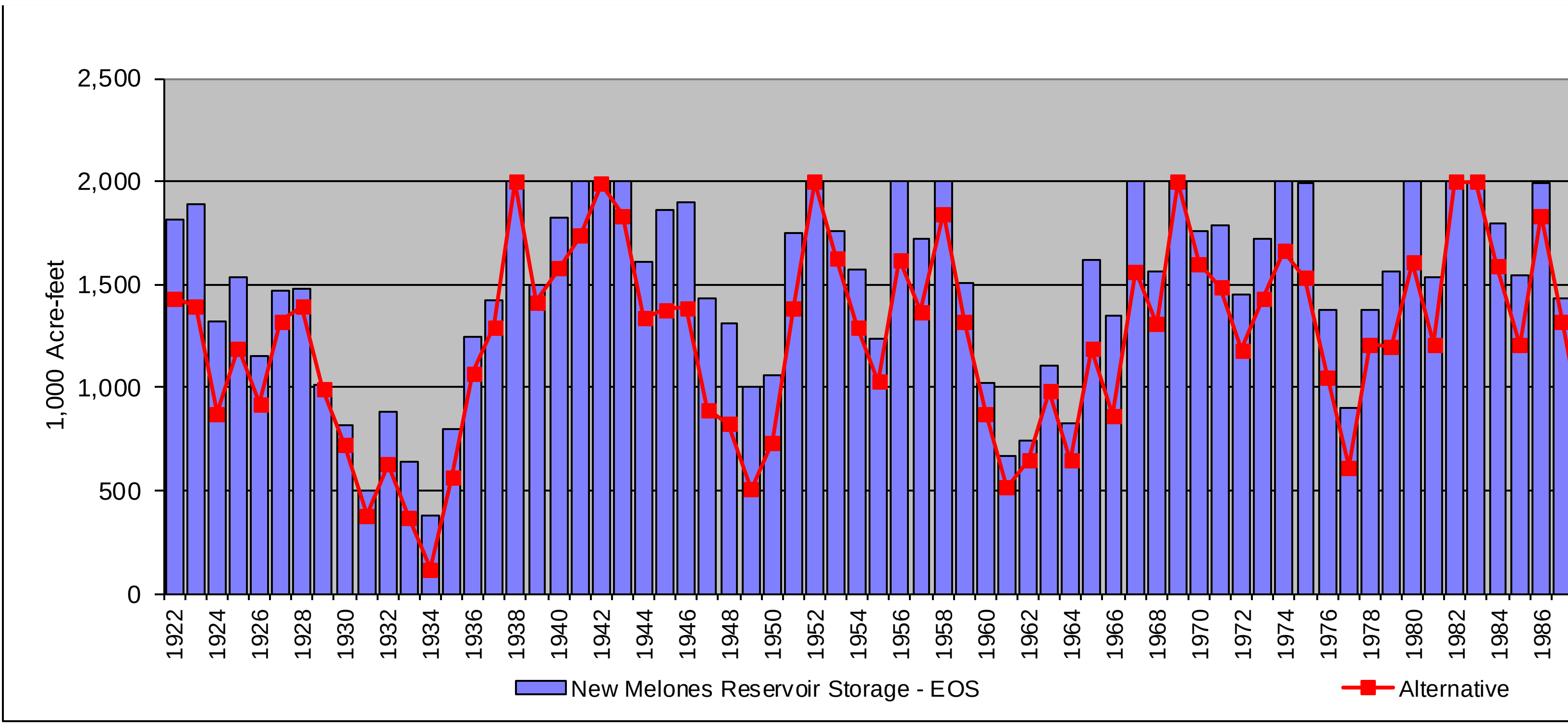
Current River – RPA



1997 IOP – Adapted to Current SJR (Blue Bar) v Current River RPA (Red Line)

1997 IOP – Adapted to Current SJR (Blue Bar) v September 2012 District Proposal (Red Line)

September 2012 District Proposal (Blue Bar) v Current River RPA (Red Line)

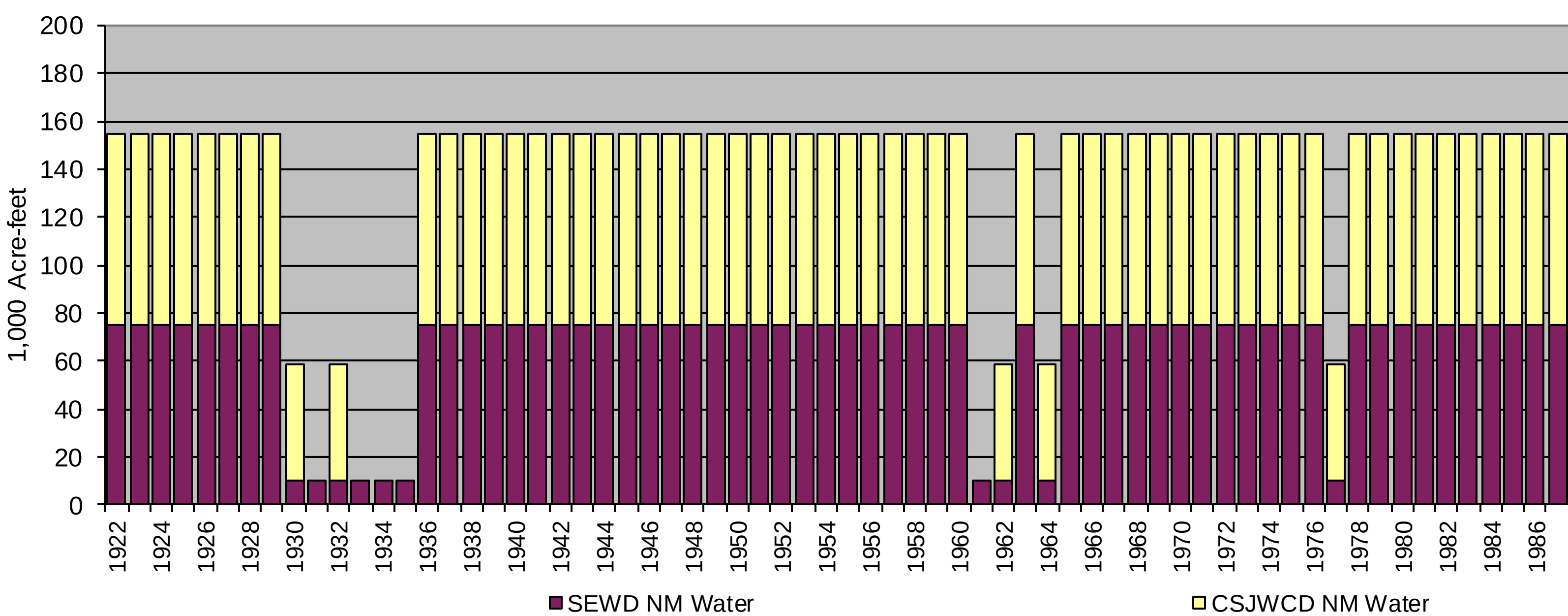


CVP Contractor Annual Allocations

1997 IOP – Adapted to Current SJR

Current River – RPA

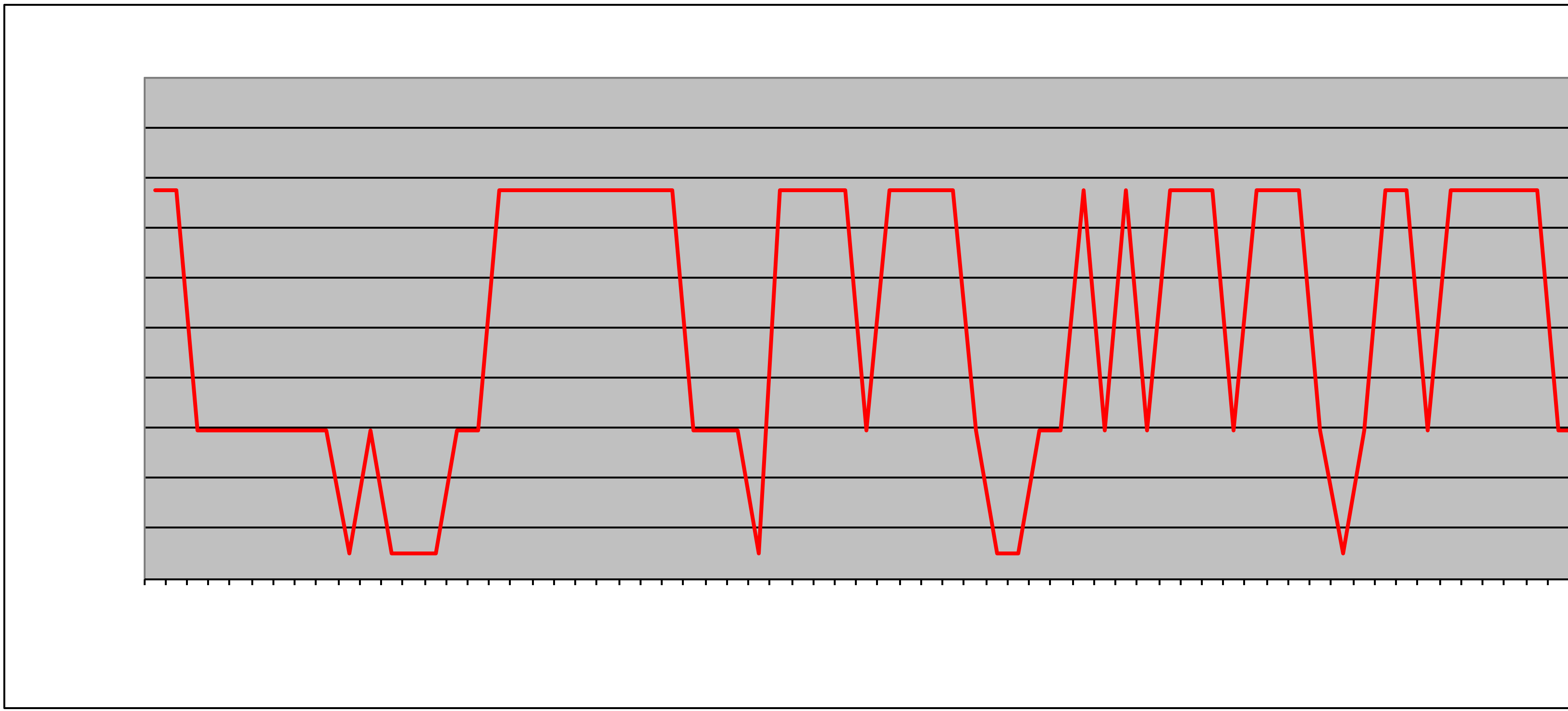
September 2012 District Proposal



1997 IOP – Adapted to Current SJR (Bars) v Current River RPA (Red Line)

1997 IOP – Adapted to Current SJR (Bars) v September 2012 District Proposal (Red Line)

September 2012 District Proposal (Bars) v Current River RPA (Red Line)

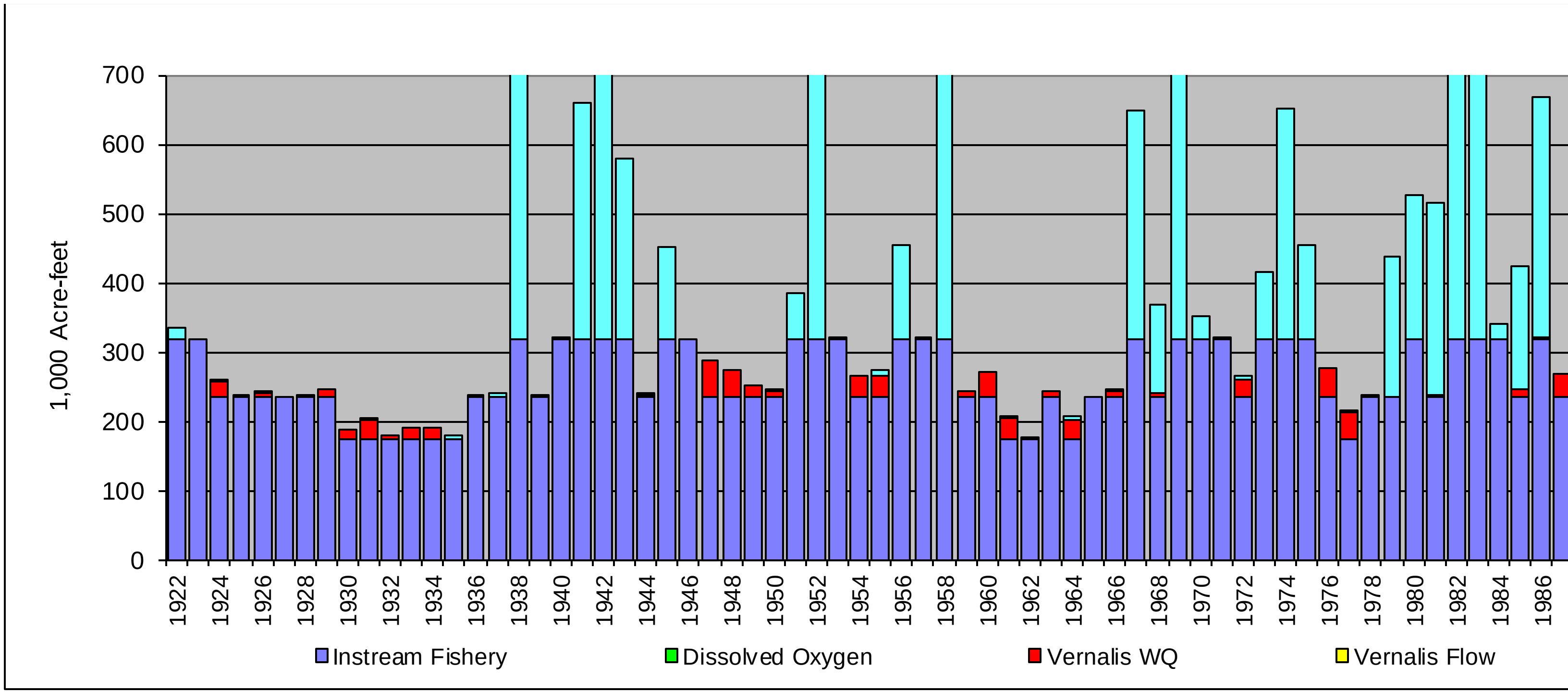


Goodwin Dam Annual Releases to Stanislaus River

1997 IOP – Adapted to Current SJR

Current River – RPA

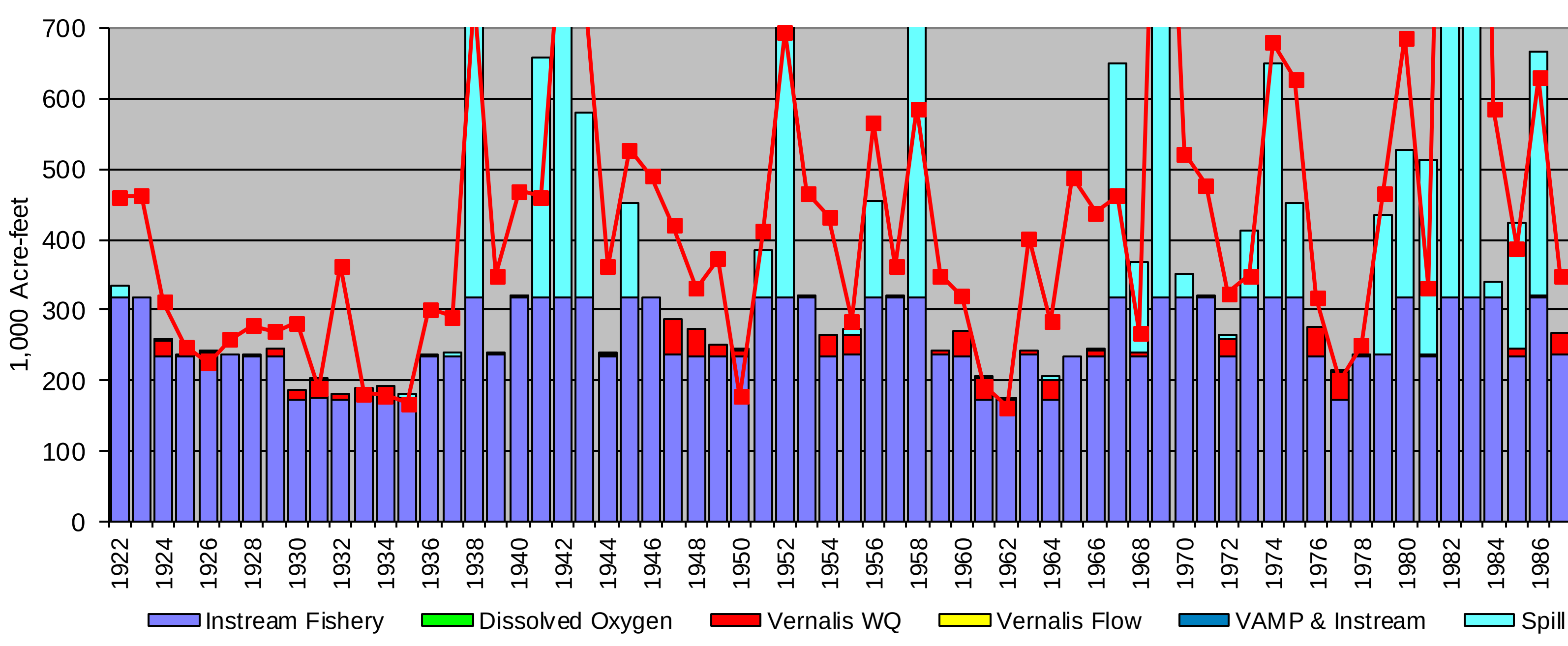
September 2012 District Proposal



1997 IOP – Adapted to Current SJR (Bars) v Current River RPA (Red Line)

1997 IOP – Adapted to Current SJR (Bars) v September 2012 District Proposal (Red Line)

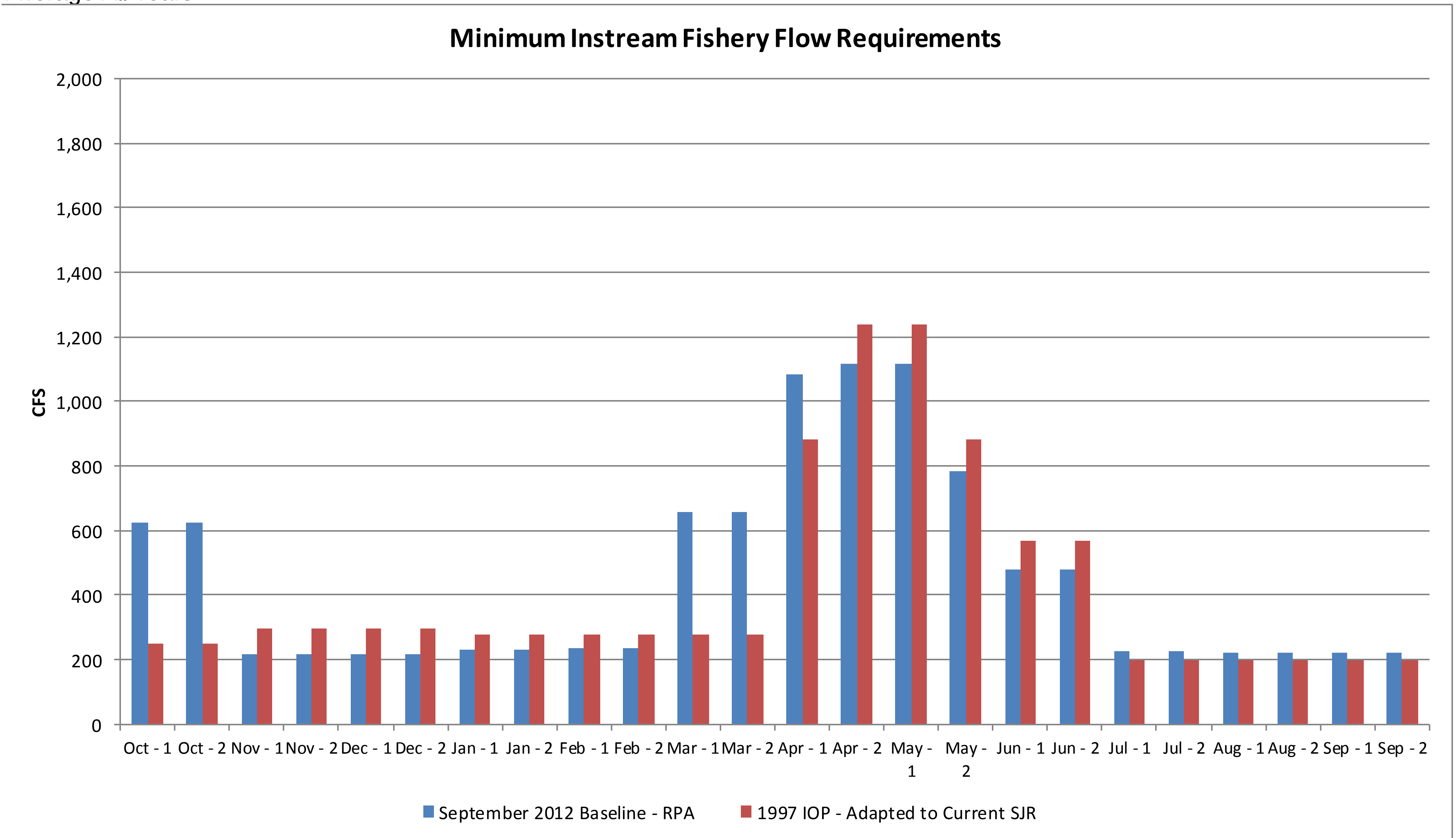
September 2012 District Proposal (Bars) v Current River RPA (Red Line)

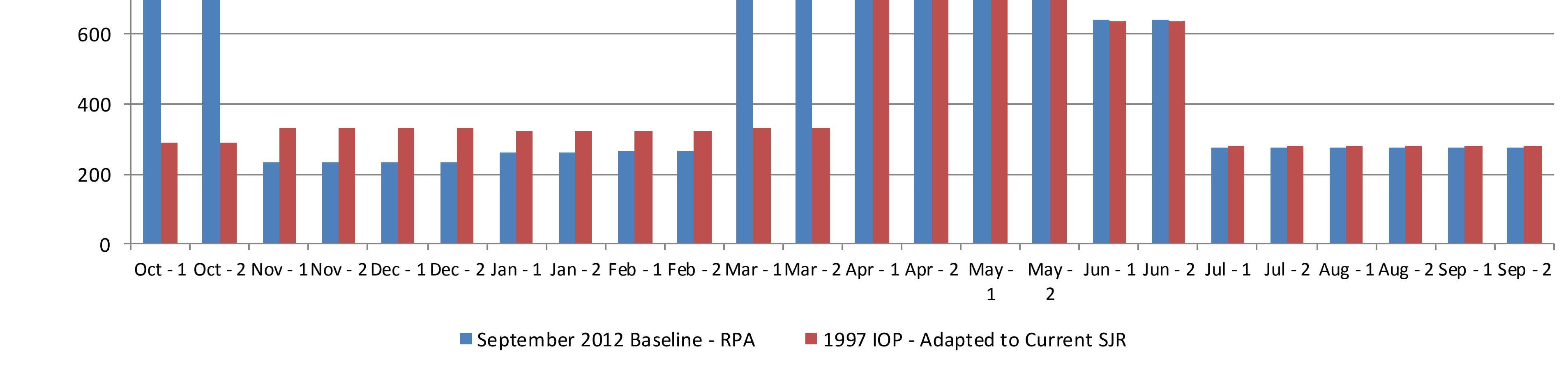


Difference (September 2012 Baseline - RPA minus 1997 IOP - Adapted to Current SJR)
Minimum Instream Fishery Requirement
Average Period CFS

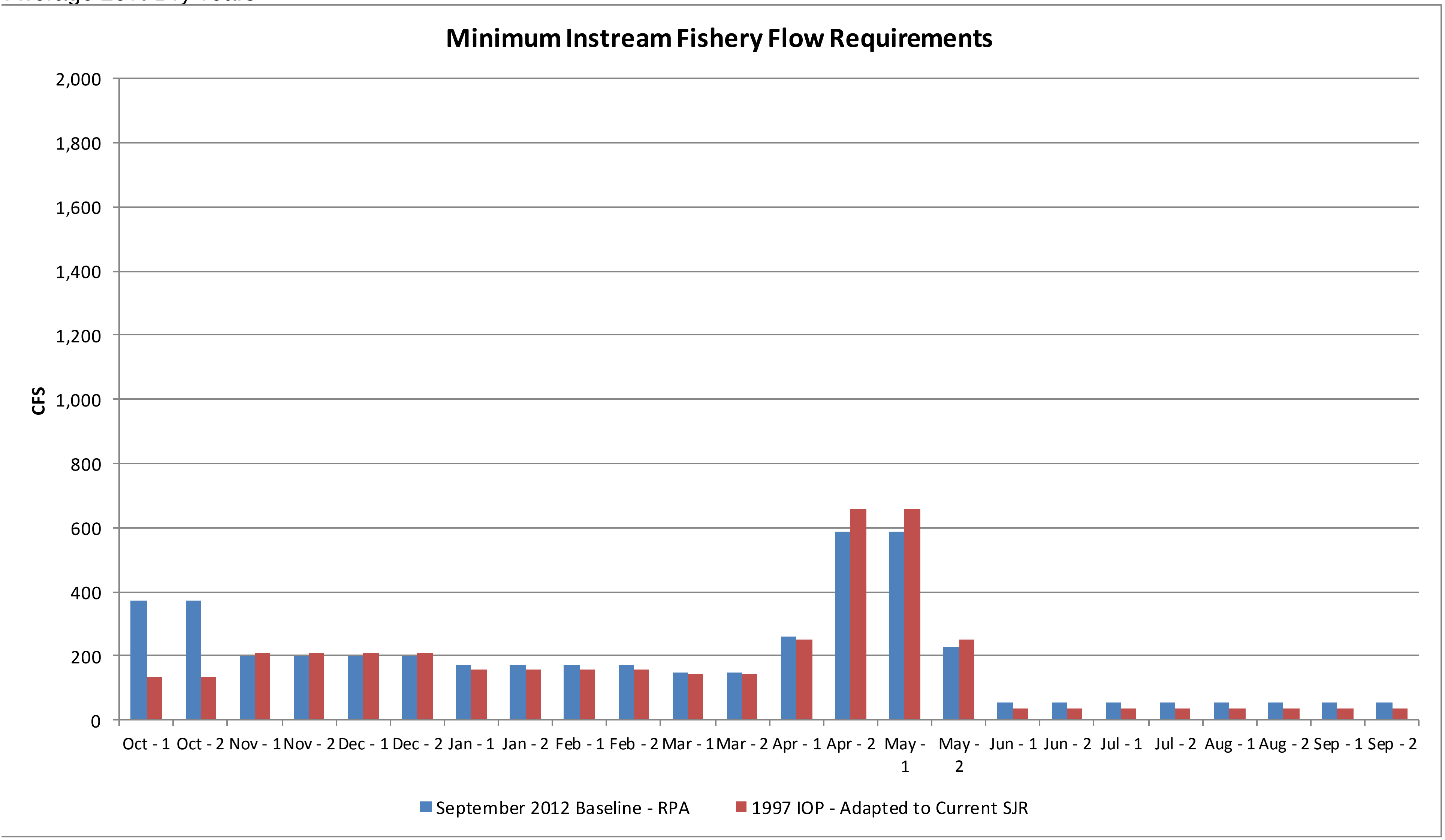
Year Type	Oct - 1	Oct - 2	Nov - 1	Nov - 2	Dec - 1	Dec - 2	Jan - 1	Jan - 2	Feb - 1	Feb - 2	Mar - 1	Mar - 2
25% W Ave	449	449	-122	-122	-122	-122	-88	-88	-84	-84	1,138	1,138
25% AN Ave	417	417	-95	-95	-95	-95	-62	-62	-58	-58	461	461
25% BN Ave	398	398	-96	-96	-96	-96	-64	-64	-61	-61	-55	-55
25% D Ave	236	236	-11	-11	-11	-11	15	15	16	16	7	7
10% D Ave	163	163	11	11	11	11	29	29	30	30	7	7
All Avg	374	374	-80	-80	-80	-80	-49	-49	-46	-46	378	378

Average All Years





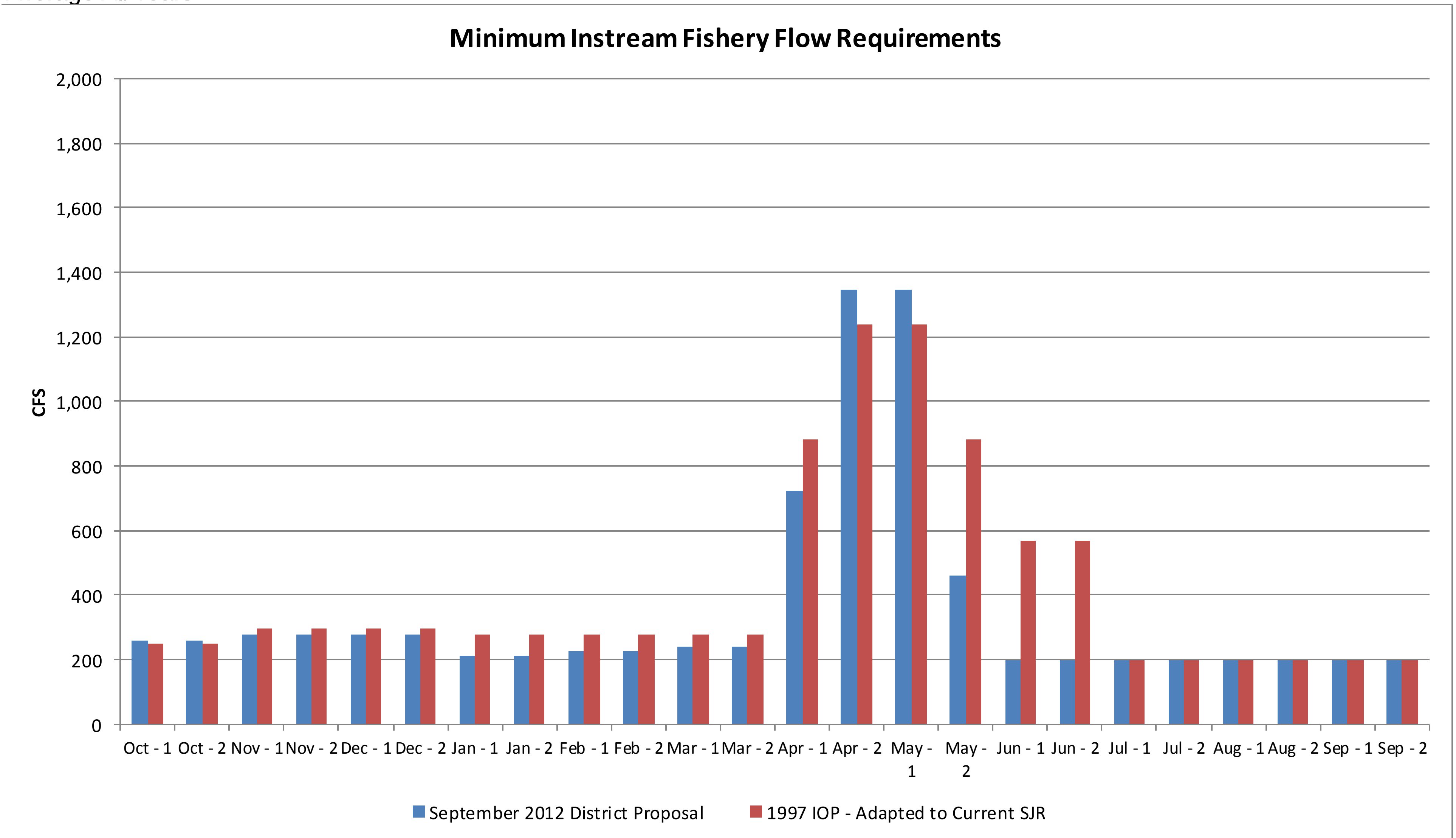
Average 25% Dry Years

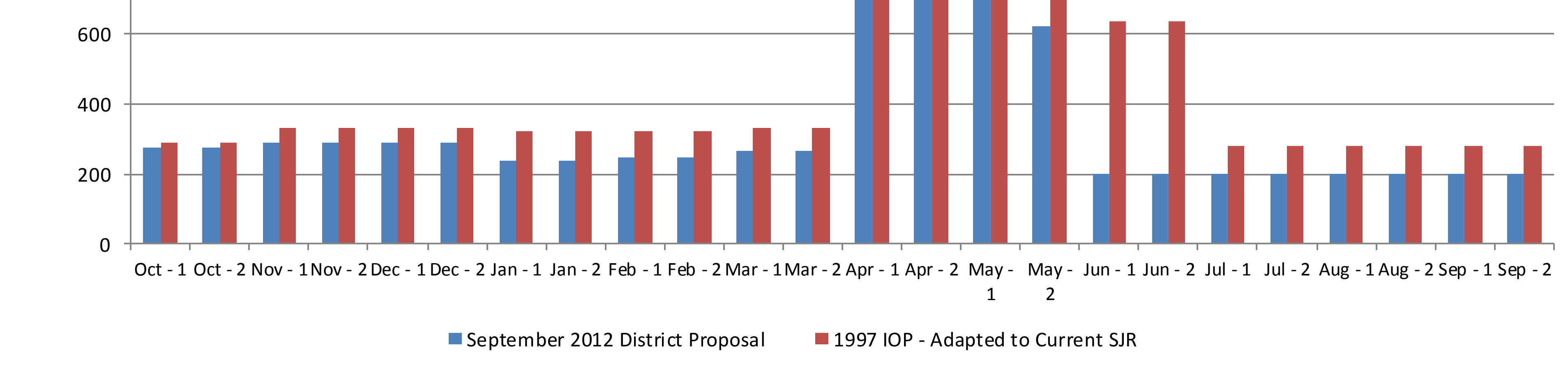


Difference (September 2012 District Proposal minus 1997 IOP - Adapted to Current SJR)
Minimum Instream Fishery Requirement
Average Period CFS

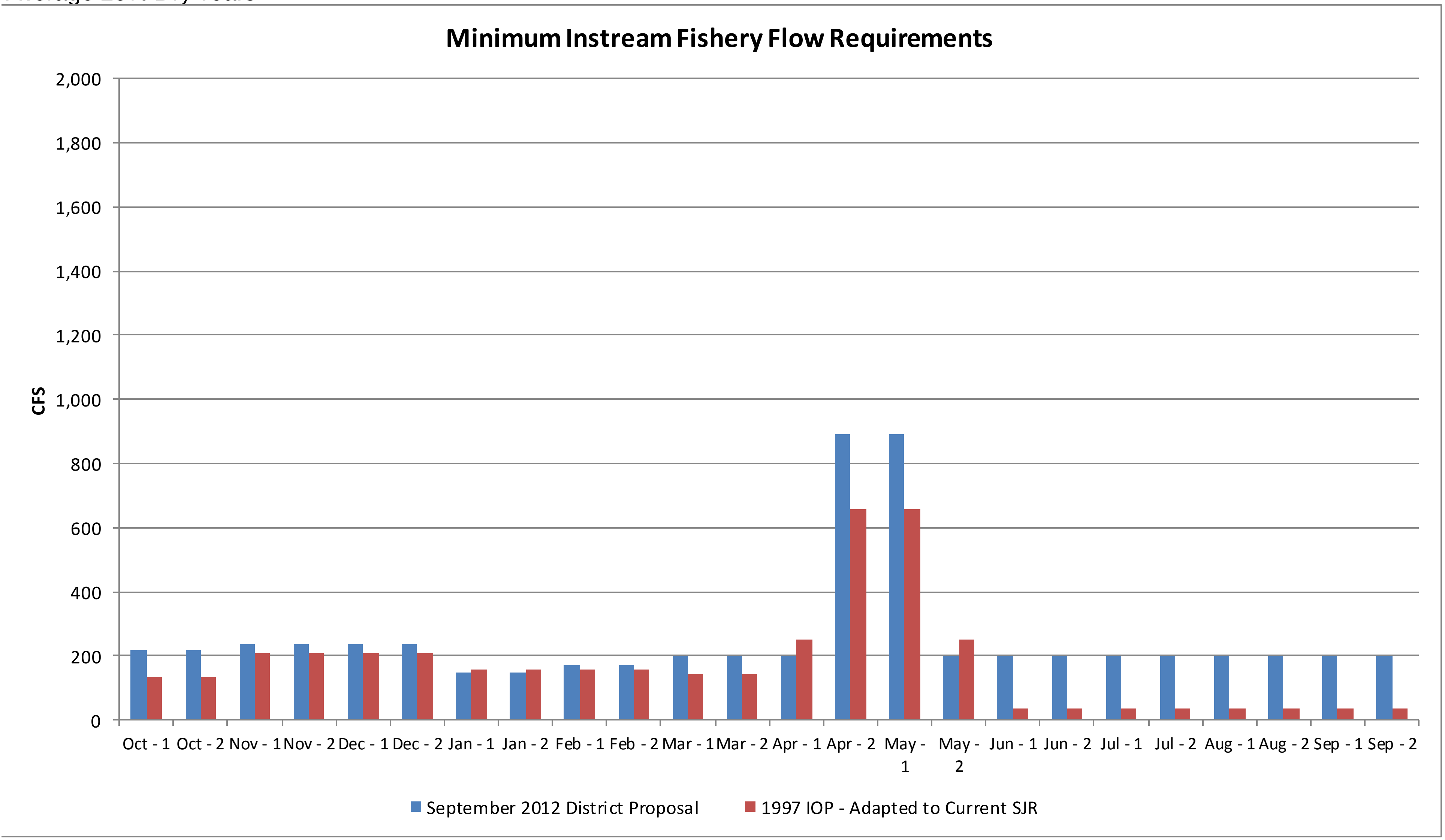
Year Type	Oct - 1	Oct - 2	Nov - 1	Nov - 2	Dec - 1	Dec - 2	Jan - 1	Jan - 2	Feb - 1	Feb - 2	Mar - 1	Mar - 2
25% W Ave	-28	-28	-42	-42	-42	-42	-93	-93	-85	-85	-93	-93
25% AN Ave	-14	-14	-40	-40	-40	-40	-84	-84	-75	-75	-68	-68
25% BN Ave	-6	-6	-24	-24	-24	-24	-97	-97	-82	-82	-55	-55
25% D Ave	85	85	28	28	28	28	-8	-8	15	15	58	58
10% D Ave	97	97	22	22	22	22	25	25	48	48	82	82
All Avg	10	10	-19	-19	-19	-19	-70	-70	-56	-56	-39	-39

Average All Years





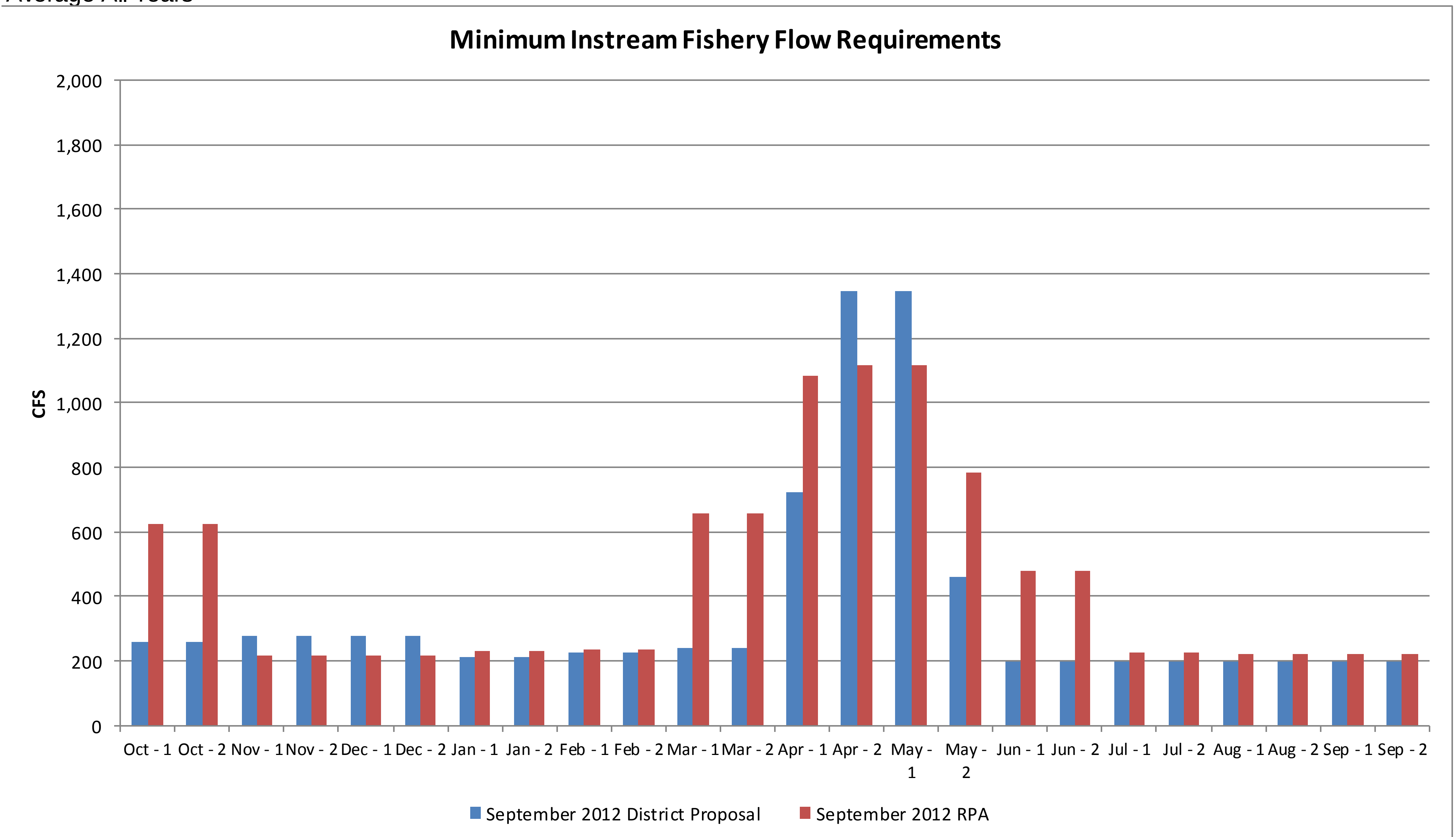
Average 25% Dry Years

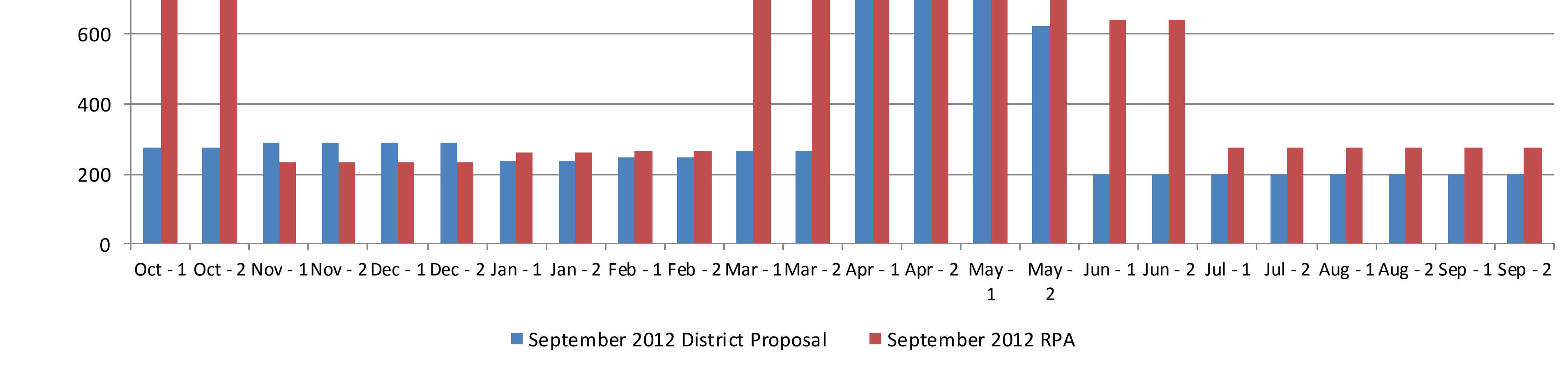


Difference (September 2012 District Proposal minus September 2012 RPA)
Minimum Instream Fishery Requirement
Average Period CFS

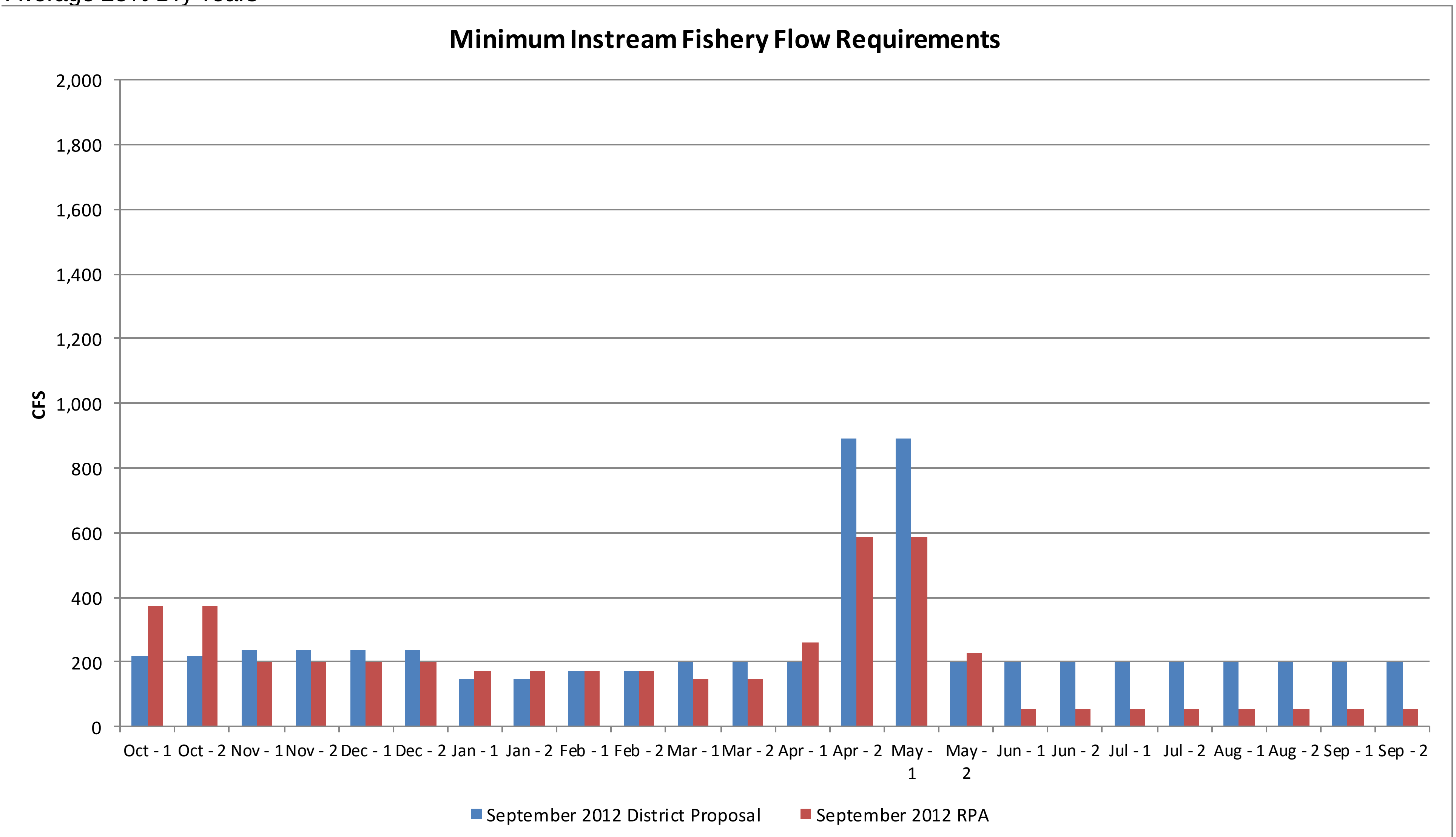
Year Type	Oct - 1	Oct - 2	Nov - 1	Nov - 2	Dec - 1	Dec - 2	Jan - 1	Jan - 2	Feb - 1	Feb - 2	Mar - 1	Mar - 2
25% W Ave	-477	-477	80	80	80	80	-5	-5	-1	-1	-1,231	-1,231
25% AN Ave	-431	-431	55	55	55	55	-22	-22	-16	-16	-529	-529
25% BN Ave	-404	-404	72	72	72	72	-32	-32	-21	-21	0	0
25% D Ave	-151	-151	39	39	39	39	-23	-23	-1	-1	50	50
10% D Ave	-66	-66	12	12	12	12	-5	-5	18	18	76	76
All Avg	-364	-364	61	61	61	61	-21	-21	-10	-10	-417	-417

Average All Years





Average 25% Dry Years



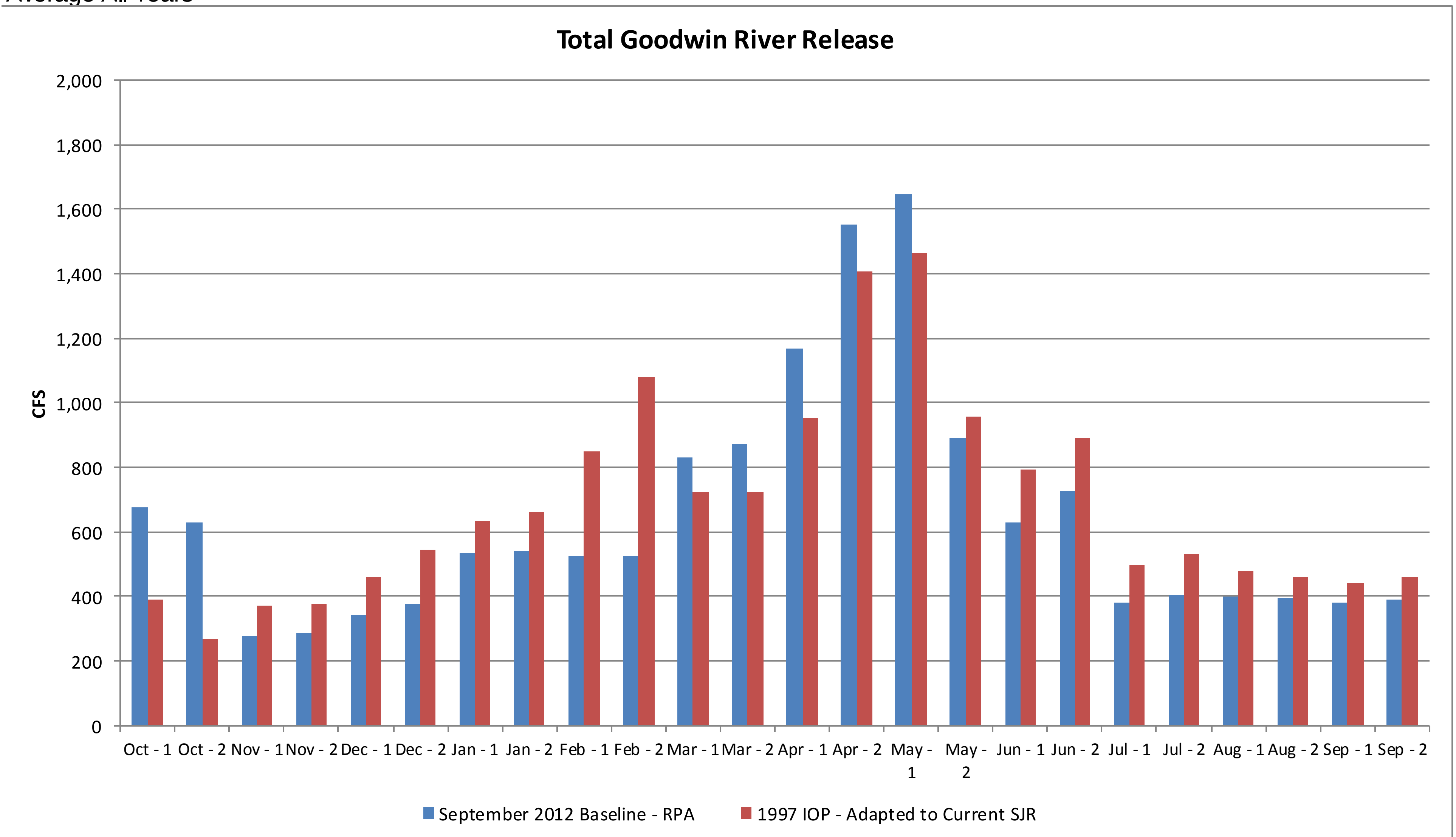
Difference (September 2012 Baseline - RPA minus 1997 IOP - Adapted to Current SJR)
Minimum Instream Fishery Requirement
Average Period CFS

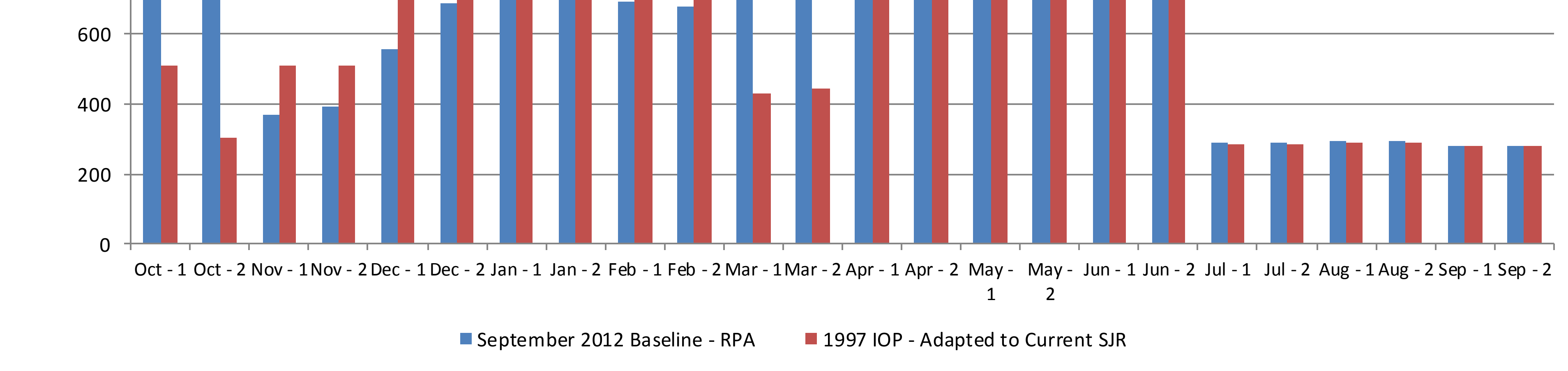
Total Goodwin River Release

1997 IOP – Adapted to Current

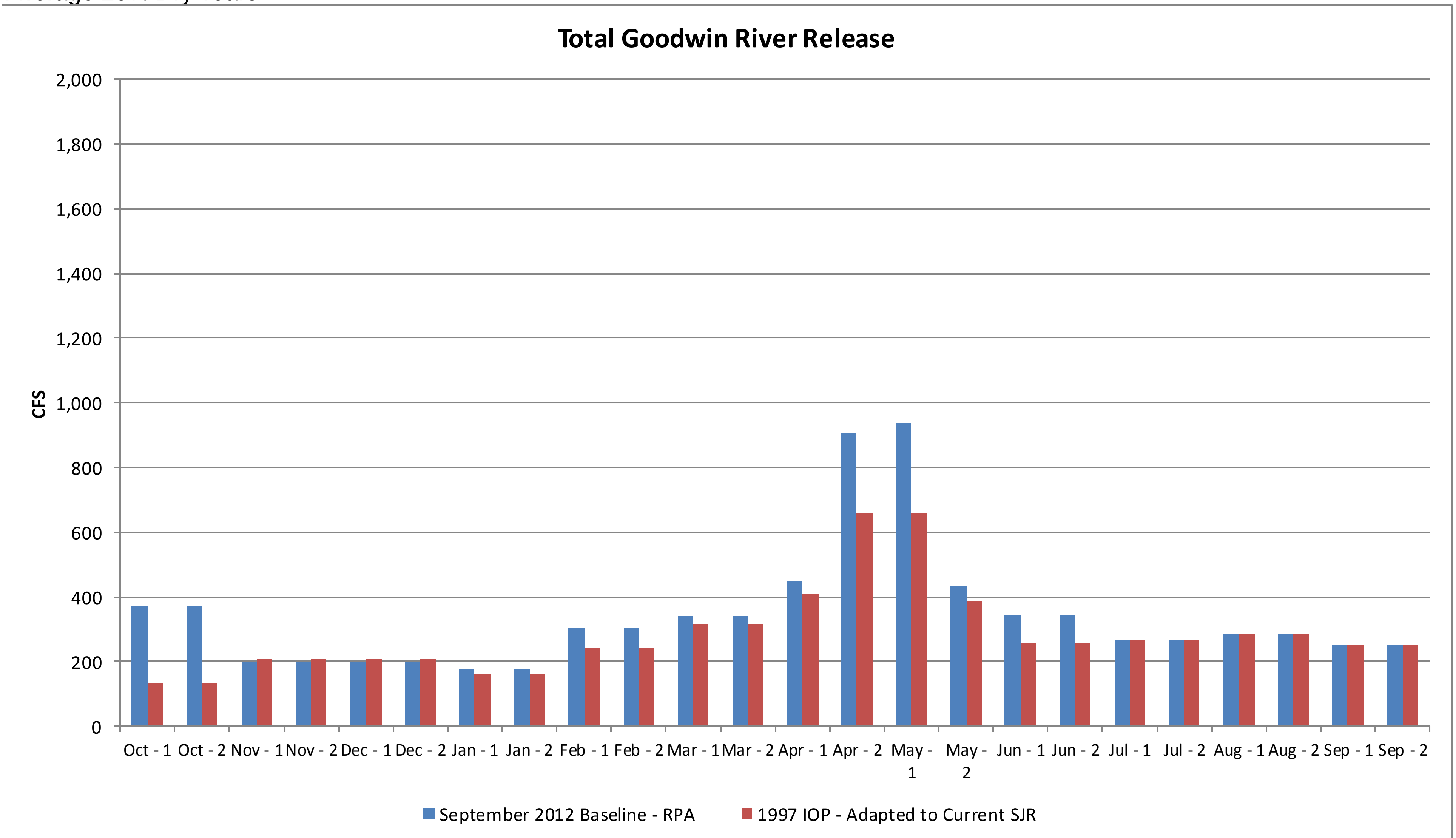
Year Type	Oct - 1	Oct - 2	Nov - 1	Nov - 2	Dec - 1	Dec - 2	Jan - 1	Jan - 2	Feb - 1	Feb - 2	Mar - 1	Mar - 2
25% W Ave	305	411	-124	-124	-158	-179	-193	-298	-1,128	-1,993	-9	191
25% AN Ave	259	403	-140	-119	-211	-398	-154	-156	-194	-292	418	401
25% BN Ave	346	398	-96	-96	-96	-96	-64	-64	-54	-61	-10	-11
25% D Ave	236	236	-11	-11	-11	-11	16	16	58	60	24	24
10% D Ave	163	163	11	11	11	11	31	31	49	49	3	3
All Avg	287	361	-92	-87	-117	-168	-97	-123	-322	-558	103	148

Average All Years





Average 25% Dry Years



Difference (September 2012 District Proposal minus 1997 IOP - Adapted to Current SJR)
Minimum Instream Fishery Requirement
Average Period CFS

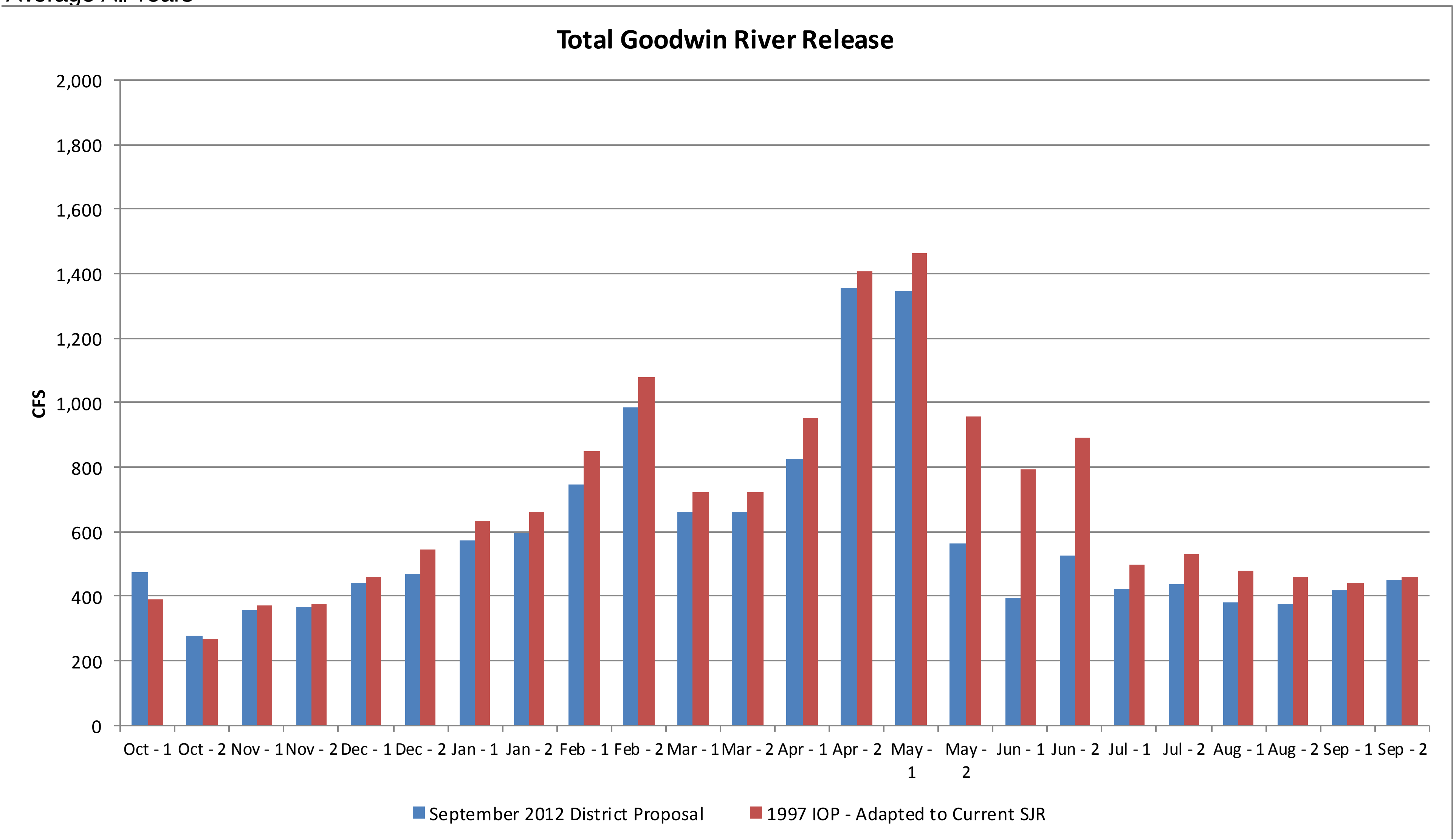
Work Product – Subject to Revision

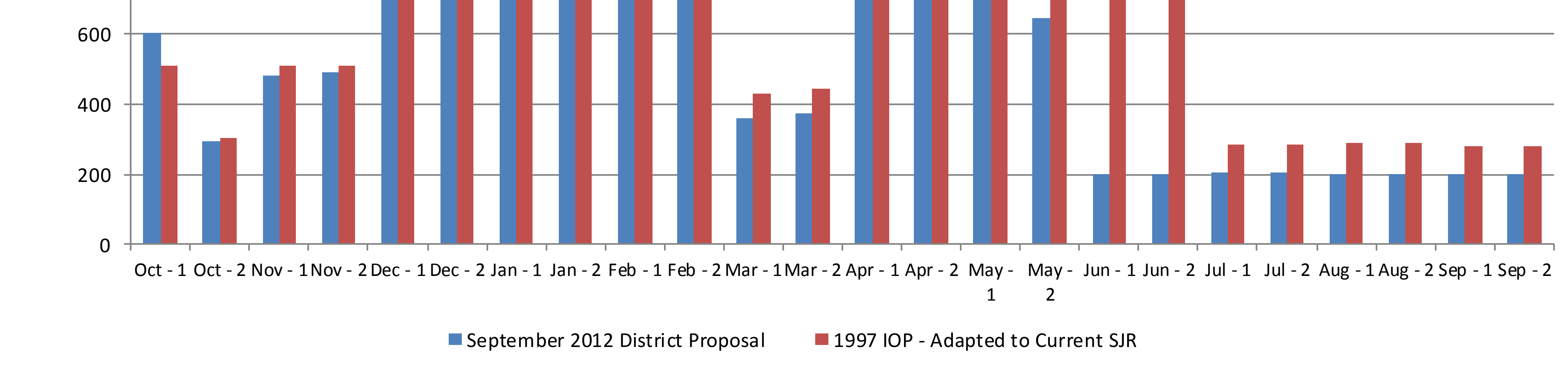
DBS – September 30, 2012

Year Type	Oct - 1	Oct - 2	Nov - 1	Nov - 2	Dec - 1	Dec - 2	Jan - 1	Jan - 2	Feb - 1	Feb - 2	Mar - 1	Mar - 2
25% W Ave	26	-23	-29	-22	-56	-18	-43	-120	-405	-295	-156	-146
25% AN Ave	93	-9	-28	-20	-26	-313	-142	-125	-35	-110	-67	-70
25% BN Ave	128	-4	-17	-17	-10	1	-50	-18	-12	-30	-52	-53
25% D Ave	85	85	28	28	28	28	-9	-9	38	40	15	14
10% D Ave	97	97	22	22	22	22	22	22	60	60	20	19
All Avg	84	13	-11	-7	-15	-74	-60	-66	-101	-96	-64	-63

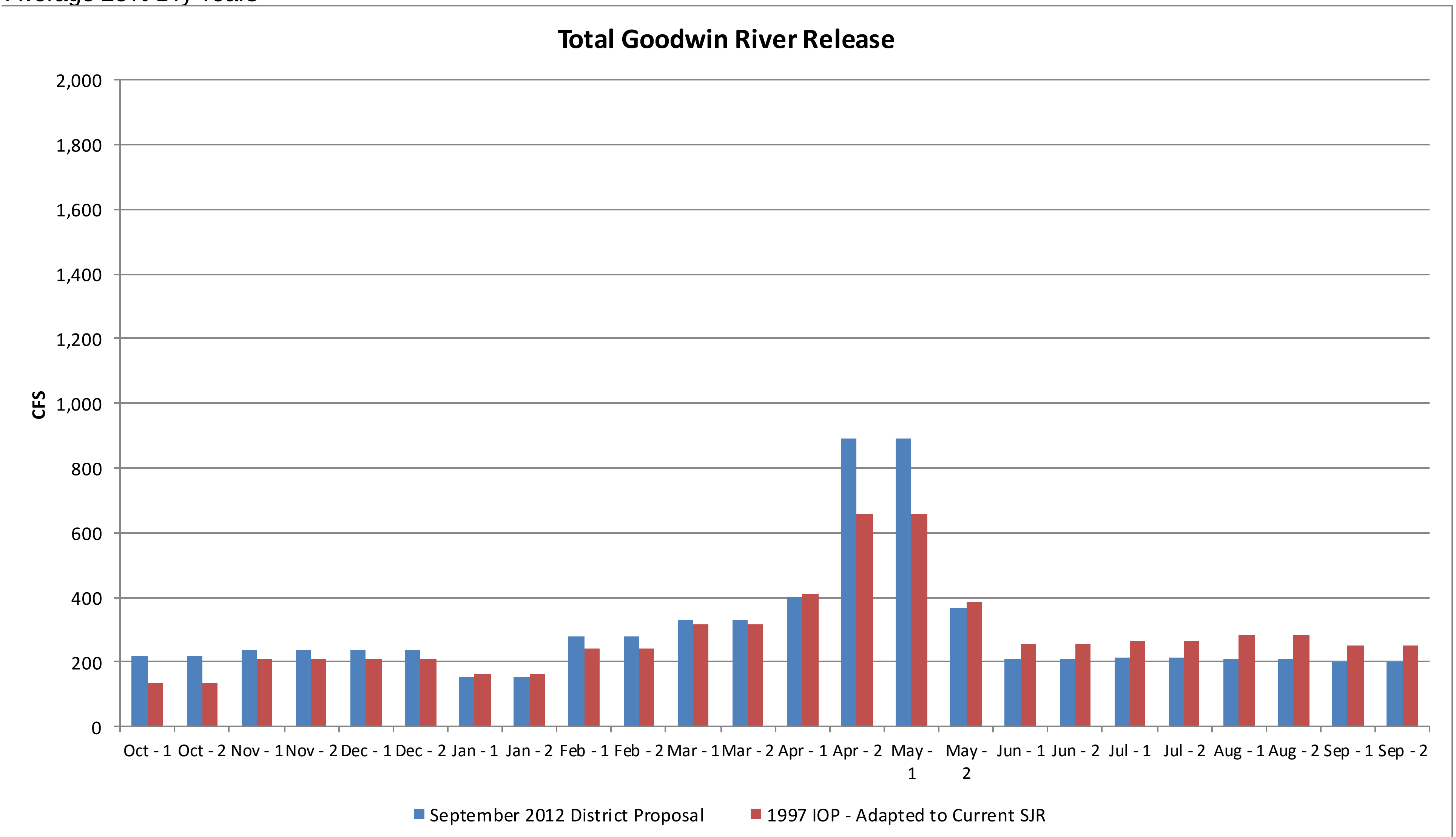
1997 IOP – Adap

Average All Years





Average 25% Dry Years



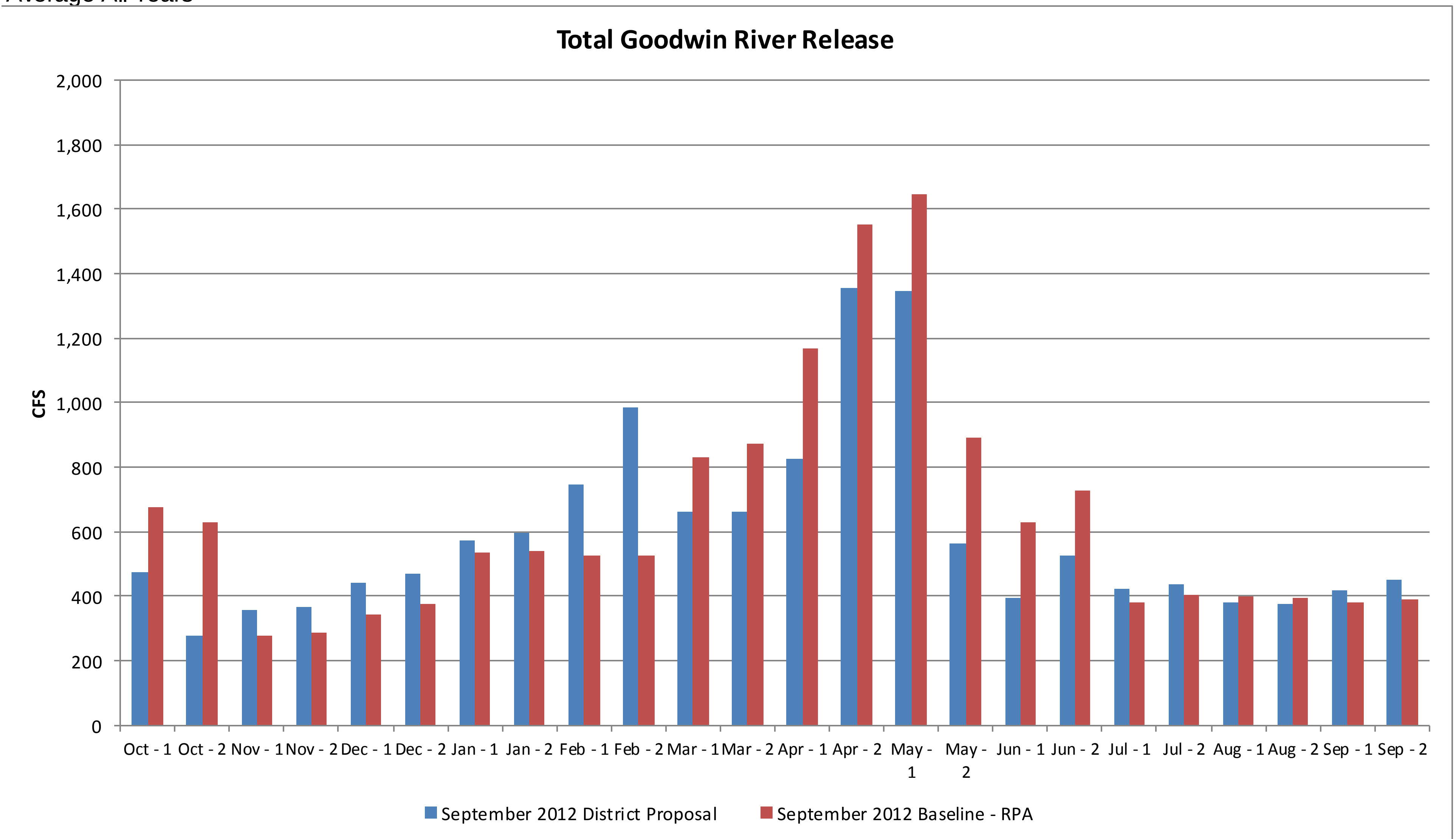
Difference (September 2012 District Proposal minus September 2012 Baseline - RPA)
Minimum Instream Fishery Requirement
Average Period CFS

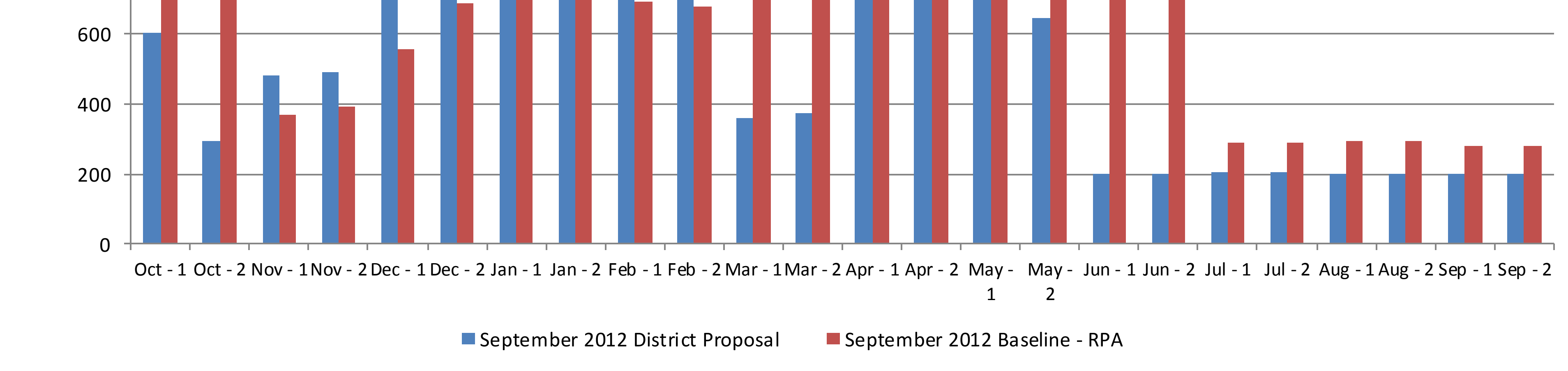
Work Product – Subject to Revision   DBS – September 30, 2012

Year Type	Oct - 1	Oct - 2	Nov - 1	Nov - 2	Dec - 1	Dec - 2	Jan - 1	Jan - 2	Feb - 1	Feb - 2	Mar - 1	Mar - 2
25% W Ave	-279	-434	94	102	101	160	150	179	723	1,698	-147	-337
25% AN Ave	-166	-412	112	99	185	85	12	32	159	182	-485	-471
25% BN Ave	-218	-402	79	79	86	96	14	46	42	31	-43	-42
25% D Ave	-151	-151	39	39	39	39	-25	-25	-20	-20	-9	-10
10% D Ave	-66	-66	12	12	12	12	-9	-9	10	10	17	15
All Avg	-203	-348	80	79	102	94	37	57	221	461	-167	-210

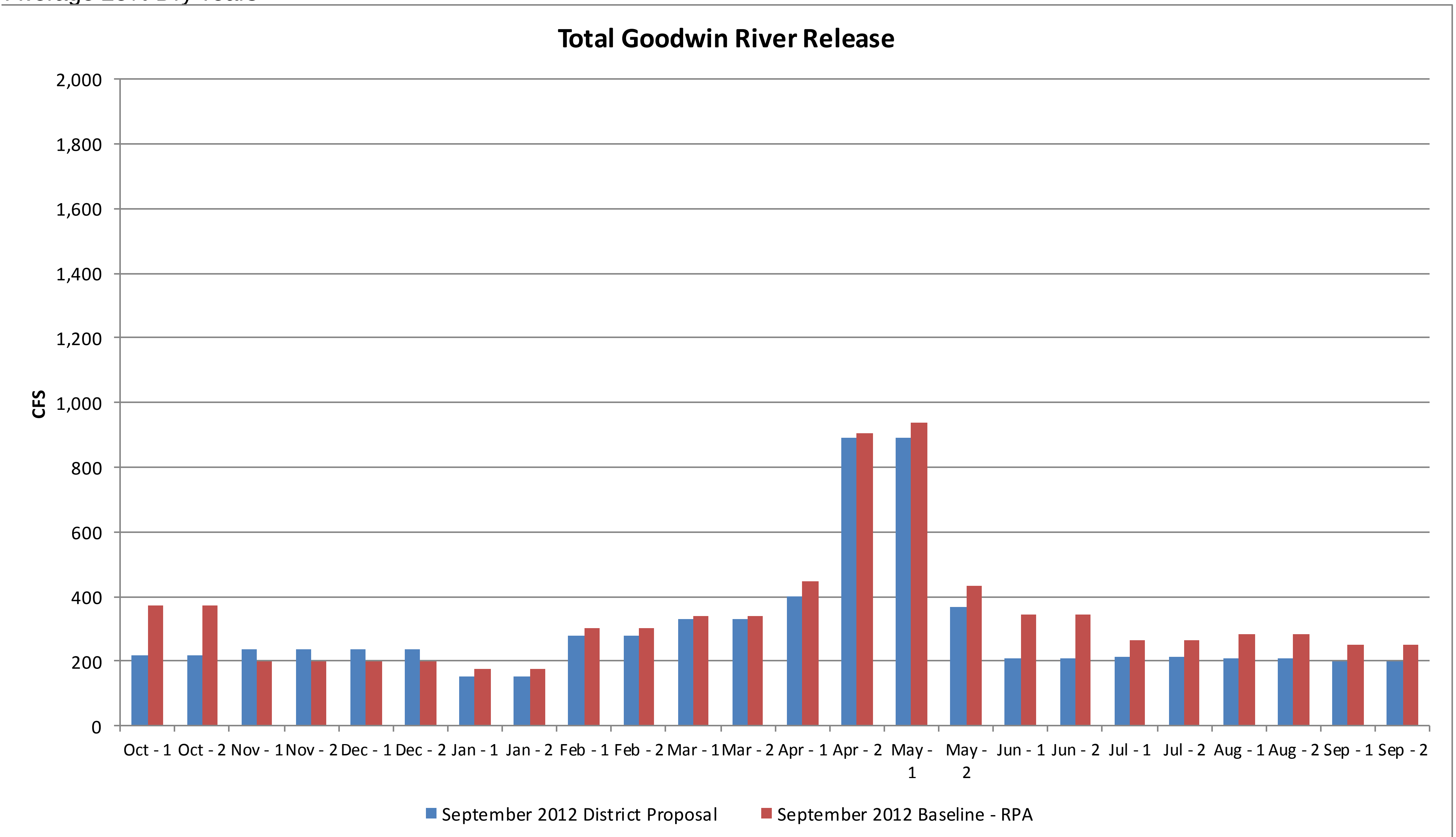
Se...posal v Current River RPA

Average All Years





Average 25% Dry Years



1943	1538	1930	0	484	10	80	468	0	0	51	713	194	3090
1944	649	1584	0	547	8	39	301	5	0	0	307	0	2397
1945	1228	1776	0	474	10	80	399	0	0	60	492	32	2722
1946	1175	1858	0	481	10	80	418	0	0	26	444	0	2801
1947	634	1460	0	600	7	33	274	11	22	0	308	0	2334
1948	853	1463	0	489	4	18	209	27	30	0	267	0	2186
1949	732	1328	0	583	1	6	155	39	18	0	211	0	2065
1950	1027	1494	0	549	5	25	239	18	4	0	674	413	2254
1951	1656	1733	0	505	10	80	394	0	0	30	486	63	2697
1952	1844	2000	0	496	10	80	467	0	0	0	1063	596	3430
1953	965	1763	0	546	10	80	393	0	0	0	393	0	2695
1954	882	1596	0	590	9	45	329	2	4	0	335	0	2462
1955	656	1395	0	516	2	12	180	25	35	0	322	82	2121
1956	1825	2000	0	527	10	80	467	0	0	95	631	70	3082
1957	878	1729	0	557	10	80	382	0	0	0	382	0	2649
1958	1599	2000	0	419	10	80	467	0	0	0	896	429	3200
1959	624	1560	0	556	7	37	292	8	0	0	299	0	2374
1960	574	1247	0	583	0	0	126	30	61	0	217	0	2001
1961	446	929	0	497	0	0	109	23	66	0	199	2	1623
1962	863	1050	0	540	0	0	113	44	15	0	172	0	1715
1963	1227	1526	0	481	4	19	214	26	4	0	244	0	2198
1964	632	1281	0	578	1	6	154	29	40	0	228	5	2062
1965	1666	1867	0	500	10	80	445	0	0	102	547	0	2910
1966	733	1582	0	552	9	43	319	2	0	0	322	0	2439
1967	1831	2000	0	486	10	80	468	0	0	0	939	471	3297
1968	670	1600	0	534	8	40	308	4	0	0	487	175	2413
1969	2118	2000	0	502	10	80	467	0	0	0	1465	999	3474
1970	1321	1695	0	528	10	80	399	0	0	67	496	30	2720
1971	1066	1716	0	528	10	80	377	0	1	13	391	0	2627
1972	764	1460	0	600	7	32	270	12	7	0	291	2	2325
1973	1237	1751	0	490	10	80	374	0	0	0	488	113	2618
1974	1500	1951	0	439	10	80	467	0	0	97	719	155	3045
1975	1210	1805	0	492	10	80	450	0	0	152	656	54	2927
1976	467	1381	0	511	2	10	173	26	48	0	247	0	2105
1977	271	982	0	381	0	0	105	23	72	0	203	3	1540
1978	1311	1574	0	454	5	22	227	21	0	0	249	1	2228
1979	1139	1630	0	529	10	80	375	0	0	100	722	247	2619
1980	1721	1920	0	481	10	80	467	0	0	104	607	36	3005
1981	634	1573	0	540	7	35	286	9	0	0	614	320	2361
1982	2229	2000	0	429	10	80	467	0	0	0	1880	1413	3419
1983	2900	2000	0	413	10	80	468	0	0	0	2320	1853	3965
1984	1621	1783	0	549	10	80	410	0	0	0	431	21	2765
1985	744	1577	0	510	8	39	302	4	1	0	514	206	2400
1986	1869	1932	0	475	10	80	467	0	0	0	777	310	3149
1987	497	1480	0	531	5	24	237	16	25	0	278	0	2248
1988	390	1099	0	460	0	0	115	23	76	0	214	0	1759
1989	648	950	0	548	0	0	110	36	70	0	216	0	1648
1990	491	658	0	527	0	0	95	32	68	0	195	0	1354
1991	502	437	0	526	0	0	75	29	53	0	159	1	1068
1992	459	198	0	506	0	0	58	63	41	0	166	4	830
1993	1275	827	0	477	0	0	100	63	33	0	197	1	1428
1994	501	546	0	529	0	0	88	47	62	0	201	4	1244
1995	2160	1869	0	452	10	80	383	0	0	0	589	206	2653
1996	1512	1968	0	517	10	80	467	0	0	0	1623	1157	3024
1997	1902	1653	0	556	10	80	406	0	0	97	559	56	2749
1998	1876	2000	0	444	10	80	467	0	0	0	1322	856	3374
1999	1326	1866	0	508	10	80	433	0	0	12	544	99	2860
2000	1062	1802	0	488	10	80	394	0	0	21	441	26	2702
2001	588	1549	0	469	6	28	253	12	19	0	284	0	2286
2002	710	1369	0	548	3	13	185	21	53	0	259	0	2132
2003	896	1405	0	530									2155

All units in 1,000 acre-feet unless otherwise noted. Vernalis WQ Release from Goodwin (1) DO Release from Goodwin

1943	1538	1835	0	484	75	80	588	0	0	50	757	120	3090
1944	649	1338	0	547	75	80	347	3	0	12	362	0	2289
1945	1228	1380	0	474	75	80	462	0	0	67	528	0	2455
1946	1175	1388	0	481	75	80	462	0	0	29	491	0	2441
1947	634	891	0	600	10	49	235	15	38	134	421	0	1872
1948	853	821	0	489	10	49	185	27	39	80	331	0	1607
1949	732	506	0	583	10	49	185	25	19	144	373	0	1400
1950	1027	733	0	549	10	0	98	51	22	0	178	6	1397
1951	1656	1386	0	505	75	80	347	3	0	60	414	3	2371
1952	1844	2000	0	496	75	80	587	0	0	0	697	110	3125
1953	965	1630	0	546	75	80	462	0	5	0	467	0	2695
1954	882	1294	0	590	75	80	347	3	12	72	433	0	2325
1955	656	1028	0	516	10	49	235	13	20	10	285	8	1791
1956	1825	1621	0	527	75	80	462	0	3	101	565	0	2759
1957	878	1369	0	557	75	80	347	3	8	4	362	0	2329
1958	1599	1844	0	419	75	80	587	0	0	0	587	0	2843
1959	624	1319	0	556	75	80	347	3	0	0	350	0	2267
1960	574	874	0	583	10	49	234	15	23	48	321	0	1737
1961	446	516	0	497	10	0	98	24	69	0	193	2	1206
1962	863	647	0	540	10	0	98	46	18	0	163	1	1305
1963	1227	982	0	481	10	49	235	15	4	148	402	0	1799
1964	632	647	0	578	10	49	185	22	33	38	284	5	1483
1965	1666	1188	0	500	75	80	347	3	0	140	490	0	2243
1966	733	863	0	552	10	49	234	14	2	189	439	0	1777
1967	1831	1564	0	486	75	80	462	0	0	0	462	0	2528
1968	670	1308	0	534	10	49	234	15	1	11	269	8	2070
1969	2118	2000	0	502	75	80	587	0	0	0	1273	686	3337
1970	1321	1601	0	528	75	80	462	0	0	62	523	0	2720
1971	1066	1484	0	528	75	80	462	0	7	9	478	0	2536
1972	764	1184	0	600	10	49	234	15	15	58	325	3	2087
1973	1237	1430	0	490	75	80	347	3	0	0	350	0	2329
1974	1500	1662	0	439	75	80	587	0	0	94	681	0	2839
1975	1210	1531	0	492	75	80	462	0	0	167	629	0	2699
1976	467	1048	0	511	10	49	234	14	29	40	317	0	1845
1977	271	615	0	381	10	0	98	22	77	0	200	3	1171
1978	1311	1211	0	454	10	49	234	15	0	0	250	1	1863
1979	1139	1197	0	529	75	80	347	3	0	113	466	3	2231
1980	1721	1606	0	481	75	80	587	0	0	101	688	0	2818
1981	634	1211	0	540	10	49	234	15	0	79	333	5	2034
1982	2229	2000	0	429	75	80	587	0	0	0	1761	1175	3362
1983	2900	2000	0	413	75	80	588	0	0	0	2256	1668	3965
1984	1621	1589	0	549	75	80	587	0	0	0	587	0	2765
1985	744	1204	0	510	75	80	347	2	1	33	388	5	2182
1986	1869	1835	0	475	75	80	587	0	0	0	630	44	2954
1987	497	1324	0	531	10	49	235	15	20	80	350	0	2139
1988	390	773	0	460	10	49	185	15	64	74	338	0	1551
1989	648	570	0	548	10	0	98	37	74	0	210	0	1265
1990	491	282	0	527	10	0	98	26	94	0	218	0	978
1991	502	150	116	526	10	0	99	23	57	0	180	1	673
1992	459	150	275	506	10	0	98	24	71	0	197	4	536
1993	1275	766	0	477	10	0	98	64	33	0	196	1	1381
1994	501	474	0	529	10	0	98	19	88	0	209	4	1183
1995	2160	1655	0	452	75	80	462	0	0	0	462	0	2577
1996	1512	1871	0	517	75	80	587	0	0	0	1548	961	3013
1997	1902	1545	0	556	75	80	462	0	0	102	569	5	2749
1998	1876	2000	0	444	75	80	587	0	0	0	1185	598	3295
1999	1326	1706	0	508	75	80	588	0	0	9	597	0	2860
2000	1062	1580	0	488	75	80	462	0	0	24	488	3	2587
2001	588	1292	0	469	10	49	234	12	18	64	328	0	2062
2002	710	874	0	548	10	49	234	11	35	203	483	0	1846
2003	896	712	0	530									1612

All units in 1,000 acre-feet unless otherwise noted. Vernalis WQ Release from Goodwin (1) DO Release from Goodwin

1943	1538	2000	0	484	75	80	318	0	0	0	580	261	3090
1944	649	1606	0	547	75	80	235	0	1	0	238	1	2464
1945	1228	1865	0	474	75	80	318	0	0	0	452	134	2748
1946	1175	1902	0	481	75	80	318	0	0	0	318	0	2801
1947	634	1431	0	600	75	80	236	0	51	0	287	0	2395
1948	853	1312	0	489	75	80	235	0	39	0	275	0	2152
1949	732	1006	0	583	75	80	235	0	15	0	251	0	1893
1950	1027	1056	0	549	75	80	235	0	7	0	243	0	1901
1951	1656	1747	0	505	75	80	318	0	0	0	385	67	2661
1952	1844	2000	0	496	75	80	318	0	0	0	998	680	3430
1953	965	1761	0	546	75	80	318	0	2	0	319	0	2695
1954	882	1569	0	590	75	80	235	0	30	0	266	0	2470
1955	656	1235	0	516	75	80	236	0	29	0	273	8	2098
1956	1825	2000	0	527	75	80	318	0	0	0	454	137	2979
1957	878	1717	0	557	75	80	318	0	2	0	320	0	2649
1958	1599	2000	0	419	75	80	318	0	0	0	828	510	3197
1959	624	1502	0	556	75	80	236	0	7	0	243	0	2374
1960	574	1025	0	583	75	80	235	0	35	0	271	0	1947
1961	446	668	0	497	10	0	174	0	31	0	207	2	1365
1962	863	746	0	540	10	49	174	0	0	0	174	0	1449
1963	1227	1104	0	481	75	80	236	0	7	0	243	0	1877
1964	632	829	0	578	10	49	174	0	26	0	206	5	1620
1965	1666	1617	0	500	75	80	235	0	0	0	235	0	2453
1966	733	1347	0	552	75	80	235	0	7	0	243	1	2232
1967	1831	2000	0	486	75	80	318	0	0	0	650	332	3071
1968	670	1559	0	534	75	80	235	0	5	0	368	128	2413
1969	2118	2000	0	502	75	80	318	0	0	0	1413	1096	3474
1970	1321	1761	0	528	75	80	318	0	0	0	350	33	2720
1971	1066	1782	0	528	75	80	318	0	3	0	321	0	2706
1972	764	1453	0	600	75	80	235	0	25	0	265	5	2407
1973	1237	1725	0	490	75	80	318	0	0	0	414	96	2603
1974	1500	2000	0	439	75	80	318	0	0	0	652	334	3045
1975	1210	1993	0	492	75	80	318	0	0	0	453	135	2927
1976	467	1372	0	511	75	80	235	0	41	0	276	0	2240
1977	271	896	0	381	10	49	174	0	38	0	214	2	1502
1978	1311	1373	0	454	75	80	235	0	0	0	236	1	2128
1979	1139	1562	0	529	75	80	236	0	0	0	436	201	2402
1980	1721	2000	0	481	75	80	318	0	0	0	526	209	3005
1981	634	1535	0	540	75	80	235	0	1	0	515	278	2381
1982	2229	2000	0	429	75	80	318	0	0	0	1823	1505	3419
1983	2900	2000	0	413	75	80	318	0	0	0	2255	1937	3965
1984	1621	1792	0	549	75	80	318	0	0	0	341	24	2765
1985	744	1548	0	510	75	80	235	0	11	0	424	178	2423
1986	1869	1991	0	475	75	80	318	0	2	0	667	347	3149
1987	497	1430	0	531	75	80	236	0	33	0	269	0	2297
1988	390	991	0	460	10	49	174	0	55	0	229	0	1692
1989	648	771	0	548	10	49	174	0	43	0	217	0	1508
1990	491	456	0	527	10	0	174	0	53	0	227	0	1159
1991	502	187	0	526	10	0	174	0	22	0	197	0	838
1992	459	150	257	506	10	0	174	0	33	0	211	4	563
1993	1275	757	0	477	10	0	174	0	32	0	206	0	1381
1994	501	452	0	529	10	0	174	0	50	0	228	4	1169
1995	2160	1752	0	452	75	80	318	0	0	0	418	100	2550
1996	1512	2000	0	517	75	80	318	0	0	0	1558	1240	3024
1997	1902	1755	0	556	75	80	318	0	0	0	489	171	2749
1998	1876	2000	0	444	75	80	318	0	0	0	1260	942	3374
1999	1326	1903	0	508	75	80	318	0	0	0	478	160	2860
2000	1062	1820	0	488	75	80	318	0	0	0	346	29	2702
2001	588	1486	0	469	75	80	235	0	30	0	266	0	2316
2002	710	1162	0	548	75	80	235	0	49	0	284	0	2060
2003	896	1047	0	530									1921

All units in 1,000 acre-feet unless otherwise noted.

Vernalis WQ Release from Goodwin (1) #N/A

1.C.2.3 Attachments to Comments of South Delta Water Agency

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Compliance Standards

for the Sacramento - San Joaquin Delta and Suisun Marsh
Tuesday, April 30, 2013

Criteria	Standard	Status
Flow/Operational		
% of inflow diverted	35 %	23 %
Vernalis Base Flow : Monthly average *	>= 1,140 or 710 cfs	2,193 cfs
7 Day average *	>=912 or 568 cfs	3,789 cfs
Habitat Protection, X2 / Flow	19 days at Chipps Island	21 days
	30 days at Collinsville	30 days
Water Quality		
Days @ CCWD PP#1 w/ chlorides <= 150 mg/l	165 days	120 days
Export Areas for SWP, CVP, CCWD, et al	<= 250 mg/l Cl	36 mg/l
14dm EC at Emmaton	<= 0.45 mS/cm	0.56 mS/cm
14dm EC at Jersey Point	<= 0.45 mS/cm	0.29 mS/cm
Maximum 30 day running average of mean daily EC at:		
Vernalis	<=1.0 mS/cm	0.6 mS/cm
Brandt Bridge	<= 1.0 mS/cm	0.7 mS/cm
Old River Near Tracy	<=1.0 mS/cm	0.9 mS/cm
Old River Near Middle River	<=1.0 mS/cm	0.6 mS/cm

SUISUN MARSH:

Suisun Marsh Salinity Control Gates : 3 Open / 0 Closed / 0 Full Tide Open
Flashboard Status : In
Boat Lock Status : Open

California Hydrologic Conditions: (California Cooperative Snow Surveys Forecast, April 1, 2013)

Previous Month's Index (8RI for Mar.): 1.713 MAF
Water Year Type: Dry
Sacramento valley water year type index (40/30/30) @ 50%:6.0 MAF (Dry)
San Joaquin valley water year type index (60/20/20) @ 75%: 1.8 MAF (Critical)

Electrical Conductivity (EC) in milliSiemens per Centimeter.
Chlorides (Cl) in milligrams per liter
mht - mean high tides
md - mean daily
14 dm - fourteen day running mean
28 dm - twenty-eight day running mean
NR - No Record
NC - Average not computed due to insufficient data.
BR : Below Rating
e - estimated value

Montezuma Slough Gate Operation:
Number of gates operating at either Open, Closed, or Full Tide Open
Flashboard Status : In, Out, or Modified In
Boat Lock Status : Open or Closed

Coordinated Operation Agreement Delta Status:
c = excess Delta conditions
b = balanced Delta cond. w/ no storage withdrawal
s = balanced Delta cond. w/ storage withdrawal
Excess Delta conditions with restrictions:
f = fish concerns
r = E/I ratio concerns

* NDOI, Rio Vista & Vernalis Flows:
- Monthly average is progressive daily mean.
- 7 day average is progressive daily mean for the first six days of the month.

Delta Water Quality Conditions

Date	Antioch Tides		Net Delta Ouflow Index	Martinez	Port Chicago		Mallard	Chipps Island		Collinsville	
	High	Half	cfs	mdEC	mdEC	14dm	mdEC	mdEC	14dm	mdEC	14dm
04/01/2013	6.10	3.98	15,753	20.40	10.76	10.71	5.58	5.04	3.81	2.51	1.50
04/02/2013	5.89	3.95	18,249	19.07	12.11	11.05	4.96	4.43	4.00	2.09	1.60
04/03/2013	5.68	3.94	19,557	17.99	10.63	11.27	4.13	3.61	4.12	1.55	1.67
04/04/2013	5.66	4.03	20,780	18.47	10.05	11.40	3.74	3.24	4.17	1.22	1.71
04/05/2013	5.47	3.85	21,744	17.08	8.69	11.37	3.04	2.57	4.17	0.89	1.70
04/06/2013	5.36	3.78	19,484	16.65	8.40	11.25	2.61	2.18	4.10	0.68	1.69
04/07/2013	5.33	3.85	17,737	16.82	8.42	11.09	2.49	2.07	4.00	0.50	1.64
04/08/2013	6.02	4.02	17,513	15.14	7.68	10.80	2.38	1.97	3.83	0.63	1.57
04/09/2013	5.43	3.58	18,388	13.97	5.75	10.37	1.44	1.13	3.60	0.53	1.48
04/10/2013	5.54	3.68	16,350	13.62	6.35	9.96	1.66	1.32	3.36	0.39	1.38
04/11/2013	5.87	3.92	15,537	14.70	6.97	9.60	1.88	1.51	3.18	0.41	1.30
04/12/2013	5.93	4.06	15,110	14.94	7.18	9.26	1.77	1.41	2.97	0.46	1.21
04/13/2013	6.00	4.13	13,928	15.54	7.48	8.84	1.91	1.54	2.69	0.47	1.06
04/14/2013	5.87	4.21	13,201	15.01	7.03	8.39	1.90	1.53	2.40	0.48	0.91
04/15/2013	6.05	4.36	13,006	16.10	7.53	8.16	2.00	1.62	2.15	0.58	0.78
04/16/2013	5.30	3.81	11,996	12.75	5.11	7.66	1.18	0.91	1.90	0.40	0.66
04/17/2013	4.62	3.44	11,692	10.87	3.83	7.18	0.91	0.68	1.69	0.35	0.57
04/18/2013	4.51	3.45	10,332	14.05	6.29	6.91	1.32	1.03	1.53	0.33	0.51
04/19/2013	4.84	3.53	9,139	16.43	8.65	6.90	2.74	2.30	1.51	0.55	0.48
04/20/2013	4.93	3.50	8,211	18.80	11.88	7.15	4.52	3.99	1.64	1.65	0.55
04/21/2013	5.12	3.57	7,471	21.29	13.71	7.53	6.22	5.68	1.90	2.35	0.68
04/22/2013	5.33	3.66	7,059	22.73	15.38	8.08	6.75	6.22	2.20	3.03	0.85
04/23/2013	5.73	3.88	6,849	24.39	15.82	8.80	7.88	7.37	2.65	4.18	1.12
04/24/2013	6.07	4.19	6,605	25.78	18.18	9.65	9.84	9.43	3.23	5.31	1.47
04/25/2013	6.47	4.25	7,038	26.40	18.77	10.49	10.63	10.27	3.86	6.13	1.88
04/26/2013	6.32	4.08	7,896	25.52	17.32	11.21	9.19	8.74	4.38	5.33	2.22
04/27/2013	6.31	4.02	9,030	24.92	16.30	11.84	8.76	8.29	4.86	4.95	2.54
04/28/2013	6.36	4.08	10,396	24.58	15.35	12.44	8.30	7.81	5.31	4.66	2.84
04/29/2013	6.40	4.24	10,578	24.44	14.82	12.96	8.21	7.72	5.75	4.38	3.11
04/30/2013	6.24	4.15	10,798	23.98	13.59	13.56	7.92	7.42	6.21	4.37	3.40

Antioch Tides measured in feet above mean sea level.
Net Delta Ouflow Index calculated from equation as specified in D-1641, revised June 1995.
Chipps Island EC calculated from measurements recorded at Mallard Slough.
Electrical Conductivity (EC) units: milliSiemens per Centimeter
md : mean daily
14dm : fourteen day running mean
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e - estimated value

Delta Water Quality Conditions

Date	Antioch		Jersey Point		Emmaton		Cache Slough	Good Year Slough	Sunrise Club	Volanti Slough	Beldon Landing	Collinsville
	mdEC	14mdEC	mdEC	14mdEC	mdEC	14mdEC	mdEC	mhtEC	mhtEC	mhtEC	mhtEC	mhtEC
04/01/2013	1.20	0.79	0.38	0.32	0.33	0.25	0.63	9.74	8.00	7.90	7.75	3.11
04/02/2013	1.01	0.82	0.36	0.33	0.29	0.26	0.53	9.77	7.51	7.61	7.52	2.60
04/03/2013	0.84	0.84	0.33	0.33	0.27	0.26	0.52	9.61	7.35	7.46	7.60	2.15
04/04/2013	0.77	0.86	0.32	0.33	0.26	0.26	0.57	9.47	7.28	7.48	7.69	1.53
04/05/2013	0.66	0.87	0.30	0.33	0.22	0.27	0.65	9.37	6.87	7.44	7.30	1.30
04/06/2013	0.58	0.88	0.29	0.33	0.21	0.27	0.63	9.27	6.78	7.23	7.32	1.08
04/07/2013	0.55	0.87	0.28	0.33	0.21	0.27	0.62	9.06	6.94	7.19	7.26	0.63
04/08/2013	0.54	0.86	0.29	0.32	0.22	0.27	0.61	8.94	6.75	7.06	7.37	1.11
04/09/2013	0.44	0.83	0.26	0.32	0.19	0.26	0.55	9.05	6.48	6.78	6.94	0.58
04/10/2013	0.42	0.80	0.26	0.32	0.19	0.26	0.55	8.39	6.17	6.56	7.11	0.53
04/11/2013	0.44	0.77	0.26	0.31	0.20	0.25	0.54	7.59	5.89	6.56	6.86	0.48
04/12/2013	0.43	0.74	0.26	0.31	0.20	0.25	0.53	6.84	5.87	6.37	6.58	0.53
04/13/2013	0.41	0.68	0.25	0.30	0.20	0.24	0.50	6.51	6.19	6.08	6.29	0.56
04/14/2013	0.40	0.62	0.25	0.29	0.21	0.23	0.45	6.60	6.01	6.06	6.22	0.67
04/15/2013	0.44	0.57	0.26	0.28	0.22	0.22	0.43	6.39	5.85	5.98	6.20	0.72
04/16/2013	0.38	0.52	0.24	0.27	0.19	0.21	0.39	6.58	5.80	6.01	6.10	0.45
04/17/2013	0.33	0.48	0.24	0.27	0.18	0.21	0.38	6.63	5.74	6.00	6.08	0.42
04/18/2013	0.32	0.45	0.23	0.26	0.18	0.20	0.37	6.20	5.51	5.95	5.98	0.37
04/19/2013	0.33	0.43	0.23	0.26	0.19	0.20	0.39	6.00	5.23	5.71	5.70	1.21
04/20/2013	0.39	0.42	0.23	0.25	0.20	0.20	0.39	5.83	5.06	5.62	5.55	2.04
04/21/2013	0.61	0.42	0.24	0.25	0.22	0.20	0.40	5.92	5.40	6.19	5.60	3.56
04/22/2013	0.87	0.44	0.24	0.25	0.25	0.20	0.42	6.13	5.97	6.77	5.93	4.39
04/23/2013	1.16	0.49	0.25	0.25	0.29	0.21	0.42	6.94	7.31	8.39	7.40	5.37
04/24/2013	1.93	0.60	0.30	0.25	0.71	0.25	0.42	8.71	8.59	10.03	9.00	6.92
04/25/2013	2.36	0.74	0.36	0.26	1.28	0.32	0.43	9.73	8.79	10.32	9.24	7.42
04/26/2013	1.91	0.85	0.33	0.26	1.06	0.39	0.43	10.74	9.36	10.77	9.23	6.54
04/27/2013	1.87	0.95	0.34	0.27	1.00	0.44	0.42	11.60	9.71	11.16	9.59	5.86
04/28/2013	1.93	1.06	0.35	0.27	0.89	0.49	0.43	11.74	9.83	10.73	10.02	5.61
04/29/2013	2.04	1.17	0.36	0.28	0.75	0.53	0.45	11.84	10.00	11.33	10.34	5.73
04/30/2013	1.90	1.28	0.37	0.29	0.64	0.56	0.46	11.91	9.92	11.63	10.50	5.40

Electrical Conductivity (EC) units: milliSiemens per Centimeter
Chloride (Cl) units: milligrams per liter
mht : mean high tides
md : mean daily
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e : estimated value

Delta Water Quality Conditions

Date	Bethel Island mdEC	Farrar Park mdEC	Holland Tract mdEC	Bacon Island mdEC	Contra Costa mdEC	Clifton Court mdEC	Tracy Pumping Plant mdEC	Antioch mdCl	Bacon Island mdCl	Contra Costa mdCl	Delta Status
04/01/2013	0.29	0.33	0.28	0.27	0.29	0.42	0.49	313	33	30	r
04/02/2013	0.29	0.33	0.28	0.28	0.29	0.66	0.50	251	34	30	r
04/03/2013	0.30	0.33	0.28	0.28	0.29	0.72	0.48	199	35	29	b
04/04/2013	0.29	0.33	0.28	0.29	0.29	0.69	0.48	174	36	30	b
04/05/2013	0.30	0.34	0.28	0.29	0.29	0.72	0.48	140	37	30	b
04/06/2013	0.29	0.34	0.28	0.29	0.29	0.76	0.48	114	38	31	b
04/07/2013	0.29	0.34	0.28	0.30	0.29	0.77	0.48	105	39	31	b
04/08/2013	0.29	0.33	0.28	0.29	0.28	0.72	0.46	103	38	31	b
04/09/2013	0.28	0.32	0.27	0.29	0.28	0.75	0.48	69	38	31	b
04/10/2013	0.27	0.32	0.27	0.30	0.28	0.79	0.48	63	39	31	b
04/11/2013	0.27	0.31	0.27	0.29	0.28	0.70	0.48	70	38	31	b
04/12/2013	0.27	0.31	0.27	0.29	0.26	0.69	0.47	66	38	31	b
04/13/2013	0.26	0.31	0.27	0.29	0.27	0.69	0.47	61	37	34	b
04/14/2013	0.27	0.30	0.26	0.28	0.30	0.71	0.47	57	36	34	b
04/15/2013	0.27	0.28	0.26	0.28	0.31	0.57	0.76	69	35	36	b
04/16/2013	0.27	0.29	0.26	0.29	0.31	0.68	0.86	51	36	37	b
04/17/2013	0.26	0.29	0.26	0.28	0.33	0.68	0.88	36	35	35	f
04/18/2013	0.25	0.28	0.25	0.28	0.34	0.68	0.86	31	35	37	f
04/19/2013	0.25	0.28	0.26	0.28	0.34	0.61	0.81	34	34	38	f
04/20/2013	0.25	0.29	0.26	0.27	0.34	0.57	0.75	54	33	37	f
04/21/2013	0.25	0.29	0.25	0.27	0.32	0.51	0.68	124	32	38	f
04/22/2013	0.24	0.29	0.25	0.27	0.33	0.46	0.60	206	32	37	f
04/23/2013	0.24	0.29	0.25	0.27	0.33	0.43	0.50	298	31	37	f
04/24/2013	0.25	0.28	0.25	0.27	0.32	0.40	0.49	545	31	37	f
04/25/2013	0.26	0.27	0.25	0.26	0.32	0.38	0.42	683	31	36	f
04/26/2013	0.26	0.29	0.26	0.27	0.31	0.35	0.43	537	32	36	b
04/27/2013	0.25	0.29	0.26	0.28	0.32	0.32	0.40	524	34	36 e	b
04/28/2013	0.26	0.29	0.26	0.28	0.32	0.32	0.35	544	35	36 e	b
04/29/2013	0.26	0.30	0.26	0.28	0.29	0.31	0.32	581	35	36	b
04/30/2013	0.26	0.30	0.26	0.28	0.31	0.34	0.33	535	34	36	b

Electrical Conductivity (EC) units: milliSiemens per Centimeter
Chloride (Cl) units: milligrams per liter
md : mean daily
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e : estimated value
Antioch and Bacon Island mdCl are calculated from the respective mdEC values.

Coordinated Operation Agreement Delta Status:
c = excess Delta conditions
b = balanced Delta cond. w/ no storage withdrawal
s = balanced Delta cond. w/ storage withdrawal
Excess Delta conditions with restrictions:
f = fish concerns
r = E/I ratio concerns

Delta Water Quality Conditions

South Delta Stations

Date	Vernalis		Brandt Bridge		Old River Near Tracy		Old River Near Middle River	
	md EC	30 day avg	md EC	30 day avg	md EC	30 day avg	md EC	30 day avg
04/01/2013	0.81	0.85	0.93	0.83	1.21	0.98	0.94	0.80
04/02/2013	0.78	0.85	0.94	0.84	1.21	0.99	0.89	0.80
04/03/2013	0.79	0.85	0.89	0.84	1.14	1.01	0.81	0.81
04/04/2013	0.85	0.86	0.84	0.85	1.11	1.02	0.82	0.81
04/05/2013	0.82	0.86	0.83	0.85	1.09	1.02	0.88	0.82
04/06/2013	0.83	0.87	0.87	0.86	1.05	1.03	0.89	0.82
04/07/2013	0.82	0.87	0.88	0.86	1.02	1.04	0.89	0.83
04/08/2013	0.82	0.87	0.88	0.87	1.04	1.05	0.90	0.84
04/09/2013	0.83	0.88	0.89	0.87	1.02	1.06	0.90	0.84
04/10/2013	0.83	0.88	0.90	0.88	1.06	1.06	0.93	0.85
04/11/2013	0.81	0.88	0.91	0.88	1.13	1.07	0.94	0.86
04/12/2013	0.76	0.88	0.93	0.89	1.16	1.08	0.95	0.87
04/13/2013	0.75	0.87	0.94	0.89	1.15	1.09	0.94	0.88
04/14/2013	0.73	0.87	0.94	0.90	1.16	1.09	0.88	0.89
04/15/2013	0.67	0.86	0.92	0.90	1.13	1.10	0.87	0.90
04/16/2013	0.62	0.85	0.88	0.90	1.07	1.10	0.79	0.90
04/17/2013	0.48	0.84	0.84	0.90	1.02	1.10	0.76	0.90
04/18/2013	0.43	0.83	0.76	0.90	1.02	1.11	0.63	0.90
04/19/2013	0.35	0.81	0.65	0.89	1.04	1.11	0.55	0.89
04/20/2013	0.39	0.79	0.52	0.88	0.90	1.10	0.40	0.87
04/21/2013	0.30	0.77	0.41	0.86	0.76	1.09	0.43	0.85
04/22/2013	0.30	0.75	0.42	0.84	0.64	1.08	0.33	0.84
04/23/2013	0.27	0.72	0.32	0.82	0.62	1.07	0.31	0.81
04/24/2013	0.25	0.70	0.30	0.80	0.47	1.05	0.26	0.79
04/25/2013	0.24	0.68	0.24	0.78	0.41	1.02	0.22	0.77
04/26/2013	0.24	0.65	0.22	0.76	0.34	1.00	0.21	0.74
04/27/2013	0.23	0.62	0.21	0.73	0.38	0.97	0.21	0.72
04/28/2013	0.23	0.60	0.21	0.71	0.38	0.94	0.21	0.69
04/29/2013	0.22	0.58	0.21	0.68	0.37	0.91	0.20	0.66
04/30/2013	0.22	0.56	0.20	0.66	0.35	0.88	0.20	0.64

Electrical Conductivity (EC) units: milliSiemens per Centimeter
md : mean daily
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e : estimated value

Compliance Standards

for the Sacramento - San Joaquin Delta and Suisun Marsh
Tuesday, June 04, 2013

Criteria		Standard	Status
Flow/Operational			
% of inflow diverted		35 %	14 %
Vernalis Base Flow :	Monthly average *	>= 710 cfs	900 cfs
	7 Day average *	>= 568 cfs	900 cfs
Habitat Protection, X2 / Flow			
		30 days at Collinsville	4 days
Water Quality			
Days @ CCWD PP#1 w/ chlorides <= 150 mg/l		165 days	155 days
Export Areas for SWP, CVP, CCWD, et al		<= 250 mg/l Cl	41 mg/l
14dm EC at Emmaton		<= 0.45 mS/cm	0.39 mS/cm
14dm EC at Jersey Point		<= 0.45 mS/cm	0.33 mS/cm
Maximum 30 day running average of mean daily EC at:			
Vernalis		<=0.7 mS/cm	0.4 mS/cm
Brandt Bridge		<= 0.7 mS/cm	0.4 mS/cm
Old River Near Tracy		<=0.7 mS/cm	0.6 mS/cm
Old River Near Middle River		<=0.7 mS/cm	mS/cm

SUISUN MARSH:

Suisun Marsh Salinity Control Gates : 1 Open / 0 Closed / 2 Full Tide Open
Flashboard Status : In
Boat Lock Status : Open

California Hydrologic Conditions: (California Cooperative Snow Surveys Forecast, May 1, 2013)

Previous Month's Index (8RI for April.): 2.023 MAF
Water Year Type: Dry
Sacramento valley water year type index (40/30/30) @ 50%:5.8 MAF (Dry)
San Joaquin valley water year type index (60/20/20) @ 75%: 1.6 MAF (Critical)

Electrical Conductivity (EC) in milliSiemens per Centimeter.
Chlorides (Cl) in milligrams per liter
mht - mean high tides
md - mean daily
14 dm - fourteen day running mean
28 dm - twenty-eight day running mean
NR - No Record
NC - Average not computed due to insufficient data.
BR : Below Rating
e - estimated value

Montezuma Slough Gate Operation:
Number of gates operating at either Open, Closed, or Full Tide Open
Flashboard Status : In, Out, or Modified In
Boat Lock Status : Open or Closed

Coordinated Operation Agreement Delta Status:
c = excess Delta conditions
b = balanced Delta cond. w/ no storage withdrawal
s = balanced Delta cond. w/ storage withdrawal
Excess Delta conditions with restrictions:
f = fish concerns
r = E/I ratio concerns

* NDOI, Rio Vista & Vernalis Flows:
- Monthly average is progressive daily mean.
- 7 day average is progressive daily mean for the first six days of the month.

Delta Water Quality Conditions

Date	Antioch Tides		Net Delta Outflow Index	Martinez	Port Chicago		Mallard	Chipps Island		Collinsville	
	High	Half	cfs	mdEC	mdEC	14dm	mdEC	mdEC	14dm	mdEC	14dm
05/06/2013	6.15	4.19	9,388	24.14	11.38	14.50	8.18	7.69	7.76	4.51	4.50
05/07/2013	6.06	4.10	9,350	23.80	11.10	14.17	8.04	7.54	7.77	4.44	4.52
05/08/2013	6.01	4.07	9,129	24.07	10.98	13.65	8.21	7.71	7.65	4.37	4.46
05/09/2013	6.05	4.08	9,695	23.57	9.40	12.98	7.95	7.45	7.45	4.07	4.31
05/10/2013	6.06	4.08	10,994	22.85	8.69	12.37	7.50	6.98	7.32	3.91	4.21
05/11/2013	6.04	4.03	11,743	21.76	7.75	11.76	6.63	6.09	7.17	3.39	4.10
05/12/2013	5.98	4.06	11,861	20.78	7.95	11.23	6.40	5.87	7.03	3.28	4.00
05/13/2013	5.94	4.12	11,402	21.10	7.48	10.70	6.19	5.65	6.88	3.12	3.91
05/14/2013	5.80	4.16	11,153	21.37	6.97	10.23	6.22	5.68	6.76	2.89	3.80
05/15/2013	5.72	4.15	10,114	21.13	5.60	9.82	6.14	5.60	6.72	2.74	3.71
05/16/2013	5.26	4.02	9,550	21.54	2.97	9.16	5.75	5.21	6.69	2.87	3.70
05/17/2013	5.18	3.95	8,987	21.04	2.33	8.46	5.39	4.85	6.60	1.99	3.63
05/18/2013	5.07	3.63	9,399	18.61	2.09	7.69	4.55	4.02	6.38	1.69	3.47
05/19/2013	5.27	3.48	9,727	18.03	1.99	6.91	4.14	3.62	6.00	1.52	3.20
05/20/2013	5.64	3.65	9,987	19.36	2.12	6.24	4.63	4.10	5.74	1.81	3.01
05/21/2013	5.76	3.94	9,870	23.02	2.39	5.62	6.82	6.29	5.65	2.74	2.88
05/22/2013	5.98	3.76	9,066	22.35	2.32	5.00	6.13	5.59	5.50	2.58	2.76
05/23/2013	5.96	3.77	9,551	22.31	2.36	4.50	6.24	5.70	5.37	2.49	2.64
05/24/2013	6.16	3.92	9,224	23.18	2.30	4.04	6.72	6.19	5.32	2.83	2.57
05/25/2013	6.46	4.10	9,069	24.10	2.27	3.65	7.40	6.88	5.37	3.17	2.55
05/26/2013	6.59	4.23	9,123	24.61	2.06	3.23	7.75	7.24	5.47	3.70	2.58
05/27/2013	6.52	4.13	8,997	24.24	1.75	2.82	7.48	6.97	5.57	3.35	2.60
05/28/2013	6.29	4.18	9,358	23.47	1.61	2.44	6.76	6.23	5.61	3.21	2.62
05/29/2013	6.04	4.17	9,502	23.58	1.59	2.15	6.82	6.29	5.65	3.23	2.66
05/30/2013	5.57	3.93	9,779	21.54	1.55	2.05	5.75	5.21	5.65	2.53	2.63
05/31/2013	5.38	3.71	10,488	19.57	1.48	1.99	4.64	4.11	5.60	1.95	2.63
06/01/2013	5.67	3.76	9,583	19.02	1.45	1.94	4.66	4.13	5.61	1.86	2.64
06/02/2013	6.13	4.02	9,053	20.43	1.52	1.91	5.41	4.87	5.70	2.22	2.69
06/03/2013	6.45	4.49	8,563	23.94	7.89	2.32	7.18	6.66	5.88	3.35	2.80
06/04/2013	6.55	4.57	7,386	25.19	16.19	3.31	8.01	7.52	5.97	3.96	2.89

Antioch Tides measured in feet above mean sea level.
Net Delta Ouflow Index calculated from equation as specified in D-1641, revised June 1995.
Chipps Island EC calculated from measurements recorded at Mallard Slough.
Electrical Conductivity (EC) units: milliSiemens per Centimeter
md : mean daily
14dm : fourteen day running mean
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e - estimated value

Delta Water Quality Conditions

Date	Antioch		Jersey Point		Emmaton		Cache Slough	Good Year Slough	Sunrise Club	Volanti Slough	Beldon Landing	Collinsville
	mdEC	14mdEC	mdEC	14mdEC	mdEC	14mdEC	mdEC	mhtEC	mhtEC	mhtEC	mhtEC	mhtEC
05/06/2013	1.87	1.76	0.39	0.35	0.67	0.68	0.42	11.57	9.68	10.58	8.64	5.54
05/07/2013	1.71	1.80	0.37	0.36	0.62	0.71	0.43	11.61	9.25	9.83	7.57	5.72
05/08/2013	1.66	1.78	0.36	0.36	0.63	0.70	0.45	11.64	8.67	9.42	7.11	5.77
05/09/2013	1.63	1.73	0.36	0.36	0.61	0.65	0.48	11.79	8.13	9.21	6.63	5.27
05/10/2013	1.48	1.70	0.35	0.36	0.57	0.62	0.50	11.99	7.76	8.60	6.49	5.24
05/11/2013	1.32	1.66	0.34	0.36	0.46	0.58	0.48	12.11	7.49	8.22	6.05	4.24
05/12/2013	1.32	1.61	0.34	0.36	0.41	0.54	0.45	11.82	7.10	7.63	5.50	4.49
05/13/2013	1.18	1.55	0.34	0.36	0.37	0.52	0.45	11.36	6.59	7.07	4.94	3.93
05/14/2013	1.12	1.50	0.34	0.36	0.34	0.50	0.43	11.33	6.13	6.45	4.24	4.30
05/15/2013	1.11	1.48	0.33	0.35	0.37	0.50	0.42	11.16	5.72	5.97	3.88	3.56
05/16/2013	1.03	1.46	0.32	0.35	0.32	0.50	0.40	10.60	5.18	5.67	3.68	NR
05/17/2013	0.91	1.44	0.31	0.35	0.29	0.49	NR	10.25	5.10	5.62	3.53	3.14
05/18/2013	0.74	1.38	0.30	0.35	0.25	0.48	NR	10.12	5.04	5.56	3.31	2.43
05/19/2013	0.70	1.27	0.29	0.34	0.23	0.44	NR	9.95	4.98	5.51	2.97	2.33
05/20/2013	0.73	1.19	0.29	0.33	0.21	0.41	NR	9.41	5.03	5.33	2.87	2.79
05/21/2013	0.99	1.14	0.31	0.33	0.27	0.38	NR	8.64	4.43	4.88	2.50	4.05
05/22/2013	1.05	1.09	0.32	0.32	0.27	0.35	NR	8.81	4.36	4.77	2.25	3.64
05/23/2013	1.09	1.06	0.31	0.32	0.28	0.33	NR	9.16	4.31	4.59	2.60	3.57
05/24/2013	1.21	1.04	0.33	0.32	0.33	0.31	0.28	9.18	5.54	5.28	4.32	4.16
05/25/2013	1.43	1.04	0.34	0.32	0.43	0.31	0.26	9.15	6.83	6.34	5.06	3.98
05/26/2013	1.61	1.07	0.36	0.32	0.59	0.32	0.25	9.39	7.47	6.86	6.19	4.71
05/27/2013	1.53	1.09	0.34	0.32	0.54	0.34	0.26	10.04	7.64	7.48	6.47	4.41
05/28/2013	1.37	1.11	0.33	0.32	0.45	0.35	0.25	10.26	7.57	7.88	7.16	4.44
05/29/2013	1.40	1.13	0.34	0.32	0.47	0.35	0.26	10.43	7.18	7.32	7.19	4.02
05/30/2013	1.09	1.13	0.32	0.32	0.34	0.35	0.29	10.38	6.67	7.33	6.95	3.54
05/31/2013	0.90	1.13	0.30	0.32	0.26	0.35	0.39	10.26	6.56	7.79	6.68	2.87
06/01/2013	0.86	1.14	0.30	0.32	0.27	0.35	0.36	10.19	6.68	7.36	7.25	2.92
06/02/2013	0.98	1.16	0.31	0.32	0.28	0.36	0.37	10.03	6.83	7.29	7.20	3.58
06/03/2013	1.26	1.20	0.35	0.32	0.38	0.37	0.32	9.86	7.12	7.97	7.89	4.31
06/04/2013	1.61	1.24	0.40	0.33	0.57	0.39	0.30	10.18	7.10	8.90	7.64	5.07

Electrical Conductivity (EC) units: milliSiemens per Centimeter
Chloride (Cl) units: milligrams per liter
mht : mean high tides
md : mean daily
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e : estimated value

Delta Water Quality Conditions

Date	Bethel Island mdEC	Farrar Park mdEC	Holland Tract mdEC	Bacon Island mdEC	Contra Costa mdEC	Clifton Court mdEC	Tracy Pumping Plant mdEC	Antioch mdCl	Bacon Island mdCl	Contra Costa mdCl	Delta Status
05/06/2013	0.29	0.31	0.28	0.28	0.29	0.25	0.28	525	35	33	s
05/07/2013	0.29	0.32	0.28	0.29	0.29	0.24	NR	475	37	33	s
05/08/2013	0.30	0.33	0.29	0.29	0.28	0.24	NR	458	38	33	s
05/09/2013	0.30	0.33	0.29	0.30	0.30	0.25	NR	448	40	34	s
05/10/2013	0.31	0.34	0.30	0.30	0.30	0.26	NR	400	41	35	s
05/11/2013	0.31	0.33	0.30	0.31	0.29	0.28	NR	351	42	36	s
05/12/2013	0.31	0.34	0.30	0.31	0.31	0.29	NR	351	43	36	s
05/13/2013	0.31	0.33	0.31	0.32	0.32	0.31	NR	307	44	37	s
05/14/2013	0.31	0.33	0.31	0.32	0.32	0.30	NR	288	45	39	s
05/15/2013	0.31	0.34	0.31	0.32	0.32	0.32	NR	283	45	36	s
05/16/2013	0.31	0.34	0.31	0.32	NR	0.34	NR	257	45	40	s
05/17/2013	0.31	0.34	0.31	0.32	NR	0.35	NR	220	46	42	s
05/18/2013	0.31	0.34	0.31	0.33	NR	0.36	NR	166	47	38	s
05/19/2013	0.31	0.34	0.31	0.33	NR	0.39	NR	151	47	39	s
05/20/2013	0.31	0.34	0.30	0.33	NR	0.42	NR	164	47	40	s
05/21/2013	0.31	0.33	0.30	0.32	NR	0.44	NR	246	46	42	s
05/22/2013	0.31	0.33	0.30	0.32	NR	0.45	0.45	265	46	42	s
05/23/2013	0.30	0.33	0.30	0.32	NR	0.46	0.48	278	46	43	s
05/24/2013	0.30	0.33	0.30	0.32	NR	0.44	0.48	317	45	44	s
05/25/2013	0.30	0.33	0.30	0.31	NR	0.45	0.47	385	44	44 e	s
05/26/2013	0.30	0.32	0.30	0.31	NR	0.42	0.47	444	43	44 e	s
05/27/2013	0.30	0.32	0.30	0.31	NR	0.43	0.47	416	42	44 e	s
05/28/2013	0.30	0.32	0.30	0.31	NR	0.42	0.49	367	43	42	s
05/29/2013	0.30	0.32	0.29	0.31	NR	0.42	0.50	376	43	45	s
05/30/2013	0.30	0.32	0.29	0.31	0.38	0.43	0.50	277	43	45	s
05/31/2013	0.30	0.32	0.29	0.31	0.37	0.48	0.52	215	43	45 e	s
06/01/2013	0.30	0.33	0.29	0.31	0.36	0.46	0.52	204	42	45 e	s
06/02/2013	0.30	0.33	0.29	0.30	0.35	0.43	0.50	241	41	45 e	s
06/03/2013	0.30	0.33	0.28	0.30	0.34	0.41	0.48	330	39	44	s
06/04/2013	0.30	0.32	0.28	0.29	0.33	0.40	0.44	443	38	41	s

Electrical Conductivity (EC) units: milliSiemens per Centimeter
Chloride (Cl) units: milligrams per liter
md : mean daily
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e : estimated value
Antioch and Bacon Island mdCl are calculated from the respective mdEC values.

Coordinated Operation Agreement Delta Status:
- c = excess Delta conditions
- b = balanced Delta cond. w/ no storage withdrawal
- s = balanced Delta cond. w/ storage withdrawal
- Excess Delta conditions with restrictions:
  - f = fish concerns
  - r = E/I ratio concerns

Delta Water Quality Conditions

South Delta Stations

Date	Vernalis		Brandt Bridge		Old River Near Tracy		Old River Near Middle River	
	md EC	30 day avg	md EC	30 day avg	md EC	30 day avg	md EC	30 day avg
05/06/2013	0.19	0.43	0.17	0.52	0.25	0.72	0.17	0.50
05/07/2013	0.20	0.41	0.18	0.50	0.28	0.69	0.18	0.48
05/08/2013	0.20	0.39	0.20	0.48	0.31	0.67	0.20	0.45
05/09/2013	0.22	0.37	0.20	0.45	0.30	0.64	0.21	0.43
05/10/2013	0.22	0.35	0.22	0.43	0.29	0.62	NR	NC
05/11/2013	0.21	0.33	0.23	0.41	0.29	0.59	NR	NC
05/12/2013	0.21	0.31	0.22	0.38	0.29	0.56	NR	NC
05/13/2013	0.22	0.29	0.22	0.36	0.30	0.53	0.23	NC
05/14/2013	0.26	0.28	0.24	0.34	0.30	0.50	0.25	NC
05/15/2013	0.33	0.27	0.27	0.32	0.31	0.48	0.29	NC
05/16/2013	0.38	0.26	0.32	0.30	0.36	0.45	0.37	NC
05/17/2013	0.40	0.26	0.37	0.28	0.43	0.43	0.44	NC
05/18/2013	0.44	0.26	0.44	0.27	0.47	0.42	0.47	NC
05/19/2013	0.48	0.26	0.47	0.27	0.54	0.40	0.51	NC
05/20/2013	0.48	0.26	0.50	0.26	0.60	0.39	0.55	NC
05/21/2013	0.50	0.27	0.52	0.27	0.67	0.39	0.57	NC
05/22/2013	0.52	0.28	0.54	0.27	0.68	0.39	0.58	NC
05/23/2013	0.53	0.29	0.56	0.28	0.66	0.39	0.59	NC
05/24/2013	0.54	0.30	0.56	0.29	0.70	0.40	0.62	NC
05/25/2013	0.53	0.31	0.57	0.30	0.74	0.41	0.63	NC
05/26/2013	0.51	0.32	0.57	0.31	0.77	0.42	0.56	NC
05/27/2013	0.52	0.32	0.59	0.32	0.77	0.43	0.54	NC
05/28/2013	0.56	0.34	0.61	0.34	0.78	0.45	0.58	NC
05/29/2013	0.54	0.35	0.62	0.35	0.81	0.46	0.55	NC
05/30/2013	0.53	0.36	0.62	0.37	0.81	0.48	0.62	NC
05/31/2013	0.57	0.37	0.62	0.38	0.82	0.50	0.59	NC
06/01/2013	0.56	0.38	0.62	0.39	0.84	0.51	0.63	NC
06/02/2013	0.56	0.39	0.63	0.41	0.89	0.53	0.62	NC
06/03/2013	0.55	0.41	0.62	0.42	0.92	0.55	0.69	NC
06/04/2013	0.59	0.42	0.61	0.44	0.93	0.57	0.68	NC

Electrical Conductivity (EC) units: milliSiemens per Centimeter
md : mean daily
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e : estimated value

Compliance Standards

for the Sacramento - San Joaquin Delta and Suisun Marsh
Thursday, June 27, 2013

Criteria	Standard	Status
Flow/Operational		
% of inflow diverted	35 %	25 %
Vernalis Base Flow : Monthly average *	>= 710 cfs	763 cfs
7 Day average *	>= 568 cfs	672 cfs
Habitat Protection, X2 / Flow		
	30 days at Collinsville	27 days
Water Quality		
Days @ CCWD PP#1 w/ chlorides <= 150 mg/l	165 days	178 days
Export Areas for SWP, CVP, CCWD, et al	<= 250 mg/l Cl	40 mg/l
14dm EC at Emmaton	<= 0.45 mS/cm	0.44 mS/cm
14dm EC at Jersey Point	<= 0.45 mS/cm	0.37 mS/cm
Maximum 30 day running average of mean daily EC at:		
Vernalis	<=0.7 mS/cm	0.6 mS/cm
Brandt Bridge	<= 0.7 mS/cm	0.6 mS/cm
Old River Near Tracy	<=0.7 mS/cm	0.9 mS/cm
Old River Near Middle River	<=0.7 mS/cm	0.6 mS/cm
SUISUN MARSH:		
Suisun Marsh Salinity Control Gates :	3 Open / 0 Closed / 0 Full Tide Open	
Flashboard Status : Out		
Boat Lock Status : Closed		

California Hydrologic Conditions: (California Cooperative Snow Surveys Forecast, May 1, 2013)

Previous Month's Index (8RI for April.): 2.023 MAF
Water Year Type: Dry
Sacramento valley water year type index (40/30/30) @ 50%:5.8 MAF (Dry)
San Joaquin valley water year type index (60/20/20) @ 75%: 1.6 MAF (Critical)

Electrical Conductivity (EC) in milliSiemens per Centimeter.
Chlorides (Cl) in milligrams per liter
mht - mean high tides
md - mean daily
14 dm - fourteen day running mean
28 dm - twenty-eight day running mean
NR - No Record
NC - Average not computed due to insufficient data.
BR : Below Rating
e - estimated value

Montezuma Slough Gate Operation:
Number of gates operating at either Open, Closed, or Full Tide Open
Flashboard Status : In, Out, or Modified In
Boat Lock Status : Open or Closed

Coordinated Operation Agreement Delta Status:
c = excess Delta conditions
b = balanced Delta cond. w/ no storage withdrawal
s = balanced Delta cond. w/ storage withdrawal
Excess Delta conditions with restrictions:
f = fish concerns
r = E/I ratio concerns

* NDOI, Rio Vista & Vernalis Flows:
- Monthly average is progressive daily mean.
- 7 day average is progressive daily mean for the first six days of the month.

Delta Water Quality Conditions

Date	Antioch Tides		Net Delta Outflow Index	Martinez	Port Chicago		Mallard	Chipps Island		Collinsville	
	High	Half	cfs	mdEC	mdEC	14dm	mdEC	mdEC	14dm	mdEC	14dm
05/29/2013	6.04	4.17	9,502	23.58	1.59	2.15	6.82	6.29	5.65	3.23	2.66
05/30/2013	5.57	3.93	9,779	21.54	1.55	2.05	5.75	5.21	5.65	2.53	2.63
05/31/2013	5.38	3.71	10,488	19.57	1.48	1.99	4.64	4.11	5.60	1.95	2.63
06/01/2013	5.67	3.76	9,583	19.02	1.45	1.94	4.66	4.13	5.61	1.86	2.64
06/02/2013	6.13	4.02	9,053	20.43	1.52	1.91	5.41	4.87	5.70	2.22	2.69
06/03/2013	6.45	4.49	8,563	23.94	7.89	2.32	7.18	6.66	5.88	3.35	2.80
06/04/2013	6.55	4.57	7,386	25.19	16.19	3.31	8.01	7.52	5.97	3.96	2.89
06/05/2013	6.55	4.52	7,243	25.18	15.54	4.25	7.66	7.15	6.08	4.01	2.99
06/06/2013	6.61	4.54	7,307	24.66	15.14	5.17	7.40	6.88	6.17	2.76	3.01
06/07/2013	6.62	4.52	7,507	24.01	14.92	6.07	7.23	6.71	6.20	3.69	3.07
06/08/2013	6.60	4.75	7,527	23.41	16.14	7.06	7.70	7.19	6.22	4.16	3.14
06/09/2013	7.09	5.07	6,899	26.86	17.96	8.19	10.24	9.85	6.41	5.78	3.29
06/10/2013	6.74	4.67	7,371	25.20	15.39	9.17	8.01	7.51	6.45	4.40	3.36
06/11/2013	6.26	4.39	7,262	23.15	14.10	10.06	6.65	6.12	6.44	3.22	3.37
06/12/2013	6.11	4.28	7,472	22.24	14.23	10.96	6.60	6.07	6.43	3.16	3.36
06/13/2013	5.62	3.99	7,196	21.30	13.17	11.79	5.74	5.19	6.42	2.58	3.36
06/14/2013	5.16	3.80	7,413	19.46	11.64	12.52	4.71	4.18	6.43	2.21	3.38
06/15/2013	5.49	4.07	7,374	21.18	13.41	13.38	5.95	5.41	6.52	2.78	3.45
06/16/2013	5.52	3.90	6,959	20.98	13.47	14.23	6.12	5.58	6.57	2.64	3.48
06/17/2013	5.73	3.79	7,541	22.59	12.82	14.58	6.07	5.53	6.49	2.53	3.42
06/18/2013	6.15	3.99	7,458	23.41	13.86	14.42	6.49	5.95	6.38	2.78	3.33
06/19/2013	5.98	3.86	7,162	22.07	13.73	14.29	6.25	5.72	6.28	2.79	3.25
06/20/2013	6.14	3.87	7,222	22.49	13.91	14.20	6.40	5.86	6.20	2.66	3.24
06/21/2013	6.42	4.11	7,284	23.76	14.74	14.18	6.91	6.38	6.18	3.28	3.21
06/22/2013	6.61	4.23	7,950	24.47	15.64	14.15	7.60	7.08	6.17	3.79	3.19
06/23/2013	6.82	4.41	8,129	25.63	16.97	14.08	8.74	8.27	6.06	4.17	3.07
06/24/2013	6.82	4.33	7,283	25.37	15.53	14.09	7.90	7.40	6.05	3.94	3.04
06/25/2013	6.56	4.29	7,411	24.94	10.20	13.81	7.45	6.93	6.11	3.65	3.07
06/26/2013	6.28	4.23	7,529	23.80	9.40	13.46	7.17	6.65	6.15	3.66	3.10
06/27/2013	5.92	4.09	7,111	22.50	12.92	13.45	6.73	6.20	6.22	3.16	3.15

Antioch Tides measured in feet above mean sea level.
Net Delta Ouflow Index calculated from equation as specified in D-1641, revised June 1995.
Chipps Island EC calculated from measurements recorded at Mallard Slough.
Electrical Conductivity (EC) units: milliSiemens per Centimeter
md : mean daily
14dm : fourteen day running mean
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e - estimated value

Delta Water Quality Conditions

Date	Antioch		Jersey Point		Emmaton		Cache Slough	Good Year Slough	Sunrise Club	Volanti Slough	Beldon Landing	Collinsville
	mdEC	14mdEC	mdEC	14mdEC	mdEC	14mdEC	mdEC	mhtEC	mhtEC	mhtEC	mhtEC	mhtEC
05/29/2013	1.40	1.13	0.34	0.32	0.47	0.35	0.26	10.43	7.18	7.32	7.19	4.02
05/30/2013	1.09	1.13	0.32	0.32	0.34	0.35	0.29	10.38	6.67	7.33	6.95	3.54
05/31/2013	0.90	1.13	0.30	0.32	0.26	0.35	0.39	10.26	6.56	7.79	6.68	2.87
06/01/2013	0.86	1.14	0.30	0.32	0.27	0.35	0.36	10.19	6.68	7.36	7.25	2.92
06/02/2013	0.98	1.16	0.31	0.32	0.28	0.36	0.37	10.03	6.83	7.29	7.20	3.58
06/03/2013	1.26	1.20	0.35	0.32	0.38	0.37	0.32	9.86	7.12	7.97	7.89	4.31
06/04/2013	1.61	1.24	0.40	0.33	0.57	0.39	0.30	10.18	7.10	8.90	7.64	5.07
06/05/2013	1.52	1.28	0.40	0.34	0.57	0.41	0.31	10.55	7.51	8.69	7.64	4.73
06/06/2013	1.53	1.31	0.40	0.34	0.48	0.43	0.31	11.79	7.81	8.97	7.64	
06/07/2013	1.58	1.33	0.42	0.35	0.52	0.44	0.34	12.76	7.99	9.95	8.09	4.84
06/08/2013	1.77	1.36	0.43	0.36	0.63	0.45	0.33	11.95	8.33	10.00	8.55	4.91
06/09/2013	2.43	1.42	0.60	0.37	1.25	0.50	0.29	11.59	8.76	9.99	9.63	7.18
06/10/2013	1.80	1.43	0.43	0.38	0.78	0.52	0.33	12.07	8.73	10.69	8.74	5.40
06/11/2013	1.50	1.44	0.38	0.38	0.47	0.52	0.39	12.42	8.73	9.91	8.63	4.17
06/12/2013	1.50	1.45	0.40	0.39	0.42	0.52	0.40	12.49	8.52	9.85	8.76	3.99
06/13/2013	1.27	1.46	0.38	0.39	0.33	0.51	0.37	12.53	8.15	9.37	8.29	3.61
06/14/2013	1.18	1.48	0.35	0.40	0.27	0.52	0.37	12.59	8.05	9.06	8.27	3.03
06/15/2013	1.21	1.51	0.36	0.40	0.33	0.52	0.36	12.58	8.20	8.95	8.74	4.09
06/16/2013	1.13	1.52	0.36	0.40	0.28	0.52	0.36	12.24	8.51	8.99	8.52	3.97
06/17/2013	1.08	1.51	0.34	0.40	0.29	0.51	0.38	12.82	8.43	9.73	8.20	3.55
06/18/2013	1.19	1.48	0.35	0.40	0.33	0.50	0.36	12.56	9.86	9.86	8.46	4.18
06/19/2013	1.27	1.46	0.35	0.40	0.36	0.48	0.37	12.33	9.59	9.62	8.45	3.44
06/20/2013	1.23	1.44	0.34	0.39	0.36	0.47	0.32	11.76	9.47	10.21	8.75	3.79
06/21/2013	1.47	1.43	0.37	0.39	0.49	0.47	0.28	11.58	9.60	10.00	9.35	4.15
06/22/2013	1.67	1.42	0.40	0.39	0.57	0.47	0.25	11.43	9.80	10.03	9.55	4.76
06/23/2013	2.03	1.40	0.42	0.37	0.74	0.43	0.28	11.38	10.01	10.00	10.25	5.61
06/24/2013	1.88	1.40	0.40	0.37	0.64	0.42	0.30	11.59	9.95	10.18	10.32	5.36
06/25/2013	1.75	1.42	0.39	0.37	0.54	0.42	0.27	11.76	9.77	9.90	10.69	5.41
06/26/2013	1.63	1.43	0.38	0.37	0.50	0.43	0.27	11.85	9.62	10.59	11.01	4.65
06/27/2013	1.47	1.44	0.37	0.37	0.40	0.44	0.28	12.06	9.45	11.06	10.77	3.87

Electrical Conductivity (EC) units: milliSiemens per Centimeter
Chloride (Cl) units: milligrams per liter
mht : mean high tides
md : mean daily
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e : estimated value

Delta Water Quality Conditions

Date	Bethel Island mdEC	Farrar Park mdEC	Holland Tract mdEC	Bacon Island mdEC	Contra Costa mdEC	Clifton Court mdEC	Tracy Pumping Plant mdEC	Antioch mdCl	Bacon Island mdCl	Contra Costa mdCl	Delta Status
05/29/2013	0.30	0.32	0.29	0.31	NR	0.42	0.50	376	43	45	s
05/30/2013	0.30	0.32	0.29	0.31	0.38	0.43	0.50	277	43	45	s
05/31/2013	0.30	0.32	0.29	0.31	0.37	0.48	0.52	215	43	45 e	s
06/01/2013	0.30	0.33	0.29	0.31	0.36	0.46	0.52	204	42	45 e	s
06/02/2013	0.30	0.33	0.29	0.30	0.35	0.43	0.50	241	41	45 e	s
06/03/2013	0.30	0.33	0.28	0.30	0.34	0.41	0.48	330	39	44	s
06/04/2013	0.30	0.32	0.28	0.29	0.33	0.40	0.44	443	38	41	s
06/05/2013	0.29	0.35	0.28	0.29	0.32	0.44	0.48	415	38	40	s
06/06/2013	0.29	0.35	0.28	0.29	0.31	0.43	0.46	417	38	43	s
06/07/2013	0.30	0.37	0.29	0.29	0.31	0.43	0.48	434	37	39	s
06/08/2013	0.30	0.37	0.29	0.29	0.31	0.43	0.49	492	37	39 e	s
06/09/2013	0.32	0.37	0.29	0.29	0.30	0.40	0.46	703	37	39 e	s
06/10/2013	0.32	0.39	0.29	0.29	0.30	0.46	0.44	503	38	39 e	s
06/11/2013	0.32	0.39	0.30	0.29	0.30	0.42	0.53	409	38	37	s
06/12/2013	0.31	0.40	0.31	0.30	0.30	0.46	0.49	409	39	37	s
06/13/2013	0.32	0.39	0.31	0.30	0.31	0.48	0.49	334	39	38	s
06/14/2013	0.32	0.38	0.30	0.30	0.31	0.42	0.50	305	40	39	s
06/15/2013	0.32	0.38	0.30	0.30	0.31	0.38	0.45	314	40	40	s
06/16/2013	0.32	0.37	0.30	0.30	0.32	0.38	0.45	291	40	41	s
06/17/2013	0.32	0.36	0.29	0.30	0.32	0.40	0.48	273	40	42	s
06/18/2013	0.32	0.35	0.29	0.30	0.31	0.39	0.47	308	39	42	s
06/19/2013	0.32	0.35	0.29	0.29	0.31	0.36	0.43	334	39	41	s
06/20/2013	0.32	0.36	0.29	0.29	0.31	0.34	0.42	322	38	42	s
06/21/2013	0.31	0.36	0.29	0.29	0.31	0.35	0.38	398	38	41	s
06/22/2013	0.31	0.36	0.29	0.29	0.31	0.35	0.36	463	38	41 e	s
06/23/2013	0.31	0.35	0.28	0.29	0.30	0.35	0.36	578	37	41 e	s
06/24/2013	0.31	0.35	0.28	0.29	0.30	0.35	0.36	528	37	39	s
06/25/2013	0.30	0.34	0.28	0.29	0.30	0.34	0.41	488	37	39	s
06/26/2013	0.30	0.34	0.28	0.29	0.30	0.33	0.38	450	36	41	s
06/27/2013	0.30	0.35	0.28	0.28	0.30	0.34	0.38	398	35	40	s

Electrical Conductivity (EC) units: milliSiemens per Centimeter
Chloride (Cl) units: milligrams per liter
md : mean daily
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e : estimated value
Antioch and Bacon Island mdCl are calculated from the respective mdEC values.

Coordinated Operation Agreement Delta Status:
- c = excess Delta conditions
- b = balanced Delta cond. w/ no storage withdrawal
- s = balanced Delta cond. w/ storage withdrawal
- Excess Delta conditions with restrictions:
  - f = fish concerns
  - r = E/I ratio concerns

Delta Water Quality Conditions

South Delta Stations

Date	Vernalis		Brandt Bridge		Old River Near Tracy		Old River Near Middle River	
	md EC	30 day avg	md EC	30 day avg	md EC	30 day avg	md EC	30 day avg
05/29/2013	0.54	0.35	0.62	0.35	0.81	0.46	0.55	NC
05/30/2013	0.53	0.36	0.62	0.37	0.81	0.48	0.62	NC
05/31/2013	0.57	0.37	0.62	0.38	0.82	0.50	0.59	NC
06/01/2013	0.56	0.38	0.62	0.39	0.84	0.51	0.63	NC
06/02/2013	0.56	0.39	0.63	0.41	0.89	0.53	0.62	NC
06/03/2013	0.55	0.41	0.62	0.42	0.92	0.55	0.69	NC
06/04/2013	0.59	0.42	0.61	0.44	0.93	0.57	0.68	NC
06/05/2013	0.55	0.43	0.62	0.45	0.95	0.59	0.66	NC
06/06/2013	0.56	0.44	0.62	0.47	0.95	0.62	0.66	NC
06/07/2013	0.52	0.45	0.62	0.48	0.94	0.64	0.66	NC
06/08/2013	0.52	0.46	0.63	0.49	0.91	0.66	0.67	NC
06/09/2013	0.52	0.47	0.59	0.51	0.90	0.68	0.67	NC
06/10/2013	0.52	0.48	0.59	0.52	0.81	0.70	0.65	NC
06/11/2013	0.54	0.50	0.63	0.53	0.78	0.71	0.63	0.56
06/12/2013	0.53	0.51	0.63	0.55	0.78	0.73	0.63	0.57
06/13/2013	0.54	0.52	0.63	0.56	0.80	0.74	0.63	0.58
06/14/2013	0.55	0.52	0.64	0.57	0.81	0.76	0.69	0.60
06/15/2013	0.53	0.53	0.63	0.58	0.87	0.78	0.69	0.61
06/16/2013	0.56	0.53	0.62	0.59	0.90	0.79	0.70	0.62
06/17/2013	0.56	0.54	0.62	0.60	0.89	0.81	0.69	0.62
06/18/2013	0.58	0.54	0.63	0.60	0.88	0.82	0.67	0.63
06/19/2013	0.58	0.54	0.62	0.61	0.89	0.83	0.64	0.63
06/20/2013	0.58	0.55	0.64	0.61	0.94	0.84	0.67	0.64
06/21/2013	0.57	0.55	0.64	0.61	1.02	0.85	0.66	0.64
06/22/2013	0.56	0.55	0.64	0.62	1.11	0.86	0.68	0.64
06/23/2013	0.53	0.55	0.65	0.62	1.11	0.88	0.69	0.64
06/24/2013	0.58	0.55	0.67	0.62	1.13	0.89	0.66	0.65
06/25/2013	0.63	0.55	0.69	0.63	1.18	0.90	0.60	0.65
06/26/2013	0.64	0.56	0.69	0.63	1.20	0.92	0.46	0.64
06/27/2013	0.59	0.56	0.68	0.63	1.21	0.93	0.42	0.64

Electrical Conductivity (EC) units: milliSiemens per Centimeter
md : mean daily
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e : estimated value

Compliance Standards

for the Sacramento - San Joaquin Delta and Suisun Marsh
Tuesday, August 06, 2013

Criteria	Standard	Status
Flow/Operational		
% of inflow diverted	65 %	45 %
NDOI, monthly average *	>= 3,500 cfs	5,553 cfs
NDOI, 7 day average*	>= 2,500 cfs	5,553 cfs

Water Quality

Days @ CCWD PP#1 w/ chlorides <= 150 mg/l	165 days	216 days
Export Areas for SWP, CVP, CCWD, et al	<= 250 mg/l Cl	166 mg/l
14dm EC at Emmaton	<= 1.67 mS/cm	0.66 mS/cm
14dm EC at Jersey Point	<= 1.35 mS/cm	1.19 mS/cm
Maximum 30 day running average of mean daily EC at:		
Vernalis	<=0.7 mS/cm	0.5 mS/cm
Brandt Bridge	<= 0.7 mS/cm	0.7 mS/cm
Old River Near Tracy	<=0.7 mS/cm	0.8 mS/cm
Old River Near Middle River	<=0.7 mS/cm	0.7 mS/cm

SUISUN MARSH:

Suisun Marsh Salinity Control Gates : 3 Open / 0 Closed / 0 Full Tide Open
Flashboard Status : Out
Boat Lock Status : Closed

California Hydrologic Conditions: (California Cooperative Snow Surveys Forecast, May 1, 2013)

Previous Month's Index (8RI for April.): 2.023 MAF
Water Year Type: Dry
Sacramento valley water year type index (40/30/30) @ 50%:5.8 MAF (Dry)
San Joaquin valley water year type index (60/20/20) @ 75%: 1.6 MAF (Critical)

Electrical Conductivity (EC) in milliSiemens per Centimeter.
Chlorides (Cl) in milligrams per liter
mht - mean high tides
md - mean daily
14 dm - fourteen day running mean
28 dm - twenty-eight day running mean
NR - No Record
NC - Average not computed due to insufficient data.
BR : Below Rating
e - estimated value

Montezuma Slough Gate Operation:
Number of gates operating at either Open, Closed, or Full Tide Open
Flashboard Status : In, Out, or Modified In
Boat Lock Status : Open or Closed

Coordinated Operation Agreement Delta Status:
c = excess Delta conditions
b = balanced Delta cond. w/ no storage withdrawal
s = balanced Delta cond. w/ storage withdrawal
Excess Delta conditions with restrictions:
f = fish concerns
r = E/I ratio concerns

* NDOI, Rio Vista & Vernalis Flows:
- Monthly average is progressive daily mean.
- 7 day average is progressive daily mean for the first six days of the month.

Delta Water Quality Conditions

Date	Antioch Tides		Net Delta Outflow Index	Martinez	Port Chicago		Mallard	Chipps Island		Collinsville	
	High	Half	cfs	mdEC	mdEC	14dm	mdEC	mdEC	14dm	mdEC	14dm
07/08/2013	6.70	4.61	4,134	26.14	16.49	14.36	9.88	9.47	7.33	5.46	3.93
07/09/2013	6.39	4.35	5,204	24.47	15.62	14.74	8.90	8.44	7.44	4.67	4.00
07/10/2013	6.20	4.44	5,217	25.61	16.17	15.23	9.26	8.82	7.59	4.99	4.09
07/11/2013	6.12	4.43	5,226	26.21	16.10	15.45	9.30	8.85	7.78	5.18	4.24
07/12/2013	5.87	4.36	5,079	25.71	15.33	15.59	8.99	8.54	8.00	4.91	4.39
07/13/2013	5.56	4.24	5,014	24.84	14.42	15.66	8.31	7.82	8.16	4.48	4.52
07/14/2013	5.79	4.25	5,090	25.16	15.03	15.78	8.70	8.23	8.34	4.60	4.64
07/15/2013	6.11	4.33	4,884	26.04	15.65	15.99	9.18	8.74	8.55	4.94	4.80
07/16/2013	6.18	4.30	4,724	27.04	15.76	16.08	9.14	8.69	8.69	4.96	4.90
07/17/2013	6.28	4.13	5,300	25.12	14.96	16.10	8.23	7.74	8.70	4.34	4.92
07/18/2013	6.60	4.29	5,476	25.42	14.81	16.01	8.78	8.31	8.70	4.68	4.93
07/19/2013	6.77	4.47	5,365	25.83	16.76	15.92	9.47	9.03	8.69	5.29	4.97
07/20/2013	6.94	4.63	5,001	26.95	17.54	15.87	10.38	10.00	8.74	6.13	5.02
07/21/2013	7.21	4.83	4,974	28.62	17.39	15.86	11.37	11.05	8.84	7.02	5.12
07/22/2013	7.24	4.76	5,198	28.27	17.78	15.95	11.22	10.90	8.94	6.84	5.22
07/23/2013	6.89	4.47	5,352	27.81	17.11	16.06	10.44	10.07	9.06	6.09	5.32
07/24/2013	6.52	4.42	4,989	27.22	14.75	15.96	10.18	9.79	9.13	5.98	5.39
07/25/2013	6.32	4.50	5,130	27.04	14.18	15.82	10.46	10.08	9.21	6.08	5.45
07/26/2013	5.96	4.42	5,780	26.61	13.49	15.69	10.29	9.90	9.31	5.95	5.53
07/27/2013	6.01	4.37	6,288	26.62	14.11	15.66	9.95	9.54	9.43	5.81	5.62
07/28/2013	6.27	4.46	6,029	27.17	14.02	15.59	9.85	9.43	9.52	5.88	5.71
07/29/2013	6.34	4.52	4,962	27.56	13.56	15.44	10.05	9.65	9.59	5.95	5.79
07/30/2013	6.22	4.37	5,034	26.53	13.40	15.27	9.65	9.23	9.62	5.52	5.83
07/31/2013	6.28	4.43	5,510	26.43	12.77	15.12	9.64	9.22	9.73	5.60	5.92
08/01/2013	6.22	4.34	5,127	26.29	11.50	14.88	9.32	8.88	9.77	5.12	5.95
08/02/2013	6.16	4.27	5,669	25.38	10.11	14.41	8.81	8.34	9.72	4.70	5.90
08/03/2013	6.30	4.36	6,242	26.46	7.72	13.71	9.27	8.82	9.64	5.14	5.83
08/04/2013	6.41	4.40	6,130	26.94	6.32	12.91	9.85	9.44	9.52	5.40	5.72
08/05/2013	6.31	4.32	5,050	26.71	5.77	12.06	9.43	8.99	9.39	5.12	5.60
08/06/2013	6.23	4.30	5,101	26.82	10.46	11.58	9.46	9.02	9.31	5.17	5.53

Antioch Tides measured in feet above mean sea level.
Net Delta Ouflow Index calculated from equation as specified in D-1641, revised June 1995.
Chipps Island EC calculated from measurements recorded at Mallard Slough.
Electrical Conductivity (EC) units: milliSiemens per Centimeter
md : mean daily
14dm : fourteen day running mean
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e - estimated value

Delta Water Quality Conditions

Date	Antioch		Jersey Point		Emmaton		Cache Slough	Good Year Slough	Sunrise Club	Volanti Slough	Beldon Landing	Collinsville
	mdEC	14mdEC	mdEC	14mdEC	mdEC	14mdEC	mdEC	mhtEC	mhtEC	mhtEC	mhtEC	mhtEC
07/08/2013	2.75	1.90	0.79	0.51	0.65	0.45	0.33	11.96	11.05	12.13	10.94	6.27
07/09/2013	2.61	1.96	0.76	0.54	0.54	0.45	0.33	12.16	10.58	11.34	10.73	5.71
07/10/2013	2.64	2.03	0.82	0.57	0.56	0.45	0.34	12.29	10.37	11.32	11.05	6.14
07/11/2013	2.64	2.11	0.86	0.60	0.55	0.46	0.39	12.38	10.21	11.74	10.90	6.15
07/12/2013	2.53	2.20	0.86	0.64	0.45	0.47	0.44	12.45	10.12	11.69	11.05	6.32
07/13/2013	2.40	2.28	0.86	0.68	0.40	0.48	0.43	12.57	10.01	11.54	10.70	5.42
07/14/2013	2.44	2.36	0.89	0.71	0.39	0.49	0.41	12.66	10.05	11.57	10.69	5.94
07/15/2013	2.52	2.44	0.93	0.75	0.45	0.50	0.41	12.74	10.10	11.81	10.79	6.58
07/16/2013	2.50	2.51	0.93	0.79	0.45	0.51	0.41	14.06	10.10	11.56	11.17	6.14
07/17/2013	2.40	2.55	0.90	0.81	0.44	0.52	0.43	15.17	9.99	11.52	11.08	5.75
07/18/2013	2.46	2.57	0.93	0.84	0.54	0.53	0.37	15.12	10.04	12.26	11.33	6.40
07/19/2013	2.79	2.58	1.02	0.86	0.72	0.54	0.32	14.77	10.22	12.45	11.91	6.26
07/20/2013	3.22	2.62	1.12	0.89	0.98	0.56	0.27	14.56	10.36	12.56	11.87	7.45
07/21/2013	3.61	2.68	1.24	0.92	1.22	0.60	0.25	14.93	10.52	12.48	11.91	8.34
07/22/2013	3.71	2.75	1.25	0.95	1.24	0.64	0.28	15.39	10.73	12.28	12.00	8.49
07/23/2013	3.34	2.80	1.08	0.98	0.91	0.66	0.33	15.27	10.91	12.11	12.22	7.61
07/24/2013	3.19	2.84	1.15	1.00	0.86	0.69	0.31	15.72	11.19	12.30	12.93	6.83
07/25/2013	3.21	2.88	1.19	1.02	0.89	0.71	0.32	15.46	11.68	13.44	13.27	7.43
07/26/2013	3.12	2.92	1.20	1.05	0.76	0.73	0.32	15.13	11.38	12.79	12.69	7.47
07/27/2013	2.99	2.96	1.18	1.07	0.65	0.75	0.36	15.06	11.17	12.49	12.64	6.90
07/28/2013	2.99	3.00	1.17	1.09	0.60	0.77	0.37	15.25	11.26	12.76	12.41	7.23
07/29/2013	3.11	3.05	1.20	1.11	0.59	0.78	0.45	15.49	11.45	12.49	12.25	7.22
07/30/2013	3.02	3.08	1.20	1.13	0.48	0.78	0.52	16.73	11.34	12.54	12.38	6.89
07/31/2013	2.99	3.12	1.21	1.15	0.53	0.78	0.52	17.93	11.12	12.45	12.86	6.48
08/01/2013	2.91	3.16	1.20	1.17	0.57	0.79	0.52	e	e	14.26	12.62	6.07
08/02/2013	2.81	3.16	1.18	1.18	0.57	0.78	0.51	17.62	10.77	13.75	12.82	5.65
08/03/2013	2.92	3.14	1.21	1.19	0.65	0.75	0.42	17.36	10.89	13.33	12.38	6.10
08/04/2013	2.98	3.09	1.23	1.19	0.72	0.72	0.39	16.97	10.95	12.78	12.42	6.75
08/05/2013	2.82	3.03	1.18	1.18	0.68	0.68	0.36	16.81	10.87	12.82	12.05	5.96
08/06/2013	2.88	2.99	1.18	1.19	0.68	0.66	0.33	16.77	10.81	12.48	11.81	6.24

Electrical Conductivity (EC) units: milliSiemens per Centimeter
Chloride (Cl) units: milligrams per liter
mht : mean high tides
md : mean daily
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e : estimated value

Delta Water Quality Conditions

Date	Bethel Island mdEC	Farrar Park mdEC	Holland Tract mdEC	Bacon Island mdEC	Contra Costa mdEC	Clifton Court mdEC	Tracy Pumping Plant mdEC	Antioch mdCl	Bacon Island mdCl	Contra Costa mdCl	Delta Status
07/08/2013	0.40	0.45	0.36	0.30	0.28	0.27	0.30	806	41	35	s
07/09/2013	0.42	0.47	0.39	0.33	0.28	0.27	0.31	763	48	36	s
07/10/2013	0.44	0.50	0.39	0.35	0.29	0.28	0.29	771	53	37	s
07/11/2013	0.46	0.54	0.41	0.36	0.30	0.29	0.29	770	55	39	s
07/12/2013	0.48	0.55	0.42	0.38	0.31	0.30	0.29	737	60	43	s
07/13/2013	0.50	0.57	0.44	0.40	0.34	0.31	0.30	695	65	49	s
07/14/2013	0.53	0.61	0.46	0.41	0.36	0.31	0.30	706	69	55	s
07/15/2013	0.55	0.64	0.48	0.42	0.38	0.32	0.30	733	72	60	s
07/16/2013	0.56	0.66	0.51	0.44	0.39	0.32	0.30	727	77	65	s
07/17/2013	0.59	0.66	0.53	0.47	0.40	0.32	0.31	696	84	69	s
07/18/2013	0.61	0.68	0.56	0.49	0.42	0.33	0.32	714	90	74	s
07/19/2013	0.64	0.72	0.57	0.51	0.43	0.36	0.32	818	95	76	s
07/20/2013	0.67	0.75	0.58	0.51	0.46	0.38	0.34	957	95	83	s
07/21/2013	0.72	0.78	0.60	0.52	0.48	0.38	0.34	1,080	97	89	s
07/22/2013	0.75	0.79	0.62	0.53	0.51	0.37	0.35	1,112	100	96	s
07/23/2013	0.76	0.81	0.64	0.55	0.53	0.39	0.37	992	106	100	s
07/24/2013	0.77	0.82	0.65	0.57	0.55	0.40	0.36	945	112	108	s
07/25/2013	0.79	0.83	0.66	0.59	0.56	0.41	0.37	952	115	116	s
07/26/2013	0.81	0.84	0.68	0.60	0.56	0.41	0.37	922	119	113	s
07/27/2013	0.82	0.84	0.69	0.62	0.58	0.41	0.39	882	123	116	s
07/28/2013	0.84	0.83	0.73	0.65	0.59	0.41	0.40	881	131	121	s
07/29/2013	0.85	0.82	0.75	0.68	0.59	0.42	0.42	922	139	120	s
07/30/2013	0.86	0.82	0.77	0.70	0.61	0.43	0.44	890	145	128	s
07/31/2013	0.87	0.82	0.78	0.71	0.62	0.46	0.44	882	148	132	s
08/01/2013	0.88	0.81	0.77	0.71	0.63	0.50	0.46	857	148	136	s
08/02/2013	0.88	0.79	0.75	0.70	0.65	0.49	0.46	826	145	139	s
08/03/2013	0.87	0.78	0.75	0.68	0.67	0.50	0.47	859	139	146	s
08/04/2013	0.89	0.80	0.75	0.66	0.70	0.49	0.46	879	135	152	s
08/05/2013	0.89	0.81	0.74	0.66	0.71	0.48	0.46	827	135	157	s
08/06/2013	0.89	0.80	0.76	0.67	0.74	0.48	0.44	848	138	166	s

Electrical Conductivity (EC) units: milliSiemens per Centimeter
Chloride (Cl) units: milligrams per liter
md : mean daily
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e : estimated value
Antioch and Bacon Island mdCl are calculated from the respective mdEC values.

Coordinated Operation Agreement Delta Status:
- c = excess Delta conditions
- b = balanced Delta cond. w/ no storage withdrawal
- s = balanced Delta cond. w/ storage withdrawal
- Excess Delta conditions with restrictions:
  - f = fish concerns
  - r = E/I ratio concerns

Delta Water Quality Conditions

South Delta Stations

Date	Vernalis		Brandt Bridge		Old River Near Tracy		Old River Near Middle River	
	md EC	30 day avg	md EC	30 day avg	md EC	30 day avg	md EC	30 day avg
07/08/2013	0.50	0.55	0.71	0.65	0.82	0.95	0.66	0.63
07/09/2013	0.52	0.55	0.71	0.65	0.78	0.95	0.64	0.62
07/10/2013	0.48	0.54	0.69	0.65	0.78	0.95	0.60	0.62
07/11/2013	0.49	0.54	0.68	0.66	0.79	0.95	0.62	0.62
07/12/2013	0.55	0.54	0.71	0.66	0.79	0.95	0.67	0.62
07/13/2013	0.46	0.54	0.73	0.66	0.79	0.95	0.69	0.63
07/14/2013	0.48	0.54	0.74	0.66	0.80	0.95	0.70	0.63
07/15/2013	0.50	0.54	0.73	0.67	0.81	0.95	0.70	0.63
07/16/2013	0.53	0.54	0.72	0.67	0.81	0.94	0.68	0.63
07/17/2013	0.49	0.53	0.70	0.67	0.82	0.94	0.65	0.62
07/18/2013	0.51	0.53	0.68	0.68	0.85	0.94	0.68	0.62
07/19/2013	0.54	0.53	0.68	0.68	0.86	0.94	0.66	0.62
07/20/2013	0.52	0.53	0.75	0.68	0.86	0.94	0.69	0.63
07/21/2013	0.53	0.53	0.81	0.69	0.85	0.93	0.68	0.63
07/22/2013	0.51	0.52	0.82	0.69	0.88	0.92	0.69	0.63
07/23/2013	0.48	0.52	0.81	0.70	0.86	0.91	0.70	0.63
07/24/2013	0.49	0.52	0.79	0.70	0.86	0.91	0.69	0.63
07/25/2013	0.54	0.52	0.76	0.70	0.86	0.89	0.70	0.63
07/26/2013	0.49	0.51	0.73	0.70	0.86	0.88	0.72	0.64
07/27/2013	0.51	0.51	0.70	0.71	0.86	0.87	0.73	0.65
07/28/2013	0.49	0.51	0.67	0.71	0.87	0.86	0.74	0.66
07/29/2013	0.52	0.50	0.67	0.70	0.89	0.85	0.73	0.67
07/30/2013	0.53	0.50	0.66	0.70	0.89	0.85	0.72	0.67
07/31/2013	0.53	0.50	0.65	0.70	0.90	0.85	0.71	0.67
08/01/2013	0.45	0.50	0.65	0.70	0.91	0.85	0.69	0.68
08/02/2013	0.53	0.50	0.65	0.71	0.92	0.85	0.68	0.68
08/03/2013	0.47	0.50	0.66	0.71	0.92	0.85	0.69	0.68
08/04/2013	0.47	0.50	0.68	0.71	0.87	0.85	0.70	0.68
08/05/2013	0.51	0.50	0.70	0.71	0.85	0.85	0.70	0.68
08/06/2013	0.53	0.50	0.71	0.71	0.87	0.85	0.70	0.69

Electrical Conductivity (EC) units: milliSiemens per Centimeter
md : mean daily
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e : estimated value

Compliance Standards

for the Sacramento - San Joaquin Delta and Suisun Marsh
Thursday, October 24, 2013

Criteria	Standard	Status
Flow/Operational		
% of inflow diverted	65 %	33 %
NDOI, monthly average *	>= 4,000 cfs	3,801 cfs
NDOI, 7 day average*	>= 3,000 cfs	3,574 cfs
Rio Vista flow, monthly average *	>= 4,000 cfs	3,939 cfs
Rio Vista flow, 7 day average*	>= 3,000 cfs	3,663 cfs

Water Quality

Days @ CCWD PP#1 w/ chlorides <= 150 mg/l	165 days	216 days
Export Areas for SWP, CVP, CCWD, et al	<= 250 mg/l Cl	115 mg/l
Maximum 30 day running average of mean daily EC at:		
Vernalis	<=1.0 mS/cm	0.5 mS/cm
Brandt Bridge	<=1.0 mS/cm	0.6 mS/cm
Old River Near Tracy	<=1.0 mS/cm	0.8 mS/cm
Old River Near Middle River	<=1.0 mS/cm	0.6 mS/cm

SUISUN MARSH:

Suisun Marsh Salinity Control Gates : 3 Open / 0 Closed / 0 Full Tide Open
Flashboard Status : Out
Boat Lock Status : Closed

California Hydrologic Conditions: (California Cooperative Snow Surveys Forecast, May 1, 2013)

Previous Month's Index (8RI for May): 1.430 MAF
Water Year Type: Dry
Sacramento valley water year type index (40/30/30) @ 50%:5.8 MAF (Dry)
San Joaquin valley water year type index (60/20/20) @ 75%: 1.6 MAF (Critical)

Electrical Conductivity (EC) in milliSiemens per Centimeter.
Chlorides (Cl) in milligrams per liter
mht - mean high tides
md - mean daily
14 dm - fourteen day running mean
28 dm - twenty-eight day running mean
NR - No Record
NC - Average not computed due to insufficient data.
BR : Below Rating
e - estimated value

Montezuma Slough Gate Operation:
Number of gates operating at either Open, Closed, or Full Tide Open
Flashboard Status : In, Out, or Modified In
Boat Lock Status : Open or Closed

Coordinated Operation Agreement Delta Status:
(Note: below label begins on October 1, 2013)
c = excess Delta conditions
b = balanced Delta conditions
r = excess Delta conditions with restrictions:

* NDOI, Rio Vista & Vernalis Flows:
- Monthly average is progressive daily mean.
- 7 day average is progressive daily mean for the first six days of the month.

Delta Water Quality Conditions

Date	Antioch Tides		Net Delta Outflow Index	Martinez	Port Chicago		Mallard	Chipps Island		Collinsville	
	High	Half	cfs	mdEC	mdEC	14dm	mdEC	mdEC	14dm	mdEC	14dm
09/25/2013	5.94	4.30	4,585	24.18	16.69	16.72	9.31	8.87	8.62	5.15	4.97
09/26/2013	5.61	4.16	4,430	22.95	14.82	16.55	8.37	7.89	8.51	4.85	4.91
09/27/2013	5.32	3.91	4,202	22.69	15.22	16.41	7.77	7.26	8.37	4.23	4.82
09/28/2013	5.37	3.89	3,921	22.68	15.08	16.28	8.30	7.81	8.28	4.16	4.74
09/29/2013	5.46	3.96	4,304	24.79	16.71	16.26	9.24	8.79	8.26	4.73	4.70
09/30/2013	5.44	3.97	4,067	25.18	16.98	16.29	9.63	9.20	8.30	5.20	4.73
10/01/2013	5.56	3.99	4,302	25.62	17.85	16.33	10.13	9.74	8.40	5.42	4.78
10/02/2013	5.48	3.91	4,055	25.43	18.03	16.47	9.88	9.47	8.54	5.78	4.88
10/03/2013	5.38	3.82	4,312	25.67	17.63	16.57	9.64	9.21	8.65	5.94	4.99
10/04/2013	5.39	3.72	4,027	25.37	16.46	16.50	9.09	8.64	8.63	5.99	5.06
10/05/2013	5.58	3.72	3,970	26.43	18.29	16.61	10.48	10.10	8.71	5.44	5.09
10/06/2013	5.76	3.82	3,366	26.81	19.03	16.80	10.61	10.25	8.85	5.89	5.16
10/07/2013	6.13	4.10	3,522	27.82	20.04	17.11	11.63	11.34	9.09	6.97	5.33
10/08/2013	6.31	4.20	3,865	28.75	20.52	17.38	12.36	12.13	9.34	7.87	5.54
10/09/2013	6.47	4.43	4,189	29.86	22.19	17.77	13.47	13.34	9.65	8.27	5.77
10/10/2013	6.28	4.41	4,135	29.23	21.27	18.23	12.95	12.77	10.00	7.80	5.98
10/11/2013	5.98	4.22	3,949	28.16	21.10	18.65	12.72	12.52	10.38	7.40	6.20
10/12/2013	5.92	4.18	3,762	28.27	20.77	19.06	12.62	12.41	10.71	8.16	6.49
10/13/2013	5.58	4.02	3,618	27.76	19.67	19.27	12.17	11.93	10.93	7.57	6.69
10/14/2013	5.37	3.79	4,033	27.41	19.61	19.46	11.72	11.44	11.09	7.30	6.84
10/15/2013	5.50	3.88	3,671	28.01	19.89	19.61	11.95	11.68	11.23	7.35	6.98
10/16/2013	5.62	3.92	3,635	28.99	20.68	19.80	12.61	12.40	11.44	8.09	7.14
10/17/2013	5.90	4.01	3,786	29.17	21.26	20.06	13.16	13.00	11.71	8.59	7.33
10/18/2013	6.05	4.16	3,626	29.26	21.87	20.44	13.70	13.59	12.06	9.52	7.59
10/19/2013	6.10	4.15	3,731	29.21	20.86	20.62	13.73	13.62	12.31	9.41	7.87
10/20/2013	6.12	4.21	3,365	28.95	22.14	20.85	14.08	14.01	12.58	9.96	8.16
10/21/2013	6.12	4.27	3,163	29.25	22.18	21.00	14.66	14.65	12.82	10.20	8.39
10/22/2013	5.97	4.20	3,033	28.07	20.96	21.03	13.04	12.87	12.87	8.84	8.46
10/23/2013	6.06	4.34	4,176	29.73	22.41	21.05	14.78	14.77	12.97	10.33	8.61
10/24/2013	5.91	4.47	3,922	30.27	22.55	21.14	15.64	15.73	13.19	10.86	8.83

Antioch Tides measured in feet above mean sea level.
Net Delta Ouflow Index calculated from equation as specified in D-1641, revised June 1995.
Chipps Island EC calculated from measurements recorded at Mallard Slough.
Electrical Conductivity (EC) units: milliSiemens per Centimeter
md : mean daily
14dm : fourteen day running mean
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e - estimated value

Delta Water Quality Conditions

Date	Antioch		Jersey Point		Emmaton		Cache Slough	Good Year Slough	Sunrise Club	Volanti Slough	Beldon Landing	Collinsville
	mdEC	14mdEC	mdEC	14mdEC	mdEC	14mdEC	mdEC	mhtEC	mhtEC	mhtEC	mhtEC	mhtEC
09/25/2013	2.90	2.80	0.97	1.08	NR	NC	0.53	15.49	e	13.86	15.28	6.04
09/26/2013	2.62	2.75	0.92	1.05	NR	NC	0.51	15.38	12.36	14.35	15.23	5.99
09/27/2013	2.37	2.70	0.85	1.02	0.56	NC	0.48	15.33	11.91	14.82	15.22	5.40
09/28/2013	2.49	2.67	0.86	0.99	0.59	NC	0.47	15.11	12.02	14.76	15.20	5.81
09/29/2013	2.62	2.65	0.85	0.97	0.66	NC	0.47	14.68	12.23	14.61	15.18	5.73
09/30/2013	2.76	2.63	0.85	0.95	0.72	NC	0.47	14.39	12.36	14.40	15.15	6.39
10/01/2013	2.89	2.65	0.86	0.93	0.78	NC	0.47	14.34	12.35	14.23	15.33	6.75
10/02/2013	2.79	2.67	0.81	0.92	0.74	NC	0.46	14.44	12.35	14.19	15.27	7.18
10/03/2013	2.66	2.68	0.82	0.91	0.63	NC	0.51	14.66	12.27	14.05	15.22	6.58
10/04/2013	2.26	2.65	0.81	0.89	0.50	NC	0.49	15.02	12.08	13.81	15.11	6.59
10/05/2013	2.74	2.64	0.83	0.88	0.94	NC	0.44	15.86	12.73	14.55	15.46	6.54
10/06/2013	3.18	2.68	0.86	0.87	1.15	NC	0.44	16.37	12.84	14.99	16.02	7.49
10/07/2013	3.66	2.76	0.91	0.87	1.48	NC	0.44	16.49	12.98	15.21	16.41	8.38
10/08/2013	4.19	2.87	0.98	0.87	1.67	NC	0.43	16.46	12.87	15.46	16.73	9.39
10/09/2013	4.84	3.00	1.13	0.88	1.95	NC	0.42	16.63	13.50	16.18	16.98	9.96
10/10/2013	4.83	3.16	1.20	0.90	1.85	1.02	0.41	16.85	13.98	16.84	17.29	9.76
10/11/2013	4.45	3.31	1.04	0.91	1.75	1.10	0.44	17.15	14.01	16.79	16.94	8.37
10/12/2013	4.27	3.44	1.04	0.93	1.72	1.18	0.44	17.35	14.14	16.95	17.47	9.31
10/13/2013	4.21	3.55	1.02	0.94	1.53	1.24	0.46	17.50	14.45	16.80	17.67	8.71
10/14/2013	3.84	3.63	0.97	0.95	1.47	1.30	0.49	17.64	14.48	16.97	17.75	8.42
10/15/2013	4.07	3.71	0.95	0.95	1.57	1.35	0.50	17.76	14.58	16.86	17.96	9.53
10/16/2013	4.52	3.84	1.03	0.97	2.03	1.45	0.53	17.79	14.75	16.96	18.05	9.45
10/17/2013	4.84	3.99	1.10	0.99	2.26	1.56	0.56	17.85	14.85	17.30	17.73	10.38
10/18/2013	5.45	4.22	1.33	1.03	2.40	1.70	0.56	17.94	15.00	17.72	17.65	10.97
10/19/2013	5.54	4.42	1.35	1.06	2.55	1.81	0.54	18.06	15.00	17.42	18.05	10.77
10/20/2013	5.68	4.60	1.41	1.10	2.82	1.93	0.52	18.25	15.08	17.49	18.18	10.77
10/21/2013	5.73	4.75	1.43	1.14	2.99	2.04	0.51	18.42	15.11	17.69	18.37	11.40
10/22/2013	4.82	4.79	1.18	1.16	2.25	2.08	0.54	18.55	15.09	17.59	18.50	10.70
10/23/2013	5.94	4.87	1.67	1.19	2.94	2.15	0.65	18.68	15.11	17.28	18.45	11.50
10/24/2013	5.98	4.95	1.73	1.23	3.22	2.25	0.70	18.78	15.13	17.78	18.43	12.17

Electrical Conductivity (EC) units: milliSiemens per Centimeter
Chloride (Cl) units: milligrams per liter
mht : mean high tides
md : mean daily
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e : estimated value

Delta Water Quality Conditions

Date	Bethel Island mdEC	Farrar Park mdEC	Holland Tract mdEC	Bacon Island mdEC	Contra Costa mdEC	Clifton Court mdEC	Tracy Pumping Plant mdEC	Antioch mdCl	Bacon Island mdCl	Contra Costa mdCl	Delta Status
09/25/2013	0.82	1.01	0.71	0.66	0.86	0.57	0.58	853	136	209	b
09/26/2013	0.82	0.99	0.70	0.66	0.93	0.58	0.57	763	135	212	b
09/27/2013	0.79	0.98	0.67	0.66	0.93	0.55	0.58	685	135	212	b
09/28/2013	0.75	0.96	0.63	0.65	0.93	0.55	0.58	723	132	202	b
09/29/2013	0.73	0.94	0.61	0.62	0.93	0.55	0.56	764	123	202	b
09/30/2013	0.72	0.92	0.60	0.59	0.92	0.54	0.52	809	117	202	b
10/01/2013	0.71	0.90	0.60	0.57	0.93	0.55	0.52	851	112	211	b
10/02/2013	0.71	0.89	0.59	0.56	0.90	0.53	0.51	819	109	204	b
10/03/2013	0.70	0.87	0.59	0.55	0.90	0.53	0.51	776	107	190	b
10/04/2013	0.69	0.85	0.57	0.56	0.89	0.52	0.50	649	108	182	b
10/05/2013	0.66	0.83	0.54	0.56	0.89	0.51	0.50	803	109	190	b
10/06/2013	0.65	0.82	0.53	0.54	0.85	0.52	0.50	943	104	182	b
10/07/2013	0.64	0.81	0.53	0.53	0.80	0.51	0.50	1,094	99	188	b
10/08/2013	0.64	0.80	0.53	0.51	0.77	0.50	0.50	1,264	95	165	b
10/09/2013	0.65	0.81	0.52	0.50	0.76	0.50	0.50	1,471	93	168	b
10/10/2013	0.65	0.81	0.50	0.50	0.73	0.50	0.50	1,469	92	168	b
10/11/2013	0.65	0.80	0.50	0.49	0.70	0.50	0.51	1,347	91	158	b
10/12/2013	0.65	0.80	0.50	0.49	0.69	0.51	0.51	1,290	90	153	b
10/13/2013	0.65	0.79	0.49	0.49	0.67	0.50	0.51	1,271	90	149	b
10/14/2013	0.65	0.78	0.49	0.49	0.64	0.49	0.51	1,152	90	147	b
10/15/2013	0.64	0.78	NR	0.49	0.64	0.50	0.51	1,225	89	137	b
10/16/2013	0.64	0.79	NR	0.49	0.63	0.49	0.51	1,369	89	131	b
10/17/2013	0.65	0.80	NR	0.48	0.62	0.48	0.52	1,471	88	129	b
10/18/2013	0.67	0.82	0.55	0.48	0.61	0.48	0.52	1,665	88	128	b
10/19/2013	0.68	0.83	0.55	0.48	0.59	0.45	0.53	1,694	88	128 e	b
10/20/2013	0.70	0.86	0.55	0.48	0.59	0.46	0.52	1,739	88	128 e	b
10/21/2013	0.71	0.87	0.56	0.49	0.59	0.46	0.52	1,754	89	121	b
10/22/2013	0.70	0.84	0.55	0.49	0.59	0.46	0.55	1,465	89	121	b
10/23/2013	0.74	0.93	0.58	0.49	0.58	0.46	0.52	1,821	90	118	b
10/24/2013	0.77	0.96	0.57	0.50	0.57	0.48	0.51	1,835	91	115	b

Electrical Conductivity (EC) units: milliSiemens per Centimeter
Chloride (Cl) units: milligrams per liter
md : mean daily
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e : estimated value
Antioch and Bacon Island mdCl are calculated from the respective mdEC values.

Coordinated Operation Agreement Delta Status:
(Note: below label begins on October 1, 2013)
c = excess Delta conditions
b = balanced Delta conditions
r = excess Delta conditions with restrictions:

Delta Water Quality Conditions

South Delta Stations

Date	Vernalis		Brandt Bridge		Old River Near Tracy		Old River Near Middle River	
	md EC	30 day avg	md EC	30 day avg	md EC	30 day avg	md EC	30 day avg
09/25/2013	0.31	0.55	0.54	0.67	0.85	0.84	0.45	0.63
09/26/2013	0.32	0.54	0.40	0.66	0.80	0.84	0.36	0.62
09/27/2013	0.31	0.53	0.36	0.65	0.71	0.84	0.35	0.61
09/28/2013	0.28	0.52	0.37	0.64	0.66	0.83	0.37	0.61
09/29/2013	0.30	0.51	0.36	0.63	0.65	0.83	0.36	0.60
09/30/2013	0.40	0.51	0.34	0.62	0.60	0.82	0.34	0.59
10/01/2013	0.50	0.50	0.35	0.60	0.63	0.82	0.36	0.58
10/02/2013	0.55	0.50	0.42	0.59	0.60	0.81	0.43	0.57
10/03/2013	0.58	0.50	0.50	0.58	0.60	0.80	0.52	0.56
10/04/2013	0.62	0.50	0.58	0.58	0.63	0.80	0.57	0.56
10/05/2013	0.58	0.50	0.64	0.58	0.64	0.79	0.63	0.56
10/06/2013	0.58	0.51	0.65	0.57	0.69	0.78	0.66	0.56
10/07/2013	0.61	0.51	0.68	0.57	0.74	0.78	0.67	0.56
10/08/2013	0.64	0.51	0.66	0.57	0.81	0.78	0.65	0.56
10/09/2013	0.58	0.51	0.66	0.57	0.86	0.78	0.66	0.56
10/10/2013	0.61	0.51	0.70	0.57	0.88	0.78	0.69	0.56
10/11/2013	0.66	0.52	0.71	0.57	0.90	0.79	0.69	0.56
10/12/2013	0.61	0.52	0.68	0.57	0.89	0.79	0.68	0.57
10/13/2013	0.65	0.53	0.70	0.58	0.86	0.79	0.71	0.57
10/14/2013	0.67	0.53	0.74	0.58	0.86	0.79	0.74	0.57
10/15/2013	0.62	0.53	0.71	0.58	0.86	0.79	0.71	0.58
10/16/2013	0.51	0.53	0.75	0.58	0.89	0.79	0.74	0.58
10/17/2013	0.52	0.53	0.75	0.59	0.91	0.79	0.72	0.59
10/18/2013	0.54	0.52	0.62	0.59	0.90	0.79	0.60	0.59
10/19/2013	0.63	0.53	0.59	0.59	0.90	0.79	0.58	0.59
10/20/2013	0.63	0.53	0.60	0.59	0.88	0.79	0.60	0.58
10/21/2013	0.58	0.52	0.68	0.59	0.83	0.79	0.68	0.58
10/22/2013	0.57	0.52	0.71	0.59	0.80	0.78	0.70	0.59
10/23/2013	0.55	0.53	0.67	0.59	0.80	0.78	0.67	0.59
10/24/2013	0.47	0.53	0.65	0.59	0.84	0.78	0.65	0.58

Electrical Conductivity (EC) units: milliSiemens per Centimeter
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Compliance Standards

for the Sacramento - San Joaquin Delta and Suisun Marsh
Tuesday, June 03, 2014

Criteria	Standard	Status
Flow/Operational		
% of inflow diverted	35 %	13 %
NDOI, 14 day average*	>= 4,000 cfs	
Water Quality		
Days @ CCWD PP#1 w/ chlorides <= 150 mg/l	155 days	123 days
Export Areas for SWP, CVP, CCWD, et al	<= 250 mg/l Cl	79 mg/l
14dm EC at Threemile Slough at Sac	<= 2.78 mS/cm	1.57 mS/cm
14dm EC at Jersey Point	<= 2.20 mS/cm	1.44 mS/cm
Maximum 30 day running average of mean daily EC at:		
Vernalis	<=0.7 mS/cm	0.2 mS/cm
Brandt Bridge	<=0.7 mS/cm	0.3 mS/cm
Old River Near Tracy	<=0.7 mS/cm	1.0 mS/cm
Old River Near Middle River	<=0.7 mS/cm	0.3 mS/cm

SUISUN MARSH:

Suisun Marsh Salinity Control Gates : 0 Open / 0 Closed / 3 Full Tide Open
Flashboard Status : In
Boat Lock Status : Open

California Hydrologic Conditions: (California Cooperative Snow Surveys Forecast, May 1, 2014)

Previous Month's Index (8RI for Apr): 1.712 MAF
Water Year Type: Critical
Sacramento valley water year type index (40/30/30) @ 50%: 4.0 MAF (Critical)
San Joaquin valley water year type index (60/20/20) @ 75%: 1.1 MAF (Critical)

Electrical Conductivity (EC) in milliSiemens per Centimeter.
Chlorides (Cl) in milligrams per liter
mht - mean high tides
md - mean daily
14 dm - fourteen day running mean
28 dm - twenty-eight day running mean
NR - No Record
NC - Average not computed due to insufficient data.
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Montezuma Slough Gate Operation:
Number of gates operating at either Open, Closed, or Full Tide Open
Flashboard Status : In, Out, or Modified In
Boat Lock Status : Open or Closed

Coordinated Operation Agreement Delta Status:
(Note: below label begins on October 1, 2013)
c = excess Delta conditions
b = balanced Delta conditions
r = excess Delta conditions with restrictions:

* NDOI, Rio Vista & Vernalis Flows:
- Monthly average is progressive daily mean.
- 7 day average is progressive daily mean for the first six days of the month.

Delta Water Quality Conditions

Date	Antioch Tides		Net Delta Outflow Index	Martinez	Port Chicago		Mallard	Chipps Island		Collinsville	
	High	Half	cfs	mdEC	mdEC	14dm	mdEC	mdEC	14dm	mdEC	14dm
05/05/2014	5.45	4.17	4,476	23.19	16.64	9.49	10.00	9.60	8.18	6.13	4.91
05/06/2014	5.06	3.92	3,943	22.08	15.43	10.37	9.43	8.99	8.23	5.61	4.97
05/07/2014	5.11	3.74	4,277	22.48	15.71	11.36	9.19	8.74	8.34	5.24	5.06
05/08/2014	5.25	3.74	3,520	23.77	15.93	12.35	9.32	8.88	8.48	5.23	5.16
05/09/2014	5.33	3.70	3,013	23.42	16.51	13.39	9.79	9.37	8.61	5.68	5.28
05/10/2014	5.48	3.68	3,438	23.84	16.46	14.43	9.78	9.37	8.73	5.75	5.36
05/11/2014	5.36	3.55	4,515	23.09	14.23	15.31	9.01	8.55	8.80	5.74	5.47
05/12/2014	5.53	3.62	4,437	24.14	16.99	15.87	9.42	8.98	8.93	5.94	5.59
05/13/2014	5.72	3.68	4,313	25.00	17.61	16.13	10.17	9.77	9.14	6.28	5.74
05/14/2014	5.91	3.82	4,025	25.35	18.42	16.42	11.07	10.74	9.35	6.95	5.90
05/15/2014	6.22	4.08	3,746	26.55	18.80	16.64	12.35	12.12	9.60	8.19	6.11
05/16/2014	6.36	4.25	2,927	27.33	19.67	16.89	13.39	13.25	9.89	9.27	6.35
05/17/2014	6.47	4.31	3,476	28.58	21.44	17.20	14.33	14.28	10.20	9.61	6.58
05/18/2014	6.36	4.36	3,741	28.63	19.43	17.38	14.38	14.34	10.50	9.69	6.81
05/19/2014	6.16	4.31	3,389	28.32	20.85	17.68	14.16	14.10	10.82	9.64	7.06
05/20/2014	5.81	4.16	3,511	27.56	19.88	17.99	13.48	13.34	11.13	8.90	7.29
05/21/2014	5.61	4.03	4,150	25.70	19.91	18.29	12.67	12.47	11.40	8.43	7.52
05/22/2014	5.80	4.05	3,536	26.05	18.41	18.47	12.98	12.80	11.68	8.36	7.74
05/23/2014	6.01	4.15	3,340	26.48	19.83	18.71	13.65	13.54	11.97	9.39	8.01
05/24/2014	6.07	4.15	3,223	27.41	16.55	18.71	13.97	13.88	12.30	9.71	8.29
05/25/2014	6.20	4.18	3,393	27.90	20.36	19.15	13.90	13.81	12.67	9.96	8.60
05/26/2014	6.28	4.20	3,665	27.98	20.24	19.38	14.17	14.10	13.04	10.05	8.89
05/27/2014	6.27	4.19	3,615	28.16	21.26	19.65	14.58	14.55	13.38	10.40	9.18
05/28/2014	6.26	4.04	3,611	27.61	19.33	19.71	14.08	14.01	13.61	9.80	9.39
05/29/2014	6.13	4.13	4,288	27.91	20.56	19.84	13.96	13.88	13.74	9.14	9.45
05/30/2014	6.27	4.31	3,924	28.60	21.25	19.95	14.76	14.76	13.85	10.48	9.54
05/31/2014	6.19	4.25	3,948	28.32	20.55	19.89	14.73	14.72	13.88	10.47	9.60
06/01/2014	6.06	4.34	4,232	27.92	19.37	19.88	14.57	14.54	13.89	10.43	9.65
06/02/2014	6.09	4.52	3,978	29.39	21.13	19.90	15.70	15.80	14.01	10.99	9.75
06/03/2014	5.66	4.29	3,407	28.79	19.74	19.89	14.47	14.43	14.09	9.93	9.82

Antioch Tides measured in feet above mean sea level.
Net Delta Ouflow Index calculated from equation as specified in D-1641, revised June 1995.
Chipps Island EC calculated from measurements recorded at Mallard Slough.
Electrical Conductivity (EC) units: milliSiemens per Centimeter
md : mean daily
14dm : fourteen day running mean
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e - estimated value

Delta Water Quality Conditions

Date	Antioch		Jersey Point		Threemile Slough		Cache Slough	Good Year Slough	Sunrise Club	Volanti Slough	Beldon Landing	Collinsville
	mdEC	14mdEC	mdEC	14mdEC	mdEC	14mdEC	mdEC	mhtEC	mhtEC	mhtEC	mhtEC	mhtEC
05/05/2014	3.03	2.32	0.67	0.55	0.63	NC	0.40	8.95	6.18	6.25	6.11	7.91
05/06/2014	2.65	2.35	0.62	0.56	0.57	NC	0.39	9.08	-0.01 m	6.50	6.57	6.70
05/07/2014	2.35	2.39	0.56	0.57	0.52	NC	0.40	9.29	6.77	6.83	6.81	6.35
05/08/2014	2.50	2.45	0.56	0.57	0.54	NC	0.43	9.46	6.74	3.65	6.64	6.60
05/09/2014	2.65	2.50	0.57	0.58	0.57	NC	0.52	9.64	6.81	6.59	6.16	7.24
05/10/2014	2.72	2.56	0.58	0.58	0.63	NC	0.56	9.83	6.75	6.91	5.86	7.36
05/11/2014	2.35	2.59	0.55	0.59	0.54	0.57	0.52	10.00	6.60	6.98	6.05	6.55
05/12/2014	2.63	2.64	0.58	0.59	0.59	0.58	0.52	10.17	7.23	7.45	6.30	7.26
05/13/2014	2.97	2.72	0.61	0.60	0.72 e	0.60	0.52	10.29	7.30	7.19	6.39	8.42
05/14/2014	3.46	2.81	0.70	0.61	0.84	0.63	0.44	10.25	7.82	7.35	6.59	8.85
05/15/2014	4.23	2.92	0.83	0.63	1.04	0.66	0.40	10.34	8.19	7.77	6.87	10.64
05/16/2014	4.77	3.06	1.00	0.66	1.30	0.71	0.42	10.55	8.44	7.87	6.70	11.14
05/17/2014	5.19	3.21	1.12	0.69	1.54	0.77	0.41	11.09	8.33	7.61	7.31	11.19
05/18/2014	5.64	3.37	1.24	0.73	1.62	0.83	0.42	11.67	8.58	7.09	8.01	11.56
05/19/2014	5.43	3.54	1.21	0.77	1.53	0.90	0.52	11.97	8.86	7.93	8.70	11.71
05/20/2014	5.03	3.71	1.12	0.80	1.32	0.95	0.50	12.25	9.31	8.57	9.47	10.94
05/21/2014	4.40	3.85	1.01	0.83	1.12	0.99	0.54	12.32	10.27	8.59	9.72	10.52
05/22/2014	4.53	4.00	1.05	0.87	1.16	1.04	0.50	12.38	10.21	9.62	9.55	10.80
05/23/2014	4.85	4.16	1.15	0.91	1.35	1.09	0.51	12.60	10.75	10.10	9.05	11.40
05/24/2014	5.13	4.33	1.22	0.96	1.49	1.15	0.46	12.81	10.47	10.10	9.08	11.53
05/25/2014	5.20	4.53	1.25	1.01	1.58	1.23	0.41	12.98	10.48	9.95	9.10	11.44
05/26/2014	5.40	4.73	1.35	1.06	1.66	1.30	0.39	13.18	10.32	10.14	9.55	11.68
05/27/2014	5.60	4.92	1.37	1.12	1.74	1.38	0.36	13.27	10.23	10.33	9.96	12.18
05/28/2014	5.62	5.07	1.40	1.17	1.66	1.44	0.33	13.44	9.71	10.21	10.12	11.48
05/29/2014	5.60	5.17	1.31	1.20	1.58	1.47	0.34	13.40	9.79	10.50	10.62	11.82
05/30/2014	6.25	5.28	1.66	1.25	1.80	1.51	0.33	13.38	10.32	10.36	10.33	12.31
05/31/2014	6.13	5.34	1.76	1.29	1.80	1.53	0.34	13.49	9.41	9.92	10.12	12.01
06/01/2014	6.17	5.38	1.82	1.33	1.69	1.53	0.41	13.59	9.85	10.12	10.24	12.19
06/02/2014	6.68	5.47	2.11	1.40	1.87	1.56	0.43	13.60	9.69	9.64	10.57	12.99
06/03/2014	6.01	5.54	1.74	1.44	1.55	1.57	0.44	13.67	9.95	10.27	10.99	11.86

Electrical Conductivity (EC) units: milliSiemens per Centimeter
Chloride (Cl) units: milligrams per liter
mht : mean high tides
md : mean daily
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e : estimated value

Delta Water Quality Conditions

Date	Emmaton mdEC	Bethel Island mdEC	Farrar Park mdEC	Holland Tract mdEC	Bacon Island mdEC	Contra Costa mdEC	Clifton Court mdEC	Tracy Pumping Plant mdEC	Antioch mdCl	Bacon Island mdCl	Contra Costa mdCl	Delta Status
05/05/2014	1.52	0.43	0.53	0.42	0.41	0.42	0.47	0.44	896	69	61	b
05/06/2014	1.25	0.44	0.54	0.43	0.41	0.42	0.46	0.44	773	70	61	b
05/07/2014	1.15	0.44	0.54	0.43	0.42	0.42	0.46	0.43	679	71	61	b
05/08/2014	1.21	0.44	0.54	0.44	0.42	0.42	0.46	0.43	726	72	61	b
05/09/2014	1.25	0.45	0.55	0.44	0.42	0.43	0.45	0.45	774	72	65	b
05/10/2014	1.25	0.46	0.55	0.44	0.43	0.43	0.47	0.46	796	73	62	b
05/11/2014	1.01	0.46	0.54	0.44	0.43	0.43	0.48	0.47	678	73	62	b
05/12/2014	1.30	0.45	0.55	0.44	0.43	0.43	0.48	0.46	766	74	63	b
05/13/2014	1.59	0.45	0.55	0.44	0.43	0.44	0.48	0.46	877	75	63	b
05/14/2014	1.89	0.46	0.55	0.44	0.43	0.47	0.48	0.46	1,033	75	64	b
05/15/2014	2.34	0.46	0.56	0.44	0.43	0.49	0.48	0.47	1,279	75	68	b
05/16/2014	2.93	0.48	0.57	0.45	0.43	0.51	0.48	0.47	1,449	75	70	b
05/17/2014	3.40	0.49	0.58	0.45	0.43	0.52	0.48	0.47	1,583	74	73	b
05/18/2014	3.56	0.51	0.63	0.46	0.43	0.53	0.47	0.47	1,726	75	74	b
05/19/2014	3.40	0.52	0.65	0.47	0.43	0.54	0.47	0.46	1,658	75	75	b
05/20/2014	2.78	0.53	0.67	0.48	0.44	0.55	0.47	0.46	1,533	75	75	b
05/21/2014	2.37	0.55	0.65	0.49	0.44	0.56	0.46	0.45	1,331	76	76	b
05/22/2014	2.51	0.56	0.67	0.50	0.45	0.56	0.48	0.46	1,372	78	76	b
05/23/2014	2.81	0.59	0.71	0.52	0.46	0.55	0.49	0.47	1,475	81	75	b
05/24/2014	3.10	0.60	0.73	0.54	0.46	0.55	0.49	0.48	1,565	83	75 e	b
05/25/2014	3.37	0.63	0.75	0.56	0.48	0.55	0.49	0.48	1,588	86	75 e	b
05/26/2014	3.43	0.65	0.79	0.58	0.48	0.55	0.48	0.48	1,648	88	75 e	b
05/27/2014	3.62	0.67	0.81	0.59	0.49	0.55	0.48	0.48	1,712	91	75	b
05/28/2014	3.33	0.69	0.84	0.62	0.50	0.55	0.48	0.48	1,718	93	78	b
05/29/2014	3.16	0.71	0.85	0.63	0.52	0.56	0.48	0.48	1,713	97	77	b
05/30/2014	3.64	0.74	0.89	0.65	0.54	0.57	0.48	0.48	1,922	103	78	b
05/31/2014	3.63	0.77	0.88	0.65	0.56	0.57	0.49	0.33	1,884	108	78 e	b
06/01/2014	3.59	0.79	0.91	0.65	0.57	0.57	0.49	0.03	1,897	110	78 e	b
06/02/2014	3.83	0.84	0.97	0.67	0.58	0.57	0.49	0.39	2,057	113	79	b
06/03/2014	3.13	0.81	0.97	0.68	0.58	0.57	0.50	0.50	1,845	112	79	b

Electrical Conductivity (EC) units: milliSiemens per Centimeter
Chloride (Cl) units: milligrams per liter
md : mean daily
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e : estimated value
Antioch and Bacon Island mdCl are calculated from the respective mdEC values.

Coordinated Operation Agreement Delta Status:
(Note: below label begins on October 1, 2013)
c = excess Delta conditions
b = balanced Delta conditions
r = excess Delta conditions with restrictions:

Delta Water Quality Conditions

South Delta Stations

Date	Vernalis		Brandt Bridge		Old River Near Tracy		Old River Near Middle River	
	md EC	30 day avg	md EC	30 day avg	md EC	30 day avg	md EC	30 day avg
05/05/2014	0.18	0.44	0.19	0.45	1.09	1.17	0.19	0.50
05/06/2014	0.18	0.41	0.20	0.43	1.10	1.17	0.20	0.48
05/07/2014	0.18	0.38	0.20	0.41	1.12	1.17	0.21	0.45
05/08/2014	0.15	0.34	0.21	0.40	1.13	1.17	0.21	0.42
05/09/2014	0.15	0.31	0.19	0.37	1.14	1.17	0.21	0.39
05/10/2014	0.14	0.28	0.18	0.35	1.16	1.16	0.19	0.35
05/11/2014	0.13	0.25	0.17	0.32	1.15	1.16	0.19	0.32
05/12/2014	0.13	0.23	0.16	0.28	1.14	1.16	0.18	0.29
05/13/2014	0.12	0.21	0.16	0.25	1.16	1.15	0.17	0.26
05/14/2014	0.13	0.19	0.15	0.22	1.16	1.15	0.17	0.24
05/15/2014	0.11	0.17	0.15	0.20	1.14	1.15	0.16	0.22
05/16/2014	0.12	0.16	0.15	0.19	1.13	1.14	0.16	0.20
05/17/2014	0.16	0.16	0.14	0.17	1.09	1.13	0.14	0.18
05/18/2014	0.21	0.15	0.17	0.17	1.07	1.13	0.15	0.18
05/19/2014	0.24	0.16	0.20	0.17	1.03	1.12	0.19	0.17
05/20/2014	0.23	0.16	0.24	0.17	1.02	1.11	0.23	0.18
05/21/2014	0.21	0.16	0.29	0.18	0.99	1.10	0.28	0.18
05/22/2014	0.24	0.16	0.32	0.18	0.95	1.09	0.33	0.19
05/23/2014	0.25	0.17	0.34	0.19	0.93	1.08	0.34	0.19
05/24/2014	0.26	0.17	0.34	0.19	0.89	1.07	0.35	0.20
05/25/2014	0.27	0.18	0.35	0.20	0.89	1.07	0.35	0.21
05/26/2014	0.24	0.18	0.36	0.21	0.84	1.06	0.37	0.21
05/27/2014	0.26	0.19	0.38	0.22	0.85	1.05	0.38	0.22
05/28/2014	0.30	0.19	0.39	0.23	0.81	1.04	0.39	0.23
05/29/2014	0.32	0.19	0.39	0.23	0.80	1.04	0.39	0.24
05/30/2014	0.28	0.20	0.40	0.24	0.81	1.03	0.40	0.24
05/31/2014	0.28	0.20	0.40	0.25	0.80	1.02	0.39	0.25
06/01/2014	0.30	0.20	0.40	0.25	0.81	1.01	0.41	0.26
06/02/2014	0.32	0.21	0.41	0.26	0.85	1.00	0.43	0.27
06/03/2014	0.31	0.21	0.42	0.27	0.87	1.00	0.47	0.27

Electrical Conductivity (EC) units: milliSiemens per Centimeter
md : mean daily
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e : estimated value

Compliance Standards

for the Sacramento - San Joaquin Delta and Suisun Marsh
Wednesday, July 02, 2014

Criteria	Standard	Status
Flow/Operational		
% of inflow diverted	65 %	16 %
NDOI, monthly average *	>= 3,000 cfs	3,772 cfs
Water Quality		
Days @ CCWD PP#1 w/ chlorides <= 150 mg/l	155 days	152 days
Export Areas for SWP, CVP, CCWD, et al	<= 250 mg/l Cl	99 mg/l
14dm EC at Threemile Slough at Sac	<= 2.78 mS/cm	1.33 mS/cm
14dm EC at Jersey Point	<= 2.20 mS/cm	1.35 mS/cm
Maximum 30 day running average of mean daily EC at:		
Vernalis	<=0.7 mS/cm	0.4 mS/cm
Brandt Bridge	<=0.7 mS/cm	0.5 mS/cm
Old River Near Tracy	<=0.7 mS/cm	1.0 mS/cm
Old River Near Middle River	<=0.7 mS/cm	0.6 mS/cm

SUISUN MARSH:

Suisun Marsh Salinity Control Gates : 3 Open / 0 Closed / 0 Full Tide Open
Flashboard Status : Out
Boat Lock Status : Closed

California Hydrologic Conditions: (California Cooperative Snow Surveys Forecast, May 1, 2014)

Previous Month's Index (8RI for Apr): 1.712 MAF
Water Year Type: Critical
Sacramento valley water year type index (40/30/30) @ 50%: 4.0 MAF (Critical)
San Joaquin valley water year type index (60/20/20) @ 75%: 1.1 MAF (Critical)

Electrical Conductivity (EC) in milliSiemens per Centimeter.
Chlorides (Cl) in milligrams per liter
mht - mean high tides
md - mean daily
14 dm - fourteen day running mean
28 dm - twenty-eight day running mean
NR - No Record
NC - Average not computed due to insufficient data.
BR : Below Rating
e - estimated value

Montezuma Slough Gate Operation:
Number of gates operating at either Open, Closed, or Full Tide Open
Flashboard Status : In, Out, or Modified In
Boat Lock Status : Open or Closed

Coordinated Operation Agreement Delta Status:
(Note: below label begins on October 1, 2013)
c = excess Delta conditions
b = balanced Delta conditions
r = excess Delta conditions with restrictions:

* NDOI, Rio Vista & Vernalis Flows:
- 14 day average is progressive daily mean for the first thirteen days of the month.

Delta Water Quality Conditions

Date	Antioch Tides		Net Delta Outflow Index	Martinez	Port Chicago		Mallard	Chipps Island		Collinsville	
	High	Half	cfs	mdEC	mdEC	14dm	mdEC	mdEC	14dm	mdEC	14dm
06/03/2014	5.66	4.29	3,407	28.79	19.74	19.89	14.47	14.43	14.09	9.93	9.82
06/04/2014	5.35	4.16	4,591	27.20	19.00	19.83	13.36	13.21	14.14	8.99	9.86
06/05/2014	5.66	4.22	4,248	27.47	18.32	19.82	13.60	13.48	14.19	9.26	9.93
06/06/2014	5.90	4.28	4,086	29.29	18.61	19.73	13.88	13.79	14.21	9.68	9.95
06/07/2014	6.01	4.25	4,565	28.65	17.46	19.80	13.82	13.72	14.20	9.62	9.94
06/08/2014	6.05	4.13	4,796	27.88	17.81	19.62	12.86	12.67	14.12	8.58	9.84
06/09/2014	6.28	4.23	4,840	28.48	18.70	19.51	13.16	13.00	14.04	8.80	9.76
06/10/2014	6.56	4.62	4,202	30.47	21.02	19.49	15.39	15.45	14.10	10.77	9.78
06/11/2014	7.07	4.88	3,628	31.62	21.73	19.66	16.60	16.80	14.30	11.90	9.93
06/12/2014	6.99	4.64	3,762	31.77	20.29	19.64	15.93	16.05	14.46	11.03	10.07
06/13/2014	6.81	4.38	4,203	30.00 e	17.00 e	19.34	14.50 e	14.47 e	14.44	9.00 e	9.96
06/14/2014	6.60	4.30	4,138	29.99	15.12	18.95	14.12	14.05	14.39	8.44	9.82
06/15/2014	6.61	4.42	4,254	30.81	20.28	19.02	14.98	15.00	14.42	9.81	9.77
06/16/2014	6.50	4.43	4,503	30.40	19.95	18.93	15.20	15.24	14.38	9.54	9.67
06/17/2014	6.07	4.22	4,853	29.07	17.98	18.81	13.49	13.36	14.31	9.14	9.61
06/18/2014	5.58	3.99	5,638	27.67	18.04	18.74	12.43	12.21	14.23	8.34	9.57
06/19/2014	5.77	4.05	5,389	27.51	16.66	18.62	12.61	12.40	14.16	8.33	9.50
06/20/2014	6.00	4.05	5,290	27.49	18.80	18.63	12.72	12.52	14.07	8.42	9.41
06/21/2014	6.29	4.21	5,001	28.90	20.46	18.85	13.20	13.05	14.02	8.49	9.33
06/22/2014	6.29	4.25	4,979	28.45	20.96	19.07	13.26	13.11	14.05	8.73	9.34
06/23/2014	6.37	4.30	5,050	29.00	21.25	19.25	13.32	13.17	14.06	9.02	9.35
06/24/2014	6.44	4.43	5,336	29.69	21.72	19.30	13.89	13.80	13.94	9.16	9.24
06/25/2014	6.58	4.48	5,321	29.83	21.90	19.32	12.83	12.64	13.65	9.21	9.05
06/26/2014	6.55	4.44	5,610	29.81	21.38	19.39	13.54	13.42	13.46 e	8.91	8.89
06/27/2014	6.45	4.40	6,093	29.41	21.05	19.68	13.29	13.14	13.36	8.71	8.87
06/28/2014	6.39	4.37	6,055	29.23	19.48	19.99	12.80	12.61	13.26	8.39	8.87
06/29/2014	6.23	4.33	5,407	28.31	19.82	19.96	12.22	11.98	13.05	7.76	8.72
06/30/2014	6.19	4.52	5,195	28.34	20.32	19.99	12.44	12.22	12.83	7.89	8.61
07/01/2014	6.36	4.89	4,042	31.17	21.23	20.22	14.14	14.07	12.88	9.47	8.63
07/02/2014	5.97	4.64	3,503	30.09	19.77	20.34	13.13	12.97	12.93	8.89	8.67

Antioch Tides measured in feet above mean sea level.
Net Delta Ouflow Index calculated from equation as specified in D-1641, revised June 1995.
Chipps Island EC calculated from measurements recorded at Mallard Slough.
Electrical Conductivity (EC) units: milliSiemens per Centimeter
md : mean daily
14dm : fourteen day running mean
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e - estimated value

Delta Water Quality Conditions

Date	Antioch		Jersey Point		Threemile Slough		Cache Slough	Good Year Slough	Sunrise Club	Volanti Slough	Beldon Landing	Collinsville
	mdEC	14mdEC	mdEC	14mdEC	mdEC	14mdEC	mdEC	mhtEC	mhtEC	mhtEC	mhtEC	mhtEC
06/03/2014	6.01	5.54	1.74	1.44	1.55	1.57	0.44	13.67	9.95	10.27	10.99	11.86
06/04/2014	5.59	5.63	1.68	1.49	1.22	1.58	0.41	13.76	10.39	11.27	11.82	10.62
06/05/2014	5.69	5.71	1.70	1.54	1.20	1.58	0.45	13.90	10.59	11.89	12.61	11.05
06/06/2014	5.83	5.78	1.84	1.59	1.30	1.58	0.43	14.18	11.00	12.41	13.11	11.70
06/07/2014	5.67	5.82	1.81	1.63	1.31	1.57	0.41	14.54	11.43	14.12	13.08	10.97
06/08/2014	5.43	5.83	1.65	1.66	1.29	1.55	0.38	15.02	12.07	14.99	13.65	9.52
06/09/2014	5.61	5.85	1.55	1.67	1.43	1.53	0.37	15.57	12.88	14.76	14.56	10.16
06/10/2014	6.60	5.92	2.17	1.73	1.94	1.54	0.33	16.05	13.50	14.65	15.45	11.16
06/11/2014	7.27	6.04	2.69	1.82	2.63	1.61	0.33	16.68	14.00	14.91	15.85	13.21
06/12/2014	6.93	6.13	2.24	1.89	2.29	1.66	0.33	17.74	14.97	15.48	16.10	12.48
06/13/2014	6.00 e	6.12	2.00 e	1.91	1.96	1.68	0.33 e	18.34	14.71	15.81	16.48	12.00 e
06/14/2014	5.96	6.10	1.58	1.90	1.70	1.67	0.33	18.31	14.70	15.64	16.50	12.00 e
06/15/2014	6.24	6.11	1.92	1.90	1.98	1.69	0.32	18.26	15.32	15.51	17.09	11.40
06/16/2014	6.14	6.07	1.83	1.88	2.05	1.70	0.45	18.25	15.80	15.12	17.21	11.12
06/17/2014	5.42	6.03	1.56	1.87	1.70	1.71	0.51	18.27	15.50	15.34	17.40	10.62
06/18/2014	4.83	5.97	1.37	1.85	1.38	1.72	0.48	18.25	15.11	15.05	17.34	10.07
06/19/2014	4.68	5.90	1.38	1.83	1.35	1.74	0.51	18.26	15.04	15.64	17.17	10.30
06/20/2014	4.66	5.82	1.31	1.79	1.32	1.74	0.47	18.18	15.59	16.75	16.92	9.74
06/21/2014	5.01	5.77	1.31	1.75	1.40	1.74	0.45	17.88	15.84	16.63	17.05	10.21
06/22/2014	5.15	5.75	1.29	1.73	1.49	1.76	0.52	17.77	15.98	16.37	17.19	9.36
06/23/2014	5.17	5.72	1.30	1.71	1.45	1.76	0.57	17.74	15.99	16.57	17.01	10.36
06/24/2014	5.44	5.64	1.52	1.66	1.49	1.73	0.53	17.69	16.09	16.20	17.19	9.90
06/25/2014	5.56	5.51	1.56	1.58	1.59	1.65	0.45	17.71	15.91	16.42	17.60	10.11
06/26/2014	5.39	5.40	1.52	1.53	1.46	1.59	0.41	17.90	16.16	16.00	17.69	10.21
06/27/2014	5.04	5.34	1.40	1.49	1.32	1.55	0.35	18.03	16.17	16.30	17.48	9.75
06/28/2014	4.70	5.25	1.30	1.47	1.18	1.51	0.32	18.02	16.35	16.02	17.61	9.36
06/29/2014	4.32	5.11	1.17	1.42	1.07	1.45	0.38	18.02	16.36	16.06	17.66	8.80
06/30/2014	4.53	4.99	1.23	1.37	1.07	1.38	0.44	17.97	16.44	15.77	17.67	9.48
07/01/2014	5.21	4.98	1.44	1.36	1.28	1.35	0.39	17.84	16.57	15.77	17.64	11.05
07/02/2014	4.69	4.97	1.19	1.35	1.10	1.33	0.36	18.65	16.45	15.49	17.57	10.33

Electrical Conductivity (EC) units: milliSiemens per Centimeter
Chloride (Cl) units: milligrams per liter
mht : mean high tides
md : mean daily
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e : estimated value

Delta Water Quality Conditions

Date	Emmaton mdEC	Bethel Island mdEC	Farrar Park mdEC	Holland Tract mdEC	Bacon Island mdEC	Contra Costa mdEC	Clifton Court mdEC	Tracy Pumping Plant mdEC	Antioch mdCl	Bacon Island mdCl	Contra Costa mdCl	Delta Status
06/03/2014	3.13	0.81	0.97	0.68	0.58	0.57	0.50	0.50	1,845	112	79	b
06/04/2014	2.58	0.85	0.98	0.70	0.58	0.58	0.50	0.51	1,711	114	79	b
06/05/2014	2.51	0.88	1.03	0.74	0.60	0.58	0.51	0.51	1,742	120	80	b
06/06/2014	2.58	0.92	1.13	0.77	0.63	0.59	0.52	0.52	1,786	127	80	b
06/07/2014	2.61	0.94	1.19	0.81	0.65	0.59	0.53	0.53	1,736	133	82	b
06/08/2014	2.51	0.98	1.21	0.84	0.67	0.59	0.54	0.53	1,661	136	83	b
06/09/2014	2.82	0.99	1.23	0.85	0.69	0.61	0.54	0.53	1,718	141	82	b
06/10/2014	3.73	1.02	1.39	0.89	0.73	0.61	0.56	0.54	2,033	153	85	b
06/11/2014	4.76	1.08	1.49	0.91	0.75	0.60	0.58	0.53	2,246	159	82	b
06/12/2014	4.45	1.12	1.51	0.92	0.75	0.64	0.58	0.54	2,136	158	80	b
06/13/2014	3.00 e	1.12 e	1.30 e	0.90 e	0.80 e	0.65 e	0.60 e	0.54 e	1,841 e	171 e	88	b
06/14/2014	2.66	1.12	1.30	0.93	0.78	0.65	0.60	0.54	1,829	165	85	b
06/15/2014	3.97	1.11	1.39	0.96	0.80	0.64	0.61	0.54	1,917	172	82	b
06/16/2014	4.11	1.12	1.38	0.95	0.81	0.64	0.61	0.54	1,886	174	82	b
06/17/2014	3.39	1.10	1.32	0.94	0.81	0.63	0.62	0.54	1,657	175	88	b
06/18/2014	2.76	1.07	1.27	0.94	0.82	0.63	0.63	0.54	1,468	175	88	b
06/19/2014	2.70	1.04	1.26	0.93	0.81	0.62	0.64	0.54	1,421	175	88	b
06/20/2014	2.61	1.04	1.25	0.92	0.82	0.62	0.65	0.54	1,415	176	88	b
06/21/2014	2.88	1.04	1.25	0.93	0.83	0.61	0.66	0.54	1,526	178	85	b
06/22/2014	2.85	1.03	1.24	0.91	0.82	0.61	0.67	0.54	1,570	178	85	b
06/23/2014	2.80	1.02	1.24	0.91	0.82	0.62	0.67	0.54	1,576	177	85	b
06/24/2014	2.70	1.00	1.22	0.90	0.82	0.66	0.69	0.54	1,663	176	92	b
06/25/2014	3.03	0.98	1.24	0.89	0.81	0.63	0.69	0.54	1,702	175	95	b
06/26/2014	2.87	0.97	1.24	0.87	0.80	0.64	0.70	0.54	1,647	172	91	b
06/27/2014	2.72	0.95	1.22	0.87	0.79	0.64	0.71	0.54	1,535	169	92	b
06/28/2014	2.52	0.93	1.19	0.86	0.79	0.65	0.73	0.57	1,426	168	95	b
06/29/2014	2.19	0.91	1.17	0.85	0.78	0.67	0.74	0.73	1,307	166	97	b
06/30/2014	2.30	0.86	1.14	0.85	0.77	0.69	0.72	0.72	1,372	165	97	b
07/01/2014	2.93	0.81	1.16	0.85	0.77	0.70	0.71	0.70	1,590	162	93	b
07/02/2014	2.24	0.86	1.14	0.83	0.76	0.71	0.70	0.69	1,425	161	99	b

Electrical Conductivity (EC) units: milliSiemens per Centimeter
Chloride (Cl) units: milligrams per liter
md : mean daily
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e : estimated value
Antioch and Bacon Island mdCl are calculated from the respective mdEC values.

Coordinated Operation Agreement Delta Status:
(Note: below label begins on October 1, 2013)
c = excess Delta conditions
b = balanced Delta conditions
r = excess Delta conditions with restrictions:

Delta Water Quality Conditions

South Delta Stations

Date	Vernalis		Brandt Bridge		Old River Near Tracy		Old River Near Middle River	
	md EC	30 day avg	md EC	30 day avg	md EC	30 day avg	md EC	30 day avg
06/03/2014	0.31	0.21	0.42	0.27	0.87	1.00	0.47	0.27
06/04/2014	0.30	0.22	0.44	0.28	1.02	0.99	0.49	0.28
06/05/2014	0.30	0.22	0.45	0.28	1.10	0.99	0.51	0.29
06/06/2014	0.36	0.23	0.46	0.29	1.20	1.00	0.51	0.30
06/07/2014	0.38	0.23	0.46	0.30	1.22	1.00	0.51	0.31
06/08/2014	0.37	0.24	0.47	0.31	1.24	1.00	0.51	0.33
06/09/2014	0.37	0.25	0.48	0.32	1.25	1.01	0.52	0.34
06/10/2014	0.43	0.26	0.46	0.33	1.01	1.00	0.51	0.35
06/11/2014	0.43	0.27	0.44	0.34	0.90	0.99	0.54	0.36
06/12/2014	0.44	0.28	0.46	0.35	0.84	0.98	0.55	0.37
06/13/2014	0.40 e	0.29	0.48 e	0.36	0.80 e	0.97	0.55 e	0.38
06/14/2014	0.40	0.30	0.50	0.37	0.79	0.96	0.58	0.40
06/15/2014	0.38	0.31	0.50	0.38	0.80	0.95	0.59	0.41
06/16/2014	0.37	0.31	0.52	0.40	0.85	0.94	0.60	0.43
06/17/2014	0.37	0.32	0.54	0.41	0.91	0.94	0.60	0.44
06/18/2014	0.36	0.32	0.56	0.42	0.94	0.93	0.62	0.46
06/19/2014	0.35	0.33	0.57	0.43	0.94	0.93	0.62	0.47
06/20/2014	0.45	0.34	0.57	0.44	1.00	0.93	0.63	0.48
06/21/2014	0.42	0.34	0.56	0.45	0.95	0.93	0.63	0.49
06/22/2014	0.39	0.35	0.55	0.46	0.94	0.93	0.63	0.50
06/23/2014	0.45	0.35	0.56	0.46	0.91	0.93	0.64	0.51
06/24/2014	0.43	0.36	0.57	0.47	0.87	0.93	0.64	0.52
06/25/2014	0.46	0.37	0.58	0.48	0.85	0.93	0.64	0.53
06/26/2014	0.45	0.37	0.59	0.49	0.86	0.93	0.69	0.54
06/27/2014	0.44	0.38	0.60	0.49	0.89	0.93	0.79	0.55
06/28/2014	0.45	0.38	0.61	0.50	0.96	0.94	0.88	0.57
06/29/2014	0.42	0.39	0.63	0.51	0.99	0.95	0.91	0.59
06/30/2014	0.38	0.39	0.63	0.52	1.08	0.95	0.90	0.60
07/01/2014	0.40	0.39	0.63	0.52	1.05	0.96	0.86	0.62
07/02/2014	0.35	0.39	0.63	0.53	1.00	0.97	0.86	0.63

Electrical Conductivity (EC) units: milliSiemens per Centimeter
md : mean daily
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
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Compliance Standards

for the Sacramento - San Joaquin Delta and Suisun Marsh
Tuesday, August 04, 2015

Criteria	Standard	Status
Flow/Operational		
% of inflow diverted	65 %	8 %
NDOI, monthly average *	>= 3,000 cfs	3,774 cfs
NDOI, 7 day average*	>= 2,000 cfs	3,774 cfs
Water Quality		
Days @ CCWD PP#1 w/ chlorides <= 150 mg/l	155 days	124 days
Export Areas for SWP, CVP, CCWD, et al	<= 250 mg/l Cl	167 mg/l
14dm EC at Threemile Slough at Sac	<= 2.78 mS/cm	2.54 mS/cm
14dm EC at Jersey Point	<= 2.20 mS/cm	1.84 mS/cm
14dm EC at San Andreas Landing	<= 0.87 mS/cm	0.61 mS/cm
14dm EC at Terminous	<= 0.54 mS/cm	0.14 mS/cm
Maximum 30 day running average of mean daily EC at:		
Vernalis	<=0.7 mS/cm	0.7 mS/cm
Brandt Bridge	<=0.7 mS/cm	1.1 mS/cm
Old River Near Tracy	<=0.7 mS/cm	1.0 mS/cm
Old River Near Middle River	<=0.7 mS/cm	1.1 mS/cm

SUISUN MARSH:

Suisun Marsh Salinity Control Gates : 3 Open / 0 Closed / 0 Full Tide Open
Flashboard Status : Out
Boat Lock Status : Closed

California Hydrologic Conditions: (California Cooperative Snow Surveys Forecast, May 1, 2015)

Previous Month's Index (8RI for Apr): 766 TAF
Sacramento valley water year type index (40/30/30) @ 50%: 4.0 MAF (Critical)
San Joaquin valley water year type index (60/20/20) @ 75%: 0.7 MAF (Critical)

Electrical Conductivity (EC) in milliSiemens per Centimeter.
Chlorides (Cl) in milligrams per liter
mht - mean high tides
md - mean daily
14 dm - fourteen day running mean
NR - No Record
NC - Not Computed due to insufficient data
BR : Below Rating
e - estimated value

Montezuma Slough Gate Operation:
Number of gates operating at either Open, Closed, or Full Tide Open
Flashboard Status : In, Out, or Modified In
Boat Lock Status : Open or Closed

Coordinated Operation Agreement Delta Status:
c = excess Delta conditions
b = balanced Delta conditions
r = excess Delta conditions with restrictions:

* NDOI, Rio Vista & Vernalis Flows and Suisun Marsh mhtEC:
- 7 day average is progressive daily mean for the first six days of the month.
- Monthly average is progressive daily mean from the beginning of the month

Delta Water Quality Conditions

Date	Antioch Tides		Net Delta Outflow Index	Martinez	Port Chicago		Mallard	Chipps Island		Collinsville	
	High	Half	cfs	mdEC	mdEC	14dm	mdEC	mdEC	14dm	mdEC	14dm
07/06/2015	6.36	4.60	2,702	31.87	21.78	21.21	16.59	16.79	15.78	12.22	11.17
07/07/2015	6.14	4.42	3,311	30.36	20.13	21.29	15.97	16.09	16.01	11.26	11.35
07/08/2015	6.41	4.47	3,072	30.48	19.10	21.28	16.17	16.32	16.23 e	11.35	11.52
07/09/2015	6.44	4.42	2,854	30.48	21.09	21.38	15.75	15.85	16.39	11.09	11.66
07/10/2015	6.57	4.34	3,498	29.91	19.86	21.29	15.26	15.31	16.43	10.68	11.68
07/11/2015	6.72	4.48	3,851	30.15	21.75	21.26	15.84	15.96	16.41	11.25	11.65
07/12/2015	6.75	4.53	3,723	30.82	21.81	21.33	16.12	16.26	16.43	11.55	11.66
07/13/2015	6.81	4.59	4,018	30.83	21.95	21.34	15.86	15.98	16.45	11.54	11.70
07/14/2015	6.89	4.61	4,169	31.16	22.52	21.57	16.38	16.55	16.55	11.48	11.75
07/15/2015	6.84	4.64	3,911	30.77	20.98	21.52	16.10	16.24	16.56	11.57	11.77
07/16/2015	6.91	4.78	3,881	32.00	22.88	21.60	16.70	16.92	16.56	12.34	11.79
07/17/2015	6.80	4.80	3,682	31.39	22.42	21.59	16.81	17.04	16.53	12.23	11.76
07/18/2015	6.77	4.82	4,139	31.15	20.09	21.38	16.79	17.02	16.47	12.26	11.72
07/19/2015	6.26	4.42	4,202	30.09	16.68	20.93	14.99	15.01	16.24	10.44	11.52
07/20/2015	5.89	4.38	4,388	29.15	19.50	20.77	14.28	14.23	16.05	9.82	11.35
07/21/2015	6.02	4.52	3,359	29.86	20.47	20.79	14.95	14.96	15.97	10.30	11.28
07/22/2015	6.21	4.60	3,358	30.86	18.77	20.77	15.42	15.49	15.91	10.46	11.21
07/23/2015	6.09	4.44	3,149	29.69	18.79	20.60	14.50	14.46	15.81	9.65	11.11
07/24/2015	6.09	4.25	3,079	28.36	20.39	20.64	13.73	13.62	15.69	9.03	10.99
07/25/2015	6.36	4.34	3,024	29.19	20.13	20.53	14.21	14.15	15.57	9.73	10.89
07/26/2015	6.70	4.63	3,183	30.95	19.09	20.33	15.28	15.33	15.50	10.65	10.82
07/27/2015	6.72	4.61	2,775	29.83	17.19	19.99	15.06	15.09	15.43	9.64	10.69
07/28/2015	6.78	4.61	3,510	30.25	19.25	19.76	15.17	15.21	15.34	10.54	10.62
07/29/2015	6.87	4.71	3,365	30.72	21.93	19.83	16.01	16.14	15.33	11.36	10.60
07/30/2015	7.14	4.86	3,357	31.63	23.39	19.86	17.39	17.68	15.39	12.76	10.63
07/31/2015	7.14	4.80	3,521	31.40	22.71	19.88	17.22	17.49	15.42	12.70	10.67
08/01/2015	7.03	4.74	3,908	31.08	21.44	19.98	17.07	17.33	15.44	12.48	10.68
08/02/2015	6.79	4.67	3,823	31.04	18.14	20.08	16.87	17.10	15.59	12.16	10.81
08/03/2015	6.45	4.61	3,638	30.09	18.88	20.04	16.59	16.79	15.77	11.57	10.93
08/04/2015	6.11	4.41	3,725	30.46	17.23	19.81	15.68	15.77	15.83	10.89	10.97

Antioch Tides measured in feet relative to the NAVD88 Datum
Net Delta Ouflow Index calculated from equation as specified in D-1641, revised March 2000.
Chipps Island EC calculated from measurements recorded at Mallard Slough.
Electrical Conductivity (EC) units: milliSiemens per Centimeter
md : mean daily
14dm : fourteen day running mean
NR : No Record
NC : Not Computed due to insufficient data
BR : Below Rating
e - estimated value

Delta Water Quality Conditions

Date	Antioch		Jersey Point		Emmaton		Three Mile Slough		San Andreas Landing		Terminous	
	mdEC	14dm	mdEC	14dm	mdEC	14dm	mdEC	14dm	mdEC	14dm	mdEC	14dm
07/06/2015	7.29	6.65	2.42	2.12	5.77	4.62	3.61	2.77	0.62	0.65	0.14	0.16
07/07/2015	6.76	6.78	2.16	2.17	5.10	4.74	3.11	2.85	0.57	0.65	0.15	0.15
07/08/2015	6.90	6.91	2.10	2.20	5.18	4.89	3.21	2.94	0.55	0.65	0.15	0.15
07/09/2015	6.84	7.00	2.09	2.23	5.02	5.03	3.11	3.03	0.54	0.65	0.14	0.15
07/10/2015	6.66	7.02	1.98	2.24	4.66	5.10	2.77	3.09	0.54	0.64	0.14	0.15
07/11/2015	7.17	7.03	2.08	2.23	4.83	5.15	2.88	3.11	0.57	0.63	0.14	0.15
07/12/2015	7.37	7.08	2.30	2.24	5.20	5.21	3.00	3.15	0.61	0.63	0.14	0.15
07/13/2015	6.71	7.10	2.01	2.23	4.81	5.23	2.93	3.17	0.59	0.62	0.14	0.15
07/14/2015	6.99	7.15	1.97	2.23	5.01	5.27	2.94	3.20	0.58	0.62	0.14	0.15
07/15/2015	7.01	7.16	2.06	2.22	4.84	5.27	2.99	3.21	0.60	0.62	0.14	0.14
07/16/2015	7.15	7.13	2.18	2.21	5.21	5.27	3.10	3.20	0.63	0.61	0.14	0.14
07/17/2015	7.07	7.11	2.28	2.20	5.32	5.24	3.06	3.17	0.62	0.61	0.14	0.14
07/18/2015	7.06	7.06	2.28	2.18	5.34	5.20	3.03	3.13	0.62	0.60	0.14	0.14
07/19/2015	6.06	6.93	1.90	2.13	4.11	5.03	2.38	3.01	0.52	0.58	0.14	0.14
07/20/2015	5.73	6.82	1.59	2.07	3.75	4.88	2.14	2.90	0.50	0.57	0.14	0.14
07/21/2015	6.08	6.77	1.70	2.04	3.73	4.79	2.11	2.83	0.57	0.57	0.15	0.14
07/22/2015	6.38	6.73	1.62	2.00	3.54	4.67	2.13	2.75	0.61	0.58	0.14	0.14
07/23/2015	6.08	6.68	1.64	1.97	3.14	4.53	1.77	2.66	0.59	0.58	0.15	0.14
07/24/2015	5.84	6.62	1.57	1.94	2.68	4.39	1.50	2.57	0.58	0.58	0.15	0.14
07/25/2015	6.09	6.54	1.59	1.91	3.03	4.26	1.59	2.48	0.59	0.59	0.14	0.14
07/26/2015	6.45	6.48	1.66	1.86	3.76	4.16	2.01	2.41	0.63	0.59	0.14	0.14
07/27/2015	6.40	6.46	1.82	1.85	3.86	4.09	2.36	2.36	0.63	0.59	0.14	0.14
07/28/2015	6.57	6.43	1.74	1.83	4.11	4.03	2.51	2.33	0.63	0.59	0.14	0.14
07/29/2015	6.86	6.42	1.77	1.81	4.68	4.02	2.74	2.32	0.64	0.60	0.14	0.14
07/30/2015	7.52	6.44	2.26	1.82	5.39	4.03	3.24	2.33	0.67	0.60	0.14	0.14
07/31/2015	7.26	6.46	2.14	1.81	5.56	4.05	3.21	2.34	0.65	0.60	0.14	0.14
08/01/2015	7.13	6.46	2.13	1.79	5.69	4.07	3.30	2.36	0.62	0.60	0.14	0.14
08/02/2015	6.99	6.53	2.06	1.81	5.67	4.18	3.28	2.42	0.59	0.61	0.14	0.14
08/03/2015	6.96	6.61	1.97	1.83	5.51	4.31	3.17	2.49	0.56	0.61	0.14	0.14
08/04/2015	6.56	6.65	1.80	1.84	4.81	4.39	2.73	2.54	0.51	0.61	0.14	0.14

Electrical Conductivity (EC) units: milliSiemens per Centimeter
Chloride (Cl) units: milligrams per liter
md : mean daily
14dm : fourteen day running mean
NR : No Record
NC : Not Computed due to insufficient data
BR : Below Rating
e : estimated value

Delta Water Quality Conditions

Date	Bethel Island mdEC	Farrar Park mdEC	Holland Tract mdEC	Bacon Island mdEC	Contra Costa mdEC	Clifton Court mdEC	Tracy Pumping Plant mdEC	Antioch mdCl	Bacon Island mdCl	Contra Costa mdCl	Delta Status
07/06/2015	0.99	1.81	0.74	0.75	0.80	0.72	0.78	2,252	159	170	b
07/07/2015	0.97	1.81	0.72	0.75	0.80	0.72	0.77	2,082	158	169	b
07/08/2015	0.94	1.84	0.72	0.74	0.80	0.72	0.77	2,127	156	170	b
07/09/2015	0.95	1.80	0.70	0.74	0.80	0.71	0.77	2,110	155	171	b
07/10/2015	0.94	1.78	0.71	0.73	0.79	0.73	0.76	2,050	153	170	b
07/11/2015	0.95	1.82	0.72	0.73	0.79	0.73	0.77	2,213	152	170 e	b
07/12/2015	0.98	1.89	0.75	0.72	0.78	0.73	0.77	2,278	151	170 e	b
07/13/2015	0.98	1.85	0.75	0.73	0.79	0.73	0.77	2,066	152	172	b
07/14/2015	0.96	1.75	0.76	0.73	0.78	0.73	0.77	2,156	153	170	b
07/15/2015	0.95	1.76	0.77	0.73	0.78	0.73	0.76	2,162	153	169	b
07/16/2015	0.97	1.80	0.81	0.73	0.78	0.73	0.77	2,206	153	168	b
07/17/2015	1.02	1.75	0.79	0.73	0.78	0.73	0.77	2,181	154	169	b
07/18/2015	1.02	1.76	0.78	0.74	0.77	0.73	0.77	2,180	155	169 e	b
07/19/2015	0.99	1.68	0.75	0.74	0.77	0.73	0.76	1,861	155	169 e	b
07/20/2015	0.94	1.59	0.76	0.72	0.76	0.73	0.76	1,755	150	170	b
07/21/2015	0.93	1.59	0.77	0.74	0.77	0.73	0.76	1,865	155	167	b
07/22/2015	0.94	1.59	0.77	0.73	0.77	0.73	0.76	1,962	154	168	b
07/23/2015	0.93	1.56	0.75	0.73	0.77	0.73	0.76	1,865	153	168	b
07/24/2015	0.92	1.52	0.74	0.73	0.77	0.75	0.76	1,791	153	170	b
07/25/2015	0.91	1.54	0.74	0.72	0.77	0.77	0.76	1,869	151	170 e	b
07/26/2015	0.91	1.59	0.75	0.72	0.77	0.76	0.76	1,985	149	170 e	b
07/27/2015	0.92	1.59	0.76	0.71	0.77	0.76	0.76	1,969	148	172	b
07/28/2015	0.93	1.60	0.77	0.71	0.77	0.76	0.76	2,022	148	171	b
07/29/2015	0.92	1.63	0.77	0.71	0.77	0.76	0.76	2,116	147	178	b
07/30/2015	0.97	1.73	0.76	0.71	0.77	0.76	0.76	2,326	147	172	b
07/31/2015	0.97	1.79	0.77	0.71	0.77	0.75	0.76	2,242	147	171	b
08/01/2015	0.96	1.79	0.75	0.71	0.77	0.74	0.76	2,201	147	171 e	b
08/02/2015	0.95	1.77	0.73	0.71	0.76	0.73	0.76	2,156	147	171 e	b
08/03/2015	0.94	1.72	0.72	0.71	0.75	0.72	0.75	2,148	147	169	b
08/04/2015	0.93	1.66	0.71	0.70	0.75	0.72	0.75	2,019	146	167	b

Electrical Conductivity (EC) units: milliSiemens per Centimeter
Chloride (Cl) units: milligrams per liter
md : mean daily
NR : No Record
NC : Not Computed due to insufficient data
BR : Below Rating
e : estimated value
Antioch and Bacon Island mdCl are calculated from the respective mdEC values.

Coordinated Operation Agreement Delta Status:
- c = excess Delta conditions
- b = balanced Delta conditions
- r = excess Delta conditions with restrictions:

Delta Water Quality Conditions

South Delta Stations

Date	Vernalis		Brandt Bridge		Old River Near Tracy		Old River Near Middle River	
	mdEC	30dm	mdEC	30dm	mdEC	30dm	mdEC	30dm
07/06/2015	0.74	0.69	1.16	1.05	0.96	1.04	1.17	1.05
07/07/2015	0.87	0.70	1.14	1.05	0.96	1.04	1.17	1.06
07/08/2015	0.98	0.71	1.13	1.06	0.96	1.04	1.15	1.07
07/09/2015	0.66	0.71	1.13	1.07	0.95	1.03	1.12	1.09
07/10/2015	0.59	0.70	1.12	1.08	0.96	1.03	1.11	1.10
07/11/2015	0.57	0.70	1.12	1.08	0.95	1.03	1.11	1.11
07/12/2015	0.57	0.69	1.11	1.09	0.93	1.03	1.11	1.12
07/13/2015	0.56	0.69	1.10	1.09	0.92	1.02	1.11	1.13
07/14/2015	0.53	0.69	1.09	1.10	0.93	1.02	1.11	1.14
07/15/2015	0.52	0.68	1.08	1.10	0.95	1.02	1.12	1.15
07/16/2015	0.66	0.68	1.08	1.10	0.99	1.01	1.12	1.16
07/17/2015	0.78	0.68	1.08	1.10	0.99	1.01	1.11	1.16
07/18/2015	0.78	0.68	1.09	1.10	0.98	1.01	1.11	1.17
07/19/2015	0.75	0.68	1.08	1.10	0.96	1.01	1.11	1.17
07/20/2015	0.61	0.68	1.07	1.10	0.95	1.01	1.11	1.17
07/21/2015	0.83	0.69	1.07	1.10	0.95	1.01	1.11	1.16
07/22/2015	0.75	0.69	1.08	1.10	0.95	1.00	1.10	1.16
07/23/2015	0.55	0.68	1.08	1.10	0.98	1.00	1.11	1.15
07/24/2015	0.41	0.67	1.06	1.11	1.01	1.00	1.11	1.15
07/25/2015	0.54	0.67	1.06	1.11	1.06	0.99	1.12	1.14
07/26/2015	0.74	0.67	1.07	1.11	1.04	0.99	1.12	1.14
07/27/2015	0.80	0.67	1.07	1.11	1.01	0.99	1.11	1.13
07/28/2015	0.94	0.68	1.07	1.11	1.01	0.99	1.12	1.13
07/29/2015	0.87	0.69	1.08	1.10	0.97	0.99	1.09	1.13
07/30/2015	0.93	0.70	1.09	1.10	0.95	0.98	1.11	1.12
07/31/2015	0.71	0.71	1.10	1.10	0.93	0.98	1.11	1.12
08/01/2015	0.51	0.70	1.10	1.10	0.94	0.98	1.10	1.12
08/02/2015	0.36	0.68	1.10	1.10	0.94	0.97	1.09	1.12
08/03/2015	0.45	0.67	1.09	1.10	0.96	0.97	1.09	1.12
08/04/2015	0.54	0.67	1.08	1.09	0.98	0.97	1.09	1.11

Electrical Conductivity (EC) units: milliSiemens per Centimeter
md : mean daily
30dm : thirty day running mean
NR : No Record
NC : Not Computed due to insufficient data
BR : Below Rating
e : estimated value

Delta Water Quality Conditions

Suisun Marsh Stations

Date	Collinvsille mhtEC	National Steel mhtEC	Beldon Landing mhtEC	Sunrise Club mhtEC	Volanti Slough mhtEC	Goodyear Slough mhtEC
07/06/2015	12.99	14.39	19.31	18.29	15.86	21.77
07/07/2015	12.38	14.26	19.12	18.46	15.92	21.97
07/08/2015	12.80	14.67	18.96	18.64	16.18	22.09
07/09/2015	12.49	14.71	18.96	18.84	16.56	22.16
07/10/2015	11.91	14.67	19.26	18.82	16.76	22.09
07/11/2015	12.00	14.63	19.44	19.00	17.05	21.94
07/12/2015	12.67	14.90	19.47	19.25	17.15	21.90
07/13/2015	12.06	14.79	19.87	19.36	17.60	21.69
07/14/2015	12.37	14.77	19.77	19.55	18.11	21.61
07/15/2015	12.58	15.16	20.14	18.74	18.23	21.59
07/16/2015	13.14	15.75	20.37	18.11	19.02	21.34
07/17/2015	13.01	15.78	20.27	20.12	19.67	21.33
07/18/2015	13.34	15.42	20.23	20.32	19.62	21.29
07/19/2015	11.27	15.56	19.83	20.17	19.01	21.39
07/20/2015	11.06	15.59	19.76	21.02	18.84	21.44
07/21/2015	12.02	15.79	19.95	22.67	18.98	21.28
07/22/2015	11.81	16.12	20.02	21.55	19.15	21.18
07/23/2015	10.37	16.13	20.01	20.92	18.81	21.21
07/24/2015	10.00	15.77	19.83	20.63	18.57	21.39
07/25/2015	10.88	15.30	19.75	20.29	18.53	21.46
07/26/2015	12.05	14.95	19.99	19.99	19.04	21.22
07/27/2015	10.81	14.55	20.02	19.85	19.08	21.08
07/28/2015	11.89	14.61	19.94	19.64	19.04	21.05
07/29/2015	11.73	15.18	20.10	19.58	18.96	20.94
07/30/2015	13.36	15.42	20.08	19.43	19.31	20.73
07/31/2015	13.71	15.47	20.10	20.25	19.23	20.90
08/01/2015	13.60	15.73	20.14	21.31	19.31	21.04
08/02/2015	13.09	16.37	20.22	21.19	19.53	21.26
08/03/2015	12.77	16.59	20.11	21.00	19.58	21.45
08/04/2015	12.03	16.18	20.32	20.76	19.33	21.51

Electrical Conductivity (EC) units: milliSiemens per Centimeter
mht : mean high tides
NR : No Record
NC : Not Computed due to insufficient data
BR : Below Rating
e : estimated value

Compliance Standards

for the Sacramento - San Joaquin Delta and Suisun Marsh
Thursday, September 11, 2014

Criteria	Standard	Status
Flow/Operational		
% of inflow diverted	65 %	30 %
NDOI, monthly average *	>= 3,000 cfs	3,405 cfs
NDOI, 7 day average*	>= 2,000 cfs	3,649 cfs
Water Quality		
Days @ CCWD PP#1 w/ chlorides <= 150 mg/l	155 days	223 days
Export Areas for SWP, CVP, CCWD, et al	<= 250 mg/l Cl	141 mg/l
Maximum 30 day running average of mean daily EC at:		
Vernalis	<=1.0 mS/cm	0.4 mS/cm
Brandt Bridge	<=1.0 mS/cm	0.7 mS/cm
Old River Near Tracy	<=1.0 mS/cm	1.1 mS/cm
Old River Near Middle River	<=1.0 mS/cm	0.6 mS/cm

SUISUN MARSH:

Suisun Marsh Salinity Control Gates : 3 Open / 0 Closed / 0 Full Tide Open
Flashboard Status : In
Boat Lock Status : Open

California Hydrologic Conditions: (California Cooperative Snow Surveys Forecast, May 1, 2014)

Previous Month's Index (8RI for Apr): 1.712 MAF
Water Year Type: Critical
Sacramento valley water year type index (40/30/30) @ 50%: 4.0 MAF (Critical)
San Joaquin valley water year type index (60/20/20) @ 75%: 1.1 MAF (Critical)

Electrical Conductivity (EC) in milliSiemens per Centimeter.
Chlorides (Cl) in milligrams per liter
mht - mean high tides
md - mean daily
14 dm - fourteen day running mean
28 dm - twenty-eight day running mean
NR - No Record
NC - Average not computed due to insufficient data.
BR : Below Rating
e - estimated value

Montezuma Slough Gate Operation:
Number of gates operating at either Open, Closed, or Full Tide Open
Flashboard Status : In, Out, or Modified In
Boat Lock Status : Open or Closed

Coordinated Operation Agreement Delta Status:
(Note: below label begins on October 1, 2013)
c = excess Delta conditions
b = balanced Delta conditions
r = excess Delta conditions with restrictions:

* NDOI, Rio Vista & Vernalis Flows:
- 14 day average is progressive daily mean for the first thirteen days of the month.

Delta Water Quality Conditions

Date	Antioch Tides		Net Delta Outflow Index	Martinez	Port Chicago		Mallard	Chipps Island		Collinsville	
	High	Half	cfs	mdEC	mdEC	14dm	mdEC	mdEC	14dm	mdEC	14dm
08/13/2014	6.09	4.39	2,509	29.95	20.99	19.91	13.40	13.26	12.78	7.15	6.20
08/14/2014	6.01	4.27	1,907	29.08	20.17	20.08	12.97	12.79	12.81	6.89	6.35
08/15/2014	6.10	4.28	3,475	28.37	20.41	20.11	12.92	12.74	12.86	6.93	6.48
08/16/2014	6.18	4.31	2,464	- - NR	19.66	20.12	12.81	12.62	12.89	6.96	6.59
08/17/2014	6.31	4.40	1,818	- - NR	20.45	20.21	13.22	13.07	12.94	7.23	6.70
08/18/2014	6.44	4.54	2,794	- - NR	21.36	20.32	13.78	13.67	13.10	7.62	6.83
08/19/2014	6.47	4.57	2,840	- - NR	21.50	20.45	13.98	13.89	13.25	7.88	6.99
08/20/2014	6.34	4.57	2,449	- - NR	21.07	20.61	14.02	13.94	13.40	7.90	7.15
08/21/2014	6.38	4.47	3,343	- - NR	18.20	20.38	13.21	13.05	13.36	7.44	7.22
08/22/2014	6.36	4.56	3,300	- - NR	21.03	20.43	13.81	13.71	13.38	7.81	7.29
08/23/2014	6.39	4.53	2,636	- - NR	19.61	20.28	13.74	13.63	13.36	7.74	7.34
08/24/2014	6.39	4.61	4,311	- - NR	19.71	20.32	14.05	13.98	13.41	8.09	7.43
08/25/2014	6.34	4.58	3,508	- - NR	21.91	20.58	14.08	14.01	13.45	8.02	7.50
08/26/2014	6.12	4.40	3,081	- - NR	20.66	20.48	13.10	12.94	13.38	7.68	7.52
08/27/2014	5.83	4.24	3,393	- - NR	20.44	20.44	12.54	12.32	13.31	7.42	7.54
08/28/2014	5.65	4.27	3,105	- - NR	19.97	20.43	12.47	12.24	13.27	7.52	7.59
08/29/2014	5.78	4.34	2,788	- - NR	19.50	20.36	12.40	12.17	13.23	7.74	7.64
08/30/2014	5.92	4.27	3,417	- - NR	19.47	20.35	12.34	12.10	13.19	7.42	7.68
08/31/2014	5.96	4.27	2,807	- - NR	19.58	20.29	12.21	11.96	13.12	7.41	7.69
09/01/2014	6.11	4.29	3,183	- - NR	19.66	20.16	11.79	11.51	12.96	7.04	7.65
09/02/2014	6.43	4.57	3,268	31.28	21.42	20.16	13.35	13.21	12.91	8.05	7.66
09/03/2014	6.61	4.68	2,410	30.51	21.46	20.19	13.73	13.63	12.89	8.45	7.70
09/04/2014	6.82	4.87	3,055	30.61	22.29	20.48	14.43	14.39	12.99	8.77	7.80
09/05/2014	6.63	4.76	3,975	30.65	22.18	20.56	14.62	14.60	13.05	8.97	7.88
09/06/2014	6.72	4.61	3,018	29.77	20.90	20.65	14.15	14.09	13.08	8.69	7.95
09/07/2014	6.63	4.58	2,782	29.84	18.71	20.58	14.24	14.18	13.10	8.72	7.99
09/08/2014	6.55	4.62	4,957	30.28	21.40	20.54	14.57	14.54	13.13	9.01	8.06
09/09/2014	6.37	4.45	4,140	29.44	16.65	20.26	13.82	13.72	13.19	8.42	8.12
09/10/2014	6.14	4.42	2,798	29.27	20.13	20.24	13.44	13.30	13.26	8.02	8.16
09/11/2014	6.35	4.55	3,870	29.18	18.27	20.11	13.77	13.66	13.36	8.40	8.22

Antioch Tides measured in feet above mean sea level.
Net Delta Ouflow Index calculated from equation as specified in D-1641, revised June 1995.
Chipps Island EC calculated from measurements recorded at Mallard Slough.
Electrical Conductivity (EC) units: milliSiemens per Centimeter
md : mean daily
14dm : fourteen day running mean
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e - estimated value

Delta Water Quality Conditions

Date	Antioch		Jersey Point		Threemile Slough		Cache Slough	Good Year Slough	Sunrise Club	Volanti Slough	Beldon Landing	Collinsville
	mdEC	14mdEC	mdEC	14mdEC	mdEC	14mdEC	mdEC	mhtEC	mhtEC	mhtEC	mhtEC	mhtEC
08/13/2014	4.97	NC	1.39	1.26	1.17	1.14	0.40	18.53	16.32	17.38	17.93	8.22
08/14/2014	4.74	NC	1.32	1.27	1.16	1.16	0.46	18.56	16.36	17.84	17.73	7.52
08/15/2014	4.80	NC	1.33	1.28	1.17	1.17	0.51	18.72	16.40	17.93	17.64	7.72
08/16/2014	4.75	NC	1.31	1.29	1.18	1.19	0.49	18.65	16.43	17.82	17.61	8.09
08/17/2014	4.98	NC	1.37	1.30	1.23	1.21	0.47	18.58	16.43	17.80	17.78	8.29
08/18/2014	5.15	NC	1.50	1.33	1.31	1.24	0.44	18.56	16.48	17.83	17.81	8.45
08/19/2014	5.32	NC	1.52	1.35	1.44	1.27	0.42	18.61	16.55	17.48	17.91	8.72
08/20/2014	5.47	NC	1.60	1.39	1.51	1.31	0.47	18.58	16.59	17.47	17.84	8.55
08/21/2014	5.14	NC	1.46	1.40	1.40	1.31	0.55	18.72	16.58	17.83	17.81	8.52
08/22/2014	5.26	NC	1.44	1.41	1.37	1.31	0.57	18.71	16.60	17.67	18.01	8.15
08/23/2014	5.17	NC	1.45	1.41	1.40	1.31	0.55	18.73	16.67	17.58	17.90	8.34
08/24/2014	5.43	5.05	1.49	1.42	1.47	1.31	0.49	18.71	16.80	17.54	18.01	8.79
08/25/2014	5.29	5.13	1.43	1.43	1.43	1.32	0.50	18.68	16.99	17.51	18.13	8.82
08/26/2014	4.81	5.09	1.27	1.42	1.19	1.32	0.49	18.83	16.99	17.13	18.10	8.29
08/27/2014	4.41	5.05	1.18	1.41	1.05	1.31	0.46	18.98	16.98	17.03	18.09	8.53
08/28/2014	4.41	5.03	1.15	1.39	0.99	1.30	0.46	19.06	17.01	17.78	17.86	8.23
08/29/2014	4.46	5.00	1.20	1.38	0.96	1.28	0.47	18.99	18.13	18.43	18.12	8.80
08/30/2014	4.41	4.98	1.19	1.38	0.92	1.26	0.48	18.96	18.78	18.42	18.17	8.36
08/31/2014	4.37	4.93	1.13	1.36	0.89	1.24	0.44	18.92	18.30	18.31	18.15	8.56
09/01/2014	4.47	4.89	1.17	1.33	0.88	1.21	0.45	18.79	17.99	18.16	18.09	8.18
09/02/2014	5.03	4.87	1.33	1.32	1.03	1.18	0.46	18.49	17.77	17.90	18.15	9.32
09/03/2014	5.18	4.85	1.44	1.31	1.14	1.15	0.48	18.27	17.55	18.02	18.07	10.01
09/04/2014	5.59	4.88	1.57	1.32	1.25	1.14	0.47	17.98	17.33	18.07	18.13	10.12
09/05/2014	5.67	4.91	1.63	1.33	1.47	1.15	0.50	17.88	17.18	17.94	17.70	9.97
09/06/2014	5.35	4.92	1.53	1.34	1.32	1.14	0.50	17.89	16.99	17.49	17.30	10.66
09/07/2014	5.34	4.91	1.49	1.34	1.25	1.13	0.46	17.95	16.59	17.24	16.36	10.22
09/08/2014	5.55	4.93	1.53	1.34	1.30	1.12	0.45	17.96	16.19	16.63	15.34	10.73
09/09/2014	5.00	4.95	1.35	1.35	1.19	1.12	0.45	18.13	15.36	15.29	13.63	10.13
09/10/2014	5.01	4.99	1.35	1.36	1.17	1.13	0.44	17.83	14.48	14.25	12.68	9.86
09/11/2014	5.33	5.05	1.41	1.38	1.29	1.15	0.45	16.98	13.80	14.07	12.03	10.77

Electrical Conductivity (EC) units: milliSiemens per Centimeter
Chloride (Cl) units: milligrams per liter
mht : mean high tides
md : mean daily
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e : estimated value

Delta Water Quality Conditions

Date	Emmaton mdEC	Bethel Island mdEC	Farrar Park mdEC	Holland Tract mdEC	Bacon Island mdEC	Contra Costa mdEC	Clifton Court mdEC	Tracy Pumping Plant mdEC	Antioch mdCl	Bacon Island mdCl	Contra Costa mdCl	Delta Status
08/13/2014	2.68	0.73	0.81	0.66	0.61	0.88	0.56	0.58	1,513	123	124	b
08/14/2014	2.42	0.74	0.79	0.66	0.62	0.88	0.56	0.57	1,438	123	126	b
08/15/2014	2.40	0.78	0.78	0.67	0.62	0.88	0.56	0.56	1,458	124	127	b
08/16/2014	2.32	0.76	0.81	0.67	0.62	0.88	0.56	0.58	1,444	125	127	b
08/17/2014	2.43	0.81	0.84	0.68	0.63	0.89	0.56	0.57	1,516	126	128	b
08/18/2014	2.72	0.78	0.82	0.67	0.63	0.90	0.55	0.55	1,569	126	128	b
08/19/2014	3.03	0.82	0.81	0.66	0.63	0.86	0.56	0.56	1,623	126	128	b
08/20/2014	3.15	0.79	0.77	0.68	0.63	0.90	0.57	0.57	1,672	125	130	b
08/21/2014	2.78	0.83	0.75	0.68	0.63	0.90	0.57	0.58	1,566	126	130	b
08/22/2014	2.83	0.79	0.75	0.70	0.63	0.90	0.57	0.58	1,606	127	131	b
08/23/2014	2.93	0.82	0.70	0.62	0.64	0.90	0.57	0.58	1,578	129	131	b
08/24/2014	3.03	0.83	0.67	0.70	0.64	0.91	0.56	0.60	1,659	130	132	b
08/25/2014	3.11	0.80	0.66	0.70	0.64	0.91	0.57	0.59	1,615	130	133	b
08/26/2014	2.64	0.83	0.66	0.70	0.65	0.91	0.57	0.58	1,463	131	132	b
08/27/2014	2.14	0.82	0.66	0.69	0.65	0.91	0.57	0.61	1,335	133	134	b
08/28/2014	2.16	0.70	0.68	0.68	0.66	0.91	0.57	0.59	1,335	133	134	b
08/29/2014	2.09	0.80	0.67	0.65	0.66	0.91	0.57	0.57	1,350	135	135	b
08/30/2014	1.98	0.80	0.63	0.65	0.67	0.91	0.56	0.55	1,335	136	139	b
08/31/2014	1.77	0.79	0.59	0.63	0.66	0.91	0.55	0.57	1,321	136	140	b
09/01/2014	1.65	0.76	0.62	0.63	0.66	0.91	0.56	0.57	1,355	135	139	b
09/02/2014	2.16	0.78	0.69	0.65	0.65	0.91	0.57	0.56	1,531	133	139	b
09/03/2014	2.39	0.79	0.76	0.59	0.65	0.90	0.57	0.57	1,580	131	137	b
09/04/2014	2.65	0.76	0.94	0.62	0.64	0.90	0.57	0.57	1,710	130	138	b
09/05/2014	2.76	0.81	1.03	0.67	0.64	0.91	0.57	0.56	1,736	129	139	b
09/06/2014	2.52	0.82	1.04	0.68	0.64	0.92	0.56	0.56	1,633	128	139 e	b
09/07/2014	2.65	0.81	1.05	0.69	0.64	0.92	NR	0.57	1,632	128	139 e	b
09/08/2014	2.88	0.82	1.07	0.69	0.64	0.92	NR	0.60	1,698	129	140	b
09/09/2014	2.62	0.79	1.03	0.69	0.64	0.91	NR	0.58	1,521	129	142	b
09/10/2014	2.48	0.80	1.01	0.69	0.64	0.90	0.56	0.58	1,524	130	141	b
09/11/2014	2.72	0.77	1.01	0.70	0.65	0.91	NR	0.57	1,626	132	141	b

Electrical Conductivity (EC) units: milliSiemens per Centimeter
Chloride (Cl) units: milligrams per liter
md : mean daily
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e : estimated value
Antioch and Bacon Island mdCl are calculated from the respective mdEC values.

Coordinated Operation Agreement Delta Status:
(Note: below label begins on October 1, 2013)
c = excess Delta conditions
b = balanced Delta conditions
r = excess Delta conditions with restrictions:

Delta Water Quality Conditions

South Delta Stations

Date	Vernalis		Brandt Bridge		Old River Near Tracy		Old River Near Middle River	
	md EC	30 day avg	md EC	30 day avg	md EC	30 day avg	md EC	30 day avg
08/13/2014	0.36	0.32	0.68	0.70	1.16	1.16	0.56	0.78
08/14/2014	0.40	0.33	0.68	0.70	1.19	1.16	0.54	0.77
08/15/2014	0.40	0.33	0.69	0.70	1.22	1.17	0.54	0.75
08/16/2014	0.40	0.33	0.70	0.70	1.19	1.18	0.55	0.74
08/17/2014	0.38	0.34	0.71	0.69	1.22	1.19	0.55	0.73
08/18/2014	0.40	0.34	0.73	0.69	1.26	1.20	0.56	0.72
08/19/2014	0.42	0.34	0.74	0.69	1.26	1.21	0.56	0.71
08/20/2014	0.44	0.35	0.75	0.69	1.27	1.22	0.55	0.70
08/21/2014	0.44	0.35	0.74	0.70	1.23	1.23	0.55	0.69
08/22/2014	0.47	0.36	0.74	0.70	1.16	1.24	0.56	0.68
08/23/2014	0.45	0.36	0.74	0.70	1.09	1.24	0.57	0.67
08/24/2014	0.44	0.37	0.74	0.70	1.08	1.24	0.58	0.66
08/25/2014	0.44	0.37	0.73	0.70	1.01	1.23	0.59	0.66
08/26/2014	0.42	0.37	0.71	0.70	0.96	1.23	0.59	0.65
08/27/2014	0.43	0.38	0.68	0.70	0.95	1.22	0.59	0.64
08/28/2014	0.45	0.38	0.66	0.70	0.94	1.20	0.58	0.64
08/29/2014	0.42	0.39	0.65	0.70	0.94	1.19	0.59	0.63
08/30/2014	0.48	0.39	0.65	0.70	0.94	1.18	0.62	0.63
08/31/2014	0.48	0.40	0.64	0.69	0.94	1.16	0.64	0.63
09/01/2014	0.46	0.40	0.64	0.69	0.99	1.15	0.63	0.63
09/02/2014	0.55	0.41	0.65	0.69	1.06	1.14	0.62	0.62
09/03/2014	0.56	0.42	0.65	0.69	1.04	1.13	0.63	0.62
09/04/2014	0.50	0.42	0.66	0.69	1.03	1.12	0.63	0.61
09/05/2014	0.45	0.43	0.70	0.69	1.00	1.11	0.64	0.61
09/06/2014	0.42	0.43	0.70	0.69	0.96	1.09	0.64	0.61
09/07/2014	0.38	0.43	0.70	0.69	0.96	1.08	0.64	0.60
09/08/2014	0.40	0.43	0.69	0.69	0.95	1.08	0.65	0.60
09/09/2014	0.48	0.43	0.68	0.69	0.91	1.07	0.65	0.59
09/10/2014	0.46	0.44	0.66	0.69	0.94	1.07	0.66	0.59
09/11/2014	0.58	0.44	0.67	0.69	1.08	1.06	0.64	0.60

Electrical Conductivity (EC) units: milliSiemens per Centimeter
md : mean daily
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e : estimated value

Compliance Standards

for the Sacramento - San Joaquin Delta and Suisun Marsh
Thursday, December 11, 2014

Criteria	Standard	Status
Flow/Operational		
% of inflow diverted	65 %	51 %
NDOI, monthly average *	>= 4,500 cfs	16,956 cfs
NDOI, 7 day average*	>= 3,500 cfs	20,811 cfs
Rio Vista flow, monthly average *	>= 4,500 cfs	16,058 cfs
Rio Vista flow, 7 day average*	>= 3,500 cfs	20,424 cfs

Water Quality

Criteria	Standard	Status
Days @ CCWD PP#1 w/ chlorides <= 150 mg/l	155 days	310 days
Export Areas for SWP, CVP, CCWD, et al	<= 250 mg/l Cl	150 mg/l

Maximum 30 day running average of mean daily EC at:

Location	Standard	Status
Vernalis	<=1.0 mS/cm	0.6 mS/cm
Brandt Bridge	<=1.0 mS/cm	0.6 mS/cm
Old River Near Tracy	<=1.0 mS/cm	0.7 mS/cm
Old River Near Middle River	<=1.0 mS/cm	mS/cm

SUISUN MARSH:

Suisun Marsh Salinity Control Gates : 0 Open / 0 Closed / 3 Full Tide Open
Flashboard Status : In
Boat Lock Status : Open

California Hydrologic Conditions: (California Cooperative Snow Surveys Forecast, December 1, 2014)

Previous Month's Index (8RI for Nov): 0.46 MAF
Water Year Type: Dry
Sacramento valley water year type index (40/30/30) @ 50%: 5.6 MAF (Dry)
San Joaquin valley water year type index (60/20/20) @ 75%: 1.4 MAF (Critical)

Electrical Conductivity (EC) in milliSiemens per Centimeter.
Chlorides (Cl) in milligrams per liter
mht - mean high tides
md - mean daily
14 dm - fourteen day running mean
28 dm - twenty-eight day running mean
NR - No Record
NC - Average not computed due to insufficient data.
BR : Below Rating
e - estimated value

Montezuma Slough Gate Operation:
Number of gates operating at either Open, Closed, or Full Tide Open
Flashboard Status : In, Out, or Modified In
Boat Lock Status : Open or Closed

Coordinated Operation Agreement Delta Status:
(Note: below label begins on October 1, 2013)
c = excess Delta conditions
b = balanced Delta conditions
r = excess Delta conditions with restrictions:

* NDOI, Rio Vista & Vernalis Flows:
- 7 day average is progressive daily mean for the first six days of the month.

Delta Water Quality Conditions

Date	Antioch Tides		Net Delta Outflow Index	Martinez	Port Chicago		Mallard	Chipps Island		Collinsville	
	High	Half	cfs	mdEC	mdEC	14dm	mdEC	mdEC	14dm	mdEC	14dm
11/12/2014	5.62	4.26	5,109	27.60	14.18	16.60	13.01	12.84	13.56	8.67	9.20
11/13/2014	5.30	3.75	4,812	26.52	14.37	16.15	11.89	11.62	13.36	7.84	9.07
11/14/2014	5.30	3.97	5,733	26.31	13.89	15.70	12.86	12.67	13.19	8.02	8.90
11/15/2014	5.33	3.79	5,818	26.16	12.32	15.03	12.50	12.28	12.99	7.85	8.72
11/16/2014	5.21	3.54	5,573	25.76	11.40	14.42	11.43	11.13	12.82	7.25	8.56
11/17/2014	5.26	3.51	5,480	26.61	11.80	14.10	11.85	11.57	12.73	7.43	8.46
11/18/2014	5.51	3.68	4,870	27.83	11.69	13.84	12.88	12.69	12.74	8.27	8.44
11/19/2014	5.97	3.97	3,357	29.37	12.58	13.61	14.09	14.02	12.85	9.45	8.52
11/20/2014	6.07	4.05	4,423	29.80	13.02	13.49	14.98	14.99	12.99	9.92	8.60
11/21/2014	6.17	4.09	4,271	29.93	13.39	13.40	15.09	15.12	13.12	10.33	8.70
11/22/2014	6.47	4.25	4,450	30.26	14.62	13.46	15.83	15.94	13.33	10.60	8.84
11/23/2014	6.12	3.92	5,015	29.01	13.53	13.47	14.75	14.74	13.44	10.25	8.95
11/24/2014	5.97	3.81	5,361	28.74	13.74	13.34	13.98	13.90	13.44	9.52	8.95
11/25/2014	5.71	3.69	4,553	28.09	17.38	13.42	13.59	13.47	13.36	9.04	8.89
11/26/2014	5.74	3.76	4,714	28.50	20.97	13.91	13.77	13.66	13.42	8.95	8.91
11/27/2014	5.66	3.90	3,825	28.93	21.40	14.41	14.45	14.41	13.61	9.33	9.02
11/28/2014	5.59	4.03	3,016	28.38	22.26	15.01	15.00	15.02	13.78	9.97	9.15
11/29/2014	5.81	4.18	2,892	28.29	22.16	15.71	15.39	15.46	14.01	10.29	9.33
11/30/2014	5.91	4.06	3,297	28.42	21.90	16.46	15.04	15.06	14.29	10.13	9.53
12/01/2014	5.87	3.92	5,770	28.18	21.44	17.15	14.48	14.45	14.49	9.98	9.72
12/02/2014	6.27	4.22	5,410	28.46	21.96	17.88	15.17	15.21	14.67	10.28	9.86
12/03/2014	7.13	4.89	11,695	29.64	19.93	18.41	16.92	17.16	14.90	10.97	9.97
12/04/2014	7.05	4.86	17,961	29.14	22.34	19.07	15.41	15.48	14.93	9.95	9.97
12/05/2014	6.90	4.73	22,572	27.88	20.73	19.60	13.84	13.74	14.84	8.58	9.85
12/06/2014	6.80	4.71	26,063	26.61	19.25	19.93	12.11	11.86	14.54	7.25	9.61
12/07/2014	6.65	4.50	32,406	24.73	17.01	20.18	9.68	9.26	14.15	5.16	9.24
12/08/2014	6.52	4.51	23,448	23.85	14.88	20.26	8.55	8.07	13.74	4.13	8.86
12/09/2014	6.25	4.43	16,919	22.51	10.68	19.78	7.21	6.68	13.25	3.37	8.45
12/10/2014	6.13	4.42	14,101	22.13	9.36	18.95	6.95	6.42	12.73	2.94	8.02
12/11/2014	6.74	5.23	10,167	24.82	13.55	18.39	8.57	8.09	12.28	3.27	7.59

Antioch Tides measured in feet above mean sea level.
Net Delta Ouflow Index calculated from equation as specified in D-1641, revised June 1995.
Chipps Island EC calculated from measurements recorded at Mallard Slough.
Electrical Conductivity (EC) units: milliSiemens per Centimeter
md : mean daily
14dm : fourteen day running mean
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e - estimated value

Delta Water Quality Conditions

Date	Antioch		Jersey Point		Threemile Slough		Cache Slough	Good Year Slough	Sunrise Club	Volanti Slough	Beldon Landing	Collinsville
	mdEC	14mdEC	mdEC	14mdEC	mdEC	14mdEC	mdEC	mhtEC	mhtEC	mhtEC	mhtEC	mhtEC
11/12/2014	5.25	5.74	1.50	1.59	1.71	1.81	0.78	18.27	15.33	16.35	16.40	9.45
11/13/2014	4.65	5.62	1.37	1.56	1.63	1.76	0.78	19.06	15.32	15.77	15.85	8.43
11/14/2014	4.96	5.49	1.23	1.52	1.36	1.69	0.79	19.97	15.30	15.81	16.34	8.87
11/15/2014	4.72	5.35	1.17	1.47	1.19	1.61	0.80	20.31	15.11	15.89	16.16	9.50
11/16/2014	4.27	5.26	1.08	1.45	1.07	1.56	0.80	20.65	15.39	15.83	15.85	8.81
11/17/2014	4.43	5.20	1.09	1.42	1.11	1.52	0.79	20.64	15.34	15.85	15.96	9.09
11/18/2014	5.00	5.18	1.18	1.41	1.27	1.51	0.78	20.16	15.31	15.91	16.46	9.19
11/19/2014	6.02	5.24	1.44	1.41	1.65	1.52	0.75	19.26	15.37	15.89	16.66	10.45
11/20/2014	6.46	5.31	1.58	1.41	1.94	1.55	0.76	18.77	15.38	16.94	16.85	11.49
11/21/2014	6.52	5.38	1.67	1.42	2.17	1.60	0.75	18.41	15.39	17.86	16.81	12.35
11/22/2014	7.35	5.51	2.00	1.45	2.61	1.67	0.74	18.57	15.51	17.59	17.06	11.74
11/23/2014	6.50	5.58	1.67	1.46	2.01	1.69	0.82	18.75	15.43	17.34	16.86	11.74
11/24/2014	6.10	5.59	1.63	1.45	1.96	1.69	0.75	19.23	15.50	17.07	16.97	10.97
11/25/2014	5.93	5.58	1.60	1.44	1.83	1.68	0.66	19.50	15.32	16.79	17.03	10.24
11/26/2014	6.03	5.64	1.70	1.46	1.91	1.69	0.62	19.64	15.12	16.75	17.07	10.19
11/27/2014	6.37	5.76	1.83	1.49	2.06	1.72	0.64	19.45	15.21	16.72	17.08	10.80
11/28/2014	6.78	5.89	2.07	1.55	2.31	1.79	0.69	19.11	15.32	16.60	17.20	11.77
11/29/2014	7.21	6.07	2.21	1.63	2.56	1.89	0.73	18.31	15.38	16.77	17.34	12.24
11/30/2014	7.13	6.27	2.15	1.70	2.49	1.99	0.81	18.27	15.25	16.45	17.24	11.96
12/01/2014	6.87	6.45	2.00	1.77	2.32	2.08	0.74	18.45	NR	16.27	17.26	11.78
12/02/2014	7.22	6.61	2.21	1.84	2.44	2.16	0.62	17.94	14.88	16.30	17.29	12.33
12/03/2014	8.87	6.81	3.15	1.96	3.29	2.28	0.35	16.70	13.72	15.59	17.21	12.83
12/04/2014	8.51	6.96	3.11	2.07	2.76	2.34	0.36	16.58	12.67	16.53	17.16	12.68
12/05/2014	7.48	7.03	2.74	2.15	1.66	2.30	0.44	16.32	11.36	17.14	16.71	10.90
12/06/2014	6.36	6.95	2.52	2.19	1.05	2.19	0.48	16.19	12.47	16.58	16.35	9.06
12/07/2014	4.96	6.84	2.12	2.22	0.81	2.10	0.54	16.04	11.74	15.63	15.82	6.69
12/08/2014	4.09	6.70	1.94	2.24	0.72	2.01	0.59	16.76	11.76	14.81	16.16	5.54
12/09/2014	3.40	6.52	1.77	2.25	0.66	1.93	0.61	16.62	11.91	14.09	16.44	4.04
12/10/2014	2.96	6.30	1.75	2.26	0.58	1.84	0.64	16.75	11.80	13.59	16.21	3.86
12/11/2014	3.53	6.10	2.11	2.28	0.57	1.73	0.54	15.16	11.81	13.34	15.09	3.97

Electrical Conductivity (EC) units: milliSiemens per Centimeter
Chloride (Cl) units: milligrams per liter
mht : mean high tides
md : mean daily
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e : estimated value

Delta Water Quality Conditions

Date	Emmaton mdEC	Bethel Island mdEC	Farrar Park mdEC	Holland Tract mdEC	Bacon Island mdEC	Contra Costa mdEC	Clifton Court mdEC	Tracy Pumping Plant mdEC	Antioch mdCl	Bacon Island mdCl	Contra Costa mdCl	Delta Status
11/12/2014	3.32	0.94	1.06	0.77	0.77	0.86	0.61	0.59	1,602	164	150 e	b
11/13/2014	3.21	0.92	1.04	0.76	0.77	0.84	0.60	0.57	1,410	163	150 e	b
11/14/2014	2.93	0.91	1.02	0.75	0.77	0.85	0.65	0.57	1,509	162	150 e	b
11/15/2014	2.41	0.90	1.01	0.75	0.76	0.85	0.68	0.57	1,434	161	150 e	b
11/16/2014	1.93	0.90	0.99	0.76	0.76	0.85	0.68	0.58	1,290	161	150 e	b
11/17/2014	2.16	0.87	0.99	0.75	0.76	0.84	0.69	0.59	1,341	161	150 e	b
11/18/2014	2.46	0.81	0.99	0.74	0.76	0.84	0.71	0.65	1,522	160	150 e	b
11/19/2014	3.43	0.76	1.00	0.73	0.75	0.84	0.72	0.62	1,847	158	150 e	b
11/20/2014	3.92	0.83	0.99	0.72	0.74	0.83	0.71	0.65	1,988	156	150 e	b
11/21/2014	4.33	0.83	0.99	0.71	0.73	0.83	0.69	0.65	2,005	153	150 e	b
11/22/2014	4.85	0.81	1.00	0.69	0.72	0.79	0.69	0.65	2,272	150	150 e	b
11/23/2014	4.01	0.84	0.98	0.69	0.71	0.82	0.68	0.65	1,999	147	150 e	b
11/24/2014	3.81	0.84	0.97	0.68	0.70	0.81	0.68	0.62	1,874	144	150 e	b
11/25/2014	3.58	0.84	0.96	0.68	0.68	0.81	0.66	0.65	1,820	140	150 e	b
11/26/2014	3.60	0.85	0.97	0.68	0.67	0.80	0.66	0.65	1,851	138	150 e	b
11/27/2014	3.92	0.86	0.98	0.68	0.66	0.81	0.65	0.64	1,960	135	150 e	b
11/28/2014	4.29	0.88	1.00	0.68	0.66	0.80	0.64	0.63	2,088	134	150 e	b
11/29/2014	4.47	0.94	1.02	0.67	0.66	0.80	0.63	0.62	2,226	133	150 e	b
11/30/2014	4.56	0.97	1.01	0.67	0.65	0.79	0.62	0.63	2,202	133	150 e	b
12/01/2014	4.02	1.00	1.00	0.67	0.65	0.79	0.62	0.63	2,117	132	150 e	b
12/02/2014	4.29	1.06	1.03	0.68	0.65	0.75	0.60	0.63	2,230	132	150 e	b
12/03/2014	5.54	1.18	1.13	0.69	0.65	0.70	0.60	0.64	2,756	132	150 e	b
12/04/2014	4.29	1.23	1.17	0.71	0.65	0.67	0.61	0.63	2,640	133	150 e	b
12/05/2014	3.15	1.30	1.19	0.75	0.66	0.67	0.59	0.63	2,312	136	150 e	b
12/06/2014	1.27	1.37	1.22	0.78	0.69	0.65	0.58	0.62	1,957	141	150 e	b
12/07/2014	0.79	1.38	1.22	0.82	0.71	0.64	0.59	0.61	1,510	147	150 e	b
12/08/2014	0.68	1.36	1.25	0.86	0.74	0.64	0.59	0.60	1,231	156	150 e	b
12/09/2014	0.55	1.32	1.26	0.91	0.77	0.64	0.58	0.58	1,013	165	150 e	b
12/10/2014	0.55	1.27	1.28	0.90	0.81	0.63	0.60	0.58	874	174	150 e	b
12/11/2014	0.88	1.25	1.35	0.89	0.82	0.63	0.62	0.58	1,055	175	150 e	b

Electrical Conductivity (EC) units: milliSiemens per Centimeter
Chloride (Cl) units: milligrams per liter
md : mean daily
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e : estimated value
Antioch and Bacon Island mdCl are calculated from the respective mdEC values.

Coordinated Operation Agreement Delta Status:
(Note: below label begins on October 1, 2013)
c = excess Delta conditions
b = balanced Delta conditions
r = excess Delta conditions with restrictions:

Delta Water Quality Conditions

South Delta Stations

Date	Vernalis		Brandt Bridge		Old River Near Tracy		Old River Near Middle River	
	md EC	30 day avg	md EC	30 day avg	md EC	30 day avg	md EC	30 day avg
11/12/2014	0.52	0.36	0.42	0.40	0.52	0.85	0.46	0.42
11/13/2014	0.54	0.36	0.44	0.40	0.55	0.84	0.50	0.42
11/14/2014	0.54	0.36	0.45	0.39	0.62	0.83	0.54	0.41
11/15/2014	0.53	0.36	0.47	0.39	0.67	0.83	0.57	0.41
11/16/2014	0.53	0.36	0.49	0.39	0.68	0.82	0.57	0.41
11/17/2014	0.53	0.37	0.50	0.39	0.72	0.82	0.56	0.41
11/18/2014	0.52	0.37	0.51	0.38	0.74	0.81	0.57	0.41
11/19/2014	0.52	0.37	0.51	0.38	0.77	0.81	0.57	0.42
11/20/2014	0.53	0.37	0.51	0.38	0.76	0.81	0.56	0.42
11/21/2014	0.54	0.38	0.52	0.38	0.73	0.80	0.55	0.42
11/22/2014	0.56	0.39	0.54	0.38	0.71	0.80	0.55	0.42
11/23/2014	0.59	0.40	0.53	0.38	0.72	0.79	0.56	0.41
11/24/2014	0.61	0.41	0.54	0.37	0.70	0.78	0.57	0.41
11/25/2014	0.62	0.42	0.54	0.37	0.72	0.77	0.59	0.42
11/26/2014	0.62	0.43	0.55	0.38	0.74	0.77	0.62	0.42
11/27/2014	0.64	0.44	0.56	0.39	0.76	0.76	0.62	0.43
11/28/2014	0.66	0.45	0.58	0.40	0.75	0.75	NR	NC
11/29/2014	0.68	0.47	0.59	0.41	0.75	0.74	NR	NC
11/30/2014	0.68	0.48	0.59	0.42	0.75	0.73	NR	NC
12/01/2014	0.63	0.50	0.58	0.43	0.76	0.72	0.67	NC
12/02/2014	0.61	0.51	0.57	0.44	0.80	0.71	0.67	NC
12/03/2014	0.58	0.52	0.58	0.46	0.85	0.70	0.62	NC
12/04/2014	0.51	0.53	0.59	0.47	0.82	0.70	0.61	NC
12/05/2014	0.56	0.54	0.59	0.48	0.73	0.69	0.59	NC
12/06/2014	0.61	0.55	0.61	0.50	0.69	0.69	0.52	NC
12/07/2014	0.64	0.56	0.61	0.51	0.68	0.69	0.55	NC
12/08/2014	0.72	0.57	0.63	0.52	0.66	0.70	0.60	NC
12/09/2014	0.88	0.59	0.65	0.53	0.65	0.70	0.63	NC
12/10/2014	0.91	0.60	0.71	0.54	0.69	0.71	0.67	NC
12/11/2014	0.81	0.61	0.84	0.56	0.79	0.72	0.80	NC

Electrical Conductivity (EC) units: milliSiemens per Centimeter
md : mean daily
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e : estimated value

Compliance Standards

for the Sacramento - San Joaquin Delta and Suisun Marsh
Monday, January 05, 2015

Criteria	Standard	Status
Flow/Operational		
% of inflow diverted	65 %	18 %
NDOI, monthly average *	>= 4,500 cfs	11,148 cfs
NDOI, 7 day average*	>= 3,500 cfs	11,148 cfs
Water Quality		
Days @ CCWD PP#1 w/ chlorides <= 150 mg/l	155 days	days
Export Areas for SWP, CVP, CCWD, et al	<= 250 mg/l Cl	mg/l
14dm EC at Jersey Point	<= 2.20 mS/cm	0.33 mS/cm
Maximum 30 day running average of mean daily EC at:		
Vernalis	<=1.0 mS/cm	0.9 mS/cm
Brandt Bridge	<=1.0 mS/cm	0.9 mS/cm
Old River Near Tracy	<=1.0 mS/cm	1.1 mS/cm
Old River Near Middle River	<=1.0 mS/cm	0.9 mS/cm

SUISUN MARSH:

Suisun Marsh Salinity Control Gates : 0 Open / 0 Closed / 3 Full Tide Open
Flashboard Status : In
Boat Lock Status : Open

California Hydrologic Conditions: (California Cooperative Snow Surveys Forecast, December 1, 2014)

Previous Month's Index (8RI for Nov): 0.46 MAF
Water Year Type: Dry
Sacramento valley water year type index (40/30/30) @ 50%: 5.6 MAF (Dry)
San Joaquin valley water year type index (60/20/20) @ 75%: 1.4 MAF (Critical)

Electrical Conductivity (EC) in milliSiemens per Centimeter.
Chlorides (Cl) in milligrams per liter
mht - mean high tides
md - mean daily
14 dm - fourteen day running mean
28 dm - twenty-eight day running mean
NR - No Record
NC - Average not computed due to insufficient data.
BR : Below Rating
e - estimated value

Montezuma Slough Gate Operation:
Number of gates operating at either Open, Closed, or Full Tide Open
Flashboard Status : In, Out, or Modified In
Boat Lock Status : Open or Closed

Coordinated Operation Agreement Delta Status:
(Note: below label begins on October 1, 2013)
c = excess Delta conditions
b = balanced Delta conditions
r = excess Delta conditions with restrictions:

* NDOI, Rio Vista & Vernalis Flows:
- 7 day average is progressive daily mean for the first six days of the month.

Delta Water Quality Conditions

Date	Antioch Tides		Net Delta Outflow Index	Martinez	Port Chicago		Mallard	Chipps Island		Collinsville	
	High	Half	cfs	mdEC	mdEC	14dm	mdEC	mdEC	14dm	mdEC	14dm
12/07/2014	6.65	4.50	32,406	24.73	17.01	20.18	9.68	9.26	14.15	5.16	9.24
12/08/2014	6.52	4.51	23,448	23.85	14.88	20.26	8.55	8.07	13.74	4.13	8.86
12/09/2014	6.25	4.43	16,919	22.51	10.68	19.78	7.21	6.68	13.25	3.37	8.45
12/10/2014	6.13	4.42	14,101	22.13	9.36	18.95	6.95	6.42	12.73	2.94	8.02
12/11/2014	6.74	5.23	10,167	24.82	13.55	18.39	8.57	8.09	12.28	3.27	7.59
12/12/2014	6.33	4.93	25,695	19.25	13.35	17.75	6.86	6.33	11.66	2.87	7.08
12/13/2014	5.96	4.32	33,149	16.73	9.77	16.87	4.11	3.59	10.81	1.17	6.43
12/14/2014	5.81	4.16	45,427	14.83	7.00	15.80	2.48	2.06	9.89	0.63	5.75
12/15/2014	6.01	4.48	49,468	14.07	6.95	14.77	1.90	1.53	8.96	0.29	5.06
12/16/2014	6.67	4.88	60,179	13.76	6.14	13.64	1.77	1.42	7.98	0.26	4.34
12/17/2014	6.79	4.82	56,774	13.49	5.25	12.59	1.24	0.95	6.82	0.21	3.58
12/18/2014	6.90	4.80	51,404	10.83	3.01	11.21	0.85	0.63	5.76	0.22	2.88
12/19/2014	7.15	4.91	49,639	9.23	2.51	9.91	0.71	0.52	4.81	0.27	2.29
12/20/2014	7.15	4.93	50,919	7.10	1.62	8.65	0.61	0.44	4.00	0.25	1.79
12/21/2014	7.21	4.91	50,884	5.23	1.29	7.52	0.58	0.41	3.37	0.25	1.44
12/22/2014	6.91	4.67	47,468	3.74	0.83	6.52	0.53	0.38	2.82	0.23	1.16
12/23/2014	6.85	4.68	46,826	3.31	0.69	5.81	0.51	0.36	2.37	0.22	0.93
12/24/2014	7.13	4.93	45,175	3.45	0.73	5.19	0.48	0.34	1.93	0.22	0.74
12/25/2014	6.35	4.53	41,454	2.05	0.54	4.26	0.41	0.28	1.37	0.21	0.52
12/26/2014	5.77	4.27	36,676	2.48	0.46	3.34	0.38	0.26	0.94	0.22	0.33
12/27/2014	5.80	4.06	30,711	3.74	0.46	2.68	0.38	0.26	0.70	0.22	0.26
12/28/2014	5.83	3.93	26,911	5.42	0.60	2.22	0.36	0.24	0.57	0.23	0.23
12/29/2014	6.01	3.95	22,778	7.09	1.27	1.81	0.35	0.24	0.48	0.24	0.23
12/30/2014	6.29	3.76	19,102	7.63	1.57	1.49	0.38	0.26	0.40	0.25	0.23
12/31/2014	5.91	3.77	16,496	8.33	1.97	1.25	0.37	0.25	0.35	0.25	0.23
01/01/2015	6.34	4.07	14,652	11.50	3.41	1.28	0.74	0.54	0.34	0.28	0.24
01/02/2015	6.47	4.23	12,327	13.23	5.05	1.46	1.18	0.91	0.37	0.30	0.24
01/03/2015	6.37	4.24	10,567	- - NR	5.54	1.74	NR	- - NR		0.35	0.25
01/04/2015	6.22	4.05	9,481	- - NR	5.75	2.06	NR	- - NR		0.36	0.25
01/05/2015	6.02	3.94	8,715	13.82	5.84	2.42	1.82	1.46		0.43	0.27

Antioch Tides measured in feet above mean sea level.
Net Delta Ouflow Index calculated from equation as specified in D-1641, revised June 1995.
Chipps Island EC calculated from measurements recorded at Mallard Slough.
Electrical Conductivity (EC) units: milliSiemens per Centimeter
md : mean daily
14dm : fourteen day running mean
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e - estimated value

Delta Water Quality Conditions

Date	Antioch		Jersey Point		Threemile Slough		Cache Slough	Good Year Slough	Sunrise Club	Volanti Slough	Beldon Landing	Collinsville
	mdEC	14mdEC	mdEC	14mdEC	mdEC	14mdEC	mdEC	mhtEC	mhtEC	mhtEC	mhtEC	mhtEC
12/07/2014	4.96	6.84	2.12	2.22	0.81	2.10	0.54	16.04	11.74	15.63	15.82	6.69
12/08/2014	4.09	6.70	1.94	2.24	0.72	2.01	0.59	16.76	11.76	14.81	16.16	5.54
12/09/2014	3.40	6.52	1.77	2.25	0.66	1.93	0.61	16.62	11.91	14.09	16.44	4.04
12/10/2014	2.96	6.30	1.75	2.26	0.58	1.84	0.64	16.75	11.80	13.59	16.21	3.86
12/11/2014	3.53	6.10	2.11	2.28	0.57	1.73	0.54	15.16	11.81	13.34	15.09	3.97
12/12/2014	2.73	5.81	1.64	2.25	0.68	1.61	0.28	13.44	2.63	8.67	14.94	3.84
12/13/2014	2.12	5.45	1.33	2.18	0.63	1.48	0.36	12.98	4.15	7.47	14.06	1.58
12/14/2014	1.70	5.06	1.17	2.11	0.50	1.33	0.45	13.18	5.16	7.99	13.71	0.84
12/15/2014	1.48	4.67	1.07	2.05	0.40	1.20	0.45	13.00	4.35	7.64	13.28	0.28
12/16/2014	1.31	4.25	1.00	1.96	0.30	1.04	0.34	11.33	3.20	6.69	12.25	0.28
12/17/2014	1.21	3.70	0.86	1.80	0.37	0.83	0.35	9.68	2.80	6.17	10.70	0.17
12/18/2014	1.06	3.17	0.74	1.63	0.38	0.66	0.46	9.23	4.82	7.47	9.79	0.24
12/19/2014	0.89	2.70	0.64	1.48	0.35	0.57	0.48	8.22	7.35	6.88	7.21	0.30
12/20/2014	0.78	2.30	0.56	1.34	0.33	0.52	0.37	7.90	5.65	6.02	7.04	0.25
12/21/2014	0.68	2.00	0.50	1.22	0.30	0.48	0.48	7.19	5.93	5.77	6.55	0.26
12/22/2014	0.60	1.75	0.43	1.11	0.28	0.45	0.58	7.25	5.95	5.22	5.97	0.23
12/23/2014	0.54	1.54	0.40	1.01	0.25	0.42	0.66	6.51	5.96	4.73	5.51	0.21
12/24/2014	0.50	1.37	0.39	0.92	0.24	0.40	0.70	5.48	5.68	4.41	4.79	0.21
12/25/2014	0.46	1.15	0.35	0.79	0.23	0.38	0.76	7.17	5.79	4.50	5.80	0.22
12/26/2014	0.41	0.98	0.33	0.70	0.23	0.34	0.77	7.90	6.12	4.68	5.68	0.21
12/27/2014	0.40	0.86	0.32	0.63	0.24	0.32	0.79	7.67	6.33	4.60	5.51	0.21
12/28/2014	0.38	0.76	0.32	0.56	0.25	0.30	0.84	7.81	6.47	4.45	5.18	0.23
12/29/2014	0.37	0.68	0.31	0.51	0.25	0.29	0.88	7.13	6.73	4.11	4.50	0.24
12/30/2014	0.37	0.62	0.31	0.46	0.27	0.28	0.87	8.88	5.93	4.40	4.37	0.24
12/31/2014	0.36	0.56	0.31	0.42	0.28	0.28	0.87	7.09	5.80	4.50	4.52	0.25
01/01/2015	0.36	0.51	0.32	0.39	0.28	0.27	0.86	5.91	5.51	4.17	4.25	0.31
01/02/2015	0.36	0.47	0.32	0.37	0.30	0.27	NR	4.73	5.40	4.25	4.35	0.33
01/03/2015	- - NR	NC	0.32	0.35	0.30	0.26	NR	4.65	5.45	e	e	0.36
01/04/2015	- - NR	NC	0.32	0.34	0.30	0.26	NR	5.56	5.34	4.17	e	0.35
01/05/2015	0.44	NC	0.32	0.33	0.31	0.27	NR	5.96	5.16	4.03	e	0.55

Electrical Conductivity (EC) units: milliSiemens per Centimeter
Chloride (Cl) units: milligrams per liter
mht : mean high tides
md : mean daily
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e : estimated value

Delta Water Quality Conditions

Date	Emmaton mdEC	Bethel Island mdEC	Farrar Park mdEC	Holland Tract mdEC	Bacon Island mdEC	Contra Costa mdEC	Clifton Court mdEC	Tracy Pumping Plant mdEC	Antioch mdCl	Bacon Island mdCl	Contra Costa mdCl	Delta Status
12/07/2014	0.79	1.38	1.22	0.82	0.71	0.64	0.59	0.61	1,510	147	150 e	b
12/08/2014	0.68	1.36	1.25	0.86	0.74	0.64	0.59	0.60	1,231	156	150 e	b
12/09/2014	0.55	1.32	1.26	0.91	0.77	0.64	0.58	0.58	1,013	165	150 e	c
12/10/2014	0.55	1.27	1.28	0.90	0.81	0.63	0.60	0.58	874	174	150 e	c
12/11/2014	0.88	1.25	1.35	0.89	0.82	0.63	0.62	0.58	1,055	175	150 e	c
12/12/2014	0.41	1.23	1.20	0.86	0.81	0.60	0.62	0.60	799	174	150 e	c
12/13/2014	0.34	1.21	1.17	0.85	0.81	0.57	0.65	0.62	606	175	150 e	c
12/14/2014	0.30	1.16	1.15	0.84	0.82	0.55	0.64	0.67	472	176	150 e	c
12/15/2014	0.21	1.09	1.13	0.80	0.80	0.54	0.62	0.68	403	172	150 e	r
12/16/2014	0.18	1.02	1.13	0.76	0.78	0.53	0.64	0.65	346	166	150 e	r
12/17/2014	0.24	1.01	1.10	0.73	0.76	0.52	0.62	0.64	314	160	150 e	r
12/18/2014	0.29	0.94	1.06	0.70	0.73	0.52	0.63	0.66	266	154	150 e	r
12/19/2014	0.28	0.82	1.03	0.68	0.71	0.54	0.67	0.69	215	149	150 e	r
12/20/2014	0.27	0.73	1.00	0.65	0.69	0.64	0.72	0.71	177	143	150 e	r
12/21/2014	0.26	0.65	0.96	0.59	0.67	0.65	0.74	0.74	148	137	150 e	r
12/22/2014	0.26	0.59	0.92	0.59	0.65	0.65	0.77	0.75	121	132	150 e	r
12/23/2014	0.23	0.51	NR	0.54	0.63	0.67	0.77	0.76	103	126	150 e	r
12/24/2014	0.22	0.46	NR	0.51	0.59	0.67	0.78	0.76	90	117	150 e	r
12/25/2014	0.21	0.50	NR	0.43	0.55	0.68	0.75	0.76	77	107	150 e	r
12/26/2014	0.20	0.41	NR	0.43	0.53	0.69	0.78	0.77	61	101	150 e	r
12/27/2014	0.20	0.36	NR	0.43	0.51	0.68	0.77	0.78	56	95	150 e	r
12/28/2014	0.21	0.34	NR	0.42	0.47	0.67	0.71	0.80	50	86	150 e	r
12/29/2014	0.22	0.33	NR	0.41	0.45	0.66	0.64	0.79	49	80	150 e	r
12/30/2014	0.23	0.33	0.61	0.33	0.43	0.67	0.61	0.80	48	74	NR	r
12/31/2014	0.25	0.32	0.57	0.35	0.41	0.68	0.59	0.78	46	69	NR	r
01/01/2015	0.26	0.31	0.56	0.35	0.39	0.67	0.54	0.79	43	63	NR	r
01/02/2015	0.26	0.31	0.53	0.35	0.38	0.69	0.53	0.80	45	60	NR	r
01/03/2015	0.28	0.31	0.51	0.35	0.38	0.68	0.52	0.79		60	NR	r
01/04/2015	0.28	0.31	0.50	0.35	0.37	0.67	0.53	0.70		59	NR	r
01/05/2015	0.29	0.32	0.50	0.35	0.37	0.71	0.51	0.66	71	58	NR	r

Electrical Conductivity (EC) units: milliSiemens per Centimeter
Chloride (Cl) units: milligrams per liter
md : mean daily
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e : estimated value
Antioch and Bacon Island mdCl are calculated from the respective mdEC values.

Coordinated Operation Agreement Delta Status:
(Note: below label begins on October 1, 2013)
c = excess Delta conditions
b = balanced Delta conditions
r = excess Delta conditions with restrictions:

Delta Water Quality Conditions

South Delta Stations

Date	Vernalis		Brandt Bridge		Old River Near Tracy		Old River Near Middle River	
	md EC	30 day avg	md EC	30 day avg	md EC	30 day avg	md EC	30 day avg
12/07/2014	0.64	0.56	0.61	0.51	0.68	0.69	0.55	NC
12/08/2014	0.72	0.57	0.63	0.52	0.66	0.70	0.60	NC
12/09/2014	0.88	0.59	0.65	0.53	0.65	0.70	0.63	NC
12/10/2014	0.91	0.60	0.71	0.54	0.69	0.71	0.67	NC
12/11/2014	0.81	0.61	0.84	0.56	0.79	0.72	0.80	NC
12/12/2014	0.64	0.62	0.90	0.58	0.83	0.73	0.78	NC
12/13/2014	0.45	0.61	0.89	0.59	0.83	0.73	0.74	NC
12/14/2014	0.47	0.61	0.85	0.60	1.01	0.75	0.49	NC
12/15/2014	0.59	0.61	0.81	0.62	0.93	0.76	0.43	NC
12/16/2014	0.70	0.62	0.79	0.63	0.93	0.76	0.52	NC
12/17/2014	0.82	0.63	0.67	0.63	0.84	0.77	0.61	NC
12/18/2014	0.85	0.64	0.59	0.63	0.77	0.77	0.71	NC
12/19/2014	0.91	0.65	0.68	0.64	0.84	0.77	0.81	NC
12/20/2014	1.00	0.67	0.79	0.65	0.97	0.78	0.82	NC
12/21/2014	1.01	0.69	0.80	0.66	1.01	0.79	0.91	NC
12/22/2014	1.09	0.70	0.85	0.67	1.04	0.80	0.96	NC
12/23/2014	1.17	0.72	0.92	0.68	1.12	0.81	0.99	NC
12/24/2014	1.18	0.74	0.94	0.69	1.19	0.83	1.07	NC
12/25/2014	1.17	0.76	0.97	0.71	1.21	0.85	1.12	NC
12/26/2014	1.17	0.78	1.05	0.72	1.30	0.86	1.13	NC
12/27/2014	1.18	0.80	1.11	0.74	1.50	0.89	1.13	NC
12/28/2014	1.18	0.81	1.12	0.76	1.55	0.92	1.14	NC
12/29/2014	1.18	0.83	1.13	0.78	1.58	0.94	1.16	NC
12/30/2014	1.17	0.85	1.14	0.80	1.53	0.97	1.15	0.79
12/31/2014	1.15	0.86	1.15	0.82	1.47	0.99	1.16	0.80
01/01/2015	1.13	0.88	1.15	0.84	1.55	1.02	1.15	0.82
01/02/2015	1.12	0.90	1.15	0.85	1.37	1.03	1.13	0.84
01/03/2015	1.07	0.92	1.15	0.87	1.32	1.05	1.13	0.85
01/04/2015	1.06	0.93	1.16	0.89	1.32	1.07	1.12	0.87
01/05/2015	1.08	0.95	1.16	0.91	1.33	1.09	1.09	0.89

Electrical Conductivity (EC) units: milliSiemens per Centimeter
md : mean daily
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e : estimated value

Compliance Standards

for the Sacramento - San Joaquin Delta and Suisun Marsh
Tuesday, February 03, 2015

Criteria	Standard	Status
Flow/Operational		
% of inflow diverted	45 %	33 %
NDOI, monthly average *	>= 4,000 cfs	6,057 cfs
NDOI, 7 day average*	>= 3,000 cfs	6,057 cfs
Water Quality		
Days @ CCWD PP#1 w/ chlorides <= 150 mg/l	175 days	34 days
Export Areas for SWP, CVP, CCWD, et al	<= 250 mg/l Cl	50 mg/l
Maximum 30 day running average of mean daily EC at:		
Vernalis	<=1.0 mS/cm	1.0 mS/cm
Brandt Bridge	<=1.0 mS/cm	1.1 mS/cm
Old River Near Tracy	<=1.0 mS/cm	1.3 mS/cm
Old River Near Middle River	<=1.0 mS/cm	1.0 mS/cm

SUISUN MARSH:

Suisun Marsh Salinity Control Gates : 0 Open / 0 Closed / 3 Full Tide Open
Flashboard Status : In
Boat Lock Status : Open

California Hydrologic Conditions: (California Cooperative Snow Surveys Forecast, January 1, 2015)

Previous Month's Index (8RI for Dec): 2.91 MAF
Water Year Type: Below Normal
Sacramento valley water year type index (40/30/30) @ 50%: 6.7 MAF (Below Normal)
San Joaquin valley water year type index (60/20/20) @ 75%: 1.4 MAF (Critical)

Electrical Conductivity (EC) in milliSiemens per Centimeter.
Chlorides (Cl) in milligrams per liter
mht - mean high tides
md - mean daily
14 dm - fourteen day running mean
28 dm - twenty-eight day running mean
NR - No Record
NC - Average not computed due to insufficient data.
BR : Below Rating
e - estimated value s - substituted value

Montezuma Slough Gate Operation:
Number of gates operating at either Open, Closed, or Full Tide Open
Flashboard Status : In, Out, or Modified In
Boat Lock Status : Open or Closed

Coordinated Operation Agreement Delta Status:
(Note: below label begins on October 1, 2013)
c = excess Delta conditions
b = balanced Delta conditions
r = excess Delta conditions with restrictions:

* NDOI, Rio Vista & Vernalis Flows:
- 7 day average is progressive daily mean for the first six days of the month.

Delta Water Quality Conditions

Date	Antioch Tides		Net Delta Outflow Index	Martinez	Port Chicago		Mallard	Chipps Island		Collinsville	
	High	Half	cfs	mdEC	mdEC	14dm	mdEC	mdEC	14dm	mdEC	14dm
01/05/2015	6.02	3.94	8,715	13.82	5.84	2.42	1.82	1.46	0.56	0.43	0.27
01/06/2015	5.96	4.00	8,622	14.43	6.47	2.83	1.97	1.59	0.65	0.51	0.29
01/07/2015	5.92	4.08	7,105	15.06	7.24	3.30	2.50	2.07	0.77	0.61	0.32
01/08/2015	5.77	4.12	6,622	15.93	8.07	3.84	3.04	2.57	0.93	0.82	0.36
01/09/2015	5.60	4.20	6,130	15.68	8.59	4.42	3.55	3.06	1.13	1.02	0.42
01/10/2015	5.47	4.14	6,049	15.68	9.29	5.05	3.89	3.39	1.36	1.20	0.49
01/11/2015	5.54	4.01	5,788	15.81	9.62	5.69	4.10	3.59	1.60	1.29	0.56
01/12/2015	5.43	3.75	5,675	15.83	9.74	6.30	3.94	3.43	1.82	1.45	0.65
01/13/2015	5.49	3.66	5,565	16.55	10.05	6.90	4.30	3.78	2.08	1.61	0.75
01/14/2015	5.59	3.70	5,051	18.26	11.35	7.57	5.24	4.70	2.39	2.06	0.88
01/15/2015	5.77	3.78	4,606	20.91	13.23	8.27	6.47	5.93	2.78	2.57	1.04
01/16/2015	6.10	3.92	5,029	22.92	15.27	9.00	7.81	7.30	3.24	3.55	1.27
01/17/2015	6.22	3.96	5,041	23.62	15.98	9.75	8.83	8.37	3.76	4.39	1.56
01/18/2015	6.30	3.98	5,031	23.68	16.25	10.50	9.31	8.87	4.29	4.84	1.88
01/19/2015	6.27	3.93	4,996	23.76	16.42	11.25	9.51	9.08	4.84	5.17	2.22
01/20/2015	6.37	4.04	4,983	24.19	16.80	11.99	10.16	9.76	5.42	5.84	2.60
01/21/2015	6.19	3.97	4,980	23.65	16.61	12.66	10.15	9.76	5.97	5.92	2.98
01/22/2015	5.71	3.70	5,040	23.00	15.71	13.21	9.45	9.01	6.43	5.38	3.31
01/23/2015	5.49	3.68	4,977	22.28	15.55	13.70	9.43	8.99	6.85	5.15	3.60
01/24/2015	5.27	3.69	4,857	22.59	15.33	14.14	9.27	8.82	7.24	5.11	3.88
01/25/2015	5.39	3.64	4,848	22.38	15.35	14.54	9.15	8.70	7.61	5.10	4.15
01/26/2015	5.70	3.80	4,784	22.67	15.99	14.99	9.46	9.03	8.01	5.68	4.46
01/27/2015	6.03	3.87	4,878	23.33	16.16	15.43	10.08	9.68	8.43	6.01	4.77
01/28/2015	5.95	3.82	4,953	23.31	16.36	15.79	9.99	9.59	8.78	5.84	5.04
01/29/2015	6.05	3.96	4,838	23.82	16.92	16.05	10.25	9.87	9.06	5.96	5.28
01/30/2015	6.22	4.13	4,675	24.03	17.92	16.24	10.99	10.66	9.30	6.86	5.52
01/31/2015	6.25	4.20	4,772	24.79	17.76	16.37	10.86	10.51	9.45	7.45	5.74
02/01/2015	6.09	4.05	6,071	24.10	17.12	16.43	10.93	10.59	9.57	6.62	5.86
02/02/2015	5.93	3.92	5,926	23.69	16.93	16.46	10.56	10.20	9.65	6.43	5.95
02/03/2015	5.84	3.91	6,173	23.51	16.65	16.45	10.17	9.78	9.66	6.20	5.98

Antioch Tides measured in feet above mean sea level.
Net Delta Ouflow Index calculated from equation as specified in D-1641, revised June 1995.
Chipps Island EC calculated from measurements recorded at Mallard Slough.
Electrical Conductivity (EC) units: milliSiemens per Centimeter
md : mean daily
14dm : fourteen day running mean
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e - estimated value s - substituted value

Delta Water Quality Conditions

Date	Antioch		Jersey Point		Threemile Slough		Cache Slough	Good Year Slough	Sunrise Club	Volanti Slough	Beldon Landing	Collinsville
	mdEC	14mdEC	mdEC	14mdEC	mdEC	14mdEC	mdEC	mhtEC	mhtEC	mhtEC	mhtEC	mhtEC
01/05/2015	0.44	0.41	0.32	0.33	0.31	0.27	NR	5.96	5.16	4.03	e	0.55
01/06/2015	0.48	0.41	0.32	0.33	0.31	0.27	NR	5.82	4.53	3.61	2.30	0.50
01/07/2015	0.53	0.41	0.32	0.32	0.31	0.27	NR	5.88	4.23	3.17	2.01	0.67
01/08/2015	0.60	0.42	0.33	0.32	0.31	0.28	NR	5.47	3.91	3.05	1.83	0.84
01/09/2015	0.66	0.44	0.33	0.32	0.32	0.29	NR	5.49	3.65	2.76	1.60	1.42
01/10/2015	0.71	0.46	0.34	0.32	0.32	0.29	NR	5.51	3.55	2.64	1.54	1.48
01/11/2015	0.73	0.48	0.34	0.32	0.32	0.30	NR	5.57	3.60	2.69	1.62	1.62
01/12/2015	0.71	0.51	0.34	0.32	0.32	0.30	NR	6.18	4.15	3.01	1.74	1.86
01/13/2015	0.80	0.54	0.34	0.33	0.33	0.31	NR	7.18	4.48	3.30	1.93	2.55
01/14/2015	1.02	0.59	0.36	0.33	0.32	0.31	NR	7.96	5.44	3.83	2.22	3.47
01/15/2015	1.61	0.68	0.38	0.33	0.33	0.31	NR	8.24	6.25	5.07	3.21	3.20
01/16/2015	1.93	0.79	0.42	0.34	0.37	0.32	NR	8.01	7.86	6.50	3.73	5.62
01/17/2015	2.35	0.93	0.46	0.35	0.42	0.33	NR	8.79	8.36	6.58	3.37	6.62
01/18/2015	2.66	1.09	0.51	0.36	0.49	0.34	NR	9.33	8.28	6.62	3.46	7.65
01/19/2015	2.79	1.26	0.54	0.38	0.54	0.36	NR	9.66	8.31	6.57	4.08	7.74
01/20/2015	3.22	1.45	0.62	0.40	0.63	0.38	NR	10.20	7.99	5.64	5.09	7.52
01/21/2015	3.25	1.65	0.64	0.42	0.63	0.40	NR	10.38	7.68	5.91	5.35	7.23
01/22/2015	2.92	1.81	0.60	0.44	0.55	0.42	NR	10.10	7.68	6.11	5.80	6.62
01/23/2015	2.91	1.97	0.63	0.46	0.53	0.44	NR	9.91	7.58	6.09	5.93	6.68
01/24/2015	3.01	2.14	0.67	0.49	0.54	0.45	NR	9.89	7.66	6.15	6.04	6.59
01/25/2015	3.04	2.30	0.70	0.51	0.56	0.47	NR	9.87	7.68	6.01	5.76	6.10
01/26/2015	3.16	2.48	0.79	0.55	0.65	0.49	NR	9.89	7.44	6.19	5.61	6.87
01/27/2015	3.61	2.68	0.88	0.59	0.80	0.53	NR	10.29	8.02	6.70	5.74	7.63
01/28/2015	3.63	2.86	0.89	0.62	0.80	0.56	NR	10.85	7.83	7.23	5.97	8.12
01/29/2015	3.92	3.03	0.99	0.67	0.83	0.60	NR	10.79	8.05	7.47	6.33	8.03
01/30/2015	4.30	3.20	1.10	0.72	0.84	0.63	NR	10.94	9.00	7.81	6.66	8.89
01/31/2015	4.25	3.33	1.14	0.76	0.87	0.66	NR	11.08	8.74	7.93	6.77	9.50
02/01/2015	4.20	3.44	1.14	0.81	0.97	0.70	NR	11.35	9.71	7.41	6.80	7.68
02/02/2015	3.93	3.53	1.04	0.85	0.87	0.72	NR	11.65	8.68	7.39	7.32	7.92
02/03/2015	3.83	3.57	1.03	0.88	0.84	0.73	NR	11.97	9.65	7.45	7.68	8.19

Electrical Conductivity (EC) units: milliSiemens per Centimeter
Chloride (Cl) units: milligrams per liter
mht : mean high tides
md : mean daily
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e : estimated value s : substituted value

Delta Water Quality Conditions

Date	Emmaton mdEC	Bethel Island mdEC	Farrar Park mdEC	Holland Tract mdEC	Bacon Island mdEC	Contra Costa mdEC	Clifton Court mdEC	Tracy Pumping Plant mdEC	Antioch mdCl	Bacon Island mdCl	Contra Costa mdCl	Delta Status
01/05/2015	0.29	0.32	0.50	0.35	0.37	0.71	0.51	0.66	71	58	89 s	r
01/06/2015	0.29	0.30	0.50	0.35	0.37	0.77	0.53	0.68	81	58	80 s	r
01/07/2015	0.31	0.32	0.49	0.35	0.37	0.75	0.57	0.71	98	57	79 s	r
01/08/2015	0.32	0.32	0.49	0.35	0.36	0.65	0.56	0.68	120	56	70 s	r
01/09/2015	0.33	0.32	0.49	0.35	0.36	NR	0.54	0.76	140	55	65 s	r
01/10/2015	0.34	0.32	0.49	0.35	0.36	NR	0.57	0.74	155	55	66 s	r
01/11/2015	0.34	0.33	0.49	0.34	0.36	NR	0.57	0.76	164	54	67 s	r
01/12/2015	0.33	0.33	0.49	0.35	0.36	0.71	0.60	0.78	155	55	69 s	r
01/13/2015	0.32	0.33	0.49	0.34	0.36	0.69	0.54	0.82	185	54	82 s	r
01/14/2015	0.32	0.33	0.48	0.34	0.35	0.69	0.53	0.75	256	54	61 s	r
01/15/2015	0.41	0.34	0.48	0.35	0.35	0.64	0.50	0.73	443	54	70 s	b
01/16/2015	0.62	0.34	0.47	0.35	0.35	0.55	0.44	0.71	544	53	60 s	b
01/17/2015	0.76	0.34	0.47	0.35	0.35	0.56	0.45	0.66	680	54	59 s	b
01/18/2015	1.00	0.35	0.47	0.35	0.35	0.57	0.47	0.66	776	54	58 s	b
01/19/2015	1.11	0.35	0.46	0.35	0.36	0.51	0.48	0.68	820	55	57 s	b
01/20/2015	1.36	0.36	0.47	0.36	0.36	0.53	0.48	0.67	957	55	55 s	b
01/21/2015	1.33	0.37	0.47	0.36	0.36	0.52	0.48	0.70	965	56	52 s	b
01/22/2015	1.10	0.38	0.48	0.36	0.36	0.58	0.50	0.67	859	57	53 s	b
01/23/2015	1.04	0.39	0.49	0.37	0.37	0.64	0.51	0.69	858	58	51 s	b
01/24/2015	1.11	0.39	0.49	0.37	0.37	0.55	0.47	0.67	890	58	53 s	b
01/25/2015	1.10	0.42	0.50	0.38	0.37	0.43	0.46	0.64	899	59	50 s	b
01/26/2015	1.22	0.44	0.51	0.38	0.38	0.42	0.45	0.65	936	60	52 s	b
01/27/2015	1.39	0.46	0.53	0.39	0.38	0.51	0.47	0.65	1,081	62	52 s	b
01/28/2015	1.31	0.46	0.53	0.40	0.39	0.51	0.47	0.65	1,086	63	49 s	b
01/29/2015	1.41	0.52	0.56	0.41	0.39	0.43	0.41	0.65	1,179	65	53 s	b
01/30/2015	1.50	0.53	0.60	0.42	0.40	0.43	0.44	0.62	1,298	67	51 s	b
01/31/2015	1.59	0.55	0.63	0.45	0.42	0.46	0.45	0.62	1,283	70	52 s	b
02/01/2015	1.78	0.61	0.65	0.45	0.43	0.47	0.46	0.64	1,269	74	52 s	b
02/02/2015	1.57	0.64	0.66	0.47	0.44	0.49	0.50	0.63	1,183	77	52 s	b
02/03/2015	1.60	0.65	0.68	0.49	0.45	0.42	0.57	0.64	1,150	79	50 e	b

Electrical Conductivity (EC) units: milliSiemens per Centimeter
Chloride (Cl) units: milligrams per liter
md : mean daily
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e : estimated value s : substituted value
Antioch and Bacon Island mdCl are calculated from the respective mdEC values.

Coordinated Operation Agreement Delta Status:
(Note: below label begins on October 1, 2013)
c = excess Delta conditions
b = balanced Delta conditions
r = excess Delta conditions with restrictions:

Delta Water Quality Conditions

South Delta Stations

Date	Vernalis		Brandt Bridge		Old River Near Tracy		Old River Near Middle River	
	md EC	30 day avg	md EC	30 day avg	md EC	30 day avg	md EC	30 day avg
01/05/2015	1.08	0.95	1.16	0.91	1.33	1.09	1.09	0.89
01/06/2015	1.07	0.96	1.16	0.93	1.39	1.12	1.08	0.91
01/07/2015	1.05	0.98	1.16	0.95	1.37	1.14	1.09	0.92
01/08/2015	1.04	0.98	1.15	0.96	1.37	1.16	1.08	0.94
01/09/2015	1.02	0.98	1.15	0.98	1.41	1.19	1.07	0.95
01/10/2015	0.98	0.99	1.15	0.99	1.35	1.21	1.06	0.96
01/11/2015	0.97	1.00	1.14	1.00	1.38	1.22	1.03	0.97
01/12/2015	0.97	1.02	1.12	1.00	1.43	1.24	0.99	0.98
01/13/2015	0.97	1.03	1.10	1.01	1.49	1.26	0.98	0.99
01/14/2015	0.96	1.05	1.09	1.02	1.62	1.28	0.98	1.01
01/15/2015	0.91	1.05	1.08	1.03	1.64	1.31	0.98	1.03
01/16/2015	0.85	1.05	1.07	1.04	1.53	1.33	0.97	1.04
01/17/2015	0.87	1.06	1.07	1.06	1.47	1.35	0.90	1.05
01/18/2015	0.86	1.05	1.05	1.07	1.37	1.37	0.87	1.05
01/19/2015	0.86	1.05	1.04	1.08	1.26	1.38	0.88	1.05
01/20/2015	0.87	1.04	1.03	1.09	1.22	1.39	0.87	1.05
01/21/2015	0.85	1.04	1.02	1.09	1.18	1.39	0.87	1.04
01/22/2015	0.83	1.03	1.00	1.10	1.20	1.40	0.88	1.04
01/23/2015	0.83	1.01	1.00	1.10	1.23	1.40	0.87	1.03
01/24/2015	0.87	1.00	1.00	1.10	1.31	1.40	0.86	1.03
01/25/2015	0.91	0.99	1.00	1.10	1.35	1.40	0.85	1.02
01/26/2015	0.95	0.99	1.01	1.10	1.35	1.40	0.88	1.01
01/27/2015	1.01	0.98	1.02	1.09	1.30	1.39	0.91	1.00
01/28/2015	1.01	0.98	1.02	1.09	1.27	1.38	0.94	0.99
01/29/2015	0.98	0.97	1.02	1.08	1.26	1.37	0.99	0.99
01/30/2015	1.04	0.97	1.04	1.08	1.33	1.36	1.00	0.98
01/31/2015	1.00	0.96	1.05	1.08	1.31	1.36	0.98	0.98
02/01/2015	1.02	0.96	1.04	1.07	1.26	1.35	0.97	0.97
02/02/2015	1.18	0.96	1.03	1.07	1.24	1.35	0.97	0.97
02/03/2015	1.32	0.97	1.02	1.07	1.26	1.35	0.98	0.96

Electrical Conductivity (EC) units: milliSiemens per Centimeter
md : mean daily
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e : estimated value s : substituted value

Compliance Standards

for the Sacramento - San Joaquin Delta and Suisun Marsh
Thursday, March 05, 2015

Criteria	Standard	Status
Flow/Operational		
% of inflow diverted	35 %	35 %
NDOI, monthly average *	>= 4,000 cfs	5,578 cfs
NDOI, 7 day average*	>= 3,000 cfs	5,578 cfs
Vernalis Base Flow : Monthly average *	>= 500 cfs	704 cfs
7 Day average *	>= 400 cfs	704 cfs
Habitat Protection, X2 / Flow	31 day at Chipps Island	5 days
* 20 Chipps days as carryover from Febru	31 days at Collinsville	5 days
Water Quality		
Days @ CCWD PP#1 w/ chlorides <= 150 mg/l	155 days	59 days
Export Areas for SWP, CVP, CCWD, et al	<= 250 mg/l Cl	158 mg/l
Maximum 30 day running average of mean daily EC at:		
Vernalis	<=1.0 mS/cm	1.0 mS/cm
Brandt Bridge	<=1.0 mS/cm	1.0 mS/cm
Old River Near Tracy	<=1.0 mS/cm	1.2 mS/cm
Old River Near Middle River	<=1.0 mS/cm	1.0 mS/cm

SUISUN MARSH:

Suisun Marsh Salinity Control Gates : 0 Open / 0 Closed / 3 Full Tide Open
Flashboard Status : In
Boat Lock Status : Open

California Hydrologic Conditions: (California Cooperative Snow Surveys Forecast, February 1, 2015)

Previous Month's Index (8RI for Jan): 0.805 MAF
Water Year Type: Critical
Sacramento valley water year type index (40/30/30) @ 50%: 5.1 MAF (Critical)
San Joaquin valley water year type index (60/20/20) @ 75%: 1.1 MAF (Critical)

Electrical Conductivity (EC) in milliSiemens per Centimeter.
Chlorides (Cl) in milligrams per liter
mht - mean high tides
md - mean daily
14 dm - fourteen day running mean
28 dm - twenty-eight day running mean
NR - No Record
NC - Average not computed due to insufficient data.
BR : Below Rating
e - estimated value s - substituted value

Montezuma Slough Gate Operation:
Number of gates operating at either Open, Closed, or Full Tide Open
Flashboard Status : In, Out, or Modified In
Boat Lock Status : Open or Closed

Coordinated Operation Agreement Delta Status:
(Note: below label begins on October 1, 2013)
c = excess Delta conditions
b = balanced Delta conditions
r = excess Delta conditions with restrictions:

* NDOI, Rio Vista & Vernalis Flows:
- 7 day average is progressive daily mean for the first six days of the month.

Delta Water Quality Conditions

Date	Antioch Tides		Net Delta Outflow Index	Martinez	Port Chicago		Mallard	Chipps Island		Collinsville	
	High	Half	cfs	mdEC	mdEC	14dm	mdEC	mdEC	14dm	mdEC	14dm
02/04/2015	5.88	4.04	7,194	23.53	16.88	16.47	10.41	10.03	9.67	6.52	6.02
02/05/2015	6.05	4.28	7,002	24.58	17.39	16.59	11.28	10.96	9.81	6.77	6.12
02/06/2015	6.46	4.81	7,197	25.87	19.30	16.86	12.18	11.93	10.02	6.85	6.24
02/07/2015	6.27	4.56	9,392	24.45	17.67	17.03	11.12	10.79	10.16	6.75	6.36
02/08/2015	5.84	4.62	18,244	22.82	16.41	17.10	10.14	9.75	10.24	5.23	6.37
02/09/2015	6.34	4.42	24,498	21.23	14.14	16.97	8.05	7.55	10.13	3.90	6.24
02/10/2015	5.64	3.92	39,822	17.40	9.72	16.51	4.24	3.72	9.71	1.46	5.92
02/11/2015	5.68	3.82	39,879	15.03	7.08	15.85	2.53	2.11	9.17	0.76	5.55
02/12/2015	5.62	3.86	36,707	14.51	5.58	15.04	1.65	1.31	8.56	0.51	5.16
02/13/2015	5.92	4.04	33,818	15.28	5.35	14.14	1.38	1.07	7.88	0.43	4.71
02/14/2015	6.14	4.16	29,486	16.03	6.45	13.33	1.52	1.20	7.21	0.40	4.20
02/15/2015	6.28	4.21	24,399	16.65	7.15	12.62	1.70	1.35	6.55	0.39	3.76
02/16/2015	6.36	4.24	20,307	15.93	7.34	11.94	1.93	1.56	5.94	0.43	3.33
02/17/2015	6.42	4.30	17,399	16.52	7.92	11.31	2.24	1.83	5.37	0.53	2.92
02/18/2015	6.21	4.15	14,977	15.01	7.04	10.61	1.89	1.52	4.76	0.50	2.49
02/19/2015	6.05	4.08	13,243	14.73	6.68	9.84	1.87	1.50	4.09	0.52	2.05
02/20/2015	5.86	4.04	11,698	14.77	6.70	8.94	1.98	1.60	3.35	0.55	1.60
02/21/2015	5.80	4.17	10,260	15.48	7.23	8.20	2.36	1.94	2.72	0.57	1.16
02/22/2015	6.09	4.22	10,228	14.85	7.14	7.54	2.40	1.98	2.16	0.84	0.84
02/23/2015	5.99	3.99	10,638	14.45	6.17	6.97	1.99	1.61	1.74	0.88	0.63
02/24/2015	5.84	3.80	9,866	14.50	7.09	6.78	2.14	1.75	1.60	0.71	0.57
02/25/2015	5.78	3.85	8,971	14.36	7.12	6.78	2.18	1.79	1.57	0.72	0.57
02/26/2015	5.81	3.95	7,562	14.77	8.05	6.96	2.56	2.13	1.63	0.79	0.59
02/27/2015	5.87	4.20	6,633	16.51	9.52	7.26	3.39	2.90	1.76	1.08	0.64
02/28/2015	5.97	4.18	5,805	17.11	9.13	7.45	3.42	2.94	1.89	1.25	0.70
03/01/2015	5.80	4.03	5,927	16.87	8.98	7.58	3.35	2.87	2.00	1.37	0.77
03/02/2015	6.04	4.17	5,924	18.05	11.04	7.84	4.38	3.85	2.16	1.65	0.85
03/03/2015	5.70	3.97	5,230	17.74	10.51	8.03	4.27	3.75	2.30	1.57	0.93
03/04/2015	5.54	3.90	5,412	18.04	10.60	8.28	4.27	3.75	2.45	1.68	1.01
03/05/2015	5.20	3.61	5,395	17.60	10.18	8.53	4.13	3.61	2.61	1.51	1.08

Antioch Tides measured in feet above mean sea level.
Net Delta Ouflow Index calculated from equation as specified in D-1641, revised June 1995.
Chipps Island EC calculated from measurements recorded at Mallard Slough.
Electrical Conductivity (EC) units: milliSiemens per Centimeter
md : mean daily
14dm : fourteen day running mean
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e - estimated value s - substituted value

Delta Water Quality Conditions

Date	Antioch		Jersey Point		Threemile Slough		Cache Slough	Good Year Slough	Sunrise Club	Volanti Slough	Beldon Landing	Collinsville
	mdEC	14mdEC	mdEC	14mdEC	mdEC	14mdEC	mdEC	mhtEC	mhtEC	mhtEC	mhtEC	mhtEC
02/04/2015	3.83	3.61	1.01	0.90	0.82	0.75	NR	12.13	8.45	7.24	7.24	7.45
02/05/2015	4.14	3.70	1.09	0.94	0.86	0.77	NR	11.53	8.51	7.19	6.97	8.76
02/06/2015	4.88	3.84	1.23	0.98	0.99	0.80	NR	11.42	9.56	7.73	6.79	8.69
02/07/2015	4.72	3.96	1.12	1.01	0.91	0.83	NR	11.31	9.21 e	7.22	6.75	8.08
02/08/2015	3.73	4.01	0.98	1.03	0.59	0.83	NR	11.33	8.50	7.38	7.15	6.45
02/09/2015	3.28	4.02	0.94	1.04	0.50	0.82	NR	11.37	4.64	6.73	7.53	4.74
02/10/2015	1.65	3.88	0.70	1.03	0.46	0.79	NR	12.33	5.94	6.32	6.99	1.82
02/11/2015	1.19	3.70	0.60	1.01	0.38	0.77	NR	12.55	6.63	6.37	7.13	1.11
02/12/2015	0.98	3.49	0.54	0.98	0.33	0.73	NR	12.07	6.80	6.77	7.15	0.60
02/13/2015	0.84	3.25	0.52	0.93	0.31	0.69	NR	11.46	6.92	6.80	6.76	0.50
02/14/2015	0.74	3.00	0.50	0.89	0.29	0.65	NR	10.56	7.01	6.94	6.56	0.46
02/15/2015	0.68	2.74	0.47	0.84	0.28	0.60	NR	9.98	7.43	6.34	5.96	0.54
02/16/2015	0.66	2.51	0.45	0.80	0.29	0.56	NR	9.42	7.31	5.99	6.00	0.59
02/17/2015	0.64	2.28	0.44	0.76	0.29	0.52	NR	8.75	6.92	5.84	5.22	0.50
02/18/2015	0.62	2.05	0.42	0.71	0.31	0.48	NR	8.25	6.09	5.31	3.78	0.48
02/19/2015	0.60	1.80	0.41	0.66	0.31	0.45	NR	8.13	5.17	4.27	2.46	0.57
02/20/2015	0.60	1.50	0.40	0.61	0.32	0.40	NR	8.18	4.34	3.45	1.71	0.52
02/21/2015	0.61	1.20	0.39	0.55	0.32	0.36	NR	7.65	3.66	3.09	1.45	0.61
02/22/2015	0.62	0.98	0.40	0.51	0.33	0.34	NR	7.26	3.64	2.93	1.37	1.09
02/23/2015	0.58	0.79	0.40	0.47	0.34	0.33	NR	8.87	3.73	2.75	1.28	0.90
02/24/2015	0.57	0.71	0.38	0.45	0.34	0.32	NR	8.97	3.79	3.03	1.28	0.75
02/25/2015	0.58	0.67	0.38	0.44	0.34	0.32	NR	8.65	4.17	2.90	1.34	0.84
02/26/2015	0.61	0.64	0.39	0.42	0.35	0.32	NR	7.57	4.43	2.77	1.36	1.08
02/27/2015	0.69	0.63	0.40	0.42	0.34	0.32	NR	6.62	4.09	2.53	1.36	1.41
02/28/2015	0.74	0.63	0.40	0.41	0.35	0.32	NR	6.42	3.85	3.05	1.43	1.67
03/01/2015	0.74	0.63	0.40	0.40	0.35	0.33	NR	6.92	4.08	2.91	1.58	1.39
03/02/2015	0.85	0.65	0.41	0.40	0.35	0.33	NR	6.52	3.65	2.82	1.65	2.13
03/03/2015	0.87	0.66	0.40	0.40	0.35	0.34	NR	6.66	3.57	2.47	1.83	2.11
03/04/2015	0.90	0.68	0.41	0.40	0.35	0.34	NR	6.77	3.54	2.69	1.87	1.86
03/05/2015	0.87	0.70	0.40	0.40	0.35	0.34	NR	8.10	3.67	2.41	2.09	1.71

Electrical Conductivity (EC) units: milliSiemens per Centimeter
Chloride (Cl) units: milligrams per liter
mht : mean high tides
md : mean daily
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e : estimated value s : substituted value

Delta Water Quality Conditions

Date	Emmaton mdEC	Bethel Island mdEC	Farrar Park mdEC	Holland Tract mdEC	Bacon Island mdEC	Contra Costa mdEC	Clifton Court mdEC	Tracy Pumping Plant mdEC	Antioch mdCl	Bacon Island mdCl	Contra Costa mdCl	Delta Status
02/04/2015	1.65	0.67	0.70	0.49	0.46	0.34	0.50	0.61	1,149	81	56 s	b
02/05/2015	1.81	0.68	0.73	0.51	0.47	0.38	0.51	0.60	1,249	84	58 s	b
02/06/2015	2.35	0.72	0.76	0.50	0.48	0.37	0.48	0.60	1,483	88	59 s	b
02/07/2015	1.57	0.72	0.77	0.48	0.49	0.38	0.62	0.59	1,432	90	58 s	r
02/08/2015	0.99	0.72	0.76	0.50	0.49	0.40	0.59	0.68	1,116	91	59 s	r
02/09/2015	0.54	0.66	0.78	0.50	0.50	0.40	0.60	0.61	976	93	63 s	r
02/10/2015	0.34	0.71	0.74	0.53	0.51	0.40	0.61	0.73	456	94	70 s	r
02/11/2015	0.30	0.63	0.73	0.52	0.51	0.40	0.64	0.67	309	95	71 s	r
02/12/2015	0.28	0.66	0.74	0.54	0.51	0.42	0.61	0.66	242	96	74 s	r
02/13/2015	0.25	0.57	0.74	0.53	0.51	0.42	0.58	0.30	198	96	77 s	r
02/14/2015	0.23	0.53	0.74	0.50	0.51	0.39	0.51	0.56	165	94	91 s	r
02/15/2015	0.23	0.49	0.71	0.49	0.45	0.37	0.54	0.45	147	80	112 s	r
02/16/2015	0.23	0.46	0.69	0.48	0.49	0.36	0.57	0.21	141	89	119 s	r
02/17/2015	0.25	0.43	0.66	0.46	0.47	0.41	0.56	0.20	134	86	109 s	r
02/18/2015	0.26	0.41	0.63	0.43	0.46	0.41	0.56	0.59	128	83	111 s	r
02/19/2015	0.27	0.42	0.60	0.43	0.46	0.38	0.58	0.77	122	81	107 s	r
02/20/2015	0.28	0.41	0.58	0.42	0.44	0.40	0.67	0.71	119	78	102 s	r
02/21/2015	0.28	0.37	0.56	0.41	0.43	0.41	0.71	0.70	124	74	116 s	r
02/22/2015	0.31	0.38	0.54	0.40	0.42	0.41	0.57	0.61	127	71	91 s	r
02/23/2015	0.30	0.38	0.52	0.39	0.41	0.40	0.55	0.74	114	70	89 s	r
02/24/2015	0.30	0.34	0.51	0.39	0.41	0.43	0.55	0.77	111	69	128 s	r
02/25/2015	0.30	0.37	0.50	0.38	0.40	0.46	0.49	0.72	115	67	108 s	r
02/26/2015	0.31	0.36	0.50	0.38	0.40	0.40	0.50	0.74	126	66	108 s	r
02/27/2015	0.33	0.34	0.48	0.38	0.39	0.33	0.47	0.72	149	63	151 s	r
02/28/2015	0.34	0.38	0.46	0.37	0.38	0.35	0.45	0.67	166	62	118 s	r
03/01/2015	0.33	0.38	0.47	0.38	0.38	0.38	0.46	0.73	167	62	160 s	r
03/02/2015	0.37	0.37	0.47	0.38	0.38	0.38	0.46	0.60	201	61	150 s	r
03/03/2015	0.35	0.37	0.47	0.37	0.38	0.41	0.45	0.58	208	61	155 s	r
03/04/2015	0.35	0.36	0.47	0.37	0.38	0.46	0.43	0.59	215	60	158 e	r
03/05/2015	0.34	0.36	0.47	0.38	0.38	0.45	0.46	0.62	206	60	158 e	r

Electrical Conductivity (EC) units: milliSiemens per Centimeter
Chloride (Cl) units: milligrams per liter
md : mean daily
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e : estimated value s : substituted value
Antioch and Bacon Island mdCl are calculated from the respective mdEC values.

Coordinated Operation Agreement Delta Status:
(Note: below label begins on October 1, 2013)
c = excess Delta conditions
b = balanced Delta conditions
r = excess Delta conditions with restrictions:

Delta Water Quality Conditions

South Delta Stations

Date	Vernalis		Brandt Bridge		Old River Near Tracy		Old River Near Middle River	
	md EC	30 day avg	md EC	30 day avg	md EC	30 day avg	md EC	30 day avg
02/04/2015	1.27	0.98	1.01	1.06	1.33	1.35	1.11	0.96
02/05/2015	1.14	0.98	1.01	1.06	1.32	1.35	1.23	0.97
02/06/2015	1.09	0.98	1.01	1.05	1.30	1.34	1.22	0.97
02/07/2015	1.05	0.98	1.03	1.05	1.33	1.34	1.12	0.97
02/08/2015	1.01	0.98	1.07	1.04	1.35	1.34	1.02	0.97
02/09/2015	0.97	0.98	1.05	1.04	1.38	1.34	1.02	0.97
02/10/2015	0.89	0.98	1.09	1.04	1.24	1.34	0.95	0.97
02/11/2015	0.97	0.98	1.07	1.04	1.26	1.33	0.90	0.97
02/12/2015	0.97	0.98	1.05	1.04	1.28	1.32	0.84	0.96
02/13/2015	1.08	0.98	1.02	1.03	1.26	1.31	0.93	0.96
02/14/2015	1.10	0.99	0.97	1.03	1.21	1.30	0.94	0.96
02/15/2015	1.05	0.99	0.93	1.03	1.14	1.28	1.04	0.96
02/16/2015	1.01	1.00	0.88	1.02	1.14	1.27	1.07	0.97
02/17/2015	0.98	1.00	0.85	1.01	1.14	1.27	1.05	0.97
02/18/2015	0.92	1.01	0.84	1.01	1.16	1.26	1.02	0.98
02/19/2015	0.87	1.01	0.86	1.00	1.17	1.26	1.00	0.98
02/20/2015	0.83	1.00	0.87	0.99	1.19	1.26	0.92	0.98
02/21/2015	0.87	1.01	0.88	0.99	1.21	1.26	0.86	0.98
02/22/2015	0.87	1.01	0.88	0.99	1.21	1.26	0.81	0.98
02/23/2015	0.90	1.01	0.90	0.98	1.20	1.26	0.88	0.98
02/24/2015	0.84	1.01	0.90	0.98	1.11	1.25	0.87	0.98
02/25/2015	0.81	1.00	0.90	0.98	1.13	1.24	0.89	0.98
02/26/2015	0.82	0.99	0.90	0.97	1.19	1.24	0.86	0.98
02/27/2015	0.84	0.99	0.92	0.97	1.20	1.24	0.84	0.98
02/28/2015	0.87	0.99	0.96	0.97	1.16	1.23	0.86	0.97
03/01/2015	0.99	0.98	1.00	0.97	1.10	1.23	0.87	0.97
03/02/2015	1.07	0.99	1.06	0.97	1.10	1.22	0.88	0.96
03/03/2015	1.07	0.99	1.10	0.97	1.12	1.21	0.95	0.96
03/04/2015	0.98	0.98	1.14	0.97	1.11	1.21	1.02	0.96
03/05/2015	0.85	0.97	1.18	0.98	1.10	1.20	1.08	0.97

Electrical Conductivity (EC) units: milliSiemens per Centimeter
md : mean daily
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e : estimated value s : substituted value

Compliance Standards

for the Sacramento - San Joaquin Delta and Suisun Marsh
Thursday, April 02, 2015

Criteria	Standard	Status
Flow/Operational		
% of inflow diverted	35 %	19 %
NDOI, monthly average *	>= 4,000 cfs	4,092 cfs
NDOI, 7 day average*	>= 3,000 cfs	4,092 cfs
Vernalis Base Flow : Monthly average *	>= 500 cfs	822 cfs
7 Day average *	>= 400 cfs	822 cfs
Habitat Protection, X2 / Flow	31 days at Collinsville	0
Water Quality		
Days @ CCWD PP#1 w/ chlorides <= 150 mg/l	155 days	84 days
Export Areas for SWP, CVP, CCWD, et al	<= 250 mg/l Cl	68 mg/l
Maximum 30 day running average of mean daily EC at:		
Vernalis	<=1.0 mS/cm	0.6 mS/cm
Brandt Bridge	<=1.0 mS/cm	1.1 mS/cm
Old River Near Tracy	<=1.0 mS/cm	1.2 mS/cm
Old River Near Middle River	<=1.0 mS/cm	0.8 mS/cm

SUISUN MARSH:

Suisun Marsh Salinity Control Gates : 0 Open / 0 Closed / 3 Full Tide Open
Flashboard Status : In
Boat Lock Status : Open

California Hydrologic Conditions: (California Cooperative Snow Surveys Forecast, March 1, 2015)

Previous Month's Index (8RI for Feb): 2.23 MAF
Water Year Type: Critical
Sacramento valley water year type index (40/30/30) @ 50%: 4.7 MAF (Critical)
San Joaquin valley water year type index (60/20/20) @ 75%: 0.9 MAF (Critical)

Electrical Conductivity (EC) in milliSiemens per Centimeter.
Chlorides (Cl) in milligrams per liter
mht - mean high tides
md - mean daily
14 dm - fourteen day running mean
28 dm - twenty-eight day running mean
NR - No Record
NC - Average not computed due to insufficient data.
BR : Below Rating
e - estimated value s - substituted value

Montezuma Slough Gate Operation:
Number of gates operating at either Open, Closed, or Full Tide Open
Flashboard Status : In, Out, or Modified In
Boat Lock Status : Open or Closed

Coordinated Operation Agreement Delta Status:
(Note: below label begins on October 1, 2013)
c = excess Delta conditions
b = balanced Delta conditions
r = excess Delta conditions with restrictions:

* NDOI, Rio Vista & Vernalis Flows:
- 7 day average is progressive daily mean for the first six days of the month.

Delta Water Quality Conditions

Date	Antioch Tides		Net Delta Outflow Index	Martinez	Port Chicago		Mallard	Chipps Island		Collinsville	
	High	Half	cfs	mdEC	mdEC	14dm	mdEC	mdEC	14dm	mdEC	14dm
03/04/2015	5.54	3.90	5,412	18.04	10.60	8.28	4.27	3.75	2.45	1.68	1.01
03/05/2015	5.20	3.61	5,395	17.60	10.18	8.53	4.13	3.61	2.61	1.51	1.08
03/06/2015	5.16	3.62	5,359	18.10	10.65	8.81	4.50	3.97	2.77	1.71	1.17
03/07/2015	5.19	3.78	4,611	19.15	11.37	9.11	4.98	4.44	2.95	2.03	1.27
03/08/2015	5.37	3.86	4,679	18.84	12.01	9.46	5.68	5.14	3.18	2.46	1.39
03/09/2015	5.50	3.91	4,305	19.76	12.45	9.91	5.88	5.34	3.44	2.88	1.53
03/10/2015	5.61	3.93	4,184	20.06	12.71	10.31	6.15	5.61	3.72	3.04	1.70
03/11/2015	5.73	3.94	4,513	20.64	12.85	10.72	6.29	5.75	4.00	3.31	1.88
03/12/2015	5.48	3.74	5,485	20.14	12.48	11.03	5.98	5.43	4.24	3.00	2.04
03/13/2015	5.58	3.86	5,825	20.71	13.08	11.29	6.38	5.84	4.45	3.21	2.19
03/14/2015	5.60	3.95	5,104	20.94	14.08	11.64	6.88	6.35	4.69	3.38	2.34
03/15/2015	5.96	4.09	4,697	22.64	15.24	12.09	8.07	7.58	5.03	4.49	2.56
03/16/2015	5.86	4.00	5,625	23.02	15.84	12.43	8.21	7.72	5.31	4.75	2.79
03/17/2015	5.95	4.07	5,582	22.93	16.24	12.84	9.23	8.78	5.66	5.42	3.06
03/18/2015	5.75	3.93	5,562	20.16	15.73	13.21	8.86	8.40	6.00	5.19	3.31
03/19/2015	5.68	3.90	5,556	19.77	15.65	13.60	8.70	8.23	6.33	5.24	3.58
03/20/2015	5.67	4.02	5,344	20.41	15.86	13.97	9.30	8.85	6.68	5.60	3.86
03/21/2015	5.79	3.99	4,900	20.22	15.81	14.29	9.31	8.87	6.99	5.66	4.12
03/22/2015	5.89	4.02	4,897	20.22	16.17	14.58	9.61	9.18	7.28	5.67	4.35
03/23/2015	5.96	3.97	4,441	19.97	15.81	14.82	9.50	9.07	7.55	5.64	4.54
03/24/2015	5.85	3.86	4,668	20.85	15.55	15.03	9.45	9.01	7.79	5.67	4.73
03/25/2015	5.69	3.77	4,545	21.27	15.42	15.21	8.83	8.37	7.98	5.51	4.89
03/26/2015	5.57	3.79	4,525	21.33	15.11	15.40	8.65	8.18	8.17	5.22	5.05
03/27/2015	5.49	3.96	4,536	20.97	15.49	15.57	9.12	8.67	8.37	5.60	5.22
03/28/2015	5.23	3.77	4,351	22.06	15.42	15.67	8.94	8.48	8.53	5.45	5.36
03/29/2015	5.33	3.83	4,864	21.96	15.75	15.70	9.06	8.60	8.60	5.71	5.45
03/30/2015	5.48	4.01	4,240	22.59	16.61	15.76	9.68	9.26	8.71	6.14	5.55
03/31/2015	5.38	3.99	4,109	24.03	17.02	15.81	10.46	10.08	8.80	6.41	5.62
04/01/2015	5.04	3.56	4,101	22.30	15.91	15.83	9.07	8.61	8.82	5.49	5.64
04/02/2015	5.03	3.49	4,083	22.00	15.24	15.80	8.71	8.24	8.82	5.55	5.67

Antioch Tides measured in feet above mean sea level.
Net Delta Ouflow Index calculated from equation as specified in D-1641, revised June 1995.
Chipps Island EC calculated from measurements recorded at Mallard Slough.
Electrical Conductivity (EC) units: milliSiemens per Centimeter
md : mean daily
14dm : fourteen day running mean
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e - estimated value s - substituted value

Delta Water Quality Conditions

Date	Antioch		Jersey Point		Threemile Slough		Cache Slough	Good Year Slough	Sunrise Club	Volanti Slough	Beldon Landing	Collinsville
	mdEC	14mdEC	mdEC	14mdEC	mdEC	14mdEC	mdEC	mhtEC	mhtEC	mhtEC	mhtEC	mhtEC
03/04/2015	0.90	0.68	0.41	0.40	0.35	0.34	NR	6.77	3.54	2.69	1.87	1.86
03/05/2015	0.87	0.70	0.40	0.40	0.35	0.34	NR	8.10	3.67	2.41	2.09	1.71
03/06/2015	0.93	0.73	0.41	0.40	0.35	0.34	NR	8.08	3.85	2.70	2.07	2.20
03/07/2015	1.04	0.76	0.42	0.40	0.34	0.34	NR	7.82	3.63	2.72	2.18	2.26
03/08/2015	1.20	0.80	0.44	0.40	0.36	0.35	NR	6.74	3.79	3.08	2.08	3.10
03/09/2015	1.27	0.85	0.46	0.41	0.37	0.35	NR	6.60	4.01	3.41	2.13	3.46
03/10/2015	1.40	0.91	0.47	0.41	0.38	0.35	NR	6.60	4.07	3.62	2.23	4.01
03/11/2015	1.51	0.97	0.50	0.42	0.39	0.35	NR	6.74	4.21	3.88	2.65	4.01
03/12/2015	1.43	1.03	0.49	0.43	0.39	0.36	NR	7.30	4.37	3.97	3.13	3.81
03/13/2015	1.64	1.10	0.52	0.44	0.39	0.36	NR	7.74	4.77	4.06	3.33	4.42
03/14/2015	1.87	1.18	0.55	0.45	0.40	0.36	NR	8.02	5.03	3.85	3.58	4.26
03/15/2015	2.27	1.29	0.60	0.46	0.47	0.37	NR	8.40	5.62	3.72	3.69	6.01
03/16/2015	2.15	1.38	0.59	0.48	0.47	0.38	NR	8.98	5.64	3.78	3.79	5.73
03/17/2015	2.40	1.49	0.62	0.49	0.50	0.39	NR	8.82	5.72	3.98	3.98	6.45
03/18/2015	2.28	1.59	0.60	0.50	0.49	0.40	NR	9.18	5.55	4.08	4.71	6.25
03/19/2015	2.31	1.69	0.62	0.52	0.50	0.41	NR	9.31	6.00	4.09	5.05	5.85
03/20/2015	2.53	1.81	0.65	0.54	0.54	0.43	NR	9.43	6.10	4.46	5.32	6.56
03/21/2015	2.58	1.92	0.67	0.56	0.56	0.44	NR	9.64	6.11	4.51	5.18	6.95
03/22/2015	2.74	2.03	0.71	0.57	0.61	0.46	NR	9.90	6.22	4.56	5.08	6.57
03/23/2015	2.77	2.13	0.72	0.59	0.63	0.48	NR	10.31	6.06	4.66	5.24	6.94
03/24/2015	2.71	2.23	0.71	0.61	0.64	0.50	NR	10.48	6.16	4.74	5.43	7.09
03/25/2015	2.52	2.30	0.69	0.62	0.62	0.51	NR	10.61	6.40	4.92	5.63	6.03
03/26/2015	2.57	2.38	0.70	0.64	0.64	0.53	NR	10.34	6.74	5.61	5.65	6.20
03/27/2015	2.82	2.47	0.73	0.65	0.68	0.55	NR	10.14	7.06	6.45	5.62	6.95
03/28/2015	2.74	2.53	0.70	0.66	0.62	0.57	NR	10.11	7.54	6.08	5.47	6.14
03/29/2015	2.71	2.56	0.72	0.67	0.60	0.58	NR	10.23	7.80	6.33	4.28	7.08
03/30/2015	2.96	2.62	0.75	0.68	0.69	0.59	NR	10.13	7.94	6.62	5.53	7.32
03/31/2015	3.17	2.67	0.78	0.70	0.74	0.61	NR	10.49	8.24	6.34	5.59	7.65
04/01/2015	2.49	2.69	0.66	0.70	0.62	0.62	NR	11.25	7.85	6.17	5.62	6.91
04/02/2015	2.21	2.68	0.67	0.70	0.57	0.62	NR	12.34	7.78	6.29	5.93	6.11

Electrical Conductivity (EC) units: milliSiemens per Centimeter
Chloride (Cl) units: milligrams per liter
mht : mean high tides
md : mean daily
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e : estimated value s : substituted value

Delta Water Quality Conditions

Date	Emmaton mdEC	Bethel Island mdEC	Farrar Park mdEC	Holland Tract mdEC	Bacon Island mdEC	Contra Costa mdEC	Clifton Court mdEC	Tracy Pumping Plant mdEC	Antioch mdCl	Bacon Island mdCl	Contra Costa mdCl	Delta Status
03/04/2015	0.35	0.36	0.47	0.37	0.38	0.46	0.43	0.59	215	60	158 s	r
03/05/2015	0.34	0.36	0.47	0.38	0.38	0.45	0.46	0.62	206	60	172 s	r
03/06/2015	0.35	0.38	0.47	0.38	0.38	0.44	0.46	0.57	227	60	125 s	r
03/07/2015	0.38	0.36	0.47	0.38	0.38	0.44	0.42	0.57	262	60	114 s	r
03/08/2015	0.41	0.38	0.47	0.38	0.37	0.43	0.42	0.55	311	59	95 s	r
03/09/2015	0.43	0.38	0.47	0.38	0.38	0.44	0.42	0.56	335	60	100 s	r
03/10/2015	0.48	0.39	0.48	0.38	0.38	0.47	0.41	0.55	376	60	95 s	r
03/11/2015	0.48	0.39	0.48	0.39	0.38	0.61	0.41	0.53	410	60	89 s	r
03/12/2015	0.42	0.40	0.48	0.39	0.38	0.63	0.42	0.52	386	61	84 s	r
03/13/2015	0.50	0.40	0.49	0.38	0.38	0.57	0.41	0.51	453	62	78 s	r
03/14/2015	0.59	0.41	0.49	0.37	0.38	0.67	0.42	0.48	527	62	87 s	r
03/15/2015	0.79	0.42	0.50	0.37	0.39	0.68	0.42	0.49	652	62	95 s	r
03/16/2015	0.78	0.39	0.50	0.37	0.39	0.74	0.44	0.57	614	63	103 s	b
03/17/2015	0.95	0.41	0.51	0.39	0.39	0.79	0.49	0.57	694	63	103 s	b
03/18/2015	0.91	0.44	0.52	0.40	0.39	0.80	0.46	0.60	657	65	84 s	b
03/19/2015	0.96	0.45	0.52	0.42	0.40	1.04	0.51	0.61	665	66	97 s	b
03/20/2015	1.14	0.44	0.53	0.43	0.40	1.52	0.52	0.62	735	67	103 s	b
03/21/2015	1.21	0.46	0.54	0.44	0.41	1.83	0.50	0.62	752	69	66 s	b
03/22/2015	1.36	0.47	0.55	0.44	0.41	1.90	0.50	0.65	803	70	64 s	b
03/23/2015	1.31	0.46	0.56	0.45	0.42	1.79	0.48	0.65	813	71	63 s	b
03/24/2015	1.30	0.47	0.58	0.46	0.42	1.58	0.50	0.66	793	72	69 s	b
03/25/2015	1.16	0.46	0.59	0.46	0.43	1.23	0.50	0.63	731	73	48 s	b
03/26/2015	1.18	0.48	0.59	0.47	0.43	1.06	0.50	0.62	749	75	62 s	b
03/27/2015	1.30	0.46	0.59	0.48	0.45	0.96	0.51	0.66	827	79	60 s	b
03/28/2015	1.11	0.48	0.59	0.47	0.44	0.84	0.59	0.66	802	77	61 s	b
03/29/2015	1.23	0.50	0.60	0.47	0.45	0.73	0.65	0.68	792	78	60 s	b
03/30/2015	1.48	0.49	0.60	0.48	0.45	0.64	0.64	0.71	872	79	62 s	b
03/31/2015	1.59	0.52	0.62	0.48	0.45	0.58	0.64	0.66	938	79	62 s	b
04/01/2015	1.11	0.50	0.62	0.48	0.45	0.53	0.58	0.66	722	79	74	b
04/02/2015	0.79	0.52	0.63	0.50	0.45	0.49	0.51	0.58	633	80	68	b

Electrical Conductivity (EC) units: milliSiemens per Centimeter
Chloride (Cl) units: milligrams per liter
md : mean daily
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e : estimated value s : substituted value
Antioch and Bacon Island mdCl are calculated from the respective mdEC values.

Coordinated Operation Agreement Delta Status:
(Note: below label begins on October 1, 2013)
c = excess Delta conditions
b = balanced Delta conditions
r = excess Delta conditions with restrictions:

Delta Water Quality Conditions

South Delta Stations

Date	Vernalis		Brandt Bridge		Old River Near Tracy		Old River Near Middle River	
	md EC	30 day avg	md EC	30 day avg	md EC	30 day avg	md EC	30 day avg
03/04/2015	0.98	0.98	1.14	0.97	1.11	1.21	1.02	0.96
03/05/2015	0.85	0.97	1.18	0.98	1.10	1.20	1.08	0.97
03/06/2015	0.67	0.95	1.21	0.98	1.13	1.20	1.10	0.97
03/07/2015	0.62	0.93	1.23	0.99	1.16	1.19	1.07	0.96
03/08/2015	0.70	0.91	1.24	1.00	1.21	1.19	1.02	0.96
03/09/2015	0.87	0.91	1.24	1.01	1.23	1.19	0.94	0.95
03/10/2015	0.88	0.90	1.25	1.01	1.22	1.18	0.89	0.95
03/11/2015	0.73	0.90	1.25	1.02	1.23	1.18	0.88	0.94
03/12/2015	0.68	0.89	1.26	1.02	1.24	1.18	0.95	0.94
03/13/2015	0.67	0.88	1.25	1.03	1.22	1.18	0.98	0.94
03/14/2015	0.62	0.87	1.25	1.04	1.23	1.17	1.03	0.95
03/15/2015	0.73	0.86	1.24	1.04	1.25	1.17	1.04	0.95
03/16/2015	0.77	0.85	1.23	1.05	1.26	1.18	0.99	0.95
03/17/2015	0.79	0.84	1.24	1.06	1.28	1.18	0.93	0.95
03/18/2015	0.69	0.83	1.25	1.07	1.29	1.18	0.86	0.94
03/19/2015	0.63	0.81	1.24	1.09	1.29	1.19	0.85	0.94
03/20/2015	0.72	0.81	1.23	1.10	1.30	1.19	0.86	0.93
03/21/2015	0.74	0.80	1.24	1.11	1.32	1.20	0.88	0.93
03/22/2015	0.70	0.80	1.23	1.13	1.33	1.20	0.88	0.93
03/23/2015	0.73	0.79	1.21	1.14	1.31	1.21	0.86	0.93
03/24/2015	0.77	0.79	1.20	1.15	1.28	1.21	0.83	0.93
03/25/2015	0.72	0.79	1.18	1.16	1.25	1.21	0.82	0.93
03/26/2015	0.34	0.77	1.15	1.17	1.23	1.22	0.80	0.92
03/27/2015	0.20	0.75	1.11	1.17	1.20	1.22	0.79	0.92
03/28/2015	0.20	0.73	1.01	1.18	1.18	1.22	0.62	0.91
03/29/2015	0.25	0.71	0.79	1.17	1.08	1.21	0.24	0.89
03/30/2015	0.38	0.69	0.45	1.15	0.96	1.21	0.20	0.87
03/31/2015	0.41	0.67	0.26	1.13	0.85	1.20	0.23	0.85
04/01/2015	0.36	0.65	0.22	1.10	0.62	1.18	0.31	0.83
04/02/2015	0.30	0.62	0.26	1.07	0.54	1.16	0.36	0.81

Electrical Conductivity (EC) units: milliSiemens per Centimeter
md : mean daily
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e : estimated value s : substituted value

Compliance Standards

for the Sacramento - San Joaquin Delta and Suisun Marsh
Thursday, May 07, 2015

Criteria	Standard	Status
Flow/Operational		
% of inflow diverted	35 %	8 %
NDOI, monthly average *	>= 4,000 cfs	4,425 cfs
NDOI, 7 day average*	>= 3,000 cfs	4,425 cfs
Vernalis Base Flow : Monthly average *	>= 300 cfs	402 cfs
7 Day average *	>= 240 cfs	402 cfs
Habitat Protection, X2 / Flow	31 days at Collinsville	0 days
	0 day (s) at Chipps Island	0 days
Water Quality		
Days @ CCWD PP#1 w/ chlorides <= 150 mg/l	155 days	119 days
Export Areas for SWP, CVP, CCWD, et al	<= 250 mg/l Cl	143 mg/l
14dm EC at Threemile Slough at Sac	<= 2.78 mS/cm	1.75 mS/cm
14dm EC at Jersey Point	<= 2.20 mS/cm	1.66 mS/cm
Maximum 30 day running average of mean daily EC at:		
Vernalis	<=0.7 mS/cm	0.3 mS/cm
Brandt Bridge	<=0.7 mS/cm	0.3 mS/cm
Old River Near Tracy	<=0.7 mS/cm	0.7 mS/cm
Old River Near Middle River	<=0.7 mS/cm	0.3 mS/cm
SUISUN MARSH:		
Suisun Marsh Salinity Control Gates :	0 Open / 0 Closed / 3 Full Tide Open	
Flashboard Status : In		
Boat Lock Status : Open		

California Hydrologic Conditions: (California Cooperative Snow Surveys Forecast, April 1, 2015)

Previous Month's Index (8RI for Mar): 840 TAF
Water Year Type: Critical
Sacramento valley water year type index (40/30/30) @ 50%: 4.1 MAF (Critical)
San Joaquin valley water year type index (60/20/20) @ 75%: 0.7 MAF (Critical)

Electrical Conductivity (EC) in milliSiemens per Centimeter.
Chlorides (Cl) in milligrams per liter
mht - mean high tides
md - mean daily
14 dm - fourteen day running mean
28 dm - twenty-eight day running mean
NR - No Record
NC - Average not computed due to insufficient data.
BR : Below Rating
e - estimated value s - substituted value

Montezuma Slough Gate Operation:
Number of gates operating at either Open, Closed, or Full Tide Open
Flashboard Status : In, Out, or Modified In
Boat Lock Status : Open or Closed

Coordinated Operation Agreement Delta Status:
(Note: below label begins on October 1, 2013)
c = excess Delta conditions
b = balanced Delta conditions
r = excess Delta conditions with restrictions:

* NDOI, Rio Vista & Vernalis Flows:
- 7 day average is progressive daily mean for the first six days of the month.

Delta Water Quality Conditions

Date	Antioch Tides		Net Delta Outflow Index	Martinez	Port Chicago		Mallard	Chipps Island		Collinsville	
	High	Half	cfs	mdEC	mdEC	14dm	mdEC	mdEC	14dm	mdEC	14dm
04/08/2015	5.78	3.82	9,749	23.61	16.70	16.43	10.16	9.76	9.30	6.56	6.03
04/09/2015	5.59	3.80	10,786	22.68	16.81	16.56	9.88	9.47	9.40	6.22	6.10
04/10/2015	5.70	3.95	9,558	23.15	17.43	16.69	10.42	10.04	9.49	6.70	6.18
04/11/2015	5.54	3.98	8,994	23.57	17.50	16.84	10.50	10.13	9.61	6.81	6.28
04/12/2015	5.33	3.84	8,867	23.14	17.04	16.93	9.91	9.50	9.68	6.37	6.33
04/13/2015	5.08	3.76	4,740	22.93	17.21	16.98	10.05	9.65	9.70	6.83	6.38
04/14/2015	5.19	3.63	4,221	23.36	16.07	16.91	9.71	9.29	9.65	6.35	6.37
04/15/2015	4.94	3.35	5,263	22.79	16.27	16.93	9.26	8.82	9.66	5.96	6.40
04/16/2015	5.17	3.52	4,960	23.59	16.64	17.03	9.72	9.30	9.74	6.37	6.46
04/17/2015	5.59	3.76	3,879	24.47	17.81	17.17	10.94	10.59	9.87	7.20	6.58
04/18/2015	5.96	4.00	3,798	24.80	18.99	17.32	12.13	11.88	10.02	8.25	6.72
04/19/2015	6.34	4.31	3,450	25.65	19.93	17.50	13.35	13.20	10.23	9.49	6.93
04/20/2015	6.45	4.41	3,318	26.97	20.58	17.71	14.02	13.94	10.50	10.04	7.18
04/21/2015	6.53	4.46	3,890	27.49	21.25	17.87	14.40	14.36	10.71	10.47	7.40
04/22/2015	6.25	4.26	3,644	26.25	20.37	18.13	13.17	13.01	10.94	9.42	7.61
04/23/2015	6.11	4.28	3,751	26.65	18.97	18.29	13.51	13.38	11.22	9.69	7.85
04/24/2015	5.92	4.30	2,822	27.11	20.86	18.53	14.06	13.99	11.50	9.82	8.08
04/25/2015	5.62	4.24	2,895	26.70	19.88	18.70	13.32	13.17	11.72	9.30	8.25
04/26/2015	4.98	3.77	6,427	24.57	18.74	18.83	12.13	11.88	11.89	8.26	8.39
04/27/2015	5.14	3.66	7,292	24.22	18.19	18.90	11.34	11.03	11.99	7.69	8.45
04/28/2015	5.26	3.76	6,737	25.43	18.93	19.10	12.26	12.02	12.18	8.45	8.60
04/29/2015	5.30	3.77	6,058	25.35	19.48	19.33	12.30	12.06	12.42	8.59	8.79
04/30/2015	5.46	3.81	6,433	23.28	19.04	19.50	12.26	12.02	12.61	8.63	8.95
05/01/2015	5.61	4.04	4,241	22.83	20.70	19.71	13.46	13.32	12.80	9.68	9.13
05/02/2015	6.09	4.34	3,649	23.79	21.95	19.92	15.35	15.41	13.06	11.32	9.35
05/03/2015	6.26	4.09 e	4,093	24.00	22.65	20.11	15.99	16.12	13.26	12.08	9.53
05/04/2015	6.37	4.41	3,961	24.06	22.77	20.27	15.95 e	15.65	13.39	11.98	9.67
05/05/2015	6.25 e	4.14 e	4,919	27.06	22.99	20.39	15.35	15.40	13.46	11.00	9.71
05/06/2015	6.19	4.39 e	4,866	28.81	23.10	20.59	15.14	15.18	13.62	10.88	9.81
05/07/2015	6.21	4.20	5,246	28.76	22.74	20.86	14.87	14.88	13.75	10.63	9.88

Antioch Tides measured in feet above mean sea level.
Net Delta Ouflow Index calculated from equation as specified in D-1641, revised June 1995.
Chipps Island EC calculated from measurements recorded at Mallard Slough.
Electrical Conductivity (EC) units: milliSiemens per Centimeter
md : mean daily
14dm : fourteen day running mean
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e - estimated value s - substituted value

Delta Water Quality Conditions

Date	Antioch		Jersey Point		Threemile Slough		Cache Slough	Good Year Slough	Sunrise Club	Volanti Slough	Beldon Landing	Collinsville
	mdEC	14mdEC	mdEC	14mdEC	mdEC	14mdEC	mdEC	mhtEC	mhtEC	mhtEC	mhtEC	mhtEC
04/08/2015	3.39	2.95	0.87	0.77	0.84	0.69	NR	12.36	8.06	5.59	6.12	7.55
04/09/2015	3.26	3.00	0.83	0.78	0.75	0.69	NR	12.39	8.70	6.42	5.70	7.01
04/10/2015	3.44	3.04	0.89	0.79	0.79	0.70	NR	12.07	8.94	7.94	6.86	8.35
04/11/2015	3.45	3.09	0.90	0.81	0.75	0.71	NR	11.94	9.28	8.08	7.16	8.37
04/12/2015	3.16	3.12	0.84	0.81	0.68	0.72	NR	11.82	9.45	8.42	4.64	7.56
04/13/2015	3.19	3.14	0.86	0.82	0.76	0.72	NR	12.19	8.82	7.84	7.24	6.28
04/14/2015	3.10	3.14	0.80	0.82	0.73	0.72	NR	11.63	8.85	8.05	5.60	7.92
04/15/2015	2.51	3.14	0.73	0.83	0.59	0.72	NR	12.07	8.71	7.92	7.37	7.17
04/16/2015	2.82	3.18	0.79	0.84	0.66	0.73	NR	12.09	8.55	7.83	7.37	6.94
04/17/2015	3.42	3.25	0.88	0.85	0.93	0.75	NR	12.20	8.75	7.30	7.02	8.48
04/18/2015	4.02	3.33	1.03	0.87	1.18	0.79	NR	11.86	8.52	7.40	6.56	9.34
04/19/2015	4.72	3.44	1.22	0.90	1.52	0.85	NR	11.80	8.80	7.75	6.51	10.83
04/20/2015	5.13	3.56	1.43	0.94	1.76	0.93	NR	12.20	9.04	7.55	7.02	11.79
04/21/2015	5.32	3.64	1.57	0.97	2.14	1.01	NR	13.52	9.28	8.09	7.97	11.56
04/22/2015	4.85	3.74	1.43	1.01	1.71	1.07	NR	13.78	9.23	8.42	8.86	10.94
04/23/2015	5.04	3.87	1.48	1.06	1.77	1.14	NR	13.67	9.59	9.37	9.68	11.34
04/24/2015	5.52	4.02	1.59	1.11	1.87	1.22	NR	13.62	9.77	9.51	9.89	11.41
04/25/2015	5.17	4.14	1.51	1.15	1.64	1.28	NR	13.47	9.59	9.65	9.63	10.79
04/26/2015	4.47	4.23	1.27	1.18	1.24	1.32	NR	13.38	9.74	9.70	9.62	9.60
04/27/2015	4.06	4.30	1.17	1.21	0.99	1.34	NR	13.31	9.92	10.17	9.76	8.83
04/28/2015	4.46	4.39	1.23	1.24	1.27	1.38	NR	13.44	9.70	9.74	9.39	10.05
04/29/2015	4.53	4.54	1.27	1.28	1.26	1.42	NR	13.43	9.90	9.95	9.07	9.55
04/30/2015	4.71	4.67	1.33	1.31	1.22	1.46	NR	13.44	9.89	10.12	8.49	10.24
05/01/2015	5.32	4.81	1.53	1.36	1.60	1.51	NR	13.47	10.55	10.32	8.82	10.76
05/02/2015	6.11	4.96	1.91	1.42	2.03	1.57	NR	13.75	10.48	10.27	8.79	13.31
05/03/2015	6.66	5.10	2.19	1.49	2.32	1.63	NR	13.95 e	10.43 e	10.10	8.80	11.84 e
05/04/2015	6.49	5.19	2.20	1.55	2.45	1.68	NR	14.26	10.29	9.53	10.30	13.50
05/05/2015	6.61	5.29	2.06	1.58	2.16	1.68	NR	15.04	11.41	10.45	10.58	12.48
05/06/2015	6.40	5.40	2.03	1.63	2.21	1.72	NR	15.17	12.18	10.84	11.60	13.01
05/07/2015	6.41	5.50	2.02	1.66	2.28	1.75	NR	15.16	12.15	11.13	11.69	12.46

Electrical Conductivity (EC) units: milliSiemens per Centimeter
Chloride (Cl) units: milligrams per liter
mht : mean high tides
md : mean daily
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e : estimated value   s : substituted value

Delta Water Quality Conditions

Date	Emmaton mdEC	Bethel Island mdEC	Farrar Park mdEC	Holland Tract mdEC	Bacon Island mdEC	Contra Costa mdEC	Clifton Court mdEC	Tracy Pumping Plant mdEC	Antioch mdCl	Bacon Island mdCl	Contra Costa mdCl	Delta Status
04/08/2015	1.45	0.53	0.65	0.50	0.48	0.48	0.48	0.48	1,010	86	66	b
04/09/2015	1.45	0.56	0.65	0.51	0.48	0.48	0.50	0.49	968	86	68	b
04/10/2015	1.65	0.57	0.67	0.52	0.48	0.49	0.50	0.51	1,024	87	70	b
04/11/2015	1.61	0.56	0.68	0.52	0.48	0.50	0.51	0.53	1,027	88	71	b
04/12/2015	1.32	0.54	0.68	0.53	0.49	0.50	0.51	0.52	937	89	73	b
04/13/2015	1.67	0.56	0.69	0.54	0.49	0.51	0.50	0.52	946	90	74	b
04/14/2015	1.24	0.58	0.70	0.54	0.50	0.51	0.51	0.55	919	92	75	b
04/15/2015	0.98	0.55	0.70	0.55	0.50	0.51	0.53	0.58	728	93	76	b
04/16/2015	1.32	0.54	0.70	0.54	0.51	0.51	0.52	0.57	828	96	76	b
04/17/2015	1.91	0.55	0.70	0.53	0.52	0.51	0.51	0.57	1,018	98	77	b
04/18/2015	2.39	0.54	0.72	0.54	0.52	0.52	0.51	0.58	1,209	97	79	b
04/19/2015	2.95	0.59	0.75	0.55	0.52	0.53	0.51	0.57	1,434	97	81	b
04/20/2015	3.41	0.61	0.80	0.57	0.50	0.53	0.51	0.57	1,565	92	83	b
04/21/2015	3.87	0.68	0.87	0.60	0.52	0.54	0.52	0.59	1,624	99	86	b
04/22/2015	3.02	0.70	0.87	0.60	0.53	0.55	0.51	0.61	1,476	101	87	b
04/23/2015	3.22	0.73	0.90	0.65	0.55	0.53	0.52	0.63	1,537	106	89	b
04/24/2015	3.54	0.78	0.97	0.66	0.58	0.55	0.53	0.62	1,689	113	90	b
04/25/2015	3.05	0.80	1.01	0.67	0.60	0.55	0.53	0.59	1,576	118	91	b
04/26/2015	2.23	0.81	1.02	0.64	0.60	0.56	0.53	0.55	1,352	119	92	b
04/27/2015	1.84	0.82	1.02	0.67	0.61	0.57	0.53	0.53	1,224	121	93	b
04/28/2015	2.40	0.82	1.06	0.70	0.64	0.58	0.54	0.52	1,350	129	95	b
04/29/2015	2.37	0.83	1.06	0.72	0.66	0.59	0.55	0.52	1,374	135	98	b
04/30/2015	2.16	0.84	1.05	0.75	0.69	0.61	0.55	0.53	1,430	142	102	b
05/01/2015	2.87	0.85	1.06	0.77	0.71	0.63	0.55	0.52	1,625	147	107	b
05/02/2015	3.69	0.85	1.13	0.78	0.72	0.65	0.58	0.53	1,877	150	112	b
05/03/2015	4.38	0.90	1.28	0.81	0.73	0.67	0.59	0.54	2,052	153	118	b
05/04/2015	4.53	0.95 e	1.38	0.85	0.73	0.69	0.60	0.54	1,998	154	126	b
05/05/2015	3.93 e	1.05 e	1.38	0.85	0.75	0.71	0.61	0.55	2,034	157	133	b
05/06/2015	3.90	1.08	1.41	0.88	0.77	0.72	0.62	0.57	1,969	162	138	b
05/07/2015	3.73	1.10 e	1.42	0.89	0.79	0.73	0.62	0.60	1,973	170	143	b

Electrical Conductivity (EC) units: milliSiemens per Centimeter
Chloride (Cl) units: milligrams per liter
md : mean daily
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e : estimated value s : substituted value
Antioch and Bacon Island mdCl are calculated from the respective mdEC values.

Coordinated Operation Agreement Delta Status:
(Note: below label begins on October 1, 2013)
c = excess Delta conditions
b = balanced Delta conditions
r = excess Delta conditions with restrictions:

Delta Water Quality Conditions

South Delta Stations

Date	Vernalis		Brandt Bridge		Old River Near Tracy		Old River Near Middle River	
	md EC	30 day avg	md EC	30 day avg	md EC	30 day avg	md EC	30 day avg
04/08/2015	0.13	0.51	0.38	0.90	0.78	1.07	0.43	0.68
04/09/2015	0.15	0.49	0.21	0.87	0.78	1.05	0.26	0.66
04/10/2015	0.16	0.47	0.15	0.83	0.82	1.04	0.15	0.63
04/11/2015	0.16	0.45	0.16	0.80	0.78	1.02	0.17	0.61
04/12/2015	0.17	0.44	0.21	0.76	0.74	1.01	0.21	0.58
04/13/2015	0.12	0.42	0.23	0.73	0.71	0.99	0.23	0.56
04/14/2015	0.11	0.40	0.23	0.69	0.71	0.97	0.23	0.53
04/15/2015	0.14	0.38	0.14	0.66	0.68	0.95	0.19	0.50
04/16/2015	0.14	0.36	0.13	0.62	0.69	0.93	0.13	0.48
04/17/2015	0.15	0.34	0.15	0.58	0.72	0.91	0.16	0.45
04/18/2015	0.18	0.32	0.15	0.55	0.76	0.90	0.17	0.43
04/19/2015	0.20	0.31	0.16	0.51	0.79	0.88	0.17	0.41
04/20/2015	0.22	0.29	0.17	0.48	0.79	0.86	0.18	0.38
04/21/2015	0.25	0.27	0.19	0.44	0.78	0.84	0.19	0.36
04/22/2015	0.29	0.26	0.21	0.41	0.75	0.82	0.21	0.34
04/23/2015	0.35	0.25	0.22	0.38	0.73	0.81	0.23	0.32
04/24/2015	0.41	0.24	0.24	0.34	0.73	0.79	0.25	0.30
04/25/2015	0.42	0.24	0.25	0.31	0.72	0.77	0.28	0.28
04/26/2015	0.44	0.25	0.28	0.29	0.71	0.75	0.31	0.27
04/27/2015	0.45	0.25	0.30	0.26	0.71	0.74	0.35	0.26
04/28/2015	0.46	0.26	0.32	0.25	0.73	0.73	0.39	0.26
04/29/2015	0.44	0.26	0.33	0.24	0.72	0.72	0.43	0.27
04/30/2015	0.48	0.27	0.34	0.25	0.72	0.72	0.47	0.28
05/01/2015	0.51	0.27	0.35	0.25	0.71	0.72	0.50	0.28
05/02/2015	0.45	0.28	0.37	0.25	0.74	0.72	0.53	0.29
05/03/2015	0.44	0.28	0.40	0.26	0.75	0.73	0.55	0.30
05/04/2015	0.43	0.28	0.42	0.26	0.74	0.74	0.57	0.30
05/05/2015	0.46	0.29	0.43	0.26	0.72	0.74	0.61	0.31
05/06/2015	0.50	0.30	0.45	0.26	0.73	0.74	0.61	0.32
05/07/2015	0.45	0.31	0.47	0.27	0.74	0.74	0.60	0.32

Electrical Conductivity (EC) units: milliSiemens per Centimeter
md : mean daily
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e : estimated value s : substituted value

Compliance Standards

for the Sacramento - San Joaquin Delta and Suisun Marsh
Tuesday, June 02, 2015

Criteria	Standard	Status
Flow/Operational		
% of inflow diverted	35 %	9 %
NDOI, monthly average *	>= 4,000 cfs	3,852 cfs
NDOI, 7 day average*	>= 3,000 cfs	3,852 cfs
Vernalis Base Flow : Monthly average *	>= 200 cfs	320 cfs
7 Day average *	>= 160 cfs	320 cfs
Habitat Protection, X2 / Flow	30 days at Collinsville	0 days
	0 day (s) at Chipps Island	0 days
Water Quality		
Days @ CCWD PP#1 w/ chlorides <= 150 mg/l	155 days	124 days
Export Areas for SWP, CVP, CCWD, et al	<= 250 mg/l Cl	207 mg/l
14dm EC at Threemile Slough at Sac	<= 2.78 mS/cm	1.67 mS/cm
14dm EC at Jersey Point	<= 2.20 mS/cm	1.59 mS/cm
14dm EC at San Andreas Landing	<= 0.87 mS/cm	0.52 mS/cm
14dm EC at Terminous	<= 0.54 mS/cm	0.16 mS/cm
Maximum 30 day running average of mean daily EC at:		
Vernalis	<=0.7 mS/cm	0.5 mS/cm
Brandt Bridge	<=0.7 mS/cm	0.6 mS/cm
Old River Near Tracy	<=0.7 mS/cm	0.9 mS/cm
Old River Near Middle River	<=0.7 mS/cm	0.7 mS/cm
SUISUN MARSH:		
Suisun Marsh Salinity Control Gates :	3 Open / 0 Closed / 0 Full Tide Open	
Flashboard Status : Out	Boat Lock Status : Closed	

California Hydrologic Conditions: (California Cooperative Snow Surveys Forecast, May 1, 2015)

Previous Month's Index (8RI for Apr): 766 TAF
Sacramento valley water year type index (40/30/30) @ 50%: 4.0 MAF (Critical)
San Joaquin valley water year type index (60/20/20) @ 75%: 0.7 MAF (Critical)

Electrical Conductivity (EC) in milliSiemens per Centimeter.
Chlorides (Cl) in milligrams per liter
mht - mean high tides
md - mean daily
14 dm - fourteen day running mean
NR - No Record
NC - Not Computed due to insufficient data
BR : Below Rating
e - estimated value

Montezuma Slough Gate Operation:
Number of gates operating at either Open, Closed, or Full Tide Open
Flashboard Status : In, Out, or Modified In
Boat Lock Status : Open or Closed

Coordinated Operation Agreement Delta Status:
c = excess Delta conditions
b = balanced Delta conditions
r = excess Delta conditions with restrictions:

* NDOI, Rio Vista & Vernalis Flows and Suisun Marsh mhtEC:
- 7 day average is progressive daily mean for the first six days of the month.
- Monthly average is progressive daily mean from the beginning of the month

Delta Water Quality Conditions

Date	Antioch Tides		Net Delta Outflow Index	Martinez	Port Chicago		Mallard	Chipps Island		Collinsville	
	High	Half	cfs	mdEC	mdEC	14dm	mdEC	mdEC	14dm	mdEC	14dm
05/04/2015	6.37	4.41	3,961	24.06	22.77	20.27	15.95 e	15.65	13.39	11.98	9.67
05/05/2015	6.25 e	4.14 e	4,919	27.06	22.99	20.39	15.35	15.40	13.46	11.00	9.71
05/06/2015	6.19	4.39 e	4,866	28.81	23.10	20.59	15.14	15.18	13.62	10.88	9.81
05/07/2015	6.21	4.20	5,246	28.76	22.74	20.86	14.87	14.88	13.75	10.63	9.88
05/08/2015	6.11	4.26	5,401	30.33	21.96	20.94	14.48	14.45	13.79	10.30	9.91
05/09/2015	5.86	4.17	5,799	30.00 e	21.76	21.07	15.01	15.03	13.92	11.01	10.04
05/10/2015	5.66	4.15	5,387	30.00 e	21.54	21.27	14.77	14.76	14.13	10.67	10.21
05/11/2015	5.42	4.10	5,319	26.95	21.92	21.54	14.62	14.60	14.38	10.12	10.38
05/12/2015	5.57	4.04	4,858	29.18	21.16	21.70	14.55	14.53	14.56	9.96	10.49
05/13/2015	5.68	3.97	5,620	27.57	21.10	21.81	14.31	14.25	14.72	9.70	10.57
05/14/2015	5.80	3.98	4,993	27.63	21.04	21.96	14.12	14.05	14.86	9.83	10.65
05/15/2015	6.02	4.07	5,964	28.59	21.65	22.02	14.85	14.85	14.97	10.29	10.70
05/16/2015	6.27	4.12	5,447	28.00 e	22.21	22.04	14.89	14.90	14.93	10.23	10.62
05/17/2015	6.36	4.19	6,090	28.00 e	22.14	22.01	14.93	14.94	14.85 e	10.70	10.52
05/18/2015	6.39	4.25	5,476	28.77	22.30	21.97	15.45	15.52	14.81	10.82	10.44
05/19/2015	6.45	4.26	5,865	28.90	22.17	21.91	15.16	15.20	14.80	10.69	10.42
05/20/2015	6.44	4.37	6,193	29.46	22.47	21.87	15.34	15.39	14.81	10.73	10.40
05/21/2015	6.35	4.38	6,150	28.33	22.18	21.83	15.25	15.30	14.84	10.61	10.40
05/22/2015	6.05	4.25	6,422	25.88	21.48	21.79	14.52	14.49	14.84	9.83	10.37
05/23/2015	5.74	4.14	6,055	25.00 e	21.27	21.76	13.68	13.57	14.74	9.09	10.23
05/24/2015	5.41	4.10	6,057	25.00 e	20.78	21.71	13.24	13.09	14.62	8.87	10.10
05/25/2015	5.62	4.11	5,656	25.00 e	19.94	21.56	13.64	13.52	14.54	8.73	10.00
05/26/2015	5.74	4.12	5,160	26.25	20.12	21.49	13.72	13.61	14.48	9.05	9.94
05/27/2015	5.88	4.12	4,711	26.47	19.67	21.39	13.40	13.27	14.41	8.80	9.88
05/28/2015	5.86	4.07	4,278	25.66	19.80	21.30	13.11	12.94	14.33	8.74	9.80
05/29/2015	6.02	4.15	4,461	25.45	20.22	21.20	13.37	13.23	14.21	8.91	9.70
05/30/2015	6.12	4.22	3,858	25.38	20.64	21.08	13.89	13.79	14.13	9.22	9.63
05/31/2015	6.38	4.39	3,904	27.27	21.59	21.04	14.90	14.91	14.13	9.82	9.56
06/01/2015	6.51	4.37	3,265	26.98	21.58	20.99	14.63	14.61	14.07	9.93	9.50
06/02/2015	6.47	4.34	4,439	26.57	21.86	20.97	14.30	14.25	14.00	9.79	9.44

Antioch Tides measured in feet relative to the NAVD88 Datum
Net Delta Ouflow Index calculated from equation as specified in D-1641, revised March 2000.
Chipps Island EC calculated from measurements recorded at Mallard Slough.
Electrical Conductivity (EC) units: milliSiemens per Centimeter
md : mean daily
14dm : fourteen day running mean
NR : No Record
NC : Not Computed due to insufficient data
BR : Below Rating
e - estimated value

Delta Water Quality Conditions

Date	Antioch		Jersey Point		Emmaton		Three Mile Slough		San Andreas Landing		Terminous	
	mdEC	14dm	mdEC	14dm	mdEC	14dm	mdEC	14dm	mdEC	14dm	mdEC	14dm
05/04/2015	6.49	5.19	2.20	1.55	4.53	3.08	2.45	1.68	0.53	0.45	0.19	0.22
05/05/2015	6.61	5.29	2.06	1.58	3.93 e	3.09	2.16	1.68	0.52	0.45	0.20	0.22
05/06/2015	6.40	5.40	2.03	1.63	3.90	3.15	2.21	1.72	0.52	0.46	0.20	0.22
05/07/2015	6.41	5.50	2.02	1.66	3.73	3.19	2.28	1.75	0.55	0.47	0.20	0.21
05/08/2015	6.38	5.56	2.05	1.70	3.66	3.20	2.32	1.78	0.54	0.48	0.20	0.21
05/09/2015	6.21	5.63	2.00	1.73	3.81	3.25	2.18	1.82	0.54	0.49	0.20	0.21
05/10/2015	6.20	5.75	1.93	1.78	3.62	3.35	2.03	1.88	0.54	0.50	0.19	0.21
05/11/2015	5.96	5.89	1.83	1.83	3.47	3.47	1.95	1.95	0.53	0.51	0.19	0.21
05/12/2015	6.06	6.00	1.81	1.87	3.23	3.53	1.86	1.99	0.53	0.51	0.18	0.20
05/13/2015	5.84	6.10	1.76	1.90	3.01	3.57	1.67	2.02	0.52	0.52	0.18	0.20
05/14/2015	5.90	6.18	1.78	1.94	2.99	3.63	1.63	2.05	0.49	0.52	0.18	0.20
05/15/2015	6.11	6.24	1.90	1.96	3.53	3.68	1.90	2.07	0.47	0.52	0.16	0.19
05/16/2015	6.05	6.23	1.82	1.96	3.62	3.67	2.02	2.07	0.48	0.52	0.17	0.19
05/17/2015	6.19	6.20	1.79	1.93	4.01	3.65	2.16	2.06	0.47	0.52	0.19	0.19
05/18/2015	6.28	6.18	1.84	1.90	3.91	3.60	2.30	2.05	0.46	0.51	0.18	0.19
05/19/2015	6.31	6.16	1.89	1.89	3.58	3.58	2.19	2.05	0.50	0.51	0.17	0.19
05/20/2015	6.53	6.17	1.94	1.88	3.68	3.56	2.24	2.05	0.55	0.51	0.17	0.18
05/21/2015	6.57	6.18	2.06	1.89	3.28	3.53	2.08	2.04	0.55	0.51	0.16	0.18
05/22/2015	5.98	6.15	1.79	1.87	2.55	3.45	1.70	1.99	0.52	0.51	0.16	0.18
05/23/2015	5.14	6.08	1.65	1.84	2.20	3.33	1.50	1.94	0.46	0.51	0.16	0.17
05/24/2015	4.79	5.98	1.45	1.81	2.54	3.26	1.40	1.90	0.46	0.50	0.16	0.17
05/25/2015	4.69	5.89	1.37	1.78	2.63	3.20	1.42	1.86	0.45	0.49	0.16	0.17
05/26/2015	4.75	5.79	1.34	1.74	2.63	3.15	1.54	1.84	0.47	0.49	0.16	0.17
05/27/2015	4.87	5.72	1.37	1.71	2.27	3.10	1.44	1.82	0.48	0.49	0.17	0.17
05/28/2015	4.83	5.65	1.35	1.68	2.13	3.04	1.34	1.80	0.52	0.49	0.17	0.17
05/29/2015	5.00	5.57	1.41	1.65	2.38	2.96	1.41	1.77	0.54	0.49	0.17	0.17
05/30/2015	5.07	5.50	1.47	1.62	2.86	2.90	1.51	1.73	0.55	0.50	0.16	0.17
05/31/2015	5.35	5.44	1.68	1.61	3.32	2.85	1.84	1.71	0.59	0.51	0.17	0.16
06/01/2015	5.45	5.38	1.70	1.60	3.49	2.82	2.02	1.69	0.60	0.52	0.17	0.16
06/02/2015	5.76	5.34	1.65	1.59	3.46	2.81	1.93	1.67	0.60	0.52	0.17	0.16

Electrical Conductivity (EC) units: milliSiemens per Centimeter
Chloride (Cl) units: milligrams per liter
md : mean daily
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NR : No Record
NC : Not Computed due to insufficient data
BR : Below Rating
e : estimated value

Delta Water Quality Conditions

Date	Bethel Island mdEC	Farrar Park mdEC	Holland Tract mdEC	Bacon Island mdEC	Contra Costa mdEC	Clifton Court mdEC	Tracy Pumping Plant mdEC	Antioch mdCl	Bacon Island mdCl	Contra Costa mdCl	Delta Status
05/04/2015	0.95 e	1.38	0.85	0.73	0.69	0.60	0.54	1,998	154	126	b
05/05/2015	1.05 e	1.38	0.85	0.75	0.71	0.61	0.55	2,034	157	133	b
05/06/2015	1.08	1.41	0.88	0.77	0.72	0.62	0.57	1,969	162	138	b
05/07/2015	1.10 e	1.42	0.89	0.79	0.73	0.62	0.60	1,973	170	143	b
05/08/2015	1.13	1.37	0.87	0.81	0.74	0.64	0.61	1,963	174	145	b
05/09/2015	1.14	1.38	0.90	0.82	0.74	0.66	0.60	1,907	175	145 e	b
05/10/2015	1.13	1.37	0.89	0.82	0.75	0.68	0.59	1,905	178	145 e	b
05/11/2015	1.14	1.36	0.88	0.83	0.76	0.68	0.59	1,827	178	149	b
05/12/2015	1.14	1.37	0.84	0.85	0.77	0.69	0.60	1,861	183	150	b
05/13/2015	1.15	1.37	0.89	0.86	0.78	0.71	0.60	1,789	187	156	b
05/14/2015	1.15	1.41	0.93	0.87	0.79	0.72	0.62	1,809	189	159	b
05/15/2015	1.06	1.41	0.95	0.89	0.80	0.72	0.63	1,876	194	163	b
05/16/2015	1.17	1.40	0.93	0.89	0.82	0.74	0.62	1,856	196	163 e	b
05/17/2015	1.17	1.42	0.94	0.90	0.83	0.77	0.65	1,900	197	163 e	b
05/18/2015	1.17	1.40	0.93	0.91	0.82	0.78	0.70	1,930	200	175	b
05/19/2015	1.17	1.37	0.89	0.92	0.88	0.78	0.78	1,940	204	177	b
05/20/2015	1.16	1.38	0.92	0.92	0.89	0.78	0.79	2,010	204	180	b
05/21/2015	1.17	1.38	0.91	0.93	0.91	0.80	0.79	2,021	206	183	b
05/22/2015	1.16	1.37	0.95	0.92	0.92	0.81	0.79	1,833	204	188	b
05/23/2015	1.16	1.35	0.93	0.92	0.93	0.81	0.79	1,568	203	185 e	b
05/24/2015	1.16	1.33	0.94	0.92	0.94	0.82	0.78	1,455	203	185 e	b
05/25/2015	1.15	1.34	0.92	0.92	0.95	0.82	0.79	1,425	203	185 e	b
05/26/2015	1.14	1.32	0.96	0.92	0.96	0.83	0.79	1,443	203	201	b
05/27/2015	1.09	1.32	0.95	0.93	0.97	0.84	0.80	1,480	205	203	b
05/28/2015	1.08	1.31	0.95	0.92	0.97	0.83	0.84	1,469	204	204	b
05/29/2015	1.08	1.33	0.93	0.92	0.97	0.82	0.84	1,523	203	204	b
05/30/2015	1.07	1.36	0.92	0.91	0.98	0.81	0.85	1,543	201	204 e	b
05/31/2015	1.07	1.41	0.90	0.90	0.98	0.80	0.86	1,633	197	204 e	b
06/01/2015	1.03	1.43	0.87	0.88	0.98	0.81	0.85	1,667	192	206	b
06/02/2015	0.99	1.43	0.87	0.87	0.98	0.81	0.89	1,765	189	207	b

Electrical Conductivity (EC) units: milliSiemens per Centimeter
Chloride (Cl) units: milligrams per liter
md : mean daily
NR : No Record
NC : Not Computed due to insufficient data
BR : Below Rating
e : estimated value
Antioch and Bacon Island mdCl are calculated from the respective mdEC values.

Coordinated Operation Agreement Delta Status:
- c = excess Delta conditions
- b = balanced Delta conditions
- r = excess Delta conditions with restrictions:

Delta Water Quality Conditions

South Delta Stations

Date	Vernalis		Brandt Bridge		Old River Near Tracy		Old River Near Middle River	
	mdEC	30dm	mdEC	30dm	mdEC	30dm	mdEC	30dm
05/04/2015	0.43	0.28	0.42	0.26	0.74	0.74	0.57	0.30
05/05/2015	0.46	0.29	0.43	0.26	0.72	0.74	0.61	0.31
05/06/2015	0.50	0.30	0.45	0.26	0.73	0.74	0.61	0.32
05/07/2015	0.45	0.31	0.47	0.27	0.74	0.74	0.60	0.32
05/08/2015	0.48	0.32	0.49	0.27	0.75	0.74	0.62	0.33
05/09/2015	0.43	0.33	0.52	0.28	0.78	0.74	0.64	0.34
05/10/2015	0.41	0.34	0.55	0.30	0.77	0.74	0.67	0.36
05/11/2015	0.41	0.35	0.60	0.31	0.81	0.74	0.71	0.38
05/12/2015	0.46	0.36	0.63	0.32	0.82	0.74	0.72	0.39
05/13/2015	0.50	0.37	0.64	0.34	0.86	0.75	0.71	0.41
05/14/2015	0.50	0.38	0.65	0.35	0.87	0.75	0.71	0.43
05/15/2015	0.53	0.39	0.65	0.37	0.87	0.76	0.71	0.44
05/16/2015	0.50	0.41	0.66	0.39	0.84	0.76	0.71	0.46
05/17/2015	0.44	0.42	0.66	0.40	0.83	0.77	0.71	0.48
05/18/2015	0.44	0.42	0.67	0.42	0.85	0.77	0.71	0.50
05/19/2015	0.51	0.43	0.68	0.44	0.85	0.77	0.70	0.52
05/20/2015	0.54	0.45	0.68	0.45	0.87	0.77	0.69	0.54
05/21/2015	0.57	0.46	0.70	0.47	0.89	0.78	0.68	0.55
05/22/2015	0.63	0.47	0.70	0.49	0.89	0.78	0.65	0.57
05/23/2015	0.62	0.48	0.70	0.50	0.89	0.79	0.68	0.58
05/24/2015	0.60	0.48	0.70	0.52	0.91	0.79	0.68	0.60
05/25/2015	0.54	0.49	0.71	0.53	0.92	0.80	0.68	0.61
05/26/2015	0.58	0.49	0.71	0.55	0.93	0.81	0.68	0.62
05/27/2015	0.69	0.50	0.70	0.56	0.95	0.82	0.68	0.63
05/28/2015	0.78	0.51	0.71	0.57	0.98	0.82	0.69	0.64
05/29/2015	0.65	0.52	0.73	0.59	1.00	0.83	0.68	0.65
05/30/2015	0.58	0.52	0.75	0.60	1.00	0.84	0.68	0.66
05/31/2015	0.50	0.52	0.78	0.62	1.00	0.85	0.71	0.66
06/01/2015	0.51	0.52	0.80	0.63	1.02	0.86	0.71	0.67
06/02/2015	0.58	0.53	0.81	0.64	1.01	0.87	0.72	0.68

Electrical Conductivity (EC) units: milliSiemens per Centimeter
md : mean daily
30dm : thirty day running mean
NR : No Record
NC : Not Computed due to insufficient data
BR : Below Rating
e : estimated value

Delta Water Quality Conditions

Suisun Marsh Stations

Date	Collinvsille mhtEC	National Steel mhtEC	Beldon Landing mhtEC	Sunrise Club mhtEC	Volanti Slough mhtEC	Goodyear Slough mhtEC
05/04/2015	13.50	12.06	10.30	10.29	9.53	14.26
05/05/2015	12.48	10.83	10.58	11.41	10.45	15.04
05/06/2015	13.01	10.51	11.60	12.18	10.84	15.17
05/07/2015	12.46	10.58	11.69	12.15	11.13	15.16
05/08/2015	12.95	9.05	11.43	12.73	12.40	15.11
05/09/2015	13.61	9.98	11.03	12.51	11.61	15.06
05/10/2015	12.89	9.98	10.76	12.22	11.35	15.06
05/11/2015	11.79	9.81	10.71	11.84	10.98	15.14
05/12/2015	11.73	9.09	10.98	11.61	10.98	15.18
05/13/2015	11.30	8.62	10.73	11.43	10.77	15.37
05/14/2015	11.99	8.91	10.46	11.47	10.78	15.49
05/15/2015	12.11	9.48	10.33	11.62	11.04	15.60
05/16/2015	12.25	10.06	10.07	11.39	11.01	15.56
05/17/2015	12.51	10.12	10.12	11.63	10.97	15.54
05/18/2015	12.03	10.16	10.26	11.72	11.05	15.49
05/19/2015	12.24	10.04	10.45	11.31	10.66	15.46
05/20/2015	12.62	10.01	10.84	11.53	10.74	15.60
05/21/2015	12.27	10.19	10.81	11.44	11.09	15.82
05/22/2015	11.75	9.76	10.83	11.10	11.41	15.67
05/23/2015	11.25	9.20	10.89	11.08	10.11	15.41
05/24/2015	11.00	9.02	10.68	10.92	8.74	15.26
05/25/2015	10.78	8.92	10.30	10.90	9.19	15.08
05/26/2015	10.90	8.99	9.70	10.76	9.79	15.11
05/27/2015	10.17	8.88	9.78	11.16	10.40	15.22
05/28/2015	10.63	8.82	9.93	11.47	10.16	15.15
05/29/2015	10.37	9.19	9.97	11.53	10.43	15.18
05/30/2015	9.95	9.57	9.96	11.67	10.70	15.21
05/31/2015	10.88	9.92	9.95	11.32	10.62	15.44
06/01/2015	11.02	10.94	9.96	11.66	11.24	15.94
06/02/2015	11.10	9.64	10.12	11.44	11.02	16.26

Electrical Conductivity (EC) units: milliSiemens per Centimeter
mht : mean high tides
NR : No Record
NC : Not Computed due to insufficient data
BR : Below Rating
e : estimated value

Compliance Standards

for the Sacramento - San Joaquin Delta and Suisun Marsh
Monday, July 13, 2015

Criteria	Standard		Status	
Flow/Operational				
% of inflow diverted	65	%	7	%
NDOI, monthly average *	>= 3,000	cfs	3,256	cfs
NDOI, 7 day average*	>= 2,000	cfs	3,475	cfs
Water Quality				
Days @ CCWD PP#1 w/ chlorides <= 150 mg/l	155	days	124	days
Export Areas for SWP, CVP, CCWD, et al	<= 250	mg/l Cl	172	mg/l
14dm EC at Threemile Slough at Sac	<= 2.78	mS/cm	3.17	mS/cm
14dm EC at Jersey Point	<= 2.20	mS/cm	2.23	mS/cm
14dm EC at San Andreas Landing	<= 0.87	mS/cm	0.62	mS/cm
14dm EC at Terminous	<= 0.54	mS/cm	0.15	mS/cm
Maximum 30 day running average of mean daily EC at:				
Vernalis	<=0.7	mS/cm	0.7	mS/cm
Brandt Bridge	<=0.7	mS/cm	1.1	mS/cm
Old River Near Tracy	<=0.7	mS/cm	1.0	mS/cm
Old River Near Middle River	<=0.7	mS/cm	1.1	mS/cm

SUISUN MARSH:

Suisun Marsh Salinity Control Gates : 3 Open / 0 Closed / 0 Full Tide Open
Flashboard Status : Out   Boat Lock Status : Closed

California Hydrologic Conditions: (California Cooperative Snow Surveys Forecast, May 1, 2015)

Previous Month's Index (8RI for Apr): 766 TAF
Sacramento valley water year type index (40/30/30) @ 50%: 4.0 MAF (Critical)
San Joaquin valley water year type index (60/20/20) @ 75%: 0.7 MAF (Critical)

Electrical Conductivity (EC) in milliSiemens per Centimeter.
Chlorides (Cl) in milligrams per liter
mht - mean high tides
md - mean daily
14 dm - fourteen day running mean
NR - No Record
NC - Not Computed due to insufficient data
BR : Below Rating
e - estimated value

Montezuma Slough Gate Operation:
Number of gates operating at either Open, Closed, or Full Tide Open
Flashboard Status : In, Out, or Modified In
Boat Lock Status : Open or Closed

Coordinated Operation Agreement Delta Status:
c = excess Delta conditions
b = balanced Delta conditions
r = excess Delta conditions with restrictions:

* NDOI, Rio Vista & Vernalis Flows and Suisun Marsh mhtEC:
- 7 day average is progressive daily mean for the first six days of the month.
- Monthly average is progressive daily mean from the beginning of the month

Delta Water Quality Conditions

Date	Antioch Tides		Net Delta Outflow Index	Martinez	Port Chicago		Mallard	Chipps Island		Collinsville	
	High	Half	cfs	mdEC	mdEC	14dm	mdEC	mdEC	14dm	mdEC	14dm
06/14/2015	7.14	4.85	4,356	32.38	22.30	20.88	15.84	15.95	14.25	11.46	9.92
06/15/2015	7.09	4.70	3,971	31.57	20.59	20.81	15.58	15.66	14.32	10.87	9.99
06/16/2015	6.88	4.53	3,732	30.90	18.98	20.60	14.57	14.55	14.34	10.46	10.04
06/17/2015	6.72	4.49	3,370	30.59	19.74	20.37	14.49	14.46	14.34	10.39	10.09
06/18/2015	6.60	4.47	3,697	30.65	21.19	20.33	14.76	14.76	14.40	10.37	10.14
06/19/2015	6.37	4.34	3,481	30.25	20.53	20.25	14.32	14.27	14.36	10.06	10.10
06/20/2015	6.12	4.39	3,792	29.48	20.25	20.15	13.81	13.71	14.25	9.78	10.01
06/21/2015	5.87	4.32	3,595	30.19	19.97	20.09	14.18	14.12	14.23	9.91	9.99
06/22/2015	5.50	4.13	3,458	29.29	18.17	19.97	13.31	13.16	14.23	9.23	9.99
06/23/2015	5.68	4.04	3,846	28.21	19.00	19.95	13.03	12.86	14.15	8.83	9.93
06/24/2015	5.88	4.09	3,472	28.31	19.31	19.94	13.33	13.18	14.17	8.86	9.93
06/25/2015	6.07	4.15	3,281	29.04	19.67	19.95	13.76 e	13.65 e	14.25	9.14	9.97
06/26/2015	6.45	4.36	3,271	30.09	21.02	20.00	14.74	14.73	14.32	10.46	10.05
06/27/2015	6.41	4.51	3,126	30.92	22.23	20.21	16.09	16.23	14.38	11.58	10.10
06/28/2015	6.48	4.44	2,962	30.82	20.80	20.10	15.90	16.02	14.38	11.42	10.10
06/29/2015	6.58	4.44	3,113	31.16	21.78	20.19	15.63	15.71	14.39	11.09	10.11
06/30/2015	6.63	4.38	3,484	30.01	19.35	20.22	15.09	15.12	14.43	10.77	10.14
07/01/2015	6.76	4.48	3,511	30.63	21.60	20.35	16.00	16.13	14.55	11.26	10.20
07/02/2015	6.88	4.65	3,153	31.32	21.87	20.40	16.72	16.93	14.70	12.08	10.32
07/03/2015	6.97	4.68	2,809	32.23	22.48	20.54	17.12	17.39	14.92	12.58	10.50
07/04/2015	6.91	4.80	2,929	32.61	23.06	20.74	17.55	17.86	15.22	12.89	10.72
07/05/2015	6.83	4.89	2,900	33.16	22.98	20.95	17.93	18.30	15.52	13.21	10.96
07/06/2015	6.36	4.60	2,702	31.87	21.78	21.21	16.59	16.79	15.78	12.22	11.17
07/07/2015	6.14	4.42	3,311	30.36	20.13	21.29	15.97	16.09	16.01	11.26	11.35
07/08/2015	6.41	4.47	3,072	30.48	19.10	21.28	16.17	16.32	16.23 e	11.35	11.52
07/09/2015	6.44	4.42	2,854	30.48	21.09	21.38	15.75	15.85	16.39	11.09	11.66
07/10/2015	6.57	4.34	3,498	29.91	19.86	21.29	15.26	15.31	16.43	10.68	11.68
07/11/2015	6.72	4.48	3,851	30.15	21.75	21.26	15.84	15.96	16.41	11.25	11.65
07/12/2015	6.75	4.53	3,723	30.82	21.81	21.33	16.12	16.26	16.43	11.55	11.66
07/13/2015	6.81	4.59	4,018	30.83	21.95	21.34	15.86	15.98	16.45	11.54	11.70

Antioch Tides measured in feet relative to the NAVD88 Datum
Net Delta Ouflow Index calculated from equation as specified in D-1641, revised March 2000.
Chipps Island EC calculated from measurements recorded at Mallard Slough.
Electrical Conductivity (EC) units: milliSiemens per Centimeter
md : mean daily
14dm : fourteen day running mean
NR : No Record
NC : Not Computed due to insufficient data
BR : Below Rating
e - estimated value

Delta Water Quality Conditions

Date	Antioch		Jersey Point		Emmaton		Three Mile Slough		San Andreas Landing		Terminous	
	mdEC	14dm	mdEC	14dm	mdEC	14dm	mdEC	14dm	mdEC	14dm	mdEC	14dm
06/14/2015	6.73	5.81	2.22	1.76	4.85	3.66	2.91	2.16	0.71	0.63	0.17	0.17
06/15/2015	6.33	5.87	2.08	1.79	4.85	3.76	2.83	2.22	0.70	0.64	0.18	0.18
06/16/2015	6.10	5.90	1.94	1.81	4.48	3.83	2.68	2.27	0.68	0.64	0.18	0.18
06/17/2015	5.99	5.91	1.93	1.83	4.36	3.89	2.55	2.30	0.66	0.65	0.16	0.18
06/18/2015	6.10	5.96	1.78	1.83	4.47	3.97	2.67	2.35	0.62	0.65	0.16	0.17
06/19/2015	5.85	5.93	1.85	1.83	4.28	3.99	2.51	2.37	0.61	0.64	0.16	0.17
06/20/2015	5.71	5.89	1.77	1.82	4.05	3.97	2.45	2.37	0.60	0.63	0.17	0.17
06/21/2015	5.76	5.90	1.78	1.81	4.30	4.00	2.53	2.40	0.58	0.63	0.17	0.17
06/22/2015	5.06	5.88	1.62	1.81	3.60	4.01	2.18	2.41	0.51	0.63	0.17	0.17
06/23/2015	4.94	5.82	1.53	1.80	3.30	3.99	1.95	2.39	0.52	0.62	0.17	0.17
06/24/2015	5.18	5.81	1.55	1.80	3.17	4.00	1.93	2.39	0.57	0.62	0.17	0.17
06/25/2015	5.60	5.84	1.67	1.81	3.06	4.01	1.86	2.40	0.60	0.62	0.17	0.17
06/26/2015	6.35	5.88	1.89	1.83	3.70	4.04	2.04	2.40	0.68	0.62	0.17	0.17
06/27/2015	6.93	5.90	2.21	1.84	4.14	4.04	2.55	2.40	0.69	0.62	0.16	0.17
06/28/2015	6.67	5.90	2.17	1.84	4.31	4.00	2.47	2.37	0.67	0.62	0.15	0.17
06/29/2015	6.43	5.90	2.16	1.85	4.50	3.98	2.57	2.35	0.63	0.62	0.15	0.16
06/30/2015	6.31	5.92	1.99	1.85	4.43	3.98	2.58	2.34	0.60	0.61	0.15	0.16
07/01/2015	6.98	5.99	2.16	1.87	4.81	4.01	2.87	2.37	0.65	0.61	0.15	0.16
07/02/2015	7.44	6.09	2.35	1.91	5.22	4.06	3.19	2.41	0.68	0.61	0.15	0.16
07/03/2015	7.47	6.20	2.42	1.95	5.74	4.17	3.45	2.47	0.72	0.62	0.15	0.16
07/04/2015	7.63	6.34	2.55	2.00	5.98	4.30	3.63	2.56	0.75	0.63	0.15	0.16
07/05/2015	7.95	6.49	2.62	2.06	6.48	4.46	4.10	2.67	0.72	0.64	0.15	0.16
07/06/2015	7.29	6.65	2.42	2.12	5.77	4.62	3.61	2.77	0.62	0.65	0.14	0.16
07/07/2015	6.76	6.78	2.16	2.17	5.10	4.74	3.11	2.85	0.57	0.65	0.15	0.15
07/08/2015	6.90	6.91	2.10	2.20	5.18	4.89	3.21	2.94	0.55	0.65	0.15	0.15
07/09/2015	6.84	7.00	2.09	2.23	5.02	5.03	3.11	3.03	0.54	0.65	0.14	0.15
07/10/2015	6.66	7.02	1.98	2.24	4.66	5.10	2.77	3.09	0.54	0.64	0.14	0.15
07/11/2015	7.17	7.03	2.08	2.23	4.83	5.15	2.88	3.11	0.57	0.63	0.14	0.15
07/12/2015	7.37	7.08	2.30	2.24	5.20	5.21	3.00	3.15	0.61	0.63	0.14	0.15
07/13/2015	6.71	7.10	2.01	2.23	4.81	5.23	2.93	3.17	0.59	0.62	0.14	0.15

Electrical Conductivity (EC) units: milliSiemens per Centimeter
Chloride (Cl) units: milligrams per liter
md : mean daily
14dm : fourteen day running mean
NR : No Record
NC : Not Computed due to insufficient data
BR : Below Rating
e : estimated value

Delta Water Quality Conditions

Date	Bethel Island mdEC	Farrar Park mdEC	Holland Tract mdEC	Bacon Island mdEC	Contra Costa mdEC	Clifton Court mdEC	Tracy Pumping Plant mdEC	Antioch mdCl	Bacon Island mdCl	Contra Costa mdCl	Delta Status
06/14/2015	0.95	1.54	0.81	0.76	0.87	0.81	0.90	2,073	161	184	b
06/15/2015	0.90	1.53	0.79	0.76	0.86	0.80	0.87	1,945	162	184	b
06/16/2015	0.85	1.52	0.79	0.76	0.85	0.80	0.91	1,872	161	182	b
06/17/2015	0.86	1.55	0.80	0.74	0.84	0.80	0.88	1,837	156	178	b
06/18/2015	0.87	1.56	0.79	0.75	0.84	0.79	0.88	1,874	159	178	b
06/19/2015	0.87	1.53	0.79	0.74	0.84	0.78	0.86	1,792	156	178	b
06/20/2015	0.87	1.48	0.78	0.75	0.83	0.78	0.84	1,749	157	177	b
06/21/2015	0.89	1.48	0.78	0.75	0.82	0.77	0.84	1,765	158	175	b
06/22/2015	0.89	1.44	0.75	0.71	0.83	0.77	0.83	1,542	146	174	b
06/23/2015	0.86	1.42	0.75	0.73	0.82	0.76	0.82	1,504	153	175	b
06/24/2015	0.86	1.43	0.75	0.72	0.82	0.77	0.82	1,580	149	175	b
06/25/2015	0.86	1.44	0.76	0.74	0.80	0.77	0.82	1,713	156	174	b
06/26/2015	0.88	1.51	0.78	0.74	0.82	0.77	0.82	1,951	155	173	b
06/27/2015	0.96	1.57	0.77	0.74	0.82	0.76	0.82	2,137	154	174	b
06/28/2015	0.95	1.66	0.77	0.74	0.81	0.76	0.81	2,056	155	172	b
06/29/2015	0.96	1.74	0.77	0.74	0.80	0.75	0.80	1,978	155	174	b
06/30/2015	0.91	1.71	0.77	0.74	0.79	0.76	0.80	1,939	155	173	b
07/01/2015	0.89	1.76	0.78	0.74	0.79	0.76	0.80	2,152	156	172	b
07/02/2015	0.92	1.81	0.77	0.74	0.79	0.75	0.80	2,300	156	171	b
07/03/2015	0.95	1.84	0.81	0.71	0.79	0.74	0.81	2,308	148	171 e	b
07/04/2015	0.98	1.88	0.81	0.75	0.79	0.73	0.81	2,362	159	171 e	b
07/05/2015	1.02	1.91	0.76	0.75	0.79	0.73	0.80	2,461	159	171 e	b
07/06/2015	0.99	1.81	0.74	0.75	0.80	0.72	0.78	2,252	159	170	b
07/07/2015	0.97	1.81	0.72	0.75	0.80	0.72	0.77	2,082	158	169	b
07/08/2015	0.94	1.84	0.72	0.74	0.80	0.72	0.77	2,127	156	170	b
07/09/2015	0.95	1.80	0.70	0.74	0.80	0.71	0.77	2,110	155	171	b
07/10/2015	0.94	1.78	0.71	0.73	0.79	0.73	0.76	2,050	153	170	b
07/11/2015	0.95	1.82	0.72	0.73	0.79	0.73	0.77	2,213	152	170 e	b
07/12/2015	0.98	1.89	0.75	0.72	0.78	0.73	0.77	2,278	151	170 e	b
07/13/2015	0.98	1.85	0.75	0.73	0.79	0.73	0.77	2,066	152	172	b

Electrical Conductivity (EC) units: milliSiemens per Centimeter
Chloride (Cl) units: milligrams per liter
md : mean daily
NR : No Record
NC : Not Computed due to insufficient data
BR : Below Rating
e : estimated value
Antioch and Bacon Island mdCl are calculated from the respective mdEC values.

Coordinated Operation Agreement Delta Status:
- c = excess Delta conditions
- b = balanced Delta conditions
- r = excess Delta conditions with restrictions:

Delta Water Quality Conditions

South Delta Stations

Date	Vernalis		Brandt Bridge		Old River Near Tracy		Old River Near Middle River	
	mdEC	30dm	mdEC	30dm	mdEC	30dm	mdEC	30dm
06/14/2015	0.68	0.62	0.98	0.79	1.04	0.96	0.82	0.72
06/15/2015	0.69	0.62	1.02	0.80	1.06	0.97	0.85	0.73
06/16/2015	0.81	0.63	1.04	0.81	1.03	0.98	0.86	0.73
06/17/2015	0.77	0.64	1.06	0.83	1.02	0.98	0.89	0.74
06/18/2015	0.67	0.65	1.09	0.84	1.00	0.99	0.93	0.75
06/19/2015	0.63	0.65	1.08	0.85	1.01	0.99	1.11	0.76
06/20/2015	0.72	0.66	1.07	0.87	1.01	1.00	1.23	0.78
06/21/2015	0.67	0.66	1.07	0.88	1.00	1.00	1.25	0.80
06/22/2015	0.68	0.66	1.04	0.89	1.02	1.01	1.24	0.82
06/23/2015	0.75	0.67	1.01	0.90	1.04	1.01	1.25	0.84
06/24/2015	0.75	0.67	1.01	0.91	1.11	1.02	1.25	0.86
06/25/2015	0.58	0.67	1.03	0.92	1.29	1.03	1.25	0.88
06/26/2015	0.61	0.67	1.05	0.93	1.12	1.03	1.26	0.90
06/27/2015	0.73	0.67	1.08	0.95	1.07	1.04	1.24	0.91
06/28/2015	0.69	0.67	1.12	0.96	1.01	1.04	1.22	0.93
06/29/2015	0.65	0.67	1.13	0.97	1.01	1.04	1.21	0.95
06/30/2015	0.54	0.67	1.12	0.98	1.02	1.04	1.19	0.97
07/01/2015	0.58	0.68	1.13	0.99	1.02	1.04	1.17	0.98
07/02/2015	0.70	0.68	1.15	1.00	1.06	1.04	1.17	1.00
07/03/2015	0.87	0.69	1.16	1.02	1.06	1.04	1.16	1.01
07/04/2015	0.77	0.70	1.17	1.03	1.06 e	1.04	1.14	1.02
07/05/2015	0.68	0.69	1.18	1.04	1.06 e	1.04	1.15	1.04
07/06/2015	0.74	0.69	1.16	1.05	0.96	1.04	1.17	1.05
07/07/2015	0.87	0.70	1.14	1.05	0.96	1.04	1.17	1.06
07/08/2015	0.98	0.71	1.13	1.06	0.96	1.04	1.15	1.07
07/09/2015	0.66	0.71	1.13	1.07	0.95	1.03	1.12	1.09
07/10/2015	0.59	0.70	1.12	1.08	0.96	1.03	1.11	1.10
07/11/2015	0.57	0.70	1.12	1.08	0.95	1.03	1.11	1.11
07/12/2015	0.57	0.69	1.11	1.09	0.93	1.03	1.11	1.12
07/13/2015	0.56	0.69	1.10	1.09	0.92	1.02	1.11	1.13

Electrical Conductivity (EC) units: milliSiemens per Centimeter
md : mean daily
30dm : thirty day running mean
NR : No Record
NC : Not Computed due to insufficient data
BR : Below Rating
e : estimated value

Delta Water Quality Conditions

Suisun Marsh Stations

Date	Collinvsille mhtEC	National Steel mhtEC	Beldon Landing mhtEC	Sunrise Club mhtEC	Volanti Slough mhtEC	Goodyear Slough mhtEC
06/14/2015	12.64	11.23	15.74	15.45	15.26	19.64
06/15/2015	11.80	11.39	15.88	15.45	15.25	20.66
06/16/2015	11.11	11.70	16.10	16.21	16.12	20.49
06/17/2015	11.42	11.96	16.79	17.81	16.83	20.19
06/18/2015	11.24	12.10	17.19	17.14	16.15	19.85
06/19/2015	10.64	12.35	17.08	15.83	16.35	19.93
06/20/2015	10.99	12.40	17.14	15.63	16.47	19.89
06/21/2015	11.18	12.48	17.19	15.55	16.96	19.78
06/22/2015	10.58	12.52	16.73	15.21	16.84	19.81
06/23/2015	9.83	12.61	16.66	15.16	16.66	19.95
06/24/2015	10.12	12.65	17.01	15.56	16.57	20.07
06/25/2015	10.23	12.73	17.09	15.57	16.43	19.97
06/26/2015	11.89	12.77	17.10	15.61	16.02	19.88
06/27/2015	11.84	12.77	17.07	15.61	16.45	19.92
06/28/2015	12.59	13.23	16.86	15.58	16.10	20.11
06/29/2015	11.98	13.47	17.05	15.86	16.63	20.20
06/30/2015	11.89	13.56	17.13	16.48	17.09	20.44
07/01/2015	12.50	13.63	17.92	16.02	17.25	20.39
07/02/2015	13.79	13.66	18.57	16.40	17.27	20.62
07/03/2015	13.43	13.82	18.46	17.09	16.63	21.18
07/04/2015	14.10	14.16	19.08	17.99	16.13	21.30
07/05/2015	14.59	14.27	19.41	18.37	15.70	21.42
07/06/2015	12.99	14.39	19.31	18.29	15.86	21.77
07/07/2015	12.38	14.26	19.12	18.46	15.92	21.97
07/08/2015	12.80	14.67	18.96	18.64	16.18	22.09
07/09/2015	12.49	14.71	18.96	18.84	16.56	22.16
07/10/2015	11.91	14.67	19.26	18.82	16.76	22.09
07/11/2015	12.00	14.63	19.44	19.00	17.05	21.94
07/12/2015	12.67	14.90	19.47	19.25	17.15	21.90
07/13/2015	12.06	14.79	19.87	19.36	17.60	21.69

Electrical Conductivity (EC) units: milliSiemens per Centimeter
mht : mean high tides
NR : No Record
NC : Not Computed due to insufficient data
BR : Below Rating
e : estimated value

Compliance Standards

for the Sacramento - San Joaquin Delta and Suisun Marsh
Sunday, August 09, 2015

Criteria	Standard	Status
Flow/Operational		
% of inflow diverted	65 %	9 %
NDOI, monthly average *	>= 3,000 cfs	3,799 cfs
NDOI, 7 day average*	>= 2,000 cfs	3,780 cfs
Water Quality		
Days @ CCWD PP#1 w/ chlorides <= 150 mg/l	155 days	124 days
Export Areas for SWP, CVP, CCWD, et al	<= 250 mg/l Cl	167 mg/l
14dm EC at Threemile Slough at Sac	<= 2.78 mS/cm	2.73 mS/cm
14dm EC at Jersey Point	<= 2.20 mS/cm	1.90 mS/cm
14dm EC at San Andreas Landing	<= 0.87 mS/cm	0.61 mS/cm
14dm EC at Terminous	<= 0.54 mS/cm	0.14 mS/cm
Maximum 30 day running average of mean daily EC at:		
Vernalis	<=0.7 mS/cm	0.6 mS/cm
Brandt Bridge	<=0.7 mS/cm	1.1 mS/cm
Old River Near Tracy	<=0.7 mS/cm	1.0 mS/cm
Old River Near Middle River	<=0.7 mS/cm	1.1 mS/cm

SUISUN MARSH:

Suisun Marsh Salinity Control Gates : 3 Open / 0 Closed / 0 Full Tide Open
Flashboard Status : Out   Boat Lock Status : Closed

California Hydrologic Conditions: (California Cooperative Snow Surveys Forecast, May 1, 2015)

Previous Month's Index (8RI for Apr): 766 TAF
Sacramento valley water year type index (40/30/30) @ 50%: 4.0 MAF (Critical)
San Joaquin valley water year type index (60/20/20) @ 75%: 0.7 MAF (Critical)

Electrical Conductivity (EC) in milliSiemens per Centimeter.
Chlorides (Cl) in milligrams per liter
mht - mean high tides
md - mean daily
14 dm - fourteen day running mean
NR - No Record
NC - Not Computed due to insufficient data
BR : Below Rating
e - estimated value

Montezuma Slough Gate Operation:
Number of gates operating at either Open, Closed, or Full Tide Open
Flashboard Status : In, Out, or Modified In
Boat Lock Status : Open or Closed

Coordinated Operation Agreement Delta Status:
c = excess Delta conditions
b = balanced Delta conditions
r = excess Delta conditions with restrictions:

* NDOI, Rio Vista & Vernalis Flows and Suisun Marsh mhtEC:
- 7 day average is progressive daily mean for the first six days of the month.
- Monthly average is progressive daily mean from the beginning of the month

Delta Water Quality Conditions

Date	Antioch Tides		Net Delta Outflow Index	Martinez	Port Chicago		Mallard	Chipps Island		Collinsville	
	High	Half	cfs	mdEC	mdEC	14dm	mdEC	mdEC	14dm	mdEC	14dm
07/11/2015	6.72	4.48	3,851	30.15	21.75	21.26	15.84	15.96	16.41	11.25	11.65
07/12/2015	6.75	4.53	3,723	30.82	21.81	21.33	16.12	16.26	16.43	11.55	11.66
07/13/2015	6.81	4.59	4,018	30.83	21.95	21.34	15.86	15.98	16.45	11.54	11.70
07/14/2015	6.89	4.61	4,169	31.16	22.52	21.57	16.38	16.55	16.55	11.48	11.75
07/15/2015	6.84	4.64	3,911	30.77	20.98	21.52	16.10	16.24	16.56	11.57	11.77
07/16/2015	6.91	4.78	3,881	32.00	22.88	21.60	16.70	16.92	16.56	12.34	11.79
07/17/2015	6.80	4.80	3,682	31.39	22.42	21.59	16.81	17.04	16.53	12.23	11.76
07/18/2015	6.77	4.82	4,139	31.15	20.09	21.38	16.79	17.02	16.47	12.26	11.72
07/19/2015	6.26	4.42	4,202	30.09	16.68	20.93	14.99	15.01	16.24	10.44	11.52
07/20/2015	5.89	4.38	4,388	29.15	19.50	20.77	14.28	14.23	16.05	9.82	11.35
07/21/2015	6.02	4.52	3,359	29.86	20.47	20.79	14.95	14.96	15.97	10.30	11.28
07/22/2015	6.21	4.60	3,358	30.86	18.77	20.77	15.42	15.49	15.91	10.46	11.21
07/23/2015	6.09	4.44	3,149	29.69	18.79	20.60	14.50	14.46	15.81	9.65	11.11
07/24/2015	6.09	4.25	3,079	28.36	20.39	20.64	13.73	13.62	15.69	9.03	10.99
07/25/2015	6.36	4.34	3,024	29.19	20.13	20.53	14.21	14.15	15.57	9.73	10.89
07/26/2015	6.70	4.63	3,183	30.95	19.09	20.33	15.28	15.33	15.50	10.65	10.82
07/27/2015	6.72	4.61	2,775	29.83	17.19	19.99	15.06	15.09	15.43	9.64	10.69
07/28/2015	6.78	4.61	3,510	30.25	19.25	19.76	15.17	15.21	15.34	10.54	10.62
07/29/2015	6.87	4.71	3,365	30.72	21.93	19.83	16.01	16.14	15.33	11.36	10.60
07/30/2015	7.14	4.86	3,357	31.63	23.39	19.86	17.39	17.68	15.39	12.76	10.63
07/31/2015	7.14	4.80	3,521	31.40	22.71	19.88	17.22	17.49	15.42	12.70	10.67
08/01/2015	7.03	4.74	3,908	31.08	21.44	19.98	17.07	17.33	15.44	12.48	10.68
08/02/2015	6.79	4.67	3,823	31.04	18.14	20.08	16.87	17.10	15.59	12.16	10.81
08/03/2015	6.45	4.61	3,638	30.09	18.88	20.04	16.59	16.79	15.77	11.57	10.93
08/04/2015	6.11	4.41	3,725	30.46	17.23	19.81	15.68	15.77	15.83	10.89	10.97
08/05/2015	6.17	4.20	3,653	29.30	16.44	19.64	14.60	14.57	15.77	9.98	10.94
08/06/2015	6.39	4.30	3,947	28.88	16.66	19.49	14.35	14.30	15.76	9.80	10.95
08/07/2015	6.58	4.51	3,790	30.04	19.55	19.43	15.66	15.75	15.91	10.92	11.08
08/08/2015	6.57	4.50	3,888	30.34	16.79	19.19	15.59	15.67	16.02	11.08	11.18
08/09/2015	6.65	4.50	3,821	29.92	17.01	19.04	15.04	15.06	16.00	10.66	11.18

Antioch Tides measured in feet relative to the NAVD88 Datum
Net Delta Ouflow Index calculated from equation as specified in D-1641, revised March 2000.
Chipps Island EC calculated from measurements recorded at Mallard Slough.
Electrical Conductivity (EC) units: milliSiemens per Centimeter
md : mean daily
14dm : fourteen day running mean
NR : No Record
NC : Not Computed due to insufficient data
BR : Below Rating
e - estimated value

Delta Water Quality Conditions

Date	Antioch		Jersey Point		Emmaton		Three Mile Slough		San Andreas Landing		Terminous	
	mdEC	14dm	mdEC	14dm	mdEC	14dm	mdEC	14dm	mdEC	14dm	mdEC	14dm
07/11/2015	7.17	7.03	2.08	2.23	4.83	5.15	2.88	3.11	0.57	0.63	0.14	0.15
07/12/2015	7.37	7.08	2.30	2.24	5.20	5.21	3.00	3.15	0.61	0.63	0.14	0.15
07/13/2015	6.71	7.10	2.01	2.23	4.81	5.23	2.93	3.17	0.59	0.62	0.14	0.15
07/14/2015	6.99	7.15	1.97	2.23	5.01	5.27	2.94	3.20	0.58	0.62	0.14	0.15
07/15/2015	7.01	7.16	2.06	2.22	4.84	5.27	2.99	3.21	0.60	0.62	0.14	0.14
07/16/2015	7.15	7.13	2.18	2.21	5.21	5.27	3.10	3.20	0.63	0.61	0.14	0.14
07/17/2015	7.07	7.11	2.28	2.20	5.32	5.24	3.06	3.17	0.62	0.61	0.14	0.14
07/18/2015	7.06	7.06	2.28	2.18	5.34	5.20	3.03	3.13	0.62	0.60	0.14	0.14
07/19/2015	6.06	6.93	1.90	2.13	4.11	5.03	2.38	3.01	0.52	0.58	0.14	0.14
07/20/2015	5.73	6.82	1.59	2.07	3.75	4.88	2.14	2.90	0.50	0.57	0.14	0.14
07/21/2015	6.08	6.77	1.70	2.04	3.73	4.79	2.11	2.83	0.57	0.57	0.15	0.14
07/22/2015	6.38	6.73	1.62	2.00	3.54	4.67	2.13	2.75	0.61	0.58	0.14	0.14
07/23/2015	6.08	6.68	1.64	1.97	3.14	4.53	1.77	2.66	0.59	0.58	0.15	0.14
07/24/2015	5.84	6.62	1.57	1.94	2.68	4.39	1.50	2.57	0.58	0.58	0.15	0.14
07/25/2015	6.09	6.54	1.59	1.91	3.03	4.26	1.59	2.48	0.59	0.59	0.14	0.14
07/26/2015	6.45	6.48	1.66	1.86	3.76	4.16	2.01	2.41	0.63	0.59	0.14	0.14
07/27/2015	6.40	6.46	1.82	1.85	3.86	4.09	2.36	2.36	0.63	0.59	0.14	0.14
07/28/2015	6.57	6.43	1.74	1.83	4.11	4.03	2.51	2.33	0.63	0.59	0.14	0.14
07/29/2015	6.86	6.42	1.77	1.81	4.68	4.02	2.74	2.32	0.64	0.60	0.14	0.14
07/30/2015	7.52	6.44	2.26	1.82	5.39	4.03	3.24	2.33	0.67	0.60	0.14	0.14
07/31/2015	7.26	6.46	2.14	1.81	5.56	4.05	3.21	2.34	0.65	0.60	0.14	0.14
08/01/2015	7.13	6.46	2.13	1.79	5.69	4.07	3.30	2.36	0.62	0.60	0.14	0.14
08/02/2015	6.99	6.53	2.06	1.81	5.67	4.18	3.28	2.42	0.59	0.61	0.14	0.14
08/03/2015	6.96	6.61	1.97	1.83	5.51	4.31	3.17	2.49	0.56	0.61	0.14	0.14
08/04/2015	6.56	6.65	1.80	1.84	4.81	4.39	2.73	2.54	0.51	0.61	0.14	0.14
08/05/2015	6.06	6.63	1.60	1.84	3.83	4.41	2.27	2.55	0.53	0.60	0.15	0.14
08/06/2015	6.18	6.63	1.64	1.84	3.57	4.44	2.25	2.58	0.59	0.60	0.15	0.14
08/07/2015	7.01	6.72	1.96	1.87	4.05	4.54	2.42	2.65	0.66	0.61	0.15	0.14
08/08/2015	6.93	6.78	1.97	1.89	4.24	4.62	2.47	2.71	0.63	0.61	0.15	0.14
08/09/2015	6.47	6.78	1.75	1.90	3.99	4.64	2.32	2.73	0.60	0.61	0.15	0.14

Electrical Conductivity (EC) units: milliSiemens per Centimeter
Chloride (Cl) units: milligrams per liter
md : mean daily
14dm : fourteen day running mean
NR : No Record
NC : Not Computed due to insufficient data
BR : Below Rating
e : estimated value

Delta Water Quality Conditions

Date	Bethel Island mdEC	Farrar Park mdEC	Holland Tract mdEC	Bacon Island mdEC	Contra Costa mdEC	Clifton Court mdEC	Tracy Pumping Plant mdEC	Antioch mdCl	Bacon Island mdCl	Contra Costa mdCl	Delta Status
07/11/2015	0.95	1.82	0.72	0.73	0.79	0.73	0.77	2,213	152	170 e	b
07/12/2015	0.98	1.89	0.75	0.72	0.78	0.73	0.77	2,278	151	170 e	b
07/13/2015	0.98	1.85	0.75	0.73	0.79	0.73	0.77	2,066	152	172	b
07/14/2015	0.96	1.75	0.76	0.73	0.78	0.73	0.77	2,156	153	170	b
07/15/2015	0.95	1.76	0.77	0.73	0.78	0.73	0.76	2,162	153	169	b
07/16/2015	0.97	1.80	0.81	0.73	0.78	0.73	0.77	2,206	153	168	b
07/17/2015	1.02	1.75	0.79	0.73	0.78	0.73	0.77	2,181	154	169	b
07/18/2015	1.02	1.76	0.78	0.74	0.77	0.73	0.77	2,180	155	169 e	b
07/19/2015	0.99	1.68	0.75	0.74	0.77	0.73	0.76	1,861	155	169 e	b
07/20/2015	0.94	1.59	0.76	0.72	0.76	0.73	0.76	1,755	150	170	b
07/21/2015	0.93	1.59	0.77	0.74	0.77	0.73	0.76	1,865	155	167	b
07/22/2015	0.94	1.59	0.77	0.73	0.77	0.73	0.76	1,962	154	168	b
07/23/2015	0.93	1.56	0.75	0.73	0.77	0.73	0.76	1,865	153	168	b
07/24/2015	0.92	1.52	0.74	0.73	0.77	0.75	0.76	1,791	153	170	b
07/25/2015	0.91	1.54	0.74	0.72	0.77	0.77	0.76	1,869	151	170 e	b
07/26/2015	0.91	1.59	0.75	0.72	0.77	0.76	0.76	1,985	149	170 e	b
07/27/2015	0.92	1.59	0.76	0.71	0.77	0.76	0.76	1,969	148	172	b
07/28/2015	0.93	1.60	0.77	0.71	0.77	0.76	0.76	2,022	148	171	b
07/29/2015	0.92	1.63	0.77	0.71	0.77	0.76	0.76	2,116	147	178	b
07/30/2015	0.97	1.73	0.76	0.71	0.77	0.76	0.76	2,326	147	172	b
07/31/2015	0.97	1.79	0.77	0.71	0.77	0.75	0.76	2,242	147	171	b
08/01/2015	0.96	1.79	0.75	0.71	0.77	0.74	0.76	2,201	147	171 e	b
08/02/2015	0.95	1.77	0.73	0.71	0.76	0.73	0.76	2,156	147	171 e	b
08/03/2015	0.94	1.72	0.72	0.71	0.75	0.72	0.75	2,148	147	169	b
08/04/2015	0.93	1.66	0.71	0.70	0.75	0.72	0.75	2,019	146	167	b
08/05/2015	0.93	1.60	0.71	0.70	0.74	0.72	0.75	1,861	145	166	b
08/06/2015	0.91	1.59	0.72	0.70	0.74	0.72	0.75	1,900	144	166	b
08/07/2015	0.91	1.68	0.73	0.69	0.74	0.72	0.75	2,164	143	167	b
08/08/2015	1.01	1.72	0.73	0.69	0.74	0.71	0.74	2,138	143	167 e	b
08/09/2015	0.97	1.70	0.73	0.69	0.74	0.71	0.74	1,990	143	167 e	b

Electrical Conductivity (EC) units: milliSiemens per Centimeter
Chloride (Cl) units: milligrams per liter
md : mean daily
NR : No Record
NC : Not Computed due to insufficient data
BR : Below Rating
e : estimated value
Antioch and Bacon Island mdCl are calculated from the respective mdEC values.

Coordinated Operation Agreement Delta Status:
- c = excess Delta conditions
- b = balanced Delta conditions
- r = excess Delta conditions with restrictions:

Delta Water Quality Conditions

South Delta Stations

Date	Vernalis		Brandt Bridge		Old River Near Tracy		Old River Near Middle River	
	mdEC	30dm	mdEC	30dm	mdEC	30dm	mdEC	30dm
07/11/2015	0.57	0.70	1.12	1.08	0.95	1.03	1.11	1.11
07/12/2015	0.57	0.69	1.11	1.09	0.93	1.03	1.11	1.12
07/13/2015	0.56	0.69	1.10	1.09	0.92	1.02	1.11	1.13
07/14/2015	0.53	0.69	1.09	1.10	0.93	1.02	1.11	1.14
07/15/2015	0.52	0.68	1.08	1.10	0.95	1.02	1.12	1.15
07/16/2015	0.66	0.68	1.08	1.10	0.99	1.01	1.12	1.16
07/17/2015	0.78	0.68	1.08	1.10	0.99	1.01	1.11	1.16
07/18/2015	0.78	0.68	1.09	1.10	0.98	1.01	1.11	1.17
07/19/2015	0.75	0.68	1.08	1.10	0.96	1.01	1.11	1.17
07/20/2015	0.61	0.68	1.07	1.10	0.95	1.01	1.11	1.17
07/21/2015	0.83	0.69	1.07	1.10	0.95	1.01	1.11	1.16
07/22/2015	0.75	0.69	1.08	1.10	0.95	1.00	1.10	1.16
07/23/2015	0.55	0.68	1.08	1.10	0.98	1.00	1.11	1.15
07/24/2015	0.41	0.67	1.06	1.11	1.01	1.00	1.11	1.15
07/25/2015	0.54	0.67	1.06	1.11	1.06	0.99	1.12	1.14
07/26/2015	0.74	0.67	1.07	1.11	1.04	0.99	1.12	1.14
07/27/2015	0.80	0.67	1.07	1.11	1.01	0.99	1.11	1.13
07/28/2015	0.94	0.68	1.07	1.11	1.01	0.99	1.12	1.13
07/29/2015	0.87	0.69	1.08	1.10	0.97	0.99	1.09	1.13
07/30/2015	0.93	0.70	1.09	1.10	0.95	0.98	1.11	1.12
07/31/2015	0.71	0.71	1.10	1.10	0.93	0.98	1.11	1.12
08/01/2015	0.51	0.70	1.10	1.10	0.94	0.98	1.10	1.12
08/02/2015	0.36	0.68	1.10	1.10	0.94	0.97	1.09	1.12
08/03/2015	0.45	0.67	1.09	1.10	0.96	0.97	1.09	1.12
08/04/2015	0.54	0.67	1.08	1.09	0.98	0.97	1.09	1.11
08/05/2015	0.55	0.66	1.07	1.09	1.00	0.97	1.08	1.11
08/06/2015	0.66	0.66	1.06	1.09	1.09	0.97	1.08	1.11
08/07/2015	0.69	0.65	1.07	1.08	1.16	0.98	1.08	1.11
08/08/2015	0.68	0.65	1.07	1.08	1.13	0.98	1.08	1.10
08/09/2015	0.61	0.65	1.05	1.08	1.06	0.99	1.08	1.10

Electrical Conductivity (EC) units: milliSiemens per Centimeter
md : mean daily
30dm : thirty day running mean
NR : No Record
NC : Not Computed due to insufficient data
BR : Below Rating
e : estimated value

Delta Water Quality Conditions

Suisun Marsh Stations

Date	Collinvsille mhtEC	National Steel mhtEC	Beldon Landing mhtEC	Sunrise Club mhtEC	Volanti Slough mhtEC	Goodyear Slough mhtEC
07/11/2015	12.00	14.63	19.44	19.00	17.05	21.94
07/12/2015	12.67	14.90	19.47	19.25	17.15	21.90
07/13/2015	12.06	14.79	19.87	19.36	17.60	21.69
07/14/2015	12.37	14.77	19.77	19.55	18.11	21.61
07/15/2015	12.58	15.16	20.14	18.74	18.23	21.59
07/16/2015	13.14	15.75	20.37	18.11	19.02	21.34
07/17/2015	13.01	15.78	20.27	20.12	19.67	21.33
07/18/2015	13.34	15.42	20.23	20.32	19.62	21.29
07/19/2015	11.27	15.56	19.83	20.17	19.01	21.39
07/20/2015	11.06	15.59	19.76	21.02	18.84	21.44
07/21/2015	12.02	15.79	19.95	22.67	18.98	21.28
07/22/2015	11.81	16.12	20.02	21.55	19.15	21.18
07/23/2015	10.37	16.13	20.01	20.92	18.81	21.21
07/24/2015	10.00	15.77	19.83	20.63	18.57	21.39
07/25/2015	10.88	15.30	19.75	20.29	18.53	21.46
07/26/2015	12.05	14.95	19.99	19.99	19.04	21.22
07/27/2015	10.81	14.55	20.02	19.85	19.08	21.08
07/28/2015	11.89	14.61	19.94	19.64	19.04	21.05
07/29/2015	11.73	15.18	20.10	19.58	18.96	20.94
07/30/2015	13.36	15.42	20.08	19.43	19.31	20.73
07/31/2015	13.71	15.47	20.10	20.25	19.23	20.90
08/01/2015	13.60	15.73	20.14	21.31	19.31	21.04
08/02/2015	13.09	16.37	20.22	21.19	19.53	21.26
08/03/2015	12.77	16.59	20.11	21.00	19.58	21.45
08/04/2015	12.03	16.18	20.32	20.76	19.33	21.51
08/05/2015	11.64	16.21	20.48	20.47	19.18	21.50
08/06/2015	11.40	16.45	20.65	20.25	19.11	21.38
08/07/2015	12.03	16.78	20.62	20.17	19.73	21.21
08/08/2015	12.02	16.34	20.60	19.90	19.63	21.07
08/09/2015	11.41	16.23	20.53	19.72	19.72	21.12

Electrical Conductivity (EC) units: milliSiemens per Centimeter
mht : mean high tides
NR : No Record
NC : Not Computed due to insufficient data
BR : Below Rating
e : estimated value

Compliance Standards

for the Sacramento - San Joaquin Delta and Suisun Marsh
Tuesday, September 01, 2015

Criteria	Standard	Status
Flow/Operational		
% of inflow diverted	65 %	50 %
NDOI, monthly average *	>= 3,000 cfs	2,592 cfs
NDOI, 7 day average*	>= 2,000 cfs	2,592 cfs
Rio Vista flow, monthly average *	>=2,500	3,269 cfs
Rio Vista flow, 7 day average*	>= 2,000	3,269 cfs
Water Quality		
Days @ CCWD PP#1 w/ chlorides <= 150 mg/l	155 days	124 days
Export Areas for SWP, CVP, CCWD, et al	<= 250 mg/l Cl	161 mg/l
Maximum 30 day running average of mean daily EC at:		
Vernalis	<=1.0 mS/cm	0.6 mS/cm
Brandt Bridge	<=1.0 mS/cm	1.0 mS/cm
Old River Near Tracy	<=1.0 mS/cm	1.0 mS/cm
Old River Near Middle River	<=1.0 mS/cm	1.1 mS/cm

SUISUN MARSH:

Suisun Marsh Salinity Control Gates : 0 Open / 0 Closed / 3 Full Tide Open
Flashboard Status : In   Boat Lock Status : Closed

California Hydrologic Conditions: (California Cooperative Snow Surveys Forecast, May 1, 2015)

Previous Month's Index (8RI for Apr): 766 TAF
Sacramento valley water year type index (40/30/30) @ 50%: 4.0 MAF (Critical)
San Joaquin valley water year type index (60/20/20) @ 75%: 0.7 MAF (Critical)

Electrical Conductivity (EC) in milliSiemens per Centimeter.
Chlorides (Cl) in milligrams per liter
mht - mean high tides
md - mean daily
14 dm - fourteen day running mean
NR - No Record
NC - Not Computed due to insufficient data
BR : Below Rating
e - estimated value

Montezuma Slough Gate Operation:
Number of gates operating at either Open, Closed, or Full Tide Open
Flashboard Status : In, Out, or Modified In
Boat Lock Status : Open or Closed

Coordinated Operation Agreement Delta Status:
c = excess Delta conditions
b = balanced Delta conditions
r = excess Delta conditions with restrictions:

* NDOI, Rio Vista & Vernalis Flows and Suisun Marsh mhtEC:
- 7 day average is progressive daily mean for the first six days of the month.
- Monthly average is progressive daily mean from the beginning of the month

Delta Water Quality Conditions

Date	Antioch Tides		Net Delta Outflow Index	Martinez	Port Chicago		Mallard	Chipps Island		Collinsville	
	High	Half	cfs	mdEC	mdEC	14dm	mdEC	mdEC	14dm	mdEC	14dm
08/03/2015	6.45	4.61	3,638	30.09	18.88	20.04	16.59	16.79	15.77	11.57	10.93
08/04/2015	6.11	4.41	3,725	30.46	17.23	19.81	15.68	15.77	15.83	10.89	10.97
08/05/2015	6.17	4.20	3,653	29.30	16.44	19.64	14.60	14.57	15.77	9.98	10.94
08/06/2015	6.39	4.30	3,947	28.88	16.66	19.49	14.35	14.30	15.76	9.80	10.95
08/07/2015	6.58	4.51	3,790	30.04	19.55	19.43	15.66	15.75	15.91	10.92	11.08
08/08/2015	6.57	4.50	3,888	30.34	16.79	19.19	15.59	15.67	16.02	11.08	11.18
08/09/2015	6.65	4.50	3,821	29.92	17.01	19.04	15.04	15.06	16.00	10.66	11.18
08/10/2015	6.54	4.51	3,877	30.74	22.23	19.40	15.63	15.71	16.04	10.93	11.27
08/11/2015	6.66	4.51	3,605	30.32	18.75	19.37	15.32	15.38	16.05	10.77	11.29
08/12/2015	6.53	4.34	3,551	29.93	19.80	19.22	14.65	14.63	15.95	10.23	11.21
08/13/2015	6.37	4.37	3,804	30.04	17.92	18.82	14.77	14.76	15.74	10.23	11.03
08/14/2015	6.32	4.25	3,745	29.53	17.02	18.42	14.44	14.40	15.52	9.68	10.81
08/15/2015	6.06	4.08	3,714	29.05	15.81	18.01	13.56	13.44	15.24	9.12	10.57
08/16/2015	5.89	4.11	3,505	28.80	18.40	18.03	13.75	13.64	14.99	8.91	10.34
08/17/2015	5.91	4.34	2,964	29.18	16.82	17.89	14.54	14.51	14.83	9.92	10.22
08/18/2015	6.00	4.63	2,529	30.55	16.67	17.85	15.94	16.06	14.85	11.23	10.25
08/19/2015	5.95	4.51	1,700	30.51	19.30	18.05	15.93	16.05	14.96	11.31	10.34
08/20/2015	6.05	4.45	1,966	30.63	18.03	18.15	15.31	15.36	15.03	10.94	10.42
08/21/2015	6.14	4.48	2,133	30.40	20.20	18.20	15.03	15.06	14.98	10.66	10.40
08/22/2015	6.24	4.47	1,887	29.80	19.08	18.36	14.85	14.85	14.92	10.34	10.35
08/23/2015	6.25	4.48	2,313	94.36	18.61	18.47	14.71	14.70	14.90	10.24	10.32
08/24/2015	6.34	4.45	2,584	30.65	16.25	18.05	14.36	14.31	14.80	10.16	10.27
08/25/2015	6.49	4.46	2,754	30.75	18.17	18.01	14.19	14.13	14.71	9.84	10.20
08/26/2015	6.34	4.39	3,196	30.79	18.73	17.93	14.12	14.04	14.67	9.87	10.17
08/27/2015	6.49	4.32	3,231	29.86	16.41	17.82	14.04	13.96	14.61	9.55	10.13
08/28/2015	6.55	4.36	1,613	29.94	17.07	17.82	14.52	14.49	14.62	9.89	10.14
08/29/2015	6.62	4.38	1,731	30.25	19.65	18.10	14.92	14.93	14.72	10.50	10.24
08/30/2015	6.38	4.31	1,693	29.75	17.16	18.01	15.30	15.35	14.84	10.60	10.36
08/31/2015	6.14	4.28	1,645	29.97	15.01	17.88	15.44	15.51	14.92	10.59	10.41
09/01/2015	6.27	4.44	2,592	30.46	18.32	18.00	16.01	16.14	14.92	11.18	10.40

Antioch Tides measured in feet relative to the NAVD88 Datum
Net Delta Ouflow Index calculated from equation as specified in D-1641, revised March 2000.
Chipps Island EC calculated from measurements recorded at Mallard Slough.
Electrical Conductivity (EC) units: milliSiemens per Centimeter
md : mean daily
14dm : fourteen day running mean
NR : No Record
NC : Not Computed due to insufficient data
BR : Below Rating
e - estimated value

Delta Water Quality Conditions

Date	Antioch		Jersey Point		Emmaton		Three Mile Slough		San Andreas Landing		Terminous	
	mdEC	14dm	mdEC	14dm	mdEC	14dm	mdEC	14dm	mdEC	14dm	mdEC	14dm
08/03/2015	6.96	6.61	1.97	1.83	5.51	4.31	3.17	2.49	0.56	0.61	0.14	0.14
08/04/2015	6.56	6.65	1.80	1.84	4.81	4.39	2.73	2.54	0.51	0.61	0.14	0.14
08/05/2015	6.06	6.63	1.60	1.84	3.83	4.41	2.27	2.55	0.53	0.60	0.15	0.14
08/06/2015	6.18	6.63	1.64	1.84	3.57	4.44	2.25	2.58	0.59	0.60	0.15	0.14
08/07/2015	7.01	6.72	1.96	1.87	4.05	4.54	2.42	2.65	0.66	0.61	0.15	0.14
08/08/2015	6.93	6.78	1.97	1.89	4.24	4.62	2.47	2.71	0.63	0.61	0.15	0.14
08/09/2015	6.47	6.78	1.75	1.90	3.99	4.64	2.32	2.73	0.60	0.61	0.15	0.14
08/10/2015	6.76	6.81	1.83	1.90	4.47	4.68	2.63	2.75	0.59	0.60	0.15	0.14
08/11/2015	6.56	6.81	1.76	1.90	4.43	4.71	2.60	2.76	0.59	0.60	0.14	0.14
08/12/2015	6.27	6.76	1.70	1.90	3.95	4.65	2.23	2.72	0.59	0.60	0.15	0.15
08/13/2015	6.31	6.68	1.80	1.86	3.65	4.53	2.11	2.64	0.61	0.59	0.15	0.15
08/14/2015	6.08	6.59	1.74	1.83	3.54	4.38	1.95	2.55	0.61	0.59	0.15	0.15
08/15/2015	5.56	6.48	1.60	1.80	2.96	4.19	1.77	2.44	0.56	0.59	0.15	0.15
08/16/2015	5.62	6.38	1.50	1.76	3.21	4.01	1.97	2.35	0.54	0.58	0.15	0.15
08/17/2015	6.03	6.32	1.55	1.73	3.58	3.88	2.19	2.28	0.56	0.58	0.15	0.15
08/18/2015	6.65	6.32	1.76	1.72	4.43	3.85	2.60	2.27	0.61	0.59	0.15	0.15
08/19/2015	6.44	6.35	1.74	1.73	4.39	3.89	2.62	2.29	0.57	0.59	0.16	0.15
08/20/2015	6.04	6.34	1.67	1.74	4.10	3.93	2.43	2.31	0.54	0.59	0.16	0.15
08/21/2015	6.04	6.27	1.64	1.71	4.01	3.92	2.29	2.30	0.54	0.58	0.17	0.15
08/22/2015	5.99	6.20	1.66	1.69	3.85	3.90	2.13	2.27	0.53	0.57	0.16	0.15
08/23/2015	6.17	6.18	1.60	1.68	3.70	3.88	2.07	2.25	0.53	0.57	0.16	0.15
08/24/2015	5.93	6.12	1.56	1.66	3.43	3.80	1.93	2.20	0.51	0.56	0.17	0.16
08/25/2015	5.59	6.05	1.49	1.64	3.19	3.71	1.79	2.15	0.49	0.56	0.17	0.16
08/26/2015	5.54	6.00	1.53	1.63	3.18	3.66	1.80	2.12	0.49	0.55	0.17	0.16
08/27/2015	5.37	5.93	1.48	1.61	3.22	3.63	1.78	2.09	0.48	0.54	0.17	0.16
08/28/2015	5.61	5.90	1.48	1.59	3.37	3.62	1.89	2.09	0.49	0.53	0.17	0.16
08/29/2015	6.16	5.94	1.62	1.59	3.58	3.66	2.13	2.11	0.50	0.53	0.16	0.16
08/30/2015	6.14	5.98	1.57	1.60	3.47	3.68	2.02	2.12	0.50	0.52	0.17	0.16
08/31/2015	6.15	5.99	1.55	1.60	3.39	3.66	1.92	2.10	0.50	0.52	0.19	0.17
09/01/2015	6.62	5.98	1.73	1.59	3.57	3.60	2.14	2.07	0.54	0.51	0.20	0.17

Electrical Conductivity (EC) units: milliSiemens per Centimeter
Chloride (Cl) units: milligrams per liter
md : mean daily
14dm : fourteen day running mean
NR : No Record
NC : Not Computed due to insufficient data
BR : Below Rating
e : estimated value

Delta Water Quality Conditions

Date	Bethel Island mdEC	Farrar Park mdEC	Holland Tract mdEC	Bacon Island mdEC	Contra Costa mdEC	Clifton Court mdEC	Tracy Pumping Plant mdEC	Antioch mdCl	Bacon Island mdCl	Contra Costa mdCl	Delta Status
08/03/2015	0.94	1.72	0.72	0.71	0.75	0.72	0.75	2,148	147	169	b
08/04/2015	0.93	1.66	0.71	0.70	0.75	0.72	0.75	2,019	146	167	b
08/05/2015	0.93	1.60	0.71	0.70	0.74	0.72	0.75	1,861	145	166	b
08/06/2015	0.91	1.59	0.72	0.70	0.74	0.72	0.75	1,900	144	166	b
08/07/2015	0.91	1.68	0.73	0.69	0.74	0.72	0.75	2,164	143	167	b
08/08/2015	1.01	1.72	0.73	0.69	0.74	0.71	0.74	2,138	143	164	b
08/09/2015	0.97	1.70	0.73	0.69	0.74	0.71	0.74	1,990	143	163	b
08/10/2015	0.95	1.69	0.73	0.69	0.74	0.71	0.74	2,084	143	165	b
08/11/2015	0.94	1.66	0.72	0.69	0.73	0.70	0.74	2,021	143	161	b
08/12/2015	0.94	1.64	0.74	0.69	0.73	0.70	0.73	1,928	143	161	b
08/13/2015	0.95	1.65	0.73	0.69	0.73	0.71	0.73	1,940	143	169	b
08/14/2015	0.96	1.64	0.73	0.69	0.72	0.72	0.73	1,868	143	162	b
08/15/2015	0.95	1.57	0.73	0.69	0.72	0.73	0.74	1,700	143	156	b
08/16/2015	0.94	1.52	0.73	0.69	0.72	0.73	0.74	1,720	143	160	b
08/17/2015	0.93	1.51	0.72	0.69	0.72	0.73	0.74	1,851	144	162	b
08/18/2015	0.94	1.56	0.72	0.69	0.72	0.73	0.74	2,047	143	159	b
08/19/2015	1.02	1.59	0.71	0.69	0.72	0.72	0.74	1,983	143	157	b
08/20/2015	0.98	1.56	0.70	0.69	0.72	0.72	0.74	1,854	142	157	b
08/21/2015	0.93	1.57	0.69	0.69	0.72	0.72	0.74	1,852	142	160	b
08/22/2015	0.95	1.59	0.69	0.69	0.72	0.72	0.72	1,836	141	161	b
08/23/2015	0.98	1.60	0.68	0.68	0.72	0.71	0.72	1,894	141	161	b
08/24/2015	0.99	1.60	0.68	0.68	0.71	0.75	0.72	1,818	140	161	b
08/25/2015	0.97	1.57	0.69	0.68	0.71	0.72	0.72	1,711	140	163	b
08/26/2015	0.96	1.53	0.68	0.68	0.71	0.71	0.71	1,693	140	160	b
08/27/2015	0.96	1.50	0.69	0.68	0.71	0.71	0.71	1,639	139	162	b
08/28/2015	0.95	1.46	0.69	0.68	0.71	0.70	0.70	1,716	139	165	b
08/29/2015	0.95	1.48	0.71	0.66	0.71	0.69	0.69	1,891	135	165 e	b
08/30/2015	0.95	1.50	0.70	0.66	0.71	0.68	0.69	1,886	134	165 e	b
08/31/2015	0.96	1.50	0.67	0.65	0.71	0.67	0.68	1,890	132	162	b
09/01/2015	0.95	1.54	0.69	0.64	0.70	0.67	0.68	2,038	130	161	b

Electrical Conductivity (EC) units: milliSiemens per Centimeter
Chloride (Cl) units: milligrams per liter
md : mean daily
NR : No Record
NC : Not Computed due to insufficient data
BR : Below Rating
e : estimated value
Antioch and Bacon Island mdCl are calculated from the respective mdEC values.

Coordinated Operation Agreement Delta Status:
c = excess Delta conditions
b = balanced Delta conditions
r = excess Delta conditions with restrictions:

Delta Water Quality Conditions

South Delta Stations

Date	Vernalis		Brandt Bridge		Old River Near Tracy		Old River Near Middle River	
	mdEC	30dm	mdEC	30dm	mdEC	30dm	mdEC	30dm
08/03/2015	0.45	0.67	1.09	1.10	0.96	0.97	1.09	1.12
08/04/2015	0.54	0.67	1.08	1.09	0.98	0.97	1.09	1.11
08/05/2015	0.55	0.66	1.07	1.09	1.00	0.97	1.08	1.11
08/06/2015	0.66	0.66	1.06	1.09	1.09	0.97	1.08	1.11
08/07/2015	0.69	0.65	1.07	1.08	1.16	0.98	1.08	1.11
08/08/2015	0.68	0.65	1.07	1.08	1.13	0.98	1.08	1.10
08/09/2015	0.61	0.65	1.05	1.08	1.06	0.99	1.08	1.10
08/10/2015	0.61	0.65	1.05	1.08	0.98	0.99	1.09	1.10
08/11/2015	0.68	0.65	1.04	1.08	0.97	0.99	1.09	1.10
08/12/2015	0.49	0.65	1.03	1.07	0.97	0.99	1.10	1.10
08/13/2015	0.49	0.65	1.01	1.07	0.99	0.99	1.11	1.10
08/14/2015	0.50	0.65	0.99	1.07	1.02	1.00	1.12	1.10
08/15/2015	0.52	0.64	0.95	1.06	1.00	1.00	1.12	1.10
08/16/2015	0.53	0.64	0.92	1.06	1.01	1.00	1.12	1.10
08/17/2015	0.58	0.63	0.91	1.05	1.01	1.00	1.13	1.10
08/18/2015	0.65	0.63	0.92	1.05	0.99	1.00	1.13	1.10
08/19/2015	0.63	0.63	0.92	1.04	0.97	1.00	1.13	1.10
08/20/2015	0.74	0.62	0.91	1.04	0.94	1.00	1.14	1.11
08/21/2015	0.58	0.62	0.91	1.03	0.91	1.00	1.14	1.11
08/22/2015	0.45	0.61	0.91	1.03	0.91	1.00	1.14	1.11
08/23/2015	0.42	0.61	0.91	1.02	0.92	0.99	1.14	1.11
08/24/2015	0.36	0.61	0.90	1.01	0.94	0.99	1.14	1.11
08/25/2015	0.42	0.60	0.89	1.01	0.96	0.99	1.15	1.11
08/26/2015	0.46	0.59	0.89	1.00	0.96	0.98	1.15	1.11
08/27/2015	0.53	0.57	0.88	1.00	0.96	0.98	1.15	1.11
08/28/2015	0.75	0.57	0.88	0.99	0.96	0.98	1.13	1.11
08/29/2015	0.75	0.56	0.88	0.98	0.98	0.98	1.05	1.11
08/30/2015	0.80	0.57	0.89	0.98	0.99	0.99	0.96	1.11
08/31/2015	0.60	0.57	0.89	0.97	1.00	0.99	0.92	1.10
09/01/2015	0.56	0.58	0.89	0.96	0.99	0.99	0.91	1.09

Electrical Conductivity (EC) units: milliSiemens per Centimeter
md : mean daily
30dm : thirty day running mean
NR : No Record
NC : Not Computed due to insufficient data
BR : Below Rating
e : estimated value

Delta Water Quality Conditions

Suisun Marsh Stations

Date	Collinvsille mhtEC	National Steel mhtEC	Beldon Landing mhtEC	Sunrise Club mhtEC	Volanti Slough mhtEC	Goodyear Slough mhtEC
08/03/2015	12.77	16.59	20.11	21.00	19.58	21.45
08/04/2015	12.03	16.18	20.32	20.76	19.33	21.51
08/05/2015	11.64	16.21	20.48	20.47	19.18	21.50
08/06/2015	11.40	16.45	20.65	20.25	19.11	21.38
08/07/2015	12.03	16.78	20.62	20.17	19.73	21.21
08/08/2015	12.02	16.34	20.60	19.90	19.63	21.07
08/09/2015	11.41	16.23	20.53	19.72	19.72	21.12
08/10/2015	12.04	16.04	20.45	19.60	19.72	21.09
08/11/2015	11.66	16.58	20.59	19.48	19.70	21.07
08/12/2015	11.57	16.63	20.68	19.24	19.56	21.17
08/13/2015	11.21	16.67	20.78	19.03	19.59	21.13
08/14/2015	10.70	16.46	20.72	18.81	19.62	20.95
08/15/2015	9.71	16.85	20.60	18.69	19.53	20.93
08/16/2015	9.45	16.79	20.65	18.60	19.43	20.65
08/17/2015	10.27	17.45	20.56	18.47	19.54	20.27
08/18/2015	12.41	17.53	20.45	18.48	19.49	19.50
08/19/2015	12.04	16.50	20.53	18.40	19.49	19.39
08/20/2015	11.78	16.05	20.75	18.48	19.89	19.49
08/21/2015	11.58	15.09	20.59	18.52	19.98	19.70
08/22/2015	10.83	14.24	20.42	18.51	19.81	20.01
08/23/2015	10.82	13.85	20.35	18.70	19.50	20.23
08/24/2015	10.80	13.31	20.24	18.63	18.78	20.50
08/25/2015	10.73	13.47	20.13	18.75	18.58	20.66
08/26/2015	11.23	13.09	20.81	18.65	18.42	20.68
08/27/2015	10.65	13.60	20.81	18.64	18.38	20.71
08/28/2015	11.42	12.87	20.79	18.67	18.35	20.58
08/29/2015	12.20	8.98	20.18	18.55	18.80	20.45
08/30/2015	12.73	8.80	18.38	18.07	18.73	20.31
08/31/2015	13.08	8.83	15.74	17.22	17.28	20.25
09/01/2015	13.11	8.99	13.57	16.10	15.24	19.95

Electrical Conductivity (EC) units: milliSiemens per Centimeter
mht : mean high tides
NR : No Record
NC : Not Computed due to insufficient data
BR : Below Rating
e : estimated value

Appendix 1D

Comments from Interest Groups and Responses

This section contains copies of comment letters from interest groups on the Draft Environmental Impact Statement (EIS) for the Coordinated Long-term Operation of the Central Valley Project (CVP) and State Water Project (SWP). Each comment in the comment letters was assigned a number, in sequential order. The numbers were combined with the name of the interest group (example: AA 1). The comments with the associated responses are arranged alphabetically by interest group name, and appear in the chapter in that order.

Copies of the comments are provided in Section 1D.1. Responses to each of the comments follow the comment letters, and are numbered in accordance with the numbers assigned in the letters.

Large attachments included with letters from AquAlliance; California Water Impact Network and California Sportfishing Protection Alliance; Natural Resources Defense Council and The Bay Institute; and North Coast Rivers Alliance are provided in Section 1D.2.

1D.1 Comments and Responses

The interest groups listed in Table 1D.1 provided comments on the Draft EIS.

Table 1D.1 Interest Groups Providing Comments on the Draft Environmental Impact Statement

Acronym	Commenter
AA	AquAlliance
CFBF	California Farm Bureau Federation
CSD	Coalition for a Sustainable Delta
CWIN	California Water Impact Network
CWIN - CSPA	California Water Impact Network and California Sportfishing Protection Alliance
CESAR	The Center for Environmental Science Accuracy and Reliability
EWC 1	Environmental Water Caucus
EWC 2	Environmental Water Caucus
FOTR	Friends of the River
GGSA-PC	Golden Gate Salmon Association and Pacific Coast Federation of Fishermen’s Association
NRDC-TBI	Natural Resources Defense Council and The Bay Institute
NCRA	North Coast Rivers Alliance
Restore the Delta	Restore the Delta
SVWA	South Valley Water Association
SWC	State Water Contractors

1D.1.1 AquAlliance

AQUALLIANCE
DEFENDING NORTHERN CALIFORNIA WATERS

September 29, 2015

Ben Nelson, Natural Resources Specialist
Bureau of Reclamation, Bay-Delta Office
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Sacramento, CA 95814-2536
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(916) 414-2439 fax

Re: Comments on the Bureau of Reclamation's *Coordinated Long-Term Operation of the Central Valley Project and State Water Project* Draft Environmental Impact Statement.

Dear Mr. Nelson:

AquAlliance submits the following comments and questions on the Bureau of Reclamation's *Coordinated Long-Term Operation of the Central Valley Project and State Water Project* ("Project") Draft Environmental Impact Statement ("DEIS"). This National Environmental Policy Act ("NEPA") analysis was ordered by the United States District Court for the Eastern District because the Bureau of Reclamation hadn't analyzed direct, indirect and cumulative impacts from Central Valley Project ("CVP") and State Water Project ("SWP") ("Projects") while implementing the 2008 Fish and Wildlife Service ("FWS") Biological Opinion ("BO") and a 2009 National Marine Fisheries Service ("NMFS") BO. AA 1

AquAlliance exists to sustain and defend northern California waters. We have participated in CVP and SWP water transfer processes, commented on past transfer documents, commented on the Bureau of Reclamation ("Bureau") and Department of Water Resources ("DWR") ("Agencies") Temporary Urgency Change Petitions, commented on the DEIS/EIR for the Bay Delta Conservation Plan ("BDCP"), and sued the Bureau three times in the last five years. In doing so we seek to protect the Sacramento River's watershed in order to sustain family farms and communities, enhance Delta water quality, protect creeks and rivers, native flora and fauna, vernal pools and recreational opportunities, and to participate in planning locally and regionally for the watershed's long-term future.

The *Coordinated Long-Term Operation of the Central Valley Project and State Water Project* is seriously deficient and should be withdrawn. If the Bureau is determined to pursue operations that are as or more damaging to Sacramento Valley and Delta communities, groundwater dependent farmers, and the environment as has occurred under the No Action Alternative (current AA 2 operations), the Bureau must prepare a DEIS that truly discloses the damage the Projects have inflicted on California. AA 2 continued

This letter relies significantly on, references, and incorporates by reference as though fully stated herein, for which we expressly request that a response to each comment contained therein be provided, the following comments submitted here by AquAlliance: AA 3

- Custis, Kit H., 2014. Comments and recommendations on U.S. Bureau of Reclamation and San Luis & Delta-Mendota Water Authority Draft Long-Term Water Transfer DRAFT EIS/EIR, Prepared for AquAlliance.
- ECONorthwest, 2014. Critique of Long-Term Water Transfers Environmental Impact Statement/Environmental Impact Report Public Draft, Prepared for AquAlliance.
- Mish, Kyran D., 2014. Comments for AquAlliance on Long-Term Water Transfers Draft EIR/EIS.
- Cannon, Tom, Comments on Long Term Transfers EIR/EIS, Review of Effects on Special Status Fish. Prepared for California Sportfishing Protection Association.

In addition, we renew the following comments previously submitted, attached hereto, as fully bearing upon the presently proposed project and request: AA 4

- *2009 Drought Water Bank* ("DWB").
- *2010-2011 Water Transfer Program.*
- *2013 Water Transfer Program.*
- *2014 Water Transfer Program.*
- C-WIN, CSPA, AquAlliance Comments and Attachments for the Bay Delta Conservation Plan's EIS/EIR.
- AquAlliance's comments on the Bay Delta Conservation Plan's EIS/EIR.
- CSPA's comments on the Bay Delta Conservation Plan's EIS/EIR.
- CSPA's comments on this DEIS for the *Coordinated Long-Term Operation of the Central Valley Project and State Water Project* AA 5

I. The DEIS Contains an Inadequate Project Description.

NEPA requires an accurate and consistent project description in order to fulfill its purpose of allowing informed decision-making. 43 u.s.c. s 4332(2)(c). Without a complete and accurate description of the project and all of its components, an accurate environmental analysis is not possible. *See, e.g.*, *Blue Mountains Biodiversity Project v. United States Forest Service*, 161 F.3d 1208, 1215 (9th Cir. 2008). AA 6

<u>The Project Description Contains an Inadequate Statement of Objectives, Purpose, and Need.</u>

The lack of a stable project description and proposed alternative obfuscates the need for and impacts from the Project. The importance of this section in a NEPA document can't be overstated. "It establishes why the agency is proposing to spend large amounts of taxpayers' money while at the same time causing significant environmental impacts… As importantly, the project purpose and need drives the process for alternatives consideration, in-depth analysis, and ultimate selection. The Council on Environmental Quality (CEQ) regulations requires that the EIS address the "no-action" alternative and "rigorously explore and objectively evaluate all reasonable alternatives." Furthermore, a well-justified purpose and need is vital to meeting the requirements of Section 4(f) (49 U.S.C. 303) and the Executive Orders on Wetlands (E.O. 11990) and Floodplains (E.O. 11988) and the Section 404(b)(1) Guidelines. Without a well-defined, well-established and well justified purpose and need, it will be difficult to determine which alternatives are reasonable, prudent and practicable, and it may be impossible to dismiss the no-build alternative" [1] AA 6 continued

The DEIS fails to fully inform the public due to the omissions in the DEIS of recently past and current operations that would explain the No Action Alternative. For example, the joint operations in the last two years have operated outside state and federal laws as presented in the Temporary Urgency Change Petitions sought by the Agencies. Fish were slaughtered in 2014 while the Agencies operated outside water quality and flow requirements with the approval of the State Water Resources Control Board ("SWRCB").[2] AA 7

<u>The Project Description Lacks Detail Necessary for Full Environmental Analysis.</u> AA 8

The operation of the CVP and SWP were intended to be contingent on lawful acts, but the Projects have so seriously stepped outside the boundaries of contract and environmental laws that the ability to have a stable Project description in the DEIS is impossible. Of the many possible examples, two of the most current instances that severely alter the Project and are not disclosed in the DEIS are the Firebaugh Canal Water District v. the United States of America settlement and the 2014 and 2015 Temporary Urgency Change petitions and orders. Without full disclosure of 1) the ramifications of a settlement that provides a secure water delivery to a junior CVP claimant south of the Delta with an unknown ability, commitment, and timeframe to manage its polluted drainage and 2) the inability of the Projects to plan for and manage dry years in California without Temporary Urgency Change petitions and orders that have and are currently destroying public trust resources, the DEIS is meaningless. The DEIS must not only describe what is on paper for CVP and SWP operations, but what is actually happening on the ground, as it were, that follows and deviates, sometimes significantly, from plans, programs, and the law. AA 9

<u>The Project Description does Not Include all Project Components.</u>

i. The Bureau Fails to Disclose Significant Past, Present, and Future Streamflow Depletion AA 10

Streamflow depletion is only mentioned once in the DEIS. This deficiency strikes at the core of our critique, which views the CVP and the SWP as once operating within the law, albeit with more water on paper than could ever be available, until the limits of hydrology caused the Agencies and some of their contractors to look for tools to game the law – and the hydrology - of California. The CVP and SWP have extended water far from the areas of origin for agricultural, urban, and

[1] Federal Transportation and Highway Administration, 1990. *NEPA and Transportation Decisionmaking: The Importance of Purpose and Need in Environmental Documents.* http://www.environment.fhwa.dot.gov/projdev/tdmneed.asp

[2] California Sportfishing Protection Alliance et al., 2015.Protest –(Petitions) Objection Petition for Reconsideration Petition for a Hearing, (p. 3).

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industrial uses. In so doing, particularly with paper water, the state and federal governments have facilitated a destructively unrealistic demand for water. Ever willing to destroy natural systems to meet demand for profit, the San Joaquin River dried up and subsidence caused by groundwater depletion in the San Joaquin Valley is even cracking water conveyance facilities.[3] Enter conjunctive use where the Agencies facilitate and their contractors implement river water sales and pump groundwater to continue crop production. The continual, long-term groundwater overdraft in the San Joaquin Valley, the expansion of new permanent crops in both the San Joaquin and Sacramento valleys, and groundwater substitution transfers by CVP and SWP contractors *all* cause streamflow depletion (also see Groundwater Section below). Failing to disclose how the CVP and SWP cause streamflow depletion is a major omission that must be corrected and included in a recirculated DEIS. AA 10 continued

ii. Historic Flow Data are Not Disclosed

In providing an "[o]verview of hydrologic conditions in the Trinity River and Central Valley watersheds," the DEIS fails to provide actual, historic flow data. (p.5-14) There are broad descriptions of infrastructure, capacities, and mean daily flows in Chapter 5, but no mention of historic ranges of flow above or below dams. Additionally, the maps provided in the section *Surface Water Resources and Water Supply Figures* fail to identify towns that are used for geographic identification such as Douglas City. AA 11

iii. Water Conservation History and Potential is Absent

The DEIS mentions that, "Water conservation is an integral part of water management in the study area," but fails to provide even a modicum of detail and analysis for the reader. (p. 5-58) The discussion ends in one paragraph without any reference to additional material in the DEIS. This is a serious omission that must be remedied in a recirculated draft EIS. AA 12

iv. Historic Water Transfer Background is Minimally Disclosed

"Water transfers also are an integral part of water management," is the introduction to water transfers on page 5-58, yet the discussion focuses on 2012 and 2013 with minimal detail and then lists a few long-term transfer approvals from 2008 forward. What this divulges is that they are an "integral part of water management," *now*. That water transfers have become so essential in the past decade forces an examination of the Projects' foundational assumptions, operations, and management, or, as some would say, mismanagement. (see Water Claims below). AA 13

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[3] Sneed, et al., 2012. Abstract: *Renewed Rapid Subsidence in the San Joaquin Valley, California*.
"The location and magnitude of land subsidence during 2006–10 in parts of the SJV were determined by using an integration of Interferometric Synthetic Aperture Radar (InSAR), Global Positioning System (GPS), and borehole extensometer techniques. Results of the InSAR measurements indicate that a 3,200-km^2 area was affected by at least 20 mm of subsidence during 2008–10, with a localized maximum subsidence of at least 540 mm. Furthermore, InSAR results indicate subsidence rates doubled during 2008. Results of a comparison of GPS, extensometer, and groundwater-level data suggest that most of the compaction occurred in the deep aquifer system, that the critical head in some parts of the deep system was exceeded in 2008, and that the subsidence measured during 2008–10 was largely permanent." Conference presentation at *Water for Seven Generations: Will California Prepare For It?*, Chico, CA.

AA 13 continued

The DEIS acknowledges that water transfers from the Sacramento Valley to south of the Delta began in earnest in 2001 and that up to 298,806 af were transferred between 2001 and 2012 – we assume the Bureau means this as an annual figure. (p. 5-58) However, only south-of-Delta transfers by Program are disclosed and for only two years: 2012 and 2013. Essential information is noticeably absent from the DEIS, such as:

- The Bureau, DWR, and individual water districts have claimed much of the transfer water market was "one-year," "short-term," or an "emergency." The serial and escalating nature of water transfers from the Sacramento Valley to south-of-Delta fit none of those descriptions. Examples of the kind of material that should be provided in the DEIS include:
  a. Environmental Assessment and Findings of No Significant Impact ("FONSI") for the *2008 Option and Forbearance Agreement Between Glenn-Colusa Irrigation District, San Luis & Delta-Mendota Water Authority and the United States Bureau of Reclamation, and Related Forbearance Program*. The proposed project planned to transfer Sacramento River water, up to 85,000 acre-feet (AF), in accordance with a forbearance program undertaken by Glenn Colusa Irrigation Project ("GCID") through voluntary crop idling or crop shifting (82,500AF), and to provide up to 2,500 acre-feet with groundwater substitution produced from two GCID-owned groundwater wells located near the western edge of Butte County. Final figures for this water sale and all other planned and actual sales in 2008 should be disclosed by contractor.
  b. Environmental Assessment and FONSI, *2009 Drought Water Bank*. The Bureau and 20 of its contractors planned to sell 199,885 af through a combination of crop idling, crop substitution, groundwater substitution, and reservoir reoperation. (Final FONSI pp. 2-3) "The cumulative total amount potentially transferred under the DWB from all sources would be up to 370,935 af." (*Id.* p. 10) However, DWR and the Bureau allowed up to a maximum 600,000 af .[4] Final figures for all planned and actual water sales in 2008 should be disclosed by contractor.
  c. Environmental Assessment and FONSI for the *2010-2011 Water Transfer Program*. 395,910 AF of CVP and non-CVP water. This should be disclosed and whatever amount of water was actually transferred. That AquAlliance sued over the inadequate Environmental Assessment should be noted.
  d. In 2012 and 2013 the DEIS discloses the amount of water that was actually transferred, but fails to reveal that significantly more water was planned for south-of-Delta transfers. This is a crucial point when considering a growing dependence on transfers as demand escalates and in analyzing cumulative impacts.
     i. Initiating Section 7 Consultation letter 2012. "For 2012 water transfers, Reclamation anticipates a maximum of approximately 76,000 acre-feet of water could be transferred. The 76,000 acre-feet of transfer water would be made available through groundwater substitution." (p. 2) The DEIS reveals that 47,420 af were actually transferred, but the uppermost potential for the 76,000 af transfer all from groundwater substitution combined with all other transfers is not disclosed and should be.

[4] DWR 2009. *Addendum to the Environmental Water Account Environmental Impact Statement/Environmental Impact Report.* http://www.usbr.gov/mp/nepa/nepa_projdetails.cfm?Project_ID=107

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   ii. The DEIS discloses that in 2013 63,790 af were transferred. The amount of water planned for transfer from all sources should also be disclosed.

e. The Bureau and the San Luis Delta Mendota Water Authority's ("SLDMWA") 2014 Environmental Assessment/Initial Study. Not disclosed in the DEIS is that, "The Proposed Action is for sellers to potentially make available up to 175,226 AF of water based on a 75 percent CVP water supply forecast for Settlement Contractors. Sellers could make water available for transfer through groundwater substitution, cropland idling, or crop shifting. Other transfers not involving the SLDMWA and its participating members could occur during the same time period. The Tehama Colusa Canal Authority (TCCA) released a separate EA/IS to analyze transfers from a very similar list of sellers to the TCCA Member Units." AquAlliance sued the Bureau over the inadequate EA/IS. This complete background information should be corrected in a revised and recirculated DEIS.

f. The Bureau and SLDMWA's *Environmental Impact Statement* and *Environmental Impact Report* for the 2015-2024 *Long Term North-to-South Water Transfer Program*. The DEIS mentions the 10-year water transfer program, but failed to disclose the uppermost amount of water that may be transferred: 600,000 af each year. Also lacking is that AquAlliance and partners sued over the inadequate EIS/EIR, which is moving forward.

- The Bureau should disclose how it and DWR began a Programmatic EIS to facilitate water transfers from the Sacramento Valley and the interconnected actions that are integrally related to it, but never completed that EIS and for years impermissibly broke out the annual transfers from the overall Program for piecemeal review as AquAlliance presents above. See 68 Federal Register 46218 (Aug 5, 2003) (promising a Programmatic EIS on these related activities, "include[ing] groundwater substitution in lieu of surface water supplies, conjunctive use of groundwater and surface water, refurbish existing groundwater extraction wells, install groundwater monitoring stations, install new groundwater extraction wells…" *Id.* At 46219. See also http://www.usbr.gov/mp/nepa/nepa_projdetails.cfm?Project_ID=788 (current Bureau website on *Short-term Sacramento Valley Water Management Program EIS/EIR*).

AA 14

Lastly, noticeably missing from the DEIS is also the Agencies involvement in funding infrastructure to expand water transfers. One example is the *U.S. Bureau of Reclamation September 2006 Grant Assistance Agreement with Glenn Colusa Irrigation District*. "GCID shall define three hypothetical water delivery systems from the State Water Project (Oroville), the Central Valley Project (Shasta) and the Orland Project reservoirs sufficient to provide full and reliable surface water delivery to parties now pumping from the Lower Tuscan Formation. The purpose of this activity is to describe and compare the performance of three alternative ways of furnishing a substitute surface water supply to the current Lower Tuscan Formation groundwater users to eliminate the risks to them of more aggressive pumping from the Formation and to optimize conjunctive management of the Sacramento Valley water resources." Disclosure of this and all other funding actions that are part of CVP and SWP operations must be presented in a revised and recirculated DEIS.

The Over Allocation of Water Claims is not Disclosed AA 15

The DEIS must describe existing water right claims of sellers, buyers, the Bureau, and DWR. Without this foundational background, the reviewer is unable to understand the Project. In response to inquiries from the Governor's Delta Vision Task Force, the SWRCB acknowledged that while average runoff in the Delta watershed between 1921 and 2003 was 29 million acre-feet annually, the 6,300 active water right permits issued by the SWRCB is approximately 245 million acre-feet [5] (pp. 2-3). In other words, **water rights on paper are 8.4 times greater than the real water in California's Central Valley rivers and streams diverted to supply those rights on an average annual basis.** And the SWRCB acknowledges that this 'water bubble' does not even take account of the higher priority rights to divert held by pre-1914 appropriators and riparian water right holders (*Id.* p. 1). More current research reveals that the average annual unimpaired flow in the Sacramento River basin is 21.6 MAF, but the consumptive use claims are an extraordinary 120.6 MAF – 5.6 times more claims than there is available water. [6] Informing the public about water rights claims would necessarily show that buyers and the Agencies clearly possess junior water rights as compared with those of many willing sellers. Full disclosure of these disparate water rights claims and their priority is needed to help explain the Project. Without it, the public and decision makers have insufficient information on which to support and make informed choices.

To establish a proper legal context for these water rights, the DEIS should also describe more extensively the applicable California Water Code sections about the treatment of water rights involved in water transfers.

Like federal financial regulators failing to regulate the shadow financial sector, subprime mortgages, Ponzi schemes, and toxic assets of our recent economic history, the Bureau and the State of California have been derelict in its management of scarce water resources. As we mentioned above we are supplementing these comments on this matter of wasteful use and diversion of water by incorporating by reference and attaching the 2011 complaint to the State Water Resources Control Board of the California Water Impact Network the California Sportfishing Protection Alliance, and AquAlliance on public trust, waste and unreasonable use and method of diversion as additional evidence of a systemic failure of governance by the State Water Resources Control Board, the Department of Water Resources and the U.S. Bureau of Reclamation, filed with the SWRCB on April 21, 2011.[7]

AA 16

II. Alternatives

The No Action Alternative is supposed to describe the current operations of the CVP and SWP ("Projects") in the last seven years that were to follow the Reasonable and Prudent Alternatives ("RPAs") from the Biological Opinions ("BOs"). (DEIR p. 3-3) Yet the species that were meant to

[5] SWRCB, 2008. Water Rights Within the Bay Delta Watershed

[6] California Water Impact Network, AquAlliance, and California Sportfishing Protection Alliance 2012. *Testimony on Water Availability Analysis for Trinity, Sacramento, and San Joaquin River Basins Tributary to the Bay-Delta Estuary.*

[7] C-WIN et al. 2011. Complaint, California Water Impact Network, AquAlliance, and California Sportfishing Protection Alliance v. SWRCB, DWR and Respondent Bureau of Reclamation.

AA 16 continued

be protected by the BOs are tipping into extinction due to the mismanagement of the Projects and the consistent waiver of requirements that have been sought by the Bureau and DWR and approved by the State Water Resources Control Board ("SWRCB") in temporary urgency change orders.[8] [9]

AA 17

- Alternative 1 would eliminate RPA actions that would not otherwise occur without the RPA's, and revert to operations and flow requirements that existed prior to issuance of the BOs. However, it would retain non-operational RPA requirements that have already been implemented or are in the process of being implemented. Alternative 1 also predicts, "Long-term average annual exports would be 1,051 TAF (22 percent) more …" (DEIS p. 3-60)

- Alternative 2 would eliminate a series of physical measures included in the RPA's, including fish passage at CVP dams, temperature improvements at CVP dams on the American River, actions to reduce entrainment at CVP and SWP export facilities, and others. (DEIS p. 3-32)

- Alternative 3 would eliminate RPA actions that would not otherwise occur without the RPA's. It would weaken Old and Middle River (OMR) export restrictions from the present restrictions in the BOs, implement a suite of actions on the Stanislaus River that substantially reduce flow requirements and establish a "predator control program," trap and haul salmonid out-migrants in the San Joaquin River from March through June, and reduce ocean harvest of salmon.

- Alternative 4 would eliminate RPA actions that would not otherwise occur without the RPA's. It would limit development in floodplains, replace levee riprap with vegetation, establish a "predator control program," trap and haul salmonid out-migrants in the San Joaquin River from March through June, and reduce ocean harvest of salmon.

- Alternative 5 would implement the RPA's and additionally require positive OMR flows in April and May. It would also require April and May pulse flows from the Stanislaus River, whose volume would be determined by water year type and the location of X2. (DEIS p. 3-42)

AA 18

As we explain throughout our comments, none of the alternatives, including the No Action Alternative are sufficient to avoid jeopardy to listed species or to protect other public trust resources consistent with applicable law. The Bureau must reject the Alternatives in the DEIS including the No Action Alternative and craft Project Alternatives that is fully compliant with the Endangered Species Act and fully protective of all public trust resources.

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[8] C-WIN et al. 2011. Complaint, California Water Impact Network, AquAlliance, and California Sportfishing Protection Alliance v. SWRCB, DWR and Respondent Bureau of Reclamation.
[9] The Bay Institute, 2015. Appendix to Temporary Urgency Change Protest, February 2015.

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III. Modeling

The Central Valley Hydrologic Model (CVHM) spans a 42-year simulation period starting in water year 1962. The model ends in 2003, which fails to account for current conditions, accelerating climate change conditions, and future conditions. On this basis alone the model is completely inadequate and any conclusions from the model are as well. (p. 7-110) It is impossible for the public to have any confidence in modeling results that are using such antiquated input data. Moreover, that "[C]alSIM outputs are included in the CVHM input files," exacerbates AquAlliance's concerns regarding the modeling as CalSIM's adequacy has repeatedly been called into question. [10] Just one of the many issues with CalSIM is the shocking assumption that, "Groundwater resources are assumed infinite, i.e., there is no upper limit to groundwater pumping." (*Id.* p. 8) AA 19

AA 20

We also question the heavy reliance on modeling when the Agencies have had decades of opportunity to gather and use actual stream and groundwater data. The DEIS relies only on modeling to consider impacts from the Project when it needs to compile and present results from actual monitoring and reporting prior to recirculating a revised DEIS.

<u>Climate Change</u>

AA 21

The DEIS discloses that, "A growing body of evidence indicates that Earth's atmosphere is warming. Records show that surface temperatures have risen about 0.7°C since the early twentieth century and that 0.5°C of this increase has occurred since 1978 (NAS 2006)." (p. 5A A-25). It acknowledges that, "Observed climate and hydrologic records indicate that more substantial warming has occurred since the 1970s and that this is likely a response to the increases in greenhouse gas (GHG) increases during this time." (*Id.*) Moreover, the DEIS reveals that, "The GCM [global climate models] simulations of historical climate capture the historical range of variability reasonably well (Cayan et al. 2009), but historical trends are not well captured in these models. Projections of future precipitation are much more uncertain than those for temperature." (*Id.*) One would think that the modeling weaknesses with historical trends and projections of future precipitation would cause alarm at the Bureau. What has prevented the Agencies from locating models with better predictability? Barring location of more proficient models, and in light of the devastating environmental impacts from current operation of the Projects,[11] [12] the Agencies must err on the side of caution and reject the Alternatives in the DEIS including the No Action Alternative and craft a Project Alternative that is fully compliant with the Endangered Species Act and fully protective of all public trust resources. AA 22

AA 23

The DEIS relates that, "Projected change in stream flow is calculated using the VIC macroscale hydrologic model. The use of the VIC model is primarily intended to generate changes in inflow magnitude and timing for use in subsequent CalSim II modeling. While the model contains several sub-grid mechanisms, the coarse grid scale should be noted when considering results and analysis of local-scale phenomena. The VIC model is currently best applied for the regional-scale

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[10] Close, A., et al, 2003. A Strategic Review of CALSIM II and its Use for Water Planning, Management, and Operations in Central California

[11] C-WIN et al. 2011. Complaint, California Water Impact Network, AquAlliance, and California Sportfishing Protection Alliance v. SWRCB, DWR and Respondent Bureau of Reclamation.

[12] The Bay Institute, 2015. Appendix to Temporary Urgency Change Protest, February 2015.

AA 23 continued

hydrologic analyses. There are several limitations to long-term gridded meteorology related to spatial-temporal interpolation due to limited availability of meteorological stations that provide data for interpolation. In addition, the inputs to the model do not include any transient trends in the vegetation or water management that may affect stream flows; they should only be analyzed from a "naturalized" flow change standpoint. Finally, the VIC model includes three soil zones to capture the vertical movement of soil moisture, but does not explicitly include groundwater. The exclusion of deeper groundwater is not likely a limiting factor in the upper watersheds of the Sacramento and San Joaquin river watersheds that contribute approximately 80 to 90 percent of the runoff to the Delta. However, in the valley floor, interrelation of groundwater and surface water management is considerable. Water management models such as CalSim II should be used to characterize the heavily "managed" portions of the system." (5A.A-38 to 5A A-39) This paragraph raises numerous concerns: 1) We appreciate that the DEIS disclosed some of the major limitations of the VIC model, but wonder what the Agencies intend to do to overcome the "the coarse grid scale" and "long-term gridded meteorology related to spatial-temporal interpolation" problems. This should be disclosed. 2) The DEIS dismisses that the VIC model "does not explicitly include groundwater" and asserts that it is not a limiting factor in the upper watersheds although "upper watershed" is not defined or illustrated in a map. The Bureau must elaborate further by describing where the upper watershed begins and ends and how ignoring all groundwater there is inconsequential. 3) The DEIS states that "CalSim II should be used to characterize the heavily "managed" portions of the system," without answering why this hasn't already happened. This should have preceded the DEIS. And again, we encourage the Bureau to seek a model other than CalSIM for all of the reasons presented above.

Lastly, what prevented the Bureau from using science from reputable sources such as Souymaya Belmecheri and colleagues who find that, "The exceptional character of the 2012-2015 drought has been revealed in millennium-length paleoclimate records…" and "The spring snowpack on mountains crucial to California's water supply reached its lowest level this year in half a millennium, according to a study published on 14 September in Nature Climate Change."[13] Not only does this demonstrate the importance of using more recent data than what the Bureau models used (e.g. CVHM ending in 2003), but the results should have significant bearing on the creation and analysis of alternatives.

Groundwater Storage Modeling

AA 24

A U.C. Davis Master's Thesis finds that the CVHM model used for the DEIS varies drastically from DWR's model, C2VSIM.[14] "As seen in the change in storage region totals at the bottom of Table 3.5, the differences are large in the Sacramento region, with CVHM showing overall gain to the groundwater storage and C2VSIM showing 12.4 MAF of overdraft." (*Id.* p. 34) Table 3.5 reveals that the CVHM model calculates an <u>increase in storage</u> for the Sacramento Valley of approximately 8.4 million acre-feet ("maf"), which when combined with the C2VSIM results becomes a difference of approximately 20.8 maf. (*Id.*) This is hardly a trivial matter when the Bureau is relying on a model that produces wildly different conclusions from its' SWP partner to

[13] Belmecheri, Soumaya et al., 2015. *Mid-Century evaluation of Sierra Nevada snowpack*. Correspondence. http://www.nature.com/news/california-snowpack-lowest-in-past-500-years-1.18345

[14] Chou, Heidi, 2010. *Groundwater Overdraft in California's Central Valley: Updated CALVIN Modeling Using Recent CVHM and C2VSIM Representations*. Table 3.5, p. 35.

AA 24 continued

determine impacts to about half of the entire state (most of the CVP facilities and service areas and all of the SWP facilities and service areas, DEIS p. 1-10)

IV. Groundwater

The Bureau Fails to Disclose Existing Groundwater Conditions in the Sacramento Valley AA 25

The DEIS provides limited groundwater elevation data of the Sacramento Valley groundwater basin in the Groundwater Resources and Groundwater Quality chapter. (pp. 7-1 to 7-184) The DEIS erroneously concludes that, "Overall, the Sacramento Groundwater Basin is approximately balanced with respect to annual recharge and pumping demand." (p. 7-14) Without defining "approximately balanced," the DEIS continues by stating, "However, there are several locations showing early signs of persistent drawdown, suggesting limitations due to increased groundwater use in dry years. Locations of persistent drawdown include: Glenn County, areas near Chico in Butte County, northern Sacramento County, and portions of Yolo County." (*Id.*) Unfortunately, the DEIS fails to elaborate through maps or text leaving the public without specific details.

AquAlliance's tables below cover 11 years and illustrate what could have been shared with the public in the DEIS. They show maximum and average groundwater elevation decreases for Butte, Colusa, Glenn, and Tehama counties, all the counties believed to overlie the Tuscan Aquifer, at three aquifer levels in the Sacramento Valley between the fall of 2004 and 2014.[15] These data contradiction numbers provided in Section 7.3, the Affected Environment, that provides windows of decline that are shorter, albeit mostly incorrect without the ending caveat, "[a]nd in some areas more than 10 feet." (p. 7-17) If the Bureau wanted to truly share significant shorter term data, they should disclose that maximum fall decreases for deep wells between 2013 and 2014 were 3.1 feet for Butte, 42.2 feet for Colusa, 26.9 feet for Glenn ,and 15.1 feet for Tehama – three counties significantly over 10 feet! (*Id.*)

County Fall '04 - '14	Deep Wells (Max decrease gwe)	Deep Wells (Avg. decrease gwe)
Butte	-12.7 (-11.4)*	-10.5 (-8.8)*
Colusa	-59.5 (-31.2)*	-59.5 (-20.4)*
Glenn	-79.7 (-60.7)*	-44.3 (-37.7)*
Tehama	-34.6 (-19.5)*	-10.9 (-6.6)*

County Fall '04 - '14	Intermediate Wells (Max decrease gwe)	Intermediate Wells (Avg. decrease gwe)
Butte	-23.0 (-21.8)*	-9.4 (-6.5)*
Colusa	-40.6 (-39.1)*	-22.6 (-16.0)*
Glenn	-57.2 (-40.2)*	-25.0 (-14.5)*
Tehama	-30.2 (-20.1)*	-12.4 (-7.9)*

[15] *Id.*

County Fall '04 - '14	Shallow Wells (Max decrease gwe)	Shallow Wells (Avg. decrease gwe)
Butte	-17.6 (-13.3)*	-5.9 (-3.2)*
Colusa	-36.7 (-20.9)*	-7.6 (-3.8)*
Glenn	-53.5 (-44.4)*	-15.1 (-8.1)*
Tehama	-30.2 (-15.7)*	-9.5 (-6.6)*

* 2004-2013 monitoring results are in parentheses for comparison.

AA 25 continued

Below are the results from DWR's spring monitoring for Sacramento Valley groundwater basin from 2004 to 2014. Monitoring from spring 2015 is still not available.

County Spring '04 - '14	Deep Wells (Max decrease gwe)	Deep Wells (Avg. decrease gwe)
Butte	-20.8 (-10.6)	-14.6 (-8.9)
Colusa	-26.9 (-10.5)	-12.6 (-7.1)
Glenn	-49.4 (-36.2)	-29.2 (-19.9)
Tehama	-6.1 (-4.7)	-5.3 (-4.2)

County Spring '04 - '14	Intermediate Wells (Max decrease gwe)	Intermediate Wells (Avg. decrease gwe)
Butte	-25.6 (-27.9)	-12.8 (-8.1)
Colusa	-49.9 (-24.6)	-15.4 (-7.4)
Glenn	-54.5 (-44.9)	-21.7 (-13.8)
Tehama	-16.2 (-16.5)	-7.9 (-8.8)

County Spring '04 - '14	Shallow Wells (Max decrease gwe)	Shallow Wells (Avg. decrease gwe)
Butte	-23.8 (-12.7)	-7.6 (-4.1)
Colusa	-25.3 (-11.0	-12.9 (-3.3)
Glenn	-46.5 (-23.9)	-12.6 (-8.3)
Tehama	-38.6 (-16.9)	-10.8 (-7.4)

* 2004-2013 monitoring results are in parentheses for comparison.

Despite the available material presented in our tables, Section 7.3.3.1.4, Lower Sacramento Valley (East of Sacramento River) concludes that, "The West Butte subbasin is located within Butte, Glenn, and Sutter counties. In the West Butte subbasin, groundwater levels declined during the 1976 to 1977 and 1987 to 1992 droughts, followed by a recovery in groundwater levels to pre-drought conditions of the early 1980s and 1990s (DWR 2004o, 2013a)." (p. 7-21) For the East Butte subbasin the DEIS asserts that, "In the southern part of Butte County, groundwater fluctuations for wells constructed in the confined and semi-confined aquifer system average 4 feet during normal years and up to 5 feet during drought years." All of this is contradicted by material compiled by Christina Buck, PhD in her February 2014 presentation *on Groundwater Conditions in Butte County*. Pages 18, 20, and 22 illustrate that wells have not recovered to pre-drought conditions, show a steady decline, and that fluctuations may be significantly more than 4 feet in normal years and 5 feet in drought years.

12

COMMENTS OF AQUALLIANCE FOR THE BUREAU OF RECLAMATION'S DEIS FOR THE *Coordinated Long-Term Operation of the Central Valley Project and State Water Project* (September 29, 2015)

1

AA 26

The Bureau acknowledges that its partner in coordination of the Projects, DWR, hasn't provided a comprehensive assessment of groundwater overdraft in California for 35 years! (DEIS p. 7-12) Undaunted by such a dearth of information, the DEIS suggest that _assumptions_ made by DWR in 2003 are a sufficient substitute for factual data today: "[o]verdraft is estimated at between 1 to 2 million acre-feet annually." (*Id.*) AquAlliance strenuously objects to the adequacy of this material that feigns as fact in the DEIS and raises the following conclusions and questions. 1) An *estimate* of a serious overdraft condition fails to provide the reviewer with accurate information. 2) If groundwater conditions are as serious or more so than the estimated 1 to 2 maf annually, this represents a devastating environmental impact that hasn't been analyzed as an impact in the DEIS. 3) No matter what the actual groundwater overdraft is in California, how do significant and continuing groundwater withdrawals by the Projects' contractors deplete current and future stream flow thereby escalating a cycle of hydrologic deficit (see section "The Bureau Fails to Analyze Significant Past, Present, and Future Streamflow Depletion" below)? Strikingly, nothing remotely touching on this critical hydrologic reality is presented or analyzed in the DEIS thereby making the document wholly deficient.

AA 27

Lastly, the DEIS continues a Bureau pattern by ignoring the importance of the Cascade Range to the hydrology of the Sacramento River and Valley, Cascade streams in this particular statement: "The hydrology of this area is dominated by numerous smaller drainages that originate in the Sierra Nevada and Coast Ranges and drain to the Sacramento River (DWR 2003a)." (p. 7-16) Please correct this.

AA 28

The Bureau Has Failed to Consider the Cumulative Impact of Other Groundwater Development and Surface Water Diversions Affecting the Sacramento Valley

See Cumulative Impact section below.

AA 29

Past CVP transfers allowed groundwater substitution and appear to violate CVPIA's mandate that any transfer have no significant impact on the seller's groundwater.

CVPIA Section 3405 (a)(l)(J) states that no transfer shall be approved unless it is determined that "such transfer will have no significant long-term adverse impacts on groundwater conditions in the transferor's service area." However, The DEIS fails to include an analysis of impacts to groundwater in the areas of origin participating in CVP and SWP water transfers. Therefore the DEIS makes no findings on impacts and proposes no mitigation to evaluate the actual effects on groundwater levels and subsequent measures to insure the long-term protection of the underlying basins. To comply with the provision of CVPIA, the Bureau will have to arrive at some level of certainty that groundwater substitution will not adversely affect the transferor's basin under current operations or the preferred alternative. Again, this must be developed and presented in a revised and recirculated DEIS.

Subsidence

AA 30

This is the only mention of subsidence in Chapter 7. "Land subsidence due to groundwater withdrawals historically occurred in the Yolo subbasin of the Sacramento Valley Groundwater Basin and Delta-Mendota and Westside subbasins of the San Joaquin Valley Groundwater Basin in the Central Valley Region; Santa Clara Valley Groundwater Basin in the San Francisco Bay

AA 30 continued

Area Region; and the Antelope Valley and Lucerne Valley groundwater basins in the Southern California Region. Under the No Action Alternative, it is anticipated that increased groundwater withdrawals due to reductions in CVP and SWP water supplies and reduced groundwater recharge due to climate change could result in increased irreversible land subsidence in these areas." (p. 7-117)

Even Appendix 7A just touches on subsidence that was modeled by CVHM, the model that spans a 42-year simulation period starting in water year 1962 and ends in 2003. As noted above, this eliminates the last 12 years and fails to account for current conditions and future conditions. The DEIS acknowledges another vulnerability: "The subsidence package, as implemented in the version of CVHM used for the impacts analysis, does not consider the potential reduction in the rate of subsidence that would occur as the magnitude of compaction approaches the physical thickness of the affected fine-grained interbeds. Thus, subsidence forecasts from the predictive versions of CVHM were judged to be overly conservative. Therefore, a qualitative approach was used for estimating the potential for increased land subsidence in areas of the Central Valley that have historically experienced inelastic subsidence because of the compaction of fine-grained interbeds." (pp. 7-112 and 7A-17). However, the Impact section of Chapter 7, Groundwater Resources and Groundwater Quality, provides nothing in the way of analysis. The conclusions are:

- "As described above and summarized in Table 7.3, implementation of Alternatives 1 through 5 as compared to the No Action Alternative would result in either similar or less groundwater pumping and potential for land subsidence; and similar groundwater quality conditions. Therefore, there would be no adverse impacts to groundwater; and no mitigation measures are needed." (p. 7-141)
- "However, implementation of No Action Alternative and Alternative 5 (in the Central Valley, San Francisco Bay Area, Central Coast, and Southern California regions) and Alternative 3 (in the San Francisco Bay Area, Central Coast, and Southern California regions) as compared to the Second Basis of Comparison would result in increased groundwater pumping and associated potential for land subsidence and poorer groundwater quality; and could contribute to cumulative impacts related to groundwater conditions as compared to the Second Basis of Comparison conditions." (pp. 7-142 and 7-143)

How were the conclusions reached, specifically? There is subsidence occurring right now and has for decades in some areas served by the Projects. To state that the No Action Alternative, "[w]ould result in either similar or less groundwater pumping and potential for land subsidence; and similar groundwater quality conditions," circumvents requirements of NEPA. Because impacts may be "similar" does not stop past, present or future direct and indirect impacts that require disclosure, avoidance, and/or mitigation. Even when the DEIS finds impacts (pp. 7-142 and 7-143), still there is no mitigation offered. This is another seriously deficient attempt at meeting NEPA requirements.

AA 31

The DEIS also fails to mention that DWR has a continuous global positioning system (GPS) network for periodic monitoring of changes in ground elevation. A baseline GPS survey was performed in 2004 and DWR and the Bureau conducted a second survey jointly in 2008.[16] Since these surveys aren't even mentioned in the DEIS, specific information on the results of the GPS

[16] Department of Water Resources and United State Bureau of Reclamation, 2008, Project Report, *2008 DWR/USBR Sacramento Valley GPS Subsidence Report, September 30, 2008*, 7 pp., Appendices A to F.

AA 31 continued

subsidence monitoring is also lacking. The Bureau's SWP partner, DWR, presented the results of the 2004 and 2008 GPS subsidence monitoring to the Glenn County Water Advisory Committee in February 2015, which identified an area of subsidence east of the GCID wells at an average of -0.38 feet.[17] Also absent from the DEIS is the potential impact from land subsidence due to the Glenn Colusa Irrigation District's past, current, and planned groundwater extraction in an already stressed groundwater basin[18] and that there are five extensometers near GCID's existing and planned wells in Glenn County. This is demonstrated in comments submitted by AquAlliance on GCID's 10-Wells EIR.[19] It is the lack of disclosure like this that requires the Bureau to revise and recirculate another Draft Environmental Impact Statement.

The Bureau Failed to Analyze Impacts to Groundwater Quality

AA 32

The DEIS extrapolates that many impacts could occur. For example, "Changes in groundwater quality could occur in several ways under implementation of the alternatives as compared to the No Action Alternative and Second Basis of Comparison. Reductions in groundwater levels could change groundwater flow directions, potentially causing poorer quality groundwater to migrate into areas with higher quality groundwater, or cause intrusion of poor water quality (e.g. from aquitards) as water levels decline." (p. 7-112)

While the DEIS suggests that analysis was conducted, there are no conclusions reached beyond those that are very general in nature as with the quoted section above. "Within the Central Valley, changes in groundwater use and groundwater flow direction are analyzed using the CVHM. The model does not directly simulate changes in groundwater quality. However, in regions with existing poorer quality groundwater, changes in groundwater levels or flow directions can be used to evaluate potential impacts to groundwater quality. For example, declines in groundwater levels that result in seawater intrusion, or the migration of good quality groundwater into areas with poor quality can result in groundwater quality degradation. Further, reduction in groundwater quality could also occur due to migration or upwelling of poorer quality groundwater into areas with good quality groundwater." (p. 7-113) With such ambiguous conclusions, the Bureau quite obviously finds that none of the Alternatives including the No Action Alternative would cause a significant impact, so no mitigation is offered.

How this is remotely possible fails to pass the blush test. The CVP alone has caused massive pollution in San Joaquin Valley groundwater. You don't need a model to know that. Is it the Bureau's belief that the groundwater is already so bad that any additional groundwater degradation would be minimal? Before a call of less than significance may be made the DEIS must first provide maps and data that disclose where known groundwater contamination exists, what are the MCLs for pollutants in those locations, and what activities that are part of CVP and SWP operations could exacerbate them. This should be done for all of the Project Area.

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[17] Ehorn, B., 2015, Letter to Glenn County Board of Supervisors, and Glenn County Water Advisory Committee, on results of 2004 to 2008 land subsidence GPS surveys performed in Glenn County, dated February 3, 2015, presented at February 10, 2015 Water Advisory Committee meeting, Willows, CA, 3 pp., 1 Figure.

[18] http://www.water.ca.gov/groundwater/data_and_monitoring/northern_region/GroundwaterLevel/gw_level_monitoring.cfm#Well%20Depth%20Summary%20Maps

[19] AquAlliance, 2015. *Comments on the Draft Environmental Impact Report for the Glenn Colusa Irrigation District 10-Wells Project (Groundwater Supplemental Supply Project SCH# 2014092076).* Custis Exhibit 16.

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AA 32 continued

Regarding the Sacramento Valley, all of the alternatives have the potential to degrade water quality due to the escalating involvement of groundwater substitution transfers. As we suggested above, the Bureau must provide maps and data that disclose where known groundwater contamination exists, what are the MCLs for pollutants in those areas, and what activities that are part of CVP and SWP operations could exacerbate them.

AA 33

<u>The Bureau Fails to Analyze Significant Past, Present, and Future Streamflow Depletion</u>

All water discharged by wells is balanced by a loss of water somewhere.[20] The DEIS unfortunately fails to present existing conditions for the Sacramento Valley. The increasing use of groundwater has caused the loss of 1.5 maf per year from Sacramento Valley rivers and streams as suggested by C.F. Brush and colleagues and the Northern California Water Association ("NCWA").[21] Kit Custis created a graphic depiction of this historic groundwater extraction and stream interaction (1920s – 2009) that illustrates groundwater pumping, groundwater change in storage, and stream accretion.[22] He found that stream accretion flattened in the mid to late 1990s which suggests that , "First, after depleting 1.5 MAFY from the Sacramento Valley streams, the surface waters may not be able to provide much more, at least no increase to match the pumping. Second, this may also be a consequence of the model design because the number of streams simulated was limited. Third, the model's grid may not extend out far enough to encompass all of the streams that contribute to groundwater recharge." (*Id.* p. 35) This cries out for additional analysis that the Projects should fund or tackle.

Custis goes on to state, that "Accounting for the transfer of groundwater between regions is critical for understanding the impacts of pumping in one region or area on the adjacent regions. The sources of water backfilling a groundwater depression don't all have to come from surface waters, ie., stream depletion, precipitation, deep percolation, and artificial recharge. Some of that "recharge" can come from adjacent aquifers by horizontal and vertical flow." (*Id.* p. 33) The DEIS fails to account for any of the information provided here or by Brush, Custis, or NCWA. Without this context, the DEIS improperly defeats its own purpose under NEPA to fully disclose the setting as a baseline for evaluating water supply and groundwater impacts of the alternatives and recommending mitigation measures.

i. The Bureau Fails to Adequately Assess Economic Costs

AA 34

The solitary mention of streamflow depletion is presented in Appendix 19A that discusses the *California Water Economics Spreadsheet Tool (CWEST) Documentation* and states that, "Additional costs associated with groundwater use include lower groundwater tables, subsidence, streamflow depletion, depreciation, and well replacement that should be included," as well as costs to treat groundwater that may become contaminated. (p. 19A-20) However, the need for these additional costs are only estimated since the Bureau claims that, "No consistent source of

[20] Theis, C.V. 1940. The source of water derived from wells—Essential factors controlling the response of an aquifer to development. Civil Engineering 10: 277–280.
[21] Custis, Kit 2014. Comments and Recommendations prepared for AquAlliance on U.S. Bureau of Reclamation and San Luis & Delta Mendota Water Authority Long-Term Water Transfer Draft EIS/EIR. pp. 33-34.
[22] Custis, Kit 2014. Exhibit 10.7 prepared for AquAlliance on U.S. Bureau of Reclamation and San Luis & Delta Mendota Water Authority Long-Term Water Transfer Draft EIS/EIR.

information is available to assess these other costs…" (*Id.*) This conclusion is indefensible without disclosure why such information isn't found in the public domain.

AA 34 continued

The information necessary to analyze impact/cost most likely exists in academic literature, government reports, and reports by industry and interest groups. In the event that economic analysis isn't able to exactly quantify dollar costs per quantity of groundwater use, it would provide a likely range of impacts, and be able to talk about the degree of uncertainty in the resulting estimate. Unfortunately, the Bureau's response was to arbitrarily increase costs by 10 percent in the DEIS, which lacks foundation. How was 10 percent selected, what factors were considered, and what information did they review? If a "consistent source" isn't available, all relevant information should have been considered and reviewed to reach an impact/cost from available information.

Municipal and Industrial Groundwater Impacts

AA 35

The DEIS presents that, "It is recognized that municipal and industrial pumping in urban areas in the Central Valley could cause localized impacts to groundwater levels from increased drawdown. The increased withdrawals could also impact groundwater quality due to the migration of existing plumes, as described in the Affected Environment section." (p. 7-11) Despite this acknowledgement, the DEIS again takes the position that there are no significant impacts and offers no mitigation measures.

In summary for Chapter 7, *Groundwater and Groundwater Quality*, the DEIS failed to find any impacts of significance and therefore produced no mitigation measures. Sadly, the Bureau improperly defeats its own purpose under NEPA to fully disclose the setting as a baseline for evaluating all the alternative's water supply and groundwater impacts and recommending mitigation measures.

V. The EIS/EIR Fails to Adequately Analyze Numerous Cumulative Impacts.

The Ninth Circuit Court makes clear that NEPA mandates "a useful analysis of the cumulative impacts of past, present and future projects." *Muckleshoot Indian Tribe v. U.S. Forest Service*, 177 F.3d 800, 810 (9th Cir. 1999). "Detail is required in describing the cumulative effects of a proposed action with other proposed actions." *Id.*

AA 36

In assessing the significance of a project's impact, the Bureau must consider "[c]umulative actions, which when viewed with other proposed actions have cumulatively significant impacts and should therefore be discussed in the same impact statement." 40 C.F.R. §1508.25(a)(2). A "cumulative impact" includes "the impact on the environment which results from the incremental impact of the action when added to *other past, present and reasonably foreseeable future actions* regardless of what agency (Federal or non-Federal) or person undertakes such other actions." *Id.* §1508.7. The regulations warn that "[s]ignificance cannot be avoided by terming an action temporary or by breaking it down into small component parts." *Id.* §1508.27(b)(7).

An environmental impact statement should also consider "[c]onnected actions." *Id.* §1508.25(a)(1). Actions are connected where they "[a]re interdependent parts of a larger action and depend on the larger action for their justification." *Id.* §1508.25(a)(1)(iii). Further, an environmental impact statement should consider "[s]imilar actions, which when viewed together with other *reasonably foreseeable or proposed agency actions*, have similarities that provide a basis for evaluating their environmental consequences together, such as common timing or geography." *Id.* §1508.25(a)(3) (emphasis added).

AA 36 continued

As discussed, below, and in the 2014 expert reports submitted by *Custis*, *EcoNorthwest*, *Cannon*, and *Mish* on behalf of AquAlliance for the 10-Year Water Transfer Program (aka Long-Term Transfer Program), the DEIS fails to comport with these standards for cumulative impacts upon surface and groundwater supplies, vegetation, and biological resources; and, the baseline and modeling data relied upon by the DEIS that does not account for related projects in the last 12 years.

Recent Past Transfers.

Because the groundwater modeling effort didn't include the most recent 11 years record (1970-2003), it appears to have missed simulating the most recent periods of groundwater substitution transfer pumping and other groundwater impacting events, such as recent changes in groundwater elevations and groundwater storage (DWR, 2014b), and the reduced recharge due to the recent periods of drought. Without taking the hydrologic conditions during the recent 11 years into account, the results of the CVHM model simulation may not accurately depict the current conditions or predict the effects from the proposed groundwater substitution transfer pumping during the next 10 years.

- In 2009, the Bureau approved a 1 year water transfer program under which a number of transfers were made. Regarding NEPA, the Bureau issued a FONSI based on an EA.
- In 2010, the Bureau approved a 2 year water transfer program (for 2010 and 2011). No actual transfers were made under this approval. Regarding NEPA, the Bureau again issued a FONSI based on an EA.
- The Bureau planned 2012 water transfers of 76,000 AF of CVP water all through groundwater substitution.[23]
- In 2013, the Bureau approved a 1 year water transfer program, again issuing a FONSI based on an EA. The EA incorporated by reference the environmental analysis in the 2010-2011 EA.
- The Bureau and SLDMWA's 2014 Water Transfer Program proposed transferring up to 91,313 AF under current hydrologic conditions and up to 195,126 under improved conditions. This was straight forward, however, when attempting to determine how much water may come from fallowing or groundwater substitution during two different time periods, April-June and July-September, the reader was left to guess.[24]

[23] USBR 2012. Memo to the Deputy Assistant Supervisor, Endangered Species Division, Fish and Wildlife Office, Sacramento, California regarding Section 7 Consultation.
[24] The 2014 Water Transfer Program's EA/MND was deficient in presenting accurate transfer numbers and types of transfers. The numbers in the "totals" row of Table 2-2 presumably should add up to 91,313. Instead, they add up to 110, 789. The numbers in the "totals" row of Table 2-3 presumably should add up to 195,126. Instead, they add up to 249,997. Both Tables 2-2 and 2-3 have a footnote stating: "These totals cannot be added together. Agencies could make water available through groundwater substitution, cropland idling, or a combination of the two; however, they

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These closely related projects impact the same resources, are not accounted for in the environmental baseline, and must be considered as cumulative impacts. AA 36 continued

Yuba Accord

The relationship between the Projects and the Lower Yuba River Accord is not found in the DEIS, but is illuminated in a 2013 Environmental Assessment. "The Lower Yuba River Accord (Yuba Accord) provides supplemental dry year water supplies to state and Federal water contractors under a Water Purchase Agreement between the Yuba County Water Agency and the California Department of Water Resources (DWR). Subsequent to the execution of the Yuba Accord Water Purchase Agreement, DWR and The San Luis & Delta- Mendota Water Authority (Authority) entered into an agreement for the supply and conveyance of Yuba Accord water, to benefit nine of the Authority's member districts (Member Districts) that are SOD [south of Delta] CVP water service contractors." [25] AA 37

In a Fact Sheet produced by the Bureau, it provides some numerical context and more of DWR's involvement by stating, "Under the Lower Yuba River Accord, up to 70,000 acre-feet can be purchased by SLDMWA members annually from DWR. This water must be conveyed through the federal and/or state pumping plants in coordination with Reclamation and DWR. Because of conveyance losses, the amount of Yuba Accord water delivered to SLDMWA members is reduced by approximately 25 percent to approximately 52,500 acre-feet. Although Reclamation is not a signatory to the Yuba Accord, water conveyed to CVP contractors is treated as if it were Project water." [26] However, the Yuba County Water Agency ("YCWA") may transfer up to 200,000 under Corrected Order WR 2008-0014 for Long-Term Transfer and, "In any year, up to 120,000 af of the potential 200,000 af transfer total may consist of groundwater substitution. (YCWA-1, Appendix B, p. B-97.)." [27]

Potential cumulative impacts from the Project and the YCWA Long-Term Transfer Program from 2008 - 2025 are not disclosed or analyzed in the DEIS. Moreover, the *2015-2024 Water Transfer Program* could transfer up to 600,000 AF per year through the same period that the YCWA Long-Term Transfers are potentially sending 200,000 AF into and south of the Delta. How these two projects operate simultaneously could have a very significant impact on the environment and economy of the Feather River and Yuba River's watersheds and counties as well as the Delta. The involvement of Browns Valley Irrigation District and Cordua Irrigation District in both long-term programs must also be considered. This must be analyzed and presented to the public in a revised DEIS.

Also not available in the DEIS is disclosure of any issues associated with the YCWA transfers that have usually been touted as a model of success. The YCWA transfers have encountered troubling

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will not make the full quantity available through both methods. Table 2-1 reflects the total upper limit for each agency."

[25] Bureau of Reclamation, 2013. *Storage, Conveyance, or Exchange of Yuba Accord Water in Federal Facilities for South of Delta Central Valley Project Contractors.*

[26] Bureau of Reclamation, 2013. *Central Valley Project (CVP) Water Transfer Program Fact Sheet.*

[27] State Water Resources Control Board, 2008. ORDER WR 2008 - 0025

AA 37 continued

trends for over a decade that, according to the draft Environmental Water Account ("EWA") EIS/EIR, are mitigated by deepening domestic wells (2003 p. 6-81). While digging deeper wells is at least a response to an impact, it hardly serves as a proactive measure to avoid impacts. Additional information finds that it may take 3-4 years to recover from groundwater substitution in the south sub-basin[28] although YCWA's own analysis fails to determine how much river water is sacrificed to achieve the multi-year recharge rate. None of this is found in the EIS/EIR. What is found in the EIS/EIR is that even the inadequate SACFEM2013 modeling reveals that it could take more than six years in the Cordua ID area to recover from multi-year transfer events, although recovery is not defined (pp, 3.3-69 to 3.3-70). This is a very significant impact that isn't addressed individually or cumulatively.

BDCP

AA 38

The DEIS acknowledges the Bay Delta Conservation Plan ("BDCP") in its Cumulative Impacts list. However we believe that DEIS fails to consider the potential cumulative impacts if the Twin Tunnels are built as planned with the capacity to take 15,000 cubic feet per second ("cfs") from the Sacramento River. They will have the capacity to drain almost two-thirds of the Sacramento River's average annual flow of 23,490 cfs at Freeport[29] (north of the planned Twin Tunnels). As proposed, the Twin Tunnels will also increase water transfers when the infrastructure for the Project has capacity. This will occur during dry years when SWP contractor allocations drop to 50 percent of Table A amounts or below or when CVP agricultural allocations are 40 percent or below, or when both projects' allocations are at or below these levels (BDCP DEIS/EIR Chapter 5, 2013). With BDCP, North to South water transfers would be in demand and feasible.

Communication regarding assurances for BDCP indicates that the purchase of approximately 1.3 million acre-feet of water is being planned as a mechanism to move water into the Delta to make up for flows that would be removed from the Sacramento River by the BDCP tunnels. [30] There is only one place that this water can come from: the Sacramento Valley's watersheds. It is well know that the San Joaquin River is so depleted that it will not have any capacity to contribute meaningfully to Delta flows. Additionally, the San Joaquin River doesn't flow past the proposed north Delta diversions and neither does the Mokelumne River.

The DEIS also fails to reveal many more programs, plans and projects to develop water transfers in the Sacramento Valley, to develop a "conjunctive" system for the region, and to place water districts in a position to integrate the groundwater into the state water supply. BDCP is one of those plans that the federal agencies, together with DWR, SLDMWA, water districts, and others have been pursuing and developing for many years.

i. Biggs-West Gridley

AA 39

The *Biggs-West Gridley Water District Gray Lodge Wildlife Area Water Supply* Project, a Bureau project, is not mentioned anywhere in the Vegetation and Wildlife or Cumulative Impacts

[28] 2012. *The Yuba Accord, GW Substitutions and the Yuba Basin*. Presentation to the Accord Technical Committee. (pp. 21, 22).
[29] USGS 2009. http://wdr.water.usgs.gov/wy2009/pdfs/11447650.2009.pdf Exhibit KK)
[30] Belin, Lety, 2013. E-mail regarding Summary of Assurances. February 25 (Department of Interior). (Exhibit LL)

AA 39 continued

sections. [31] This water supply project is located in southern Butte County where Western Canal WD, Richvale ID, Biggs-West Gridley WD, and Butte Water District actively sell water on a regular basis, yet impacts to GGS from this project are not disclosed. This is a serious omission that must be remedied in a recirculated draft DEIS.

ii. Other Projects

AA 40

a) Court settlement discussions between the Bureau and Westlands Water District over provisions of drainage service. Case # CV-F-88-634-LJO/DLB will further strain the already over allocated Central Valley Project with the following conditions:

- A permanent CVP contract for 890,000 acre-feet of water a year exempt from acreage limitations.
- Minimal land retirement consisting of 100,000 acres; the amount of land Westlands claims it has already retired (115,000 acres) will be credited to this final figure. Worse, the Obama administration has stated it will be satisfied with 100,000 acres of "permanent" land retirement.
- Forgiveness of nearly $400 million owed by Westlands to the federal government for capital repayment of Central Valley Project debt.

b) Five-Year Warren Act Contracts for Conveyance of Groundwater in the Tehama-Colusa and Corning Canals – Contract Years 2013 through 2017 (March 1, 2013, through February 28, 2018).

Additional projects with cumulative impacts upon groundwater and surface water resources affected by the Project:

- The DWR Dry Year Purchase Agreement for Yuba County Water Agency water transfers from 2015-2025 to SLDMWA.[32]
- GCID's *Stony Creek Fan Aquifer Performance Testing Plan* to install seven production wells in 2009 to extract 26,530 AF of groundwater as an experiment that was subject to litigation due to GCID's use of CEQAs exemption for research.
- Installation of numerous production wells by the Sellers in this Project many with the use of public funds such as Butte Water District,[33] GCID, Anderson Cottonwood Irrigation District,[34] and Yuba County Water Authority [35] among others.

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[31] http://www.usbr.gov/mp/nepa/nepa_projdetails.cfm?Project_ID=15381

[32] SLDMWA Resolution # 2014 386 http://www.sldmwa.org/OHTDocs/pdf_documents/Meetings/Board/Prepacket/2014_1106_Board_PrePacket.pdf

[33] Prop 13. Ground water storage program: 2003-2004 Develop two production wells and a monitoring program to track changes in ground.

[34] "The ACID Groundwater Production Element Project includes the installation of two groundwater wells to supplement existing district surface water and groundwater supplies." http://www.usbr.gov/mp/nepa/nepa_projdetails.cfm?Project_ID=8081

[35] Prop 13. Ground water storage program 2000-2001: Install eight wells in the Yuba-South Basin to improve water supply reliability for in-basin needs and provide greater flexibility in the operation of the surface water management facilities. $1,500,00;

AA 40 continued

- GCID's 10 Wells Project proposes to install five new production wells and continue operating five additional production wells during dry and critically dry years for 8.5 months from approximately February 15-Marh 15 and April 1-November 15. The annual, maximum, cumulative total pumping is 28,500 af and is more water than the annual use of the Chico district of California Water Service Company that serves over 100,000 people.[36]

VI. Procedural Issues

AA 41

- Will there be a California Environmental Quality Act ("CEQA") equivalent document for the Project that is produced and circulated for public comment?

AA 42

- When will mitigation measures be circulated for public review and comment? "Consideration for Mitigation Measures" are not mitigation measures.

AA 43

- The public is prevented from knowing what the preferred alternative is because, "This Draft EIS does not recommend a preferred alternative. A preferred alternative will be included in the Final EIS." (p. ES-5) Letting the public know in a final document is not sufficient for a project of this magnitude.

AA 44

- The public is unnecessarily confused by the creation of a Second Basis of Comparison that, "[i]s not a true alternative, in accordance with NEPA guidelines, Reclamation could not select Second Basis of Comparison as a preferred alternative. Therefore, Alternative 1 was defined as being identical to the Second Basis of Comparison, as defined in Section 3.3.2." (p. 3-31)

AA 45

As demonstrated in our comments, the DEIS is seriously deficient and should be withdrawn. AquAlliance hopes that the Bureau and DWR may better understand the serious harm the Projects have wrought on Sacramento Valley, San Joaquin Valley, and Delta communities, groundwater dependent farmers, and the environment over many decades. AquAlliance requests that the Bureau regroup and prepare an adequate DEIS with a new suite of alternatives that are less damaging and potentially restorative.

Sincerely,

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[36] California Water Service Company *2010 Urban Water Management Plan Chico-Hamilton City District*, p. 32.

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1D.1.1.1 Attachments to Comments from AquAlliance

Attachments to the AquAlliance letter are included in Attachment 1D.1 located at the end of Appendix 1D.

1D.1.1.2 Responses to Comments from AquAlliance

AA 1: Comment noted.

AA 2: Comment noted. The EIS analysis adequately addresses the effects of the coordinated long-term operation of the CVP and SWP.

AA 3: The letters listed in this comment were submitted to Reclamation as comments on another project, the Long-Term Transfers EIR/EIS. Responses to those comments can be found in the Final Long-term Transfers EIR/EIS posted on the Reclamation website at www.usbr.gov/mp/nepa/index.cfm.

AA 4: The letters listed in this comment were submitted to Reclamation as comments on other projects, not the EIS for the coordinated long-term operation of the CVP and SWP. Responses to those comments on projects that have completed the NEPA process are included in the final version of the NEPA documents posted on the Reclamation website at http://www.usbr.gov/mp/nepa/index.cfm.

Responses to comments on projects that are still undergoing evaluation will be posted on the Reclamation website at www.usbr.gov/mp/nepa/index.cfm in the final NEPA documents.

AA 5: Please see responses to Comments AA 6 through AA 40.

AA 6: The purpose of the action is presented in Chapter 2, Purpose and Need, of the EIS, and considers the purposes for which the CVP was authorized, as amended by CVPIA, as well as the regulatory limitations on CVP operations, including applicable state and federal laws and water rights.

The need for the action also is presented in Chapter 2, and in accordance with the District Court order is to evaluate potential modifications to the continued long-term operation of the CVP, in coordination with the operation of the SWP, related to Reclamation's acceptance and implementation of the Reasonable and Prudent Alternatives (RPAs) included in the Biological Opinions (BOs) issued in 2008 and 2009 by the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS), respectively, pursuant to the Federal Endangered Species Act of 1973 (ESA) as amended (United States Code [U.S.C.] 1531 et. seq.).

AA 7: The CVP and SWP operate within the federal and state regulatory requirements, as described in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations. More details have been included in Section 5.3.3 of Chapter 5, Surface Water Resources and Water Supplies, and Section 9.3.8 of Chapter 9, Fish and Aquatic Resources, in the Final EIS to describe historical responses by CVP and SWP to these drought conditions and changes in fisheries resources.

AA 8: The *Westlands v. United States* Settlement in the *Firebaugh Canal Co v. United States* was signed on September 15, 2015. This settlement agreement requires congressional authorization prior to implementation. Therefore, this project has been included in the cumulative effects analysis in the Final EIS.

AA 9: The CVP and SWP operations prioritize meeting federal and state regulatory requirements and deliveries to senior water rights holders. The modeling analyses presented in the EIS include these prioritizations for long-term operation of the CVP and SWP using an 82-year hydrology analyzed with the CalSim II model. This analytical approach results in low water storage elevations in CVP and SWP reservoirs and low deliveries to CVP agricultural water service contractors located to the south of the Delta in critical dry periods. The modeled operations do not include changes in SWRCB requirements intended to reduce the effects of extreme flood or drought events, such as the recent changes in CVP and SWP drought operations.

Droughts have occurred throughout California's history, and are constantly shaping and innovating the ways in which Reclamation and DWR balance both public health standards and urban and agricultural water demands while protecting the Delta ecosystem and its inhabitants. The most notable droughts in recent history are the droughts that occurred in 1976-77, 1987-92, and the ongoing drought. More details have been included in Section 5.3.3 of Chapter 5, Surface Water Resources and Water Supplies, and Section 9.3.8 of Chapter 9, Fish and Aquatic Resources, in the Final EIS to describe historical responses by CVP and SWP to these drought conditions, as described in the response to Comment AA 7.

AA 10: The interaction of streamflow and groundwater is included in the groundwater analytical tool, CVHM, as described in Appendix 7A, Groundwater Model Documentation.

AA 11: The historic reservoir storages and stream flows presented in Figures 5.7 through 5.45 in the EIS were generally presented for the period of time from 2001 through 2012. This time frame represents conditions under the operations of the CVP and SWP since full implementation of operations in accordance with State Water Resources Control Board (SWRCB) Decision 1641 (D-1641) and biological opinions adopted by the USFWS and NMFS in the early 2000s. Historic stream flow data and locations of the gauges, such as Douglas City, can be found on the CDEC website at www.cdec.water.ca.gov.

AA 12: The EIS does include references to the efforts being implemented to meet the statewide goals for reduction of municipal per capita water use by 20 percent by 2020 and optimization of agricultural water use efficiency. The EIS analysis is conducted at the Year 2030, and it is assumed that the legislative requirements of water conservation by municipal and agricultural water users have been achieved in the No Action Alternative, Second Basis of Comparison, and Alternatives 1 through 5.

AA 13: Many of the projects referenced in this comment are related to short-term water transfer programs. It is acknowledged in the No Action Alternative, Second Basis of Comparison, and Alternatives 1 through 5 that these annual water transfer programs are anticipated to continue in the Year 2030. The Long-Term North-to-South Water Transfer Program is acknowledged in this EIS to provide for water transfers from 2015 through 2024. As with the short-term water transfer programs, it is anticipated that similar programs would continue in the Year 2030 in the No Action Alternative, Second Basis of Comparison, and Alternatives 1 through 5.

The maximum amount of water transfers across the Delta referenced in this comment were defined by Reclamation in the *Biological Assessment on the Continued Long-Term Operations of the Central Valley Project and the State Water Project* August 2008 document. These limitations were included in the 2008 USFWS BO and 2009 NMFS BO as the Proposed Action from the Biological Assessment. The effect of moving total amounts of water (including transferred water) across the Delta through CVP and SWP facilities is conducted in accordance with the federal and state requirements, as in included in the CalSim II model.

AA 14: The project referenced in this comment was not completed by Glenn-Colusa Irrigation District; and therefore, it was not included in the No Action Alternative, the Second Basis of Comparison, or Alternatives 1 through 5.

AA 15: The coordinated long-term operation of the CVP and SWP assumes continued use of water rights by Reclamation, DWR, and all other water users. The EIS analysis is conducted with projected conditions at Year 2030 with climate change and sea level rise assumptions. The climate change assumptions include a reduction in snow pack, warmer air temperatures, and larger rainfall events than in recent history. As described in Chapter 5, Surface Water Resources and Water Supplies, and Chapter 7, Groundwater Resources and Groundwater Quality, this could lead to less carryover storage in all reservoirs in September and less natural groundwater recharge. This could affect the amount of water available for all water rights holders.

The water rights system in California was developed with consideration of a highly variable hydrology. The water rights system is based upon a priority of diversion rates (e.g., maximum daily rates or instantaneous diversion rates), limited to beneficial uses and not wasteful uses, instead of a priority of volumes. The maximum daily or instantaneous diversion rates are frequently expressed as maximum monthly or annual volumes. However, the volume of water that can be diverted is determined through the prioritization of water rights and minimum downstream flows required for other water users and environmental considerations as regulated by federal and state agencies. Many of the water rights are for non-consumptive use (such as for power generation). Many consumptive use water rights holders also return a portion of their diversions to the river as agricultural return flows and wastewater effluent. These return flows are also available for downstream uses. The CalSim II model used in this EIS simulates this complex system. The model prioritizes deliveries and associated return flows to water rights holders and federal and state stream flow and water quality requirements prior to determining the available water supplies for CVP and SWP water contractors. Listings of water rights in California can be found on the SWRCB website at www.swrcb.ca.gov/waterrights.

AA 16: The EIS describes that under the No Action Alternative, benefits from implementation of the 2008 USFWS BO and 2009 NMFS BO RPA actions are anticipated to improve aquatic resources conditions. However, it must be recognized that some of the RPA actions are either under construction, or recently completed construction (e.g., Battle Creek restoration and Red Bluff Pumping Plant, respectively). Other RPA actions are still under development (e.g., fish passage around CVP reservoirs). Therefore, conditions described in the Affected Environment section of Chapter 9 do not represent the anticipated conditions that would occur under the No Action Alternative by the Year 2030 with full implementation of the RPA actions.

AA 17: The comment is consistent with the information presented in the EIS related to Alternatives 1 through 5.

AA 18: The analysis in the EIS compares conditions under Alternatives 1 through 5 with the No Action Alternative to identify beneficial and adverse impacts for a broad range of physical, environmental, and human resources. The NEPA analysis does not determine if the alternatives would change the findings of the biological opinions in the determination of the likelihood of the alternatives to cause jeopardy to the continued existence of the species, or destroy or adversely affect their critical habitat.

AA 19: CVHM was used to support the EIS groundwater analysis as is it was deemed to have the greatest resolution (vertically and spatially) and more robust calibration than any of the other currently available Central-Valley wide models. While it is true that the CVHM model simulation period ends at the end of 2003, none of the Central-Valley wide models that simulate groundwater conditions for more recent periods post-2003 were available or deemed adequate for the analysis at the time of preparation of the EIS. The 1961 through 2003 time period simulated by CVHM includes varying hydrologic conditions that range from extreme dry periods (such as 1987-92) and extreme wet periods (such as 1983). The model includes assumptions for climate and typical hydrologic conditions at 2030 that alternate between dry and wet conditions to capture the range of possible impacts.

The CalSim II model output used in the CVHM model includes river flows and CVP and SWP water deliveries. It is recognized that the CalSim II model does include assumptions for groundwater use in the Sacramento Valley.

AA 20: Models are used in the EIS analysis to evaluate the differences of long-term operations under the various alternatives as compared to the No Action Alternative and Second Basis of Comparison. Historical conditions cannot be used to evaluate expected results under varying operational alternatives since operational constraints have changed continuously since the project was first developed. Furthermore, the EIS analysis is conducted to analyze conditions in 2030 which will include changes from recent conditions in land use, hydrology, and water quality due to future development, climate change, and sea level rise.

Sole use of historic observations would not be appropriate for evaluating operations under these future conditions. However, the historic observations were used in development of the analytical tools that are used in this EIS.

AA 21: Additional details have been included in Appendix 5A, Section A, CalSim II and DSM2 Modeling, to provide more clarity about the climate change assumptions used in CalSim II, CVHM, and all related models. As described in Appendix 5A, Section A, the climate change models used in this EIS indicate that the future conditions are anticipated to result in less snow pack, warmer air temperatures, and more intense rainfall events. These conditions would result in a reduction of water available for CVP and SWP contractors as compared to historical conditions, as discussed in Section 5.4.2 of Chapter 5, Surface Water Resources and Water Supplies. These conditions are included in the No Action Alternative, Second Basis of Comparison, and Alternatives 1 through 5.

AA 22: Please response to Comment AA 18.

AA 23: As discussed in this comment, the analytical tools do have limitations and uncertainties, as discussed in the appendices of the EIS. The acknowledgement of these limitations and uncertainties is why all model results in all EIS chapters must be used in a comparative manner to determine the incremental differences between Alternatives 1 through 5 as compared to the No Action Alternative, and between the No Action Alternative and Alternatives 1 through 5 as compared to the Second Basis of Comparison. The model results are not used to project specific physical, biological, or human resource values. By using the models in a comparative manner, the results of the analysis are less affected by the limitations and uncertainties. The quantitative model results are used in conjunction with the qualitative analyses presented in this EIS to consider the comparative results of the entire analyses.

AA 24: Central Valley groundwater models are complex due to the extremely differing hydrogeology in the watershed that provides groundwater recharge and the wide range of depletions that occur through wells, streamflow depletion, and losses to deep aquifers. As stated in the 2010 Masters Thesis (referred to in the comment), "Actual groundwater storage capacity in California is unknown and is not accurately measureable at this time."

The two Central Valley wide groundwater flow models, CVHM and C2VSim, differ in their structure, simulation period, and input assumptions. CVHM was used for the EIS groundwater impact analysis because it provides higher resolution (both in horizontal grid spacing and vertical layering – 10 layers versus 3 layers) and has undergone a more robust calibration.

A peer review of these models was led by CWEMF (California Water Environment Modeling Forum) and developed by renowned groundwater scientists in 2013. The findings indicate that both C2VSim and CVHM are valid models for the evaluation of water resources planning and impact studies in the Central Valley. Therefore, while differences in model forecast exist, CVHM is a more robust tool to support the EIS impact analysis.

AA 25: The EIS cites different groundwater drawdown magnitudes than mentioned in the comment, as it used the data presented in the 2014 DWR Drought Update report (as cited in Chapter 9, Groundwater Resources and Groundwater Quality in the EIS).

The differences between the reported groundwater level trends the EIS and the Butte County groundwater levels included in the comment are due to the differences in groundwater data references cited. It is recognized that local and regional data are collected and reported for many locations throughout the state. However, because the EIS study area included a large portion of the state, federal and state data references were used in the EIS to provide a uniform dataset for the entire analysis.

AA 26: The actual magnitude of overdraft in the Central Valley groundwater basin is known at specific locations with groundwater elevations; however, regional overdraft values are only estimates based upon groundwater models and regional observations. DWR is the state agency tasked with collecting state-wide groundwater elevation data and therefore is a reasonable source for estimates of the type mentioned in the comment. The EIS impact analysis is based upon a comparative methodology to inform Reclamation and others about the differences between Alternatives 1 through 5 as compared to the No Action Alternative, and between the No Action Alternative and Alternatives 1 through 5 as compared to the Second Basis of Comparison. The EIS provides information related to the effects of the alternatives as compared to the No Action Alternative and the Second Basis of Comparison on groundwater in the Central Valley.

AA 27: The EIS referenced the Sierra Nevada as a surrogate for all eastside streams. The text on page 7-16 of the Draft EIS should have stated the "Sierra Nevada and Cascade Ranges", and will be modified in the Final EIS.

AA 28: Please see responses to Comment AA 36 through AA 40.

AA 29: The requirements for water transfers, including transfers with provisions for groundwater substitution, that involve either CVP and SWP water contract water supplies or facilities are described in Section 5.4.2.1.3 of Chapter 5, Surface Water Resources and Water Supplies. It is assumed that water transfers occurring under the No Action Alternative, Second Basis of Comparison, and Alternatives 1 through 5 would meet the requirements listed in CVPIA and any other requirements. Specific water transfers for the Year 2030 have not been identified at this time except for continued water transfers under the Lower Yuba River Accord. Therefore, quantitative analyses presented in the EIS only included water transfers under the Lower Yuba River Accord, as described in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations. Qualitative analyses for conditions that could occur for other water transfers by 2030 are presented in the EIS.

AA 30: Please see responses to Comments AA19 and AA24 for the discussion on the adequacy of using CVHM for the groundwater impacts analysis.

The first bullet in this comment states that Alternatives 1 through 5 as compared to the No Action Alternative would result in similar or less groundwater pumping. This is based on modeling results. If implementation of these alternatives results in similar or less pumping than under No Action Alternative, there is no potential for additional drawdown-induced subsidence to occur, and further analysis is not required.

Conclusions regarding subsidence impacts are reached by comparing groundwater level changes between the No Action Alternative, Second Basis of Comparison, and Alternatives 1 through 5. If groundwater levels decline, subsidence impacts are more likely to occur, due to the potential for compaction of subsurface materials with the loss of groundwater in storage. However, if groundwater levels are similar or slightly decline, the potential for land subsidence to occur is minimal.

AA 31: Major subsidence in the Sacramento Valley, such as up to 4 feet in the Yolo basin area, is discussed in Section 7.3.3 of Chapter 7, Groundwater Resources and Groundwater Quality, of the EIS. The text acknowledges overdraft conditions that could result in subsidence do occur in other portions of the Sacramento Valley, including the West Butte Subbasin in Butte, Glenn, and Sutter Counties.

AA 32: The groundwater water quality analysis described in the EIS consists of comparing the groundwater levels and flow directions under the alternatives as compared to the No Action Alternative and Second Basis of Comparison. Any change in groundwater levels or flow directions due to implementation of the alternatives are further analyzed to determine whether the changes result in conditions that would lead to degradation of groundwater quality (e.g. inducement of migration of poorer quality groundwater into areas of higher quality).

No mitigation measures were included in the EIS for groundwater conditions because groundwater pumping would be similar or decrease and groundwater elevations would be similar or rise under Alternatives 1 through 5 as compared to the No Action Alternative. The Second Basis of Comparison was included in the EIS for informational purposes only, as described in Chapter 3, Description of Alternatives. The Second Basis of Comparison does not comply with the definition of the No Action Alternative under the NEPA guidelines. Therefore, mitigation measures have not been considered for changes under Alternatives 1 through 5 and the No Action Alternative as compared to the Second Basis of Comparison.

The analysis in the EIS assumes compliance with ongoing surface water and groundwater quality programs by 2030 under the No Action Alternative, Second Basis of Comparison, and Alternatives 1 through 5, including the Grassland Bypass Project in the San Joaquin Valley.

As described in the response to Comment AA 29, the EIS analysis assumes compliance with all requirements for water transfers, including transfers with provisions for groundwater substitution, that involve either CVP and SWP water contract water supplies or facilities are described in Section 5.4.2.1.3 of

Chapter 5, Surface Water Resources and Water Supplies, to protect other groundwater uses and groundwater quality under the No Action Alternative, Second Basis of Comparison, and Alternatives 1 through 5.

AA 33: The EIS analysis is conducted to evaluate the No Action Alternative, Second Basis of Comparison, and Alternatives 1 through 5 comparative conditions in Year 2030. Historic data, including streamflow depletion values, were used to develop the input values and assumptions used in the CVHM model, as described in Appendix 7A, Groundwater Model Documentation. The existing conditions maps are included in the reference cited in the EIS, the 2009 U.S. Geological Survey report entitled *Groundwater Availability of the Central Valley Aquifer, California,* which used the CVHM model for the evaluation of the Central Valley aquifer conditions. It is recognized that the U.S. Geological Survey is currently updating this report.

AA 34: The analysis includes an estimated 10 percent cost increase in groundwater pumping to include other additional economic costs (lower groundwater tables, subsidence, streamflow depletion, depreciation, well replacement, and increased treatment costs). This estimate was based on a review of water management studies with projected costs for a range of water resource supplies during the development of Chapter 19, Socioeconomics, and Appendix 19A, California Water Economics Spreadsheet Tool (CWEST) Documentation. Relevant information was reviewed and considered to reach the 10 percent conclusion. General information is available in the literature, but the information necessary to accurately assign a unique and representative cost to each individual contractor does not exist. The additional costs of lower groundwater tables, subsidence, streamflow depletion, depreciation, well replacement, and increased treatment costs are influenced by regional factors and should not be entirely attributed to the amount of water pumped. Variations among regions in precipitation, recharge patterns, and groundwater hydraulics, and technology may have more influence on these additional costs than the amount of groundwater pumped. For example, in some regions, close connectivity between groundwater and surface water might allow a large rainfall event to eliminate lower groundwater levels. In other regions, lower groundwater tables might be sustained indefinitely. Some regions experience subsidence and streamflow depletion, others do not. Depreciation of wells and pumps is related to age of the equipment and changing technology as well as the amount of water pumped. In most regions, changes in groundwater costs, other than the direct pumping costs, are a very small fraction of all changes in water operating expenses caused by an alternative.

AA 35: As described in the response to Comment AA 32, no mitigation measures were included in the EIS for groundwater conditions because groundwater pumping would be similar or decrease and groundwater elevations would be similar or increased under Alternatives 1 through 5 as compared to the No Action Alternative. The Second Basis of Comparison was included in the EIS for informational purposes only, as described in Chapter 3, Description of Alternatives. The Second Basis of Comparison does not comply with the definition of the No Action Alternative under the NEPA guidelines. Therefore, mitigation measures have not been considered for changes under Alternatives 1 through 5 and the No Action Alternative as compared to the Second Basis of Comparison.

AA 36: The cumulative effects do include water transfers. The discussion of cumulative effects associated with water transfers in Chapter 7, Groundwater Resources and Groundwater Quality, has been modified in the Final EIS.

AA 37: Continuation of the Lower Yuba River Accord water transfers is assumed in the No Action Alternative, Second Basis of Comparison, and Alternatives 1 through 5. Surface water diversions and flows from this program are included in the CalSim II model and are input into the CVHM model as a diversion node. When surface water transfers occur, the CVHM model automatically adjusts the groundwater pumping to make up for reduced surface water availability used locally in the Feather River and Yuba River watersheds. Therefore, the effects of this transfer program are included in the modeling analysis for each alternative and are independent of the impacts from the alternatives.

AA 38: The Bay Delta Conservation Plan (BDCP) would primarily convey water from North Delta and South Delta intakes in wet water year conditions. During drier years, the intakes could convey less water than under the No Action Alternative and there would be many months when the North Delta intakes would not be allowed to operate, as described in the Draft EIR/EIS for the Bay Delta Conservation Plan (BDCP). The BDCP would be operated in a manner to protect water users and environmental habitat located upstream of and in the Delta in accordance with permits issued by the SWRCB, USFWS, NMFS, and California Department of Fish and Wildlife. As described in the Draft EIR/EIS for the BDCP, the full capacity of the North Delta intakes would only be used during periods with high river flows, such as following a major rainfall event or rapid snow melt event.

AA 39: Section 7.3 of Chapter 7, Groundwater Resources and Groundwater Quality, has been modified to include a discussion of the project referred to in this comment.

AA 40: The projects listed in this comment are either considered to be relatively short-term and may not be implemented in 2030 or speculative.

The cumulative effects analysis in the Final EIS has been modified to include the 2015 *Westlands v. United States* Settlement.

The transfer projects described in this comment are scheduled to be completed before 2030. However, as described in the response to Comment AA 29, it is anticipated that similar programs would continue in the Year 2030 in the No Action Alternative, Second Basis of Comparison, and Alternatives 1 through 5. Therefore, these projects are not also included in the cumulative impact analysis.

Future installation of groundwater wells also is considered to continue in the Year 2030 in the No Action Alternative, Second Basis of Comparison, and Alternatives 1 through 5. However, it would be speculative to project the details of specific projects. The expansion of wellfields was anticipated in the EIS as groundwater is used to replace reductions in CVP and SWP water deliveries under some alternatives as compared to the No Action Alternative and Second Basis of Comparison. The impacts of the additional withdrawals are included in the impact analysis in Chapter 7, Groundwater Resources and Groundwater Quality. The programs listed in this comment could be part of those actions as CVP water deliveries have been reduced as compared to historical conditions.

AA 41: The District Court required Reclamation to prepare a NEPA document upon the provisional acceptance of the RPA actions in the 2008 USFWS BO and 2009 NMFS BO. Reclamation has consulted DWR on this matter and DWR has stated that there was no state action requiring CEQA.

AA 42: The mitigation measures adopted by Reclamation will be included in the Record of Decision.

AA 43: The Preferred Alternative was defined following review of comments on the Draft EIS. The Preferred Alternative is described in Section 1.5 of Chapter 1, Introduction, of the Final EIS.

AA 44: As described in Section 3.3, Reclamation included the Second Basis of Comparison to identify changes that would occur due to actions that would not have been implemented without Reclamation's provisional acceptance of the BOs, as required by the District Court order. Alternative 1 is included in the range of alternatives considered in this EIS because the Second Basis of Comparison is not an alternative under NEPA.

AA 45: Comment noted. The EIS analysis adequately addresses the effects of the coordinated long-term operation of the CVP and SWP.

1D.1.2 California Farm Bureau Federation

From: **Justin Fredrickson** <JEF@cfbf.com>
Date: Tue, Sep 29, 2015 at 5:17 PM
Subject: California Farm Bureau Federation Staff Comments On Draft Eis Re: Long-Term CVP/SWP Coordinated Operations
To: "bcnelson@usbr.gov" <bcnelson@usbr.gov>

The following general input is offered on the above-referenced Draft EIS:

NEPA requires Reclamation to consider impacts of the proposed action, not only on the physical environment, but also on the quality of the human environment, and to choose the least damaging, self-mitigating alternative. This is especially important in light of the severe social, economic, and environmental impacts of the current biological opinions and to the extent our courts have held that the Endangered Species Act makes no provision for human and economic impacts and essentially allows no balancing of harms. CFBF 1

Groundwater is a key physical impact to consider when looking at long-term impacts of coordinated CVP/SWP operations under the existing biological opinions. Surface water supply is another key parameter to consider. CFBF 2

Agricultural resources and land use impacts and socioeconomic impacts—including, especially, agricultural employment and economic impacts to agriculture—are key impacts to consider in relation to the human environment. CFBF 3 Groundwater can indirectly impact the human environment by impacting domestic wells, drinking water, disadvantaged communities, etc. Air quality impacts from less land in production are another key consideration with respect to the human environment. CFBF 4

In general terms, NEPA compels Reclamation to implement the alternative with the least adverse impacts to surface supplies and associated groundwater pumping that would, in turn, go furthest to reduce adverse impacts to the human environment—including especially impacts on agricultural resources, land use, and the socio-economics. CFBF 5

1

The EIS's assumptions about groundwater as a straight 1:1 substitute for lost surface water deliveries through 2030 (or even 2042), and on associated impacts to agricultural resources, land use, and socioeconomics, regardless of the impact on groundwater levels, pumping costs, and new state regulation of groundwater, are questionable assumptions and appear to mask the severity of potential adverse effects in these key resource areas. CFBF 6

Justin E. Fredrickson

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California Farm Bureau Federation

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1D.1.2.1 Responses to Comments from California Farm Bureau Federation

CFBF 1: The Council of Environmental Quality regulations provide for the lead agency (Reclamation for this EIS) to identify the preferred alternative that will fulfill the statutory mission and responsibilities, with consideration to physical, environmental, human resource, and economic factors. The preferred alternative does not need to be the least damaging, self-mitigating alternative. The Preferred Alternative is described in Section 1.5 of Chapter 1, Introduction, of the Final EIS.

CFBF 2: The changes in groundwater and surface water conditions under the alternatives in this EIS as compared to the No Action Alternative and the Second Basis of Comparison can be used to differentiate between the alternatives, including the No Action Alternative, as described in Chapter 5, Surface Water Resources and Water Supplies, and Chapter 7, Groundwater Resources and Groundwater Quality, of this EIS.

CFBF 3: The EIS analysis includes an evaluation of changes in CVP and SWP water deliveries based on the CalSim II models and the related changes in groundwater elevations, agricultural land uses, and agricultural economics in the CVP and SWP water service areas, as described in Chapter 5; Chapter 7; and Chapter 12, Agricultural Resources, in the EIS. As described in Chapter 12, changes in CVP and SWP surface water deliveries and groundwater use would result in no substantial changes in agricultural land use and employment.

CFBF 4: The EIS analysis indicates that agricultural land use would not substantially change under the Alternatives 1 through 5 as compared to the No Action Alternative, and under the No Action Alternative and Alternatives 1 through 5 as compared to the Second Basis of Comparison. Therefore, there are no changes in dust generation from agricultural lands, as described in Chapter 16, Air Quality and Greenhouse Gas Emissions.

CFBF 5: As described in the response to Comment CFBF 1, the Council of Environmental Quality regulations provide for the lead agency (Reclamation for this EIS) to identify the preferred alternative that will fulfill the statutory mission and responsibilities, with consideration to physical, environmental, human resource, and economic factors. The preferred alternative does not need to be the alternative with the least adverse impacts to surface water supplies, groundwater, agricultural production, land use, and socioeconomics.

CFBF 6: The SWAP model, a regional agricultural production and economic optimization model that simulates the decisions of farmers across 93 percent of agricultural land in California, was used to determine changes in agricultural land use and employment based upon changes in CVP and SWP water deliveries and cost-effective water supplies, as described in Appendix 12A, Statewide Agricultural Production Model (SWAP) Documentation, of the EIS. The SWAP model simulates changes in Year 2030 based upon economic optimization factors related to crop selection, water supplies, and other factors to maximize profits with consideration of resource constraints, technical production relationships, and market conditions. The model indicated that even with the cost of groundwater pumping from greater depths, the overall agricultural production could be maintained. The analysis assumes changes occur under the No Action Alternative and Second Basis of Comparison between the recent conditions and Year 2030 with or without implementation of the 2008 USFWS BO and the 2009 NMFS BO; and the EIS evaluates changes in 2030 under the alternatives discussed Chapter 5 through 21 of the EIS.

1D.1.3 Coalition for a Sustainable Delta

Coalition for a Sustainable Delta

September 29, 2015

VIA E-MAIL

Ben Nelson
U.S. Bureau of Reclamation
Bay-Delta Office
801 I Street, Suite 140
Sacramento, CA 95814-2536
bcnelson@usbr.gov

Re: Draft Environmental Impact Statement for the Coordinated Long-Term Operation of the Central Valley Project and State Water Project

Dear Mr. Nelson,

CSD 1

The Coalition for a Sustainable Delta (Coalition) is a California nonprofit corporation comprised of agricultural, municipal, and industrial water users, as well as individuals in the San Joaquin Valley. The Coalition and its members depend on water from the Sacramento-San Joaquin Delta (Delta) for their continued livelihood. Individual Coalition members frequently use the Delta for environmental, aesthetic, and recreational purposes; thus, the economic and non-economic interests of the Coalition and its members are dependent on a healthy and sustainable Delta ecosystem.

The Coalition appreciates the opportunity to review the Draft Environmental Impact Statement for the Coordinated Long-Term Operation of the Central Valley Project (CVP) and State Water Project (SWP) issued on July 31, 2015 (DEIS). The Coalition also appreciates the Bureau of Reclamation's (Bureau) efforts to involve stakeholders in the scoping process, as well as during the preparation of the DEIS. The Coalition believes that this collaborative approach will enable the Bureau to fully evaluate the potential environmental impacts of the proposed action and to otherwise fulfill its obligations under the National Environmental Policy Act (NEPA).

CSD 2

The Coalition has reviewed the DEIS and has a few concerns regarding the following:

1. The improperly narrow purpose of the proposed action;
2. The range of alternatives;
3. The disparate treatment of scientific uncertainty;

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4. The assumptions regarding groundwater;

5. The lack of factual support for the Bureau's conclusions as respects ocean harvest; and

6. The failure to fully incorporate relevant, high quality scientific information.

The Coalition encourages the Bureau to consider these concerns, which are discussed in further detail below, as it moves forward in preparing the final environmental impact statement (EIS).

CSD 2 continued

I. Purpose of the Proposed Action.

As noted by the Coalition in its prior letter to the Bureau dated July 13, 2015, the purpose of the proposed action is defined too narrowly, so as to preclude evaluation of potentially significant changes to CVP and SWP operations. In pertinent part, the DEIS states that the purpose of the proposed action is to continue the operation of the CVP and SWP in a manner that "[i]s similar to historic [sic] operational parameters with certain modifications." DEIS at 2-1. This statement improperly restricts the scope of the Bureau's environmental review, and precludes consideration of alternatives that would alter operations from those implemented in the past. This statement also does not reflect the "underlying" purpose of the proposed action, which is more general in nature. *See* 40 C.F.R. § 1502.13; *see also City of Carmel-By-The-Sea v. U.S. Dept. of Transp.*, 123 F.3d 1142, 1155 (9th Cir. 1997) (it is an abuse of discretion to define project objectives in unreasonably narrow terms because "[t]he stated goal of a project necessarily dictates the range of 'reasonable' alternatives.") (citation omitted). Thus, the Coalition urges the Bureau to revise the purpose of the proposed action to omit any reference to "historical operational parameters."

CSD 3

II. Description of Alternatives.

The Coalition recognizes and appreciates that the Bureau has developed Alternatives 3 and 4 based on scoping comments submitted by the Coalition. However, the Coalition has concerns regarding two of the Bureau's conclusions relating to the Coalition's proposed suite of actions.

A. San Joaquin River Inflow.

Action IV.2.1 of the Reasonable and Prudent Alternative (RPA) included in the National Marine Fisheries Service's (NMFS) 2009 Biological Opinion (BiOp) imposes an inflow to export (I:E) ratio requirement on San Joaquin River flows during certain periods of the year. As reflected in Table 3.1 of the DEIS, the Coalition suggested that these flow criteria be modified as follows:

> Flows in San Joaquin River at Vernalis (7-day running average shall not be less than 7 percent of the target requirement) shall be based on the New Melones

CSD 4

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Index (as described in [NMFS BiOp] RPA Action IV.2.1) as follows for January 1 through June 15: CSD 4 continued

a) If the Index is 999 TAF or less - no minimum flow requirement[;]

b) If the Index is 1000-1399 TAF - minimum flow is the greater of the SWRCB D-1641 requirement or 1500 cfs[;]

c) If the Index is 1400-1999 TAF - minimum flow is the greater of the SWRCB D-1641 requirement or 3000 cfs[;]

d) If the Index is 2000-2499 TAF - minimum flow is 4500 cfs[;]

e) If the Index is above 2499 TAF - minimum flow is 6000 cfs.

DEIS at 3-25, 3-26. The DEIS states, however, that "this criteria is not implementable following the completion of the Vernalis Adaptive Management Program [VAMP]." *Id.* at 3-25. The Bureau's explanation with respect to this issue is confusing. Is the Bureau asserting that it will not have sufficient water to satisfy the Coalition's proposed flow criteria without implementation of VAMP? If so, this would appear to mean that, while the Bureau believes there is enough water to satisfy the current I:E ratio requirements, the Bureau believes there is not enough water (without VAMP) to satisfy the proposed inflow requirements, with no limitations on exports. This would suggest that the export limitation component of the I:E ratio is the driving factor allowing the Bureau to satisfy that requirement. Thus, according to the Bureau, inflow requirements alone, as proposed by the Coalition, cannot be satisfied without VAMP.

The Bureau's reasoning with respect to this issue in unclear. Please provide additional details regarding why the Bureau believes that the proposed modifications are not implementable. In the alternative, please analyze the Coalition's proposed alternative without adjusting the inflow requirement.

B. Wastewater Treatment Plants.

As set forth in Table 3.1, the Coalition suggested that water quality improvement programs at two water treatment plants—the Sacramento Regional Wastewater Treatment Plant and the Fairfield-Suisun Sewer District treatment plant—be expedited to allow for earlier realization of the expected benefits. DEIS at 3-28, 3-29. According to the Bureau, however, "both of these actions would be complete by 2030, the study period considered in [the DEIS]." DEIS at 3-43. That is, "[b]ecause the Environmental Consequences analysis in this EIS is conducted as a 'snapshot' in time at 2030, inclusion of a provision to require compliance with the discharge requirements prior to 2020 [c]ould not be evaluated." *Id.* The Bureau's reasoning with respect CSD 5 to this issue is problematic. The fact that the proposed actions would be completed prior to 2020 should not preclude the Bureau's consideration of them.[1] The proposal could ultimately improve conditions in the Delta prior to 2030. That is, the proposal could result in different—likely better—baseline conditions in 2030. Thus, the Bureau could consider the benefits that would result from the proposal, and be present in the Delta, in 2030. This would be consistent with the Bureau's "snapshot" approach.

CSD 5 continued

The flaws in the Bureau's reasoning are also apparent in other sections of the DEIS. For example, in Chapter 6, with respect to Alternative 4, the DEIS states: "Water quality under Alternative 4 would be identical to conditions under the Second Basis of Comparison." DEIS at 6-105. But, this is only the case because the Bureau has rejected the Coalition's water treatment plant proposal. Nothing in the Bureau's "snapshot" approach precludes the Bureau from taking into account the benefits of the Coalition's proposal. The Bureau could simply analyze the extent to which water quality conditions would improve under Alternative 4 (qualitatively, if necessary), and then continue its analysis from there.

This issue arises in other contexts as well, including with respect to invasive species. The DEIS states that a Total Maximum Daily Load (TMDL) addressing impairment due to invasive species is expected to be complete by 2019. DEIS at 6-73. Yet the water quality benefits of the TMDL, which should be included within the No Action Alternative and the Second Basis of Comparison, are not part of the baseline. *See* Daniel R. Mandelker, NEPA Law and Litig. § 10:33.20 (2014) (EIS must contain "an adequate compilation of relevant data and information, including baseline data) (citing, among others*, Northern Plains Resource Council, Inc. v. Surface Transp. Bd.*, 668 F.3d 1067 (9th Cir. 2011) (baseline data inadequate)).

Moreover, in general, the Bureau's "snapshot" approach is concerning. DEIS at 3-43; *see also id.* at 4-1 (describing that the DEIS does "not address interim changes that would occur between now and 2030"); *id.* at 1-11 ("this EIS analyzes future conditions projected for 2030"); *id.* at 3-4 ("[c]hanges that will occur over the next 15 years without implementation of the alternatives are not analyzed in this EIS."). While agencies have discretion to establish the temporal scope of NEPA analyses, this discretion is not unlimited. *See Selkirk Conservation Alliance v. Forsgren*, 336 F.3d 944, 962 (9th Cir. 2003) (NEPA does not impose a requirement that federal agencies analyze impacts of actions for any particular length of time). An agency cannot select a temporal scope that allows them to "shirk their responsibilities under NEPA." *Id.* Here, as a practical matter, the EIS ignores significant impacts that could occur in the Delta in the near-term, and only analyzes impacts in the long-term. It is not clear that this approach

[1] To the extent that the Bureau is asserting that the proposal could not be evaluated because it could not be quantitatively modeled, the Bureau should have at least analyzed the proposal qualitatively. This is consistent with qualitative analyses already performed by the Bureau with respect to the alternatives. *See, e.g.,* DEIS at 7-122.

CSD 5 continued

satisfies the Bureau's obligations to take a "hard look" at the environmental consequences of the proposed action. *Id.* at 959.

Thus, the Coalition requests that the Bureau incorporate the Coalition's wastewater treatment plant proposal into Alternative 4. The Coalition further requests that the Bureau ensure that its "snapshot" approach is applied in a manner that is consistent with NEPA, including with respect to invasive species.

III. Disparate Treatment of Scientific Uncertainty

CSD 6

The Bureau appears to have concluded that the benefits associated with the non-operational components of Alternatives 3 and 4 (i.e., ocean harvest restrictions, predator control measures, and trap and haul requirements) are uncertain. *See,* e.g., DEIS at 9-402 ("Overall, given the small differences between Alternative 3 and the No Action Alternative conditions and the *uncertainty regarding the non-operational components*, distinguishing a clear difference is not possible) (emphasis added); *see also* 9-281, 9-287, 9-296, 9-300 (same). The Coalition has several concerns regarding these conclusions.

As an initial matter, and as more fully set forth below in Section V with respect to ocean harvest, the analyses in the DEIS do not support the Bureau's conclusions that benefits associated with non-operational components are uncertain. For example, with respect to trap and haul, the DEIS states:

> "To assess the potential benefits and risks of a transportation [trap and haul] program for salmonids in the San Joaquin River, an analysis of [coded-wire-tag] recovery rates for Chinook Salmon reared at the Feather River Hatchery and the Mokelumne River Hatchery was performed. Based on this analysis, *Alternative 3 is expected to directly benefit juvenile fall-run Chinook Salmon and steelhead smolts originating from the San Joaquin River basin by comparison to the No Action Alternative*. The program would also benefit spring-run Chinook Salmon if these fish become established as part of the San Joaquin River Restoration Program, or as part of the New Melones fish passage project."

DEIS at 316 (emphasis added). Yet, on multiple occasions, the Bureau characterizes these benefits as "uncertain." *Id.* at 9-281, 9-287, 9-296, 9-300, 9-402; *see also* Section V., *infra*. In doing so, the Bureau has failed to comply with bedrock principles of administrative law, which require agencies to provide a rational connection between the facts found and the choices made. *Motor Vehicles Mfrs. Ass'n of U.S., Inc. v. State Farm Mut. Auto Ins. Co.*, 463 U.S. 29, 43 (1983).

CSD 7

Even assuming that the benefits associated with the non-operational components of Alternatives 3 and 4 are in fact uncertain, the Bureau has failed to take into account or

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otherwise address uncertainty in a consistent manner in the DEIS. In particular, many of the Bureau's conclusions with respect to measures quantitatively analyzed, including Old and Middle River (OMR) measures, are expressed without any acknowledgement of the associated uncertainty. CSD 7 continued

For example, in Appendix 9G, the DEIS explains that the delta smelt entrainment analysis is based on regression equations that take into account combined OMR flows and the location of X2.[2] The analysis is premised on the assertion that X2 is an indicator of suitable abiotic habitat for delta smelt. Yet, in other chapters, the DEIS acknowledges that this conclusion has been questioned. DEIS at 9-64, 9-66. Agencies are required to discuss areas of controversy and opposing points of view, 40 C.F.R. §§ 1502.9(b), 1502.12, in order to provide the public with a "full and fair discussion" of significant environmental impacts. *Id.* at § 1502.1. Here, a more even-handed approach would be to revise Appendix 9G to acknowledge the inherent uncertainty that arises when using a formula that relies on a hypothesis that is scientifically questionable.

In sum, the Bureau's conclusions ignore the inherent uncertainty found in all scientific modeling. The fact that certain measures are capable of quantitative analyses does not make the conclusions derived therefrom less uncertain, particularly where, as here, there are significant, unproved assumptions that are incorporated into the modeling. Yet, the Bureau emphasizes the uncertainty associated with non-operational proposals, but does not do the same with respect to operational measures. The Bureau's analyses in the DEIS should be revised to correct the disparate treatment of scientific uncertainty.

IV. Groundwater Assumptions.

CSD 8

The DEIS contains several inaccurate assumptions relating to groundwater. For example, Chapter 5, relating to Surface Water Resources and Water Supplies, states: "The No Action Alternative and the Second Basis of Comparison assume that groundwater would continue to be used even if groundwater overdraft conditions continue or become worse." DEIS at 5-68. The DEIS acknowledges that the Sustainable Groundwater Management Act (SGMA) was enacted in 2014, but concludes that: "[T]o achieve sustainable conditions in many areas, measures could require several years to design and construct water supply facilities to replace groundwater, such as seawater desalination. Therefore, it does not appear to be reasonable and foreseeable that sustainable groundwater management would be achieved by 2030; and it is assumed that groundwater pumping will continue to be used to meet water demands not fulfilled with surface water supplies or other alternative water supplies in 2030." DEIS at 5-69.

[2] X2 refers to the point in the Delta where the isohaline is two parts per thousand.

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CSD 8 continued

Notably, the DEIS expressly acknowledges the significant adverse effects that are caused by groundwater overdraft. *See, e.g.,* DEIS at 7-15, 7-18, 7-21, 7-31, 7-45 (describing concerns regarding subsidence, increased water supply well drilling, and significant drops in groundwater levels between 2010 and 2014 due to drought (up to 40 feet in Kern County)). Thus, contrary to the Bureau's conclusions, it is unreasonable to assume that affected agencies and stakeholders will continue to rely on groundwater, given all of the deleterious impacts associated with groundwater exploitation. *See id.* at 7-116.

Moreover, the groundwater assumptions in the DEIS with respect to agriculture are particularly concerning. Chapter 12, relating to Agricultural Resources, states: "The analysis does not restrict groundwater withdrawals based upon groundwater overdraft or groundwater quality conditions....Therefore, it was assumed that Central Valley agriculture water users would not reduce groundwater use by 2030, and that groundwater use would increase in response to reduced CVP and SWP water supplies." DEIS at 12-24. Based on these assumptions, the Bureau concludes that there will be no changes in conditions for agricultural resources under Alternatives 1 through 5 because, according to the Bureau, decreases in CVP and SWP water supplies will be made up with groundwater. DEIS at 12-57.

The Bureau's conclusions are simply not supported by the facts. Indeed, the analysis in Chapter 12 includes several examples of how agriculture has been significantly impacted by reduced CVP and SWP water supplies. These examples include:

- "In extreme dry periods, such as 2014 when there were no deliveries of CVP water to San Joaquin Valley water supply agencies with CVP water service contracts, permanent crops were removed because the plants would not survive the stress of no water or saline groundwater (Fresno Bee 2014)." DEIS at 12-10.

- Due to the increased frequency of water supply reductions, especially in drier years ..., the amount of fallowed and non-harvested lands has increased as a percentage of total lands within Westlands Water District. *Id.* at 12-12.

- Since 2000, farmers have increased the amount of fallowed and non-harvested acres to 10 to 34 percent of the total land in the [Westlands water] district. *Id.* at 12-15.

If the Bureau's assumptions were correct – that loss of CVP and SWP water supplies would be made up with groundwater – these conditions would not have occurred. The fact that agricultural production has decreased significantly over the past several years undermines the Bureau's conclusions.

CSD 9

Furthermore, the Bureau's assumptions with respect to groundwater use and agriculture are not necessary. Using the same Statewide Agricultural Production Model utilized in the DEIS, DEIS at 12-23, the Bureau could have modeled alternative ranges of groundwater pumping.

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This approach was employed in 2009, under similar drought conditions. *See* Richard E. Howitt, Duncan MacEwan, and Josue Medellin-Azuara, *Economic Impacts of Reductions in Delta Exports on Central Valley Agriculture*, AGRICULTURAL AND RESOURCE ECONOMICS, Vol 12, No. 3 (Jan/Feb 2009). In assessing the economic impacts of reductions in CVP and SWP exports on Central Valley agriculture, Howitt et al. expressly acknowledged: "[T]he ability of farmers to pump additional groundwater depends on both its availability and the cost of pumping. Due to uncertainty in the ability of farmers to increase pumping in the short run, results are calculated for a range of groundwater pumping increases of 25, 50, 75, and 100%." The results of their analyses therefore reflect this range of groundwater pumping. *Id.* at 2 ("Revenue losses for Central Valley farmers range from $1.2 to $1.6 billion for 2009, depending on farmer groundwater pumping response."); *id.* ("Depending on the ability of farmers to increase groundwater pumping, gross revenue losses could range as high as $1.6 billion."). CSD 9 continued

Not only do Howitt et al. provide an alternative approach by which the Bureau could analyze agricultural impacts,[3] but they demonstrate that the Bureau's current assumptions with respect to groundwater are flawed. And it is improper for the Bureau to rely on incorrect assumptions. *See Natural Res. Def. Council v. U.S. Forest Serv.*, 421 F.3d 797, 812 (9th Cir. 2005) (rejecting U.S. Forest Service's conclusions in an EIS because they were based on incorrect data and assumptions). Moreover, courts do not hesitate to reject methodologies that are clearly flawed. *See, e.g., Conservation Nw. v. Rey*, 674 F. Supp. 2d 1232, 1249 (W.D. Wash. 2009) (holding the "Agencies' methodology [as respects forest plans] is flawed enough to be a violation of NEPA"). In short, Howitt et al.'s results directly contradict the Bureau's conclusions that agricultural resources will not be impacted under Alternatives 1 through 5. Howitt et al. at 3-4 ("SWAP model results show that substantial reductions in available water from CVP and SWP deliveries ... will severely reduce Central Valley income, employment, revenues, and cropped acres.").

Nor do the Bureau's conclusions make sense as a practical matter. It is well established that CVP and SWP exports will be significantly reduced under the No Action Alternative, as compared to the Second Basis of Comparison, due to implementation of the RPAs included in 2008 U.S. Fish and Wildlife BiOp and the 2009 NMFS BiOp. *See* DEIS at ES-20 ("Long-term average annual exports would be 1,051 [thousand acre feet] (22 percent) more under Alternative 1 [Second Basis of Comparison] as compared to the No Action Alternative"); *see also* CSD 10

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[3] Other publications also suggest that alternative groundwater modeling approaches are available to assess the impacts of CVP and SWP export reductions on agriculture. *See* Nicholas Brozovic, David Zilberman, and David Sunding, *On The Spatial Nature of the Groundwater Pumping Externality,* RESOURCE AND ENERGY ECONOMICS 32(2010): 154-164*;* Steven Buck, Maximillian Auffhammer, and David Sunding, *Land Markets and the Value of Water Supply: Hedonic Analysis using Panel Data,* AMERICAN JOURNAL OF AGRICULTURAL ECONOMICS 96(2014): 953-969.

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State Water Project Final Delivery Reliability Report (2011) at 38-39 (showing a decrease in SWP exports from 2005 to 2011 of 10.4% due to implementation of the RPAs); State Water Project Final Delivery Reliability Report (2013) at 30-32 (showing a decrease in SWP exports from 2005 to 2013 of 9.4% due to implementation of the RPAs). It is simply not reasonable to assume that farmers will be able to pump over a thousand acre feet of groundwater to recoup this loss. As explained by Howitt et al., there is significant doubt associated with groundwater availability and cost, and the Bureau has altogether ignored this uncertainty. [4] CSD 10 continued

In sum, the Bureau's assumptions with respect to groundwater are fundamentally flawed. Not only are local agencies subject to the requirements of the SGMA, which requires Groundwater Sustainability Plans by 2020, but it is simply unreasonable to assume that agencies will exploit groundwater resources in the manner suggested. The Bureau's analysis should be revised to better reflect the range of groundwater pumping that could occur under Alternatives 1 through 5, and the impacts that this range would have on agricultural resources.

V. Ocean Harvest Conclusions are Unsupported by the Facts.

In the context of a NEPA challenge, an agency's decision is arbitrary and capricious if the agency (1) relied on factors Congress did not intend it to consider, (2) entirely failed to consider an important aspect of the problem, or (3) *offered an explanation that runs counter to the evidence before the agency*. *Ctr. for Biological Diversity v. Salazar*, 695 F.3d 893, 902 (9th Cir. 2012) (emphasis added); *Friends of Endangered Species, Inc. v. Jantzen*, 760 F.2d 976, 986 (9th Cir. 1985) (agency must engage in "a reasoned analysis of the evidence before it"). CSD 11

Alternatives 3 and 4 include an action to modify ocean harvest for the purpose of minimizing mortality of natural original Central Valley Chinook Salmon. DEIS at 3-37, 3-40. The DEIS explains that, although approximately 75-90 percent of harvested salmon are hatchery fish, the

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[4] Notably, the recently released Partially Recirculated Draft Environmental Impact Report/Supplemental Draft EIS for the Bay Delta Conservation Plan/California WaterFix (RDEIR/SDEIS) includes statements inconsistent with those found in the DEIS. For example, with respect to agricultural resources, the RDEIR/SDEIS states: "The responses of water agencies to extended droughts provide good insights into the effects of *further reductions in exports of Delta water supplies*. The 1987–1992 drought had severe impacts on water agencies. Many purchased water from alternative sources to offset reduced Delta supplies, often at very high costs that some clients were unable to afford. Farmers responded to the resultant higher costs by increasing their own groundwater pumping and reducing their purchases from water agencies, *but also fallowed large acreages of both annual and permanent crop land*." RDEIR/SDEIS at 4.2-9 (emphasis added). Thus, while increased groundwater pumping may occur as a result of reduced Delta exports, it is unreasonable to assume that agricultural resources will not be impacted.

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fishery is often required to protect ESA-listed stocks, which include runs of Central Valley Chinook salmon. *Id.* at 9-277. The Bureau notes that "the impact of ocean harvest varies considerably by stock, but all stocks are impacted by harvest …." *Id.* The Bureau further explains: "We have the tools, the knowledge and the ability to manage Chinook ocean harvest in whatever way is needed. As such, Alternative 3 is, from a technical and scientific level, entirely feasible." *Id.* CSD 11 contined

Noting the intense harvest pressure on the various Chinook runs, the Bureau goes on to detail the benefits that would occur from reduced ocean harvest. DEIS at 9-278 ("reduced ocean harvest [for spring-run] would contribute substantially to age at-maturity diversity (certainly demographically, if not genetically) and thereby enhance population viability"); *id.* at 9-279 ("in the absence of this harvest, winter-run Chinook Salmon would have a larger fraction of their population maturing at age-4 or possibly older [which would] enhance demographic population viability, but also benefit the population by more effectively spawning in coarse substrates, and producing more, larger, and more thermally tolerant eggs); *id.* at 279-280 (noting "harvest of natural origin fall-run Chinook Salmon appears to occur at a much higher rate than population productivity can sustain" and concluding "[c]hanges in harvest strategies which could more effectively target hatchery origin fall Chinook while better protecting natural origin fish would yield substantial benefits"). The Bureau concludes: "Managing ocean salmon harvest as described in Alternative 3 would contribute to the abundance, productivity and diversity viability criteria for natural origin spring-run, winter-run, and fall-run Chinook Salmon." *Id.* at 9-280.

Inexplicably, however, the benefits of the ocean harvest action are simply not reflected in the Bureau's conclusions. After stating that ocean harvest restrictions "could" benefit winter-run, spring-run, and fall-run, the Bureau concludes that, due to "uncertainty regarding the non-operational components [including ocean harvest restrictions], distinguishing a clear difference between alternatives is not possible." *Id.* at 9-280, 9-287, 9-296. This conclusion is unsupported by the Bureau's earlier analysis, in which it noted that the proposed harvest restrictions were technically feasible and would benefit the populations. The Bureau's conclusions should be revised to better reflect its analyses, which indicate that the ocean harvest restrictions will benefit listed Chinook salmon. To do otherwise would be contrary to the administrative mandate that agencies provide a rational connection between the facts found and the choices made. *See Motor Vehicles Mfrs. Ass'n of U.S., Inc. v. State Farm Mut. Auto Ins. Co.*, 463 U.S. at 43.

It should also be noted that, with respect to Alternative 4, which includes the same ocean harvest action as Alternative 3, there is no alternatives analysis whatsoever. In one conclusory sentence, the DEIS states: "Conditions related to salmonid survival could be improved under Alternative 4 as compared to the No Action Alternative due to implementation of: trap and haul program, changes in bag limits, and changes in PMFC/NMFS harvest limits." *Id.* at 342. This is CSD 12

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certainly not a reasoned scientific analysis sufficient to satisfy NEPA. *See Friends of Endangered Species, Inc. v. Jantzen,* 760 F.2d at 986.

CSD 12 continued

VI. Full Incorporation of New Scientific Information.

CSD 13

In the Coalition's previous letter dated July 13, 2015, the Coalition included an exhibit setting forth a list of publications that the Bureau should consider in its analyses. The Coalition appreciates that the Bureau has revised certain sections of the DEIS to reflect this list of publications. *E.g.,* DEIS at 9-64, 9-73, 9-141.

However, the Coalition is concerned that only certain sections have been updated, while other relevant sections are still based on incomplete information. For example, Section 9.4.1.3.5, the analysis on page 9-194, and Appendix 9G, which all relate to delta smelt, should be updated to reflect new, relevant scientific information.

NEPA requires information contained within an EIS to be of "high quality." 40 C.F.R. § 1500.1(b). "Accurate scientific analysis, expert agency comments, and public scrutiny are essential to implementing NEPA." *Id.* Agencies must "insure the professional integrity, including scientific integrity, of the discussions and analyses in [an EIS]." 40 C.F.R. § 1502.24.

Thus, the Coalition requests that the Bureau revise the EIS to ensure that all relevant analyses are updated to reflect the new, relevant scientific information previously identified by the Coalition.

V. Conclusion.

CSD 14

In sum, the Coalition urges the Bureau to address the foregoing items prior to issuance of the final EIS. We would be happy to discuss these issues further at your convenience.

Sincerely,

William D. Phillimore
Board Member

cc: Patricia Aaron, U.S. Bureau of Reclamation

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1D.1.3.1 Attachments to Comments from Coalition for a Sustainable Delta

Attachments to the Coalition for a Sustainable Delta letter are included in Attachment 1D.1 located at the end of Appendix 1D.

1D.1.3.2 Responses to Comments from Coalition for a Sustainable Delta

CSD 1: Comment noted.

CSD 2: Please see responses to Comments CSD 3 through CSD 20.

CSD 3: Reclamation was directed by the District Court to remedy its failure to conduct a NEPA analysis when it accepted and implemented the 2008 USFWS BO RPA and the 2009 NMFS BO RPA pursuant to the Federal Endangered Species Act of 1973 (ESA) as amended (United States Code [U.S.C.] 1531 et. seq.). In order to satisfy the Court's directive, Reclamation has analyzed operation of the CVP, in coordination with the operation of the SWP, consistent with the BOs, as well as alternatives which represent potential modifications to the continued long-term operation of the CVP in coordination with the SWP. The purpose of the action, as described in Chapter 2, Purpose and Need, considers the purposes for which the CVP was authorized, as amended by CVPIA, as well as the regulatory limitations on CVP operations, including applicable state and federal laws and water rights. This purpose statement does not limit the analysis of the range of alternatives which includes alternatives with CVP and SWP operational assumptions substantially different than historic operational parameters. Because existing facilities were designed and constructed to operate under a variety of hydrologic conditions, Reclamation's operation of the CVP facilities is within the original designed range of operations.

CSD 4: The limited water supply available to Reclamation on the Stanislaus River through water rights associated with the New Melones Reservoir, are fully committed to multiple beneficial uses, including those on the Stanislaus River. The Vernalis Adaptive Management Program allowed for additional sources of water, other than available water within New Melones Reservoir to be used to maintain flow in the San Joaquin River. After the completion of this program, Reclamation does not have sufficient supply available in New Melones Reservoir to meet inflow targets suggested by CSD. Therefore, the I:E ratio can only be met through export limitations, and not through releases from New Melones Reservoir.

CSD 5: The wastewater treatment plant improvements for the Sacramento Regional Wastewater Treatment Plant are under construction. The final facilities, the tertiary treatment plant facilities, are scheduled to be completed in 2023. Because construction is underway on a site that requires continuous operation of existing facilities, it would be difficult for Reclamation to require an accelerated construction schedule. The new facilities are anticipated to be operated at least seven years prior to the Year 2030. Therefore, it is assumed that these facilities will be constructed and in operation in the same manner under the No Action Alternative, Second Basis of Comparison, and Alternatives 1 through 5 in the Year 2030. The EIS analysis does not compare conditions under the existing conditions to conditions under the No Action Alternative, Second Basis of Comparison, and Alternatives 1 through 5.

The EIS analysis is a comparative analysis of conditions at Year 2030 that compares Alternatives 1 through 5 to the No Action Alternative, and No Action Alternative and Alternatives 1 through 5 to the Second Basis of Comparison. Implementation of the Total Maximum Daily Load and other existing water quality objectives by 2020 in accordance with identified schedules would be consistent under the No Action Alternative, Alternatives 1 through 5, and Second Basis of Comparison. Therefore, the results of the comparison of the alternatives would not be affected by implementation of these criteria.

CSD 6: Additional details of the analysis of the trap and haul program associated with Alternatives 3 and 4 is included in the Final EIS as Appendix 9O and Section 9.4.1 of Chapter 9, Fish and Aquatic Resources. Text revisions to page 9-316 of the Draft EIS indicate an improvement in survival and clarify uncertainty by describing the potential for unintended consequences associated with the trap and haul program. Text was also added to pages 9-287, 9-296, and 9-300 of the Draft EIS to indicate the potential for improved survival due to the non-operational measures included in Alternative 3.

CSD 7: The text on page 9G-2 of Appendix 9G, Smelt Analysis, has been modified to reflect the uncertainty associated with using X2 as an indicator of suitable habitat for Delta Smelt. Text has been added to Chapter 9 of the Final EIS related to uncertainty regarding analysis of operational measures.

CSD 8: It is impossible to exactly predict how groundwater users would respond to changes in surface water deliveries in Year 2030. The Sustainable Groundwater Management Act does not prevent increased groundwater withdrawals until the Groundwater Sustainability Plans are completely implemented in 2040 to 2042. The SWAP model, as described in Chapter 12, Agricultural Resources, of the EIS, indicates that groundwater elevations under the No Action Alternatives, the Second Basis of Comparison, and Alternatives 1 through 5 would not result in adverse economic impacts on a regional basis. As described in Section 12.4.3 of Chapter 12, reduced cultivation of agricultural lands could occur within individual farms; however, the amount of lands affected would be relatively small on a regional basis. The EIS analysis compares conditions in Year 2030 under the No Action Alternative with conditions under Alternatives 1 through 5; and conditions in 2030 under the Second Basis of Comparison with conditions under the No Action Alternative and Alternatives 1 through 5. The EIS analysis does not compare conditions under the alternatives and Second Basis of Comparison to the existing conditions in the NEPA analysis.

CSD 9: The cited Howitt et al. drought impact study was updated and revised in later months as more information became available, resulting in substantially lower estimated impacts (see Howitt et al., "Drought, Jobs, and Controversy: Revisiting 2009", Agricultural and Resource Economics, Vol 14, No. 6, Jul/Aug 2011). Importantly, the analysis in that drought impact study did not include a detailed groundwater modeling analysis to assess the physical effects of reduced water supplies on groundwater conditions. Therefore, it relied on a set of assumptions about how pumping might change. In contrast, the analysis in this EIS includes a detailed groundwater modeling analysis (as described in Chapter 7, Groundwater Resources and Groundwater Quality). The agricultural analysis in Chapter 12, Agricultural Resources, was performed based on and consistent with the results of the groundwater analysis. Based on the estimated pumping lift changes (and therefore pumping costs) relative to the value of agricultural production, the SWAP model estimates that changes in irrigated acreage and value of production would be less than 1 percent (relative to the 2030 No Action Alternative) on a regional basis. As described in Section 12.4.3 of Chapter 12, reduced cultivation of agricultural lands could occur within individual farms with more limited access to groundwater.

CSD 10: The Sustainable Groundwater Management Act does not prevent increased groundwater withdrawals until the Groundwater Sustainability Plans are completely implemented in 2040 to 2042. Therefore, groundwater use is not limited in the EIS groundwater analysis. It should be noted that Figures 7.15 through 7.60 in Chapter 7, Groundwater Resources and Groundwater Quality, have been modified in the Final EIS to correct an error that increased the changes in groundwater elevation by a factor of 3.25. This miscalculation was due to an error in a model post-processor that generates the figures related to changing the values from CVHM Model output from meters to feet. Therefore, the results in these figures and the related text in Chapter 7 are less than reported in the Draft EIS. The figures and the text have been revised in the Final EIS. No changes are required to the CVHM model.

The revised results in the figures and the text in Chapter 7 are consistent with the findings of the SWAP model.

CSD 11: The summary for winter-run Chinook Salmon effects under Alternatives 3 and 4 have been modified in Section 9.4 of Chapter 9, Fish and Aquatic Resources, in the Final EIS to provide additional details regarding the level of uncertainty associated with harvest restrictions. The modified text indicates that the harvest restrictions would likely benefit salmon.

CSD 12: As described in Appendix 9I, Onchorhynchus Bayesian Analysis (OBAN) Model Documentation, the analysis presents changes in Alternatives 3 and 4 as compared to the No Action Alternative and Second Basis of Comparison, including changes related to harvest restrictions and Old and Middle River criteria.

CSD 13: A wide range of reference materials were evaluated in the preparation of the aquatic resource analysis in the EIS, as noted in Section 9.5 of Chapter 9, Fish and Aquatic Resources. The reference materials were used to develop the affected environment sections and to consider the results of the impact analyses. During preparation of the Final EIS, the references identified in the exhibit attached to the Coalition for a Sustainable letter dated July 13, 2015 were examined and included as appropriate, as described below.

- Numerous references to the Anderson et al. papers (cited as Independent Review Panel) were included in the Draft EIS (including pages 9-75 and 9-79 regarding Delta smelt, pages 9-76 and 9-78 regarding fish passage and entrainment, and page 9-139 regarding the Pelagic Organism Decline.
- The Draft EIS already contains numerous references to Glibert (2010) and Glibert et al. (2011 and 2014). Note that the 2011 citation in the Draft EIS is the correct form of Glibert et al. (2012) in the list of references provided. The first Glibert et al. (2014) citation in the comment should be Glibert et al. (2013) and would add little to the discussion presented in the Draft EIS. The paper identified as Glibert et al. (2013) in the comment concerns modeling of plankton dynamics that was not conducted for the Draft EIS.
- The Manly et al. (2015) paper was included in the Draft EIS on page 9-64 in the Draft EIS and has been added to the discussion on page 9-115 and in Appendix 9G, Smelt Analysis.
- The life cycle models of Maunder and Deriso (2011) were identified in the Draft EIS on page 9-115 and numerous times in Appendix 9B, Aquatic Species Life History Accounts.
- Merz et al. (2011) is included in the list of studies on page 9-63 of the Draft EIS. Additional information from this reference was added to page 9B-126 in Appendix 9B. Longfin smelt distribution information from Merz et al. (2013) has been added to Sections 9B.11.2 and 9B.11.3 in Appendix 9B.
- Miller et al (2012) is included in the references for Delta smelt related to food webs on page 9-65 in the Draft EIS.
- The Murphy and Hamilton (2013) paper is included in the description of the Delta smelt distribution on page 9-63 and 9-64 of the Draft EIS. Murphy and Weiland (2011) concerns agency obligations during ESA consultation, and is not directly applicable to the analysis under NEPA. Similarly, Murphy et al. (2011) is a critique of the use of surrogate species when making management decisions and proposed actions during agency consultation and formulation of BOs by the management agencies and is not directly applicable to the NEPA analysis of alternatives in the Draft EIS. Murphy and Weiland (2014) also concerns the use of surrogates as proxies for the amount or extent of anticipated take, which again concerns ESA consultation and determination of jeopardy by the management agencies. The second Murphy and Weiland (2014) paper concerns the use of adaptive management which is outside the scope of the Draft EIS.
- The Weston et al. (2015) paper documents that certain insecticides are found in urban and agricultural creeks tributary to Suisun Marsh and that these compounds pose a risk of toxicity to aquatic organisms in the creeks, but not necessarily once diluted in the marsh. This type of impact could be important to Suisun Marsh conditions; however, it may not be discernable at the regional level analyzed in this EIS.

CSD 14: Comment noted.

1D.1.4 California Water Impact Network

From: **Carolee Krieger** <caroleekrieger7@gmail.com>
Date: Tue, Sep 22, 2015 at 7:45 PM
Subject: FW: C-WIN request a time extension for the comment period for the Coordinated Long-Term Operation of the CVP & SWP
To: bcnelson@usbr.gov

To Mr. Ben Nelson:

CWIN 1

The California Water Impact Network (C-WIN) requests that the Bureau extend the comment period 30 days for the Coordinated Long-Term Operation of the Central Valley Project and State Water Project Draft Environmental Impact Statement. This is a complicated topic and with the concurrent comment period on the DEIS/EIR for the California Water Fix (formerly BDCP), additional time to review this project is needed. An additional 30 days would be tremendously helpful for the public.

The DEIS is a court requirement because the Bureau of Reclamation hasn't analyzed direct, indirect and cumulative impacts from CVP and SWP operations while implementing the 2008 Fish and Wildlife Service Biological Opinion and a 2009 National Marine Fisheries Service BO.

Thank you.

Carolee Krieger

Executive Director, the California Water Impact Network

808 Romero Canyon Road

Santa Barbara, CA 93108

Ben Nelson

Natural Resources Specialist

Bureau of Reclamation, Bay-Delta Office

916-414-2424

1D.1.4.1 Responses to Comments from California Water Impact Network

CWIN 1: At the time the request for extension of the public review period was submitted, the Amended Judgement dated September 30, 2014 issued by the United States District Court for the Eastern District of California (District Court) in the *Consolidated Delta Smelt Cases* required Reclamation to issue a Record of Decision by no later than December 1, 2015. Due to this requirement, Reclamation did not have sufficient time to extend the public review period. On October 9, 2015, the District Court granted a very short time extension to address comments received during the public review period, and requires Reclamation to issue a Record of Decision on or before January 12, 2016. This current court ordered schedule does not provide sufficient time for Reclamation to extend public review period.

1D.1.5 California Water Impact Network and California Sportfishing Protection Alliance

September 29, 2015

Ben Nelson
U.S. Bureau of Reclamation
Bay-Delta Office
801 I Street, Suite 140
Sacramento, CA 95814
bcnelson@usbr.gov

Via e-mail

RE: Comments on *Draft Environmental Impact Statement for Coordinated Long Term Operation of the Central Valley Project and State Water Project*

Dear Mr. Nelson:

The California Sportfishing Protection Alliance (CSPA) and the California Water Impact Network (CWIN) respectfully submit comments on the U.S. Bureau of Reclamation's (Reclamation or BOR) *Draft Environmental Impact Statement* (DEIS) *for Coordinated Long Term Operation of the Central Valley Project* (CVP) *and State Water Project* (SWP). CWIN CSPA 1

We attach and incorporate into these comments Attachment A, titled *Complaint: Against SWRCB, USBR and DWR for Violations of Bay-Delta Plan, D-1641 Bay-Delta Plan Requirements, Clean Water Act, Endangered Species Act, Public Trust Doctrine and California Constitution*, and Attachment B, titled *COMPLAINT; Against the SWRCB and USBR for Violations of Central Valley Basin Plan, WR Order 90-05, Clean Water Act, Endangered Species Act, Public Trust Doctrine and California Constitution*. We also incorporate by reference the comments of AquAlliance on this DEIS. CWIN CSPA 2

I. Overview

The Executive Summary of the DEIS describes part of the background of the DEIS in this way: CWIN CSPA 3

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The Appellate Court confirmed the District Court ruling that Reclamation must conduct a NEPA review to determine whether the acceptance and implementation of the RPA actions cause a significant effect to the human environment.[1] CWIN CSPA 3 continued

Chapter 2 of the DEIS further describes the background of the DEIS, stating in part:

> As described in Chapter 1, Introduction, the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) concluded in their 2008 and 2009 Biological Opinions (BOs), respectively, that coordinated long-term operation of the CVP and SWP, as described in the 2008 Reclamation Biological Assessment, jeopardizes the continued existences of listed species and adversely modifies critical habitat. To remedy this, USFWS and NMFS provided Reasonable and Prudent Alternatives (RPAs) in their BOs.
>
> The U.S. Court of Appeals for the Ninth Circuit confirmed the U.S. District Court for the Eastern District of California ruling that Reclamation must conduct a NEPA review to determine whether the RPA actions cause a significant impact on the human environment. Potential modifications to the coordinated operation of the CVP and SWP analyzed in the EIS process should be consistent with the intended purpose of the action, be within the scope of Reclamation's legal authority and jurisdiction, be economically and technologically feasible, and avoid the likelihood of jeopardizing listed species or resulting in the destruction or adverse modification of critical habitat in compliance with the requirements of Section 7(a)(2) of the Endangered Species Act.[2]

The remand thus set up the requirement for a NEPA analysis of whether implementation of the RPA's would cause a significant impact on the human environment. However, since the Ninth Circuit also upheld the RPA's as necessary under the Endangered Species Act to protect listed species and their critical habitats, simply eliminating part of an RPA is not an option unless equally protective or more protective measures are substituted (and analyzed). Thus, while the "Alternative Basis of Comparison" helps to demonstrate the relative effects (largely related to socioeconomic and water supply issues) of implementing the RPA's, it cannot stand as a viable alternative under NEPA on its own, because NMFS and USFWS have stated in their BiOps, and the Ninth District Court of Appeals has upheld them, that without the RPA's the operation of the SWP and the CVP jeopardize listed species and/or adversely affect their critical habitat.

An RPA is a measure required under the Endangered Species Act to limit the effects of a federal action so that the action does not cause jeopardy or adversely affect critical habitat. The DEIS does not recommend a preferred alternative.[3] Thus it appears that BOR may incorporate in its Record of Decision any combination of the elements analyzed in any of the DEIS's NEPA alternatives. This highly unusual approach under NEPA makes it very difficult to comment on the DEIS. It is particularly difficult to provide comments that address whether effects of ultimate modifications to any of the RPA's taken under the Action will cause jeopardy or adversely affect critical habitat. CWIN CSPA 4

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[1] DEIS, p. ES-6.
[2] DEIS, p. 2-2.
[3] See DEIS, p. 1-9.

2

1

Below, we maintain that some elements that are analyzed under project alternatives would, on their face, cause jeopardy or adversely affect critical habitat. We also argue that in aggregate baseline conditions (the No Action Alternative) are already doing so. However, an additional round of analysis by BOR in a recirculated DEIS or in an FEIS will be needed in order to evaluate whether the any modifications to RPA's that BOR ultimately proposes, considered in aggregate, comply with the requirements of the ESA. No such analysis is present in the DEIS.

CWIN CSPA 5

In any case, the DEIS does not specify significant impacts or specific mitigations for such impacts insofar as the DEIS concerns reduced water supply that might be attributable to the RPA's.[4] Instead, the DEIS assumes that urban water supplies will be met by paying relatively nominal increased costs and that increased use of groundwater will replace agricultural supplies lost because of the implementation of the RPA's.[5]

In short, there is no compelling argument in the DEIS that the RPA's in whole or part are not "economically or technologically feasible."

CWIN CSPA 6

Nonetheless, the DEIS describes several alternatives that could be substituted for the parts of the RPA's. The apparent assumption is that actions proposed under these alternatives, including elimination of certain elements of the RPA's and substitution of alternative elements, would meet the requirements of the ESA and would have added benefits that might make them preferable.

Alternative 1 would eliminate RPA actions that would not otherwise occur without the RPA's, and revert to operations and flow requirements that existed prior to issuance of the BiOps. However, it would retain non-operational RPA requirements that have already been implemented or are in the process of being implemented.

Alternative 2 would eliminate a series of physical measures included in the RPA's, including fish passage at CVP dams, temperature improvements at CVP dams on the American River, actions to reduce entrainment at CVP and SWP export facilities, and others.[6]

Alternative 3 would eliminate RPA actions that would not otherwise occur without the RPA's. It would weaken Old and Middle River (OMR) export restrictions from the present restrictions in the BiOps, implement a suite of actions on the Stanislaus River that substantially reduce flow requirements, and eliminate the use of Stanislaus River flow releases to meet D-1641 water quality and pulse flow requirements. It would establish a "predator control

CWIN CSPA 7

[4] See e.g. DEIS p. 19-57: average annual increased cost of M&I water supplies to Southern California is $34 Million. See also p. 19-49: average increased regional loss of San Joaquin Valley revenue in Dry and Critical Dry years is $34.4 Million.

[5] In what appears to be an incomplete analysis, the DEIS also does not analyze whether reduced levels of groundwater, particularly on the west side of the San Joaquin Valley, are attributable to the Action and must be mitigated. See DEIS pp. 7-140 and 7-141. We would argue that the impacts arise not from the Action (the RPA's), but from excessive cultivation without a reliable water supply, a baseline condition. However, the DEIS does not state the basis for which it declines to consider whether groundwater impacts to the San Joaquin Valley are attributable to the action or whether they are potentially significant.

[6] See DEIS p. 3-32.

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program," trap and haul a portion of salmonid outmigrants in the San Joaquin River from March through June, and reduce ocean harvest of salmon. CWIN CSPA 7 continued

Alternative 4 would eliminate RPA actions that would not otherwise occur without the RPA's. It would limit development in floodplains, replace levee riprap with vegetation, establish a "predator control program," trap and haul a portion of salmonid outmigrants in the San Joaquin River from March through June, and reduce ocean harvest of salmon.

Alternative 5 would implement the RPA's and additionally require positive OMR flows in April and May. It would also require April and May pulse flows from the Stanislaus River, whose volume would be determined by water year type and the location of X2.[7]

II. The DEIS fails to present a reasonable range of alternatives.

A. None of the alternatives analyzed in the DEIS, including the No Action Alternative, are sufficient to avoid jeopardy to Delta smelt and listed salmonids or to protect other public trust fishery resources consistent with applicable law.

1. The DEIS and RPAs ignore the recent condition of pelagic and salmonid species.

Since 1967, the California Department of Fish and Wildlife's (DFW) Fall Midwater Trawl abundance indices for striped bass, Delta smelt, longfin smelt, American shad, splittail and threadfin shad have declined by 99.7, 97.8, 99.9, 91.9, 98.5 and 97.8 percent, respectively.[8] Abundance indices of these species have continued to decline despite the existence of RPA's. CWIN CSPA 8

For example, between 2008 and 2014, DFW's 2014 Fall Midwater Trawl abundance index of Delta smelt declined by 60.7 percent, and the 2014 index was the lowest in in the forty-eight year history of the trawl. The 2015 20mm Survey Delta smelt abundance index declined 89.7 percent since 2008 and was the lowest in the twenty-one year history of the survey.[9] The 2015 Spring Kodiak Trawl abundance index for Delta smelt declined 42.7 percent since 2008 and was the lowest in the thirteen-year history of the trawl.[10] The 2015 Summer Townet Delta smelt abundance index was 0.0 (100 percent decline), the lowest in the fifty-six year history of the survey.[11] Survey results for Delta smelt led U.C. Davis fisheries professor Peter Moyle to warn state officials to prepare for the extinction of Delta smelt.[12]

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[7] See DEIS Table 3.5, p. 3-42.
[8] http://www.dfg.ca.gov/delta/projects.asp?ProjectID=FMWT
[9] See Bibliography: https://www.wildlife.ca.gov/Conservation/Delta/20mm-Survey.
[10] See Bibliography: https://www.wildlife.ca.gov/Conservation/Delta/Spring-Kodiak-Trawl.
[11] See Bibliography: https://www.wildlife.ca.gov/Conservation/Delta/Townet-Survey.
[12] http://www.capradio.org/44478, http://californiawaterblog.com/2015/03/18/prepare-for-extinction-of-delta-smelt/, http://news.nationalgeographic.com/2015/04/150403-smelt-california-bay-delta-extinction-endangered-species-drought-fish/.

CWIN CSPA 8 continued

Other species may be in equal or worse shape. The 2014 Fall Midwater Trawl abundance index of longfin smelt declined by 88.5 percent since 2008.[13]

The USFWS Anadromous Fisheries Restoration Program (AFRP) documents that, since 1967, in-river natural production of Sacramento winter-run Chinook salmon and spring-run Chinook salmon have declined by 98.2 and 99.3 percent, respectively, and are only at 5.5 and 1.2 percent, respectively, of doubling levels mandated by the Central Valley Project Improvement Act, California Water Code and California Fish & Game Code.[14]

The 2013 brood years of Sacramento River winter-run, spring-run and fall-run Chinook salmon were seriously impacted by excessive temperatures in the Sacramento River below Keswick Reservoir. In 2014, lethal temperatures below Keswick led to the loss of 95% of winter-run, 98% of fall-run and virtually all of the spring-run 2014 year classes.[15] Daily average and daily maximum temperatures during critical spawning, incubation and alevin life stages at the Above-Clear-Creek-Compliance-Point during May, June and July 2015 significantly exceeded temperatures of the corresponding months of 2014.[16] The loss of a third brood year would likely jeopardize the continued existence of these species.

The DEIS ignores the continuing decline of pelagic and salmonid species following construction of the SWP and the accelerating decline in recent years despite the BOs. This continuing decline of fisheries jeopardizes the existence of species already on the brink of extinction. The failure to acknowledge and analyze the continuing decline of fisheries and impending extinction of one or more species, despite the RPAs, renders the DEIS deficient as a NEPA document.

2. The DEIS and RPAs fail to account for the SWRCB's pattern and practice of serially weakening fish and wildlife and water quality standards, with the concurrence of USFWS and NMFS.

CWIN CSPA 9

The State Water Resource Control Board's (SWRCB) San Francisco/Sacramento-San Joaquin Delta Estuary (Bay-Delta Plan) and the Central Valley Regional Water Quality Control Board's (Regional Board) Water Quality Control Plan for the Sacramento River and San Joaquin River Basins (Basin Plan) are issued pursuant to requirements of the federal Water Pollution

[13] The USFWS has found that longfin smelt, as a candidate species, warrants protection under the Endangered Species Act but the Service is precluded from adding the species at the present time because of a lack of resources and the extensive list of other species warranting listing. http://www.fws.gov/sfbaydelta/species/longfin_smelt.cfm
[14] See http://www.fws.gov/lodi/afrp/.
[15] State Water Resource Control Board, *Order Conditionally Approving a Petition for Temporary Urgency Changes in License and Permit Terms and Conditions Requiring Compliance with Delta Water Quality Objectives in Response to Drought Conditions*, 3 July 2015, pp. 15,16:
http://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/docs/tucp/2015/tucp_order070315.pdf
And
NRDC, TBI, *Drought Operations Will Cause Additional Unreasonable Impacts on Fish and Wildlife in 2015,* 20 May 2015, slide 2:
http://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/docs/workshops/nrdc_tbi_pres.pdf.
[16] http://cdec.water.ca.gov/cgi-progs/staMeta?station_id=ccr, and
CSPA, presentation before the State Water Resource Control Board 25 June 2015 Workshop, slides 4-7:
http://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/docs/workshops/062415cspa_pres.pdf

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Control Act (Clean Water Act). The SWRCB's D-1641 and Water Rights Orders 90-05, 91-01, 91-03 and 92-02 implement the Bay-Delta Plan and Basin Plan as terms and conditions in Reclamation's CVP. The BO's and RPA's are predicated on compliance with Delta water quality and flow criteria and Sacramento River temperature criteria contained in the SWRCB's D-1641 and WR Orders.

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continued

However, the SWRCB has succumbed to a pattern and practice of waiving (i.e., weakening) water quality, flow and temperature criteria whenever requested. Over the last two years, the SWRCB has weakened water quality, flow and/or temperature criteria some 35 times.[17] In 2014, the SWRCB reduced regulatory Delta outflow by 43% and increased Delta exports by 18%. In 2015, the SWRCB reduced regulatory outflow by 78% in order to increase exports by 32%. These changes shifted more than one million acre-feet of water from fisheries protection to agricultural and urban use.[18]

D-1641 Table 1, 2 and 3 water quality standards have been routinely exceeded. For example, salinity standards protecting south Delta agricultural beneficial uses have been exceeded thousands of days since 2006, and there were over 400 exceedances at Vernalis, Brandt Bridge, Old River Near Middle River, and Old River Near Tracy in calendar year 2015 alone. Delta outflow standards protecting fish and wildlife and agriculture, Vernalis flow standards protecting salmon and steelhead, and Collinsville salinity standards protecting Delta smelt habitat were exceeded numerous times in 2015, as were the Emmaton, Threemile Slough and Jersey Point salinity standards protecting agricultural beneficial uses. The narrative salmon protection doubling standard has been violated every day since D-1641 became operative.

This pattern and practice of weakening critical Delta flow and water quality standards has replicated itself over decades. For example, between 1988 and 1991, Bay-Delta standards were violated 246 times. The SWRCB's refusal to enforce Bay-Delta water quality and flow standards is more fully described in Attachment A titled *Complaint: Against SWRCB, USBR and DWR for Violations of Bay-Delta Plan, D-1641 Bay-Delta Plan Requirements, Clean Water Act, Endangered Species Act, Public Trust Doctrine and California Constitution* and incorporated into these comments.

As previously noted and described more fully in Attachment B titled *COMPLAINT; Against the SWRCB and USBR for Violations of Central Valley Basin Plan, WR Order 90-05, Clean Water Act, Endangered Species Act, Public Trust Doctrine and California Constitution*, the Regional Board established temperature criteria in the Sacramento River, pursuant to the CWA, and the SWRCB implemented the temperature criteria in Reclamation's permits and licenses in WR Order 90-05. In doing so, the SWRCB implemented temperature criteria based on average daily temperatures without determining whether average daily temperatures were protective of aquatic life. As discussed at length in pages 19-23 of Attachment B, a 56°F daily

[17] Pubic Policy Institute of California, *What if California's Drought Continues?* August 2015, page 7: http://www.ppic.org/content/pubs/report/R_815EHR.pdf and the Technical Appendix at page 6: http://www.ppic.org/content/pubs/other/815EHR_appendix.pdf

[18] SWRCB, staff presentation at the 20 May 2015 public workshop on drought activities in the Bay-Delta: http://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/docs/workshops/swrcb_staff_pres_session1b.pdf

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CWIN CSPA 9 continued

average temperature criterion is not protective of Chinook salmon spawning, egg incubation and fry emergence.[19]

Additionally, the SWRCB exempted almost 43% of identified fish spawning habitat from temperature requirements. The SWRCB then ignored the Basin Plan's Controllable Factors Policy and its own admonition to Reclamation that water necessary to meet water quality criteria was not available for delivery. When the National Marine Fisheries Service (NMFS) listed winter-run Chinook salmon as threatened under the ESA, the SWRCB inexplicably relocated the temperature compliance point further upstream to Bend Bridge, eliminating another 15 miles of spawning habitat.

Over the next 23 years, the SWRCB participated in back-room temperature management group meetings that recommended ever-changing temperature compliance points for winter-run Chinook salmon, based upon the quantities of water BOR had remaining in storage after deliveries to its water contractors. The SWRCB subsequently approved the recommendations of the temperature management group of which it is a participating member. These approvals generally relocated temperature compliance points further and further upstream, often eliminating as much as 90% or more of spawning habitat protected by the Basin Plan. For example, Clear Creek has been the designated temperature compliance point over the last two years, which has compressed spawning into the upper 10 miles of the Sacramento River downstream of Keswick Reservoir and led to superimposition of redds and conflict with other species.

Despite these yearly concessions, BOR has violated temperature criteria in nearly every year. In 2015, the SWRCB approved Reclamation's request to increase the temperature compliance requirement from a daily average of 56°F to 58°F. This despite the fact that the NMFS pointed out that an increase to 58°F would result in adverse impacts to incubating winter-run eggs and alevin in redds and that 58°F was identified in the scientific literature as lethal to incubating salmon eggs and emerging fry. In the subsequent concurrence letter, NMFS noted that "these conditions could have been largely prevented through upgrades in monitoring and modeling and ***reduced Keswick releases in April and May***" but concurred because "the plan provides a ***reasonable possibility*** that there will be ***some juvenile winter-run survival*** this year."[20] However, this is an unacceptable and illegal standard of compliance with the BO and ESA.

Drought cannot be employed as an excuse for ignoring or weakening promulgated water quality standards. Drought is normal in California's Mediterranean climate. According to DWR, there have been 10 multi-year drought sequences of large-scale extent in the last 100 years, spanning 41 years. Below normal years occur more than half the time. Agencies cannot

[19] The U.S. Environmental Protection Agency, the states of Washington, Oregon and Idaho, both North Coast and Central Valley Regional Water Quality Control Boards, NMFS, DFW, the Pacific Fishery Management Council and the majority of the scientific literature have either adopted or recommended more restrictive temperature criteria based upon a daily maximum and/or a seven-day mean of daily maximums.

[20] NMFS, *Contingency Plan for Water Year 2015 Pursuant to Reasonable and Prudent Alternative Action I.2.3.C of the 2009 Coordinated Long-term Operation of the Central Valley Project and State Water Project Biological Opinion, Including a Revised Sacramento River Water Temperature Management Plan*, p. 9. Emphasis added.

be surprised, be unprepared for, or claim emergency exemptions for something that occurs more than 40% of the time. CWIN CSPA 9 continued

However, Reclamation and DWR have continued to maximize water deliveries in the initial years of drought sequences and failed to maintain sufficient carryover storage to protect fisheries, water quality and public trust resources. The pattern and practice of delivering near normal water supplies in the early years of drought, depleting carryover storage and then relying on the SWRCB to weaken water quality standards has been extensively discussed and documented in previous CSPA presentations, protests, objections and complaints before the SWRCB.[21] As Reclamation is aware, CSPA and CWIN have filed a lawsuit in federal court regarding Reclamation's failure to comply with the Clean Water Act and filed a lawsuit in state court against the SWRCB's de facto weakening of CWA water quality standards. We incorporate by reference the allegations contained in those amended complaints into these comments.[22] CWIN CSPA 10

The continuing exceedances of water quality and flow criteria jeopardize the continued existence of species. Yet the DEIS fails to acknowledge, discuss or analyze the pattern and practice of serially weakening legally promulgated water quality and flow standards established to protect fish and water quality. It further fails to incorporate the serial failure to comply with water quality and flow standards in its modeling and assessment of the project's ability to deliver water and evaluation of alternatives. Consequently, the DEIS is deficient as a NEPA document.

3. The RPAs have failed to protect fisheries and other public trust resources.

The continuing decline of fisheries, degraded water quality, and serial exceedance of water quality and flow criteria are both a track record and report card of the RPA's. Their existence and implementation has failed to protect fisheries and has brought several species to the brink of extinction. Any weakening or elimination of the RPA's would only exacerbate an already unacceptable situation. CWIN CSPA 11

The DEIS must candidly acknowledge, discuss and analyze the failure of the RPA's to protect fisheries, water quality and public trust resources. Failure to do so would render the DEIS deficient as a NEPA document.

4. The DEIS makes no showing that Alternatives 1-4 are as protective as D-1641 with the RPA's.

The DEIS makes no showing that any of the alternatives, including the No Action alternative, meets the purpose and need of the proposed action, including most specifically the need to conform to the requirements of the ESA and to other applicable law that protects public CWIN CSPA 12

[21] See CSPA workshop presentations, protests and objections of Temporary Urgency Change Petitions and complaints over the last two years at the SWRCB's State Water Project and Central Valley Project Temporary Urgency Change Petition website, http://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/tucp/index.shtml

[22] http://calsport.org/news/

trust resources. It also makes no showing that any of the elements proposed in the alternatives will productive positive benefits for fisheries and other public trust resources.

CWIN CSPA 12 continued

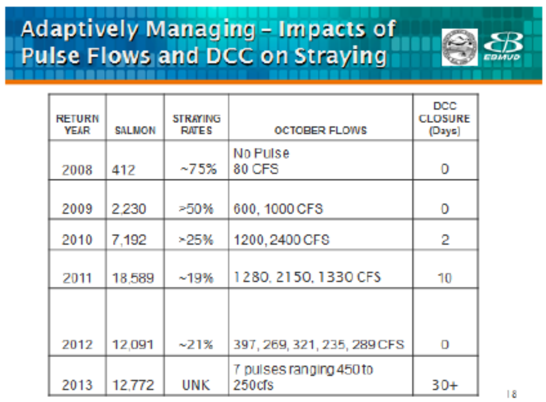
a. Alternative 1

Alternative 1 would eliminate the RPA's except those elements that would otherwise be implemented pursuant to voluntary actions or other regulatory requirements.

CWIN CSPA 13

i. Fall pulse flows

Alternative 1 would eliminate fall attraction pulse flows in the Stanislaus River for fall-run Chinook, a proven, effective and cost-efficient measure to stimulate upstream migration and reduce straying. While consultants for irrigation districts on the Stanislaus have discerned no correlation between fall pulse flows and upstream migration in that river, pulse flows on the Mokelumne have been extremely effective in reducing straying and have shown clear correlation to upstream migration. (Figures 1 and 2).


Adaptively Managing – Impacts of Pulse Flows and DCC on Straying

RETURN YEAR	SALMON	STRAYING RATES	OCTOBER FLOWS	DCC CLOSURE (Days)
2008	412	~75%	No Pulse 80 CFS	0
2009	2,230	>50%	600, 1000 CFS	0
2010	7,192	>25%	1200, 2400 CFS	2
2011	18,589	~19%	1280, 2150, 1330 CFS	10
2012	12,091	~21%	397, 269, 321, 235, 289 CFS	0
2013	12,772	UNK	7 pulses ranging 450 to 250cfs	30+

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Figure 1: Effects of pulse flows on straying rates and adult migration in the Mokelumne River 2008-2013.[23]

[23] East Bay Municipal Utility District staff presentation to MokeWISE stakeholder group, April, 2014.

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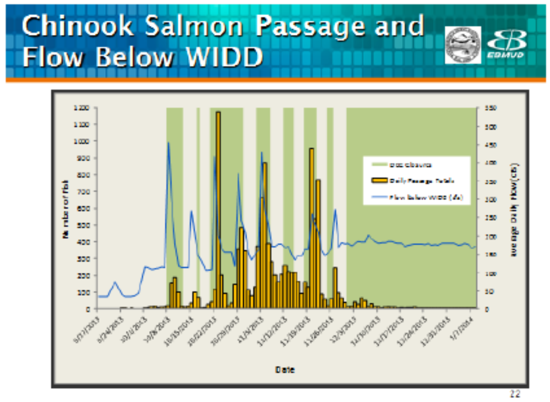

Figure 2: Relation of 2013 pulse flows and upstream migration of Mokelumne fall-run Chinook past Woodbridge Dam.[24]

More specific to the San Joaquin tributaries including the Stanislaus, Carl Mesick of the U.S. Fish and Wildlife Service found in 2001: "migration rates of adult salmon are substantially higher when Vernalis flows exceed about 3,000 cfs and total exports are less than 100% of Vernalis flows."[25]

The Bureau of Reclamation, recognizing the value and importance of fall pulse flows, ordered them for the Stanislaus in 2014 even in the face of severe drought conditions, and appears prepared to do so again in even worse storage conditions in 2015.

ii. Spring flows and pulse flows

Alternative 1 would also reduce spring flows in the Stanislaus River and eliminate spring pulse flows in the San Joaquin River sourced in the Stanislaus. High spring flows and pulse flows in the San Joaquin River at Vernalis are clearly and strongly correlated to successful outmigration of juvenile salmon.

The California Department of Fish and Game (now Department of Fish and Wildlife,) identified spring pulses in the San Joaquin River needed to double salmon in the San Joaquin river system in Exhibit 3 of its submittals in the State Water Resources Control Board's 2010 Delta Flow Criteria proceeding (Figure 3).

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[24] Id.
[25] Carl Mesick, *The Effects of San Joaquin River Flows and Delta Export Rates During October on the Number of Adult San Joaquin Chinook Salmon that Stray*, 2001, Fish Bulletin 179: Volume Two, p. 159.

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continued

Table 10 South Delta (Vernalis) Flows Needed to Double Smolt Production at Chipps Island (by Water Year Type)

	Water Year Type				
Flow Type	Critical	Dry	Below Normal	Above Normal	Wet
Base (cfs)	1,500	2,125	2,258	4,339	6,315
Pulse (cfs)	5,500	4,875	6,242	5,661	8,685
Pulse Duration	31	40	50	60	70
Total Flow (cfs)	7,000	7,000	8,500	10,000	15,000
Acre-Feet Total	614,885	778,772	1,035,573	1,474,111	2,370,768

Figure 3: DFW recommendations for spring pulse flows at Vernalis[26]

Swanson et al made similar findings and recommendations in the submittal of the Bay Institute ("*Delta Inflows*," Exhibit TBI-3) to the Delta Flow Criteria proceeding, showing a positive correlation between spring flows and salmon abundance and between a declining rate of escapement and spring flows at Vernalis of less than 5000 cfs.[27] Numerous documents by Carl Mesick (U.S. Fish and Wildlife Service and on behalf of CSPA) similarly stress the importance of high spring flows in various tributaries of the San Joaquin. [28]

Staff of the State Water Resources Control Board, in its 2010 *Delta Flow Criteria Report*, concluded:

> Following are the San Joaquin River inflow criteria based on analysis of the species specific flow criteria and other measures:
>
> 1) San Joaquin River at Vernalis: 60% of 14-day average unimpaired flow from February through June
> 2) San Joaquin River at Vernalis: 10 day minimum pulse of 3,600 cfs in late October
>
> … San Joaquin River inflow criterion 1 and 2 are Category A criteria because they are supported by sufficiently robust scientific information.[29]

[26] California Department of Fish and Game, *Flows Needed in the Delta to Restore Anadromous Salmonid Passage from the San Joaquin River at Vernalis to Chipps Island*, 2010, p. 35. http://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/deltaflow/docs/exhibits/dfg/dfg_exh3.pdf

[27] Swanson et al., *Exhibit TBI-3: Delta Inflows, SWRCB Public Trust Flow Criteria Proceedings, February 16, 2010*, p. 16, p. 23. http://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/deltaflow/docs/exhibits/bay_inst/tbi_exh3.pdf

[28] See, for example, Carl Mesick, 2009, *The High Risk of Extinction for the Natural Fall-Run Chinook Salmon Population in the Lower Tuolumne River due to Insufficient Instream Flow Releases* http://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/deltaflow/docs/exhibits/cspa/cspa_exh14.pdf
Carl Mesick, 2010, *The High Risk of Extinction for the Natural Fall-Run Chinook Salmon Population in the Lower Merced River due to Insufficient Instream Flow Releases*. http://calsport.org/doc-library/pdfs/57.pdf

[29] State Water Resources Control Board, *Development of Flow Criteria for the Sacramento-San Joaquin Delta Ecosystem; Prepared Pursuant to the Sacramento-San Joaquin Delta Reform Act of* 2009, August 3, 2010, p. 119.

CWIN CSPA 13 continued

The *Delta Flow Criteria Report* further summarized existing information:

> Available scientific information indicates that average March through June flows of 5,000 cfs on the San Joaquin River at Vernalis represent a flow threshold at which survival of juveniles and subsequent adult abundance is substantially improved for fall-run Chinook salmon and that average flows of 10,000 cfs during this period may provide conditions necessary to achieve doubling of San Joaquin basin fall-run. Both the AFRP and DFG flow recommendations to achieve doubling also seem to support these general levels of flow, though the time periods are somewhat different (AFRP is for February through May and DFG is for March 15 through June 15).[30]

State Water Board staff also emphasized: "it is important to preserve the general attributes of the natural hydrograph to which the various salmon runs adapted to over time, including variations in flows and continuity of flows."[31]

The flow regime for the Stanislaus River required in NMFS's RPA's contains a significant degree of weekly and monthly variability, although less variability than the percent-of-unimpaired approach recommended by State Water Board staff would require. Alternative 1 would revert the Stanislaus to significantly lower spring flows than RPA flows, with far less variability. Alternative 1 would reduce March-June flows in the Stanislaus River by up to 52.9% in all years and by 59.6% in Dry and Critical Dry years.[32] Overall, this flow reduction would substantially reduce the frequency and duration of floodplain inundation

iii. Restrictions on reverse flows in Old and Middle rivers (OMR)

Alternative 1 would eliminate OMR protections in the RPA's, allowing greater exports at state and federal facilities in the south Delta. The DEIS claims that this would increase exports up to about 1 million acre-feet per year.[33]

The RPA's require limits on net negative tidal flows in Old and Middle Rivers in the South Delta to protect listed winter-run and spring-run Chinook salmon, steelhead, and Delta smelt. Old and Middle River net flows are closely related to total south Delta exports. The OMR limits are not restrictive to higher exports when San Joaquin River Delta inflows are high and provide more positive net OMR. OMR limits allow restrictions on exports when Sacramento River Delta inflows are high and San Joaquin River flows are low. Without OMR limits, exports have been very high (pre-2009) when Sacramento River flows were high. High OMR reverse flows and exports can draw salmon and smelt into the central and south Delta in the winter-spring period during high Sacramento River flows.[34] Under the RPA's, the presence

[30] Id.
[31] Id., p. 120
[32] DEIS, p. 5-239.
[33] DEIS, p. 5-253. See Section IV of these comments below for discussion of why this figure may be overstated.
[34] The Delta Cross Channel is closed during most of the winter-spring period, and under such conditions Sacramento River flows contribute minimally to lower San Joaquin River and OMR flows. San Joaquin salmon and steelhead smolts that enter the Delta via Georgiana and Threemile sloughs, and smelt living in or moving into the central Delta are at risk to south Delta exports during the winter-spring period. Their presence in the central Delta or export

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CWIN CSPA 13 continued

of listed species can trigger OMR restrictions to -5000 cfs or less negative. Whichever BO RPA is the most restrictive governs operations at any given time. The RPA's prescribe an elaborate review process and triggering criteria for a Smelt Working Group (SWG[35]) and Delta Salmon and Steelhead Group (DOSS[36]) to make operations recommendations to Water Operations Management Team (WOMT), which may or may not adopt recommendations.

Old and Middle River (OMR) flow management (Actions IV.2 and IV.3) is prescribed for the period January 1 to June 15 in the NMFS BO RPA. The RPA describes the purpose of these requirements as follows: "Control the net negative flows toward the export pumps in Old and Middle rivers to reduce the likelihood that fish will be diverted from the San Joaquin or Sacramento River into the southern or central Delta. … Curtail exports when protected fish are observed near the export facilities to reduce mortality from entrainment and salvage."[37]

The USFWS's BO prescribes similar measures to protect smelt:

> The objective of Component 1 is to reduce entrainment of pre-spawning adult delta smelt during December to March by controlling OMR flows during vulnerable periods.[38]
>
> … The objective [of Component 2] is to improve flow conditions in the Central and South Delta so that larval and juvenile delta smelt can successfully rear in the Central Delta and move downstream when appropriate.[39]

The RPA's provide essential protection in the winter-spring period by limiting exports and reducing losses of salmon, steelhead, sturgeon, and smelt that would otherwise be drawn to the south Delta export pumps under the D-1641 65% export/inflow limit in December-January and 35% export/inflow limit February-June. The restrictions reduce entrainment of listed species into the central and south Delta in both dry and wet years, especially in December-January period. Even in drought years like winter-spring 2014-2015, OMR restrictions in winter reduced potential exports. Lack of prescriptions for December under the NMFS RPA did allow high negative OMR flows and exports. However, concerns for adult smelt led to voluntary reductions in exports and OMR negative flows in mid-December 2014 that subsequently were maintained through the winter.

Prior to the RPA's' OMR restrictions, salmon and smelt protections were generally limited to "take limits" in the form of salvage counts, and water quality standards that included export limits, Delta outflow requirements, and agricultural salinity standards in state water quality standards (D-1641). When these standards proved ineffective in protecting the listed salmon and smelt[40], the new biological opinions were issued, which added the OMR restrictions as well as other non-flow actions to preserve the species.

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salvage can trigger OMR restrictions that otherwise would not occur under the regular D-1641 export/inflow restrictions.

[35] http://www.fws.gov/sfbaydelta/cvp-swp/smelt_working_group.cfm

[36] http://www.westcoast.fisheries.noaa.gov/central_valley/water_operations/doss.html

[37] NMFS OCAP BO, p. 630.

[38] FWS OCAP BO, p. 280.

[39] Id., p. 282.

[40] Take limits proved irrelevant as populations dropped to new low levels.

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In recent drought years, the OMR restrictions in the RPA's have been more important than ever because D-1641 water quality standards have been weakened by the State Water Board, with the consent of NMFS and USFWS. CWIN CSPA 13 continued

A better level of protection than the RPA's would be a combination of stricter OMR restrictions and substantially improved Delta outflow and salinity standards that further limit risks to salmon and smelt.

iv. Non-flow measures that Alternative 1 would eliminate

Alternative 2 is specifically constructed to evaluate elimination of the major non-flow measures of the RPA's. These measures would also be eliminated by Alternative 1. For purposes of document organization, we analyze the consequences of eliminating the major non-flow measures of the RPA's in analyzing Alternative 2.[41]

b. Alternative 2

CWIN CSPA 14

Alternative 2 would eliminate the major non-flow elements of the RPA's except those elements that would otherwise be implemented pursuant to voluntary actions or other regulatory requirements, and also eliminate floodplain inundation flows on the Stanislaus River.

That said, it is extremely difficult to discern exactly which actions from the RPA's Alternative 2 (or overlapping actions from Alternative 1) would eliminate and which ones would remain. The DEIS should have listed the eliminated and retained actions specifically. The DEIS should also have described how any actions could be eliminated and still meet protection requirements of the ESA and other legal requirements to protect public trust resources. Absent this, the lack of clarity does not support the requirement that NEPA analysis support informed decision-making.

As we understand it, Alternative 2 would eliminate the following actions from the NMFS and USFWS RPS's:

- 2009 NMFS BO RPA Action I.2.5, Winter-Run Passage and Re-Introduction Program at Shasta Dam.
- 2009 NMFS BO RPA Action II.3, Structural Improvements for Temperature Management on the American River.
- 2009 NMFS BO RPA Action II.5, Fish Passage at Nimbus and Folsom Dams.
- 2009 NMFS BO RPA Action II.6, Implement Actions to Reduce Genetic Effects of Nimbus and Trinity River Fish Hatchery Operations.

[41] NMFS modified the RPA in 2011. See http://www.westcoast.fisheries.noaa.gov/publications/Central_Valley/Water%20Operations/Operations,%20Criteria%20and%20Plan/040711_ocap_opinion_2011_amendments.pdf

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CWIN CSPA 14 continued

• 2009 NMFS BO RPA Action III.2.1, Increase and Improve Quality of Spawning Habitat with Addition of Gravel.

• 2009 NMFS BO RPA Action III.2.2, Conduct Floodplain Restoration and Inundation Flows in Winter or Spring to Inundate Steelhead Juvenile Rearing Habitat on Stanislaus River.

• 2009 NMFS BO RPA Action III.2.3, Restore Freshwater Migratory Habitat for Juvenile Steelhead on Stanislaus River.

• 2009 NMFS BO RPA Action III.2.4, Fish Passage at New Melones, Tulloch, and Goodwin Dams.

• 2009 NMFS BO RPA Action IV.4, Tracy Fish Collection Facility Improvements to Reduce Pre-Screen Loss and Improve Screening Efficiency.

• 2009 NMFS BO RPA Action IV.4.2 Skinner Fish Collection Facility Improvements to Reduce Pre-Screen Loss and Improve Screening Efficiency.

• 2009 NMFS BO RPA Action IV.4.3 Tracy Fish Collection Facility and the Skinner Fish Collection Facility Actions to Improve Salvage Monitoring, Reporting and Release Survival Rates.[42]

The DEIS makes no effort to describe how these RPA actions could be eliminated and still conform to the ESA. It does not address the rationales for these measures provided in the NMFS RPA's. It does not address the removal of fish passage actions at Shasta, Nimbus-Folsom, and Goodwin-Tulloch-New Melones dams in the context of the 2014 NMFS Recovery Plan.[43]

In a "Public Stakeholder Seminar" on September 24, 2015 convened by Reclamation, Reclamation and representatives of state and federal agencies reaffirmed the link between the need for passage past Shasta and the recent poor survival of winter-run downstream of Lake Shasta.[44] However, the DEIS does not discuss this linkage.

Equally, it is likely that a substantial portion of the cohort of fall-run Chinook will be lost in 2015 on the American River due to high water temperatures. It is also likely that substantial mortality of juvenile steelhead and resident O. mykiss in the American and Stanislaus rivers will occur due to high water temperatures. Yet Alternative 2 makes no effort to place fish passage past dams on these rivers in the context of mortality of listed and non-listed salmonids confined in these rivers to the valley floor.

The "salvage rates" of listed and non-listed species at the Skinner and Tracy "Fish Collection Facilities" is notorious, as is the inefficiency of these facilities. Between 2000 and

[42] DEIS, p. 3-32.
[43] National Marine Fisheries Service, 2014, *Final Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-run Chinook Salmon and Central Valley Spring-run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead.* Available at: http://www.westcoast.fisheries.noaa.gov/publications/recovery_planning/salmon_steelhead/domains/california_central_valley/final_recovery_plan_07-11-2014.pdf
[44] Presentation to be posted at http://www.usbr.gov/mp/BayDeltaOffice/Documents/Shasta_Fish_Passage/

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2011, more than 130 million fish were salvaged at the CVP and SWP water export facilities in the South Delta.[45] Actual losses are far higher. Recent estimates indicated the 5-10 times more fish are lost than salvaged, largely due to the high predation losses in and around water export facilities.[46] The fish screens are unable to physically screen eggs and larval life states of fish from diversion pumps.[47] The present South Delta fish screens are based on 1950's technology. Only about 11-18% of salmon and steelhead entrained at Clifton Court Forebay survive.[48] Losses to pelagic species such as Delta smelt are much higher. CWIN CSPA 14 continued

The California "Water Fix" would add points of diversion to the south Delta export facilities, but the existing infrastructure would be used about half the time. However the "Water Fix" includes no plans to upgrade the existing south Delta fish screens. The NMFS BO extensively documents the inadequacy of the existing screens, and describes the facilities at Tracy as follows:

> … 45 percent of the time, the appropriate velocities in the primary channel and the corresponding bypass ratio are not being met and fish are presumed to pass through the louvers into the main collection channel behind the fish screen leading to the pumps. The lack of compliance with the bypass ratios during all facility operations alters the true efficiency of louver salvage used in the expansion calculations and therefore under-estimates loss at the TFCF.[49]

Since the BO's were issued, there have been no physical improvements to the fish salvage facilities at the state and federal export facilities. Yet in spite of the known loss of millions of fish annually at these facilities, Alternative 2 blithely proposes to forego improvements to this infrastructure.

In short, Alternative 2 is effectively a throwaway alternative with no justification in fact or law, without even a perfunctory let alone substantial rationale in the DEIS.

c. Alternative 3

Alternative 3 is focused on weakening Stanislaus River flow requirements and OMR requirements. It would dramatically lower flow requirements for the Stanislaus River, particularly in the spring and particularly in drier water years, allowing greater diversions, and would exempt (without legal explanation) the Stanislaus River from responsibility for complying with various aspects of D-1641, including Vernalis flow and pulse flow requirements and Delta water quality standards.[50] It would move the compliance point for the D-1422 dissolved oxygen requirement (also without legal explanation) from Ripon upstream to Orange Blossom Bridge. It CWIN CSPA 15

[45] DFW annual salvage reports for the SWP and CVP fish facilities, 2000-2011.
[46] Larry Walker Associates, 2010, *A Review of Delta Fish Population Losses from Pumping Operations in the Sacramento-San Joaquin River Delta*, p. 2. http://www.srcsd.com/pdf/dd/fishlosses.pdf
[47] DWR, 2011, *Delta Risk Management Strategy, final Phase 2 Report, Section 15, Building Block 3.3: Install Fish Screens*, pp 15-18.
[48] Id.
[49] NMFS OCAP BO, pp. 341-342. See also following pages through p. 350 for description of other facility deficiencies and associated mortality.
[50] For proposed Stanislaus River flows and changes to D-1641 and D-1422, see DEIS, p. 3-36.

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would implement a "predator control program" in the Stanislaus River and the Delta. It would tie OMR requirements to turbidity levels, to location of X2, and to the proximity of Delta smelt to Old and Middle rivers, thus at times allowing greater levels of export. It would attempt to mitigate for the potential of additional entrainment of San Joaquin watershed salmonids under the new conditions by implementing a trap and haul program of San Joaquin River salmonids; it would seek to capture 10%-20% of outmigrating juvenile salmonids at the head of Old River, place them in barges, and release them at Chipps Island. Like the No Action Alternative, it would restore 10,000 acres of tidally influenced wetlands. It would also reduce opportunities for commercial and sport ocean harvest of salmon by placing the burden of proof on fisheries managers to limit ocean harvest based on "consistency with Viable Salmonid Population Standards, including harvest management to show that abundance, productivity, and diversity (age-composition) are not appreciably reduced."[51]

CWIN CSPA 15 continued

As discussed in Section II(A)(4)(a)(ii) of these comments above, the best available science suggests that greater flows are needed in the Stanislaus River, not lower flows. The DEIS attempts to justify flow requirements for the Stanislaus based on Weighted Usable Area for spawning and egg viability. Neither of these factors would be appreciably changed by Alternative 3 compared to the No Action Alternative, in significant part because the most critical flow reductions under Alternative 3 would take place at times of year when spawning and egg incubation were not occurring, at least in the case of fall-run Chinook.

To the degree that water temperatures under Alternative 3 would not change appreciably compared to the No Action Alternative, this is likely attributable to the fact that some of the water presently used for instream flow, particularly in spring, would be devoted to storage or simply held longer in storage. Temperature increases downstream of Goodwin Dam stemming from decrease in flow would be partially offset by lower release temperatures and increased releases for irrigation from New Melones to Goodwin and Tulloch dams; the latter would tend to create lower release temperatures from Goodwin Dam into the lower Stanislaus.

This apparent wash in impacts to water temperature would occur at the expense of floodplain inundation, juvenile rearing habitat for salmonids, and flow variability that the State Water Board and numerous others have identified as key life stages and limiting factors in juvenile salmon survival. See section II(A)(4)(a)(ii) above. The DEIS does not respond to the analysis in the RPA that supports measures that provide these elements, and the DEIS does not evaluate impacts according to these metrics.

The DEIS notes about predation reduction measures that no one has shown that predation reduction measures could have an appreciable population level effect on the success of juvenile salmonid outmigrants from the Stanislaus and lower San Joaquin rivers.[52] We agree.

There is no showing that capture and transport of 10%-20% of San Joaquin River salmonid outmigrant will make a population level difference for fall-run Chinook or for steelhead. Though the program is likely worth at least a stand-alone pilot effort, and a similar

[51] DEIS, p. 3-37.
[52] "It remains uncertain, however, if predator management actions under would benefit fall-run Chinook Salmon." DEIS, p. 3-78. See also DEIS, p. 9-275.

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effort has been initiated by East Bay Municipal Utility District on the Mokelumne,[53] the DEIS provides no quantification that shows that trap and haul of downstream migrants will mitigate for the Alternative's proposed reduction in Stanislaus River flow and/or the weakening of OMR standards. There is no quantification in the DEIS of current (No Action) and projected (Alternative 3) survival of outmigrating salmonids between head of Old River and Chipps Island. Nor is there any analysis in the DEIS of existing or desired levels of juvenile salmonid survival between Oakdale and Caswell and between Caswell and head of Old River. It is likely that the relative effect of trap and haul between head of Old River and Chipps Island is limited in the face of very poor survival between spawning grounds in the Stanislaus and the head of Old River, which would likely become worse under Alternative 3. CWIN CSPA 15 continued

Alternative 3's proposed changes in OMR flows based on real time monitoring of Delta smelt are likely infeasible because Delta smelt abundance has dropped so low that they are virtually undetectable. See Section II(A)(1) above.

The analysis in Chapter 19 of economic impacts related to loss of commercial and salmon fishing opportunities that would occur with the enactment of the limitations on salmon fishing proposed in Alternative 3 (and 4) is perfunctory. There should be more analysis based on several scenarios of reduced salmon seasons in various locations, and analysis of secondary impacts on coastal communities. In the limiting case, the placement on harvesters or salmon of the burden to demonstrate no impact to listed species could eliminate harvest of salmon altogether. The DEIS should have analyzed the economic impact of the effective closure of salmon fishing in waters where California-born salmon are present.

d. Alternative 4

Alternative 4 contains many of the elements contained in Alternative 3. Like Alternative 3, Alternative 4 would substitute non-flow measures ostensibly to make up for flow reductions. However, the flow measures are different; Alternative 4 would simply eliminate the RPA flows for the Stanislaus River. D-1641 and D-1422 flow and water quality requirements would remain in place. The proposed change in OMR flow requirements in Alternative 3 is not repeated in Alternative 4. CWIN CSPA 16

Alternative 4 would add a series of actions relating to levees and floodplains. "Under Alternative 4, trees and shrubs would be planted along the levees; and vegetation, woody material, and root re-enforcement material would be installed on the levees instead of riprap for erosion protection." [54] In addition, Alternative 4 would limit development in Central Valley floodplains through a set of administrative and planning requirements. However, the DEIS makes no showing that these requirements would "protect salmonids and Delta smelt," and in particular would not devote a drop of additional water to activate these floodplains or transform them with more frequency or duration into anything other than officially unoccupied terrestrial habitat. On the contrary, the increment of floodplain inundation along the Stanislaus River and

[53] East Bay MUD's trap and haul of juvenile salmon outmigrants in the Mokelumne River was initiated in the Critically Dry year 2015. In submittals and presentations to the State Water Board in 2015 drought workshops, the present commenters supported a similar effort in Sacramento River tributaries as an interim drought measure.
[54] DEIS, p. 3-39.

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CWIN CSPA 16 continued

the lower San Joaquin under the existing RPA's would be reduced by the flow reductions proposed under Alternative 4.

5. The DEIS makes no showing that the OMR flows and the Stanislaus pulse flows proposed in Alternative 5 are sufficient to protect either smelt or salmonids.

CWIN CSPA 17

Unlike Alternatives 3 and 4, whose development and definition the DEIS attributes in substantial part to irrigation districts on the Stanislaus River and the inaptly named "Coalition for a Sustainable Delta," the DEIS does not describe the derivation of Alternative 5. Alternative 5 proposes increases in Stanislaus River flows and Vernalis River pulse flows, and additionally proposes a requirement for long-term average positive OMR flows in April and May of all water year types. The Vernalis pulse flow requirements would vary depending on the location of X2; however, the DEIS provides no rationale for reducing pulse flow magnitudes based on X2 location. Except where the RPA's conflict with these measures under Alternative 5, the RPA's would otherwise be left in place (same as the No Action Alternative).

The analysis in Chapter 9 of the fisheries impacts of this alternative that was apparently designed to be beneficial to fisheries does not indicate appreciable benefit. Whether this is an artifact of modeling or the result of specific design of the alternative, the apparent lack of benefit calls into question the details of the alternative and the basis for its definition.

The present commenters, as well as the Bay Institute and the State Water Board in its *Delta Flow Criteria Report*, have made numerous recommendations that would substantially improve survival of listed and non-listed species in the Sacramento and San Joaquin rivers, their tributaries, and the Delta. The DEIS apparently made no review of these recommendations or any effort to synthesize specific recommendations or proposals that would comprehensively protect and recover listed species and other fishery resources. The organizing principle of Alternative 5 appears to be inclusion of two elements of historic recommendations at a level that would have relatively small impact on water supply. While the measures proposed in Alternative 5 might make small incremental improvements in the condition of fisheries, the DEIS makes no showing that Alternative 5 is a serious "environmental" option or that its implementation would make a substantial difference in the condition of fisheries affected by the CVP and SWP.

B. The Alternatives in the DEIS are not sufficiently distinct and are not legally or factually defensible.

CWIN CSPA 18

As described in sections 1-3 above, D-1641 and the RPA's from the USFWS and NMFS BO's (the No Action Alternative) have not protected listed species or critical habitat from the effects of project operations. Delta smelt have gone almost undetected in 2015 in the extensive sampling performed in the Delta. 95% of the 2014 cohort of winter-run Chinook did not survive to Red Bluff, and water temperature targets for the Sacramento River were again exceeded throughout the summer of 2015. Other species have exhibited precipitous declines.

Alternatives 1-4 would substantially weaken the already inadequate existing RPA's. The DEIS makes no argument for how the elements analyzed in Alternatives 1-4 would individually or in aggregate improve existing conditions or protect listed species and other public trust resources. Alternative 5 would make a token, weak incremental improvement that even analysis in the DEIS suggests would do little to improve conditions affected by operation of the state and federal projects. CWIN CSPA 18

As discussed above, the No Action Alternative is not accurately characterized as a baseline condition that does not avoid jeopardy to listed species. Each of the other Alternatives presented in the DEIS also shares a common flaw: it would not avoid jeopardy of listed species. The DEIS must be recirculated with a range of alternatives that would achieve the project purpose of conforming to the ESA and other applicable law. A recirculated DEIS must provide the analysis that demonstrates conformance with the ESA, that shows the relative benefits of measures proposed, and that allows reasoned analysis of the best alternative or set of measures to protect fisheries and other public trust resources.

III. The stated "Purpose[s] of the Action" are in conflict.

The DEIS states the Purpose of the Action as follows: CWIN CSPA 19

The purpose of the action considered in this Environmental Impact Statement (EIS) is to continue the operation of the Central Valley Project (CVP), in coordination with operation of the State Water Project (SWP), for the authorized purposes, in a manner that:

- Is similar to historical operational parameters with certain modifications
- Is consistent with Federal Reclamation law; other Federal laws and regulations; Federal permits and licenses; and State of California water rights, permits, and licenses
- Enables the Bureau of Reclamation (Reclamation) and the California Department of Water Resources (DWR) to satisfy their contractual obligations to the fullest extent possible.[55]

The stated purpose of satisfying contractual obligations to the "fullest extent possible" conflicts with the ESA's requirements to protect listed species and their critical habitat. It routinely jeopardizes listed species because it recklessly prioritizes deliveries to contractors over carryover storage and seeks to constantly skate on the edge of compliance with OMR constraints, making minimal protections the target level of protection. It creates systemic demand to push exports to their maximum legal limit in any given year, even when prudent operation of the system would look to following years and thus operate with a substantial margin of safety. We provide an example below.

RPA Action Suite 1.2 in the NMFS BO requires a series of actions in managing Shasta Reservoir, including operations of Shasta to maintain suitable temperatures in the Sacramento River downstream of Shasta Reservoir to protect winter-run and spring-run Chinook, re- CWIN CSPA 20

[55] See DEIS, p. 2-1.

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establishing winter-run Chinook in Battle Creek, and reintroducing winter-run Chinook in rivers upstream of Shasta Reservoir.[56] While re-introduction actions in Battle Creek and upstream of Shasta are clearly not included in the Second Basis of Comparison and Alternatives 1-4, it is unclear whether the operational management of Shasta required in the RPA is included in the Second Basis of Comparison and in these Alternatives.[57] CWIN CSPA 20 continued

The RPA for Shasta operations requires: "Reclamation should operate in any year in which storage falls below 1.9 MAF EOS as potentially the first year of a drought sequence."[58] In discussing such circumstances, the RPA provides the following rationale:

> Notification to the State Water Resources Control Board (SWRCB) is essential. Sacramento Settlement Contract withdrawal volumes from the Sacramento River can be quite substantial during these months. The court has recently concluded that Reclamation does not have discretion to curtail the Sacramento Settlement contractors to meet Federal ESA requirements. Therefore, NMFS is limited in developing an RPA that minimizes take to acceptable levels in these circumstances. Consequently, other actions are necessary to avoid jeopardy to the species, including fish passage at Shasta Dam in the long term.[59]

Thus the RPA punts protection of winter-run to such time as a reintroduction program that achieves fish passage past Shasta Reservoir can be achieved. Passage past Shasta is clearly needed to achieve recovery of winter-run. However, immediate action is required to protect the species downstream of Shasta.

If Reclamation has no discretion to reduce deliveries to Sacramento River Settlement Contractors, then NMFS must otherwise limit discretionary actions by Reclamation to protect winter-run and spring-run and their critical habitat. Sacramento Settlement Contractors are entitled to a minimum of about 1.2 million acre-feet per year. In the face of such demands, the 1.9 million acre-feet end of September storage threshold in Shasta is too low to be protective or winter-run and spring-run, as the mass mortality of winter-run in 2014 (and likely 2015) has demonstrably proven. Thus, NMFS must modify its carryover storage thresholds and further limit discretionary exports and other discretionary deliveries from Shasta in order to protect Shasta storage and the Shasta cold water pool. The RPA cannot improperly defer to the "(n)otification to the State Water Resources Control Board" in the hope that the State Board will order reductions in deliveries to Sacramento Settlement Contractors. Indeed, despite repeated requests to the State Board in 2014 and 2015 by the present commenters and others including the Bay Institute and National Resources Defense Council, the State Board declined to limit deliveries to the Sacramento Settlement Contractors, even in the face of the loss of 95% of the 2014 cohort of Sacramento winter-run Chinook, as discussed in Section II(A)(1) of these comments, above.

[56] See NMFS BO, p. 590 ff.
[57] As noted above in these comments, the lack of clarity about which elements of the RPA's are and are not included in the Alternatives analyzed in the DEIS is a serious flaw that must be corrected.
[58] NMFS BO, p. 597.
[59] Id., p. 600.

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The Central Valley Project Improvement Act (CVPIA) made protection of fishery and other environmental resources an equal purpose of the Central Valley Project in relation to provision of water supply and other developmental purposes.[60] The DEIS's stated purpose of satisfying contractual obligations to the "fullest extent possible" also conflicts with this mandate. CWIN CSPA 21

A recirculated DEIS should restate the purpose of the Proposed Action so that it is consistent with the ESA and the CVPIA, as well as with the Clean Water Act and the public trust doctrine.

IV. Modeling in the DEIS does not accurately depict actual operation in multiple dry year sequences.

CalSim II assumes full compliance with the water quality and flow standards set forth in D-1641. However, in recent dry year sequences including 2007-2009 and 2012-2013, BOR and DWR have often not met some of these standards, with the tacit or de facto approval of the State Water Board. In addition, in 2014 and 2015, BOR and DWR undertook, at their own discretion, a series of temporary urgency change petitions (TUCP's) to weaken D-1641 water quality and flow standards on a large scale. CWIN CSPA 22

CalSim II also assumes that deliveries to the San Joaquin Exchange Contractors will always be met from sources north of Delta. However, in 2014 and 2015, such deliveries, to the extent they were made, were made from Millerton Reservoir on the San Joaquin River.

These modeling artifacts tend to overstate the impacts to CVP and SWP water supply, since water that is modeled as lost e.g. for salinity control is often in reality never released, because the standards are either not met or are explicitly weakened. The amount of water "conserved" because of TUCPs for the CVP and SWP was estimated by DWR to be 450,000 acre-feet in 2014[61] and 793,000 acre-feet in 2015.[62] In these circumstances, CalSim II also tends to under-report cumulative reservoir levels in CVP and SWP reservoirs with the possible exception of Millerton. Finally, CalSim II likely underestimates the impacts to fish, particularly pelagic species, because under weakened standards or conditions of non-compliance with standards, the low salinity zone in the Delta is entrained into the central Delta because of increased salinity and reduced outflow, and Delta hydrodynamics are more heavily influenced by exports. Along with the low salinity zone, Delta smelt in particular are, in such circumstances, more likely drawn into the central Delta, as are outmigrating salmon from the Sacramento River system.

Much of the socioeconomic impact analysis in Chapter 19 of the DEIS places special focus on Dry and Critical Dry years. Traditionally, water purveyors have emphasized economic impacts in dry year sequences in advocating for changes in standards or temporary weakening of CWIN CSPA 23

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[60] U.S.C. Title XXXIV, Sections 3402 and 3406.

[61] See http://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/tucp/accounting_reports/docs/dwr2014nov_droughtacct.pdf

[62] See http://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/tucp/docs/dwr2015aug_droughtacct.pdf

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waiving of standards, and it is on such dry year sequences that the balance of impacts turns. To the degree that the economic analysis presented in the DEIS relies on CalSim II, the economic impacts may thus be overstated, and in particular they may be overstated in regard to the time periods that generate the greatest controversy. CWIN CSPA 23 continued

V. **Conclusion**

BOR should recirculate the DEIS with a proposed Action and alternatives that will allow operation of the SWP and CVP to comply with the ESA and other applicable law. The recirculated DEIS should also address the additional issues raised in these comments. CWIN CSPA 24

Thank you for the opportunity to comment on the *Draft Environmental Impact Statement for Coordinated Long Term Operation of the Central Valley Project and State Water Project.* CWIN CSPA 25

Respectfully submitted,

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Attachment A: Complaint: Against SWRCB, USBR and DWR for Violations of Bay-Delta Plan, D-1641 Bay-Delta Plan Requirements, Clean Water Act, Endangered Species Act, Public Trust Doctrine and California Constitution

Attachment B: COMPLAINT; Against the SWRCB and USBR for Violations of Central Valley Basin Plan, WR Order 90-05, Clean Water Act, Endangered Species Act, Public Trust Doctrine and California Constitution

1D.1.5.1 Attachments to Comments from California Water Impact Network and California Sportfishing Protection Alliance

Attachments to the California Water Impact Network and California Sportfishing Protection Alliance Comment letter are included in Attachment 1D.2 located at the end of Appendix 1D.

1D.1.5.2 Responses to Comments from California Water Impact Network and California Sportfishing Protection Alliance

CWIN CSPA 1: Comment noted.

CWIN CSPA 2: Attachments to the California Water Impact Network and California Sportfishing Protection Alliance Comment letter are included in Attachment 1D.2 located at the end of Appendix 1D.

CWIN CSPA 3: The Council on Environmental Quality guidance describes that a "potential conflict with local or federal law does not necessarily render an alternative unreasonable, although such conflicts must be considered." Therefore, the range of alternatives considered in this EIS does include actions that are not necessarily consistent with existing federal and state requirements for the existing long-term operation of the CVP and SWP. The selection of the range of alternatives considered in the EIS was informed by several factors, including scoping comments.

CWIN CSPA 4: Comment noted.

CWIN CSPA 5: The analysis in the EIS compares conditions under Alternatives 1 through 5 with the No Action Alternative to identify beneficial and adverse impacts for a broad range of physical, environmental, and human resources. The NEPA analysis does not determine if the alternatives would change the findings of the biological opinions in the determination of the likelihood of the alternatives to cause jeopardy to the continued existence of the species, or destroy or adversely affect their critical habitat.

CWIN CSPA 6: Historically, many water users have been cooperatively using surface water and other water supplies, such as conjunctive use that increases groundwater use when CVP and SWP water is reduced. Changes in CVP and SWP water deliveries are within the overall range of projected water supplies in related urban water management plans, as described in Appendix 5D, Municipal and Industrial Water Demands and Supplies. It is anticipated that the communities would change their reliance on alternative water supplies, such as groundwater and recycled water, as described in the urban water management plans.

As is described in Chapter 12, Agricultural Resources, the SWAP model indicated that even with the cost of groundwater pumping from greater depths, the overall agricultural production could be maintained.

The discussion in Chapter 5, Surface Water Resources and Water Supplies, discusses that future surface water supplies and groundwater supplies could be reduced due to climate change, sea level rise, and projected population growth. The EIS analysis compares conditions in 2030 under the Alternatives 1 through 5 to the No Action Alternative; and under the No Action Alternative and Alternatives 1 through 5 to the Second Basis of Comparison. The EIS analysis does not compare the conditions under the alternatives, No Action Alternative, and Second Basis of Comparison to the existing conditions. The No Action Alternative represents operations consistent with implementation of the 2008 and 2009 Biological Opinions. This No Action Alternative represents the current management direction and level of management intensity consistent with the explanation of the No Action Alternative included in Council of Environmental Quality's Forty Most Asked Questions (Question 3). NEPA does not require agencies to mitigate impacts, nor does it require agencies to identify mitigation associated with the No Action Alternative.

It should be noted that Figures 7.15 through 7.60 in Chapter 7, Groundwater Resources and Groundwater Quality, have been modified in the Final EIS to correct an error that increased the changes in groundwater elevation by a factor of 3.25. This miscalculation was due to an error in a model post-processor that generates the figures related to changing the values from CVHM Model output from meters to feet. Therefore, the results in these figures and the related text in Chapter 7 are less than reported in the Draft EIS. The figures and the text have been revised in the Final EIS. No changes are required to the CVHM model. The revised results in the figures and the text in Chapter 7 are consistent with the findings of the SWAP model.

CWIN CSPA 7: As discussed in the response to Comment CWIN CSPA 3, the range of alternatives considered in this EIS does include actions that are not necessarily consistent with existing federal and state requirements for the existing long-term operation of the CVP and SWP. The EIS analysis provides a comparison of incremental differences between Alternatives 1 through 5 and the No Action Alternative; and Alternatives 1 through 5 and the No Action Alternative as compared to the Second Basis of Comparison. The description of the alternatives in the comment is consistent with Chapter 3, Description of Alternatives.

CWIN CSPA 8: It is acknowledged that the condition of aquatic resources has deteriorated recently, and it is likely that the current drought in California has undoubtedly resulted in profound effects on aquatic resources, especially on those species with already declining populations. It is recognized that droughts have occurred throughout California's history, and are constantly shaping and innovating the ways in which Reclamation and DWR balance both public health standards and urban and agricultural water demands while protecting the Delta ecosystem and its inhabitants. The most notable droughts in recent history are the droughts that occurred in 1976-77, 1987-92, and the ongoing drought. More details have been included in Section 5.3.3 of Chapter 5, Surface Water Resources and Water Supplies, and Section 9.3.8 of Chapter 9, Fish and Aquatic Resources, in the Final EIS to describe historical responses by CVP and SWP to these drought conditions and changes in fisheries resources.

CWIN CSPA 9: Reclamation acknowledges that the SWRCB has modified water quality and flow criteria over the past years in response to changing conditions of ecological and physical resources and the protection of all beneficial uses.

CWIN CSPA 10: The Draft EIS acknowledges the temperature challenges for winter-run Chinook Salmon in the Sacramento River downstream of the Shasta Dam. The Draft EIS also acknowledges the value that successfully providing upstream passage for winter-run Chinook Salmon could have for the population, especially in the long term in consideration of increasing temperatures associated with climate change (see pages 9-117 and 9-127).

The results of the impact analysis presented in Chapter 9, Fish and Aquatic Resources, indicates that due to climate change reducing snow pack and increasing air temperatures, water temperature thresholds would be exceeded frequently in the rivers downstream of CVP and SWP reservoirs under Alternatives 1 through 5, the No Action Alternative, and the Second Basis of Comparison.

CWIN CSPA 11: The EIS describes that under the No Action Alternative, benefits from implementation of the 2008 USFWS BO and 2009 NMFS BO RPA actions are anticipated to improve aquatic resources conditions. However, it must be recognized that some of the RPA actions are either under construction, or recently completed construction (e.g., Battle Creek restoration and Red Bluff Pumping Plant, respectively). Other RPA actions are still under development and are not scheduled for full development until 2020 (e.g., fish passage around CVP reservoirs). Therefore, conditions described in the Affected Environment section of Chapter 9 do not represent the anticipated conditions that would occur under the No Action Alternative by the Year 2030 with full implementation of the RPA actions.

CWIN CSPA 12: As described in the response to Comment CWIN CSPA 3, the range of alternatives considered in this EIS does include actions that are not necessarily consistent with existing federal and state requirements for the existing long-term operation of the CVP and SWP.

The EIS does indicate incremental benefits and adverse impacts of implementation of Alternatives 1 through 5 as compared to the No Action Alternative; and Alternatives 1 through 5 and the No Action Alternative as compared to the Second Basis of Comparison.

CWIN CSPA 13: Alternative 1 is included in the range of alternatives to represent an alternative without implementation of the 2008 USFWS BO and 2009 NMFS BO in accordance with the District Court Order.

CWIN CSPA 14: Alternative 2 is included in the range of alternatives to represent the initial Proposed Action as stated in the 2012 Notice of Intent for this EIS. As described in Chapter 3, Description of Alternatives, this alternative represents implementation of the RPAs that affect the CVP and SWP operations without requiring major construction.

The analysis of Alternative 2 as compared to the No Action Alternative (see pages 9-262 to 9-264 in the Draft EIS) indicates that salmonid survival could be less under Alternative 2 due to the lack of fish passage actions to move fish to portions of the Sacramento, American, and Stanislaus rivers that would provide cooler temperatures for spawning and rearing under the No Action Alternative.

Alternative 2 does not include any facilities considered under the Bay Delta Conservation Plan range of alternatives, including the California WaterFix.

The NEPA analysis in Chapter 9 of the DEIS evaluates the potential impacts on aquatic resources that could result from implementation of the various alternatives. The analysis does not evaluate compliance with ESA, which is in the purview of NMFS and USFWS. Chapter 9, however, does provide the rationale of the RPA measures (e.g., see 9.4.2.2.5, Conditions for Fish Passage) or cites the BOs where appropriate.

With regard to the fish passage at New Melones Dam, the Draft EIS (page 142) states that this measure is consistent with the recovery plan (NMFS 2014) and indicates that "salmonid survival could be less under Alternative 2 due to the lack of fish passage actions to move fish to portions of the Sacramento, American, and Stanislaus rivers that would provide cooler temperatures for spawning and rearing under the No Action Alternative" (Draft EIS, page 9-263).

CWIN CSPA 15: As described in Chapter 3, CVP operations on the Stanislaus River under Alternative 3 were suggested as part of a scoping comment.

The Weighted Useable Area methodology was not applied to the Stanislaus River analyses in Chapter 9 of the EIS.

The results of the impact analysis presented in Chapter 9 indicates that in 2030, water temperature thresholds would be exceeded frequently in the rivers downstream of CVP and SWP reservoirs under Alternative 3, the No Action Alternative, and the Second Basis of Comparison. The EIS analysis evaluates the differences in water temperatures between Alternatives 1 through 5 and the No Action Alternative and the Second Basis of Comparison and between the No Action Alternative and the Second Basis of Comparison.

The commenter's discussion of predation control effectiveness is acknowledged.

The description of the trap and haul program assumptions and methodologies presented in Chapter 9 of the Draft EIS were not extensive. Additional information has been included on the text from page 9-316 of the Draft EIS, and additional information has been provided in Appendix 9O of the Final EIS. There are no available and acceptable analytical tools that could be used to project the effectiveness of trap and haul operations primarily due to the lack of observed data. Therefore, the analysis in the EIS is qualitative.

Changes in aquatic resources due to changes in Old and Middle River flow operations under Alternative 3 as compared to the No Action Alternative and the Second Basis of Comparison are presented in Chapter 9.

Additional details have been provided in Chapter 19, Socioeconomics, related to the socioeconomics of freshwater and ocean harvest of fish.

CWIN CSPA 16: The description of Alternative 4 in this comment is consistent with the description presented in Chapter 3 of the EIS.

CWIN CSPA 17: Alternative 5 was developed including portions of scoping comments. The scoping comments suggested other methods to implement flow criteria on the San Joaquin River and to increase Delta outflow. However, the CVP and SWP reservoirs are operated in accordance with regulatory limitations, including applicable state and federal laws, regulations, and water rights first prior to deliver of water to CVP and SWP water contractors. With respect to the San Joaquin River flows, following the completion of the Vernalis Adaptive Management Program, Reclamation does not have the authority to obtain water from other sources to meet water quality requirements on the San Joaquin River. CVP and SWP operations are also constrained on methods to reduce temperatures downstream of the CVP and SWP reservoirs using reservoir storage carryover targets and temperature requirements in the 2009 NMFS BO due to requirements to meet Old and Middle River flow and Delta outflow criteria in the BOs and water rights.

Alternative 5 does include a more positive Old and Middle River flow criteria to reduce entrainment.

CWIN CSPA 18: See the response to CWIN CSPA 5.

CWIN CSPA 19: The purpose and need for the EIS includes a provision to enable Reclamation and DWR to satisfy their contractual obligations to the fullest extent possible in accordance with the authorized purposes of the CVP and SWP, as well as the regulatory limitations on CVP and SWP operations, including applicable state and federal laws and water rights.

Contract deliveries are based upon available water supplies on an annual and monthly basis after all water flow and demand requirements for applicable state and federal laws, regulations, and water rights are met. Full CVP and SWP water contract deliveries are used in the CalSim II model as a maximum delivery volume, but are only met when sufficient water is available.

CWIN CSPA 20: The Second Basis of Comparison, No Action Alternative, and Alternatives 1 through 5 include implementation of restoration actions on Battle Creek which are currently under construction.

The Second Basis of Comparison and Alternatives 1, 3, and 4 do not include Action I.2 of the 2009 NMFS BO for Shasta Lake operations.

As discussed in response to Comment CWIN CSPA 19, the CVP and SWP must operate in accordance with state water rights which reduce the ability to manage the cold water pool in Shasta Lake, especially in 2030 with increased air temperatures.

CWIN CSPA 21: As discussed in the response to Comment CWIN CSPA 19, Reclamation and DWR authorizations include methods to satisfy their contractual obligations to the fullest extent possible in accordance with the authorized purposes of the CVP and SWP, as well as the regulatory limitations on CVP and SWP operations, including applicable federal laws (e.g. Central Valley Project Improvement Act), state laws, and state water rights.

CWIN CSPA 22: The modeling analyses presented in the EIS include these prioritizations for long-term operation of the CVP and SWP using an 82-year hydrology analyzed with the CalSim II model, including delivery of Level 2 refuge water supplies in accordance with the CVPIA. This analytical approach results in low water storage elevations in CVP and SWP reservoirs and low deliveries to CVP agricultural water service contractors located to the south of the Delta in critical dry periods. The modeled operations do not include changes in SWRCB requirements intended to reduce the effects of extreme flood or drought events, such as the recent changes in CVP and SWP drought operations. More details have been included in Section 5.3.3 of Chapter 5, Surface Water Resources and Water Supplies, in the Final EIS to describe historical responses by CVP and SWP to these drought conditions, including recent deliveries of CVP water to the San Joaquin River Exchange Contractors.

CWIN CSPA 23: The 82-year CalSim II analysis of a range of hydrologic conditions with climate change and sea level rise in the Year 2030 provides a wide range of conditions to be evaluated in the agricultural economics analysis presented in Chapter 12, Agricultural Resources, and the municipal and industrial economic analysis presented in Chapter 19, Socioeconomics. This is especially appropriate for municipalities that project water supply resources and costs on an annual basis considering both extremely wet and extremely dry conditions that could last for multiple years. The information considered in the preparation of Chapter 19 water supply cost analysis included the urban water management plans prepared by the CVP and SWP water users which evaluated water supplies for multiple year droughts.

CWIN CSPA 24: Reclamation has modified the Final EIS in response to comments from CWIN CSPA and other commenters; and will use the Final EIS in the development of the Record of Decision.

CWIN CSPA 25: Comment noted.

1D.1.6 The Center for Environmental Science Accuracy and Reliability

October 27, 2015

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CODE	INITIAL	ACTION	DUE DATE	
BDO-400				PM
BDO-101		File		AB

VIA US MAIL

Ben Nelson
Bureau of Reclamation
Bay-Delta Office
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Sacramento, CA 95814-2536

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Secretary of Department of Interior
Department of the Interior
1849 C Street, N.W.
Washington DC 20240

Estevan López
Commissioner
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1849 C Street, N.W.
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Jennifer Gimbel
Principal Deputy Assistant Secretary, Water and Science
Department of the Interior
1849 C Street, N.W.
Washington DC 20240

Re: The Center for Environmental Science Accuracy and Reliability (CESAR) Comments on the Draft Environmental Impact Report (EIR) on the Coordinated Long-Term Operation of the Central Valley Project and State Water Project
Docket No.: RR02800000, 15XR0680A1, RX.17868946.0000000

Center for Environmental Science,
Accuracy & Reliability
2014 Tulare Street, Suite 423
Fresno, CA 93721
Phone: 559-554-2947

October 27, 2015

Dear Mr. Nelson,

The Center for Environmental Science, Accuracy, and Reliability ("CESAR") is a non-profit, public interest conservation organization whose mission is to ensure the efficient and effective enforcement of environmental laws, fulfill the educational goals of our members and provide educational information on environmental statutes and their application to the general public.

Our review of the draft EIR identified a number of serious omissions and errors. The document is fatally flawed both from the perspective of its compliance with both the District and Appeals Court direction and with respect to its compliance with the National Environmental Protection Act (NEPA).

The major shortcomings of the document include the following:

1. **The EIR fails to follow the direction of the Ninth Circuit Court of Appeals that,**

   "…Reclamation must conduct a NEPA review to determine whether the acceptance and implementation of the RPA actions cause a significant effect to the human environment…."[1]

Reclamation completely sidesteps the effects of implementation of the RPA actions by defining the baseline as operation of the project with the RPAs in place. This results in there being no alternative considered that does not include all or some of the RPAs. By defining the 'baseline' as project operations with the existing RPAs in place, Reclamation avoids ever having to address the catastrophic consequences of the unilateral adoption of the Services' RPAs. On its face, this is inconsistent with both the text and the intent of NEPA, does not comply with existing case law regarding consideration of "baseline" or with the March 13, 2014 decision of the 9th Circuit order.

Reclamation justifies ignoring the court's order by explaining that because the RPAs were provisionally accepted (before the court order that defined the mandatory scope of review required under the law) and the No Action Alternative represents a continuation of existing policy and management direction, the No Action Alternative includes the RPAs. This circular logic ignores the reality that under no circumstance could Reclamation adopt such far reaching and fundamental changes in operation of the projects without a NEPA review. Just because there was a temporal lag between implementation of the RPAs, and the Court's decision, doesn't mean that Reclamation can ignore the requirements of the law.

The implementation of the RPAs requires a NEPA review of that 'provisional' policy and management decision. Despite the clear order of the court, such a review has not been completed, and this EIR fails to complete such a review.

2. **The EIR fails to consider the effect of the adoption of the RPAs on the 288 listed species in California.**

[1] Draft Environmental Impact Report (EIR) on the Coordinated Long-Term Operation of the Central Valley Project and State Water Project, page ES 6.

1

October 27, 2015

The Coordinated Long-Term Operation of the Central Valley Project and State Water Project provides water from Trinity Dam all the way down to Imperial County in Southern California. California has experienced longer and deeper droughts than the one currently being experienced. However, until adoption of the RPAs in the Services 2008 and 2009 Biological Opinions, the projects have never allocated zero deliveries. There have been delivery reductions, but not a cessation of deliveries.

In the past, when drought occurred, the OCAP provided substantial supplies of water for listed species. This water, delivered in the form of irrigation water, was used directly by species both listed and unlisted. The water supported crops which provided habitat and food. The crops supported pollinators which pollinate listed plants and help sustain seed bank creation. The irrigation water provided crops such as alfalfa, nut crops, field crops which ensured populations of prey to sustain listed predator species, and reduce pressure on listed prey species. The water supplied by the OCAP blunted the devastating effects of drought on the natural world as individuals, cities, and farms sustained plant and animal life through irrigation. The EIR must consider the effect of reduced carrying capacity of the lands formerly irrigated in both the northern and southern portions of the state, on listed species both directly through reduced food and water supply, and indirectly.

3. The EIR fails to consider the disproportionate effects on low income and protected classes of people.

Reclamation's implementation of the RPAs, and its failure to consider an actual No Action Alternative as required by the court had the direct effect of immediately reducing economic activity in the service areas south of the Delta. Local counties saw unemployment rates of as much as 40% as a result of the provisionally adopted RPAs. The effects were almost exclusively visited on those populations living in rural areas, with few economic opportunities. The effects of the BiOp were not evident in any urban area or urban minority populations. Some of the towns and cities in these rural areas even suffered loss of public water supplies. The EIR must consider the disproportionate effect of the implementation of the RPAs on these populations.

Reclamation's adoption of the RPAs, which have been demonstrated to be based on little to no science, and which have subsequently been proven to have had disastrous effects, are subject to NEPA. This draft EIR does not comply with the requirements of NEPA. Thank you for consideration of these comments.

Yours Truly,

Leah Zabel
Staff Attorney
Center for Environmental Science, Accuracy & Reliability

1D.1.6.1 Responses to Comments from The Center for Environmental Science Accuracy and Reliability

The public review period for the Draft EIS ended on September 29, 2015. This letter was received on November 2, 2015, 34 days after the close of the public comment period. Therefore, specific responses were not developed for this comment letter, However, the issues discussed in this comment letter are similar to other comments received by Reclamation.

1D.1.7 Environmental Water Caucus – Number 1 Comment

From: **Conner Everts** <connere@gmail.com>
Date: Tue, Sep 22, 2015 at 4:24 PM
Subject: extend the comment period for the Coordinated Long-Term Operation of the Central Valley Project and State Water Project Draft Environmental Impact Statement
To: bcnelson@usbr.gov

EWC1 1

The Environmental Water Caucus (EWC), made up of over 30 organizations, strongly requests that the Bureau extend the comment period for the Coordinated Long-Term Operation of the Central Valley Project and State Water Project Draft Environmental Impact Statement. We are deeply involved with the concurrent comment period on the DEIS/EIR for the California Water Fix (formerly BDCP) and additional time to review this project is needed. An additional 30 days would be tremendously helpful.

Thank you,

Conner Everts
Facilitator fur EWC

Sent from my iPhone

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Ben Nelson

Natural Resources Specialist

Bureau of Reclamation, Bay-Delta Office

916-414-2424

1D.1.7.1 Responses to Comments from Environmental Water Caucus

EWC1 1: At the time the request for extension of the public review period was submitted, the Amended Judgement dated September 30, 2014 issued by the United States District Court for the Eastern District of California (District Court) in the *Consolidated Delta Smelt Cases* required Reclamation to issue a Record of Decision by no later than December 1, 2015. Due to this requirement, Reclamation did not have sufficient time to extend the public review period. On October 9, 2015, the District Court granted a very short time extension to address comments received during the public review period, and requires Reclamation to issue a Record of Decision on or before January 12, 2016. This current court ordered schedule does not provide sufficient time for Reclamation to extend the public review period.

1D.1.8 Environmental Water Caucus – Number 2 Comment

ENVIRONMENTAL WATER CAUCUS COMMENTS ON DRAFT ENVIRONMENTAL IMPACT STATEMENT ON OPERATIONS AND CRITERIA PLAN FOR CENTRAL VALLEY PROJECT AND STATE WATER PROJECT, SEPTEMBER 29, 2015

Comments on USBR Long Term Operations Draft Environmental Impact Statement
September 29, 2015

Ben Nelson
U.S. Bureau of Reclamation
Bay-Delta Office
801 I Street, Suite 140
Sacramento, CA 95814-2536

Sent via U.S. Mail and via email to bcnelson@usbr.gov

RE: Comments on Draft Environmental Impact Statement for Coordinated Long-Term Operation of the Central Valley Project and State Water Project

Dear Mr. Nelson:

On behalf of Friends of the River (FOR), Restore the Delta, the Center for Biological Diversity, Sierra Club California, the California Water Impact Network, the California Sportfishing Protection Alliance, and the Environmental Water Caucus (EWC) (a coalition of over 30 nonprofit environmental and community organizations and California Indian Tribes), we provide these comments on the Bureau of Reclamation's Draft Environmental Impact Statement for Coordinated Long-Term Operation of the Central Valley Project and State Water Project ("DEIS"). Unfortunately, the DEIS fails to comply with the requirements of the National Environmental Policy Act ("NEPA"), because it fails to include a reasonable range of alternatives, fails to accurately inform the public and decision makers of potential significant environmental impacts and necessary mitigation measures, and fails to adequately analyze cumulative impacts. Because Reclamation has failed to use sound scientific information and instead used flawed and biased methods to assess potential environmental impacts, the DEIS fails to accurately assess likely impacts on fish and wildlife populations and fails to identify and propose reasonable mitigation measures for potentially significant impacts. EWC2 1

In addition, the DEIS largely ignores that over the past several years, the combination of the drought and CVP/SWP operations (including waivers of D-1641 water quality standards and other environmental protections) has driven Delta Smelt, winter run Chinook salmon, and other species to the brink of extinction. The DEIS never mentions that minimum Delta water quality standards under D-1641 were waived, and that RPA actions required under the biological opinions were not implemented during the drought, and the DEIS wholly fails to analyze the impact of the reasonably foreseeable waiver of water quality standards in future droughts. Yet the DEIS only acknowledges under the No Action Alternative that abundance levels for delta EWC2 2

2

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EWC2 2 continued

smelt and other fisheries "are difficult to predict" and that "Currently low levels of relative abundance do not bode well for the Delta Smelt or other fish species in the Delta." DEIS at 9-139.[1] Under the Second Basis of Comparison, the DEIS concludes that,

> As described above for the No Action Alternative, abundance levels for Delta Smelt, Longfin Smelt, Striped Bass, Threadfin Shad, and American Shad are currently very low, and abundance and habitat conditions for fish in the Delta in future years are difficult to predict. It is not likely that operations of the CVP and SWP under the Second Basis of Comparison would result in improvement of habitat conditions in the Delta or increases in populations for these fish by 2030, and the recent trajectory of loss would likely continue.

DEIS at 9-150. Despite these acknowledgements that current operations may very well lead to extinction of the species, the DEIS proposes no mitigation measures and does not even conclude that the alternatives result in significant impacts to Delta Smelt. Similarly, for longfin smelt, the DEIS ignores that current operations have resulted in the U.S. Fish and Wildlife Service concluding that listing longfin smelt under the Endangered Species Act is warranted, and continuation of existing spring outflow conditions is likely to result in adverse effects on the species. As a result, the DEIS fails to accurately assess environmental impacts of CVP/SWP operations on Delta Smelt and longfin smelt.

EWC2 3

With respect to salmonids, the DEIS acknowledges that climate change will make it more difficult to achieve water temperature requirements with current upstream reservoir operations, impacting salmon and steelhead. *See, e.g.*, DEIS at 9-126 to 9-127. Yet the DEIS fails to conclude that these excessive temperatures constitute significant environmental impacts and fails to consider any mitigation measures.[2] During the current drought, the failure to meet minimum upstream water temperatures resulted in greater than 95% mortality of the 2014 brood year winter run Chinook salmon cohort, and may result in similar mortality for the 2015 brood year. Increased frequency, duration and intensity of upstream temperature exceedances as a result of climate change in combination with CVP/SWP operations are likely to cause significant

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[1] In part, this conclusion is based on inaccurate assessment of entrainment impacts of the Alternatives on Delta Smelt, as discussed below.

[2] In contrast, Reclamation's revised draft environmental impact statement for the California WaterFix concludes that under the No Action Alternative, upstream reservoir operations will result in significant adverse environmental impacts to winter run Chinook salmon and green sturgeon spawning and egg incubation. *See, e.g.,* USBR, CA WaterFix RDEIS/SDEIR at ES-48.

EWC2 3 continued

environmental impacts. The DEIS also fails to demonstrate whether operations of Shasta Dam under the No Action Alternative are consistent with requirements of the 2009 NOAA biological opinion, which includes performance measures and other requirements to maintain adequate cold water pool for winter run Chinook salmon below the dam. As a result, the DEIS must be revised to analyze compliance with the biological opinion and to consider changes in reservoir operations to mitigate upstream temperature impacts, including reductions in upstream water diversions and deliveries to CVP contractors, including senior contractors. EWC2 4

Despite these short term and long term impacts, the DEIS asserts that with respect to several salmon and steelhead runs, the effects of CVP/SWP operations under Alternative 1 are similar to those under the No Action Alternative and Alternative 2. *See, e.g.,* DEIS at ES-30 to ES-31, 9-397 to 9-398.[3] However, the federal courts have twice held that operations under Alternative 1 would jeopardize the continued existence and recovery of listed salmonids and steelhead, in violation of the Endangered Species Act. The DEIS therefore suggests that operations under the No Action Alternative and under Alternative 2 would also jeopardize these listed salmonid species (primarily because of upstream water temperature impacts). Yet the DEIS does not identify a significant environmental impact from these effects, and it proposes no clearly defined mitigation measures to address these impacts (except for programs for upstream fish passage at major dams, which are already required under the No Action Alternative). EWC2 5

The DEIS is fundamentally flawed, and Reclamation must revise the DEIS to analyze a broader range of alternatives using a credible methodology for assessing environmental impacts, including cumulative impacts.[4] EWC2 6

Adding insult to injury the DEIS assumes up to full contract delivery for CVP contractors. This is contrary to legal obligations required to protect fish and wildlife, and provisions of the San Luis Act, the 1986 Coordination Act and compliance with the feasibility report accompanying EWC2 7

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[3] This is at least In part because of Reclamation's flawed methodology for assessing impacts, particularly with respect to operations in the Delta..

[4] In addition, Reclamation and DWR have not complied with CEQA, and compliance with CEQA is required before the Department of Water Resources could propose any changes to State Water Project operations. Numerous additional permits and approvals would be required before authorizing any changes to operations, including requirements under the federal Endangered Species Act, California Endangered Species Act, and other state and federal laws.

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Comments on USBR Long Term Operations Draft Environmental Impact Statement
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that act.[5] Assumptions must not only comply with the law, but comport with reality. Assuming up to full contract deliveries at is not realistic. And does not take into account water supply impacts due to predicted weather, rain, snow and temperature changes. EWC2 7 continued

Conclusion

As discussed above, the DEIS fails to accurately assess environmental impacts of CVP/SWP operations, fails to consider a reasonable range of alternatives, and includes alternatives that violate Reclamation's water rights and the purpose and need statement of the DEIS. Reclamation must substantially revise the DEIS to comply with NEPA. EWC2 8

Thank you for consideration of our views.

Sincerely,

Conner Everts
Facilitator, Environmental Water Caucus
Executive Director,
Southern California Watershed Alliance

Jeff Miller
Conservation Advocate
Center for Biological Diversity

Dr. C. Mark Rockwell
Pacific Coast Representative
Endangered Species Coalition

Jonas Minton
Senior Water Policy Advisor
Planning and Conservation League

Chief Caleen Sisk
Spirtual Leader
Winnemen Wintu Tribe

Kathryn Phillips
Director
Sierra Club California

Jim Martin
Conservation Director
Berkley Conservation Institute, Pure Fishing

Robyn DiFalco
Executive Director
Butte Environmental Council

[5] The 1960 San Luis Act authorized irrigating only 500,000 acres in total in Merced, Fresno and Kings Counties and required fish and wildlife mitigations and compliance with the Fish and Wildlife Coordination Act's continuing jurisdiction due to impacts to salmon and fishery resources that rely on the Delta Estuary. See PL 86-488 and the feasibility report: http://cdm15911.contentdm.oclc.org/cdm/ref/collection/p15911coll10/id/2106
And Public Law 99-546 [H.R. 3113]; October 27, 1986.

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September 29, 2015

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Manager
California River Watch

Lloyd Carter
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Bill Jennings
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Carolee Krieger
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California Water Impact Network

Jim Cox
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Colin Bailey
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Amber Shelton
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Adam Scow
California Campaign Director
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Eric Wesselman
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John McManus
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Lower Sherman Island Duck Club

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Lowell Ashbaugh
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Northern California Council Federation of Fly Fishers

Frank Egger
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Tim Sloane
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Pacific Coast Federation of Fishermen's Associations

Huey Johnson
Founder and President
Resource Renewal Institute

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September 29, 2015

Barbara Barrigan-Parrilla
Executive Director
Restore the Delta

Diana Jacobs
Chair, Board of Directors
Sacramento River Preservation Trust

Lynne Plambeck
Executive Director
Santa Claritans for Planning and the Environment

Larry Collins
President
San Francisco Crab Boat Owners Association

Stephen Green
President
Save the American River Association

Dick Pool
President
Water4Fish

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1D.1.8.1 Responses to Comments from Environmental Water Caucus

EWC 2 1: Comment noted. Please see responses to Comments EWC 2 2 through EWC 2 8.

EWC 2 2: Droughts have occurred throughout California's history, and are constantly shaping and innovating the ways in which Reclamation and DWR balance both public health standards and urban and agricultural water demands while protecting the Delta ecosystem and its inhabitants. The most notable droughts in recent history are the droughts that occurred in 1976-77, 1987-92, and the ongoing drought. More details have been included in Section 5.3.3 of Chapter 5, Surface Water Resources and Water Supplies, and Section 9.3.8 of Chapter 9, Fish and Aquatic Resources, in the Final EIS to describe historical responses by CVP and SWP to these drought conditions and changes in fisheries resources.

Conditions that have led to consideration of the federal listing of Longfin Smelt are discussed on page 9-67 of the Draft EIS.

EWC 2 3: The discussion in Chapter 9, Fish and Aquatic Resources, does find that increased air temperatures and reduced snowfall would result in water temperatures that would result in substantial adverse impacts to salmonids and sturgeon in the rivers downstream of the CVP reservoirs under the No Action Alternative, Second Basis of Comparison, and Alternatives 1 through 5 (see subsections "Changes in Exceedance of Water Temperature Thresholds" in Section 9.4.3 of Chapter 9). The EIS analysis compares conditions in 2030 under the Alternatives 1 through 5 to the No Action Alternative; and under the No Action Alternative and Alternatives 1 through 5 to the Second Basis of Comparison. The EIS analysis does not compare the conditions under the alternatives, No Action Alternative, and Second Basis of Comparison to the existing conditions (as is presented in CEQA documents, such as the Bay Delta Conservation Plan Environmental Impact Report/Environmental Impact Statement).

The No Action Alternative represents operations consistent with implementation of the 2008 and 2009 Biological Opinions. As described in Section 3.3, Reclamation had provisionally accepted the provisions of the 2008 USFWS BO and 2009 NMFS BO, and was implementing the BOs at the time of publication of the Notice of Intent in March 2012. Under the definition of the No Action Alternative in the National Environmental Policy Act regulations (43 CFR 46.30), Reclamation's NEPA Handbook (Section 8.6), and Question 3 of the Council of Environmental Quality's Forty Most Asked Questions, the No Action Alternative could represent a future condition with "no change" from current management direction or level of management intensity, or a future "no action" conditions without implementation of the actions being evaluated in the EIS. The No Action Alternative in this EIS is consistent with the definition of "no change" from current management direction or level of management. Therefore, the RPAs were included in the No Action Alternative as Reclamation had been implementing the BOs and RPA actions, except where enjoined, as part of CVP operations for approximately three years at the time the Notice of Intent was issued (2008

USFWS BO implemented for three years and three months, 2009 NMFS BO implemented for two years and nine months).

EWC 2 4: As has been the case in the past, Reclamation will continue to work with NMFS and other members of the Sacramento Rivers Temperature Task Group (SRTTG) to manage water temperature in Sacramento River to maximize benefits for the species. However, it should be noted that meeting such objectives may not be possible given current regulatory environment.

The 2009 NMFS BO was written in consideration of project operations as described in the 2008 BA. Since 2008, the projects have been operating to 2008 USFWS and 2009 NMFS RPA actions. These actions include maintaining Old and Middle River flows at certain levels during December through June, increased closure of the Delta Cross Channel compared to those of previous requirements per SWRCB D-1641, export limitations in April and May based on San Joaquin flow at Vernalis, and increased Delta outflow in fall months following wet and above normal years. All of these actions affect project operations and result in increased reservoir releases. These effects include a shift in export patterns from spring to summer months that causes more water to be released from the reservoirs than that is being exported to meet the Delta water quality standards during a season where Delta is more saline, an increased need in supply from the Sacramento River in April and May since San Joaquin River supply is limited, and increased reservoir releases in fall months following wet and above normal years. Therefore, this reduction in flexibility to use available water supply in most efficient way for water supply and water quality needs further limits possibility of meeting storage and temperature performance requirements on upper Sacramento River (namely NMFS BO Actions 1.2.1, 1.2.2, 1.2.3, and 1.2.4.).

These NMFS BO RPA actions (namely NMFS BO Actions 1.2.1, 1.2.2, 1.2.3, and 1.2.4.) are included and benefits are acknowledged in the No Action Alternative, Alternative 2, and Alternative 5; however, in this Draft EIS, it cannot be assumed that full benefits of storage performance criteria would be achieved due to reasons explained above.

More details have been included in Section 9.4.3 of Chapter 9, Fish and Aquatic Resources, in the Final EIS to qualitatively respond to RPA actions not included in the CalSim II model in the No Action Alternative and Alternatives 2 and 5.

EWC 2 5: The EIS analysis is based upon the comparison of conditions in 2030 under different alternatives. The results of those comparisons related to water temperatures show relatively minimal changes under the Alternatives 1 through 5 to the No Action Alternative; and under the No Action Alternative and Alternatives 1 through 5 to the Second Basis of Comparison. However, as described in the response to Comment EWC 2 3, the water temperatures in the rivers downstream of the CVP reservoirs would result in substantial adverse impacts to salmonids and sturgeon under Alternatives 1, 2, 3, and 4 and the Second Basis of Comparison without the addition of fish passage methods that are included in the No Action Alternative and Alternative 5.

The CVP and SWP reservoirs are operated in accordance with regulatory limitations, including applicable state and federal laws, regulations, and water rights first prior to deliver of water to CVP and SWP water contractors. The CVP and SWP cannot choose to meet the applicable state and federal laws, regulations, and water rights; and, it is not possible to fully meet the temperature thresholds downstream of the CVP and SWP reservoirs in 2030 with climate change. Therefore, fish passage around the CVP and SWP reservoirs is considered to provide habitat with appropriate water temperatures for early lifestages.

EWC 2 6: The analysis in the EIS compares conditions under Alternatives 1 through 5 with the No Action Alternative to identify beneficial and adverse impacts for the range of physical, environmental, and human resources.

EWC 2 7: Contract deliveries are based upon available water supplies on an annual and monthly basis after all water flow and demand requirements for applicable state and federal laws, regulations, and water rights are met. Full CVP and SWP water contract deliveries are used in the CalSim II model as a maximum delivery volume, but are only met when sufficient water is available.

EWC 2 8: Reclamation has modified the Final EIS in response to comments from EWC and other commenters; and will use the Final EIS in the development of the Record of Decision.

1D.1.9 Friends of the River

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September 29, 2015

Re: Supplemental Comments on Draft Environmental Impact Statement (EIS) for Coordinated Long-Term Operation of the Central Valley Project (CVP) and State Water Project (SWP)

Dear Mr. Nelson:

Introduction

FOTR 1

These are supplemental comments submitted today on behalf of Friends of the River. These comments are submitted on the Draft EIS for Coordinated Long-Term Operation of the CVP and SWP. These comments supplement those made earlier today on behalf of the Environmental Water Caucus and its over 30 coalition members including Friends of the River.[1] It is difficult if not impossible to imagine a closer relationship for NEPA and CEQA purposes than that between the proposed new Bay Delta Conservation Plan (BDCP)/California Water Fix Delta Water Tunnels and the long-term operations of the CVP and SWP. Planned long-term operations of the CVP and SWP system determine whether the Delta Water Tunnels proposed by the BDCP/Water Fix even arguably might make any sense for water supply purposes. In turn, whether or not the new conveyance proposed by the BDCP/Water Fix is approved will make a major difference in the actual long-term operations of the CVP and SWP system. FOTR 2

Despite this extremely close relationship, separate environmental review processes for the Water Fix Delta Water Tunnels on the one hand, and the long-term CVP and SWP operations on the other hand, are underway. A Draft EIS has been prepared with respect to the long-term project operations with the comment period closing today. A separate Draft EIR/EIS and Recirculated Draft EIR/Supplemental Draft EIS have been prepared for the Water Fix Tunnels with the comment period closing October 30, 2015. The Bureau of Reclamation is the federal lead agency for both of these NEPA processes.

This deliberate separation of the Water Tunnels NEPA and CEQA process from the NEPA compliance process for the Coordinated Long-term Operation of the CVP and SWP is segmentation –also referred to as piecemealing --of environmental review. That segmentation violates NEPA and CEQA.

[1] Because of the refusal of Reclamation to grant an extension, it has been virtually impossible on a crash basis to develop comprehensive comments on the Draft EIS.

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The Segmentation of Environmental Review of long-term Operations from the Proposed Delta Water Tunnels Violates NEPA and CEQA

FOTR 2 continued

The NEPA Regulations are codified at title 40 of the Code of Federal Regulations (C.F.R.). The NEPA Regulations specify that "Agencies shall make sure the proposal which is the subject of an environmental impact statement is properly defined. . . Proposals or parts of proposals which are related to each other closely enough to be, in effect, a single course of action shall be evaluated in a single impact statement." (40 C.F.R. § 1502.4(a). [2]

Pursuant to NEPA Regulation 40 C.F.R. § 1508.25(a), multiple federal actions must be evaluated in the same environmental impact statement if they are connected, cumulative, or similar. Here, the long-term operations on the one hand, and proposed Delta Water Tunnels on the other hand, are all three. They are connected, cumulative, and similar. To assist the Bureau in complying with NEPA, we include the full text of the Regulation in the footnote.[3]

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[2] In City of Rochester v. U.S. Postal Serv., 541 F.2d 967, 972-73 (2d Cir. 1976), the court explained that:

> To permit noncomprehensive consideration of a project divisible into smaller parts, each of which taken alone does not have a significant impact but which taken as a whole has cumulative significant impact would provide a clear loophole in NEPA. [citations omitted]. The guidelines of the Council on Environmental Quality make it clear that the statutory term "major Federal actions" must be assessed "with a view to the overall, cumulative impact of the action proposed, related Federal action and projects in the area, and further actions contemplated." 40 C.F.R. s 1500.6(a) (1975). The transfer decision is plainly a consequential, if not an inseparable, feature of the construction project.

3 40 C.F.R. § 1508.25. Scope consists of the range of actions, alternatives, and impacts to be considered in an environmental impact statement. The scope of an individual statement may depend on its relationships to other statements (§§ 1502.20 and 1508.28). To determine the scope of environmental impact statements, agencies shall consider 3 types of actions, 3 types of alternatives, and 3 types of impacts. They include:

(a) Actions (other than unconnected single actions) which may be: (1) Connected actions, which means that they are closely related and therefore should be discussed in the same impact statement. Actions are connected if they: (i) Automatically trigger other actions which may require environmental impact statements. (ii) Cannot or will not proceed unless other actions are taken previously or simultaneously. (iii) Are interdependent parts of a larger action and depend on the larger action for their justification.

(2) Cumulative actions, which when viewed with other proposed actions have cumulatively significant impacts and should therefore be discussed in the same impact statement.

(3) Similar actions, which when viewed with other reasonably foreseeable or proposed agency actions, have similarities that provide a basis for evaluating their environmental consequences together, such as common timing or geography. An agency may wish to analyze these actions in the same impact statement. It should do so when the best way to

The NEPA Regulations also require that agencies "Integrate the requirements of NEPA with other planning and environmental review procedures required by law or by agency practice so that all such procedures run concurrently rather than consecutively." § 1500.2(c). *See also* § 1501.2 ("Agencies shall integrate the NEPA process with other planning at the earliest possible time to insure that planning and decisions reflect environmental values, to avoid delays later in the process, and to head off potential conflicts."). FOTR 2 continued

The rules under CEQA are similar to those under NEPA in prohibiting segmenting environmental review. CEQA requires that "an agency must use its best efforts to find out and disclose all that it reasonably can" about a project being considered and its environmental impacts. *Vineyard Area Citizens v. City of Rancho Cordova*, 40 Cal.4th 412, 428 (2007). Under CEQA a "project" is defined as "the whole of an action, which has a potential for resulting in either a direct physical change in the environment, or a reasonably foreseeable indirect physical change in the environment. . ." 14 Code Cal. Regs (CEQA Guidelines) § 15378(a). The courts have explained that:

> Theoretical independence is not a good reason for segmenting environmental analysis of the two matters. Doing so runs the risk that some environmental impacts produced by the way the two matters combined or interact might not be analyzed in the separate environmental reviews. Furthermore, if the two matters are analyzed in sequence (which was a situation here) and the combined or interactive environmental effects are not fully recognized until review of the second matter, the opportunity to implement effective mitigation measures as part of the first matter may be lost. *Tuolumne County Citizens for Responsible Growth v. City of Sonora*, 155 Cal.App.4th 1214, 1230 (2007).

Preparing separate environmental impact statements for long-term operation of the CVP and SWP, and the Delta Water Tunnels proposed by the BDCP/Water Fix in the Delta is unlawful segmentation of environmental review under NEPA.

To be crystal clear, if the Bureau of Reclamation proceeds with these separate environmental review processes, the Bureau is truly proceeding in the face of "red flags flying." The U.S. Environmental Protection Agency (EPA) commented last year during the BDCP environmental review process that:

> Upstream/Downstream Impacts FOTR 3
>
> The Federal and State water management systems in the Delta are highly interconnected, both functionally and physically. The Draft EIS does not address how changes in the Delta can affect resources in downstream waters, such as San Francisco Bay, and *require changes in upstream operations, which may result in indirect environmental impacts that*

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assess adequately the combined impacts of similar actions or reasonable alternatives to such actions is to treat them in a single impact statement.

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> *must also be evaluated.* We recommend that the Supplemental Draft EIS include an analysis of upstream and downstream impacts. (EPA comments on Draft Environmental Impact Statement for the Bay Delta Conservation Plan, San Francisco Bay Delta, California (CEQ# 20130365), p. 3, August 26, 2014)(emphasis added). [4]

FOTR 3 continued

FOTR 4

There would be no proposal to develop the massive and expensive Delta Water Tunnels if there were not to be long-term CVP and SWP operations. Likewise, long-term CVP and SWP long-term operations will be vastly different depending on whether or not the Delta Water Tunnels are developed. The Introduction to the Water Fix RDEIR/SDEIS includes among the Water Tunnels project objectives;

> Restore and protect the ability of the SWP and CVP to deliver up to full contract amounts, when hydrologic conditions result in the availability of sufficient water, consistent with the requirements of state and federal law and the terms and conditions of water delivery contracts held by SWP contractors and certain members of San Luis Delta Mendota Water Authority, and other existing applicable agreements. (Water Fix RDEIR/SDEIS Introduction, p. 1-9).

To proceed in the manner required by NEPA (and CEQA), the Bureau of Reclamation must cease these two separate environmental review processes. The Bureau of Reclamation must instead prepare and issue for public review one new Draft EIS/EIR comprehensively analyzing in one environmental review process and one Draft EIS the environmental impacts of both the Coordinated Long-Term Operation of the CVP and SWP and the proposed BDCP/Water Fix Delta Water Tunnels. Because of the segmentation, the Draft EIS is "so inadequate as to preclude meaningful analysis" in violation of NEPA. 40 C.F.R. § 1502.9(a).

Conclusion

The Bureau of Reclamation, in order to comply with NEPA, must prepare and issue for public and decision-maker review and comment one Draft EIS on both the coordinated long-term operation of the CVP and SWP, and the proposed BDCP Water Fix Delta Water Tunnels.

Sincerely,

/s/ E. Robert Wright
Senior Counsel
Friends of the River

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[4] In its detailed comments attached to the letter, EPA further explained that:

> The Draft EIS does not include a comprehensive description of the CVP and SWP with and without new North Delta intake facilities or through-Delta operations. Such information as needed to assist the reader in understanding how the water delivery system operates under Existing Conditions and how it would change under CM1 [Delta Water Tunnels] alternatives. (Detailed Comments, p. 22).

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1D.1.9.1 Responses to Comments from Friends of the River

FOTR 1: Comment noted. Please see responses to the Environmental Water Caucus Letter Number 2 in Section 1D.1.7 of this appendix.

FOTR 2: This EIS addresses the coordinated long-term operation of the CVP and SWP with existing facilities. As described in Section 1.6 of Chapter 1, Introduction, of the Draft EIS, it is anticipated that substantial changes could occur to CVP and SWP operations as future projects are implemented. It is anticipated that most of these future projects have been identified in Section 3.5 of Chapter 3, Description of Alternatives, including the Bay Delta Conservation Plan (BDCP) which includes the WaterFix as one of the BDCP alternatives. Many of these future projects have not been fully defined and are not anticipated to be operational until the late 2020s. For example, operations of the BDCP has been estimated to not occur until at least 10 years following completion of the planning documents in 2016 (see Appendix 8A, Implementation Costs Supporting Materials, of the Draft Bay Delta Conservation Plan published in 2013).

If any of these future projects would substantially change CVP operations, Reclamation would evaluate the need to request for initiation of consultation under the Endangered Species Act (ESA) with the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NFMS). For example, a separate consultation is being requested by Reclamation under Section 7 of the ESA for the WaterFix. Following this and/or other new ESA consultations on future projects, coordinated long-term operation of the CVP and SWP described in the Preferred Alternative for this EIS and set forth in the Record of Decision, may or may not be revised and alternative operating parameters be put in place. As described in Chapter 1, that is the reason that the study period for this EIS concludes around 2030.

Because the future operations under future projects (including the WaterFix) have not been finalized at this time; and because projects that would substantially change CVP operations would require future consultations with USFWS and NMFS, it would be pre-decisional to include these projects in the alternatives evaluated in this EIS. This approach does not lead to segmentation of the analyses because the analyses are sequential, and not concurrent.

Reclamation is the lead agency for this action and the environmental document; therefore, the environmental document is being prepared only under the National Environmental Policy Act. Several State of California agencies are cooperating agencies for this EIS. Because compliance with the California Environmental Quality Act (CEQA) would be under DWR’s purview, Reclamation consulted with DWR on this comment. On October 5, 2015, DWR provided the following response: “The District Court required Reclamation to comply with NEPA on the provisional acceptance of the RPA actions. There is no action for the State of California requiring California Environmental Quality Act (CEQA) review.”

FOTR 3: This comment is a comment provided by the U.S. Environmental Protection Agency on the BDCP Draft Environmental Impact Report/EIS, and not on this EIS. This EIS does evaluate the effects of the coordinated long-term operation of the CVP and SWP on areas located upstream and downstream of the Delta, as described in Section 1.5 of Chapter 1, Introduction, of the Draft EIS.

FOTR 4: The CVP and SWP will be operated in accordance with the Preferred Alternative set forth in the Record of Decision for this EIS until future projects are implemented, such as the BDCP. As described in Response to Comment FOTR 2, prior to implementation of future projects, separate environmental documentation would be completed; and, if substantial changes in operation of the CVP occur, separate ESA consultations would be required. The projects that have been identified but not fully defined at this time (including BDCP/WaterFix) are included in the EIS analysis through a cumulative effects analysis in Chapters 5 through 21. Due to the possibility of these future projects, the study period for this EIS is considered to extend only to the 2030 time period.

1D.1.10 Golden Gate Salmon Association and Pacific Coast Federation of Fishermen's Association

GoldenGate Salmon Association

PACIFIC COAST FEDERATION OF FISHERMEN'S ASSOCIATIONS
PCFFA
STEWARDS OF THE FISHERIES

September 29, 2015

Ben Nelson
U.S. Bureau of Reclamation
Bay-Delta Office
801 I Street, Suite 140
Sacramento, CA 95814-2536

Sent via U.S. Mail and via email to bcnelson@usbr.gov

RE: Comments on Draft Environmental Impact Statement for Coordinated Long-Term Operation of the Central Valley Project and State Water Project

Dear Mr. Nelson:

On behalf of the Golden Gate Salmon Association and the Pacific Coast Federation of Fishermen's Associations, we provide these comments on the Bureau of Reclamation's Draft Environmental Impact Statement for Coordinated Long-Term Operation of the Central Valley Project and State Water Project ("DEIS"). Unfortunately, the DEIS fails to comply with the requirements of the National Environmental Policy Act ("NEPA"), because it fails to include a reasonable range of alternatives, fails to accurately inform the public and decision makers of potential significant environmental impacts and necessary mitigation measures, and fails to adequately analyze cumulative impacts. Because Reclamation has failed to use sound scientific information and instead used flawed and biased methods to assess potential environmental impacts, the DEIS fails to accurately assess likely impacts on fish and wildlife populations and fails to identify and propose reasonable mitigation measures for potentially significant impacts. GGSA PCFFA 1

Comments on USBR Long Term Operations Draft Environmental Impact Statement
September29, 2015

1. The DEIS Fails to Accurately Assess Environmental Impacts to Fish and Wildlife

The DEIS largely ignores that over the past several years, the combination of the drought and CVP/SWP operations (including waivers of D-1641 water quality standards and other environmental protections) has driven delta smelt, winter run Chinook salmon, and other species to the brink of extinction. The DEIS never mentions that minimum Delta water quality standards under D-1641 were waived, and that RPA actions required under the biological opinions were not implemented during the drought, and the DEIS wholly fails to analyze the impact of the reasonably foreseeable waiver of water quality standards in future droughts. Yet the DEIS only acknowledges under the No Action Alternative that abundance levels for delta smelt and other fisheries "are difficult to predict" and that "Currently low levels of relative abundance do not bode well for the Delta Smelt or other fish species in the Delta." DEIS at 9-139.[1] Under the Second Basis of Comparison, the DEIS concludes that, GGSA PCFFA 2

> As described above for the No Action Alternative, abundance levels for Delta Smelt, Longfin Smelt, Striped Bass, Threadfin Shad, and American Shad are currently very low, and abundance and habitat conditions for fish in the Delta in future years are difficult to predict. It is not likely that operations of the CVP and SWP under the Second Basis of Comparison would result in improvement of habitat conditions in the Delta or increases in populations for these fish by 2030, and the recent trajectory of loss would likely continue.

DEIS at 9-150. Despite these acknowledgements that current operations may very well lead to extinction of the species, the DEIS proposes no mitigation measures and does not even conclude that the alternatives result in significant impacts to delta smelt. Similarly, for longfin smelt, the DEIS ignores that current operations have resulted in the U.S. Fish and Wildlife Service concluding that listing longfin smelt under the Endangered Species Act is warranted, and continuation of existing spring outflow conditions is likely to result in adverse effects on the species. As a result, the DEIS fails to accurately assess environmental impacts of CVP/SWP operations on delta smelt and longfin smelt. All of this bodes poorly for the salmon that the commercial and recreational salmon fishing industry needs to survive. We strongly urge Reclamation to work with the National Marine Fisheries Service, U.S. Fish and Wildlife Service, California Department of Fish and Wildlife, and U.S. Environmental Protection Agency to address these scientific and analytic flaws.

The DEIS fails to consider an alternative that includes increased investments in local and regional water supplies. It fails to accurately assess the likely socioeconomic impacts of GGSA PCFFA 3

[1] In part, this conclusion is based on inaccurate assessment of entrainment impacts of the Alternatives on Delta Smelt, as discussed below.
[2] In contrast, Reclamation's revised draft environmental impact statement for the California

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GGSA PCFFA 3 continued

increased restrictions on ocean salmon fishing in Alternatives 3 and 4. It also fails to include any operational measures to adapt to climate change and mitigate its effects upstream.

GGSA PCFFA 4

With respect to salmon, the DEIS acknowledges that climate change will make it more difficult to achieve water temperature requirements with current upstream reservoir operations, resulting in impacts to salmon and steelhead. *See, e.g.*, DEIS at 9-126 to 9-127. Yet the DEIS fails to conclude that these temperance exceedances constitute a significant environmental impacts and fails to consider any mitigation measures.[2] During the current drought, the failure to meet minimum upstream water temperatures resulted in greater than 95 percent mortality of the 2014 brood year winter run Chinook salmon and probably as much, or more, of the fall run salmon our industry relies on. Failure to adequately forecast and manage upstream reservoirs may result in similar mortality for the 2015 brood year. Increased frequency, duration and intensity of upstream temperature exceedances as a result of climate change in combination with CVP/SWP operations are likely to cause significant environmental impacts. The DEIS also fails to demonstrate whether operations of Shasta Dam under the No Action Alternative are consistent with requirements of the 2009 NOAA biological opinion, which includes performance measures and other requirements to maintain adequate cold water pool for winter run Chinook salmon below the dam. As a result, the DEIS must be revised to analyze compliance with the biological opinion and to consider changes in reservoir operations to mitigate upstream temperature impacts.

GGSA PCFFA 5

GGSA PCFFA 6

Despite these short and long term impacts, the DEIS asserts that with respect to several salmon and steelhead runs, the effects of CVP/SWP operations under Alternative 1 are similar to those under the No Action Alternative and Alternative 2. *See, e.g.,* DEIS at ES-30 to ES-31, 9-397 to 9-398.[3] However, the federal courts have twice held that operations under Alternative 1 would jeopardize the continued existence and recovery of listed salmonids and steelhead, in violation of the Endangered Species Act. The DEIS therefore suggests that operations under the No Action Alternative and under Alternative 2 would also jeopardize these listed salmon species (primarily because of upstream water temperature impacts). Yet the DEIS does not identify a significant environmental impact from these effects, and it proposes no clearly defined mitigation measures to address these impacts (except for programs for upstream fish passage at major dams, which are already required under the No Action Alternative).

GGSA PCFFA 7

[2] In contrast, Reclamation's revised draft environmental impact statement for the California WaterFix concludes that under the No Action Alternative, upstream reservoir operations will result in significant adverse environmental impacts to winter run Chinook salmon and green sturgeon spawning and egg incubation. *See, e.g.,* USBR, CA WaterFix RDEIS/SDEIR at ES-48.

[3] This is at least In part because of Reclamation's flawed methodology for assessing impacts, particularly with respect to operations in the Delta..

The DEIS is fundamentally flawed, and Reclamation must revise the DEIS to analyze a broader range of alternatives using a credible methodology for assessing environmental impacts, including cumulative impacts.[4] GGSA PCFFA 8

Adding insult to injury, the DEIS assumes up to full contract delivery for CVP contractors. This is contrary to existing legal obligations to protect fish and wildlife, as well as provisions of the San Luis Act and compliance with the feasibility report accompanying that act.[5] Assumptions must not only comply with the law but comport with reality. Assuming up to full contract deliveries is not realistic. GGSA PCFFA 9

In general, Chapter 9 fails to utilize recent scientific information and utilizes outdated and inaccurate models to assess potential impacts to fish and wildlife populations. As a result, the DEIS fails to accurately assess the likely environmental impacts of the alternatives on fish and wildlife and significantly understates the environmental impacts of some alternatives. GGSA PCFFA 10

As with the pelagic species discussed above, the DEIS omits numerous recent scientific studies and analyses, particularly studies that indicate significant impacts of water project operations on salmonid survival and abundance. For instance, recent life cycle models for fall run Chinook salmon and spring run Chinook salmon have been developed and submitted to the Delta Science Program, which conclude that CVP/SWP delta exports significantly reduce spring and fall run salmon survival and abundance. *See* Cunningham *et al* 2015. In addition, Michel *et al* 2015 was recently published in the Canadian Journal of Fisheries and Aquatic Sciences, which reviews five years of acoustic tag data and demonstrates that increased flows dramatically increase survival of migrating salmon through the Sacramento River and Delta. These studies contradict many of the methods and models utilized by Reclamation in the DEIS to assess impacts, such as the Delta Passage model (which predicts very minimal changes in survival and abundance despite significant changes in exports and Old and Middle River reverse flows) and SALMOD.1

For example, Cunningham et al 2015 estimates that increasing exports by 30% above the 1967-2010 average would result in a 16-28% lower median survival rate from egg to adulthood for wild fall run chinook salmon and a 39-59% reduction in median survival for spring run Chinook salmon, concluding that, "[a] 30% increase in exports decreased spring and fall stock survival to the point where they would all decline regardless of the climate scenario." In contrast, the Delta

[4] In addition, Reclamation and DWR have not complied with CEQA, and compliance with CEQA is required before the Department of Water Resources could propose any changes to State Water Project operations. Numerous additional permits and approvals would be required before authorizing any changes to operations, including requirements under the federal Endangered Species Act, California Endangered Species Act, and other state and federal laws.
[5] The 1960 San Luis Act authorized irrigating only 500,000 acres in Merced, Fresno and Kings Counties and providing fish and wildlife benefits and compliance with the Fish and Wildlife Coordination Act continuing jurisdiction. See PL 86-488 and http://cdm15911.contentdm.oclc.org/cdm/ref/collection/p15911coll10/id/2106

Passage Model predicts "very similar estimates of survival" for spring and fall run Chinook salmon under the No Action Alternative compared to the Second Basis of Comparison, despite the substantial increase in exports under the Second Basis of Comparison. *See* DEIS at 9-169, 9-178. GGSA PCFFA 10 continued

In addition, the Delta Passage Model only attempts to estimate survival of salmon smolts, *see* DEIS Appendix 9J at 9J-1, and cannot assess impacts to salmon fry or parr. Yet fry and parr life stages are often the majority of salmon migrating through the Delta, and the DEIS wholly ignores the impacts of CVP/SWP operations on these salmonid life histories. GGSA PCFFA 11

Similarly, the DEIS fails to explain the contradictory information from use of the OBAN life cycle model and the Delta Passage Model on salmon survival through the Delta. On page 9-162, the DEIS states that the Delta Passage Model results in similar winter run Chinook salmon survival through the Delta under the No Action Alternative and the Second Basis of Comparison, and on the same page it states that the OBAN life cycle model predicts that median survival through the Delta would be 12 percent higher under the No Action Alternative compared to the Second Basis of Comparison. The DEIS provides no justification for its statement that the OBAN model's survival estimates "suggest a high probability of no difference between these two bases of comparison." DEIS at 9-162. In fact, the model demonstrates a very substantial difference in survival between the two alternatives, and Reclamation's conclusory statement is arbitrary and capricious. GGSA PCFFA 12

As a result, the DEIS fails to accurately assess environmental impacts of CVP/SWP operations in the Delta on migrating salmonids, and the conclusions drawn in the DEIS are arbitrary and capricious.

2. The DEIS Fails to Accurately Assess Upstream Water Temperature Impacts to Salmon

The DEIS' analysis of upstream temperature impacts on salmon is flawed and understates the adverse impacts of CVP/SWP operations on salmon (particularly in combination with climate change), and the DEIS fails to explicitly acknowledge that CVP/SWP operations cause significant adverse impacts and to propose mitigation measures to address these impacts in the short term. Reclamation's conclusions in the DEIS are arbitrary and capricious. GGSA PCFFA 13

Even using flawed methodology, the DEIS demonstrates that there will be significant adverse effects on salmon from high water temperatures as a result of climate change and CVP/SWP operations, including under the No Action Alternative:

> Under the No Action Alternative, the ability to control water temperatures depends on a number of factors and management flexibility usually ends in October when the cold water pool in Shasta Lake is depleted. With climate

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GGSA PCFFA 13 continued

> change, cold water storage at the end of May in Shasta Lake is expected to be reduced under the No Action Alternative for all water year types. This would further reduce the already limited cold water pool in late summer. **With the anticipated increase in demands for water by 2030 and less water being diverted from the Trinity River, it is expected that it would become increasingly difficult to meet water temperature targets at the various temperature compliance points. It is likely that severe temperature-related effects will be unavoidable in some years under the No Action Alternative.** Due to these unavoidable adverse effects, RPA Action Suite I.2 also specifies other actions that Reclamation must take, within its existing authority and discretion, to compensate for these periods of unavoidably high temperatures. These actions include restoration of habitat at Battle Creek (see below) which may support a second population of winter-run Chinook Salmon, and a fish passage program at Keswick and Shasta dams to partially restore winter-run Chinook Salmon to their historical cold water habitat.

DEIS at 9-127 to 9-128 (emphasis added).[6] The DEIS also uses Reclamation's salmon mortality model to estimate temperature impacts on salmon production and mortality, concluding that the impacts from the No Action Alternative and the Second Basis of Comparison are similar, *see* DEIS at 9-160, that winter run Chinook salmon mortality is 31.4% in critically dry years under the No Action Alternative, *see* DEIS at Appendix 9C-8, and that Sacramento River spring run Chinook salmon mortality is 21.9% on average, and 84.8% in critically dry years under the No Action Alternative, *see* DEIS at Appendix 9C-7. Similarly, the SALMOD model results in the DEIS estimate that in approximately 10% of years, there would be zero production of spring run Chinook salmon below Shasta Dam. *See* DEIS at Figure B-3-1. And the DEIS estimates that under both the No Action Alternative and the Second Basis of Comparison, Reclamation will frequently violate temperature standards at Shasta Dam, *see* DEIS at 9-159 to 9-160, and at other reservoirs, *see* DEIS at 9-166 to 9-168. Yet the DEIS fails to explicitly identify upstream temperature mortality as a significant adverse impact, and the only mitigation measure identified in the DEIS (fish passage program) is a long term potential measure that is already required under the No Action Alternative and is therefore part of the baseline. That mitigation measure does not address the ongoing significant adverse impact in the near term, nor does it propose anything that is not already required.

[6] However, as noted above, the DEIS also fails to demonstrate whether operations of Shasta Dam under the No Action Alternative are consistent with requirements of the 2009 NOAA biological opinion, which includes performance measures and other requirements to maintain adequate cold water pool for winter run Chinook salmon below the dam. *See* DEIS at 9-125 (describing RPA requirements). To the extent that the modeled operations under the No Action Alternative fail to meet the RPA requirements, Reclamation must revise operations to be consistent with those RPA requirements.

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Moreover, the DEIS relies on flawed methodologies to assess temperature impacts on salmonids, many of which provide contradictory results, which mislead the public as to the effects of CVP/SWP operations on salmonids. For instance, the DEIS uses the SALMOD model to calculate juvenile production and the extent of temperature related upstream mortality to eggs and fry. The document concludes that the No Action Alternative results in similar impacts to the Second Basis of Comparison. DEIS at 9-162. Yet SALMOD's estimates of mortality and production are wildly inaccurate compared to recent data. For instance, Figure B-4-1 estimates that winter run Chinook salmon production would never drop below 500,000, yet in 2014 there was a total year class failure with over 95% mortality due to water temperatures. Figure B-4-1 also shows that according to the SALMOD model, in approximately 95% of years winter run Chinook salmon production does not vary by more than a few hundred thousand fish. Yet empirical data shows that winter run Chinook salmon egg to fry survival at Red Bluff Diversion Dam from 2002 to 2012 varied substantially, from a low of 15.4% to a high of 48.6%, with a mean of 26.4%. *See* U.S. Fish and Wildlife Service 2015 at Table 6c. Estimates for other salmon runs are similarly inaccurate compared to recent Sacramento River data from the U.S. Fish and Wildlife Service. And this recent data also contradicts the information presented in Reclamation's salmon mortality model, which significantly underestimates mortality compared to the recent data. GGSA PCFFA 14

In addition, the analysis of water temperature impacts looks only at monthly average temperatures. DEIS at 9-109. As the DEIS notes briefly, "the effects of daily (or hourly) temperature swings are likely masked by the averaging process." DEIS at 9-110. This is clearly correct, and may help explain why the modeled results do not show the level of mortality seen from recent empirical data. Yet the DEIS fails to carry forward this caveat elsewhere in the discussion, when it presents the results of modeling. Similarly, the DEIS restricts its use of the IOS model to median escapement estimates and only uses a subset of the years from CALSIM, DEIS at 116, which excludes the highest mortality years in the driest years and therefore does not accurately assess impacts. GGSA PCFFA 15

Finally, the DEIS' analysis of weighted usable area for rearing habitat fail to account for more recent scientific research demonstrating the strong effect of increased flow on downstream salmonid survival in the Sacramento River. *See* DEIS at 9-107 to 9-109. The methodology used in the DEIS does not account for the significant reduction in survival of migrating salmon under lower flow conditions in the Sacramento River. *See* Michel et al 2015. As a result, the DEIS fails to accurately assess the impact of reduced flow on salmon survival in the Sacramento River using this methodology. GGSA PCFFA 16

The DEIS demonstrates that current CVP/SWP operations, including water deliveries to Sacramento River Settlement Contractors and other senior water rights holders, in combination GGSA PCFFA 17

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with climate change, will result in significant adverse effects on salmon caused by violations of water temperature requirements. The DEIS predicts that these impacts will become more severe as a result of climate change and increased demands for water. As a result, the DEIS must consider alternatives and/or mitigation measures that reduce upstream water deliveries, including deliveries to Sacramento River Settlement Contractors and other water rights holders. GGSA PCFFA 17 continued

3. The DEIS Fails to Accurately Assess Impacts to Salmonids in the San Joaquin Basin

The DEIS fails to accurately assess environmental impacts to salmonids in the San Joaquin Basin because it fails to assess impacts to spring run Chinook salmon and because it fails to assess the impacts from changes in river flows. GGSA PCFFA 18

First, the DEIS fails to acknowledge that small populations of spring run Chinook salmon have been established in recent years in the Stanislaus and other rivers. NMFS has acknowledged these populations exist, but the DEIS only analyzes impacts to fall run Chinook salmon and mistakenly concludes that spring run have been extirpated. DEIS at 9-87, 9-92. The DEIS wholly fails to analyze impacts to spring run Chinook salmon in the Stanislaus River and other San Joaquin River tributaries.

Second, the DEIS acknowledges some of the studies documenting that salmon survival in the Stanislaus River and other San Joaquin tributaries is driven by river flow conditions. For instance, the DEIS cites Zeug et al 2014 to show that higher flow generally results in higher salmon survival and subsequent abundance. DEIS at 9-92. Yet the DEIS ignores other scientific studies which conclude that flows drive salmonid survival and abundance, including Sturrock et al 2015, Buchanan et al 2015, State Water Resources Control Board 2010, 2012.[7] The DEIS also fails to emphasize that inadequate flow is the dominant factor limiting salmon survival and abundance, instead relying on outdated research from 1982 to assert that survival through the Stockton Deepwater Ship Channel is one of the most limiting factors. DEIS at 9-92.[8] GGSA PCFFA 19

The DEIS fails to utilize this recent scientific information on the importance of river flow in assessing environmental impacts. Although the DEIS analyzes impacts from changes in operations on water temperatures, it wholly fails to assess the impacts from changes in flows on the Stanislaus River. *See, e.g.,* DEIS at 2-202 to 2-209 (analyzing impacts to fall run Chinook

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[7] The DEIS also cites to 2001 research by Mesick on the effect of fall flows and exports on straying, but ignores Marston et al 2012, which concluded that fall pulse flows and export rates are correlated with higher rates of straying.

[8] The DEIS also incorrectly asserts that flows must exceed 5,000 cfs to mobilize gravel in the Stanislaus River. DEIS at 9-95. That is incorrect; Kondolf 2001 concluded that flows below 5,000 cfs could mobilize the riverbed, particularly in certain reaches of the river.

salmon and Steelhead).[9] The available scientific evidence demonstrates that a reduction in flows below the minimum requirements of the biological opinion would result in very significant adverse effects on steelhead, fall run Chinook salmon, spring run Chinook salmon. *See, e.g.,* Sturrock et al 2015; Zeug et al 2014; Buchanan et al 2015; State Water Resources Control Board 2010, 2012. And the State Water Resources Control Board, National Marine Fisheries Service, U.S. Fish and Wildlife Service, California Department of Fish and Wildlife, and many others have demonstrated that current flow levels on the Stanislaus River and other San Joaquin River tributaries are causing significant impacts to salmon and steelhead, demonstrating a need to substantially increase flows to sustain salmon. GGSA PCFFA 19 continued

This is particularly problematic for Alternative 3, which proposes to substantially reduce Stanislaus River flows. The DEIS wholly fails to analyze the impact of reduced flows and, based solely on temperature modeling, concludes that that Alternative 3 would have slightly beneficial effects on fall run Chinook salmon. DEIS at 9-316. Because the DEIS fails to assess the environmental impacts of reduced flows, which is the dominant factor affecting salmon and steelhead on the Stanislaus, Lower San Joaquin River, and other tributaries, the DEIS fails to accurately assess the environmental impacts of CVP/SWP operations on salmonids in the San Joaquin Basin. Reclamation's conclusions in the DEIS are arbitrary and capricious. GGSA PCFFA 20

In addition, the DEIS fails to credibly analyze the impacts of the proposed trapping and barging of San Joaquin basin salmonids through the Delta under Alternative 3 and 4. The document makes unsubstantiated conclusions that this action would benefit salmonids without providing any analysis in the document. DEIS at 9-315 to 9-316. As a result, Reclamation's conclusion in the DEIS is arbitrary and capricious. There are substantial uncertainties regarding the effectiveness of capture operations (the stated goal is capturing 10-20% of the population) and potential adverse impacts. Moreover, coded wire tag data from the California Department of Fish and Wildlife show that salmon from the Merced Hatchery have successfully migrated through the Delta in recent years. *See* Kormos et al 2012; Palmer-Zwahlen and Kormos 2013. And in their comments on the ADEIS, NMFS raised substantial concerns that a trap and haul program would cause substantial adverse impacts on salmonids. GGSA PCFFA 21

The DEIS also fails to assess whether such a program is consistent with Reclamation's obligation to double natural production of salmon populations under the Central Valley Project GGSA PCFFA 22

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[9] Elsewhere, the DEIS asserts that under the No Action Alternative, Reclamation will not fully implement the biological opinion requirements regarding Stanislaus River and Lower San Joaquin River flows, in order to make water available to contractors, yet asserts with no justification that the impacts would be "similar or reduced relative to recent conditions." DEIS at 9-133. The DEIS reaches a similarly flawed conclusion with respect to the Second Basis of Comparison, concluding that the failure to implement the biological opinion requirements on the Stanislaus River would not improve in the future. DEIS at 9-149.

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GGSA PCFFA 22 continued

Improvement Act.[10] Reclamation must substantially revise this section of the DEIS to provide a basis for its conclusions and to respond to the concerns raised by NMFS and others.

GGSA PCFFA 23

4. The DEIS Concludes that the Effects of Predator Control Program are Highly Uncertain and Could Cause Significant Adverse Environmental Impacts

GGSA PCFFA 24

As compared to the administrative draft, the DEIS' analysis of the impacts of predator control programs is substantially improved. For instance, the DEIS cites repeatedly to the Delta Science Program's independent peer review report (Grossman et al 2013) regarding the effects of predation on salmonids and the caveats statements that predator control programs will work as intended. *See* DEIS at 9-274 to 9-275. It also cites work by Peter Moyle suggesting that predator control programs could harm delta smelt, and acknowledges that predator control programs at the Columbia River have not demonstrated population level effects. DEIS at 9-274 to 9-276. As a result, the DEIS concludes that,

> the program may be difficult to implement, may not be effective, and may cause unintended harm to other native Delta fish species. Consequently, the outcome of the predator management program is highly uncertain. Compared to the No Action Alternative, which does not include a predator reduction program, Alternative 3 may or may not provide a benefit to salmonids and may result in an adverse effect on Delta smelt.

DEIS at 9-276.

However, the DEIS fails to acknowledge that USBR's own studies regarding the Head of Old River Barrier on the San Joaquin River have shown that increased flows reduce predation on salmonids, and reduced flows increase predation and reduce survival. *See* Bowen et al 2009 and 2010 (USBR Technical Memorandum 86-68290-10-07 and 86-68290-11). And the DEIS also inconsistently addresses the impact of CVP/SWP operations in contributing to predation by nonnative species, particularly by causing habitat conditions in the Delta and other rivers that favor non-native species. For instance, on page 9-354, the DEIS concludes that Alternative 5 may adversely affect striped bass, but the DEIS does not analyze whether or how that impact to striped bass may subsequently affect salmonids or other species.

5. The DEIS Fails to Accurately Assess Impacts of Fishing Mortality and Greater Restrictions on Salmon Fishing Proposed in Some Alternatives

[10] More broadly, the DEIS fails to assess whether any of the alternatives meet Reclamation's obligations under section 3406(b).

The DEIS incorrectly assesses the impact of greater restrictions on salmon fishing under Alternatives 3 and 4. For instance, the DEIS downplays the effectiveness of the recent restrictions on salmon fishing as a result of the 2012 winter run Chinook salmon biological opinion, and it does not mention that NMFS' recovery plan for winter run Chinook salmon lists the ocean fishery as a low stressor on the population. *See* DEIS at 9-118, 9-277 to 9-278. The DEIS must be revised to account for this information in assessing impacts. Moreover, mark select fisheries are likely to substantially reduce fishing opportunities and may not improve conditions for wild salmon. The DEIS fails to analyze these potential adverse impacts of mark select fisheries.[11] In addition, as NMFS noted in its comments on the ADEIS, the harvest rule specified in Alternatives 3 and 4 may be less protective of winter run Chinook salmon than the existing biological opinion, given the restrictions on fishing at low levels of abundance. As noted in our prior comments, we strongly recommend that Reclamation work with the Pacific Fishery Management Council regarding these conclusions. GGSA PCFFA 25

6. The DEIS Fails to Accurately Assess Impacts of Climate Change on Salmon and Propose Mitigation Measures to Address those Impacts

We appreciate that the DEIS includes the potential effects of climate change on precipitation and temperature, in order to assess how climate change may affect CVP/SWP operations. The DEIS assumes that climate change will reduce reservoir storage and cause increased temperature impacts on salmonids. *See, e.g.,* DEIS at 9-120, 9-123, 9-126 to 9-127, 9-130, 9-132 to 9-133, 9-146. However, the document wholly fails to propose any short term measures to mitigate the effects of CVP/SWP operations in combination with climate change in order to avoid violations of downstream water temperature standards that imperil salmon. As a result, the DEIS predicts more significant impacts on salmonids from increased upstream temperature, without proposing any changes or modifications to operations in order for Reclamation to meet its existing obligations under state and federal law to avoid violating water temperature requirements. The DEIS must be revised to analyze mitigation measures and alternatives that reduce or avoid water temperature violations below dams, consistent with Reclamation's legal obigations to protect and restore salmoninds, including reduced upstream diversions and deliveries to senior water contractors. GGSA PCFFA 26

7. Conclusion

As discussed above, the DEIS fails to accurately assess environmental impacts of CVP/SWP operations, fails to consider a reasonable range of alternatives, and includes alternatives that GGSA PCFFA 27

[11] In addition, the DEIS fails to analyze the socioeconomic effects of reducing salmon fishing as proposed under Alternatives 3 and 4. *See, e.g.,* DEIS at 19-77.

violate Reclamation's water rights and the purpose and need statement of the DEIS. Reclamation must substantially revise the DEIS to comply with NEPA. GGSA PCFFA 27 continued

Thank you for consideration of our views.

Sincerely,

John McManus
Executive Director
Golden Gate Salmon Association

Tim Sloane
Executive Director
Pacific Coast Federation of Fishermen's Associations

1D.1.10.1 Responses to Comments from Golden Gate Salmon Association and Pacific Coast Federation of Fishermen's Association

GGSA PCFFA 1: Comment noted. Please see responses to Comments GGSA PCFFA 2 through GGSA PCFFA 27.

GGSA PCFFA 2: Droughts have occurred throughout California's history, and are constantly shaping and innovating the ways in which Reclamation and DWR balance both public health standards and urban and agricultural water demands while protecting the Delta ecosystem and its inhabitants. The most notable droughts in recent history are the droughts that occurred in 1976-77, 1987-92, and the ongoing drought. More details have been included in Section 5.3.3 of Chapter 5, Surface Water Resources and Water Supplies, and Section 9.3.8 of Chapter 9, Fish and Aquatic Resources, in the Final EIS to describe historical responses by CVP and SWP to these drought conditions and changes in fisheries resources.

Conditions that have led to consideration of the federal listing of Longfin Smelt are discussed on page 9-67 of the Draft EIS.

GGSA PCFFA 3: Alternative 5 increases fisheries protection related to the Old and Middle River positive flow regime as compared to the Alternatives 1 through 4, No Action Alternative, and Second Basis of Comparison; and increases reliance on increased investments in local and regional water supplies.

Additional details have been provided in Chapter 19, Socioeconomics, related to the socioeconomics of freshwater and ocean harvest of fish.

GGSA PCFFA 4: The EIS alternatives include consistent climate change conditions without consideration of potential regulatory or operational changes due to climate conditions in the future. Potential climate-related operational changes are currently unknown and it would be speculative to develop such assumptions for a NEPA analysis. The impact analysis compares conditions under the Alternatives 1 through 5 to the No Action Alternative; and under the No Action Alternative and Alternatives 1 through 5 to the Second Basis of Comparison. This comparative approach eliminates the effects of climate change from the incremental changes between the alternatives, No Action Alternative, and Second Basis of Comparison.

GGSA PCFFA 5: The discussion in Chapter 9, Fish and Aquatic Resources, does find that increased air temperatures and reduced snowfall would result in water temperatures that would result in substantial adverse impacts to salmonids and sturgeon in the rivers downstream of the CVP reservoirs under the No Action Alternative, Second Basis of Comparison, and Alternatives 1 through 5 (see subsections "Changes in Exceedance of Water Temperature Thresholds" in Section 9.4.3 of Chapter 9). The EIS analysis compares conditions in 2030 under the Alternatives 1 through 5 to the No Action Alternative; and under the No Action Alternative and Alternatives 1 through 5 to the Second Basis of Comparison. The EIS analysis has been prepared in accordance with NEPA and does not compare the conditions under the alternatives, No Action Alternative, and Second Basis of Comparison to the existing conditions (as is presented in CEQA documents, such as the Bay Delta Conservation Plan Environmental

Impact Report/Environmental Impact Statement). The No Action Alternative represents operations consistent with implementation of the 2008 and 2009 Biological Opinions. This No Action Alternative represents the current management direction and level of management intensity consistent with the explanation of the No Action Alternative included in Council of Environmental Quality's Forty Most Asked Questions (Question 3). NEPA does not require agencies to mitigate impacts, nor does it require agencies to identify mitigation associated with the No Action Alternative.

Droughts have occurred throughout California's history, and are constantly shaping and innovating the ways in which Reclamation and DWR balance both public health standards and urban and agricultural water demands while protecting the Delta ecosystem and its inhabitants. The most notable droughts in recent history are the droughts that occurred in 1976-77, 1987-92, and the ongoing drought. More details have been included in Section 9.3.8 of Chapter 9, Fish and Aquatic Resources, in the Final EIS to describe historical responses by CVP and SWP to these drought conditions and changes in fisheries resources, including recent impacts to winter-run Chinook Salmon.

GGSA PCFFA 6: As has been the case in the past, Reclamation will continue to work with NMFS and other members of the Sacramento Rivers Temperature Task Group (SRTTG) to manage water temperature in Sacramento River to maximize benefits for the species. However, it should be noted that meeting such objectives may not be possible given current regulatory environment.

The 2009 NMFS BO was written in consideration of project operations as described in the 2008 BA. Since 2008, the projects have been operating to 2008 USFWS and 2009 NMFS RPA actions. These actions include maintaining Old and Middle River flows at certain levels during December through June, increased closure of the Delta Cross Channel compared to those of previous requirements per SWRCB D-1641, export limitations in April and May based on San Joaquin River flow at Vernalis, and increased Delta outflow in fall months following wet and above normal years. All of these actions affect project operations and result in increased reservoir releases. These effects include a shift in export patterns from spring to summer months that causes more water to be released from the reservoirs than that is being exported to meet the Delta water quality standards during a season where Delta is more saline, an increased need in supply from the Sacramento River in April and May since San Joaquin River supply is limited, and increased reservoir releases in fall months following wet and above normal years. Therefore, this reduction in flexibility to use available water supply in most efficient way for water supply and water quality needs further limits possibility of meeting storage and temperature performance requirements on upper Sacramento River (namely NMFS BO Actions 1.2.1, 1.2.2, 1.2.3, and 1.2.4.).

These NMFS BO RPA actions (namely NMFS BO Actions 1.2.1, 1.2.2, 1.2.3, and 1.2.4.) are included and benefits are acknowledged in the No Action Alternative, Alternative 2, and Alternative 5; however, in this Draft EIS, it cannot be assumed that full benefits of storage performance criteria would be achieved due to reasons explained above.

More details have been included in Section 9.4.3 of Chapter 9, Fish and Aquatic Resources, in the Final EIS to qualitatively responses to RPA actions not included in the CalSim II model in the No Action Alternative and Alternatives 2 and 5.

GGSA PCFFA 7: The EIS analysis is based upon the comparison of conditions in 2030 under different alternatives. The results of those comparisons related to water temperatures show relatively minimal changes under the Alternatives 1 through 5 to the No Action Alternative; and under the No Action Alternative and Alternatives 1 through 5 to the Second Basis of Comparison. However, as described in the response to Comment GGSA PCFFA 5, the water temperatures in the rivers downstream of the CVP reservoirs would result in substantial adverse impacts to salmonids and sturgeon under Alternatives 1, 2, 3, and 4 and the Second Basis of Comparison without the addition of fish passage methods that are included in the No Action Alternative and Alternative 5.

The CVP and SWP reservoirs are operated in accordance with regulatory limitations, including applicable state and federal laws, regulations, and water rights first prior to deliver of water to CVP and SWP water contractors. The CVP and SWP cannot choose to meet the applicable state and federal laws, regulations, and water rights; and, it is not possible to fully meet the temperature thresholds downstream of the CVP and SWP reservoirs in 2030 with climate change. Therefore, fish passage around the CVP and SWP reservoirs is considered to provide habitat with appropriate water temperatures for early lifestages.

GGSA PCFFA 8: The analysis in the EIS compares conditions under Alternatives 1 through 5 with the No Action Alternative to identify beneficial and adverse impacts for the range of physical, environmental, and human resources.

GGSA PCFFA 9: Contract deliveries are based upon available water supplies on an annual and monthly basis after all water flow and demand requirements for applicable state and federal laws, regulations, and water rights are met. Full CVP and SWP water contract deliveries are used in the CalSim II model as a maximum delivery volume, but are only met when sufficient water is available.

GGSA PCFFA 10: The results described in Cunningham et al. (2015) was added on page 9-78 (of the Draft EIS) to quantify the effects of exports on salmonid survival. Differences, such as those described by Cunningham in relation to exports, are not exhibited in a comparison of the No Action Alternative with Alternatives 1 through 5 since the impact analyses results for all of the alternatives comparisons do not result in the distinct export regimes (+1 standard deviations of the mean) modeled by Cunningham et al. (2015). Results of the SALMOD model for late fall-run Chinook Salmon in the Sacramento River (Table B-2-5 of Appendix 9D) show comparable results for pre-smolt and smolt mortality due to habitat (flow) as Michel et al. (2015) in that mortality is increased in drier years as compared to wetter years.

GGSA PCFFA 11: Please see Appendix 9M, Salmonid Salvage Analysis, which describes the methods for addressing the effects of export facilities on juvenile salmonids. This analysis, based on coded wire tagged fish, covers a broader range of size classes than does the DPM analysis.

GGSA PCFFA 12: Although the median survival predicted by the OBAN model was 12 percent higher under the No Action Alternative than under the Second Basis of Comparison, the probability intervals indicated that no difference between scenarios was a likely outcome (i.e. the dashed line of no difference lies within the dark gray central 0.50 probability interval in Figure 9I-14). The text on page 9-162 (of the Draft EIS) has been modified for clarity; however, specific degrees of certainty cannot be determined with the existing analytical tools.

GGSA PCFFA 13: Please see response to GGSA PCFFA 7.

GGSA PCFFA 14: SALMOD is not used as a predictive model, it is used as a comparative tool for analyzing differences between alternatives that would occur over a range of hydrologic conditions represented by output from the 82-year CalSim II model (see Appendix 9D, SALMOD Model Documentation). As used, SALMOD output represents the mean values for production and mortality each year with the same initial conditions for population parameters and varying operations simulated by CalSim II. It is not a life-cycle model and does not provide a time trajectory of production. There is no expectation that SALMOD output will mirror recent (or historical) data on production or mortality. However, the comparison of mean values for production and mortality are a valid and appropriate method of comparing possible outcomes among the various alternatives. Similarly, the Reclamation Salmon Mortality Model utilizes CalSim II output through the temperature models and is not expected to mirror recent or historical estimates of mortality (see Appendix 9C, Reclamation's Salmon Mortality Model Analysis Documentation). It too is used as a comparative tool to distinguish potential effects among the alternatives. The results of the impact analysis is to understand the differences in the outcomes of the alternatives as compared to the No Action Alternative and the Second Basis of Comparison.

GGSA PCFFA 15: As described and presented in Appendix 9H of the Draft EIS, the IOS model uses the full 82-year CalSim II simulation period. The impact analysis used in the EIS evaluates the differences between alternatives based on changes in the median annual escapement and the range of escapement values encompassed in the first and second quartiles (25 to 75 percent of years) over the 82-year CalSim II simulation period (see page 9-116 of the Draft EIS). As described in the response to Comment GGSA PCFFA 14, SALMOD is not used as a predictive model to mirror past data, it is used as a comparative tool for analyzing differences between alternatives that would occur over a range of hydrologic conditions represented by output from the 82-year CalSim II model. As used, SALMOD output represents the mean values for production and mortality each year with the same initial conditions for population parameters and varying operations simulated by CalSim II. It is not a life-cycle model and does not provide a time trajectory of production. However, the comparison of mean values for production and mortality are a valid and appropriate method of comparing possible outcomes among the various alternatives under a NEPA analysis. Similarly, the Reclamation Salmon Mortality Model is used as a comparative tool to distinguish potential effects among the alternatives.

While likely effects from water temperature on early life stages occur at a shorter temporal scale than these models, comparative analyses are useful for long-term analyses, as in the EIS, because there is moderate certainty for long-term conditions.

GGSA PCFFA 16: The analysis of weighted usable area (WUA) in the Draft EIS is not intended to describe salmonid survival. The WUA methodology is used as a metric for evaluating changes in physical habitat related to flow as described in Appendix 9E, Weighted Useable Area Analysis, and on page 9-108 of the Draft EIS. The results of the SALMOD model are used to evaluate changes in salmonid survival in the Sacramento River (see Appendix 9D). Results of the SALMOD model for late fall-run Chinook Salmon in the Sacramento River (Table B-2-5 of Appendix 9D) show that mortality for pre-smolts and smolts is increased in drier years as compared to wetter years; this is consistent with Michel et al. (2015).

GGSA PCFFA 17: The EIS alternatives include consistent climate change conditions without consideration of potential regulatory or operational changes due to climate conditions in the future. Potential climate-related operational changes are currently unknown and it would be speculative to develop such assumptions for a NEPA analysis. This comparative approach eliminates the effects of climate change from the incremental changes between the alternatives, No Action Alternative, and Second Basis of Comparison.

The EIS analysis has been prepared in accordance with NEPA and does not compare the conditions under the alternatives, No Action Alternative, and Second Basis of Comparison to the existing conditions (as is presented in CEQA documents). The No Action Alternative represents operations consistent with implementation of the 2008 and 2009 Biological Opinions. This No Action Alternative represents the current management direction and level of management intensity consistent with the explanation of the No Action Alternative included in Council of Environmental Quality's Forty Most Asked Questions (Question 3). NEPA does not require agencies to mitigate impacts, nor does it require agencies to identify mitigation associated with the No Action Alternative.

GGSA PCFFA 18: "Spring-running" fish were not analyzed due to uncertainty whether they are genotypically spring-run, and if so, whether they are strays or a distinct population; and their exemption from take related to diverting or receiving water in accordance with the San Joaquin River reintroduction program. In the most recent Recovery Plan (NMFS 2014), it is stated that native spring-run Chinook salmon have been extirpated from all tributaries in the San Joaquin River Basin.

GGSA PCFFA 19: The references included in the comment provide additional information that is consistent with citations already included in the Draft EIS. Many of these reports also indicate that there still remains uncertainty in the flow-survival relationship. Sturrock et al. (2015) did not conclude that flows drive salmonid survival and abundance but did provide evidence that salmon populations fluctuate considerably with river flows experienced during juvenile rearing. The text on page 9-92 of the Draft ESI has been modified to include the reference in the comment, and to indicate that mortality in the Deep Water Ship Channel is one of the limiting factors.

Footnote 8 in the comment regarding Kondolf is not correct. Despite one site having a lower value (i.e., TMI 280 cfs) than 5,000 cfs, Kondolf used a combination of sites to identify that mobility overall occurs beginning at about 5,000 cfs. On page 36 of Kondolf, it states "Results of the bed mobility analysis for five (TMl, RI, RS, R28A, and R78) of nine sites studied suggest that flows around 5,000 to 8,000 cfs are necessary to mobilize the D50 of the channel bed material (Table 7.1 and Appendix C)." There was one site (TMI 1) where flows less than 5,000 cfs (280 cfs) would mobilize gravel, but as Kondolf explains "The mobility of the gravel at TMI probably reflects the smaller diameter of the augmented gravel, rather than the mobility of the gravels that would naturally occur in this steeper reach."

Text has been modified on the page 9-149 of the Draft EIS has been modified in the Final EIS to provide more clarity on the statement referenced in Footnote 9 of this comment.

GGSA PCFFA 20: Long-term average flows are not substantially reduced under Alternative 3 as compared to the No Action Alternative or the Second Basis of Comparison for the Stanislaus River below Goodwin Dam (see Figures 5-68, 5-69, and 5-70 in Chapter 5, Surface Water Resources and Water Supplies). There are anticipated flow reductions generally from March through June and particularly in October under Alternative 3, but flows are anticipated to be increased under Alternative 3 relative to the No Action Alternative and comparable to flows under the Second Basis of Comparison in many months. As described on pages 9-313 through 9-315 of the Draft EIS, water temperatures under Alternative 3 are anticipated to be similar to the No Action Alternative or slightly lower in most months and lead to a slight reduction in egg mortality for fall-run Chinook salmon. The text on page 9-316 of the Draft EIS has been modified to improve the readability.

GGSA PCFFA 21: The description of the trap and haul program assumptions and methodologies presented in Chapter 9 of the Draft EIS were not extensive. Additional information has been included on page 9-316 of the Draft EIS, and additional information has been provided in Appendix 9O of the Final EIS.

GGSA PCFFA 22: Reclamation's proposed action in the 2008 Biological Assessment included actions developed to contribute to Section 3406(b)(1) of the Central Valley Project Improvement Act (CVPIA) and other requirements of CVPIA. These actions were analyzed as part of the proposed action in the 2008 USFWS BO and 2009 NMFS BO. These actions are therefore also incorporated in the No Action Alternative and Alternative 5. Alternatives 1 through 4 and the

Second Basis of Comparison due not fully contribute to the goals of Section 3406(b)(1).

GGSA PCFFA 23: Please see responses to comments from National Marine Fisheries Service in Appendix 1.A.1.

GGSA PCFFA 24: Text has been added to Section 9.4.3.4 of the FEIS to include the studies by Bowen et al. (2009, 2010) regarding predation on salmonids around a Head of Old River barrier.

While the two-year study observed a variable and negative relationship between flow and survival past the Head of Old River barrier, there remained uncertainty due to the actual barrier structural configuration and how they would affect predator habitat in this reach. These studies did not speculated about overall survival rates or the biological significance of reach specific mortality around the Head of Old River barrier. Overall, the conclusions indicated that survival around the Head of Old River barrier would be structural design specific and highly variable; therefore certainty of the effect of the structures remains low.

GGSA PCFFA 25: The analysis in the Draft EIS did not rely on the 2012 Biological Opinion for analysis of effects. The latest (2014) Final Recovery Plan lists ocean harvest as a “very high” stressor on the winter-run Chinook Salmon population. Additional text has been added to Chapter 15, Recreation Resources, and Chapter 19, Socioeconomics, related to the effects of the harvest restrictions in Alternatives 3 and 4. The harvest rules specified in Alternatives 3, and especially Alternative 4, may be less protective for winter-run Chinook Salmon because this run is not allowed to be captured in either sport or commercial ocean salmon fishing. Additional text has been added to Section 9.4.3.5.2 on consistency of these alternatives with NMFS fisheries management framework for reducing the impact of ocean salmon fishery on winter-run Chinook Salmon.

GGSA PCFFA 26: Please see response to Comment GGSA PCFFA 17.

GGSA PCFFA 27: Reclamation has modified the Final EIS in response to comments from GGSA PCFFA and other commenters; and will use the Final EIS in the development of the Record of Decision.

1D.1.11 Natural Resources Defense Council and The Bay Institute

NRDC

The Bay Institute

September 29, 2015

Ben Nelson
U.S. Bureau of Reclamation
Bay-Delta Office
801 I Street, Suite 140
Sacramento, CA 95814-2536

Sent via U.S. Mail and via email to bcnelson@usbr.gov

RE: Comments on Draft Environmental Impact Statement for Coordinated Long-Term Operation of the Central Valley Project and State Water Project

Dear Mr. Nelson:

On behalf of the Natural Resources Defense Council and The Bay Institute, we are writing to provide comments on the Bureau of Reclamation's Draft Environmental Impact Statement for Coordinated Long-Term Operation of the Central Valley Project and State Water Project ("DEIS"). Unfortunately, the DEIS fails to comply with the requirements of the National Environmental Policy Act ("NEPA"), because it fails to include a reasonable range of alternatives, fails to accurately inform the public and decisionmakers of potential significant environmental impacts and necessary mitigation measures, and fails to adequately analyze cumulative impacts. Because Reclamation has failed to use sound scientific information and instead used flawed and biased methods to assess potential environmental impacts, the DEIS fails to accurately assess likely impacts on fish and wildlife populations and fails to identify and propose reasonable mitigation measures for potentially significant impacts. NRDC TBI 1

In addition, the DEIS largely ignores that over the past several years, the combination of the drought and CVP/SWP operations (including waivers of D-1641 water quality standards and other environmental protections) has driven Delta Smelt, winter run Chinook salmon, and other species to the brink of extinction. The DEIS never mentions that minimum Delta water quality standards under D-1641 were waived, and that RPA actions required under the biological opinions were not implemented during the drought, and the DEIS wholly fails to analyze the NRDC TBI 2

NRDC TBI 2 continued

impact of the reasonably foreseeable waiver of water quality standards in future droughts. Yet the DEIS only acknowledges under the No Action Alternative that abundance levels for delta smelt and other fisheries "are difficult to predict" and that "Currently low levels of relative abundance do not bode well for the Delta Smelt or other fish species in the Delta." DEIS at 9-139.[1] Under the Second Basis of Comparison, the DEIS concludes that,

> As described above for the No Action Alternative, abundance levels for Delta Smelt, Longfin Smelt, Striped Bass, Threadfin Shad, and American Shad are currently very low, and abundance and habitat conditions for fish in the Delta in future years are difficult to predict. It is not likely that operations of the CVP and SWP under the Second Basis of Comparison would result in improvement of habitat conditions in the Delta or increases in populations for these fish by 2030, and the recent trajectory of loss would likely continue.

DEIS at 9-150.[2] Despite these acknowledgements that current operations may very well lead to extinction of the species, the DEIS proposes no mitigation measures and does not even conclude that the alternatives result in significant impacts to Delta Smelt. Similarly, for longfin smelt, the DEIS ignores that current operations have resulted in the U.S. Fish and Wildlife Service concluding that listing longfin smelt under the Endangered Species Act is warranted, and continuation of existing spring outflow conditions is likely to result in adverse effects on the species. As a result, the DEIS fails to accurately assess environmental impacts of CVP/SWP operations on Delta Smelt and longfin smelt.

NRDC TBI 3

With respect to salmonids, the DEIS acknowledges that climate change will make it more difficult to achieve water temperature requirements with current upstream reservoir operations, impacting salmon and steelhead. *See, e.g.*, DEIS at 9-126 to 9-127. Yet the DEIS fails to conclude that these temperance exceedances constitute a significant environmental impacts and fails to consider any mitigation measures.[3] During the current drought, the failure to meet minimum upstream water temperatures resulted in greater than 95% mortality of the 2014 brood year winter run Chinook salmon cohort, and may result in similar mortality for the 2015 brood year. Increased frequency, duration and intensity of upstream temperature exceedances as a

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[1] In part, this conclusion is based on inaccurate assessment of entrainment impacts of the alternatives on Delta Smelt, as discussed below.

[2] Many of the flaws identified in the Second Basis of Comparison (which is the same as Alternative 1) also affect the analyses of Alternatives 3 and 4, and our comments are intended to address the similar flaws in the analyses of those alternatives as well.

[3] In contrast, Reclamation's revised draft environmental impact statement for the California WaterFix concludes that under the No Action Alternative, upstream reservoir operations will result in significant adverse environmental impacts to winter run Chinook salmon and green sturgeon spawning and egg incubation. *See, e.g.,* USBR, CA WaterFix RDEIS/SDEIR at ES-48.

NRDC TBI 3 continued

result of climate change in combination with CVP/SWP operations are likely to cause significant environmental impacts. The DEIS also fails to demonstrate whether operations of Shasta Dam under the No Action Alternative are consistent with requirements of the 2009 NOAA biological opinion, which includes performance measures and other requirements to maintain adequate cold water pool for winter run Chinook salmon below the dam. As a result, the DEIS must be revised to analyze compliance with the biological opinion and to consider changes in reservoir operations to mitigate upstream temperature impacts, including reductions in upstream water diversions and deliveries to CVP contractors, including senior contractors. NRDC TBI 4

Despite these short term and long term impacts, the DEIS asserts that with respect to several salmon and steelhead runs, the effects of CVP/SWP operations under Alternative 1 are similar to those under the No Action Alternative and Alternative 2. *See, e.g.,* DEIS at ES-30 to ES-31, 9-397 to 9-398.[4] However, the federal courts have twice held that operations under Alternative 1 would jeopardize the continued existence and recovery of listed salmonids and steelhead, in violation of the Endangered Species Act. The DEIS therefore suggests that operations under the No Action Alternative and under Alternative 2 would also jeopardize these listed salmonid species (primarily because of upstream water temperature impacts). Yet the DEIS does not identify a significant environmental impact from these effects, and it proposes no clearly defined mitigation measures to address these impacts (except for programs for upstream fish passage at major dams, which are already required under the No Action Alternative). NRDC TBI 5

The DEIS is fundamentally flawed, and Reclamation must revise the DEIS to analyze a broader range of alternatives using a credible methodology for assessing environmental impacts, including cumulative impacts.[5] NRDC TBI 6

I. <u>The DEIS Fails to Accurately Assess Environmental Impacts to Fish and Wildlife:</u> In general, Chapter 9 of the DEIS fails to utilize recent scientific information and utilizes outdated and inaccurate models to assess potential impacts to fish and wildlife populations. As a result, the DEIS fails to accurately assess the likely environmental impacts of the alternatives on fish and wildlife and significantly understates the environmental impacts of some alternatives. NRDC TBI 7

[4] This is at least in part because of Reclamation's flawed methodology for assessing impacts, particularly with respect to operations in the Delta, as discussed elsewhere in this letter.
[5] In addition, Reclamation and DWR have not complied with CEQA, and compliance with CEQA is required before the Department of Water Resources could propose any changes to State Water Project operations. Numerous additional permits and approvals would be required before authorizing any changes to operations, including requirements under the federal Endangered Species Act, California Endangered Species Act, and other state and federal laws.

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A. *The DEIS Fails to Accurately Assess Impacts to Delta Smelt:*

The DEIS substantially understates the environmental impacts of the alternatives on Delta Smelt because it ignores numerous recent scientific publications regarding the impact of water project operations on Delta Smelt, including: Rose et al 2013a, Rose et al 2013b, USGS 2015 (MAST report), and MacNally et al 2010. For instance, the only citation of Rose et al 2013a and 2013b in the DEIS occurs on page 9-115, in a discussion of delta smelt habitat, where it states that the DEIS chose not to use the life cycle model developed in these papers to assess impacts (the DEIS arbitrarily fails to provide any justification for choosing not to use this peer reviewed life cycle model to assess impacts). The DEIS' analysis of entrainment impacts on delta smelt wholly fails to discuss the conclusions of Rose et al 2013a and 2013b, which found that entrainment by the CVP and SWP was an important factor in the decline of delta smelt. *See* DEIS at 9-78 to 9-79. Similarly, the species description in the DEIS understates the role of entrainment as a stressor on the population and does not even mention the population level effects of entrainment. DEIS at 9-63 to 9-66. As a result of the failure to use sound scientific information, the DEIS misleads the reader on the impacts of entrainment by CVP/SWP operations on delta smelt. NRDC TBI 7 continued

In addition to failing to use the life cycle model prepared by Rose et al 2013 to assess impacts, the methodology used in the ADEIS to assess entrainment impacts is flawed and fails to adequately assess impacts under the alternatives. NRDC TBI 8

First, the DEIS uses average OMR values to calculate entrainment. DEIS at 9-114. As a result, the DEIS does not account for changes in operations within the OMR ranges specified under the biological opinion under the No Action Alternative, Alternative 2, and Alternative 5. Because the DEIS does not account for reductions in OMR to avoid significant entrainment events and to manage entrainment throughout the season, and the estimates of smelt entrainment are therefore unreasonably high under these alternatives. This substantially biases the comparison of entrainment impacts in the DEIS under these alternatives as compared to other alternatives. NRDC TBI 9

Second, the DEIS fails to adequately analyze entrainment impacts because it fails to assess whether entrainment under the alternatives would exceed the incidental take statement in the biological opinion, which is estimated to be 5% of the adult population based on the Fall Midwater Trawl Survey. *See* 2008 Delta Smelt biological opinion at 387. Modeling information in the DEIS indicates that entrainment would exceed the incidental take limit under several of the alternatives, as discussed below. Exceeding the incidental take limit would cause significant impacts. NRDC TBI 10

Third, the DEIS also fails to adequately assess entrainment impacts by using a 5% threshold, such that alternatives with entrainment estimates within 5% are considered to have similar effects. DEIS at 9-114. This is unreasonable and understates the environmental impacts of NRDC TBI 11

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entrainment because it could result in a doubling of entrainment (5% versus 10%), and as noted above could result in substantially exceeding the incidental take limit. Kimmerer 2011 demonstrated that entrainment losses averaging 10% per year can be "…simultaneously nearly undetectable in regression analysis, and devastating to the population." NRDC TBI 11 continued

The estimated entrainment under the Second Basis of Comparison approaches that 10% threshold for adults and greatly exceeds it for juveniles, *see* DEIS at 9-194, and Reclamation's estimated entrainment under this alternative and several others would likely exceed the take limit in many years. This would cause significant adverse effects that are not reported in the DEIS.

As a result of these substantial flaws, the DEIS fails to adequately analyze Delta Smelt entrainment impacts under the alternatives. The DEIS must be revised to analyze whether entrainment would exceed the incidental take limit (5% of the population), revise estimates of entrainment under the No Action Alternative, Alternative 2, and Alternative 5 to account for changes in operations under Actions 1-3 of the Delta Smelt biological opinion, and to eliminate use of the 5% threshold of significance. NRDC TBI 12

With respect to the effect of changes in X2 on Delta Smelt, the DEIS wholly fails to analyze the effects of changes in spring X2 on Delta Smelt. *See* Mast Report 2015. The DEIS also fails to analyze the effects on Delta Smelt of waiving spring X2 requirements in recent years during the drought, as the population has declined to record low levels. With respect to changes in Fall X2, the document also largely ignores all of the comments of the Fish and Wildlife Service in the Bay Delta Conservation Plan process, and it ignores the additional biological analysis of BDCP impacts on delta smelt by Kimmerer et al prepared for the Nature Conservancy in 2013. These analyses demonstrate the significant role of CVP/SWP operations on delta smelt. Instead, the DEIS provides misleading information about other stressors. For instance, the DEIS repeatedly hypothesizes that discharge of agricultural runoff from the Colusa Drain led to measureable improvements in zooplankton abundance in 2011 and 2012, but it fails to inform the reader that Delta Smelt populations declined substantially in 2012. *See* DEIS at 9-65 and 9-66. In addition, on the same page the DEIS misstates the conclusions of the MAST report regarding the importance of implementation of the fall outflow RPA in 2011 (rather than agricultural runoff) on subsequent delta smelt abundance. NRDC TBI 13

In addition, the DEIS fails to analyze the effects of CVP/SWP operations on Delta food webs, including phytoplankton and zooplankton that support delta smelt populations. Existing scientific information documents how changes in exports, residence time, and flows can affect these populations. *See, e.g.,* Jassby et al. 1995; Kimmerer 2002; Winder et al. 2011; Cloern and Jassby 2012. We raised this issue in our 2012 scoping comments, yet the DEIS wholly fails to analyze this impact. More recent studies document how changes in delta outflow can affect corbula populations and thus affect delta food webs. *See, e.g.,* Brown et al. 2012; Thompson et NRDC TBI 14

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al. 2012; Teh 2012; Baxter and Slater 2012. And while the DEIS mentions the effect of introduced species on the food web, see DEIS at 9-65, it ignores peer reviewed research that hydrologic modifications, including diversions by the CVP and SWP, have facilitated invasions of the estuary. *See* Winder et al 2011. The DEIS must be revised to analyze these effects of CVP/SWP operations on delta food webs. NRDC TBI 14 continued

Finally, although the DEIS discusses the effects of predation on Delta Smelt, it fails to consider the role of CVP/SWP operations in facilitating the abundance of invasive predators and worsening water quality. For instance, DWR and Reclamation have concluded that waiver of D-1641 outflow requirements during the drought have resulted in increased microcystis blooms, other water quality impairments, and increased populations of black bass and other nonnative predators that impact Delta Smelt. *See* USBR/DWR March 30, 2015 Temporary Urgency Change Petition, Attachment A, at 69-70. However, the DEIS wholly fails to analyze these indirect impacts of operations on water quality and fisheries, including analysis of changes in residence time as a result of operations, even though Reclamation's NEPA analysis of the California WaterFix includes modeling of changes in residence time and how that affects microcystis and other harmful algal blooms. The DEIS must be revised to analyze these effects of CVP/SWP operations on water quality, microcystis, and other harmful algal blooms. NRDC TBI 15

The DEIS fails to use sound scientific information for the assessment of environmental impacts of the alternatives on delta smelt and it wholly fails to analyze important direct and indirect effects of CVP/SWP operations on Delta Smelt (such as spring X2, effects on food webs, effects on predator populations). As a result, the DEIS understates the impacts of Alternatives 1, 3, 4, and the Second Basis of Comparison, and it overstates the impacts of the No Action Alternative, Alternative 2, and Alternative 5. NRDC TBI 16

B. The DEIS Fails to Accurately Assess Impacts to Longfin Smelt[6]

As with Delta Smelt, the DEIS fails to reference recent scientific information regarding longfin smelt, resulting in the document inaccurately assessing environmental impacts on the species. For instance, the DEIS fails to reference numerous recent scientific studies documenting winter / spring delta outflow as the primary driver of subsequent longfin smelt abundance, including MacNally et al 2010 and recent analysis by the Fish and Wildlife Service and California Department of Fish and Wildlife regarding flow and longfin smelt during the BDCP process (including Rosenfield and Nobriga in press). For instance, in 2013 the Fish and Wildlife Service noted that, "More than forty years of science has clearly established that Delta outflow is a NRDC TBI 17

[6] We also note that the Bureau of Reclamation is also subject to the requirements of the California Endangered Species Act with respect to longfin smelt, which is listed as a threatened species under state law, consistent with section 3406(b) of the Central Valley Project Improvement Act of 1992 and Section 8 of the Reclamation Act of 1902.

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primary driver of longfin smelt abundance (e.g. Thomson et al. 2010). " In contrast, page 9-67 includes a single sentence about the effect of delta outflow being the largest factor affecting longfin smelt abundance. In addition, as discussed above, the DEIS fails to analyze the effects of CVP/SWP operations on delta food webs and indirect effects on longfin smelt. NRDC TBI 17 continued

The DEIS uses an equation from Kimmerer 2009 to calculate average longfin smelt abundance by water year type, but because this analysis looks at each year in isolation, it understates the environmental impacts of multiple years of low outflow. In addition, because the DEIS ignores more recent scientific studies on flow thresholds for longfin smelt population growth prepared by the U.S. Fish and Wildlife Service in the BDCP process, the DEIS fails to assess whether spring outflows are likely to result in population growth. As a result, the DEIS likely understates the environmental impacts of the alternatives. We agree with the DEIS that the Second Basis of Comparison would result in far more adverse effects on longfin smelt that the No Action Alternative, DEIS at 9-196, but the DEIS fails to analyze whether the No Action Alternative results in adverse effects on longfin smelt.

The DEIS' conclusion that the Second Basis of Comparison would "maintain the recent trajectory of loss" for longfin smelt (page 9-152) is understated; it is likely that the Second Basis of Comparison and Alternatives 1, 3 and 4 will jeopardize the continued existence and recovery of longfin smelt, consistent with the U.S. Fish and Wildlife Service's recent conclusion that listing of longfin smelt under the Endangered Species Act is warranted but precluded. *See* 77 Fed. Reg. 19775 (April 2, 2012). In addition, the DEIS fails to demonstrate that implementation of the No Action Alternative would not result in significant impacts to the species, consistent with the finding that ESA listing is warranted and the ongoing population declines observed in numerous surveys. In fact, language in the DEIS admits that the No Action Alternative would result in "less adverse" effects than the Second Basis of Comparison, *see* DEIS at 9-156, but the DEIS fails to clearly state that the No Action Alternative results in adverse impacts on longfin smelt or to propose any mitigation measures to address that impact.

C. *The DEIS Fails to Accurately Assess Impacts on Salmonids*

As with the pelagic species discussed above, the DEIS fails to accurately assess the environmental impacts of CVP/SWP operations on salmonid survival and abundance. The DEIS omits references to important scientific studies, and instead relies on contradictory modeling information that does not accurately assess impacts. As a result, the DEIS fails to accurately assess environmental impacts and propose necessary mitigation measures. NRDC TBI 18

1. *The DEIS Fails to Accurately Assess Impacts to Migrating Salmonids in the Delta*

NRDC TBI 18 concluded

The DEIS fails to accurately assess impacts of CVP/SWP export pumping operations in the Delta on migrating salmonids, significantly understating the environmental impacts of increased pumping during migration seasons. For instance, recent life cycle models for fall run Chinook salmon and spring run Chinook salmon have been submitted to the Delta Science Program, which conclude that CVP/SWP delta exports significantly reduce spring and fall run salmon survival and abundance. *See* Cunningham et al 2015. The DEIS mentions this study briefly, but it fails to utilize this life cycle model to assess impacts. Similarly, Michel et al 2015 was recently published in the Canadian Journal of Fisheries and Aquatic Sciences, which reviews five years of acoustic tag data and demonstrates that increased flows dramatically increase survival of migrating salmon through the Sacramento River and Delta. Both of these studies contradict many of the methods and models utilized by Reclamation in the DEIS to assess impacts, such as the Delta Passage model (which predicts very minimal changes in survival and abundance despite significant changes in exports and Old and Middle Reverse Flows).

For example, Cunningham et al 2015 estimates that increasing exports by 30% above the 1967-2010 average would result in a 16-28% lower median survival rate from egg to adulthood for wild fall run Chinook salmon and a 39-59% reduction in median survival for spring run Chinook salmon, concluding that, "[a] 30% increase in exports decreased spring and fall stock survival to the point where they would all decline regardless of the climate scenario." In contrast, the Delta Passage Model predicts "very similar estimates of survival" for spring and fall run Chinook salmon under the No Action Alternative compared to the Second Basis of Comparison, despite the substantial increase in exports under the Second Basis of Comparison. *See* DEIS at 9-169, 9-178.

NRDC TBI 19

In addition, the Delta Passage Model only attempts to estimate survival of salmon smolts, *see* DEIS Appendix 9J at 9J-1, and cannot assess impacts to salmon fry or parr. Yet fry and parr life stages are often the majority of salmon migrating through the Delta, and the DEIS wholly ignores the impacts of CVP/SWP operations on these salmonid life histories.

NRDC TBI 20

Similarly, the DEIS fails to explain the contradictory information from use of the OBAN life cycle model and the Delta Passage Model on salmon survival through the Delta. On page 9-162, the DEIS states that the Delta Passage Model results in similar winter run Chinook salmon survival through the Delta under the No Action Alternative and the Second Basis of Comparison, and on the same page it states that the OBAN life cycle model predicts that median survival through the Delta would be 12 percent higher under the No Action Alternative compared to the Second Basis of Comparison. The DEIS provides no justification for its statement that the OBAN model's survival estimates "suggest a high probability of no difference between these

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two bases of comparison." DEIS at 9-162. In fact, the model demonstrates a very substantial difference in survival between the two alternatives, and Reclamation's conclusory statement is arbitrary and capricious. NRDC TBI 20 continued

As a result, the DEIS fails to accurately assess environmental impacts of CVP/SWP operations in the Delta on migrating salmonids, and the conclusions drawn in the DEIS are arbitrary and capricious.

2. *The DEIS Fails to Accurately Assess Upstream Water Temperature Impacts to Salmonids*

The DEIS' analysis of upstream temperature impacts on salmonids is flawed and understates the adverse impacts of CVP/SWP operations on salmonids (particularly in combination with climate change), and the DEIS fails to explicitly acknowledge that CVP/SWP operations cause significant adverse impacts and to propose mitigation measures to address these impacts in the short term. Reclamation's conclusions in the DEIS are arbitrary and capricious. NRDC TBI 21

Even using flawed methodology, the DEIS demonstrates that there will be significant adverse effects on salmon from high water temperatures as a result of climate change and CVP/SWP operations, including under the No Action Alternative:

> Under the No Action Alternative, the ability to control water temperatures depends on a number of factors and management flexibility usually ends in October when the cold water pool in Shasta Lake is depleted. With climate change, cold water storage at the end of May in Shasta Lake is expected to be reduced under the No Action Alternative for all water year types. This would further reduce the already limited cold water pool in late summer. **With the anticipated increase in demands for water by 2030 and less water being diverted from the Trinity River, it is expected that it would become increasingly difficult to meet water temperature targets at the various temperature compliance points. It is likely that severe temperature-related effects will be unavoidable in some years under the No Action Alternative. Due to these unavoidable adverse effects,** RPA Action Suite I.2 also specifies other actions that Reclamation must take, within its existing authority and discretion, to compensate for these periods of unavoidably high temperatures. These actions include restoration of habitat at Battle Creek (see below) which may support a second population of winter-run Chinook Salmon, and a fish passage program at Keswick and Shasta dams to partially restore winter-run Chinook Salmon to their historical cold water habitat.

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DEIS at 9-127 to 9-128 (emphasis added).[7] The DEIS also uses Reclamation's salmon mortality model to estimate temperature impacts on salmon production and mortality, concluding that the impacts from the No Action Alternative and the Second Basis of Comparison are similar, *see* DEIS at 9-160, that winter run Chinook salmon mortality is 31.4% in critically dry years under the No Action Alternative, *see* DEIS at Appendix 9C-8, and that Sacramento River spring run Chinook salmon mortality is 21.9% on average and 84.8% in critically dry years under the No Action Alternative, *see* DEIS at Appendix 9C-7. Similarly, the SALMOD model results in the DEIS estimate that in approximately 10% of years, there would be zero production of spring run Chinook salmon below Shasta Dam. *See* DEIS at Figure B-3-1. And the DEIS estimates that under both the No Action Alternative and the Second Basis of Comparison, Reclamation will frequently violate temperature standards at Shasta Dam, *see* DEIS at 9-159 to 9-160, and at other reservoirs, *see* DEIS at 9-166 to 9-168. Yet the DEIS fails to explicitly identify upstream temperature mortality as a significant adverse impact, and the only mitigation measure identified in the DEIS (fish passage program) is a long term potential measure that is already required under the No Action Alternative and is therefore part of the baseline. That mitigation measure does not address the ongoing significant adverse impact in the near term, nor does it propose anything that is not already required. NRDC TBI 21 continued

Moreover, the DEIS relies on flawed methodologies to assess temperature impacts on salmonids, many of which provide contradictory results, and which mislead the public as to the effects of CVP/SWP operations. For instance, the DEIS uses the SALMOD model to calculate juvenile production and the extent of temperature related upstream mortality to eggs and fry, and concludes that the No Action Alternative results in similar impacts to the Second Basis of Comparison. DEIS at 9-162. Yet SALMOD's estimates of mortality and production are wildly inaccurate compared to recent data. For instance, Figure B-4-1 estimates that winter run Chinook salmon production would never drop below 500,000, yet in 2014 there was a total year class failure with over 95% mortality due to water temperatures. Figure B-4-1 also shows that according to the SALMOD model, in approximately 95% of years winter run Chinook salmon production does not vary by more than a few hundred thousand fish. Yet empirical data shows that winter run Chinook salmon egg to fry survival at Red Bluff Diversion Dam from 2002 to 2012 varied substantially, from a low of 15.4% to a high of 48.6%, with a mean of 26.4%. *See* U.S. Fish and Wildlife Service 2015 at Table 6c. Estimates for other salmon runs are similarly inaccurate compared to recent Sacramento River data from the U.S. Fish and Wildlife Service. NRDC TBI 22

[7] However, as noted above, the DEIS also fails to demonstrate whether operations of Shasta Dam under the No Action Alternative are consistent with requirements of the 2009 NOAA biological opinion, which includes performance measures and other requirements to maintain adequate cold water pool for winter run Chinook salmon below the dam. *See* DEIS at 9-125 (describing RPA requirements). To the extent that the modeled operations under the No Action Alternative fail to meet the RPA requirements, Reclamation must revise operations to be consistent with those RPA requirements.

And this recent data also contradicts the information presented in Reclamation's salmon mortality model, which significantly underestimates mortality compared to the recent data. NRDC TBI 22 continued

In addition, the analysis of water temperature impacts looks only at monthly average temperatures. DEIS at 9-109. As the DEIS notes briefly, "the effects of daily (or hourly) temperature swings are likely masked by the averaging process." DEIS at 9-110. This is clearly correct, and may help explain why the modeled results do not show the level of mortality seen from recent empirical data. Yet the DEIS fails to carry forward this caveat elsewhere in the discussion, when it presents the results of modeling. Similarly, the DEIS restricts its use of the IOS model to median escapement estimates and only uses a subset of the years from CALSIM, DEIS at 116, which excludes the highest mortality years in the driest years and therefore does not accurately assess impacts. NRDC TBI 23

Finally, the DEIS' analysis of weighted usable area for rearing habitat fails to account for more recent scientific research demonstrating the strong effect of increased flow on downstream salmonid survival in the Sacramento River. *See* DEIS at 9-107 to 9-109. The methodology used in the DEIS does not account for the significant reduction in survival of migrating salmon under lower flow conditions in the Sacramento River. *See* Michel et al 2015. As a result, the DEIS fails to accurately assess the impact of reduced flow on salmon survival in the Sacramento River using this methodology. NRDC TBI 24

The DEIS demonstrates that current CVP/SWP operations, including water deliveries to Sacramento River Settlement Contractors and other senior water rights holders, in combination with climate change, will result in significant adverse effects on salmon caused by violations of water temperature requirements. The DEIS predicts that these impacts will become more severe as a result of climate change and increased demands for water. As a result, the DEIS must consider alternatives and/or mitigation measures that reduce upstream water deliveries, including deliveries to Sacramento River Settlement Contractors and other water rights holders. NRDC TBI 25

3. The DEIS Fails to Accurately Assess Impacts to Salmonids in the San Joaquin Basin

The DEIS fails to accurately assess environmental impacts to salmonids in the San Joaquin Basin because it fails to assess impacts to spring run Chinook salmon and because it fails to assess the impacts from changes in river flows. NRDC TBI 26

First, the DEIS fails to acknowledge that small populations of spring run Chinook salmon have been established in recent years in the Stanislaus and other rivers. NMFS has acknowledged these populations exist, but the DEIS only analyzes impacts to fall run Chinook salmon and mistakenly concludes that spring run have been extirpated. DEIS at 9-87, 9-92. The DEIS

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NRDC TBI 26 continued

wholly fails to analyze impacts to spring run Chinook salmon in the Stanislaus River and other San Joaquin River tributaries.

NRDC TBI 27

Second, the DEIS acknowledges some of the studies documenting that salmon survival in the Stanislaus River and other San Joaquin tributaries is driven by river flow conditions. For instance, the DEIS cites Zeug et al 2014 to show that higher flow generally results in higher salmon survival and subsequent abundance. DEIS at 9-92. Yet the DEIS ignores other scientific studies which conclude that flows drive salmonid survival and abundance, including Sturrock et al 2015, Buchanan et al 2015, State Water Resources Control Board 2010, 2012.[8] The DEIS also fails to emphasize that inadequate flow is the dominant factor limiting salmon survival and abundance, instead relying on outdated research from 1982 to assert that survival through the Stockton Deepwater Ship Channel is one of the most limiting factors. DEIS at 9-92.[9]

However, the DEIS fails to utilize this scientific information on the importance of river flow in assessing environmental impacts. While the DEIS analyzes impacts from changes in operations on water temperatures, it wholly fails to assess the impacts from changes in flows on the Stanislaus River. *See, e.g.,* DEIS at 2-202 to 2-209 (analyzing impacts to fall run Chinook salmon and steelhead).[10] The available scientific evidence demonstrates that a reduction in flows below the minimum requirements of the biological opinion would result in very significant adverse effects on steelhead, fall run Chinook salmon, and spring run Chinook salmon. *See, e.g.,* Sturrock et al 2015; Zeug et al 2014; Buchanan et al 2015; State Water Resources Control Board 2010, 2012. And the State Water Resources Control Board, National Marine Fisheries Service, U.S. Fish and Wildlife Service, California Department of Fish and Wildlife, and many others have demonstrated that current flow levels on the Stanislaus River and other San Joaquin River tributaries are causing significant impacts to salmon and steelhead, demonstrating a need to substantially increase flows to sustain salmon.

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[8] The DEIS also cites to 2001 research by Mesick on the effect of fall flows and exports on straying, but ignores Marston et al 2012, which concluded that fall pulse flows and export rates are correlated with higher rates of straying.

[9] The DEIS also incorrectly asserts that flows must exceed 5,000 cfs to mobilize gravel in the Stanislaus River. DEIS at 9-95. That is incorrect; Kondolf 2001 concluded that flows below 5,000 cfs could mobilize the riverbed, particularly in certain reaches of the river.

[10] Elsewhere, the DEIS asserts that under the No Action Alternative, Reclamation will not fully implement the biological opinion requirements regarding Stanislaus River and Lower San Joaquin River flows, in order to make water available to contractors, yet asserts with no justification that the impacts would be "similar or reduced relative to recent conditions." DEIS at 9-133. The DEIS reaches a similarly flawed conclusion with respect to the Second Basis of Comparison, concluding that the failure to implement the biological opinion requirements on the Stanislaus River would not improve. DEIS at 9-149.

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This is particularly problematic for Alternative 3, which proposes to substantially reduce Stanislaus River flows. The DEIS wholly fails to analyze the impact of reduced flows, and based solely on temperature modeling concludes that Alternative 3 would have slightly beneficial effects on fall run Chinook salmon. DEIS at 9-316. Because the DEIS fails to assess the environmental impacts of reduced flows, which is the dominant factor affecting salmon and steelhead on the Stanislaus, Lower San Joaquin River, and other tributaries, the DEIS fails to accurately assess the environmental impacts of CVP/SWP operations on salmonids in the San Joaquin Basin. Reclamation's conclusions in the DEIS are arbitrary and capricious. NRDC TBI 28

In addition, the DEIS fails to credibly analyze the impacts of the proposed trapping and barging of San Joaquin basin salmonids through the Delta under Alternative 3 and 4. The document makes unsubstantiated conclusions that this action would benefit salmonids without providing any analysis in the document. DEIS at 9-315 to 9-316. As a result, Reclamation's conclusion in the DEIS is arbitrary and capricious. There are substantial uncertainties regarding the effectiveness of capture operations (the stated goal is capturing 10-20% of the population) and potential adverse impacts. Moreover, coded wire tag data from the California Department of Fish and Wildlife show that salmon from the Merced Hatchery have successfully migrated through the Delta in recent years. *See* Kormos et al 2012; Palmer-Zwahlen and Kormos 2013. And in their comments on the ADEIS, NMFS raised substantial concerns that a trap and haul program would cause substantial adverse impacts on salmonids. The DEIS also fails to assess whether such a program is consistent with Reclamation's obligation to double natural production of salmon populations under the Central Valley Project Improvement Act.[11] Reclamation must substantially revise this section of the DEIS to provide a basis for its conclusion and to respond to the concerns raised by NMFS and others. NRDC TBI 29 NRDC TBI 30 NRDC TBI 31

4. *The DEIS Concludes that the Effects of Predator Control Program are Highly Uncertain and Could Cause Significant Adverse Environmental Impacts:*

As compared to the administrative draft, the DEIS' analysis of the impacts of predator control programs is substantially improved. For instance, the DEIS cites repeatedly to the Delta Science Program's independent peer review report (Grossman et al 2013) regarding the effects of predation on salmonids and the caveats that predator control programs will work as intended. *See* DEIS at 9-274 to 9-275. It also cites work by Peter Moyle suggesting that predator control programs could harm Delta Smelt, and acknowledges that predator control programs at the Columbia River have not demonstrated population level effects. DEIS at 9-274 to 9-276. As a result, the DEIS concludes that, NRDC TBI 32

[11] More broadly, the DEIS fails to assess whether any of the alternatives meet Reclamation's obligations under section 3406(b).

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> the program may be difficult to implement, may not be effective, and may cause unintended harm to other native Delta fish species. Consequently, the outcome of the predator management program is highly uncertain. Compared to the No Action Alternative, which does not include a predator reduction program, Alternative 3 may or may not provide a benefit to salmonids and may result in an adverse effect on Delta smelt.

NRDC TBI 32 continued

DEIS at 9-276.

However, the DEIS fails to acknowledge that USBR's own studies regarding the Head of Old River Barrier on the San Joaquin River have shown that increased flows reduce predation on salmonids and reduced flows increase predation and reduce survival. *See* Bowen et al 20019 and 2010 (USBR Technical Memorandum 86-68290-10-07 and 86-68290-11). And the DEIS also inconsistently addresses the impact of CVP/SWP operations in contributing to predation by nonnative species, particularly by providing habitat conditions in the Delta and other rivers that favor non-native species. For instance, on page 9-354, the DEIS concludes that Alternative 5 may adversely affect striped bass, but the DEIS does not analyze whether or how that impact to striped bass may subsequently affect salmonids or other species.

5. The DEIS Fails to Accurately Assess Impacts of Fishing Mortality and Greater Restrictions on Salmon Fishing Proposed in Some Alternatives:

NRDC TBI 33

The DEIS incorrectly assesses the impact of greater restrictions on salmon fishing under Alternatives 3 and 4. For instance, the DEIS downplays the effectiveness of the recent restrictions on salmon fishing as a result of the 2012 winter run Chinook salmon biological opinion, and it does not mention that NMFS' recovery plan for winter run Chinook salmon lists the ocean fishery as a low stressor on the population. *See* DEIS at 9-118, 9-277 to 9-278. The DEIS must be revised to account for this information in assessing impacts. Moreover, mark select fisheries are likely to substantially reduce fishing opportunities and may not improve conditions for wild salmon because of bycatch mortality, and the DEIS fails to analyze these potential adverse impacts of mark select fisheries.[12] In addition, as NMFS noted in its comments on the ADEIS, the harvest rule specified in Alternatives 3 and 4 may be less protective of winter run Chinook salmon than the existing biological opinion, given the restrictions on fishing at low levels of abundance. As noted in our prior comments, we strongly recommend that Reclamation work with the Pacific Fishery Management Council regarding these conclusions.

[12] In addition, the DEIS fails to analyze the socioeconomic effects of reducing salmon fishing as proposed under Alternatives 3 and 4. *See, e.g.,* DEIS at 19-77.

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6. The DEIS Fails to Accurately Assess Impacts of Climate Change on Salmon and Propose Mitigation Measures to Address those Impacts:

We appreciate that the DEIS includes the potential effects of climate change on precipitation and temperature, in order to assess how climate change may affect CVP/SWP operations. The DEIS assumes that climate change will reduce reservoir storage and cause increased temperature impacts on salmonids. *See, e.g.,* DEIS at 9-120, 9-123, 9-126 to 9-127, 9-130, 9-132 to 9-133, 9-146. However, the document wholly fails to propose any short term measures to mitigate the effects of CVP/SWP operations in combination with climate change in order to avoid violations of downstream water temperature standards that imperil salmon. As a result, the DEIS predicts more significant impacts on salmonids from increased upstream temperature, without proposing any changes or modifications to operations in order for Reclamation to meet its existing obligations under state and federal law to avoid violating water temperature requirements. The DEIS must be revised to analyze mitigation measures and alternatives that reduce or avoid water temperature violations below dams, including reduced upstream diversions and deliveries to senior water contractors. NRDC TBI 34

II. The DEIS Fails to Include a Reasonable Range of Alternatives:

NEPA requires consideration of a reasonable range of alternative actions that might achieve similar goals with less environmental impact. *See, e.g.,* 40 C.F.R. §1502.14. However, the DEIS fails to include any alternatives that substantially improve conditions for fish and wildlife species, or that incorporate increased water supply from other sources like water use efficiency or wastewater recycling. Reclamation has violated NEPA by failing to include any alternatives that reduce impacts on fish and wildlife populations and/or that meaningfully reduce reliance on the Delta, as required by the Delta Reform Act of 2009 (Cal. Water Code § 85021). NRDC TBI 35

In our scoping comments, we requested that Reclamation analyze an alternative in the DEIS that substantially increases Delta outflow in the winter-spring period to protect longfin smelt and other fish and wildlife species, and includes increased water use efficiency, water recycling, and other regional water supply programs to increase water supply reliability even if Delta exports decrease. *See* attachment 1 (scoping comments). However, Alternative 5 wholly fails to include any increase in regional and local water supplies, and Alternative 5 also fails to meaningfully increase Delta outflow.

Appendix 19A of the DEIS makes assumptions regarding investments in regional and local water supplies by SWP and CVP contractors, demonstrating that changes in local and regional water supplies are a reasonable alternative to consider. Yet Reclamation has failed to include an alternative that includes increased investments in these regional supplies, despite our scoping comments.

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Similarly, none of the alternatives meaningfully increase Delta outflow in the winter and spring months, despite the significant adverse impacts on longfin smelt and other species affected by current outflow levels. Alternative 5 provides extremely limited increases in delta outflow. The model runs for Alternative 5 appear to be constrained by several assumptions, including assumptions concerning the amount of deliveries in any year to upstream contractors such as the Sacramento River Settlement Contractors, and export levels. Those assumptions can and should be modified to reflect alternative water supplies available to contractors and the need to reduce CVP/SWP diversions and deliveries to comply with environmental requirements. Modifying those assumptions would allow significant changes in the model output to improve reservoir levels and outflows. As noted above, the DEIS assumes that increased outflow necessarily results in reduced reservoir storage and increased water temperatures at upstream reservoirs, but that depends on assumptions regarding water diversions and exports. We understand that Phase 2 of the State Water Resources Control Board's update of the Bay Delta Water Quality Control Plan includes operational changes so that substantially increased delta outflow does not impact water temperature control at upstream reservoirs, and that the same is true for Alternative 8 in the BDCP / California WaterFix EIS. Reclamation must review this work to modify Alternative 5 so that it results in substantial increases in spring outflow and does not impair upstream water temperature compliance, even if that results in reduced exports and diversions upstream. NRDC TBI 35 continued

Finally, the DEIS also fails to include any alternatives that address the impacts of upstream operations and climate change. As noted above, the DEIS asserts that the effects of climate change and CVP/SWP operations (including water deliveries to senior contractors) will make it difficult to meet temperature compliance standards. DEIS at 9-126 to 9-127. However, the DEIS fails to include any alternative that would avoid this impact and meet temperature compliance obligations, including reductions in water deliveries to senior contractors. NRDC TBI 36

Overall, the DEIS fails to analyze a reasonable range of alternatives that would eliminate or reduce the environmental impacts of ongoing CVP/SWP operations, as required by NEPA. NRDC TBI 37

III. Alternatives are Not Consistent with Reclamation's Water Rights and the Purpose and Need Statement

In addition, Alternative 3 is not consistent with the stated purpose and need in the DEIS, because the New Melones Operations Criteria in Alternative 3 would cause Reclamation to violate the terms and conditions of its existing water rights and the State Water Resources Control Board's Water Rights Decision 1641 ("D-1641"). *See, e.g.*, DEIS at 3-36. It appears that other alternatives, except for Alternative 5, likewise would result in violations of Reclamation's water rights permits with respect to Vernalis pulse flow obligations under D-1641. *See* DEIS at 3-42. Reclamation is obligated to meet Vernalis pulse flow requirements under D-1641, as the State NRDC TBI 38

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Water Resources Control Board has repeatedly made clear, and Reclamation must include these pulse flows under the No Action Alternative. NRDC TBI 38 continued

IV. <u>The DEIS Fails to Accurately Assess Cumulative Impacts</u>

Reclamation has violated NEPA by failing to analyze the cumulative impacts. The DEIS identifies a number of other projects that could result in cumulatively significant impacts, including new reservoirs (including Temperance Flat and raising Shasta Dam) and the California WaterFix project, as well as other regional water supply projects. DEIS at 3-45 to 3-55. Many of these projects, such as the California WaterFix, Temperance Flat Dam, and expansion of Shasta Dam, have prepared CALSIM modeling as part of their NEPA analyses, enabling quantitative analysis of the cumulative effects. However, the DEIS wholly fails to provide any quantitative analysis of the cumulative impacts of CVP/SWP operations in conjunction with these other projects, and provides only a single page of analysis of cumulative impacts. DEIS at 9-422 to 9-423. This vague discussion only considers a few of the actions identified in Chapter 3, (regulatory flow standards), and this discussion of cumulative impacts does not include any analysis of cumulative impacts from the California WaterFix, reservoir proposals (including Temperance Flat dam and expansion of Shasta Dam, for which Reclamation has prepared NEPA documents), and the other water supply projects identified in Chapter 3 of the DEIS. NRDC TBI 39

V. <u>Conclusion</u>

As discussed above, the DEIS fails to accurately assess environmental impacts of CVP/SWP operations, fails to consider a reasonable range of alternatives, and includes alternatives that violate Reclamation's water rights and the purpose and need statement of the DEIS. Reclamation must substantially revise the DEIS and recirculate it for public comment to comply with NEPA. NRDC TBI 40

Thank you for consideration of our views.

Sincerely,

Doug Obegi
Natural Resources Defense Council

Gary Bobker
The Bay Institute

Enclosures

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1D.1.11.1 Attachments to Comments from Natural Resources Defense Council and The Bay Institute

Attachments to the Natural Resources Defense Council and The Bay Institute Comment letter are included in Attachment 1D.3 located at the end of Appendix 1D.

1D.1.11.2 Responses to Comments from Natural Resources Defense Council and The Bay Institute

NRDC TBI 1: Comment Noted. Please see responses to Comments NRDC TBI 2 through NRDC TBI 40.

NRDC TBI 2: Droughts have occurred throughout California's history, and are constantly shaping and innovating the ways in which Reclamation and DWR balance both public health standards and urban and agricultural water demands while protecting the Delta ecosystem and its inhabitants. The most notable droughts in recent history are the droughts that occurred in 1976-77, 1987-92, and the ongoing drought. More details have been included in Section 5.3.3 of Chapter 5, Surface Water Resources and Water Supplies, and Section 9.3.8 of Chapter 9, Fish and Aquatic Resources, in the Final EIS to describe historical responses by CVP and SWP to these drought conditions and changes in fisheries resources.

Conditions that have led to consideration of the federal listing of Longfin Smelt are discussed on page 9-67 of the Draft EIS.

NRDC TBI 3: The population of winter-run Chinook salmon is at extreme risk. NMFS recently named Sacramento River winter-run Chinook salmon as one of the eight species most at-risk of extinction in the near future. Last year (2014), due to a lack of ability to regulate water temperatures in the Sacramento River in September and October, water temperature rose to greater than 60°F. This reduced early life stage survival (eggs and fry) from Keswick to Red Bluff from a recent average of approximately 27 percent (egg-to-fry survival estimates averaged 26.4 percent for winter-run Chinook salmon in 2002-2012) down to 5 percent in 2014. Consequently, 95 percent of the year class of wild winter-run Chinook was lost last year. Additional information regarding key components of the 2015 Shasta Temperature Management Plan is provided at: http://www.usbr.gov/mp/drought/docs/shasta-temp-mgmt-plan-key-components-06-18-15.pdf.

The 2014 spawning run of spring-run Chinook salmon returning to the upper Sacramento River system also experienced significant impacts due to drought conditions as well as elevated temperatures on the Sacramento River and other tributaries. Similar to winter-run, spring-run eggs in the Sacramento River experienced significant and potentially complete mortality due to high water temperatures downstream of Keswick Dam starting in early September 2014 when water temperatures exceeded 56° F. Few juvenile spring-run Chinook Salmon were observed this year migrating downstream of the Sacramento River during high winter flows, when spring-run originating from the upper Sacramento River, Clear Creek, and other northern tributaries are typically observed, indicating that the population was significantly impacted. Similar concerns for spring-run exist this year as for winter-run. While spring-run have greater distribution and inhabit locations in addition to the Sacramento River, conditions on those streams are also expected to be poor due to the drought. The conservation of storage expected as a result of the changes requested in the Temporary Urgency Change (TUC) Permit submitted by Reclamation and DWR in response to drought conditions are expected to also benefit spring-run this year. Additional information regarding CVP and SWP operations under a TUC Order issued on July 3, 2015, by the State Water Resources Control Board is provided at: http://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/docs/tucp/2015/tucp_order070315.pdf.

The discussion in Chapter 9, Fish and Aquatic Resources, does find that increased air temperatures and reduced snowfall would result in water temperatures that would result in substantial adverse impacts to salmonids and sturgeon in the rivers downstream of the CVP reservoirs under the No Action Alternative, Second Basis of Comparison, and Alternatives 1 through 5 (see subsections "Changes in Exceedance of Water Temperature Thresholds" in Section 9.4.3 of Chapter 9). The EIS analysis compares conditions in 2030 under the Alternatives 1 through 5 to the No Action Alternative; and under the No Action Alternative and Alternatives 1 through 5 to the Second Basis of Comparison. The EIS analysis has been prepared in accordance with NEPA and does not compare the conditions under the alternatives, No Action Alternative, and Second Basis of Comparison to the existing conditions (as is presented in CEQA documents, such as the Bay Delta Conservation Plan Environmental Impact Report/Environmental Impact Statement). The No Action Alternative represents operations consistent with implementation of the 2008 and 2009 Biological Opinions. This No Action Alternative represents the current management direction and level of management intensity consistent with the explanation of the No Action Alternative included in Council of Environmental Quality's Forty Most Asked Questions (Question 3). NEPA does not require agencies to mitigate impacts, nor does it require agencies to identify mitigation associated with the No Action Alternative.

NRDC TBI 4: More details have been included in Section 9.4.3 of Chapter 9, Fish and Aquatic Resources, in the Final EIS to qualitatively responses to RPA actions not included in the CalSim II model in the No Action Alternative and Alternatives 2 and 5. Please also see response to Comment NRDC TBI 4.

NRDC TBI 5: The EIS analysis is based upon the comparison of conditions in 2030 under different alternatives. The results of those comparisons related to water temperatures show relatively minimal changes under the Alternatives 1 through 5 to the No Action Alternative; and under the No Action Alternative and Alternatives 1 through 5 to the Second Basis of Comparison. However, as described in the response to Comment NRDC TBI 3, the water temperatures in the rivers downstream of the CVP reservoirs would result in substantial adverse impacts to salmonids and sturgeon under Alternatives 1, 2, 3, and 4 and the Second Basis of Comparison without the addition of fish passage methods that are included in the No Action Alternative and Alternative 5.

The CVP and SWP reservoirs are operated in accordance with regulatory limitations, including applicable state and federal laws, regulations, and water rights first prior to deliver of water to CVP and SWP water contractors. The CVP and SWP cannot choose to meet only portions of the applicable state and federal laws, regulations, and water rights; and, it is not possible to fully meet the temperature thresholds downstream of the CVP and SWP reservoirs in 2030 with climate change. Therefore, fish passage around the CVP and SWP reservoirs is the only measure available to provide habitat with appropriate water temperatures for early lifestages.

NRDC TBI 6: Because compliance with the California Environmental Quality Act (CEQA) would be under DWR's purview, Reclamation consulted with DWR on this comment. On October 5, 2015, DWR provided the following response: "The District Court required Reclamation to comply with NEPA on the provisional acceptance of the RPA actions. There is no action for the State of California requiring California Environmental Quality Act (CEQA) review."

NRDC TBI 7: The reference to Rose et al. (2013 a, b) and Baxter et al. (2010) has been included in the Final EIS on page 9-62 of the Draft EIS. The MAST report is referenced and described on pages 9-65 and 9-66 of the Draft EIS. A summary of conclusions in Rose et al.,(2013), MacNally et al. (2010) and Thomson (2010) was added to page 9-62 of the Draft EIS.

NRDC TBI 8: The life cycle model developed by Rose et al. (2013a, b) was not included in this analysis because it uses a wide array of daily data, many of the assumptions and parameter values were based on judgment.

NRDC TBI 9: Implementation of OMR flow requirements under the No Action Alternative, Alternative 2, and Alternative 5 are consistent with the approach explained in Appendix 5A, Section B (5A.8.1) and takes into account day-weighted monthly averages of trigger and off-ramp conditions. Implementation of 2008 USFWS BO RPA actions in CalSim II model were developed in 2009 through discussions with several agencies, as described in Section 9.4.1.3.3. Not all aspects of the 2008 USFWS BO and 2009 NMFS BO can be simulated in the CalSim II model which is a monthly time-step model.

In Alternative 3, OMR requirements are implemented in a similar fashion. It is acknowledged in Chapter 9, Fish and Aquatic Resources, that both Alternative 1 and Alternative 3 would have increased adverse effects compared to the No Action Alternative (See Table 9.4). Therefore, although the benefits of the OMR action are not fully captured in model output, the impact analysis in Chapter 9 includes a discussion of the quantitative results from the models and a qualitative analysis of other aspects in Alternative 3, including the benefits from the OMR criteria.

NRDC TBI 10: The analysis in the EIS compares conditions under Alternatives 1 through 5 with the No Action Alternative to identify beneficial and adverse impacts for a broad range of physical, environmental, and human resources.

The analytical tools used in the impact assessment of fisheries resources described in Chapter 9, Fish and Aquatic Resources, evaluate differences in conditions related to different lifestages of different species in the Delta watershed. However, there are no available analytical tools to quantitatively predict the total population differences for all species considered in this EIS which consider all portions of the life histories of the fish (by species and run), including ocean harvest conditions for anadromous fish. Results from life cycle models for winter-run Chinook Salmon, as presented in Chapter 9, predict life stage survival and adult escapement, but not total populations. At this time, accepted population models do not exist to analyze the effects of the alternatives for the fisheries species and runs considered in this EIS. Therefore, the NEPA analysis does not determine if the alternatives would cause violations of existing biological opinion take limits. Rather, the NEPA analysis presents incremental differences between the alternatives, No Action Alternative, and Second Basis of Comparison.

NRDC TBI 11: The statement in this comment regarding Kimmerer (2011) is misconstrued and inaccurate. Kimmerer was reporting on an analysis designed to determine what level of impact could be detected by correlative methods. His regression analysis was between a simulated stock-recruitment index and OMR flows (assumed 0 if OMR is greater than 0 [northward]) to determine how large the maximum percentage loss (Pmax) would be before losses become detectable in the regression analysis. His results showed that the losses were not generally detectable in the regression until Pmax reached about 60 to 80 percent and maximum losses less than 20 percent were generally undetectable. Repeating the simulation 10,000 times with Pmax equal to 20 percent, the upper 95 and 90 percent confidence limits of the regression slope excluded zero (i.e., was statistically detectable) in 5 and 9 percent of the cases, respectively. This led to the conclusion that "a loss to export pumping on the order reported by Kimmerer (2008) can be simultaneously nearly undetectable in regression analysis, and devastating to the population." He also noted that "This also illustrates how inappropriate statistical significance is in deciding whether an effect is biologically relevant." Which was the sole reason for this exercise. Kimmerer (2011) did not imply there was a threshold of 10 percent mortality that would lead to devastating impacts on the population.

The determination of similar results based upon an incremental difference of 5 percent or less is indicative of a level of uncertainty in the model results. The EIS impact analysis starts with use of the monthly CalSim II model to project CVP and SWP water deliveries. Because this regional model uses monthly time steps to simulate requirements that change weekly or change through observations, it was determined that changes in the model of 5 percent or less were related to the uncertainties in the model processing. Therefore, reductions of 5 percent or less in this comparative analysis are considered to be not substantially different, or "similar." The definition of the similar results has been added to the text in several locations in Chapter 9, Fish and Aquatic Resources, and to the appendices of Chapter 9 in the Final EIS.

NRDC TBI 12: Please refer to responses to Comments NRDC TBI 10 and NRDC TBI 11.

NRDC TBI 13: As noted in the Appendix 5A, the No Action Alternative, Second Basis of Comparison, and Alternatives 1 through 5 include and meet the SWRCB D-1641 requirements to the extent allowed by the hydrology. The modeling for the EIS simulates the operations results are intended to be a reasonable representation of long-term operational trends. The Draft EIS also included an analysis of larval/juvenile delta smelt entrainment, based on Kimmerer (2008) regression estimating percentage entrainment as a function of X2 and OMR. The specific actions undertaken under recent droughts were not included in the EIS modeling efforts because the analysis considers the coordinated long-term operation of the CVP and SWP. The analysis is based upon an 82-year hydrology which includes conditions that occur in a wide range of hydrology, including droughts. However, specific responses to the droughts and floods would be developed on individual basis and are not considered in the long-term analysis. The Draft EIS included an analysis of the fall X2 requirements as discussed in Appendix 9G based on the Feyrer et al. (2011).

The Draft EIS, at two locations in the document, suggested that food resources for Delta Smelt may have been supplemented in 2011 and 2012 when the release of Colusa Basin Drain water through the Yolo Bypass resulted in increases in nutrients and phytoplankton that led to measurable increases in zooplankton in the Yolo Bypass, Cache Slough, and the Sacramento River near Rio Vista. This was based on information contained in Frantzich (2014). The trends in Delta Smelt abundance, including the index value for 2012, are indicated in Table 9.1 on page 9-63 of the Draft EIS.

It is unclear how the Draft EIS, as suggested in the comment, "misstates the conclusions of the MAST report regarding the importance of implementation of the fall outflow RPA in 2011 (rather than agricultural runoff) on subsequent delta smelt abundance." The conclusions from the MAST Report reported on page 9-66 of the DEIS are nearly verbatim. The paragraph following the MAST Report conclusions in the DEIS suggests that agricultural runoff through the Yolo Bypass may have contributed to an increase of food resources. This paragraph was deleted in the Final EIS because it repeats information stated previously.

NRDC TBI 14: Existing conceptual models were considered in the preparation of the aquatic resources analysis in the EIS. Predicting and analyzing the differential effects of alternative project operations on the abundance and composition of phytoplankton, zooplankton and benthic organisms would require a coupled hydrodynamic-food web model of the Delta. Such a model is currently not available. However, additional text was added to Section 9.4.1.3.2 of the Draft EIS to better capture the current literature on this subject.

NRDC TBI 15: The analysis of changes in hydrology resulting from operations contained was based on CalSim II modeling, which relies on a long-term period of record. As mentioned in Section 5A.A.3.5, "In CalSim II, operational decisions are made on a monthly basis, based on a set of predefined rules that represent the assumed regulations. The model has no capability to adjust these rules based on a sequence of hydrologic events such as a prolonged drought, or based on statistical performance criteria such as meeting a storage target in an assumed percentage of years.." Nonetheless, text has been added to Chapter 9 to acknowledge the current drought and its effects on aquatic resources, including algal blooms and invasive species.

As indicated in the comment, the BDCP/WaterFix environmental documents included an analysis of residence time to evaluate changes in microcystis and invasive species. For that study, residence time was strongly influenced by shifting diversion to the north Delta (and by increased habitat restoration areas in early stages of the project under BDCP/WaterFix). Under the Draft EIS alternatives, all diversions would be conducted at the current export facilities and all alternatives would include the same acreage of restoration. The operations in summer months would not vary significantly to affect temperature (mostly affected by ambient conditions) and residence time. Thus, incremental changes between alternatives regarding microcystis and invasive species would be indiscernible.

NRDC TBI 16: Please refer to response to Comments NRDC TBI 14 and NRDC TBI 15.

NRDC TBI 17: The analysis in the EIS analysis compares conditions under Alternatives 1 through 5 with the No Action Alternative to identify beneficial and adverse impacts for Longfin Smelt. The NEPA analysis does not determine if the alternatives would change the findings of the biological opinions in the determination of the likelihood of the alternatives to cause jeopardy to the continued existence of the species, or destroy or adversely affect their critical habitat.

NRDC TBI 18: The results described in Cunningham et al. (2015) was added on page 9-78 (of the Draft EIS) to quantify the effects of exports on salmonid survival. Differences, such as those described by Cunningham in relation to exports are not exhibited in a comparison of the No Action Alternative with Alternatives 1 through 5 since the impact analyses results for all of the alternatives comparisons do not result in the distinct export regimes (+1 standard deviations of the mean) modeled by Cunningham et al. (2015). Results of the SALMOD model for late fall-run Chinook Salmon in the Sacramento River (Table B-2-5 of Appendix 9D) show comparable results for pre-smolt and smolt mortality due to habitat (flow) as Michel et al. (2015) in that mortality is increased in drier years as compared to wetter years.

NRDC TBI 19: Please see Appendix 9M, Salmonid Salvage Analysis, which describes the methods for addressing the effects of export facilities on juvenile salmonids. This analysis, based on coded wire tagged fish, covers a broader range of size classes than does the DPM analysis.

NRDC TBI 20: Although the median survival predicted by the OBAN model was 12 percent higher under the No Action Alternative than under the Second Basis of Comparison, the probability intervals indicated that no difference between scenarios was a likely outcome (i.e. the dashed line of no difference lies within the dark gray central 0.50 probability interval in Figure 9I-14). The text on page 9-162 (of the Draft EIS) has been modified for clarity; however, specific degrees of certainty cannot be determined with the existing analytical tools.

NRDC TBI 21: Please see response to NRDC TBI 5.

NRDC TBI 22: SALMOD is not used as a predictive model, it is used as a comparative tool for analyzing differences between alternatives that would occur over a range of hydrologic conditions represented by output from the 82-year CalSim II model (see Appendix 9D, SALMOD Model Documentation). As used, SALMOD output represents the mean values for production and mortality each year with the same initial conditions for population parameters and varying operations simulated by CalSim II. It is not a life-cycle model and does not provide a time trajectory of production. There is no expectation that SALMOD output will mirror recent (or historical) data on production or mortality. However, the comparison of mean values for production and mortality are a valid and appropriate method of comparing possible outcomes among the various alternatives. Similarly, the Reclamation Salmon Mortality Model utilizes CalSim II output through the temperature models and is not expected to mirror recent or historical estimates of mortality (see Appendix 9C, Reclamation's Salmon Mortality Model Analysis Documentation). It too is used as a comparative tool to distinguish potential effects among the alternatives. The results of the impact analysis is to understand the differences in the outcomes of the alternatives as compared to the No Action Alternative and the Second Basis of Comparison.

NRDC TBI 23: As described and presented in Appendix 9H of the Draft EIS, the IOS model uses the full 82-year CalSim II simulation period. The impact analysis used in the EIS evaluates the differences between alternatives based on changes in the median annual escapement and the range of escapement values encompassed in the first and third quartiles (25 to 75 percent of years) over the 82-year CalSim II simulation period (see page 9-116 of the Draft EIS). As described in the response to Comment NRDC TBI 22, SALMOD is not used as a predictive model to mirror past data, it is used as a comparative tool for analyzing differences between alternatives that would occur over a range of hydrologic conditions represented by output from the 82-year CalSim II model. As used, SALMOD output represents the mean values for production and mortality each year with the same initial conditions for population parameters and varying operations simulated by CalSim II. It is not a life-cycle model and does not provide a time trajectory of production. However, the comparison of mean values for production and mortality are a valid and appropriate method of comparing possible outcomes among the various alternatives under a NEPA analysis. Similarly, the Reclamation Salmon Mortality Model is used as a comparative tool to distinguish potential effects among the alternatives.

While likely effects from water temperature on early life stages occur at a shorter temporal scale than these models, comparative analyses are useful for long-term analyses, as in the EIS, because there is moderate certainty for long-term conditions.

NRDC TBI 24: The analysis of weighted usable area (WUA) in the Draft EIS is not intended to describe salmonid survival. The WUA methodology is used as a metric for evaluating changes in physical habitat related to flow as described in Appendix 9E, Weighted Useable Area Analysis, and on page 9-108 of the Draft EIS. The results of the SALMOD model are used to evaluate changes in salmonid survival in the Sacramento River (see Appendix 9D). Results of the SALMOD model for late fall-run Chinook Salmon in the Sacramento River (Table B-2-5 of Appendix 9D) show that mortality for pre-smolts and smolts is increased in drier years as compared to wetter years; this is consistent with Michel et al. (2015).

NRDC TBI 25: The EIS alternatives include consistent climate change conditions without consideration of potential regulatory or operational changes due to climate conditions in the future. Potential climate-related operational changes are currently unknown and it would be speculative to develop such assumptions for a NEPA analysis. This comparative approach eliminates the effects of climate change from the incremental changes between the alternatives, No Action Alternative, and Second Basis of Comparison.

The EIS analysis has been prepared in accordance with NEPA and does not compare the conditions under the alternatives, No Action Alternative, and Second Basis of Comparison to the existing conditions (as is presented in CEQA documents). The No Action Alternative represents operations consistent with implementation of the 2008 and 2009 Biological Opinions. This No Action Alternative represents the current management direction and level of management intensity consistent with the explanation of the No Action Alternative included in Council of Environmental Quality's Forty Most Asked Questions (Question 3). NEPA does not require agencies to mitigate impacts, nor does it require agencies to identify mitigation associated with the No Action Alternative.

NRDC TBI 26: "Spring-running" fish were not analyzed due to uncertainty whether they are genotypically spring-run, and if so, whether they are strays or a distinct population; and their exemption from take related to diverting or receiving water in accordance with the San Joaquin River reintroduction program. In the most recent Recovery Plan (NMFS 2014), it is stated that native spring-run Chinook salmon have been extirpated from all tributaries in the San Joaquin River Basin.

NRDC TBI 27: The references included in the comment provide additional information that is consistent with citations already included in the Draft EIS. Many of these reports also indicate that there still remains uncertainty in the flow-survival relationship. Sturrock et al. (2015) did not conclude that flows drive salmonid survival and abundance but did provide evidence that salmon populations fluctuate considerably with river flows experienced during juvenile rearing. The text on page 9-92 of the Draft EIS has been modified to include the reference in the comment, and to indicate that mortality in the Stockton Deep Water Ship Channel is one of the limiting factors.

Footnote 9 in the comment regarding Kondolf is not correct. Despite one site having a lower value (i.e., TMI 280 cfs) than 5,000 cfs, Kondolf used a combination of sites to identify that mobility overall occurs beginning at about 5,000 cfs. On page 36 of Kondolf, it states "Results of the bed mobility analysis for five (TMl, RI, RS, R28A, and R78) of nine sites studied suggest that flows around 5,000 to 8,000 cfs are necessary to mobilize the D50 of the channel bed material (Table 7.1 and Appendix C)." There was one site (TMI 1) where flows less than 5,000 cfs (280 cfs) would mobilize gravel, but as Kondolf explains "The mobility of the gravel at TMI probably reflects the smaller diameter of the augmented gravel, rather than the mobility of the gravels that would naturally occur in this steeper reach."

Text has been modified on the page 9-149 of the Draft EIS has been modified in the Final EIS to provide more clarity on the statement referenced in Footnote 9 of this comment.

NRDC TBI 28: Long-term average flows are not substantially reduced under Alternative 3 as compared to the No Action Alternative or the Second Basis of Comparison for the Stanislaus River below Goodwin Dam (see Figures 5-68, 5-69, and 5-70 in Chapter 5, Surface Water Resources and Water Supplies). There are anticipated flow reductions generally from March through June and particularly in October under Alternative 3, but flows are anticipated to be increased under Alternative 3 relative to the No Action Alternative and comparable to flows under the Second Basis of Comparison in many months. As described on pages 9-313 through 9-315 of the Draft EIS, water temperatures under Alternative 3 are anticipated to be similar to the No Action Alternative or slightly lower in most months and lead to a slight reduction in egg mortality for fall-run Chinook salmon. The text on page 9-316 of the Draft EIS has been modified to improve the readability

NRDC TBI 29: The description of the trap and haul program assumptions and methodologies presented in Chapter 9 of the Draft EIS were not extensive. Additional information has been included on the text from page 9-316 of the Draft EIS, and additional information has been provided in Appendix 9O of the Final EIS.

NRDC TBI 30: Reclamation's proposed action in the 2008 Biological Assessment included actions developed to contribute to Section 3406(b)(1) of the Central Valley Project Improvement Act (CVPIA) and other requirements of CVPIA. These actions were analyzed as part of the proposed action in the 2008 USFWS BO and 2009 NMFS BO. These actions are therefore also incorporated in the No Action Alternative and Alternative 5. Alternatives 1 through 4 and the Second Basis of Comparison due not fully contribute to the goals of Section 3406(b)(1).

NRDC TBI 31: Please see responses to comments from National Marine Fisheries Service in Appendix 1.A.1.

NRDC TBI 32: Text has been added to Section 9.4.3.4 of the FEIS to include the studies by Bowen et al. (2009, 2010) regarding predation on salmonids around a Head of Old River barrier.

While the two-year study observed a variable and negative relationship between flow and survival past the Head of Old River barrier, there remained uncertainty due to the actual barrier structural configuration and how they would affect predator habitat in this reach. These studies did not speculated about overall survival rates or the biological significance of reach specific mortality around the Head of Old River barrier. Overall, the conclusions indicated that survival around the Head of Old River barrier would be structural design specific and highly variable; therefore certainty of the effect of the structures remains low.

NRDC TBI 33: The analysis in the Draft EIS did not rely on the 2012 Biological Opinion for analysis of effects. The latest (2014) Final Recovery Plan lists ocean harvest as a "very high" stressor on the winter-run Chinook Salmon population. Additional text has been added to Chapter 15, Recreation Resources, and Chapter 19, Socioeconomics, related to the effects of the harvest restrictions in Alternatives 3 and 4. The harvest rules specified in Alternatives 3, and especially Alternative 4, may be less protective for winter-run Chinook Salmon because this run is not allowed to be captured in either sport or commercial ocean salmon fishing. Additional text has been added to Section 9.4.3.5.2 on consistency of these alternatives with NMFS fisheries management framework for reducing the impact of ocean salmon fishery on winter-run Chinook Salmon.

NRDC TBI 34: Please see response to Comment NRDC TBI 25.

NRDC TBI 35: The CVP and SWP reservoirs are operated in accordance with regulatory limitations, including applicable state and federal laws, regulations, and water rights first prior to deliver of water to CVP and SWP water contractors. Under the current regulatory scenario, it is not possible to fully meet the temperature thresholds downstream of the CVP and SWP reservoirs in 2030 with climate change. Additional reservoir releases to increase Delta outflow would result in further temperature issues in the rivers downstream of the CVP and SWP reservoirs. Reclamation cannot modify the state water rights requirements or SWRCB water quality criteria.

The EIS analysis indicates in that alternative water supplies would be required under Alternatives 1 through 5, the No Action Alternative, and the Second Basis of Comparison because CVP and SWP water deliveries are anticipated to be less than under existing conditions and full water contract amounts are only delivered in extremely wet years, as described in Chapter 5, Surface Water Resources and Water Supplies, and Chapter 19, Socioeconomics. Many of the municipalities are considering the alternative water supplies as part of their urban water management plans, as described in Appendix 5D, Municipal and Industrial Water Demands and Supplies.

As described in Section 1.6 of Chapter 1, Introduction, of the Draft EIS, it is anticipated that substantial changes could occur to CVP and SWP operations as future projects are implemented. It is anticipated that most of these future projects have been identified in Section 3.5 of Chapter 3, Description of Alternatives, including the Bay Delta Water Quality Control Plan Update. Many of these future projects have not been fully defined and are not anticipated to be operational until the late 2020s. If any of these future projects would substantially change CVP operations, Reclamation would evaluate the need to request initiation of consultation under ESA with the USFWS and NMFS.

The future projects are being developed for different project objectives than the purpose and need in this EIS for the coordinated long-term operation of the CVP and SWP. Because the future operations under future projects have not been finalized at this time; and because projects that would substantially change CVP operations would require future consultations with USFWS and NMFS, it would be pre-decisional to include these projects in the alternatives evaluated in this EIS. Therefore, the alternatives under these future projects are considered in the cumulative effects analysis in this EIS.

NRDC TBI 36: Please refer to response to Comment NRDC TBI 34.

NRDC TBI 37: The EIS analysis compares conditions under a range of alternatives (Alternatives 1 through 5) with the No Action Alternative to identify beneficial and adverse impacts for a broad range of physical, environmental, and human resources. A reasonable range of alternatives includes technically and economically feasible alternatives to address the purpose and need for the action (40 CFR 1502.14). However, the range of alternatives can be limited if the alternatives analyzed address the full spectrum of alternatives (Question 1b of CEQ Forty Most Asked Questions). The range of alternative concepts were evaluated with respect to screening criteria defined in the purpose of the action (see Chapter 2, Purpose and Need), a determination if the concept addressed one or more significant issues, and if the concept was included in one or more alternatives (Table 3.1 in Chapter 3, Description of Alternatives).

NRDC TBI 38: The Council on Environmental Quality guidance describes that a "potential conflict with local or federal law does not necessarily render an alternative unreasonable, although such conflicts must be considered." Therefore, the range of alternatives considered in this EIS does include actions that are not necessarily consistent with existing federal and state requirements for the existing long-term operation of the CVP and SWP. The selection of the range of alternatives considered in the EIS was informed by several factors, including scoping comments, as described in Section 3.4 of Chapter 3, Description of Alternatives, in the EIS. Alternative 3 was developed through consideration of scoping comments from the Coalition for a Sustainable Delta, Oakdale Irrigation District, and South San Joaquin Irrigation District, as described in Section 3.4.5.

NRDC TBI 39: The discussion of cumulative impacts in Chapter 9, Fish and Aquatic Resources, has been expanded in the Final EIS.

NRDC TBI 40: Reclamation has modified the Final EIS in response to comments from NRDC, TBI, and other commenters; and will use the Final EIS in the development of the Record of Decision.

1D.1.12 North Coast Rivers Alliance

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September 28, 2015

VIA EMAIL

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Re: NCRA Comments on Draft Environmental Impact Statement: Coordinated Long-Term Operation of the Central Valley Project and State Water Project (Agency/Docket Numbers: RR02800000, 15XR0680A1, RX.17868946.0000000)

Mr. Nelson:

On behalf of North Coast Rivers Alliance ("NCRA") we submit the following comments on the Bureau of Reclamation's ("Reclamation's") Draft Environmental Impact Statement for the Coordinated Long-Term Operation of the Central Valley Project and State Water Project ("DEIS"), which was prepared pursuant to the National Environmental Policy Act, 42 U.S.C. §§ 4332 et seq. ("NEPA"). NCRA strongly supports the *No Action* Alternative, which fully implements the Reasonable and Prudent Alternative ("RPA") actions identified in the 2008 Fish and Wildlife Service Biological Opinion ("2008 FWS BiOp") and 2009 National Marine Fisheries Service Biological Opinion ("2009 NMFS BiOp") (collectively, "BiOps"). NCRA 1

INTRODUCTION

The continued long-term operation of the Central Valley project ("CVP") and State Water Project ("SWP") will adversely affect numerous species reliant on the Delta. The 2008 FWS BiOp "[c]oncluded that 'the coordinated operation of the CVP and SWP, as proposed, [was] likely to jeopardize the continued existence of the Delta Smelt' and 'adversely modify Delta Smelt critical habitat.'" DEIS 1-7. Similarly, the 2009 NMFS BiOp declared that continued operation of the CVP and SWP would "[j]eopardize the continued existence of Sacramento River winter-run Chinook Salmon, Central Valley spring-run Chinook Salmon, Central Valley Steelhead, [and] Southern DPS of North American Green Sturgeon," and "[d]estroy or adversely modify critical habitat" for those species. DEIS 1-7. Federal, state, and local agencies are tasked with the duty to preserve these species and therefore any continued operation of the CVP and SWP must be accompanied by protection and conservation measures. NCRA 2

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As the situation in the Delta becomes more dire and fish populations continue their precipitous decline, the impacts of the continued long-term operation of the CVP and SWP become more severe.[1] For example, fishing yields for Chinook salmon have seen a steep decline in recent years.[2] Indeed, the 2014 commercial catch shrunk to 151,367 Chinook from 285,592 in the previous year. *Id.* At the tail end of the 2015 commercial season, preliminary yield numbers were only 96,878 Chinook. *Id.* Recreational yields for Chinook have likewise fallen, from 112,022 Chinook in 2013 to 65,936 in 2014. *Id.* As of August 31, 2015, this year's yield so far was only 25,541 Chinook. *Id.* Protection of the Delta is paramount to the survival of these species. The RPAs identified in the BiOps help protect the Delta's many imperiled fish species *before* their populations are extirpated. The ongoing drought plaguing the state will only exacerbate these potential impacts, further highlighting the importance of implementing the No Action Alternative and subsequently *all* of the RPAs. If we fail to protect these species now, we may not have a chance in the future. NCRA 2 continued

A. The Bureau Must Not Implement *Any* of the Action Alternatives Presented in the DEIS

None of the action alternatives considered in the DEIS can be approved. DEIS ES-7 to ES-14, 3-30 to 3-42. Three out of five action alternatives – Alternatives 1, 3, and 4 – fail to implement *any* of the RPAs identified in the BiOps and Alternative 2 only incorporates some of the RPAs. DEIS ES-11to ES-13, 3-31 to 3-40. Failing to fully implement the RPAs would not only risk entire populations of fish species, but it would also violate the Endangered Species Act, 16 U.S.C. §§ 1531 et seq. ("ESA"). Furthermore, the one action alternative that does implement all of the RPAs – Alternative 5 – is poisoned by the DEIS' attempt to sneak in an additional 32,000 acre-feet/year ("afy") water diversion. DEIS ES-14, 3-41 to 3-42. Since none of the action alternatives implement *all* of the RPAs while maintaining or lessening water diversions, Reclamation should approve the No Action Alternative. NCRA 3

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[1] Phillip Reese and Ryan Sabalow, *Feds scramble to avoid another mass salmon die-off in the Sacramento River,* SACRAMENTO BEE (Sept. 5, 2015) (detailing some of the most recent challenges facing Chinook salmon), attached as Exhibit 1and also available at: http://www.sacbee.com/news/state/california/water-and-drought/article34197762.html#storylink=cpy

[2] Pacific Fisheries Council, Status Report for the 2015 Ocean Salmon Fisheries off Washington, Oregon and California, Supplemental Informational Report 13 (Sept. 2015), attached as Exhibit 2 and also available at: http://www.pcouncil.org/wp-content/uploads/2015/09/SUP_IR13_Salmon_Catch_Update_SEPT2015BB.pdf

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1. Failing to Fully Implement the RPAs Would Violate the ESA

As noted above, approval of Alternatives 1 through 4 would violate the Endangered Species Act, 16 U.S.C. §§ 1531 et seq. ("ESA"). The main goals of the ESA are "to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, [and] to provide a program for the conservation of such . . . species." 16 U.S.C. § 1531(b); *See also* 50 C.F.R. § 402.01. The ESA also declares that all "Federal departments and agencies shall seek to conserve endangered species and threatened species and shall utilize their authorities in furtherance" of these purposes. 16 U.S.C. § 1531(c). Thus Reclamation must "seek to conserve" the species that continue to be decimated by the major water diversions associated with the coordinated long-term operation of the CVP and SWP. *Id.*; 50 C.F.R. §§ 402.02; 402.14, 402.15. NCRA 4

The United States courts have ardently reaffirmed the importance of the ESA. The Supreme Court held in *Tennessee Valley Authority v. Hill*, 437 U.S. 153, 180 (1978) ("*TVA*"), that the ESA "represented the most comprehensive legislation for the preservation of endangered species ever enacted by any nation," and "that Congress intended endangered species to be afforded the highest of priorities." *Id.* at 174. Indeed, the court noted that endangered species should be given "*priority over* the 'primary missions' of federal agencies." *TVA*, 437 U.S. at 185, emphasis added. If, like here, a proposed action presents a possibility of jeopardy to an endangered or threatened species or its habitat, the agency *must* consult with FWS and NMFS to create biological opinions that include RPAs to mitigate that jeopardy. 16 U.S.C. § 1536(b)(3)(A); 50 C.F.R. § 402.14(h).

Indeed, the ESA "affirmatively command[s] all federal agencies 'to insure that actions *authorized*, *funded*, or *carried out* by them do not jeopardize the continued existence' of an endangered species or '*result* in the destruction or modification of habitat of such species . . . .'" *TVA*, 437 U.S. at 173, *quoting* 16 U.S.C. § 1536, emphasis in original. This includes the affirmative requirement to adopt RPAs where necessary. 16 U.S.C. § 1536(b)(3)(A); 50 C.F.R. § 402.14(h). Agencies cannot ignore reliable information provided by FWS and NMFS in the BiOps. "Although the agency is technically not bound by findings of the . . . biological opinion[s], courts give great deference to the expertise of the FWS [and NMFS] on these issues, and an agency that attempts to proceed with an action in the face of a critical . . . biological opinion will almost certainly be found to have acted arbitrarily and capriciously and contrary to law." *Lone Rock Timber Company v. U.S. Department of the Interior*, 842 F.Supp. 433, 440 (D.Or. 1994), *citing Sierra Club v. Marsh*, 816 F.2d 1376, 1386 (9th Cir.1987) *and TVA*, 437 U.S. 153, internal citations omitted. A decision to continue long-term operation of the CVP and SWP without implementing all of the RPAs "in the face of reliable information that [it] will adversely impact protected species" violates the ESA. *Id.*

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The Ninth Circuit Court of Appeals has "recognize[d] that the preparation of an EIS will not alter Reclamation's obligations under the ESA." *San Luis & Delta-Mendota Water Authority v. Jewell*, 747 F.3d 581, 653 (2014). Here, the DEIS and both BiOps state that the continued operation of the CVP and SWP *is likely to* adversely affect protected species and their habitat, and jeopardize their continued existence. DEIS 1-7. This admission alone is more than enough to trigger these agencies' duty to insure that their actions in operating the CVP and SWP do not "jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species." 16 U.S.C. § 1536(a)(2), (b)(3)(A); 50 C.F.R. § 402.14(h). In order to insure that no such jeopardy is likely, the No Action Alternative should be approved and all of the RPAs identified in the BiOps should be implemented. NCRA 5

2. Alternative 5, the *Only* Action Alternative that Fully Implements the RPAs, Cannot Stand

Like the No Action Alternative, Alternative 5 would fully implement the RPAs. However, Alternative 5 also includes water contracts for the El Dorado County Water Agency ("EDCWA") and the El Dorado Irrigation District ("EID"). One of the contracts would allow EID to store up to 17,000 afy of non-CVP water in Folsom Dam; the other would provide up to 15,000 afy of CVP water to EDCWA from Folsom Dam. These contracts would result in reduced outflow from Folsom Dam rather than the greater flows needed for imperiled fish as noted above and discussed below. Neither the project's purpose and need, nor the RPAs, provide any specific justification for including these water contracts in any of the Action Alternatives. NCRA questions the decision to include these contracts in Alternative 5. NCRA 6

When compared with the No-Action Alternative, Alternative 5 would increase egg mortality for fall-run Chinook Salmon within the Sacramento and Feather River Systems during critically dry and below normal years, respectively. DEIS 9-347. The DEIS acknowledges that these effects would be more adverse than the No-Action Alternative. Therefore the No-Action Alternative must be selected.

There is an additional reason why Alternative 5 must be rejected. Its impacts are worse than those revealed in the DEIS. The DEIS should be revised to fully account for the likely increase in below normal rainfall years due to climate change. Although the DEIS does assume that climate change will increase short-duration, high-rainfall events that reduce snow-pack, and increase water temperature, it does not mention intensified drought conditions. Yet emerging research confirms that impacts associated with drought conditions – such as an increase in below NCRA 7

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normal rainfall years – are likely to increase with California's average temperature.[3] An increase in so-called below normal and critically dry years will amplify Alternative 5's detrimental effects on fall-run Chinook Salmon. For this additional reason, Alternative 5 must not be approved. NCRA 7 continued

CONCLUSION

For the reasons stated above, NCRA strongly urges adoption of the No-Action Alternative as the best hope to prevent extirpation of California's native fish. NCRA 8

Respectfully submitted,

Stephan C. Volker
Attorney for North Coast Rivers Alliance

SCV:taf

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[3] *See* Williams, A. P., R. Seager, J. T. Abatzoglou, B. I. Cook, J. E. Smerdon, and E. R. Cook, (2015), Contribution of anthropogenic warming to California drought during 2012–2014, Geophys. Res. Lett., 42, 6819–6828, doi:10.1002/2015GL064924, attached as Exhibit 3(finding that human caused warming intensified drought impacts). While Appendix 5A states that CalSim II modeling examined climate change effects, the DEIS does not state that CalSim II modeling included any consideration of rising temperature's impact on drought intensity. Instead, CalSim II applies historic trends forward.

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Exhibit List

1. Phillip Reese and Ryan Sabalow, *Feds scramble to avoid another mass salmon die-off in the Sacramento River,* SACRAMENTO BEE (Sept. 5, 2015)

2. Pacific Fisheries Council, Status Report for the 2015 Ocean Salmon Fisheries off Washington, Oregon and California, Supplemental Informational Report 13 (Sept. 2015)

3. Williams, A. P., R. Seager, J. T. Abatzoglou, B. I. Cook, J. E. Smerdon, and E. R. Cook, (2015), Contribution of anthropogenic warming to California drought during 2012–2014, Geophys. Res. Lett., 42, 6819–6828, doi:10.1002/2015GL064924,

1D.1.12.1 Attachments to Comments from North Coast Rivers Alliance

Attachments to the North Coast Rivers Alliance Comment letter are included in Attachment 1D.4 located at the end of Appendix 1D.

1D.1.12.2 Responses to Comments from North Coast Rivers Alliance

NCRA 1: Comment noted.

NCRA 2: The conclusions of the 2008 USFWS BO and 2009 NMFS BO cited in this comment discussed conditions that would likely jeopardize the continued existence of listed species prior to implementation of the RPA actions included in each BO. The existing conditions and the future conditions under the No Action Alternative, as described in the EIS, include implementation of the RPA actions for the coordinated long-term operation of the CVP and SWP. The RPAs contained in the BOs provide actions to modify the operations in order to avoid jeopardy of listed species or adverse modifications or destruction of critical habitat.

NCRA 3: The commenter's support of the No Action Alternative is acknowledged.

The EIS analysis compares conditions under Alternatives 1 through 5 with the No Action Alternative to identify beneficial and adverse impacts for a broad range of physical, environmental, and human resources. The NEPA analysis does not determine if the alternatives would change the findings of the biological opinions in the determination of the likelihood of the alternatives to cause jeopardy to the continued existence of the species, or destroy or adversely affect their critical habitat.

NCRA 4: The commenter's opposition of Alternatives 1 through 4 is acknowledged. As discussed in the response to Comment NCRA 3, the EIS does not determine if the alternatives would be likely to cause jeopardy to the continued existence of the species, or destroy or adversely affect their critical habitat.

NCRA 5: The comment related to the text on page 1-7 of the Draft EIS is a citation and a summary of information presented in the 2008 USFWS BO and 2009 NMFS BO. This information presented on page 1-7 of the Draft EIS is not a conclusion of the EIS.

NCRA 6: Alternative 5 was developed as part of the range of alternatives to be considered in the EIS. The commenter's opposition to Alternative 5 and support of the No Action Alternative are acknowledged.

NCRA 7: The analysis in the EIS includes a range of hydrologic conditions projected to occur with a projected 2030 level of demand and regulatory requirements (including implementation of the 2008 USFWS BO and 2009 NMFS BO. As described in Appendix 5A, Section A, CalSim II and DSM2 Modeling, of the EIS, the range of hydrologic conditions analyzed in the EIS includes severe droughts and flood periods that have occurred in a 82-year hydrology with changes for projected climate change and sea level rise. The climate change assumptions are incorporated with historical hydrologic patterns to develop projected conditions in the Year 2030 for all alternatives considered in the EIS. As indicated in the comment, the projected pattern and frequency of water year types in the Year 2030 analysis in the EIS is different than under existing conditions.

The commenter's opposition to Alternative 5 is acknowledged.

NCRA 8: The commenter's support of the No Action Alternative is acknowledged.

1D.1.13 Restore the Delta

From: **Tim Stroshane** <spillwayguy@gmail.com>
Date: Fri, Sep 18, 2015 at 2:16 PM
Subject: Request for 30-day comment period extension - OCAP
To: bcnelson@usbr.gov
Cc: Barbara Barrigan-Parrilla <barbara@restorethedelta.org>

Restore the Delta 1

I write to request a 30-day extension of the comment period on the OCAP documents.

Thank you,

Tim Stroshane
Policy Analyst
Restore the Delta

--

Ben Nelson

Natural Resources Specialist

Bureau of Reclamation, Bay-Delta Office

916-414-2424

1D.1.13.1 Responses to Comments from Restore the Delta

Restore the Delta 1: At the time the request for extension of the public review period was submitted, the Amended Judgement dated September 30, 2014 issued by the United States District Court for the Eastern District of California (District Court) in the *Consolidated Delta Smelt Cases* required Reclamation to issue a Record of Decision by no later than December 1, 2015. Due to this requirement, Reclamation did not have sufficient time to extend the public review period. On October 9, 2015, the District Court granted a very short time extension to address comments received during the public review period, and requires Reclamation to issue a Record of Decision on or before January 12, 2016. This current court ordered schedule does not provide sufficient time for Reclamation to extend the public review period.

1D.1.14 South Valley Water Association

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September 29, 2015

Bureau of Reclamation
Bay-Delta Office
801 I Street, Suite 140
Sacramento, CA 95814-2536
Attn: Ben Nelson, Natural Resources Specialist

Re: Comment on Draft EIS for the Coordinated Long-Term Operation of the Central Valley Project and State Water Project

Mr. Nelson:

The following comments are made on behalf of the South Valley Water Association ("SVWA"), an association of Friant Division Central Valley Project contractors made up of the following member irrigation and water districts: Delano-Earlimart Irrigation District, Exeter Irrigation District, Ivanhoe Irrigation District, Lower Tule River Irrigation District, Pixley Irrigation District, Shafter-Wasco Irrigation District, Stone Corral Irrigation District and Tea Pot Dome Water District. SVWA 1

The SVWA Members have direct and indirect interests in the operations of the Central Valley Project as affected by the two biological opinions ("BiOps") that are the subject of the Draft Environmental Impact Statement ("EIS") published on July 31, 2015. Consistent with those interests, we provide the following comments:

Comment 1: The public comment period should be extended.

As you are no doubt aware, the Draft EIS is an extremely voluminous document containing complicated and technical analyses. The importance and sophistication of the issues addressed in the document warrant detailed treatment, but also require a commensurate level of public analysis and review. Consequently, we respectfully request that the Bureau extend the comment period by at least thirty days. Pending your response to this request, we provide the balance of the comments while reserving the possibility of enlarging on them should the comment period be extended. SVWA 2

Comment 2: The Bureau should receive and consider comments related to its selection of a Preferred Alternative and an Environmentally Preferred Alternative SVWA 3

40 C.F.R. § 1502.14(e)[1] requires the lead agency to "identify the agency's preferred alternative if one or more exists, in the draft statement, and identify such alternative in the final statement,.." Similarly, § 1502(b) requires that the Record of Decision "specify[] the alternative or alternatives which were considered to be environmentally preferable."

[1] Unless otherwise noted, all code citations refer to Title 40 of the Code of Federal Regulations.

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The Bureau should, as soon as reasonably practicable, announce which Alternatives it intends to select as the Preferred Alternative and the Environmentally Preferable Alternative and why it believes those Alternatives to be superior to the others for their respective categories. Pursuant to its authority under § 1503.1(b),[2] the Bureau should then solicit comments on its tentative selections to ensure the public has an opportunity to participate in these crucial decisions. In this way, the Bureau will allow for greater public scrutiny and input, improve the quality of the ultimate decision, and provide greater transparency into the decision-making process.[3] SVWA 3 continued

In any event, the Final EIS must include in the Executive Summary a clear and concise explanation regarding the Bureau's selection of a Preferred Alternative and the evidence used to arrive at that conclusion.[4] Further, because an EIS must "serve as the means of assessing the environmental impact of proposed agency actions, rather than justifying decisions already made,"[5] such explanation should include a discussion of the Alternatives *not* selected as the Preferred Alternative, and an explanation as to why the Bureau declined to select those Alternatives as the Preferred Alternative.

Comment 3: The Draft EIS fails to address significant and reasonably foreseeable effects on CVP contractors resulting from water deliveries to the San Joaquin River Exchange Contractors from the San Joaquin River

The Final EIS must include a discussion of the effects of the agency action and the significance of those effects.[6] Effects can be "ecological (such as the effects on natural resources and on the components, structures, and functioning of affected ecosystems), aesthetic, historic, cultural, economic, social, or health, whether direct, indirect, or cumulative."[7] "Effects may also include those resulting from actions which may have both beneficial and detrimental effects, even if on balance the agency believes that the effect will be beneficial."[8] SVWA 4

Chapter 5 of the Draft EIS shows the changes in CVP water deliveries under the Alternatives as compared to the No Action Alternative and the Second Basis of Comparison according to CalSim II modeling results. For each comparison, the San Joaquin River Exchange

[2] § 1503.1(b) provides that "[a]n agency may request comments on a final environmental impact statement before the decision is finally made." Because the Bureau has not yet announced its selection of a Preferred Alternative, that decision will be part of the final environmental impact statement. Accordingly, this provision authorizes the Bureau to request comments on that decision before it is finally made.
[3] See § 1500.2 ("Federal agencies shall to the fullest extent possible ... encourage and facilitate public involvement in decisions which affect the quality of the human environment."); Westlands Water Dist. v. U.S. Dep't of Interior, 376 F.3d 853, 868 (9th Cir. 2004) ("The touchstone for [judicial] inquiry [into the adequacy of an EIS] is whether an EIS's selection and discussion of alternatives fosters informed decision-making and informed public participation.").
[4] See § 1502.14(e); § 1502.1 ("Statements shall be concise, clear, and to the point, and shall be supported by evidence...").
[5] § 1502.2(g).
[6] § 1502.16(a)-(b).
[7] § 1508.8.
[8] Id.

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Contractors, which are described as a "South of Delta" contractor, are shown to experience no change in CVP water deliveries.[9] SVWA 4 continued

The Exchange Contractors ordinarily receive water from the Delta but can, under certain circumstances, receive water from the San Joaquin River. Indeed, for the past two years, the Exchange Contractors have received less than 75% of their allotment from the Delta, with the remaining portion being diverted from the San Joaquin River. However, the model underlying the Draft EIS assumes that *all* water received by the Exchange Contractors, under all alternatives and in all water year types, will be satisfied exclusively from the Delta. This assumption simply does not comport with the reality.

When the Bureau delivers to the Exchange Contractors water from the San Joaquin River, that water is no longer available for CVP contractors who ordinarily receive their water from that source—namely the members of the SVWA, among others. As a result, these CVP contractors receive less water than they would have if the Exchange Contractors' water had been diverted exclusively from the Delta. However, because the Draft EIS assumes that all water received by the Exchange Contractors is derived exclusively from the Delta, it does not, and indeed cannot, account for the effects on the Friant Division CVP contractors when this does not occur, as it has in the past two years.

The impacts of this shortfall are significant.[10] By way of example, last year Friant Division contractors, including the SVWA members, received a zero percent contract allocation. Prior to the announcement that the Exchange Contractors would be receiving water from the San Joaquin River, the anticipated delivery to these contractors as a group was approximately a 15-20 percent Class 1 supply. Thus, as a direct result of the Exchange Contractors' receipt of water from the San Joaquin River, rather than the Delta, the Friant Division contractors experienced an extreme impact as compared to a scenario in which all of the Exchange Contractor entitlement is received from sources in the Delta. Because this shortage affects the entire Friant Division service area, constituting millions of acres of productive farm land, it is a cumulatively significant impact.[11] Moreover, in light of disputes regarding the nature of rights held by the Exchange Contractors, these impacts are highly controversial. Further, by failing to address these impacts, the Bureau may establish a precedent that they need not be considered in an EIS.[12]

The failure to first acknowledge and then analyze the impacts of the inability to satisfy all Exchange Contractor demands from Delta sources constitutes a major failing of the Draft EIS. As noted in the Bureau's own material announcing the availability of the Draft EIS for public comment, a major purpose of the current EIS process is to satisfy a directive from a federal court that it consider impacts to the human environment associated with the BiOps' implementation. As

[9] See Draft EIS, Ch. 5, Tables 5.26 (at 5-93), 5.43 (at 5-122), 5.60 (at 5-150), 5.77 (at 5-176), 5.94 (at 5-203), 5.111 (at 5-231).
[10] See § 1508.27 (reciting factors relevant to determination of significance).
[11] See § 1508.27(7)("Significance exists if it is reasonable to anticipate a cumulatively significant impact on the environment. Significance cannot be avoided by ... breaking it down into small component parts.")
[12] See § 1508.27(4)("The degree to which the effects on the quality of the human environment are likely to be highly controversial."); § 1508.27(6)("The degree to which the action may establish a precedent for future actions with significant effects or represents a decision in principle about a future consideration.").

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discussed above, the Draft EIS omits an entire area of severe impacts to the human environment that do not require any speculation or modeling because they are *actually occurring and readily quantifiable*. This renders the Draft EIS inadequate on its face. SVWA 4 continued

The reduction in water deliveries to south-of-delta contractors due to the Exchange Contractors receipt of water from the San Joaquin River is a significant effect or impact within the meaning of NEPA. Additionally, because this effect has actually occurred in each of the two preceding water years, it is a reasonably foreseeable consequence of the continued operation of the CVP. Therefore, consistent within its obligations pursuant to NEPA, the Bureau must include in the Final EIS an analysis and discussion of these effects, including a discussion of possible mitigation measures.[13]

Comment 4: Including two baselines of comparison (the No Action Alternative and the Second Basis of Comparison) undermines the EIS's fundamental purpose. The Second Basis of Comparison should be rebranded as the No Action Alternative and all discussion of the current No Action Alternative should be relocated to an appendix or removed entirely.

NEPA's purpose is to "foster excellent action ... [by] help[ing] public officials make decisions that are based on understanding of environmental consequences."[14] Because "scientific analysis, expert agency comments, and public scrutiny are essential to implementing NEPA,"[15] EISs must be "concise, clear, and to the point,"[16] "must concentrate on the issues that are truly significant to the action in question" and must not "amass[] needless detail."[17] Accordingly, agencies preparing an EIS are instructed to generate a document that is "*no longer than absolutely necessary* to comply with NEPA and [its] regulations."[18] Further, the document must be analytic rather than encyclopedic, written in plain language, follow a clear format, and emphasize the portions of the EIS that are useful to decision makers and the public.[19] SVWA 5

In response to comments received during the scoping process, the Bureau decided to include two bases of comparison in the Draft EIS: the No Action Alternative and the Second Basis of Comparison. While the Bureau's motives in making this decision were perhaps laudable—namely to appease critics on both sides regarding what the appropriate baseline for comparison should be—in practice, the inclusion of two baselines fundamentally impairs the Draft EIS's utility because it distracts from the core issues, effectively doubles the amount of analysis necessary to understand and comment upon the Draft EIS, and confuses the public as to what information will be considered in reaching a final decision about the continued operation of the CVP and SWP.

The inclusion of two baselines of comparison is a distraction because it forces the reader to focus on issues that are not truly significant to the environmental consequences of continued

[13] See § 1502.16(h)("[The EIS] shall include discussions of ... means to mitigate adverse environmental impacts.").
[14] § 1500.1(c).
[15] § 1500.1(b).
[16] § 1500.2(b).
[17] § 1500.1(b).
[18] § 1502.2(c) (emphasis added).
[19] See § 1500.4.

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CVP/SWP operations, such as what the two baselines are designed to represent, how to effectively interpret the results of both comparisons, and to what extent each will be relied upon in reaching an ultimate decision. The Draft EIS' failure to adequately emphasize the purposes for which each baseline is useful only exacerbates this problem. SVWA 5 continued

Furthermore, including two baselines for comparison effectively doubles the amount of analysis and review necessary to understand and comment upon the document. The impacts of continued CVP/SWP operations are wide-ranging and varied. However, it is precisely for this reason that the Final EIS must be streamlined to enable that the decisionmaker to concentrate on the issues that are truly significant and not be distracted by extraneous information.

To interpret the data in the Draft EIS, the reader must compare the baseline with five alternatives across seventeen different impact categories, many of which are subdivided based on the impacts to different locations or species. The Surface Water Resources and Water Supplies category, for instance, contains eighteen different subdivisions. Further, within this category, each subdivision is divided yet again according to the six different water-year types. And, in many cases, the impacts within each water-year type are then discreetly analyzed for each month of the year where results differ. Thus, to interpret the data related to the Surface Water Resources and Water supply category, the reader must analyze nearly 6,500 data points.[20] If a second baseline for comparison is factored in, that number is doubled to nearly 13,000—and this is for only one of seventeen impact categories. Of course, these figures do not account for the fact that often times numerous data points can be addressed and considered simultaneously; however, they do illustrate to some degree the extent of the demand placed on the reader to understand and interpret the results of the Draft EIS.

The net effect of analyzing two separate bases of comparison in the substantive portions of the Draft EIS is to mask the gravity of impacts to the human environment. It does not facilitate understanding; it overwhelms the reader with an unmanageable jumble of analysis that obfuscates the issues surrounding continued CVP/SWP operations.

As the Bureau has acknowledged, it is obligated pursuant to the District Court's instruction on remand to include a "basis of comparison" similar to conditions prior to the RPAs' implementation.[21] That directive, combined with NEPA's requirements regarding the form and contents of an EIS—particularly, that it "be no longer than absolutely necessary to comply with NEPA"—mandate that the Second Basis of Comparison be rebranded as the No Action Alternative and that all discussion of the current No Action Alternative be relocated to an appendix or removed entirely. SVWA 6

<u>Comment 5: The Preferred Alternative and the Environmentally Preferable Alternative should not be based on the 2008 BiOps.</u>

Alternatives 2 and 5 should not be selected as the Preferred Alternative or the Environmentally Preferable Alternative because they rely on the fundamentally flawed 2008 BiOps SVWA 7

[20] 5 (alternatives) x 18 (impact category subdivisions) x 6 (water-year types) x 12 (months per year) = 6,480.
[21] <u>See</u> Draft EIS, at ES-8 ("The [District Court's] comments indicated that the EIS should include a 'basis of
1 comparison' for the alternatives that was similar to conditions prior to implementation of the RPAs.").

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and would cause serious environmental and socioeconomic harm in exchange for minimal environmental benefits.

SVWA 7 continued

The 2008 BiOps are fundamentally flawed

The continued operation of CVP and SWP facilities must be based on the best available science. However, Alternatives 2 and 5 are based on scientific conclusions that we now know to be fundamentally flawed.

Rather than reiterate comments that have already been made on several occasions, we would join in comments from San Luis & Delta-Mendota Water Authority, Westlands Water District, and the Center for Environmental Science, Accuracy & Reliability as they pertain to scientific flaws and inadequacies in the 2008 BiOps, including:

- the excessive focus on X2 location as a indicator of smelt abundance;
- the insufficient focus on food availability is a driver of smelt abundance;
- the importance of considering turbidity triggers and normalized salvage in OMR flow application to reduce entrainment;
- the importance of temperature control for salmonids;
- the effects of recreational and commercial fishing on salmonids;
- the effects of ocean conditions on salmonids;
- the effects of competition from and control of hatchery fish on salmonids;
- the importance of using delta smelt life cycle models; and
- the detrimental effects of ammonia deposition on delta smelt food supply.[22]

Relative to other Alternatives, Alternatives based on the 2008 BiOps would cause serious environmental and socioeconomic harm by reducing groundwater levels and increasing groundwater extraction

SVWA 8

Groundwater is a vital resource for California. The negative consequences associated with excessive groundwater use are well-known and numerous. Excessive groundwater extraction can cause failed wells, deteriorated water quality, environmental damage, and irreversible land subsidence that damages infrastructure and diminishes the capacity of aquifers to store water for the future.[24] In Judge Wanger's words, "[t]he potential environmental impact of groundwater overdraft is beyond reasonable dispute."[25]

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[22] See SAN LUIS & DELTA-MENDOTA WATER AUTHORITY, WESTLANDS WATER DISTRICT, STATE WATER CONTRACTORS, INC., Comment re Notice of Intent and Scoping under the National Environmental Policy Act on Remanded Biological Opinions on the Coordinated Long-term Operation of the Central Valley Project and the State Water Project, June 28, 2012, p. 17-23; CENTRAL FOR ENVIRONMENTAL SCIENCE, ACCURACY & RELIABILITY, Comments in response to the U.S. Bureau of Reclamation Federal Register notice of March 28, 2012, requesting suggestions and information on the alternatives and topics to be addressed and any other important issues related to the EIS on the continued long-term operation of the CVP, in a coordinated manner with the SWP, June 28, 2012, p. 14-15; CENTER FOR ENVIRONMENTAL SCIENCE, ACCURACY & RELIABILITY, Letter re inadequacies of 2008 Biological Assessments, June 17, 2008.

[24] See also SAN LUIS & DELTA-MENDOTA WATER AUTHORITY, WESTLANDS WATER DISTRICT, STATE WATER CONTRACTORS, INC., Comment re Notice of Intent and Scoping under the National Environmental Policy Act

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The enactment by the State of California in 2014 of the Sustainable Groundwater Management Act, which mandates actions to achieve sustainable groundwater management by 2034 testifies to the fundamental importance of groundwater in California and to the state's commitment to protecting this priceless resource. In enacting this historic legislation, the California Legislature declared that "[i]t is the policy of the state that groundwater resources be managed sustainably for long-term reliability and multiple economic, social, and environmental benefits for current and future beneficial uses."[26] SVWA 8 continued

Based on the results described in the Draft EIS, Alternatives 2 and 5 would not only jeopardize this vital resource in direct contravention of the express policy of the state of California,[27] they would fail to realize any countervailing benefits capable of justifying the damage that would be caused to the state's groundwater resources.

Implementation of Alternative 2 would increase groundwater extraction and reduce groundwater levels

According to the Draft EIS, the No Action Alternative and Alternative 2 would lead to identical outcomes with respect to groundwater resources.[28] Referring to the No Action Alternative, the EIS explains that "CVP and SWP water deliveries would be less in 2030 than under recent historical conditions" and "these reductions … would result in a greater reliance on groundwater, especially during dry and critical dry years."[29] Further, according to the Bureau, "it does not appear to be reasonable and foreseeable that sustainable groundwater management would be achieved by 2030."[30] Consequently, the increased reliance on groundwater anticipated under Alternative 2 would likely lead to overdraft. Even worse, compared with the Second Basis of Comparison, Alternative 2 would increase groundwater pumping in the San Joaquin Valley by approximately 8 percent and would reduce July groundwater levels in all water-year types, ranging from up to 10 feet in central and southern San Joaquin Valley to up 200 feet in the Westside subbasin.[31] As the Draft EIS acknowledges, this reduction in groundwater levels could cause additional land subsidence.

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on Remanded Biological Opinions on the Coordinated Long-term Operation of the Central Valley Project and the State Water Project, June 28, 2012, Exhibit D Environmental Impacts.

[25] San Luis & Delta-Mendota Water Auth. v. Salazar, 686 F. Supp. 2d 1026, 1050 (E.D. Cal. 2009).

[26] Cal. Water Code § 113.

[27] See Draft EIS, Ch. 7, at 7-117 ("Under the No Action Alternative, it is anticipated that increased groundwater withdrawals due to reductions in CVP and SWP water supplies and reduced groundwater recharge due to climate change could result in increased irreversible land subsidence…"); Table ES.1, Comparison of Alternatives 1 through 5 to the No Action Alternative, at ES-xiii (showing that under Alternative 5 groundwater levels in all water year types would decline approximately 2 to 10 feet in most of the central and southern San Joaquin Valley and 25 to 50 feet in the Westside subbasin); ES.9 Impact Analysis, at ES-15 (indicating no changes between No Action Alternative and Alternative 2).

[28] See Draft EIS, Executive Summary, at ES-15.

[29] See Draft EIS, Ch. 7, at 7-120.

[30] Id.

[31] See Draft EIS, Executive Summary, at ESxlii-xliii.

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These results are unacceptable. By increasing reliance on groundwater, Alternative 2 would undermine the implementation of the Sustainable Groundwater Management Act and jeopardize California's ability to manage its most important natural resource in accordance with its stated policy.[32] SVWA 8 continued

Implementation of Alternative 5 would increase groundwater extraction and reduce groundwater levels

The Draft EIS found that, as compared with the No Action Alternative, which, as noted above, would increase groundwater reliance, Alternative 5 would *reduce groundwater levels in all water-year types*, ranging from as much as 10 feet in the Central and Southern San Joaquin Valley to as much as 50 feet in the Westside Subbasin.[33] Here too, the results are even worse when compared against the Second Basis of Comparison. Similar to the comparison with Alternative 2, under Alternative 5 groundwater pumping would increase by approximately 8 percent in the San Joaquin Valley. Further, July groundwater levels would decline in all water-year types, ranging from up to 10 feet in central and southern San Joaquin Valley to up to *500 feet* in the Westside Subbasin. SVWA 9

This cannot be allowed. At a time when the state's aquifers are at historic lows, any action that would have the effect of lowering the water table—thereby exacerbating a host of negative environmental, social, and economic consequences—should be endorsed, if at all, only with an extraordinary level of justification. However, as discussed below, to the extent any benefits would result from the implementation of Alternative 2 or 5, they would be insufficient to justify the immense collateral damage to the state's groundwater resources.

Implementation of Alternatives 1, 3, and 4 would reduce groundwater pumping and increase groundwater levels[34]

Unlike Alternatives 2 and 5, Alternatives 1, 3, and 4, all resulted in meaningful benefits to the state's groundwater resources. While the data suggests similar groundwater levels and pumping under Alternatives 1 and 4 in the Sacramento Valley, both Alternatives resulted in an 8% reduction in groundwater pumping in the San Joaquin Valley.[35] Further, July groundwater levels were predicted to increase in all water-year types by as much as 10 feet in Central and Southern San Joaquin Valley, up to 50 feet in the Delta-Mendota, Tulare Lake, and Kern County subbasins, and by as much as 500 feet in the Westside subbasin, where some of the most severe overdraft anywhere in the state is occurring. SVWA 10

[32] To the extent that the Draft EIS fails to address this conflict, the Final EIS must remedy that deficiency. The discussion of environmental consequences must include discussions of, inter alia, "possible conflicts between the proposed action and the objectives of .... State... policies ... for the area concerned." See § 1502.16(c); see also § 1506.2(d)("To better integrate environmental impact statements into State or local planning processes, statements shall discuss any inconsistency of a proposed action with any approved State or local plan and laws (whether or not federal sanctioned). Where an inconsistency exists, the statement should describe the extent to which eh agency would reconcile its proposed action with the plan or law.).
[33] See Draft EIS, Table ES.1 Comparison of Alternatives 1 through 5 to the No Action Alternative, at ES-xiii
[34] Unless otherwise noted, all comparisons in this section are to the No Action Alternative.
[35] See Draft EIS, Table ES.1 Comparison of Alternatives 1 through 5 to the No Action Alternative, at ES-xiii

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Similarly, Alternative 3, while expected to produce similar results in the Sacramento Valley, would cause a 6% reduction in groundwater pumping in the San Joaquin Valley, with July groundwater levels in all water year types expected to increase in step with the increases under Alternatives 1 and 4 (up to 10 feet in the Central and Southern San Joaquin Valley, up to 50 feet in the Delta-Mendota, and up to 500 feet in the Westside subbasin). SVWA 10 continued

On balance, Alternatives based on the 2008 BiOps would fail to produce any meaningful benefits to fish and aquatic resources.

According to the Draft EIS, Alternative 2 would not result in any reduction of adverse effects to the species considered. In fact, the effects may become more adverse for the Steelhead and Chinook Salmon in the Sacramento River System and the Stanislaus River/Lower San Joaquin River.[37] All other effects would be similar to those under the No Action Alternative.[38] Similarly, as compared with the Second Basis of Comparison, the Draft EIS predicts that implementation of Alternative 2 would result in adverse effects for the Chinook Salmon and Steelhead and similar effects for most other species considered.[39] Only the Delta Smelt and the Longfin Smelt are predicted to experience a reduction in adverse effects within this comparison. SVWA 11

Because the only reduction in adverse effects predicted under Alternative 2 is to the Delta and Longfin Smelt, and because Alternative 2 would also increase the adverse effects to Chinook Salmon and Steelhead, there is, on balance, no meaningful benefit in terms of fish and aquatic resources. Any benefit to the Delta and Longfin Smelt is effectively negated by the increased adverse effects on Chinook Salmon and Steelhead.

Likewise, the Draft EIS predicts that implementation of Alternative 5 would not result in any reduction of adverse effects to any of the species considered, as compared with the No Action Alternative.[40] On the contrary, the only change predicted by the Draft EIS would be an increase in adverse effects for Lamprey, Hardhead, and Striped Bass in the Stanislaus and San Joaquin rivers. On the other hand, when compared against the Second Basis of Comparison, the effects of implementing Alternative 5 are largely mixed. Although potentially beneficial for some species, the effects are highly uncertain in some cases and would be accompanied by increased adverse effects for many other species. In total, the Draft EIS predicts six instances of increased adverse effects and six instances of reduced adverse effects, with the balance of effects classified as similar or uncertain.[41] Thus, as with Alternative 2, Alternative 5 would fail to produce any meaningful benefit to fish and aquatic resources. SVWA 12

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[37] See id., at ES-xviii.
[38] See Draft EIS, Table ES.2 Comparison of Alternatives 1 through 5 to the Second Basis of Comparison, at ES-xlvii.
[39] See id., at ES-xliv.
[40] See Draft EIS, Table ES.1 Comparison of Alternatives 1 through 5 to the No Action Alternative, at ES-xxiii.
[41] See Draft EIS, Table ES.2 Comparison of Alternatives 1 through 5 to the Second Basis of Comparison, at ES-lii-lv (summary below).

- Trinity River Region:
  - Similar results for all species
- Sacramento River System:
  - Uncertain effects for Chinook Salmon species

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Accordingly, given the host of environmental, social, and economic consequences associated with groundwater overdraft, the effects of implementing the Alternatives based on the 2008 BiOps on fish and aquatic resources cannot justify the associated cost to California's groundwater resources. SVWA 13

Sincerely,

PELTZER & RICHARDSON, LC

Alex M. Peltzer
AMP/nc

- Increased adverse effects on 5 species: Steelhead, Green Sturgeon, White Sturgeon, Sacramento Splittail, and Pacific Lamprey
- Reduced adverse effects on 4 species: late fall-run Chinook Salmon in the Sacramento River; reduced adverse effects on the Delta Smelt, Longfin Smelt, and Black Bass
- Similar effects for 3 species: Striped Bass, American Shad, and Hardhead

- Stanislaus River/Lower San Joaquin River:
  - Similar effects for 2 species: Striped Bass and Steelhead
  - Increased adverse effects for 1 species: Reservoir fishes
  - Reduced adverse effects for 2 species: fall-run Chinook salmon and Steelhead

1D.1.14.1 Responses to Comments from South Valley Water Association

SVWA 1: Comment noted.

SVWA 2: At the time the request for extension of the public review period was submitted, the Amended Judgement dated September 30, 2014 issued by the United States District Court for the Eastern District of California (District Court) in the *Consolidated Delta Smelt Cases* required Reclamation to issue a Record of Decision by no later than December 1, 2015. Due to this requirement, Reclamation did not have sufficient time to extend the public review period. On October 9, 2015, the District Court granted a very short time extension to address comments received during the public review period, and requires Reclamation to issue a Record of Decision on or before January 12, 2016. This current court ordered schedule does not provide sufficient time for Reclamation to extend the public review period.

SVWA 3: The Preferred Alternative is described in Section 1.5 of Chapter 1, Introduction, of the Final EIS. The Environmentally Preferred Alternative will be identified and discussed in the Record of Decision, as required by the CEQ regulations.

SVWA 4: The EIS analysis assumes all water deliveries to the San Joaquin River Exchange Contractors are conveyed through the Delta; and water deliveries from Millerton Lake would be similar under all alternatives and the Second Basis of Comparison in all water year types. However, it is recognized that during extreme droughts, water can be delivered to the San Joaquin River Exchange Contractors from Millerton Lake and CVP deliveries to users along the Friant and Madera canals can be reduced. Droughts have occurred throughout California's history, and are constantly shaping and innovating the ways in which Reclamation and DWR balance both public health standards and urban and agricultural water demands while protecting the Delta ecosystem and its inhabitants. The most notable droughts in recent history are the droughts that occurred in 1976-77, 1987-92, and the ongoing drought. More details have been included in Section 5.3.3 of Chapter 5, Surface Water Resources and Water Supplies, in the Final EIS to describe historical responses by CVP and SWP to these drought conditions, including recent deliveries of CVP water to the San Joaquin River Exchange Contractors.

SVWA 5: The comment is noted that inclusion of two basies of comparison does increase the number of alternative comparisons. The results of the impact assessment were presented separately for the alternatives as compared to the No Action Alternative and to the Second Basis of Comparison. The purposes of what the two basis of comparison represent are presented in Section 3.3 of Chapter 3, Description of Alternatives.

SVWA 6: As described in Section 3.3, Reclamation had provisionally accepted the provisions of the 2008 USFWS BO and 2009 NMFS BO, and was implementing the BOs at the time of publication of the Notice of Intent in March 2012. Under the definition of the No Action Alternative in the National Environmental Policy Act regulations (43 CFR 46.30), Reclamation's NEPA Handbook (Section 8.6), and Question 3 of the Council of Environmental Quality's Forty Most Asked Questions, the No Action Alternative could represent a future condition with "no change" from current management direction or level of management intensity, or a future "no action" conditions without implementation of the actions being evaluated in the EIS. The No Action Alternative in this EIS is consistent with the definition of "no change" from current management direction or level of management. Therefore, the RPAs were included in the No Action Alternative as Reclamation had been implementing the BOs and RPA actions, except where enjoined, as part of CVP operations for approximately three years at the time the Notice of Intent was issued (2008

USFWS BO implemented for three years and three months, 2009 NMFS BO implemented for two years and nine months).

As described in Section 3.3, Reclamation included the Second Basis of Comparison to identify changes that would occur due to actions that would not have been implemented without Reclamation's provisional acceptance of the BOs, as required by the District Court order. However, the Second Basis of Comparison is not consistent with the definition of the No Action Alternative used to develop the No Action Alternative for this EIS. Therefore, mitigation measures have not been considered for changes of alternatives as compared to the Second Basis of Comparison.

SVWA 7: The commenter's opposition to Alternatives 2 and 5 is acknowledged.

SVWA 8: The commenter's discussion of groundwater conditions under Alternative 2 as compared to the No Action Alternative and Second Basis of Comparison are consistent with the discussion of the impact analysis in Section 7.4.3.3 of Chapter Groundwater Resources and Groundwater Quality of the EIS. The commenter's opposition to Alternative 2 is acknowledged.

SVWA 9: The commenter's discussion of groundwater conditions under Alternative 5 as compared to the No Action Alternative and Second Basis of Comparison are consistent with the discussion of the impact analysis in Section 7.4.3.6 of Chapter Groundwater Resources and Groundwater Quality of the EIS. The commenter's opposition to Alternative 5 is acknowledged.

SVWA 10: The commenter's discussion of groundwater conditions under Alternatives 1, 3, and 4 as compared to the No Action Alternative and Second Basis of Comparison are consistent with the discussion of the impact analysis in Sections 7.4.3.2, 7.4.3.4, and 7.4.3.5 of Chapter Groundwater Resources and Groundwater Quality of the EIS. The commenter's support of Alternatives 1, 3, and 4 is acknowledged.

SVWA 11: The commenter's opposition of Alternative 2 is acknowledged.

SVWA 12: The commenter's opposition of Alternative 5 is acknowledged.

SVWA 13: The commenter's opposition to the No Action Alternative and Alternatives 2 and 5 is acknowledged.

1D.1.15 State Water Contractors

SWC STATE WATER CONTRACTORS Served by the State Water Project FOUNDED IN 1982

September 29, 2015

Delivered via email: bcnelson@usbr.gov

Ms. Sue Fry
Bureau of Reclamation
Mid-Pacific Region
801 I Street, Ste. 140
Sacramento, CA 95814

Subject: Comments on the Draft Environmental Impact Statement for the Biological Opinions on the Coordinated Long-Term Operations of the Central Valley Project and State Water Project

Dear Ms. Fry:

SWC 1

The State Water Contractors (SWC) and its individual member agencies submit this comment letter on the Draft Environmental Impact Statement for the Biological Opinions (BiOps) on the Coordinated Long-Term Operations of the Central Valley Project and the State Water Project (Draft EIS). The SWC is a nonprofit mutual benefit corporation that represents the common interests of its 27 members in protecting the water supplies provided by California's State Water Project (SWP).[1]

SWC provided comments on the Administrative Draft EIS in a letter dated July 10, 2015 (Preliminary Comments). The Preliminary Comments are included as **Attachment 1**. As our comments have not been addressed in the Draft EIS, we are incorporating the Preliminary Comments here by reference. We request that the U.S. Bureau of Reclamation (Reclamation) respond to the Preliminary Comments, in accordance with 40 C.F.R. section 1503.4, in the Final EIS.

SWC 2

The EIS is fundamentally inadequate. The EIS manipulates the environmental baseline by failing to present a true no action alternative (i.e., without 2008 and 2009 BiOps). The EIS also makes unsupportable assumptions to hide the action's true impacts, all of which operate to conceal the actual environmental impacts of the BiOps thereby subverting the Court's order. The Draft EIS is also flawed and fails to comply with NEPA because the technical analysis is so lacking that there is no rational basis supporting the EIS' conclusions. Moreover, because the Draft EIS appears almost engineered to avoid identifying and describing the environmental impacts of the BiOps, there is no meaningful discussion of ways to mitigate the negative environmental impacts of the BiOps while also avoiding jeopardizing species.

[1] Please refer to the SWC website for the complete list of SWC member agencies, available at http://www.swc.org/about-us/member-agencies-map

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The SWC would like to work with Reclamation to resolve these issues, as compliance with the National Environmental Policy Act (NEPA) and the Endangered Species Act are not mutually exclusive. There are feasible alternatives that can cause less impacts to water supply and agricultural resources while also avoiding jeopardy. The SWC have included as **Attachment 2** a suite of proposed actions that are a cohesive, standalone alternative to the RPAs and should have been analyzed as a separate alternative, or alternatively as mitigation measures. Some of the actions are already being implemented to some extent. SWC 3

I. THE EIS FAILS TO EVALUATE A "WITHOUT RPA" ALTERNATIVE AND/OR A "WITHOUT PROJECT" NO ACTION ALTERNATIVE AND IS THEREFORE FLAWED.

The Draft EIS is contrary to the Court's order and NEPA. The United States District Court for the Eastern District of California stated: "Reclamation's implementation of the BiOp [Biological Opinions] is a major federal action because it ***substantially alters the status quo*** in the Project's operations." Memorandum Decision Re Cross Motions for Summary Judgment of NEPA Issues, Doc. 339, at pp. 42-43, E.D. Cal. Case No. 09-407 (Nov. 13, 2009) (OCAP NEPA Decision), emphasis added. Specifically, the Court explained that the potential adverse effects including, but not limited to, loss of jobs, increased groundwater pumping, fallowing land, land subsidence, air pollution resulting from heavier reliance on groundwater pumping and a decrease in surface irrigation were in and of themselves the kind of "serious questions" about whether a project may cause significant degradation of the human environment. The Court ordered Reclamation to comply with NEPA. Order Granting and Denying Cross-Motions for Summary Judgment on NEPA Issues, at p. E.D. Cal. Case No. 09-407, at p. 2 (Dec. 2, 2009). SWC 4

The Draft EIS unlawfully circumvents the Court's order by incorporating the Reasonable and Prudent Alternatives (RPAs) that the Court ordered Reclamation to analyze relative to a no-action (no RPA) alternative under NEPA into the baseline (i.e., the no action alternative). This masks the effects of the RPAs. An EIS that is developed to cure a past violation may not rationalize or justify a decision already made by assuming that the action being validly undertaken is part of the status quo and, thus, constitutes a no-action alternative. *Pit River Tribe v. United States Forest Serv.* 469 F.3d 768, 786 (9th Cir. 2006). While the CEQ's regulations and guidance note that the No Action alternative is typically the maintenance of the status quo, the CEQ has also explained that "no action" typically means that the proposed activity would not take place. *Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations,* Question 3, 46 Fed Reg. 18026 (Mar. 23, 1981). The regulations "require the analysis of the no action alternative even if the agency is under a court order or legislative command to act" and including the alternative of no action "is necessary to inform the Congress, the public, and the President as intended by NEPA." *Id*

Reclamation cannot place the RPAs in the environmental baseline and characterize these as the "no action" alternative and fulfill its Court-ordered obligation to analyze the effects of accepting the RPAs as compared to the no RPA, no-action alternative.

The use of a Second Basis of Comparison as an alternative no action baseline fails to satisfy the Court's order, in part, because the EIS does not treat the Second Basis of Comparison as a true No Action Alternative. For example, when the No Action Alternative (existing biological opinions

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baseline) is compared to the Second Basis of Comparison (no biological opinions), there is no discussion of mitigation of the effects of the biological opinions as the comparative analysis was "just for discussion purposes." (*see, e.g.* EIS at pp. ES-14 and 15.) SWC 4 continued

Reclamation also failed to evaluate the RPAs' effects because neither the Second Basis of Comparison nor Alternative 1 exclude all of the regulatory requirements contained in the biological opinions. All of the RPA Actions described in section 3.3.1.2, "Actions included in the 2008 USFWS BO and 2009 NMFS BO that Would Have Occurred without Implementation of the Biological Opinions," should have been excluded from the Second Basis of Comparison and Alternative 1. There is no basis for concluding that if Reclamation and the Department of Water Resources ("DWR") were not required to implement these RPAs, Reclamation and DWR would nevertheless have the funding and the manpower to undertake the RPAs. Furthermore, evidence of progress toward implementation of the RPAs does not suggest that these actions would have been implemented if the biological opinions did not exist, rather it merely suggests that DWR and Reclamation have been working diligently to satisfy their existing regulatory obligations. Finally, because the fishery agencies felt compelled to include all of these actions as RPAs suggests that the fishery agencies did not have confidence that these actions would occur if they were not included as requirements in the biological opinions. The EIS violates the Court's order because it failed to exclude the RPAs from the without biological opinion baseline/alternative. SWC 5

The EIS states that near-term impacts (prior to year 2030) are not addressed. (Draft EIS at p. 4-3 ["As described above, this EIS only addresses long-term operational impacts."] and p. 4-1 ["This EIS does not address interim changes that would occur between now and 2030."].) The document analyzes future conditions projected to the year 2030, based on a recognition that coordinated long-term operation of the CVP and SWP will continue to at least 2030 (p. ES-7). The analysis, however, should be focused on the impacts of implementing the RPAs and the RPA changes in the CVP and SWP operations, an action that has already started and will occur between now and 2030. The study period approach that focuses on impacts expected to occur in 2030, combined with an analysis that centers on the assumption that the no action/status quo alternative is the implementation of the RPAs, leads to flaws in the impacts analysis. The cumulative impacts analysis, for example, assumes that several projects not currently in existence will happen and will lessen or alter the impacts of implementing the RPAs. This assumption is made even though the RPAs' impacts will be felt immediately and the listed projects may not be undertaken for many years. Furthermore, many of the projects were meant to create additional supplies not to replace dwindling baseline supplies. The analysis should recognize that the RPAs, and their resulting reductions in water supplies will be occurring between now and 2030. If the short-term impacts of implementing the RPA actions were acknowledged, it would be clear that the RPA implementation will result in significant impacts. SWC 6

Reclamation should revise and recirculate the EIS so it will comply with the Court's order to analyze the environmental consequences of changing the status quo by adopting the RPAs, in accordance with NEPA. SWC 7

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II. THE DRAFT EIS FAILS TO ADEQUATELY ANALYZE DIRECT AND INDIRECT IMPACTS

The Draft EIS fails to adequately consider the effect of the RPAs on surface water resources, groundwater resources, agricultural resources and fishery resources. SWC 8

The CEQ regulations require that an EIS contain a "full and fair discussion" of significant environmental impacts. 40 C.F.R. § 1502.1. "The agency shall make available to the public high quality information, including accurate scientific analysis and expert agency comments, before decisions are made and actions are taken." Daniel R. Mandelker, *NEPA Law and Litigation* § 10:18 (2013 Ed.), citing 40 C.F.R. § 1500.1 (b). "To satisfy NEPA, the federal agency should consider every significant aspect of the environmental impact of a proposed action and inform the public that it has indeed considered environmental concerns in its decisionmaking process." *Earth Island Inst. v. U.S. Forest Serv.*, 442 F.3d 1147, 1153-54 (9th Cir. 2006) (internal quotation marks and citation omitted).

As such, NEPA requires a searching and transparent investigation of the environmental consequences of federal actions. The "agency must either obtain information that is essential to a reasoned choice among alternatives, or explain why such information was too costly or difficult to obtain." *Native Village of Point Hope v. Jewell*, 2014 U.S. App. LEXIS 1150, at p. *6 (9th Cir. Jan. 22, 2014), citing 40 C.F.R. § 1502.22. If essential information is unavailable, the EIS must state that the information provided is incomplete or unavailable and the relevance of the incomplete or unavailable information to evaluating reasonably foreseeable significant adverse impacts, summarize the existing credible evidence that is relevant, and document that the agency's evaluation is based on generally accepted methodology. 40 C.F.R. § 1502.22.

The above standards ensure that an EIS meets its primary purpose as an "action-forcing device." *See* 40 C.F.R. § 1502.1. The purpose of an EIS is to "foster both informed decision-making and informed public participation." *See State of Cal. v. Block*, 690 F.2d 753 (9th Cir. 1982). "An environmental impact statement is more than a disclosure document." 40 C.F.R. § 1502.1. "It shall be used by Federal officials in conjunction with other relevant material to plan actions and make decisions." *Ibid.*; *see also*, *League of Wilderness Defenders/Blue Mountains Biodiversity Project v. Kent Connaughton*,763 F.3d 755, 762-63 (9th Cir. 2014) ("Federal agencies must undertake a "full and fair" analysis of the environmental impacts of their activities. This is a crucial cornerstone of NEPA.").

When reviewing the adequacy of an EIS, courts demand a well-reasoned discussion. As the U.S. Supreme Court has stated, "[t]he agency must examine the relevant data and articulate a satisfactory explanation for its action including a rational connection between the facts found and the choice made." *Motor Vehicle Mfrs. Ass'n of U.S., Inc. v. State Farm Mut. Auto. Ins. Co.*, 463 U.S. 29, 43 (1983). "In order for an agency decision to pass muster under the APA's [Administrative Procedure Act's] arbitrary and capricious test the reviewing court must determine that the decision makes sense. Only by carefully reviewing the record and satisfying [itself] that the agency has made a reasoned decision can the court ensure that agency decisions are founded on a reasoned evaluation of the relevant factors." *Dubois v. U.S. Dept. of Agriculture*, 102 F.3d 1273, 1285 (1st Cir. 1996), internal quotations omitted. The Draft EIS fails to meet NEPA's requirements.

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"Whether there may be a significant effect on the environment requires consideration of two broad factors: context and intensity. Context simply delimits the scope of the agency's action, including the interests affected. Intensity relates to the degree to which the agency action affects the locale and interests identified in the context part of the inquiry." *Native Village of Chickaloon v. Nat'l. Marine Fisheries Serv.*, 947 F.Supp.2d 1031, 1069-70 (D. Ak. 2013), internal quotations omitted. Factors relevant to the intensity of an effect include whether the effects are likely to be highly controversial. 40 C.F.R. § 1508.27, subds. (b)(4) and (b)(8). SWC 8 continued

A. The EIS failed to properly analyze the effects of the RPAs on surface water supplies.

Specific issues in the analysis and its treatment of direct and indirect impacts from water supply reductions include the following:

1. The Draft EIS improperly assumes that water suppliers will be able to meet demands without adequately analyzing the impacts of the actions that may be undertaken to satisfy this assumption.

In Chapter 5, the Draft EIS explains that under the No Action Alternative and Second Basis of Comparison, it is assumed that, on a regional scale, water demands would be met on a long-term basis and in dry and critical dry years using a combination of conservation, CVP and SWP water supplies, other imported water supplies, groundwater, recycled water, infrastructure improvements, desalination water treatment, and water transfers and exchanges. The same assumptions apply for the comparison of the No Action Alternative and Alternative 1, but there is no adequate analysis of the impacts of utilizing other imported supplies, groundwater pumping, additional infrastructure projects, desalination, or other means of satisfying demands. There is no recognition of the impacts from using these alternative supplies, or the likelihood that they can adequately mitigate the impacts of CVP and SWP reductions. SWC 9

2. The Draft EIS fails to properly analyze the impacts of the RPAs on the ability to transfer water.

The Draft EIS states that it is assumed that transfers will occur in a similar manner as have occurred for the past 10 years, while simultaneously acknowledging impacts to transfers from the limits on conveyance capacity during certain months under the RPA actions but providing no measures to mitigate this impact. There are numerous inconsistencies in the manner in which the Draft EIS discusses water transfers and the impacts of the RPA actions on the ability to undertake cross Delta water transfers. SWC 10

On Page 5-64, and elsewhere throughout the document, the Draft EIS acknowledges that the 2008 USFWS BiOp and 2009 NMFS BiOp include export restrictions that limit the use of conveyance capacity for transfers in certain months. Table 5.42 purportedly includes these reductions in the comparison of Alternative 1 and the No Action Alternative.

Elsewhere, however, the document assumes that overall impacts to water supplies will be limited because of the availability of transfer water (*see, e.g.* p. 19-57). Table 5D.50 in Appendix 5D discussing MWD's water demand and supplies includes Yuba River Accord purchases, even

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though the ability to receive these supplies has been limited in recent years. Similarly, on Page 19-79 (lines 23 – 25), in the discussion of socioeconomic impacts, the Draft EIS states that it is assumed that communities that do not have alternative water supplies would utilize water transfers. This assumption is included even though the document notes elsewhere that implementation of the RPAs will impact the ability to undertake water transfers. SWC 10 continued

While the Draft EIS includes a discussion of "effects related to cross Delta water transfers" (*e.g.*, EIS p. 5-125) and "effects related to water transfers" (*e.g.*, EIS p. 6-81) in several sections, these discussions do not analyze or disclose the impacts of limiting the ability of water suppliers to obtain alternative supplies through water transfers, particularly when these alternative supplies are necessary to mitigate the impacts on reductions in contract deliveries that are caused by the implementation of the RPAs. Instead, the discussion examines impacts to flow patterns and other factors from undertaking additional water transfers, evaluating, in cursory detail, the impacts from undertaking water transfers and citing to recent analyses in a separate NEPA document examining proposed water transfers. Reclamation should revise this analysis to focus on the impacts of limiting water transfer opportunities both as a result of restrictions on conveyance capacity and a reduction in Sacramento Valley supplies and include appropriate measures to mitigate the RPA's restrictions on water transfers.

3. The Draft EIS fails to adequately consider the cumulative water supply effect of potentially reduced CVP-SWP supplies as water supply needs develop upstream.

In section 5.4.2.1.2, Draft EIS p. 5-66, the analysis considers General Plan development in the Sacramento Valley, which estimates that upstream development will increase demand by 443,000 acre-feet by 2030. The reported predicted an increase in demand would include CVP contractors as well as non-water contractors. The assumption that this projected increase in demand would occur and that it would directly result in a corresponding decrease in water supply to the non-Sacramento Valley state and federal water contractors is speculative. The Draft EIS fails to evaluate whether the existing Sacramento Valley water rights includes almost a half million acre-feet of additional supply. If Sacramento Valley water use were to increase demand by nearly a half million acre-feet, without the development of additional surface storage, there would likely be an impact on other senior water rights in the Delta watershed that would need to be addressed. Conversely, if in-Delta watershed demand were to occur, then there could be a significant impact on SWP-CVP water supplies (surface and groundwater), and this impact should have been evaluated in the cumulative impact section as it would exacerbate 2030 water supply impacts resulting from the biological opinions. SWC 11

4. The Draft EIS fails to mitigate significant water supply impacts.

In the Executive Summary and elsewhere (*see*, *e.g.* pp ES-14 and15), the Draft EIS states that mitigation measures are not included to address adverse impacts for the alternatives as compared to the Second Basis of Comparison, because this analysis was included for informational purposes only. Prior comments have pointed out the problem with this approach. Reclamation is required to propose mitigation measures: "The mitigation measures discussed in an EIS must cover the range of impacts of the proposal . . . Once the proposal itself is considered as a whole to have significant effects, all of its specific effects on the environment (whether or not 'significant') must SWC 12

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be considered, and mitigation measures must be developed where it is feasible to do so." CEQ, *Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations*, 46 Fed.Reg. 18026, Question 19 (March 23, 1981). With respect to water supply impacts, in the comparison of Alternative 1, which is identical to the Second Basis of Comparison, and the No Action Alternative, the analysis fails to fully identify the impacts of the No Action Alternative on water supply reductions relative to the Second Basis of Comparison, or to propose any mitigation for these impacts. SWC 12 continued

Draft EIS Tables 3.5 and 3.7 on pages 3-56 and 3-92, which compare the No Action Alternative and Second Basis of Comparison, disclose that long-term average annual exports would be 18 percent less under the No Action Alternative (i.e. implementation of the BiOps), and that deliveries without Article 21 water to SWP South of Delta water contractors would be reduced by 19 percent in dry years, and 22 percent in critical dry years, with deliveries of Article 21 water to SWP South of Delta contractors reduced by over 80 percent. However, the Draft EIS indicates that mitigation is not proposed for the No Action Alternative. The Draft EIS also concludes that mitigation is not necessary in Table, 3.6 (comparing Alternative 1 and the No Action Alternative) despite the same estimates of a reduction in deliveries to CVP and SWP contractors. These erroneous conclusions appear to be based on the assumption set forth in Section 5.4.2.1.3 that M&I contractors will make up for CVP and SWP supply reductions using imported water supplies, groundwater, recycled water, infrastructure improvements, desalination, and water transfers and exchanges, but simply setting forth this assumption does not satisfy the NEPA requirement to evaluate the significant effects to the human environment.

The discussion in Chapter 5 and the tables in Chapter 3 also minimize the impacts to water supplies and the related socioeconomic and other impacts by separately listing impacts in each region (*e.g.* up to 14.4 percent reductions in storage in Shasta Lake and up to 12.5 percent reduction in Lake Oroville) without discussing the cumulative or combined impact of the reductions in flows and storage levels. The overall impact of implementing the RPAs should be evaluated, with an examination of the direct and indirect impacts of implementing the RPAs and recommended mitigation to reduce the impacts.

B. The Draft EIS failed to properly analyze the effect of the RPAs on groundwater resources.

Specific issues in the analysis and its treatment of direct and indirect impacts to groundwater resources include the following:

1. The Draft EIS' position that groundwater pumping could fully mitigate reductions in surface water deliveries fails to account for existing, and the resulting future, water quality and overdraft conditions.

The Draft EIS acknowledges that groundwater quality and groundwater overdraft limit the agricultural sector's reliance on groundwater.[2] *See, e.g.,* Draft EIS, at pp. 12-5, 7-26, 7-34 and 7- SWC 13

[2] The groundwater modeling conducted for the Draft EIS focused on reasonably foreseeable changes in groundwater quality and levels as a result of the Action. *See* Draft EIS, Appendix 7A at p. 7A-3. The results of these projections

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11. However, this admission is not reflected in the analysis as the Draft EIS fails to account for groundwater quality, subsidence and/or overdraft as limiting conditions on regional groundwater withdrawals for the agricultural sector. *See* Draft EIS at p. 12-24. The Draft EIS' conclusions are inadequately supported by the facts. SWC 13 continued

For example, the Draft EIS states that under the No Action Alternative, it is anticipated that increased groundwater withdrawals due to reductions in CVP and SWP water supplies and reduced groundwater recharge due to climate change could result in increased irreversible land subsidence and continue to degrade water quality in portions of the Central Valley that are already characterized by low quality groundwater. Draft EIS, at p. 7-117-118. Groundwater levels under the No Action Alternative, as compared to the Second Basis of Comparison, could decline by as much as 200 feet in some years in portions of the central and southern San Joaquin Valley. Draft EIS, at p. 7-121. July average groundwater levels decline 10 to 50 feet in the Delta-Mendota, Tulare Lake, and Kern County subbasins; and 100 to over 200 feet in the Westside subbasin in all water year types. *Ibid.* In critical dry years, groundwater levels decline by up to 200 feet in the Westside subbasin. *Ibid.* These declines significantly exceed historic groundwater declines for the referenced regions and suggest that groundwater resources are not a sustainable replacement source of water for the agricultural sector. *See* Draft EIS, Chapter 7, Section 7.3.

Secondly, the Draft EIS quantifies the incremental changes in groundwater quality and levels, and resulting regional subsidence, but fails to state whether these changes would foreclose certain regions from relying on groundwater resources to offset reduced CVP and SWP deliveries. *See, generally*, Draft EIS, Chapter 7, and Section 7.4. This information is clearly essential to the analysis of each of the Alternative's effects on agricultural resources because Reclamation assumes that groundwater resources can offset the Action's effects and should be included in the Draft EIS. *See Native Village of Point Hope v. Jewell*, *supra*, 2014 U.S. App. LEXIS 1150, at p. *6 (9th Cir. Jan. 22, 2014), citing 40 C.F.R. § 1502.22. SWC 14

The Draft EIS appears to acknowledge that historically, groundwater resources have not effectively mitigated reductions in surface water supplies. The Draft EIS provides that "[i]n extreme dry periods, such as 2014 when there were no deliveries of CVP water to San Joaquin Valley water supply agencies with CVP water service contracts, permanent crops were removed because the plants would not survive the stress of no water or saline groundwater (Fresno Bee 2014)." Draft EIS, at p. 12-10. Elsewhere, the Draft EIS states that "[d]ue to the increased frequency of water supply reductions, especially in drier years . . . the amount of fallowed and non-harvested lands has increased as a percentage of total lands within Westlands Water District. *Id.* at 12-12. The Draft EIS also states that since 2000, farmers have increased the amount of fallowed and non-harvested acres to 10 to 34 percent of the total land in the [Westlands water] district. *Id.* at 12-15. These admissions undermine Reclamation's conclusion that implementing the RPAs would have a less than significant effect on agricultural resources.

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are used in the Statewide Agricultural Production model (SWAP) to estimate the Action's long-term effects on agricultural resources. Draft EIS, Appendix 12A at pp. 12A-3, 12A-22 ("Groundwater is an alternative source to augment local surface, SWP, and CVP water delivery in all SWAP regions. The cost and availability of groundwater therefore has an important effect on how SWAP responds to changes in delivery. However, SWAP is not a groundwater model and does not include any direct way to adjust pumping lifts and unit pumping cost in response to long-run changes in pumping quantities. Economic analysis using SWAP must rely on an accompanying groundwater analysis.").

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Reclamation should revise and recirculate the Draft EIS with a discussion on whether changes in groundwater quality and levels due to increased pumping would limit the agricultural sector's reliance on groundwater as a replacement source. Alternatively, if Reclamation is unable to characterize these effects, it is required to supplement the EIS to state why the analysis cannot be feasibly conducted. SWC 14 continued

2. **The Draft EIS failed to properly consider the impact of the Sustainable Groundwater Management Act.**

Throughout Chapter 7, the Draft EIS makes incorrect assumptions regarding groundwater and the ability to pump groundwater as replacement water in the future. First, while the Draft EIS acknowledges the California Sustainable Groundwater Management Act (SGMA), it fails to adequately consider it. Specifically and repeatedly throughout this chapter, it assumes that there can be continued groundwater pumping. This has the effect of masking significant economic and environmental impacts. SWC 15

The Draft EIS assumes that by 2030, groundwater sustainability plans (GSPs) will not be implemented. (See 7-109). This is incorrect. The GSPs must be completed by 2020 or 2022. These GSPs will identify a sustainable yield, which will require groundwater pumping to stay within the sustainable yield. One does not reach a sustainability goal in a year. Rather, it takes infrastructure projects and potential reductions in groundwater pumping to achieve sustainability over time. For this reason, groundwater use reduction measures will have to be implemented well in advance of 2030 to meet sustainable yield by 2042.

The Draft EIS incorrectly assumes that because full compliance must be achieved by 2042, reductions in pumping will not occur before 2042. That is a blatantly faulty conclusion and is inconsistent with the SGMA. The SGMA requires DWR to review plan implementation at least once every five years to ensure that the plan is meeting the sustainability goal. (Cal. Water Code, §10733.6 ["The department shall issue an assessment for each basin for which a plan or alternative has been submitted in accordance with this chapter, with an emphasis on assessing progress in achieving the sustainability goal within the basin. The assessment may include recommended corrective actions to address any deficiencies identified by the department."].) Thus, a local agency may not simply submit a GSP and then do nothing until 2042 as this EIS suggests. To the contrary, California law requires GSP implementation to occur before 2042 and if pumping exceeds the sustainable yield, pumping must be reduced or additional supplemental sources of water must be made available to meet the demand.

Additionally, SGMA allows the State, through the State Water Resources Control Board (SWRCB) to manage a basin through a probationary plan if the Department in consultation with the SWRCB determines that a groundwater sustainability plan is inadequate or that the groundwater sustainability program is not being implemented in a manner that will likely achieve the sustainability goal. (Water Code, § 10735.2.) The SWRCB through a probationary plan, and one year after the determination that certain conditions are not met, the plan can implement certain actions, including reductions in groundwater extractions. (Water Code, § 10735.8.) This can occur after 2020 for basins designated as critically overdrafted basins and after 2022 for all other basins subject to SGMA. (Water Code § 10735.2)

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Furthermore, the Draft EIS identifies that the pumping caused by reductions in surface water supply (Alternatives 5) will cause large drops in groundwater levels which will cause increased subsidence. (Draft EIS, at p. 7-136-137.) The impacts to groundwater for other alternatives are essentially masked because the No Action Alternative includes the RPAs and thus the Draft EIS does not adequately analyze or disclose the impacts caused by each of the alternatives studied. Furthermore, in Alternative 5, which specifically shows drops of water levels as high as 200 feet per year, it assumes that SGMA would not apply. However, as indicated above, that is not correct. Since the definition of a sustainability goal includes operating within the sustainable yield, and sustainable yield is defined as "the maximum quantity of water, calculated over a base period representative of long-term conditions in the basin and including any temporary surplus, that can be withdrawn annually from a groundwater supply without causing an undesirable result," this requires that the basin not have undesirable results. (Water Code, § 10721 subd. (v).) Undesirable results include "chronic lowering of groundwater levels" and "significant and unreasonable land subsidence that interferes with surface land uses." (Water Code, § 10721 subd.(w).) Thus it is not acceptable to assume that with increased pumping, decreasing water levels and potential increased subsidence that pumping can continued unfettered after 2020 or 2022 depending on the basin.[3] SWC 15 continued

Reclamation's assumption in Draft EIS section 7.4 that groundwater pumping can continue unchecked is without basis. This faulty assumption renders the analysis of groundwater impacts in the Draft EIS inadequate. Reclamation is required to grapple with the realities of groundwater use and regulation in California. Notably, the list of groundwater basins that are in critical overdraft included in the Draft EIS is out of date. DWR, in accordance with the SGMA, recently updated the list of critically overdrafted basins in California. As such, we request that Reclamation include the updated list in the Final (and supplemental) EIS. SWC 16

C. The Draft EIS failed to properly analyze the effect of the RPAs on socioeconomics resulting from diminished water supplies.

Specific issues in the analysis and its treatment of direct and indirect impacts to socioeconomics include the following: SWC 17

1. The Draft EIS failed to properly analyze the effect of the RPAs on the cost and availability of urban water supplies.

Throughout the discussion of socioeconomic impacts, the analysis assumes that shortages in municipal and industrial supplies will be minimal, due to increased use of alternative supplies. By using the long-term study period time frame, the analysis fails to recognize the significant time period required to plan and construct many infrastructure improvements, as well as recycled water, desalination, and other projects. For the short-term, there is little support for the assumption that impacts from a reduction in supplies will be minimal. Recognizing that the impacts set forth in Draft EIS Tables 19.78 and 19.79 are likely greater than the assumptions, particularly over the short term, there is no support for the failure to recognize the need to mitigate impacts.

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3 The key basins analyzed are all subject to SGMA because they are designated as high or medium priority under the California Statewide Groundwater Elevation Monitoring Program (CASGEM). (Water Code, § 10720.7.)

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In Draft EIS section 19.4.3.9.1, in the final section of the socioeconomic impact discussion, the analysis apparently assumes that the future water resource management projects included in the cumulative effects analysis, including the recycled water projects, desalination projects, and groundwater storage and recovery projects listed in Chapter 3, will reduce any adverse economic impacts associated with a reduction in supplies, even though some of these projects may not be producing water for several years and some of them produce supplies at significantly increased costs, and with associated impacts which are not accounted for in the analysis. Furthermore, many of these projects are meant to support future water demands and not to supplement the reduction of existing water supplies. SWC 17 continued

2. The Draft EIS fails to analyze the short-term impacts of reductions in water demands or the impacts of using alternative supplies.

Throughout the discussion of socioeconomic impacts, the analysis assumes that shortages in municipal and industrial supplies will be minimal, due to increased use of alternative supplies. By using the long-term study period time frame, the analysis fails to recognize the significant time period required to plan and construct many infrastructure improvements, such as as recycled water, desalination, and other projects and that many projects are planned for meeting future demands not to make up for dwindling water supplies. For the short-term, there is little support for the assumption that impacts from a reduction in supplies will be minimal. Recognizing that the impacts set forth in Tables 19.78 and 19.79 are likely greater than the assumptions, particularly over the short term, there is no support for the failure to recognize the need to mitigate impacts. SWC 18

In section 19.4.3.9.1, in the final section of the socioeconomic impact discussion, the analysis apparently assumes that the future water resource management projects included in the cumulative effects analysis, including the recycled water projects, desalination projects, and groundwater storage and recovery projects listed in Chapter 3, will reduce any adverse economic impacts associated with a reduction in supplies, even though some of these projects may not be producing water for several years and some of them produce supplies at significantly increased costs, and with associated impacts which are not accounted for in the analysis.

It should be noted that a number of the projects discussed in Section 3.5 of Chapter 3 are contingent on additional analysis and future actions, and in some cases, Congressional authorization, before they can be fully implemented. This is recognized in section 1.6, where the Draft EIS states that several projects discussed as part of the cumulative effects analysis will be incorporated into a change in operations after 2030. Thus, any assumptions that these projects will reduce the socioeconomic, water quality, public health or other impacts associated with a reduction in water supplies is inappropriate. Many of these projects were meant to support future water demands and not to mitigate the reduction of existing water supplies.

3. The Draft EIS fails to properly analyze the impacts that the RPAs would have on the cost and availability of agricultural water supplies.

Reclamation concludes in the Draft EIS that implementing the RPAs and alternative RPAs would have a less than significant effect on agricultural productivity in the long-term, and in dry and SWC 19

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critical dry years. This conclusion rests entirely on Draft EIS' assumption that "[m]ost of the change in CVP and SWP irrigation supplies would be offset by changes in groundwater pumping, with only small changes in crop acreage in production." *See, e.g.*, Draft EIS at pp. 19-39,[4] 19-48, 19-53, 19-55, 19-56, 19-59, 19-64, 19-66, 19-67, 19-70, 19-77, 19-79, 19-81, 19-86, 19-88 and 19-90. The Draft EIS' conclusion is invalid because it is contradicted by the Draft EIS and is otherwise unsupported. *See* SWC Comments, *supra,* Section III (B)(1). SWC 19 continued

The Draft EIS fails to explain its conclusion that a one percent reduction in regional agricultural production from implementing the RPAs is less than significant. *See, e.g.*, Draft EIS at pp. 19-39, 12-27-59, 19-48, 19-53, 19-55, 19-56, 19-59, 19-64, 19-66, 19-67. Even less than a one percent reduction in agricultural production in the Central Valley may be significant. As is acknowledged in the Draft EIS in the introduction to socioeconomic impacts, certain locations are likely to experience severe economic impacts due to limited alternative water supplies. *See, e.g.,* Draft EIS at p. 19-39 ("Individual growers that rely on CVP and SWP supply and have no access to groundwater would have their irrigated acreage affected by larger amounts."). Nevertheless, the Draft EIS concluded that impacts were less than significant, not requiring mitigation.

D. The Draft EIS failed to properly analyze the effect of the RPAs on agricultural resources.

The Draft EIS' discussion of agricultural resources is based on the same modeling and assumptions used in the socioeconomic and water supply analyses, and most of the errors in those sections are repeated in the agricultural resources section. For example, the conclusions of "no effect" in the agricultural resources section is also based on the incorrect assumption that lost surface supplies will be replaced by groundwater, without consideration of the availability and quality of those supplies. (*See e.g.*, pp. 12-28, 12-30, 12-33, 12-43, 12-24 (SWAP model does not restrict groundwater withdrawals based on overdraft or water quality conditions).) The analysis of agricultural resources is further flawed because it fails to analyze short-term impacts to agricultural resources resulting from the implementation of the RPAs. (*See e.g.*, 12-24 (GSP discussion) and p. 12-25 (climate change would reduce available supply but effects not considered between 2008/2009 and 2030)). As a result of the Draft EIS' failure to identify impacts to agricultural resources, the Draft EIS also fails to identify potentially significant indirect effects caused by large scale land fallowing, particularly in dry years, including but not limited to impacts to air quality (dust). SWC 20

E. The Draft EIS failed to properly analyze the effect of RPAs on fishery resources.

Specific issues in the analysis and treatment of direct and indirect impacts to fishery resources include the following:

1. The Draft EIS violates the Court's order and NEPA by using the existing BiOp RPAs as the metric for evaluating the effects of the project.

[4] The Draft EIS contains significant analytical overlap between the socioeconomic and agricultural resources sections, with the socioeconomic chapter providing greater specificity as to how the analysis was conducted.

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The Draft EIS unlawfully circumvents the Court's order by using the same RPAs that the Court ordered Reclamation to analyze as the metric for measuring the environmental effects of the RPAs and alternatives. The RPAs cannot be used as the metrics for evaluating the effects of the RPAs. Examples include: SWC 21

- Delta Smelt Fall Abiotic Index: The Draft EIS uses the Fall X2 RPA to measure the biological effects of the alternatives and Second Basis of Comparison. (Draft EIS, at p. 9G-2.) This undermines the Court's order as the EIS not only fails to consider the effects of the biological opinions, but it uses the biological opinion (in this case the Fall X2 RPA) as the measure of success or failure for each of the alternatives.

  See above regarding the Draft EIS' description of Feyrer *et al*. 2011.[5] The Draft EIS at p. 9G-2 (as well as other locations) mischaracterizes what Feyrer *et al*. concluded.

- Delta Smelt OMR: The EIS uses the biological opinion's equation for estimating Delta Smelt entrainment, which is the basis for the Delta Smelt OMR RPAs. (Draft EIS, at p. 9G-2.) As further evidence of keeping to the confines of the 2008 Delta Smelt biological opinion RPAs, the EIS fails to update the biological opinion's equation with the most recent (approximately) 10-years of data. Then, each of the alternatives were compared to the estimated entrainment in the biological opinion (No Action Alternative), and deviations from the biological opinion's estimated entrainment were used to identify potentially significant impacts.

2. The Draft EIS fails to identify a scientific rationale for determinations of significance.

In Section 9.4, significance criteria are inconsistently identified. For example, there is no presentation of the approach that will be used to assess differences among alternatives for the "Analysis of Fish Passage, Predator Control Programs, and Ocean Salmon Harvest Restrictions." This is inconsistent with other mechanisms such as "Changes in Fish Entrainment and Salmonid Production" where the models used for evaluating potential effects are presented. This approach is inadequate because an EIS "shall identify any methodologies used and shall make explicit reference by footnote to the scientific and other sources relied upon for conclusions in the statement." 40 C.F.R. § 1502.24. SWC 22

A related, but separate, issue within the analysis of mechanisms of impact (Section 9.4), is the lack of development and application of significance criteria. (*See e.g.*, Draft EIS, at p. 9-108 [What is the logic behind the assumption that differences in monthly average flows of greater than 5% are biologically meaningful and how does that relate to the analysis of flooded habitat (Yolo Bypass)?]; *see id. at* p. 9-110 [What is the justification for assumption that differences in modeled monthly average temperatures greater than 0.5°F are biologically meaningful?]). SWC 23

Several criteria are presented in the Affected Environment Section as being biologically meaningful (e.g., a change of 1% monthly average flow of less than 0.5°F (Draft EIS p. 9-153 to

[5] Feyrer, F., Newman, K., Nobriga, M., Sommer, T. 2011. Modeling the Effects of Future Outflow on the Abiotic Habitat of an Imperiled Estuarine Fish. *Estuaries and Coasts*, published online. DOI 10.1007/s12237-010-9343-9.

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9-154).) Yet, these criteria are not applied consistently in the alternatives analysis. (*See, e.g.*, Draft EIS at p. 9-221 [Draft EIS should not have found that differences less than 0.5°F are biologically meaningful according to stated significance criteria].) Moreover, the significance terminology is undefined and inconsistently applied. Sometimes temperature differences less than 0.5°F are considered "similar" and sometimes a "slight or minor increase/decrease." SWC 23 continued

The reliance on qualitative comparisons among alternatives rather than statistical analyses makes it difficult to evaluate biologically meaningful differences between alternatives. For example, in order to truly appreciate the potential effect of an absolute difference of 1°F, it is necessary to know confidence in that value, or in other words the variation around that metric, and the probability that the difference will actually occur. Accepted professional standards would suggest that a change of 1°F with a variance of 1°F or 80% confidence would not be different than no change at all. While meaningful statistical analyses should be used to detect real difference in alternatives effect, this may not always be appropriate, particularly for model outputs. In these cases, it would be appropriate to use sensitivity analysis to determine how sensitive the model is to variation in inputs. Statistical tools are invaluable in considering multiple effects as they quantify the potential for change, remove potential for subjectivity, and minimize interpretative bias.

Related to the above comment, the conclusions made for individual mechanisms of impact throughout the alternatives analysis are difficult to evaluate due to the use of subjective qualitative comparisons. As noted, the analysis is replete with characterization of numeric relationships as "similar," "slightly," "somewhat" and/or "moderately different" yet there is no attempt to define nor numerically justify these characterizations. This leads to subjective application where in one instance a temperature of less than 0.5 °F is considered a "relatively minor temperature change," (page 9-172) but in another instance the same temperature was stated to be "slightly higher" (page 9-171). Additional confusion arises from the use of terms such as "likely to have little effect." It is not clear if such a conclusion is intended to state a "no effect" or a "likely to adversely affect" conclusion. Although not preferable to statistical analyses, qualitative comparisons can be useful where statistics are unsuitable. However, it is important to define and apply standardized criteria consistently across all comparisons, so that the same change in the environment is always considered similarly.

Although the Draft EIS contains a series of tables at the end of Chapter 9 that serve to summarize the environmental consequences and highlight differences between the alternatives, the tables are entirely narrative and laden with qualitative assessments; e.g., "unlikely to be affected," "small likelihood," "slightly lower," "generally would be slightly less," etc. Again, the end result is that the reader can't track the logic behind the assessment calls made regarding potential impacts. SWC 24

3. The Draft EIS' conclusions are not well supported by the comparison of model outputs.

Draft EIS Appendices 9J, 9L, and 9M include the results of entrainment, salvage, and passage models. These results for comparative purposes are visually depicted as box plots with no presentation of values for descriptive metrics (mean, median, standard deviation, interquartile range, etc.), nor any statistical analysis comparing the model results across alternatives. Since no analysis is provided, it is not possible to determine the usefulness of the model output to compare SWC 25

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alternatives. Distributional differences among alternatives that are described in the text are often not intuitively obvious from the box plots where median values are slightly offset and interquartile ranges show substantial overlap. *See, e.g.*, Draft EIS, at p. 9-170, Fig. 9M.1 [Unclear that any of the differences, particularly March and June are statistically different]; *id.* at p. 9-180 [Box plots in Appendix 9J (Fig. 9J) do not provide visually intuitive depictions of statistically different survival estimates]; *id.* at pp. 9-204 and Fig. 9K.5 and 9L.4, p. 9-208 and Fig, 9L.2; *id.* at p. 9-237; *id.* at Appendix 9J, Fig. 9J; *id.* at p. 9-256 and 9-285, Appendix 9L, Fig. 9L.10, Fig. 9L.1, and Fig. 9L.12; EIS p. 9-330, Appendix 9M, Fig. 9M-4. SWC 25 continued

This lack of analysis results in subjective interpretation of the data (graphs) that leads to apparent discrepancies across stocks. Examples of different interpretations from the same data/graph include hydrodynamic (pages 9-169 and 9-178; 9-178 and 9-223) and salvage (pages 9-324 and 9-327). Furthermore, it is possible that the large sample size, 81 water years, could result in statistically significant differences in predicted metrics that are not relevant to the fish population due to inherent variances, and/or model sensitivity. Therefore, some discussion of the biological significance of the predicted difference in survival at the population level is needed to adequately evaluate alternatives.

4. The Draft EIS fails to disclose scientific uncertainty and disagreements among experts.

The Draft EIS describes a body of science without acknowledging that there is significant uncertainty and disagreements between experts. SWC 26

NEPA requires disclosure of uncertainty and scientific disagreements between experts. 40 C.F.R section 1502.9(b) states: "The agency shall discuss at appropriate points in the final statement any responsible opposing view which was not adequately discussed in the draft statement and shall indicate the agency's response to the issues raised." As explained in *Center for Biological Diversity v. United States Forest Service*, "The Service's failure to disclose and analyze opposing viewpoints violates NEPA and 40 C.F.R § 1502.9(b) of the implementing regulations." 349 F.3d. 1157, 1167 (9th Cir. 2003). Further, "…NEPA's requirement that responsible opposing viewpoints are included in the final impact statement 'reflects the paramount Congressional desire to internalize opposing viewpoints into the decision-making process to ensure that an agency is cognizant of all environmental trade-offs that are implicit to the decision'." (*Ibid.*, citing *Cal. v. Block*, 690 F. 2d. 753, 770-771 (9th Cir. 1982).

There are many examples of where the Draft EIS fails to acknowledge scientific uncertainty. This error raises significant questions regarding the validity of the Reclamation's conclusions. While the Draft EIS appropriately states at p. 9-119 that, "…the analysis attempts to identify the level of uncertainty and qualify effect conclusions where competing hypotheses may exist," the Draft EIS both fails to identify uncertainty and fails to identify the universe of scientific information that should have informed its "level of certainty" decisions. While the Draft EIS appropriately proposes a weight of evidence approach at p. 9-199, it only considers a small subset of the entire body of relevant scientific literature, thus it does not apply a weight of evidence approach.

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a) The Draft EIS fails to acknowledge the significant uncertainty associated with the factors affecting Delta Smelt distribution, particularly the role of salinity.

The Draft EIS fails to acknowledge the significant scientific uncertainty associated with the factors SWC 27 affecting Delta Smelt distribution. (*See e.g.*, Draft EIS, at pp. 9-64 to 9-65 and 9-115; Appendix 9B, pp. 125-126.) While Manly *et al.* (2014)[6] is mentioned, it is misconstrued. Manly *et al.* raises significant uncertainty as to whether Delta Smelt distribution is primarily influenced by salinity (position of the low salinity zone). Manly *et al.* re-evaluated Feyrer *et al.* (2011) and showed that since turbidity, salinity and geography are highly cross-correlated it is difficult to determine which, if any of these factors are most influential. Latour (2015)[7] also found that geographic location and salinity were collinear so the covariates are indistinguishable in effect. Kimmerer *et al.* (2013)[8] should also have been considered as they made a similar conclusion (p. 13):

> The lack of consistent parallels between the availability of salinity-based habitat and abundance could have had several causes. First, our use of salinity as the only variable that defines habitat is clearly inadequate. For example, turbidity is consistently important as a covariate in analyses of delta smelt distribution (Feyrer et al, 2007; Nobriga et al. 2008). Given the difficulty in determining the controls on the delta smelt population, it is not surprising that such a simple descriptor of habitat is inadequate for this species.

The Draft EIS should also have acknowledged the issues of survey inefficiency for Delta Smelt. Bennett and Burau (2014)[9] have shown that the tidal cycle significantly influences Delta Smelt catchability in the open water where the sampling occurs. Latour (2015) identified the influence of month, region, and turbidity in determining Delta Smelt catchability. If the survey data are biased by these inefficiencies and not adjusted accordingly, then Feyrer *et al.* (as well as all other studies relying on the survey data) may not be accurately describing Delta Smelt distribution irrespective of the highly cross-correlated nature of the covariates.

__Relevance__: These studies are highly relevant as they raise questions as to whether salinity can be used as the sole factor defining Delta Smelt habitat, as was done in the 2008 FWS biological opinion, and whether the abiotic habitat index is an appropriate metric for evaluating potential impacts of project operations on Delta Smelt fall habitat. Draft EIS, Appendix 9-G at pp. 203. These studies also raise significant questions as to whether salinity can be used to change Delta Smelt distribution and expand the available habitat. For example, Delta Smelt might inhabit the

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[6] Manly, B.F.J., Fullerton, D., Hendrix, A.N., Burnham, K.P. 2013. Comments on Feyrer *et al.* "Modeling the Effects of Future Outflow on the Abiotic Habitat of an Imperiled Estuarine Fish." Coastal and Estuarine Research Federation. Available: DOI 10.1007/s12237-014-9905-3.

[7] Latour, R. 2015. Explaining patterns of pelagic fish abundance in the Sacramento-San Joaquin Delta. *Estuaries and Coasts*. Published online. DOI 10.1007/s12237-01509968-9.

[8] Kimmerer, W.J., MacWilliams, M.L., Gross, E.S. 2013. Variation of Fish Habitat and Extent of the Low-Salinity Zone with Freshwater Flow in the San Francisco Estuary. *San Francisco Estuary and Watershed Science*, 11(4). Available: http://scholarship.org/ic/item/3pz7x1x8.

[9] Bennett, W.A., Burau, J.R. 2014. Riders on the storm: selective tidal movements facilitate the spawning and migration of threatened Delta Smelt in the San Francisco Estuary. *Estuaries and Coasts*. pub. online. DOI 10.1007/s12237-014-9877-3.

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low salinity zone due to its proximity to productive wetland areas, or some other geographically oriented factor, irrespective of the location of the X2 isohaline. Even if the volume of the low salinity zone is a meaningful descriptor of Delta Smelt habitat, changes in the location of X2 have not been directly linked to changes in species abundance. Kimmerer *et al.* (2013) at p. 13 explains that X2, or the volume of the low salinity zone, is not a driver of Delta Smelt abundance, which calls into question the potential biological significance of any change in the location of X2 in the fall. SWC 27 continued

b) The Draft EIS improperly assumes that SWP-CVP operations have caused the location of X2 to move further upstream in the fall (September-December).

The EIS improperly uses analyses from the 2008 FWS biological opinion to conclude that there have been project-related changes in the location of X2 (September –December). Draft EIS Appendix 9G at p.2; EIS at p. 9-73. The Draft EIS should consider Hutton *et al.* (in press)[10] which shows that the full period of record demonstrates a statistically significant trend toward a more westerly (i.e. fresher) X2 location in September and no statistically significant trend in October. Hutton *et al.* further explains that the full record does reveal a statistically significant trend toward a more easterly (i.e. saltier) X2 location in November. However, there is no statistically significant difference between pre-project (water years 1922-1967) and post-project (water years 1968-2012) November X2 position in wet and above normal water years (the water year categories targeted under the current RPA). Even though there is a statistically significant easterly trend in November X2 location using the full period of record, the cause of the trend is uncertain because there are multiple diverters in the Bay-Delta watershed of a total magnitude comparable to that of the CVP-SWP. SWC 28

__Relevance__: A comparison of the pre-project and post-project time periods informs the question of project-related effects on outflow. The data do not support the conclusion that project operations have significantly moved X2 more easterly in September and October compared to pre-project conditions and project operations have only potentially impacted X2 location in November.

c) The Drat EIS fails to acknowledge the significant scientific uncertainty associated with the interpretation of the Longfin Smelt average Jan.-June X2: FMWT correlation.

There is a statistically significant relationship between Longfin Smelt FMWT and average January-June X2 location (Jassby *et al.* 1995,[11] Kimmerer 2004,[12] Kimmerer *et al.* 2009,[13] SWC 29

[10] Hutton, P.H., Rath, J.S., Chen, L., Ungs, M.J., Roy, S.B. (*In Review*) Nine Decades of Salinity Observations in the San Francisco Bay and Delta: Modeling and Trend Evaluation. *ASCE Journal of Water Resources Planning and Management.*

[11] Jassby, A.D., Kimmerer, W.J., Monismith, S.G., Armor, C., Cloern, J.E., Powell, T.M., Schubel, J.R., Vendlinski, T.J. 1995. Isohaline position as a habitat indicator for estuarine populations. *Ecological Applications*, 5(1), pp. 272-289.

[12] Kimmerer, W. 2004. Open water processes of the San Francisco Estuary: from physical forcing to biological responses. *San Francisco Estuary and Watershed*. 2(1).

[13] Kimmerer, W.J., Gross, E.S., MacWilliams, M.L. 2009. Is the response of estuarine nekton to freshwater flow in the San Francisco estuary explained by variation in habitat volume? *Estuarines and Coasts*, 32, p. 375-389.

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Kimmerer 2013[14]). The uncertainty and the disputes between experts are related to how that correlation should be interpreted, and whether it can reasonably be used to predict project related effects on Longfin Smelt. SWC 29 continued

The Draft EIS analysis assumes that Longfin Smelt spawn upstream of the confluence, spring outflows carry the larvae downstream for feeding, and then the species migrate out of the Delta (*i.e.*, larval transport hypothesis). *See e.g.*, Draft EIS, Appendix 9G at p. 3. Since the location of X2 (used to define the location of the low salinity (LSZ) habitat) is the only constituent of early life stage habitat being analyzed, the Draft EIS is assuming that the mechanism underlying the Longfin Smelt FMWT: January-June X2 correlation changes in the volume or location of early life stage LSZ habitat. The analysis uses the Kimmerer *et al.* (2009) correlation between Longfin Smelt FMWT: January:June X2 to predict future changes in species abundance based on changes in the location of X2 over the entire January-June averaging period. *Ibid.* The Draft EIS therefore concludes that winter and spring outflow is the largest factor driving abundance. *See e.g.*, Draft EIS, at p. 67 [also evidenced by no other flow other than outflow being evaluated in the analysis].

The Draft EIS fails to acknowledge the dispute between experts and the high degree of uncertainty, as described below:

(1) The Draft EIS fails to acknowledge that because the underlying biological mechanism is unknown, any interpretation of the Longfin Smelt FMWT correlation is uncertain.

The literature has cautioned against doing the type of analysis contained in the Draft EIS because the biological mechanism(s) explaining the Longfin Smelt abundance: winter-spring X2 correlations are largely unknown. As Kimmerer *et al.* (2002),[15] p. 1285 explained, "Predicting these responses is contingent on understanding the mechanisms underlying the flow relationships." Experts cannot reliably predict how Longfin Smelt abundance would respond to changes in reservoir releases, as compared to changes in outflow originating from (for example) wet hydrology and/or inflows to tributaries to the Bay, because the biological mechanism that would explain the observed statistical relationship is unknown. If the biological mechanism is, for example, turbidity, then increasing reservoir releases will have no effect because turbidity does not increase with reservoir releases. Kimmerer *et al.* (2002), p. 1285, explains: SWC 30

> Even for a single species, the timing and duration of flow-based management should coincide with the mechanism by which the species responds to flow. This implies knowledge of the species' mechanism. A mechanism involving an increase in brackish habitat during the rearing season (mechanism 10, Table 1) may require a long period of increased flow, and opportunities for efficiency will be limited; a mechanism involving tidal stream transport and gravitational circulation in the lower estuary (mechanism 11) may occur over a relatively brief period of larval or juvenile recruitment into the estuary.

[14] Kimmerer, W.J., MacWilliams, M.L., Gross, E.S. 2013. Variation of Fish Habitat and Extent of the Low- Salinity Zone with Freshwater Flow in the San Francisco Estuary. *San Francisco Estuary and Watershed Science*, 11(4). Available: http://scholarship.org/ic/item/3pz7x1x8.

[15] Kimmerer, W.J. 2002. Effects of freshwater flow on abundance of estuarine organisms: physical effects or trophic linkages. Mar. Ecol. Prog. Ser., 243, pp. 39-55.

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> As a more specific example, Sacramento splittail clearly respond to increasing flow through inundation of floodplains during early spring (Sommer *et al.* 1997). This effect may occur through access to spawning habitat, in which case the period of effectiveness would be fairly brief, or rearing habitat, which would require a longer period of inundation. Distinguishing between these mechanisms and determining their importance to overall abundance of the species are important research objectives…. SWC 30

The Longfin Smelt life cycle model by Maunder *et al.* further illustrates this point (Maunder *et al.* 2015).[16] The results of that model suggest that flow may be important to species abundance, but just as Kimmerer observed above, the question is "which flow?" Hydrology, Delta outflow, X2 and inflows to the Bay from smaller tributaries are all cross-correlated. The Maunder and Deriso model selected Napa River flow, which could be used as a surrogate for Bay inflow, as being the strongest predictor of increased Longfin Smelt abundance. If the model is correct, the most effective Longfin Smelt management action may be restoration activities within the Bay's smaller tributaries or restoration of the marshes around the Bay.

Relevance: Since the biological mechanism is unknown, it cannot be assumed that X2 is directly related to Longfin Smelt abundance. It is equally possible that Longfin Smelt abundance is being driven by some other flow or environmental condition that is cross-correlated with flow. The Draft EIS should explain that the FMWT: January-June X2 correlation cannot be interpreted reliably until the underlying biological mechanism is identified.

(2) The Draft EIS improperly assumes that the biological mechanism underlying the Longfin Smelt FMWT: Jan-June X2 correlation is a change in LSZ habitat.

The Draft EIS analysis defines Longfin Smelt habitat only in terms of salinity, and equates project effects to changes in the size and location of low salinity conditions. (Draft EIS Appendix 9G, p. 3 [larval transport/LSZ habitat mechanism].) However, the literature does not support the assumption that the size and location of the winter-spring LSZ is the biological mechanism underlying the FMWT: January- June X2 correlation. SWC 31

In the original Jassby *et al.* (1995) paper, X2 was characterized as an estuarine habitat indicator. However, that doesn't mean that the size of the LSZ is the mechanism underlying the species abundance: X2 relationships. As Kimmerer *et al.* (2013), p. 5, explained:

> …it is important to distinguish between the LSZ as a particular habitat and the numeric value of X2 as a measure of the wide variety of the physical responses of the estuary to flow (Kimmerer 2002b). In particular, abundance of various fish species may respond to X2 or its correlates through mechanisms that are not directly related to LSZ characteristics (Kimmerer 2002b, Kimmerer et al. 2009).

[16] Maunder, M.N., Deriso, R.B., Hanson, C.H. 2014. Use of state-space population dynamics models in hypothesis testing: advantages over simple log-linear regressions for modeling survival, illustrated with application to longfin smelt (*Spirinchus thaleichthys*). Fisheries Research, 164, pp. 102-111.

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Kimmerer *et al.* (2013), p. 15, investigated whether the size of the LSZ, rather than the numerous other non-salinity components of habitat, is the mechanism underlying the various species abundance:X2 relationships and they concluded that: SWC 31 continued

> Despite the similarity among the relationships of habitat index to X2, the abundance-X2 relationships (Kimmerer *et al.* 2009) differed greatly among the species (Fig. 8). This finding together with the lack of correspondence for some species between the habitat-X2 and abundance-X2 relationships (Fig. 8), suggest that variation in the volume (or area, not shown) of physical habitat as defined by salinity is not a strong influence on abundance of many of these fish.

See also, Reed *et al.* 2014, p. 33.[17] Longfin Smelt is one of the species where changes in the size of the LSZ habitat was considered and rejected as an explanatory mechanism. This conclusion has been confirmed on several occasions. Kimmerer *et al.* (2013), p. 14, concluded:

> Nevertheless, the observed [longfin smelt] X2-abundance relationships are inconsistent with a mechanism that involved extent of low-salinity habitat…

Kimmerer *et al.* (2009), p. 10, concluded:

> Confidence limits for relationships of abundance with X2 for longfin smelt, bay shrimp, and starry flounder did not overlap with those of any of the corresponding habitat estimates. Thus, other mechanisms are likely operating to cause these species to increase in abundance with increasing flow.

And,

> The modest slope of habitat to X2 would allow for only about a twofold variation in abundance index over that X2 range. Furthermore, the extent of the longfin smelt population in terms of distance up the axis of the estuary decreases with increasing flow. Therefore, although increases in quantity of habitat may contribute, the mechanisms chiefly responsible for the X2 relationship for longfin smelt remains unknown. It may be related to the shift by young fish toward greater depth at higher salinity, possibly implying a retention mechanism.

Kimmerer (2002), p. 1283 concluded:

> Data for striped bass and longfin smelt both fail to support a mechanism by which habitat area increase with flow.

These conclusions should not be surprising as Kimmerer, one of the Jassby *et al.* (1995) co-authors who advised caution when interpreting the longfin smelt abundance:X2 correlation. "Jassby *et al.* (1995) recognized that other factors that influence species abundance, but are not correlated with

[17] Reed, D., Hollibaugh, J., Korman, J., Peebles, E., Rose, K., Smith, P., Montagna, P. 2014. Workshop on Delta Outflows and Related Stressors Panel Summary Report. Prepared for Delta Stewardship Council, Delta Science Program.

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X2, should be considered, and cautioned against 'blind adherence' to X2 as a management tool." Reed *et al.* (2014), p. 22, citing Jassby *et al.* (1995), p. 275. SWC 31 continued

<u>Relevance:</u> Since the biological mechanism is unknown, it cannot be assumed that X2 is directly related to Longfin Smelt abundance. It is equally possible that Longfin Smelt abundance is being driven by some other flow or environmental condition that is cross-correlated with flow. The Draft EIS should explain that the assumed biological mechanism of changes in the size or volume of LSZ habitat is uncertain.

(3) The Draft EIS assumes that Longfin Smelt spawn on the Sacramento River upstream of the confluence, and that flows are needed to transport larvae to Suisun Marsh and ultimately to the Bay. In so doing, the Draft EIS assumes that the biological mechanism explaining the Longfin Smelt FMWT: January-June X2 correlation is larval transport. This assumption is unsupported.

The Draft EIS assumes that the mechanism underlying the Longfin Smelt FMWT: January-June correlation is larval transport. Draft EIS Appendix 9G, p. 3 (larval transport/LSZ habitat mechanism). The Draft EIS also assumes that the geographic location of Longfin Smelt larvae is closely associated with the position of X2. *See, e.g.,* Draft EIS, at p. 9-67; EIS at p. 9B-138.[18] These assumptions are not supported by best available science. SWC 32

There is little support for the assumption that the mechanism underlying the Longfin Smelt FMWT: January-June X2 correlation is larval transport. In fact, the fishery agencies have concluded that the mechanism underlying the Longfin Smelt correlation is unknown. For example, in its Longfin Smelt listing decision, the United States Fish and Wildlife Service acknowledged that the mechanism underlying the Longfin Smelt FMWT: January-June X2 correlation is unknown, listing larval transport as only one of several potential mechanisms. The 2012 FWS Longfin Smelt listing decision states: "Despite numerous studies of Longfin Smelt abundance and flow in the Bay Delta, the underlying causal mechanisms are still not fully understood." 77 Fed. Reg. 19,756 – 19,766 (April 2, 2012).

In several of Kimmerer's publications he also agreed that the mechanism underlying the Longfin Smelt X2 correlation is unknown. *See, e.g.,* Kimmerer *et al.* (2009), p. 11. During the 2010 SWRCB flow proceedings, Kimmerer further explained that while Longfin Smelt have a strong abundance-flow relationship, they are generally distributed at locations downstream of the LSZ, and therefore the mechanism explaining the abundance-flow relationship is likely related to conditions far outside of the LSZ Dr. Kimmerer, SWRCB, WQCP Workshop 1, Day 1, video available at: http://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/comp_review_workshops.shtml.

The Delta Regional Ecosystem Restoration Implementation Plan ("DRERIP"), which is the working conceptual model for the fishery agencies and Bay-Delta scientific community, concludes similarly at p. 9 stating:

[18] Contrary to statements in the Draft EIS at p. 9-67, a preliminary analysis of Dege and Browns 2004 data does not support the conclusion that the center of the Longfin Smelt distribution is a X2 (Grimaldo, *unpub.*).

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SWC 32 continued

> The mechanism behind this relationship is not completely understood, and it is quite likely that more than one mechanism is behind the overall effect. High flows may increase available spawning habitat, increase hatching success, decrease predation on LFS larvae, increase success of larval-juvenile transformation (e.g., by increasing food sources), or some combination of these factors. Baxter (1999) and Dege and Brown (2004) observed that larval densities did not respond significantly to freshwater flow conditions. This argues against mechanisms that produce positive correlation between egg-larval increase in available spawning territories or improved egg hatching success and for mechanisms that increase success of larvae-juvenile transition….

As explained in the DRERIP model, Longfin Smelt spawning in the upper estuary is not correlated well with outflow. In wet years, there are generally low numbers of larvae captured in the upper Estuary, a likely explanation is that Longfin Smelt descend into the San Pablo Bay to spawn (Tracy Fish Facilities Report, Vol. 38, p. 41). Longfin Smelt spawning density is higher in the upper Estuary in dry years, particularly in Suisun Bay (Tracy Fish Facilities Report, Vol. 38, p. 41). Therefore, it is unlikely that increased spawning and larvae survival in the upper estuary in high outflow years is the biological mechanism behind the Longfin Smelt abundance: X2 relationship.

There is uncertainty regarding whether the geographic location of Longfin Smelt larvae is closely associated with the position of X2. *See, e.g.*,Draft EIS, at p. 9-67; *id.* at p. 9B-138.) The analysis in the EIS also fails to account for the Longfin Smelt that spawn outside of the Delta. For Longfin Smelt spawning downstream of the Delta, larval transport from the Delta cannot be a biological mechanism explaining the correlation.

The IEP surveys do not include larval sampling in the low salinity zone areas within the tributaries to the Bay, so the existence and magnitude of spawning downstream of the confluence is unknown.[19] However, there is enough evidence to suggest that downstream spawning could be substantial, particularly in wet years. Rosenfield (2010) at p. 6 explained:

> The CDFG 20 mm survey catches relatively large numbers of LFS larvae in the Napa River estuary, especially during wet winters (CDFG 20mm Survey database), indicating that spawning habitat may be periodically available in that area as well. Finally, some maturing LFS migrate into the South Bay during the fall and winter suggesting that spawning may occur in tributaries to the South Bay (*e.g.*, Coyote Creek).

In Merz *et al.* (2013),[20] the authors mapped the distribution of larval Longfin Smelt. The maps suggest that the Delta is the eastern edge of the species range. It also suggests that longfin spawn east of the confluence.

[19] The Bay Study did perform larval surveys in the 1980s, but those surveys sampled the channels rather than the shore areas where larvae would be expected, and therefore have limited informational value.

[20] Merz, J.E., Bergman, P.S., Melgo, J.F., Hamilton, S. Longfin smelt: spatial dynamics and ontogeny in the San Francisco estuary, California. California Fish and Game, 99(3), pp. 122-148.

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There have been several limited surveys of the tributaries to the Bay, and those surveys identified Longfin Smelt larvae. In 2001 (a dry year), the Department of Fish and Wildlife ("DFW") performed the 20 mm survey in the Napa River near the City of Napa and identified densities of Longfin Smelt larvae that were an order of magnitude higher than in the Sacramento River.[21] DFW completed another survey in the Napa Estuary portion of the Napa River north of Vallejo in 2006 and again identified numbers of Longfin Smelt larvae that were an order of magnitude higher than in the Sacramento River. Delta smelt larval survey data available at ftp://ftp.delta.dfg.ca.gov/Delta%20Smelt. Stillwater Sciences, a consultant to the City of Napa, sampled in the Napa River near the City of Napa in 2001-2005, and found large densities of Longfin Smelt larvae in 2001 and 2003 (dry years). (U.S. Army Corps of Engineers, 2005).[22] In the 1980s, large numbers of Longfin Smelt larvae and juveniles were captured in the Napa River (Tracy Fish Facilities Report, Vol. 38, p. 39[23] ("Juveniles are abundant in the Napa River…. ")). The sampling during this period was in the open channel so it is possible that even higher densities would have been identified in shallows, where spawning is thought to occur. The 20 mm survey consistently catches Longfin Smelt at high densities in the Napa River between Vallejo and a few miles north of Mare Island. The 20 mm survey does not start until March, which is after spawning has begun, but it nevertheless suggests that Longfin Smelt are spawning in the area. SWC 32 continued

The Draft EIS should have also discussed the more recent larval Longfin Smelt sampling studies, some of which were funded by Reclamation. These studies have also shown that Longfin Smelt spawning occurs in the tidal marshes surrounding Suisun Bay, and early results show Longfin Smelt larvae presence in Napa Marsh Complex, Petaluma River, Suisun Bay, and South Bay. (Grimaldo, Delta Science Conference presentation, 2014; Parker *et al.*, IEP Poster, 2014.)

The Draft EIS should explain that the scientific community generally agrees that the mechanism underlying the FMWT: January-June X2 correlation is unknown. The Draft EIS should have also acknowledged that here is compelling evidence suggesting that larval transport is not the mechanism underlying the correlation.

Relevance: Since the biological mechanism is unknown, the analysis is uncertain because it cannot be assumed that X2 is directly related to Longfin Smelt abundance. It is equally possible that Longfin Smelt abundance is being driven by some other flow or environmental condition that is cross-correlated with flow.

(4) The Draft EIS fails to acknowledge the significant uncertainty associated with Longfin Smelt abundance trends.

The Draft EIS should have discussed uncertainties created by different survey efficiencies. For example, the EIS should have acknowledged that the FMWT or the 20 mm survey only covers a small fraction of the Longfin Smelt's range. *See e.g.*, Draft EIS p. 9- 67; *id.* at p. 9B-138. The SWC 33

[21] 20mm survey data available at ftp://ftp.delta.dfg.ca.gov/Delta%20Smelt.
[22] U.S. Army Corps of Engineers, Sacramento District. 2006. Napa River Fisheries Monitoring Program Annual Report 2005. Contract # DACW05-01-C-0015. Prepared by: Stillwater Sciences.
[23] Bureau of Reclamation. 2007. Tracy Fish Facilities Studies, spawning, early life stages, and early life histories of the Osmerids found in the Sacramento- San Joaquin Delta of California, Vol. 38.

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SWC 33 continued

Draft EIS should have also discussed Latour's 2015 findings false zeros were associated with turbidity, which suggests turbidity related survey bias.

Longfin Smelt abundance trends are uncertain, which may be a result of survey inefficiencies. For example, the mid-water trawl and the otter trawl suggest different abundance trends, with the otter trawl suggesting much less of a decline in abundance (Acuna *et al*., Delta Science Conference, 2014). Therefore, there is uncertainty as to which surveys are the more representative of species abundance trends, and whether the differences suggest significant survey bias in the fall midwater trawl.

Relevance: The reliability of the surveys is relevant to all conclusions regarding species biology and project-related effects that are based on those surveys.

d) There is significant uncertainty about the effects of the CVP-SWP on salmonids related to Delta hydrodynamics, route selection, reach specific survival, and the effects of salvage.

SWC 34

The Affected Environment of the Draft EIS, in particular section 9.3.4.12.1 (Fish in the Delta), relies heavily on fish survival and entrainment information from 2000-2009, the majority of which was collected from mark-recapture studies with coded wire tagged fish. There is an abundance of more recent data developed in the past 5 years that provides additional information on Delta hydrodynamics, route entrainment, reach specific survival and effects of salvage. For the Draft EIS, the results from a few more recent acoustic tagging studies are used for specific analyses, e.g., changes in salvage, but they are not applied broadly. In some cases, these study results have called into question the validity of using the more historic results to infer effects under more recent Delta conditions as well as the applicability of current model(s) to predict fish and flow relationships. A list of citations for relevant studies and analyses that should be incorporated into the Draft EIS are provided in the reference list below.

SWC 35

This lack of updated information is also apparent in the use of the Delta Passage Model ("DPM"). The DPM was used to evaluate baseline conditions and changes in Fish Passage and Routing (Section 9.4.1.3.4). As it is described in Appendix 9J, this model has weaknesses that call into question its utility in predicting passage differences among the Draft EIS Alternatives. The DPM should have been updated to reflect the current state of the science. Specific comments on the DPM include:

- The source documents used to develop the biological functionality of the model are too limited and result in a simplistic depiction of Delta hydrodynamics and fish biology that does not reflect current conditions. Key critical documents that address Delta hydrodynamics, fish entrainment and survival are missing including: Perry *et al.* 2015,[24]

[24] Perry, R. W., P. L. Brandes, J. R. Burau, P. T. Sandstrom, and J. R. Skalski. 2015. Effect of Tides, River Flow, and Gate Operations on Entrainment of Juvenile Salmon into the Interior Sacramento–San Joaquin River Delta. Transactions of the American Fisheries Society 144:445-455.

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SWC 35 continued

Cavallo *et al.* 2015,[25] Buchanan *et al.* 2015,[26] Delaney *et al.* 2014,[27] Zeug and Cavallo 2013,[28] SJRGA 2013,[29] Buchanan *et al.* 2013.[30]

- The DPM operates on a daily average time step using daily average flows even though this level of analysis is too course to capture flow conditions that fish experience at junctions. Cavallo *et al.* (2013)[31] suggest that the DSM2 model run at a spatial-temporal resolution of every 15 minutes is more consistent with the probability of flow and fish entrainment patterns.

- The DPM treats the Interior Delta region as a single model reach. Recent studies with acoustic tagged fish have shown significant differences in reach and junction specific hydrodynamics (Cavallo *et al.* 2015) as well as fish entrainment and survival (Delaney *et al.* 2014, Buchanan *et al.* 2013, SJRGA 2013). In addition, data from tagging studies in the downstream Delta reaches suggest that steelhead smolts are not simply moving with flows but may be utilizing selective tidal stream transport (Delaney *et al.* 2014). These data provide biological information that could be used to refine the model for the interior Delta to incorporate separate reaches or, as an alternative, conduct a sensitivity analysis of the model to evaluate its ability to predict reach-specific entrainment and survival within the Interior Delta.

- Model documentation indicates that migration speed is modeled as a function of reach specific flow for three reaches (Sac 1, Sac 2, and GEO/DCC). No information is provided as to what data informs the migration speed for the other model reaches.

- The model uses flow to inform fish behavior at junctions and assumes proportional flow for each route except for Junction C (DCC/GEO) where a non-proportional relationship, based on acoustic data, was used. No citation is provided to facilitate an evaluation of the relationship provided at Junction C nor to understand why this is the only location where a non-proportional flow relationship is used. Cavallo *et al.* (2015) suggest that fish are less likely to enter a distributary channel than would be expected based on the proportion of flow entrained there. This is consistent with the other literature that suggest that fish

[25] Cavallo, B., P. Gaskill, J. Melgo, and S. C. Zeug. 2015. Predicting juvenile Chinook Salmon routing in riverine and tidal channels of a freshwater estuary. Environmental Biology of Fishes 98:1571-1582.
[26] Buchanan, R., P. Brandes, M. Marshall, J. S. Foott, J. Ingram, D. LaPlante, T. Liedtke, and J. Israel. 2015. 2012 South Delta Chinook Salmon Survival Study: Draft report to USFWS. Ed. by P. Brandes. 139 pages.
[27] Delaney, D., P. Bergman, B. Cavallo, and J. Malgo. 2014. Stipulation Study : Steelhead Movement and Survival in the South Delta with Adaptive Management of Old and Middle River Flows.
[28] Zeug, S. C. and B. J. Cavallo. 2014. Controls on the entrainment of juvenile Chinook Salmon (*Oncorhynchus tshawytscha*) into large water diversions and estimates of population-level loss. Plos One 9:e101479.
[29] San Joaquin River Group Authority. 2013. 2011 Annual Technical Report on Implementation and Monitoring of the San Joaquin River Agreement and the Vernalis Adaptive Management Plan (VAMP). Prepared for the California Water Resources Control Board in compliance with D-1641. Available at: http://www.sjrg.org/technicalreport/.
[30] Buchanan, R. A., J. R. Skalski, P. L. Brandes, and A. Fuller. 2013. Route Use and Survival of Juvenile Chinook Salmon through the San Joaquin River Delta. North American Journal of Fisheries Management 33:216-229.
[31] Cavallo, B., P. Gaskill, and J. Melgo. 2013. Investigating the influence of tides, inflows, and exports on sub-daily flow in the Sacramento-San Joaquin Delta. Cramer Fish Sciences Report. 64 pp. Available online at: http://www.fishsciences.net/reports/2013/Cavallo_et_al_Delta_Flow_Report.pdf .

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movement patterns are influenced by other factors including diurnal fish behavior (Delaney *et al.* 2014), tidal cycle (Perry *et al.* 2015, Cavallo *et al.* 2015, Delaney *et al.* 2014, Zeug and Cavallo 2014), velocity (Perry *et al.* 2015, SJRGA 2013, Michel *et al.* 2015)[32], and turbidity (Michel *et al.* 2015). Furthermore, Cavallo *et al.* (2015) lists seven junctions within the Interior Delta where the tidal cycle mediates any effects of inflows and exports on route selection. It seems prudent to suggest that the DPM should consider these data and the potential effects on route selection and if the model cannot be refined to incorporate some of the more recent relationships (e.g., Cavallo *et al.* 2013), then some analysis of the models sensitivity to diversion from a 1:1 fish to flow relationship is needed to evaluate the utility of the model for comparative analysis. SWC 35 continued

- Model documentation indicates that reach specific survival is predicted using daily flow for seven reaches (Sac 1, 2, 3, 4, SS, Interior Delta via SJR, Interior Delta via OR) and exports for one reach (Interior Delta via GEO/DCC). Only the GEO/DCC and Yolo reaches are informed by means and standard deviations from survival studies. Yet, some authors have reviewed years of data and failed to demonstrate a relationship between hydrodynamics and survival (Zeug and Cavallo 2014)[33], or exports and survival (Delaney *et al.* 2014) and have suggested that there is no one hydrodynamic metric that can characterizes all patterns in the Delta. These researchers (Zeug and Cavallo 2014) as well as Michel (2010) have demonstrated that other environmental factors, independent of inflow and exports, affect salmonid survival to the ocean including select water quality parameters, temperature, and fish size.

<u>Relevance</u>: The failure to use up-to-date information raises significant questions about the validity and reasonableness of all conclusions related to the CVP-SWP effects on salmonid entrainment and indirect effects.

5. The Draft EIS contains numerous technical errors, including failure to cite or misapplication of scientific literature.

The Draft EIS fails to accurately describe the conclusions of many of the studies it cites. The Draft EIS also fails to properly disclose the error bars and limitations of the studies it cites. In many locations, the Draft EIS fails to provide a scientific citation to support conclusions regarding the biology of the species, which is contrary to the NEPA regulations which require, "a summary of existing credible scientific evidence which is relevant to evaluating the reasonably foreseeable significant adverse impacts on the human environment." 40 C.F.R. §1502.22. The weight of evidence approach the Draft EIS purports to apply in its decision-making is therefore significantly compromised. Examples include, but are not limited to: SWC 36

- <u>Kimmerer 2008:</u> The Draft EIS uses the approach to estimating Delta Smelt entrainment adopted and incorporated into the 2008 biological opinion RPAs that is partially based on

[32] Michel, C. J., A. J. Ammann, E. D. Chapman, P. T. Sandstrom, H. E. Fish, M. J. Thomas, G. P. Singer, S. T. Lindley, A. P. Klimley, and R. B. MacFarlane. 2013. The effects of environmental factors on the migratory movement patterns of Sacramento River yearling late-fall run Chinook salmon (*Oncorhynchus tshawytscha*). Environmental Biology of Fishes 96:257-271

[33] Zeug, S. C. and B. J. Cavallo. 2014. Controls on the entrainment of juvenile Chinook Salmon (*Oncorhynchus tshawytscha*) into large water diversions and estimates of population-level loss. Plos One 9:e101479.

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Kimmerer 2008, however the Draft EIS fails to disclose the limitations of Kimmerer's analysis. The error bars in Kimmerer 2008 are very large. In the case of Delta Smelt, the range of estimated loss was between 0-50%. Kimmerer (2008) is also based on numerous untested assumptions. For example, Miller (2014) at Table 9 identified 11 upwardly biased assumptions but was only able to correct for approximately 3 of those. The Draft EIS only references one upward bias assumption. (Draft EIS, p. 9G-2.) The Draft EIS also fails to include Kimmerer's own qualification of his work where he explains that even though his estimates of the percent of the Delta Smelt population entrained in the CVP-SWP are periodically large, there is no evidence that entrainment has had a population level effect (Kimmerer (2008) at p. 25, "… no effect of export flow on subsequent midwater trawl abundance is evident). SWC 36 continued

- Feyrer *et al.* 2011: The Draft EIS states, "*Feyrer et al. (2011) demonstrated that Delta Smelt abiotic habitat suitability in the fall in the West Delta, Suisun Bay, and Suisun Marsh subregions, as well as smaller portion of the Cache Slough, South Delta, and North Delta subregions, is correlated with X2 location. Feyrer et al. used X2 as an indicator of the suitable salinity and water transparency for rearing older juvenile Delta Smelt.*" SWC 37

  These statements are incorrect. Feyrer *et al.* showed a correlation between salinity and species presence-absence. Feyrer *et al.* did not demonstrate that habitat suitability in the fall is correlated with X2. See discussion, above, regarding scientific uncertainty of what Feyrer *et al.* did conclude.

- Merz *et al.* 2011[34]: The Draft EIS at p. 9B-126 states that, "*…in low outflow years, Delta Smelt occur primarily in the lower Sacramento River, with the area near Decker Island consistently exhibiting greatest catch over time. In years of very high outflow, however, their distribution extends into San Pablo Bay and the Napa River (Bennett 2000),*" and, "*They typically require low-salinity, shallow openwater habitat in the estuary (Moyle 2002).*" SWC 38

  As Merz *et al.* (2011) illustrates, Delta Smelt are widely distributed in all years, with Decker Island consistently exhibiting the highest catch in all water-year types. Merz *et al.* further illustrates that Delta Smelt are caught in Suisun Marsh and Suisun Bay, which contradicts the EIS statements that Delta Smelt require low salinity shallow open water.

- Feyrer *et al.* 2007[35]: The Draft EIS cites Feyrer *et al.* (2007) to support the premise that when the habitat index is higher, it has a positive effect on subsequent abundance. (Draft EIS at p. 9B-129.) Kimmerer *et al.* 2013 directly contradicts Feyrer *et al.* findings as to the relationship between X2 and species abundance. SWC 39

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[34] Merz., J.E., Hamilton, S., Bergman, P.S. Cavallo, B. 2011. Spatial perspective for delta smelt: a summary of contemporary survey data. *California Fish and Game*, 97(4), pp. 164-189.

[35] Feyrer, F., Nobriga, M., Sommer, T. 2007. Multidecadal trends for three declining fish species: habitat patterns and mechanisms in the San Francisco Estuary, California. *Can. J. Aquat. Sci.* 64: 723-734.

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- Kimmerer 2011:[36] The Draft EIS at p. 9B-130 states, "*Thus, if numbers of adults or adult fecundity decline, juvenile production will also decline (Kimmerer 2011).*" However, the Draft EIS fails to state that Kimmerer's statement was theoretical. He did not show it to be true. SWC 40

- Bennett *et al*. 2008; Feyrer *et al*. 2007, 2011; Maunder and Deriso 2011[37]. The Draft EIS states at p. 9B-130 that, "*The mechanism causing carrying capacity to decline is likely due to the long-term accumulation of adverse changes in both physical and biological aspects of habitat during summer and fall (Bennett et al. 2008; Feyrer et al. 2007, 2011; Maunder and Deriso 2011.)*" The citations do not support this statement and there is no broad agreement on this point as the EIS is suggesting. SWC 41

- Baxter *et al*. 2010;[38] Feyrer *et al*. (2007, 2011): The Draft EIS states that, "*The overlap of the low salinity zone (or X2) with the Suisun Bay/Marsh is believed to lead to more favorable growth and survival conditions for Delta Smelt in the Fall. (Baxter et al. 2010; Feyrer et al. 2007, 2011).*" The citations do not support this conclusion. Baxter *et al*. is a description of a conceptual model to be tested. The Feyrer *et al*. papers do not show such a relationship. The proposed relationship is theoretical and has not been substantiated. SWC 42

- Cavallo *et al*. 2015 and Perry *et al*. 2015: The Draft EIS states at p. 9-137 that: "The DCC gate operations would be modified to reduce loss of emigrating salmonids…." However, gate closure decreases fish entering the Delta through DCC, but does not affect the overall number of fish entering Georgiana Slough (Cavallo *et al*. 2015 and Perry *et al*. 2015). SWC 43

- Newman and Brandes (2010):[39] The Draft EIS states at p. 9-137 that: "The closure of the DCC gates would increase the survival of salmonid emigrants through the Delta, and the early closures would reduce loss of fish with unique and valuable life history strategies in the spring-run Chinook Salmon and Central Valley steelhead populations." However, this statement assumes fish go with flow but data on route selection suggests it is more complicated. In addition, Newman and Brandes (2010) suggest survival through Georgiana Slough is not related to exports. SWC 44

- Delaney *et al*. 2104; Zeug and Cavallo 2013; SJRGA 2013: The Draft EIS states at p. 9-137 that: "This action suite includes actions to reduce the vulnerability of emigrating steelhead within the lower San Joaquin River to entrainment into the channels of the South Delta and at the export facilities by increasing the inflow to export ratio." However, recent SWC 45

[36] Kimmerer, W.J. 2011. Modeling Delta Smelt losses at the south Delta export facilities. San Francisco estuary and Watershed. 9(1).
[37] Maunder, M. and Deriso, R. 2011. A state-space multistage life cycle model to evaluate population impacts in the presence of density dependence illustrated with application to delta smelt (*Hyposmesus transpacifics*). *Can. J. Fish. Aquat*. Sci. 68: 1285-1306.
[38] Baxter, R., Breur, R., Brown, L., Conrad, L., Feyrer, F., Fong, S., Gehrts, K., Grimaoldo, L., Herbold, B., Hrodey, P., Mueller-Solger, A., Sommer, T., Souza, K. 2010. Interagency Ecological Program, 2010 Pelagic Organism Decline Work Plan and Synthesis of Results.
[39] Newman, K.B., Brandes, P.L. 2009. Hierarchial modeling of juveneil Chinook salmon survival as a function of Sacramento-San Joaquin delta water exports. *Northern American Journal of Fisheries Management*, 30, pp. 157-169.

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studies do not show strong effect of exports and inflows on route selection although hydrodynamics are junction specific (Delaney *et al.* 2014, Zeug and Cavallo 2013). OMR flows did not appear to affect steelhead route selection (SJRGA 2013) and Delaney *et al.* (2014) showed no relationship between arrival at facilities and exports. SWC 45 continued

- SJRGA 2013, Zeug and Cavallo 2014, Buchanan *et al.* 2015: The Draft EIS states at p. 9-138 that: "This is anticipated to increase the likelihood of survival of steelhead emigrating from the San Joaquin River. Reducing the risk of diversion into the central southern Delta waterways also could increase survival of listed salmonids…." Coded wire tagging and acoustic tagging studies show survival to be reach specific for both Chinook salmon and steelhead, with recent data indicating very little difference in survival between mainstem routes and central southern Delta routes. (SJRGA 2013, Zeug and Cavallo 2014, Buchanan *et al.* 2015). SWC 46

- Cavallo *et al.* 2015, Perry *et al.* 2015: The Draft EIS states at p. 9-152 that: "Operation of the gates can have a direct effect on the entrainment rate and hence the functioning of the Sacramento River as a migratory corridor. Without the modifications to DCC gate operations to reduce loss of emigrating salmonids and green sturgeon…." Recent data suggests that gate operations do not effectively alter entrainment rate, they just change the source and location of entrainment (Cavallo *et al.* 2015, Perry *et al.* 2015). SWC 47

- SJRGA 2013 and Zeug and Cavallo 2014: The Draft EIS states at p. 9-150 that: "Under the Second Basis for Comparison in 2030, many years will have passed without seasonal limitation on OMR reverse (negative) flow rates, with the anticipated result that fish entrainment would occur at levels comparable to recent historical conditions. Future pumping would continue to expose fish to the salvage facilities and entrainment losses into the future." However, recent data on salvage from SJRGA (2013) and Zeug and Cavallo (2014) indicates that salvage may actually be reducing losses relative to mortality occurring in SJR and elsewhere in the southern Delta. SWC 48

- Delany *et al.* 2014: The Draft EIS Appendix 9L states at p. 9L-2 that: "The entrainment analysis is applicable to spring- and winter–run Chinook Salmon even though only fall- and late-fall-run Chinook Salmon were used to construct the statistical model." While the Draft EIS' assumptions indicate that the analysis developed for spring- and winter-run Chinook salmon is also applicable for fall- and late-fall-run Chinook salmon (which is itself questionable), no acknowledgement is made about the applicability of this model for steelhead and yet it is used in the effects analysis for evaluating differences in steelhead entrainment. Delaney *et al.* (2014) suggest DSM2 may not predict steelhead movement. SWC 49

- Cavallo *et al.* 2015: The Draft EIS Appendix 9J at p. 9J-5 states: "At each junction in the model, smolts move in relation to the proportional movement of flow entering each route." But this is not a valid assumption. Cavallo *et al.* (2015), reported that at 7 of 9 junctions modeled tide was dominant influence and flow had "little effect on predicted routing of salmonids." SWC 50

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- Weighted Useable Area (WUA) analysis: The Draft EIS at pp. 9-108 to 9-109 incorporates the use of WUA as one of the metrics for making comparisons of different salmonid species and life-stages for a selected set of streams and rivers between the different alternatives. It is unclear why differences in monthly average WUA of greater than 5% between alternatives is considered biologically meaningful. The use of WUA as an indicator of overall habitat (of a particular species and life stage) within a stream under different flow conditions is at best a rough approximation of the available habitat. Additionally, the magnitude of some of the WUA estimates can exceed 1.5 million (see Table C 12-2) to more than 2 million sq. feet (see Table C-10-6). Therefore, the 5 % difference in WUA to denote a biological effect attributes greater accuracy to the calculation of WUA than what can be reasonably made, and presumes a relatively tight relationship between WUA and actual fish abundance, which is typically not the case given the suite of other factors that serve to control fish populations. Moreover, it is not clear whether and how the 5% difference was ever applied. SWC 51

  Inspection of the Draft EIS sections pertaining to impacts analysis that focused on Changes in Weighted Useable Area indicates that for the majority of cases, there would be little (< 5%) to no difference in WUA amounts for all species and life stages across all alternatives. An exception to this was noted in one instance (see page 9-176)– No Action Alternative versus Second Basis of Comparison for the Sacramento River, where a > 20% difference occurred (*see* Draft EIS, at p. 9-176). However, there is no explanation provided as to what would cause this difference and even the discussion of such was confusing – "Lesser amounts in long-term average spawning WUA during September (prior to the peak spawning period) under the No Action Alternative compared to the Second Basis of Comparison would be relatively large (more than 20 percent), with smaller decreases …..“ It is unclear what is actually being stated here. Clarification is needed as to why WUA was even determined or considered as one of the metrics for comparison if overall changes in river flows do not differ or only slightly differ between alternatives?

  At the same time, the results/relationships presented in the WUA-Flow tables do not appear to be the same as those presented in the source documents. For example, fall-run WUA curves for the American River depicted in Table 9E.B.10 peak at flows around 4,500 cfs; while source document (USFWS 2003) shows peak around 2,500 cfs; likewise the steelhead curve for the lower American River in Table 9E.B.11 shows peak around 4,500 cfs whereas source document shows peak around 2,500 to 2,800 cfs. Likewise the curves depicted for the Feather River for fall-run Chinook and steelhead spawning (Tables 9E.B.8 and 9) do not appear to correspond with those in the source documents (CDWR 2004); fall-run Chinook peak at 7,500 cfs in Table 9E.B.11 but around 2,000 cfs in source document (see Table 5.5-2); steelhead peak at 5,000 cfs in Table 9E.B.9 but around 1,000 cfs in the source document. The appendix needs to explain these differences.

- Lack of scientific citation: The document improperly cites policy documents and agency documents describing untested conceptual models and uses them to support important conclusions regarding entrainment risk (*i.e.*, California Resources Agency 2000 and Baxter *et al.* 2008). Draft EIS, at p. 9B-130. Examples of lack of scientific citation include but are not limited to: SWC 52

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