Appendix K
Underwater Inspection of Red Bluff Diversion Dam Fishway Attraction Study
August 13 through 17, 2001

Red Bluff Diversion Dam
Fishway Attraction Study

Spillway Operation Test

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Conducted for
Red Bluff Field Office

by

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Background

Red Bluff Diversion Dam was constructed in the mid 1960's. The dam spans the Sacramento River with eleven 60-ft wide spillway gates. Plan and sections of Red Bluff Diversion Dam and stilling basin are presented in figure 1. All spillway gates can be operated in automatic mode using an upstream lake elevation target. However, typical operation of the spillway gates has gates one through ten manually changed in response to large changes in river flow. Gate 11 operates in auto mode to regulate the upstream water surface for gravity diversion to the Tehama Colusa Canal. Downstream of gates one through ten is a Type II hydraulic jump stilling basin with a concrete apron and solid endsill. Downstream of gate 11 is a Type III hydraulic jump stilling basin. Both stilling basins have experienced significant abrasion damage over the past 40 years. Damage has occurred primarily near the basin chute blocks and endsill. The Designer's Operating Criteria (DOC) for spillway gate operation was revised in 1970 to address the problem of concrete abrasion in the stilling basins. The criteria places two constraints on spillway operation. First, the DOC requires gate 11 (sluice gate) be operated at a minimum of 2,500 cfs prior to opening any of the other 10 spillway gates. This ensures hydraulic jump stability by providing sufficient tailwater for Type II stilling basins. Second, gate openings of adjacent gates 1 through 10 shall not exceed a 1.0 ft differential. These revised operating criteria ensure flow releases through the gates are sufficiently uniform to produce a stable hydraulic jump and reduce erosion and abrasion damage to the downstream apron. Current gate operation criteria were established via a memorandum to central files by Ray Willis, Irrigation and Operation Branch, Division of Water and Land Operations, July 22, 1971.

The issue of fish passage attraction and spillway gate operation has been the subject of discussion since the early 1970's. The three main references prior to this report are; a travel report by Carlson and Kuemmich (1971), a Memorandum to Director of Design and Construction, 1975 and a Memorandum from Johnson to the Red Bluff Program Manager, 1995. In addition, other related work includes a hydraulic model study of a concept for constructing enlarged ladders, (Kubitschek, J., 1997) and a field study of the flow conditions at the entrance to the right bank ladder, (Kubitschek, J., et al. 1997). These studies show the fishway attraction flows are often masked by uniform spillway releases and more flexibility in lateral adjustment of flow releases could potentially improve attraction to the abutment fishways.

Study Objective

In August 2001, a series of field tests were conducted to investigate hydraulic conditions in the stilling basin and downstream river that result from non-uniform spillway gate operation. The tests focused on the effect of center dominated spillway releases with respect to stability of the hydraulic jump, abrasion damage potential, erosion downstream of the endsill and downstream flow patterns near the north and south bank fishway entrances.

Test Plan

Three tests of different spillway gate openings that provided center dominated spillway releases were conducted during the week of August 13, 2001. Test procedures followed a pre-test plan submitted to Red Bluff Diversion Dam Field Office June, 2001. Each spillway test consisted of examining the spillway apron, riprap, and downstream bathymetry, videoing surface flow conditions, and measuring the velocity field downstream of the spillway apron for a distance of approximately 1000 feet. Each test condition was held constant for about 20 hours to allow sufficient time for alluvial material to move in response to the flow conditions. After each test period, bays 10 and 11 were inspected. Spillway releases were then moved from the center bays to bays 10 and 11 to complete the inspection of other bays. During this period, downstream bathymetry was also mapped to identify changes that took place during the previous test. The velocity field in the river downstream of the spillway was measured during each centered dominated spillway release.

Testing

During the test period, river flows were 3,000 to 4,000 ft^3/s below expected levels. Because of this, proposed spillway gate openings cited in the original test plan had to be reduced. River flows past the dam started at 11,550 ft^3/s on 8/13/01 and decreased daily to 10,110 ft^3/s on 8/17/01. River flows are a combination of spillway flow and right and left bank fishway flows. Spillway flows during tests 1, 2, and 3 were approximately 9,200 ft^3/s, 9,000 ft^3/s and 8,500 ft^3/s, respectively.

A dive inspection of the spillway apron and downstream riprap was conducted prior to the first test and following each test. Please refer to attached dive report for detailed information. Divers were asked to identify major movement in sediment deposits on the spillway apron, conditions of downstream riprap and document damaged spillway concrete for future reference.

Spillway hydraulic parameters are based on a previous hydraulic model study conducted by Dodge in 1963. Spillway gate setting, reservoir elevation and tailwater elevation were recorded during the testing. Test conditions during each test are given in tables 1, 2, and 3 and are plotted in figure 2. During testing large flows were released through gates 5, 6, and 7 with little or no flow through the remaining gates. The largest test flows were always passed through gate 6.

During pre-test and river centered operations, river flow velocities and depth were measured in the area starting approximately 40 ft downstream of the spillway endsill and extending about 250 ft downstream of the fish screen bypass outfall. Velocity profiles and bottom depth were measured using a boat-mounted Acoustic Doppler Current Profiler (ADCP). Boat access for making measurements was limited to areas outside the bubble plume downstream of large gate openings and areas where flow depth was greater than two feet. Because of changes in river bathymetry, boat traverses could not be exactly repeated during each test, therefore the measured data was interpolated onto a square grid for comparison of different tests. River bathymetry was measured following each test concurrent with the dive inspection of the spillway. This data was also interpolated onto a square grid.

Pretest Conditions - Due to fish passage concerns in recent years, operation of the dam has changed to 4 months with spillway controlled flow releases referred to as "gates-in" and 8 months with "gates-out" (gates fully open). The gates are typically used to control flow releases from May 15 to September 15. During "gates-in" operation, a temporary fish ladder is installed in bay 6 that prevents the gate operation. The fish ladder was removed one week prior to the spillway tests. Existing guidelines for spillway releases with the center fish ladder installed and without the center ladder in place are given in tables 4 and 5. The existing gate position guidelines restrict the difference between adjacent gate openings to less than 1 ft and recommend the highest flows in the outer bays adjacent to the left and right bank fishway entrances. The Red Bluff Diversion Dam record of operation prior to the tests for the month of August 2001 is given in table 6. The flow field as denoted by depth averaged velocity vectors measured downstream of the spillway on August 13 is given on figure 3. The velocity vectors show flows from the outer gates merge as the river narrows about 700 ft downstream of the dam. Flow patterns closer to the dam were fairly chaotic. The bank weighted flow releases and the influence of downstream sediment deposits caused a large area of poorly defined flow direction downstream of bays 3 through 8 for a distance of about 600 feet. The concave spillway flow release pattern results in bed material deposits in the center of the river and deep near-bank channels downstream of each fishway entrance. In the center of the river, the gravel bar started on the spillway apron and extended well downstream from the dam. Divers estimated gravel deposits of about 20 yd^3 in spillway bays 5, 6, and 7, and 10 yd^3 in bay 8. Please refer to the attached dive report. River bathymetry measured downstream of the spillway is given on figure 4. The bathymetry data reveals scoured areas greater than 10 ft deep downstream of the gates 1 and 2 near the west banks and gates 10 and 11 on the east bank. There was a large area downstream from gates 5, 6, and 7 where flow depth was less than 2 feet. The scoured areas are probably characteristic of the pre-test gate opening pattern, however, a major influx of sediment from Red Bank Creek in the past year and short term sediment flushing operation using bays 10 and 11 also contributed to the pre-test bathymetry.

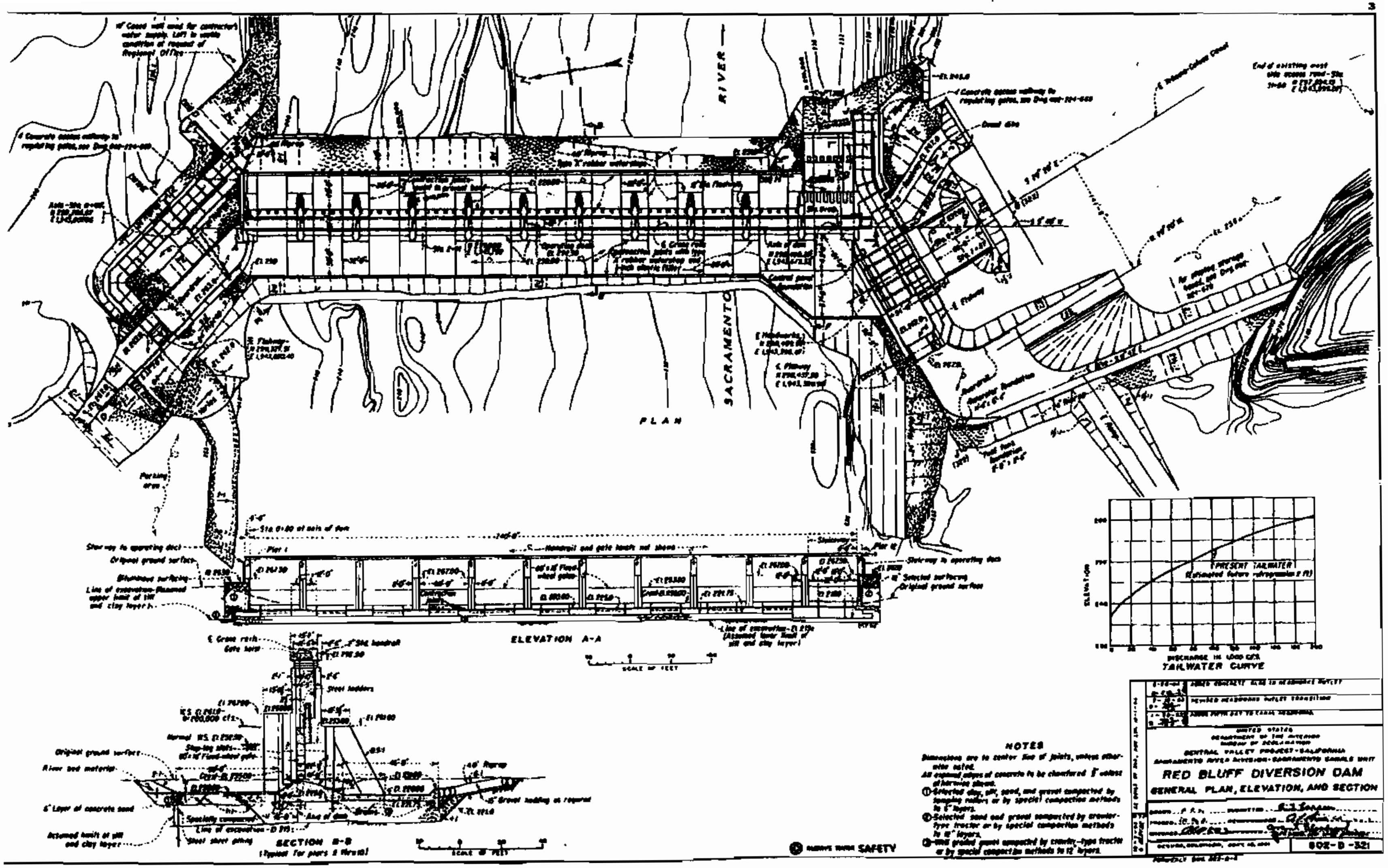
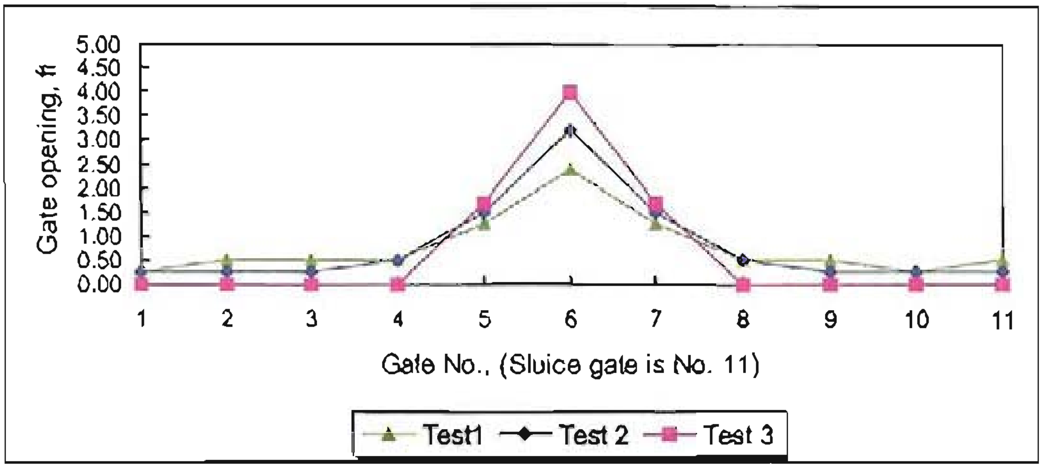
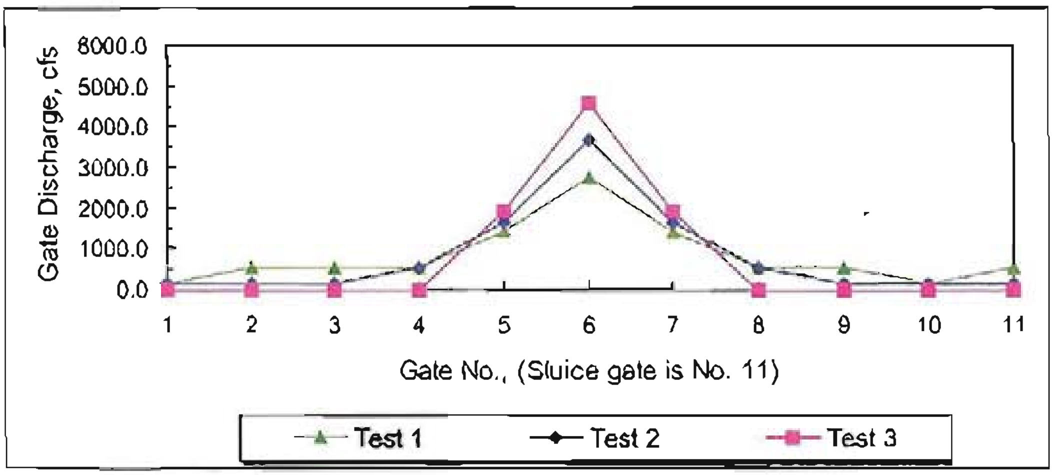


Figure 1- Plan and sections of Red Bluff Diversion Dam.





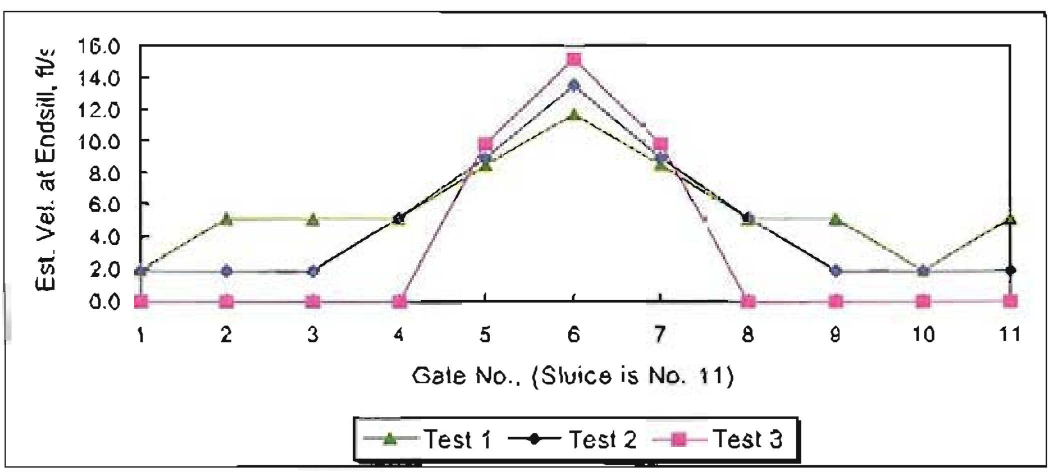


Figure 2 - Spillway operation for tests of river centered releases.

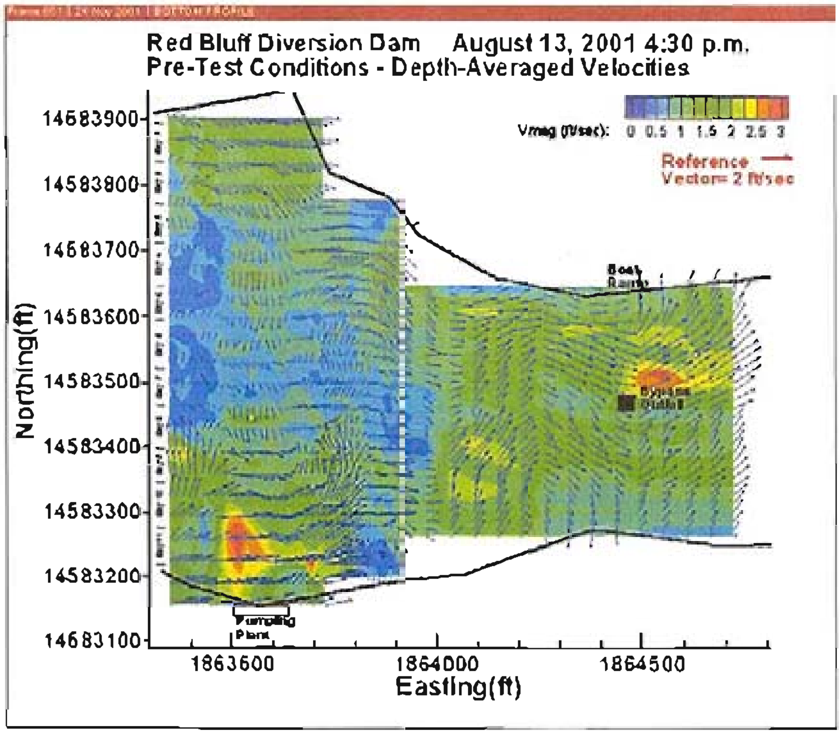


Figure 3 - Pretest depth-averaged velocities downstream of Red Bluff Diversion Dam.

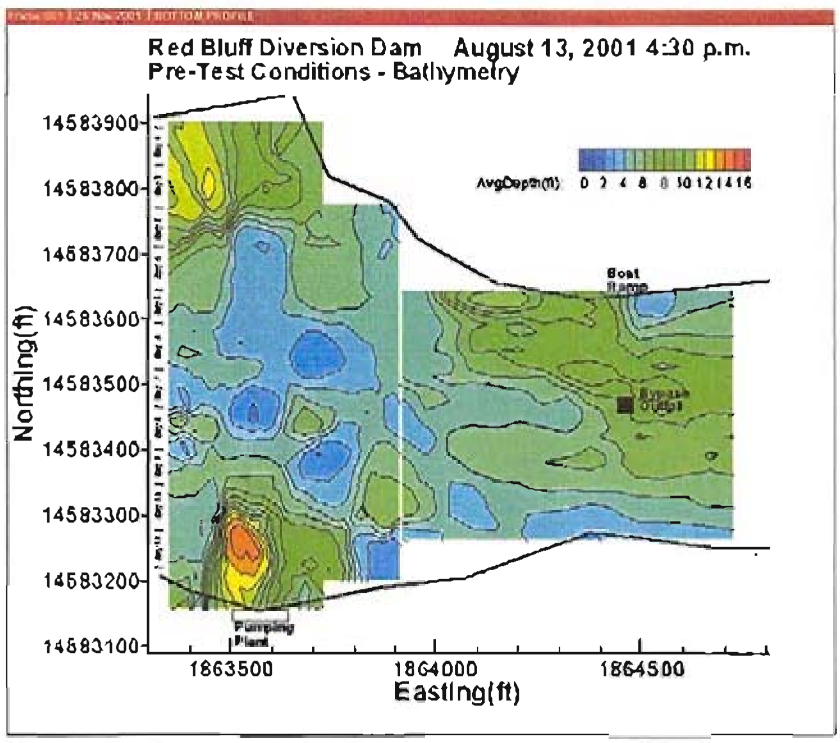


Figure 4 - Pretest river bathymetry downstream of Red Bluff Diversion Dam.

Results

River Center Spillway Release Test 1

The objective of test 1 was to evaluate spillway hydraulic conditions during a strong centered spillway release combined with smaller sediment flushing flows from all other gates. Gates 2, 3, 4, 8, 9, and 11 were opened 0.5 feet. Gates 1 and 10 were only opened 0.25 feet due to low river flow. Gates 5, 6, and 7 were opened 1.25, 2.4 and 1.25 feet respectively, giving a 1.15 feet difference between adjacent gates. The 0.5 ft gate opening used for outer gates was selected based on an estimated average flow velocity at the endsill of 5 ft/s.

Hydraulic Jump Stability - Releases from gates 5,6, and 7 produced a bubble plume that extended to approximately the spillway endsill (figure 5). The hydraulic jump downstream of gates 5, 6, and 7 appeared very stable. The gate openings tested provided a ratio of tailwater depth to hydraulic jump conjugate depth greater than one for all gates (table 1). Reclamation Engineering Monograph 25 recommends a ratio greater than 1 for good jump stability.

Spillway Apron Abrasion Damage Potential - The large gravel deposit downstream of the spillway center gates significantly effected downstream flow conditions. River bathymetry and the downstream flow field continually changed during the tests as material was scoured from the center of the channel and redeposited to the sides and downstream. The flow from gates 5, 6, and 7 spread to both sides of what was almost an island of alluvial material. Significant amounts of gravel were flushed from the spillway apron during the test. Divers estimated that the quantity of gravel on the spillway apron was about 50 percent of pre-test conditions after test 1 (Dive Report - table 1). All material was removed from bays 6 and 7 and the amount of material in bays 5 and 8 was reduced by about one-half. Some material did redeposit near the endsill in Bays 3 and 4 where no material was found during the pretest inspection. All alluvial material found on the spillway apron was located near the endsill.

River Bathymetry and Flow Conditions Downstream of the Spillway - Figure 6 gives the post test river bathymetry. Figure 7 shows the change in depth between pre and post test 1 conditions. Scouring in the center of the river was accompanied by deposition near each bank downstream of the fishway entrances. The large river center flows scoured material downstream of gates 5,6, and 7 exposing the spillway apron endsill and downstream riprap. Deposition of 6 ft to 8 ft occurred in front of the pumping plant downstream of bays 10 and 11 and downstream of bays 1 and 2. The rapid movement of material toward the river banks was driven by the lateral spread of spillway releases as the flow impacted the extensive alluvial deposit immediately downstream of the center gates. The dive inspection indicated the riprap was not affected by the test flow. River velocities measured during the test using an ADCP are given in figure 8. The flow field for a distance of nearly 600 ft downstream of the dam is poorly defined due to sediment deposits and the wide channel. Strong flows were measured about 300 ft downstream of the spillway apron along both river banks. The flow likely resulted from the movement of spillway flow around the river centered deposits rather than fishway flows. The ADCP data shows fishway flow rapidly mixed with spillway flows. Fishway flow velocities were not discernable from other spillway driven flow velocities beyond 50 to 75 ft downstream of the fishway entrance.

Figure 5 - Photographs of surface flow conditions during test 1.

View of white water turbulence downstream of gates 5, 6 and 7.

View of surface flow conditions downstream of the left bank fishway.

View of surface flow conditions downstream of the right bank fishway.

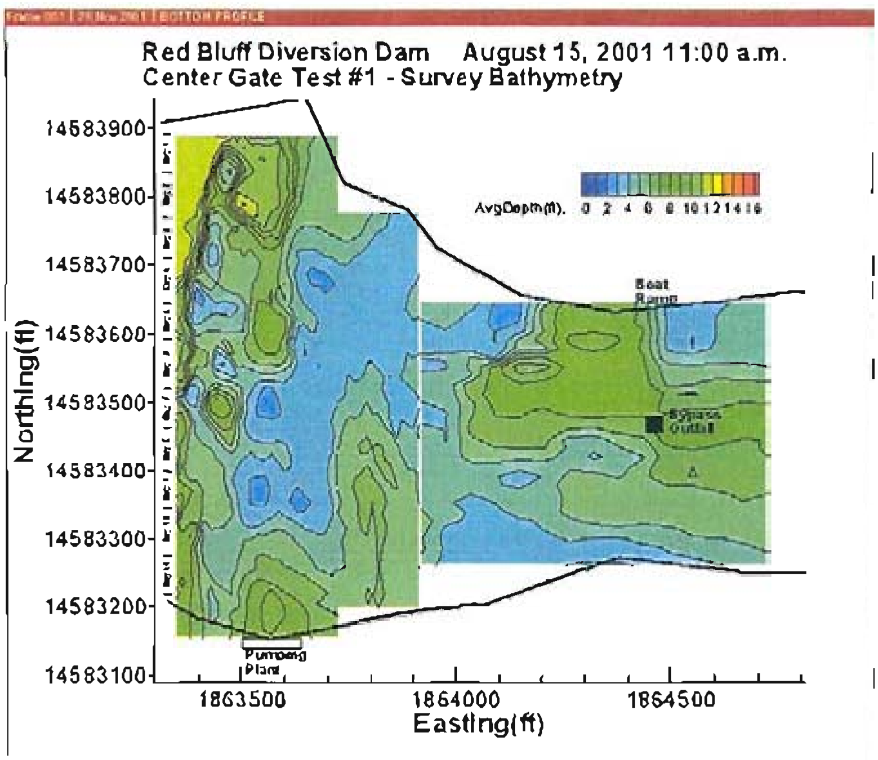


Figure 6 - River bathymetry downstream of Red Bluff Diversion Dam after test 1.

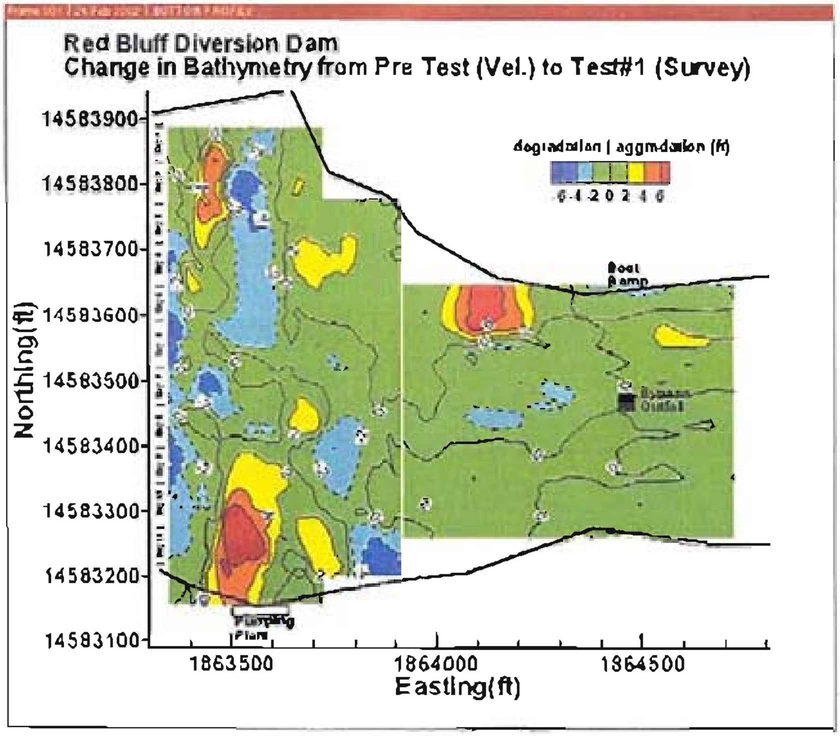


Figure 7 - Change in river bathymetry from pre-test to test 1.

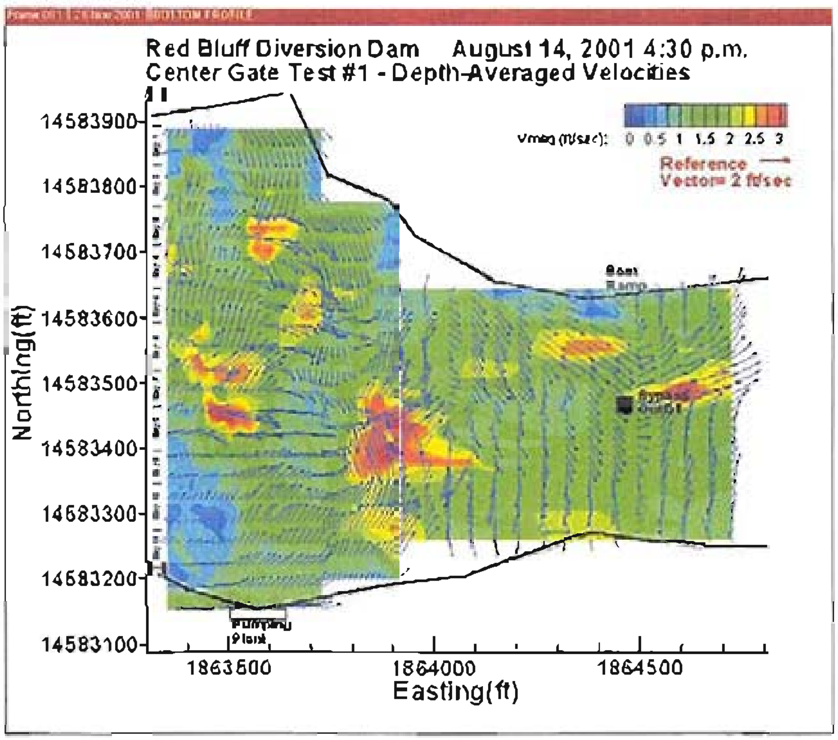


Figure 8 - Test 1 depth-averaged velocities downstream of Red Bluff Diversion Dam.

River Center Spillway Release Test 2

The objective of the second test was to further concentrate flows to the center of the spillway and test a gate opening differential between adjacent center gates significantly higher than 1 foot. Prior to test 2, center releases were increased and outer gate flows decreased. Gates 1, 2, 3, 9, 10, and 11 were opened 0.25 feet. Gates 4 and 8 remained at a 0.5 ft gate opening. Gates 5, 6, and 7 were opened 1.5, 3.2, and 1.5 ft respectively, giving a 1.7 ft differential between adjacent gates, (table 2). The 0.25 ft gate opening used for outer gates produced an estimated average flow velocity at the endsill of 2 ft/s. Gates 4 and 8 were maintained at a 0.5 ft opening to provide a stronger spillway apron flushing flow adjacent to the larger gate openings.

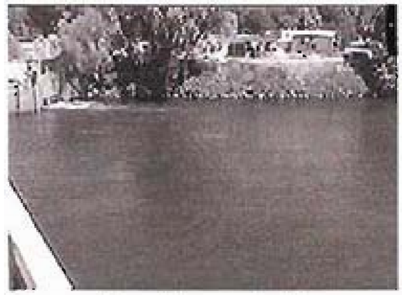
Hydraulic Jump Stability - Releases from gates 5, 6, and 7 produced a bubble plume that extended well beyond the spillway endsill, as shown in figure 9. The hydraulic jump downstream of gates 5, 6, and 7 remained stable with the increased flow of test 2. The gate openings tested provided a ratio of tailwater depth to hydraulic jump conjugate depth greater than one for all gates, (table 2).

Spillway Apron Abrasion Damage Potential - After a day of operation the flow scoured alluvial material from the spillway apron and cut several new channels through the large downstream gravel deposit. Following the test, divers found about 50 percent of the material remaining in the basin after test 1 had been removed. Material in bays 3, 4, and 5 was reduced by about 90 percent and material in bay 8 increased by about 60 percent. All gravel deposits were again located immediately upstream of the spillway apron endsill. Divers noted that a fine cover of moss attached to the spillway apron showed no evidence of abrasion upstream of the endsill as a result of the concentrated high velocity flows.

River Bathymetry and Flow Conditions Downstream of the Spillway - The high river centered releases continued to move alluvial material downstream and toward both banks. The dive inspection found no indication that the riprap apron was affected by the test flow. Figure 10 gives the post test 2 river bathymetry and figure 11 shows the change in depth between test 1 and post test 2 conditions. By the end of test 2, the flow releases had cut channels toward each bank through the remaining alluvial deposit in the center of the river. The flow resulted in 4 to 6 ft of material deposition in the river downstream of bays 1, 2, 3, 4, and 11. River velocities measured during the test are given in figure 12. The large river center alluvial deposit continued to control flow patterns upstream of the fish screen bypass outfall. Similar to test 1, fishway flows were not distinguishable in the velocity measurements taken 100 ft downstream of the spillway endsill.

Figure 9 - Photographs of surface flow conditions during test 2.

View of white water turbulence downstream of gates 5, 6 and 7.



View of surface turbulence downstream of the left bank ladder.

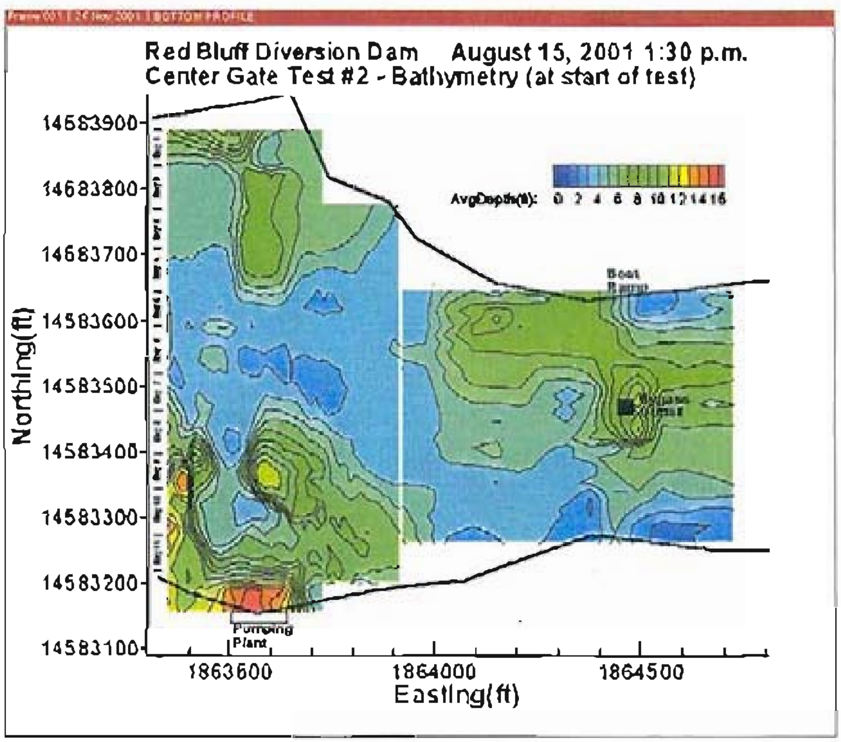


Figure 10 - River bathymetry following test 2.

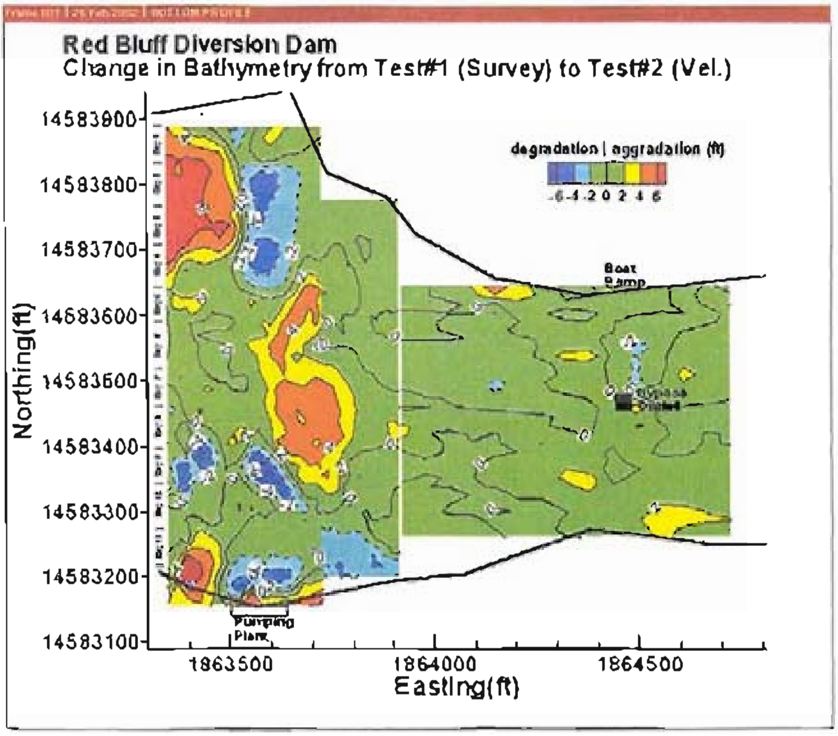


Figure 11 - Change in river bathymetry from test 1 to test 2.

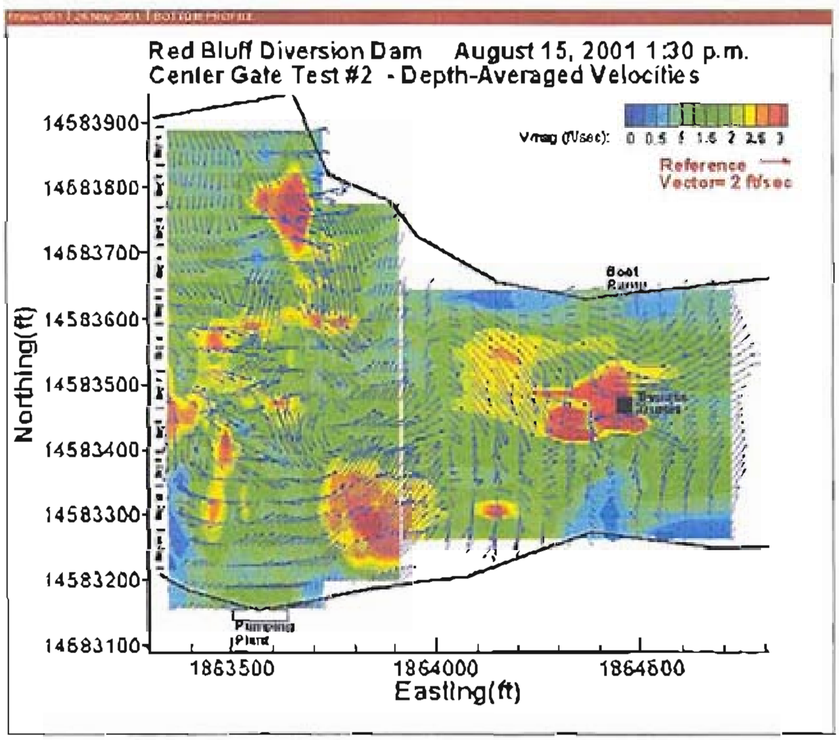


Figure 12 - Test 2 depth averaged velocities downstream of Red Bluff Diversion Dam.

River Center Spillway Release Test 3

The objective of the third test was to concentrate all spillway flows to the center of the spillway with no sediment flushing flows from adjacent gates. For test 3, center releases were increased and gates 1, 2, 3, 4, 8, 9, 10, and 11 were closed. Gates 5, 6, and 7 were opened 1.7, 4.0 and 1.7 ft respectively, giving a 2.3 ft difference between adjacent gates (table 3).

Hydraulic Jump Stability - Releases from gates 5, 6, and 7 produced a bubble plume that extended well downstream of the spillway endsill, as shown in figure 13. The hydraulic jump downstream of gates 5, 6, and 7 remained stable. The flow through gate 6 yielded a ratio of tailwater depth to hydraulic jump conjugate depth of just under 1.0, (table 3).

Spillway Apron Abrasion Damage Potential - Following test 3, the amount of material deposited on the spillway apron roughly doubled. Refer to table 1 of the Dive Report. New material was found in bays 4, 6, 7, 8, and 10. The greatest increase in material occurred in bay 8. All gravel deposits were again located immediately upstream of the spillway apron endsill.

River Bathymetry and Flow Conditions Downstream of the Spillway - The high river centered releases continued to move alluvial material downstream and toward both banks. Test 3 flows scoured a channel that extended about 800 ft downstream of the spillway (figure 14). Material removed during test 3 deposited downstream of bays 1 through 4 and 8 through 11 (figure 15). The dive inspection found no indication the riprap apron was affected by the test flow. River velocities measured during the test are given in figure 16. Similar to tests 1 and 2, fishway flows were not distinguishable in velocity measurements taken 100 ft downstream of the spillway endsill.

Figure 13 - Photographs of surface flow conditions during test 3.

View of white water turbulence downstream of gates 5, 6 and 7. Surface turbulence extended well downstream of the stilling basin endsill.

View of surface flow conditions exiting the left bank fishway.

View of surface flow conditions exiting the right bank fishway.

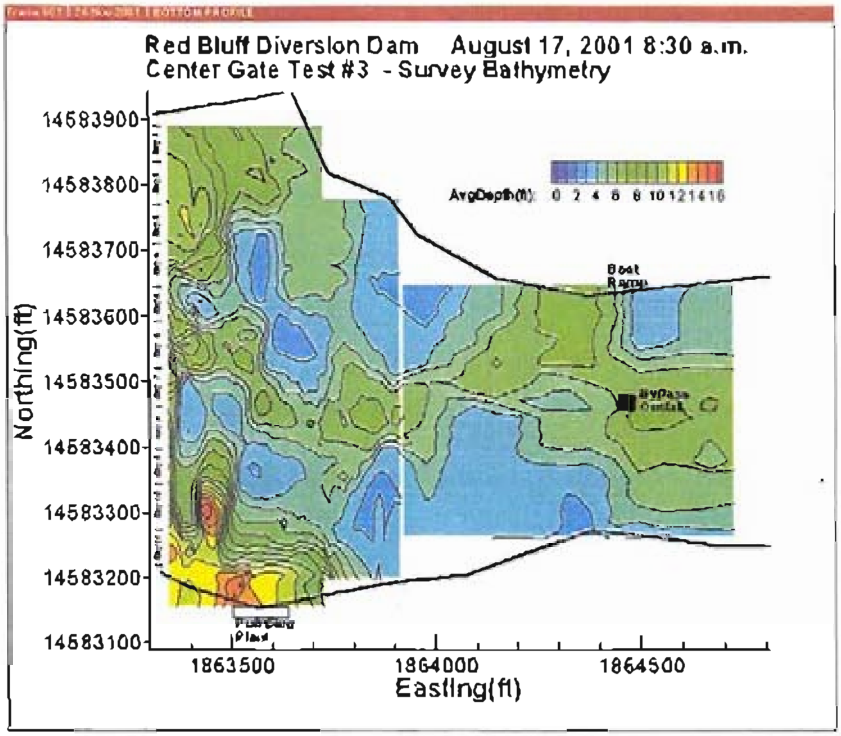


Figure 14 - River bathymetry following test 3.

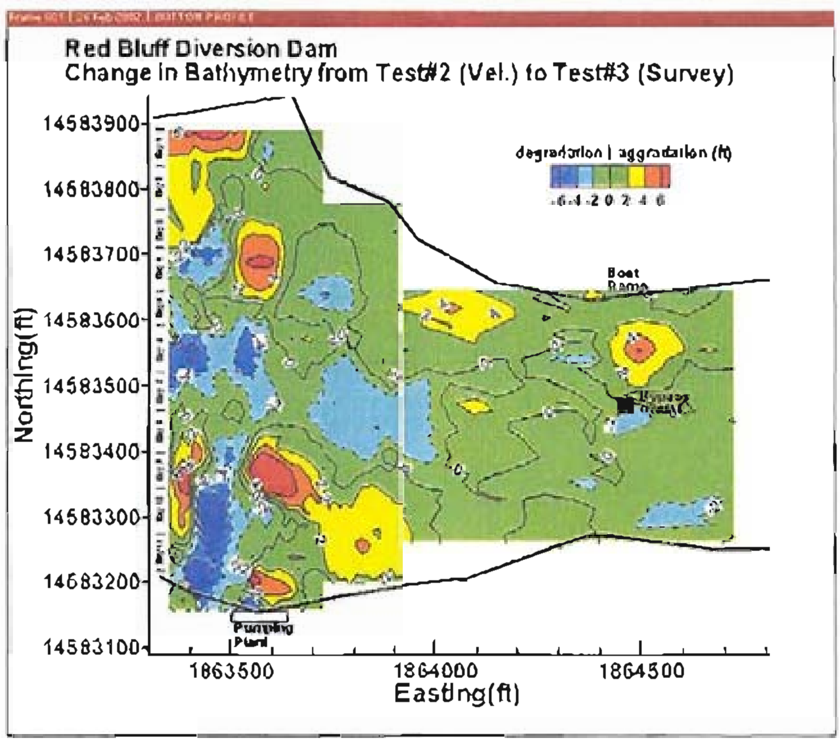


Figure 15 - Changes in river bathymetry from test 2 to test 3.

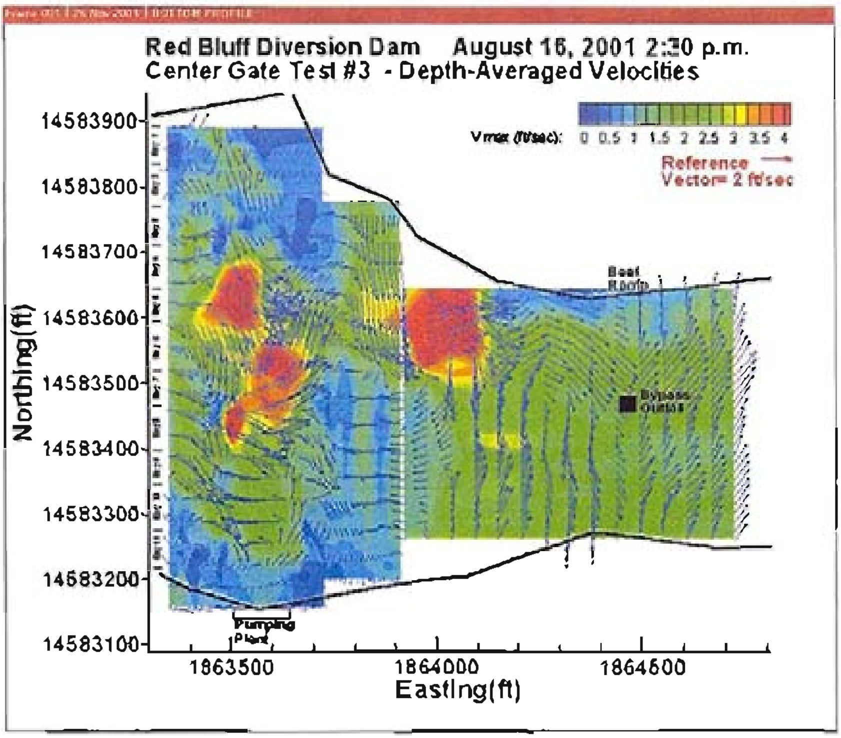


Figure 16 - Test 3 depth averaged velocities downstream of Red Bluff Diversion Dam.

Conclusions

The tests show the hydraulic jump downstream of the spillway gates is stable for conditions where the ratio of tailwater depth to hydraulic jump conjugate depth is 1.0 or greater. Low river flow conditions at the time of the testing did not allow testing tailwater depth to hydraulic jump conjugate depth ratios less than one. A value of 1.0 or greater is consistent with Reclamation Engineering Monograph 25 recommendations.

Exceeding a 1.0 ft differential gate opening between adjacent gates was not found to increase the potential for spillway apron abrasion for tests 1 and 2 where a flushing flow was provided adjacent to large gate openings. However, test 3 showed an increase in material moved upstream onto the spillway apron. Test 3 was unique in that spillway gate openings greater than 1 ft were used adjacent to closed gates. These tests indicate that spillway gate operation criteria can be relaxed to allow a differential gate opening of up to 2.0 ft between adjacent open gates if a 0.5 ft to 1.0 ft gate opening is maintained adjacent to a closed gate. The low river flow conditions at the time of the testing limited the range of non-symmetric gate operations that could be evaluated. Future tests during higher river flows would be required to evaluate adjacent gate openings of greater than 2 ft. Symmetric gate operation is recommended when fish attraction or sediment flushing is not required. Due to the limited extent of these tests, the spillway apron should be dive inspected and the criteria reevaluated after accumulating 6 months of operation with differential openings between adjacent gates of greater than 1.0 ft.

Between Red Bluff Diversion Dam and the Tehama Colusa Canal fish screen bypass outlet structure, river bathymetry and flow patterns vary greatly as a function of flow, sediment deposits, upstream bed load and spillway gate operation. The testing resulted in major changes in scour and redeposition patterns downstream of the dam. Flow patterns and depths measured in the downstream river are not necessarily indicative of future conditions resulting from spillway centered flow releases. However, the redistribution of river center deposits toward the river banks would be expected.

Table 1 - Spillway gate settings and hydraulic conditions during spillway Test No. 1

Test No.1

Sill Elevation	235.0	ft
Basin floor	228.00	ft

Reservoir elevation =	252.3	ft
Tailwater elevation =	239.8	ft

Gate No.	1	2	3	4	5	6	7	8	9	10	11 Sluice	Total Flow cfs
Opening, ft	0.25	0.50	0.50	0.50	1.25	2.40	1.25	0.50	0.50	0.25	0.50	
H1/b	69.2	34.6	34.6	34.6	13.8	7.2	13.8	34.6	34.6	69.2	34.6	
H2/b	19.1	9.5	9.5	9.5	3.8	2.0	3.8	9.5	9.5	19.1	9.5	
Cd	0.30	0.55	0.55	0.55	0.58	0.58	0.58	0.55	0.55	0.30	0.55	
Q/gate	148.9	545.9	545.9	545.9	1439.3	2763.5	1439.3	545.9	545.9	148.9	545.9	9216
Vel. gate, ft/s	14.2	26.0	26.0	26.0	27.4	27.4	27.4	26.0	26.0	14.2	26.0	
Endsill vel	2.0	5.1	5.1	5.1	8.5	11.7	8.5	5.1	5.1	2.0	5.1	
Fr1	5.0	6.5	6.5	6.5	4.3	3.1	4.3	6.5	6.5	5.0	6.5	
D2, ft	1.65	4.34	4.34	4.34	7.04	9.45	7.04	4.34	4.34	1.65	4.34	
TW(depth)/D2	7.15	2.71	2.71	2.71	1.67	1.25	1.67	2.71	2.71	7.15	2.71	

Table 2 - Spillway gate settings and hydraulic conditions during spillway Test No. 2

Test No. 2

Reservoir elevation =	252.5	ft
Tailwater elevation =	239.8	ft

Gate No.	1	2	3	4	5	6	7	8	9	10	11 Sluice	Total Flow cfs
Opening, ft	0.25	0.25	0.25	0.50	1.50	3.20	1.50	0.50	0.25	0.25	0.25	
H1/b	70.0	70.0	70.0	35.0	11.7	5.5	11.7	35.0	70.0	70.0	70.0	
H2/b	19.0	19.0	19.0	9.5	3.2	1.5	3.2	9.5	19.0	19.0	19.0	
Cd	0.30	0.30	0.30	0.56	0.56	0.58	0.56	0.56	0.30	0.30	0.30	
Q/gate	148.9	148.9	148.9	555.9	1667.6	3684.7	1667.6	555.9	148.9	148.9	148.9	9025
Vel.@gate, ft/s	14.2	14.2	14.2	26.5	26.5	27.4	26.5	26.5	14.2	14.2	14.2	
Vel. @ Endsill, ft/s	2.0	2.0	2.0	5.2	9.0	13.6	9.0	5.2	2.0	2.0	2.0	
Fr1	5.0	5.0	5.0	6.6	3.8	2.7	3.8	6.6	5.0	5.0	5.0	
D2, ft	1.65	1.65	1.65	4.42	7.36	10.73	7.36	4.42	1.65	1.65	1.65	
TW(depth)/D2	7.14	7.14	7.14	2.66	1.60	1.10	1.60	2.66	7.14	7.14	7.14	

Table 3 - Spillway gate settings and hydraulic conditions during spillway Test No. 3

Test No. 3

Reservoir elevation = 252.5 ft
Tailwater elevation = 239.7 ft

Gate No.	1	2	3	4	5	6	7	8	9	10	11 Sluice	Total Flow cfs
Opening, ft	0.00	0.00	0.00	0.00	1.70	4.00	[illegible]	0.00	0.00	0.00	0.00	
H1/b					10.2	4.3	10.2					
H2/b					2.8	1.2	2.8					
Cd					0.58	0.58	0.58					
Q/gate					1957.5	4605.8	1957.5					8521
Vel. gate					27.4	27.4	27.4					
Endsill vel					9.9	15.2	9.9					
Fr_1					3.7	2.4	3.7					
D2					8.10	11.81	8.10					
TW(depth)/D2					1.44	0.99	1.44					

Symbol definitions:

b - spillway gate opening
B - width of gates
Cd - spillway gate coefficient of discharge, $Q/(bB\sqrt{2gH1})$
D2 - hydraulic jump conjugate depth
Endsill vel. - estimated jet velocity at the stilling basin endsill
Fr_1 - Froude Number of the flow entering the stilling basin
H1 - head upstream of spillway gate referenced to the spillway crest
H2 - head downstream of spillway gate referenced to the spillway crest Q/gate - discharge per gate
Vel. gate - flow velocity through the gate opening
TW/D2 - ratio of tailwater depth to conjugate depth

References

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Appendix L
Draft Biological Assessment

Draft Biological Assessment

Chinook Salmon, Steelhead Trout and Sturgeon for the Proposed Tehama Colusa Canal Authority Fish Passage Improvement Project at the Red Bluff Diversion Dam

Chapter 1 – Introduction

Note: The Draft Biological Assessment has not been updated to reflect the most recent draft USFWS Coordination Act Report.

Introduction

This biological assessment (BA) describes the Bureau of Reclamation's (Reclamation) proposed operation of the Red Bluff Diversion Dam Fish Passage Improvement Project (Project). Reclamation is submitting this BA pursuant to Section 7(a)(2) of the Endangered Species Act (ESA) to both the Fish and Wildlife Service (FWS) and the National Marine Fisheries Service (NMFS) to ensure that the proposed action is not likely to jeopardize the continued existence of listed species and to ensure that there is coordination between what may otherwise be conflicting needs between multiple listed species.

Under the relevant regulations, the "contents of a biological assessment are at the discretion of the Federal agency and will depend on the nature of the Federal action." 50 CFR Section 402.12 (f). In the event that FWS or NMFS determine that the proposed action is likely to jeopardize the continued existence of listed species, Reclamation has identified in Appendix A to this BA a list of actions that could be implemented as reasonable and prudent alternatives to the proposed action or as reasonable and prudent measures to reduce incidental take associated with the proposed action, or to promote conservation and recovery of listed species pursuant to Section 7(a)(1) of the ESA.

Purpose of Biological Assessment

Reclamation's goal is to work with the Services toward developing an operations plan that meets Reclamation's legal commitments with respect to the Project in a manner that is consistent with the requirements of the ESA. Reclamation prepared this BA to describe and analyze the effects of its proposed actions related to operation of the Project on listed species. It covers proposed actions for __ years, from Date to Date.

Chapter 2 – Description of the Action

Introduction

Reclamation proposes, through consultation and development of a subsequent operations plan, to operate the Project to improve fish passage around the Red Bluff Diversion Dam (RBDD) and deliver reliable water to the Tehama-Colusa Canal Authority member districts. After completion of consultation with both the FWS and NMFS, Reclamation will develop an operations plan that provides for the continued operation of the Project while meeting its legal obligations under the Endangered Species Act; namely, to (1) avoid any discretionary action that is likely to jeopardize the continued existence of listed species; (2) take listed species only as permitted by the relevant Service; (3) and use Reclamation's authorities to conserve listed species. For the purposes of this BA, impacts to listed species are assessed with respect to the separate acts of construction and operation of the Project.

Summary of Project Background, Programs and Studies, and Legislative and Regulatory Influences Relevant to the Action

Introduction

Previous programs and studies; and legislative and regulatory influences guide Reclamation's proposed action. This section of the BA elaborates on the authorities, responsibilities and obligations related to Project operation.

Project Background, Authorization of the CVP, RBDD, TCC, and TCFF

The Central Valley Project (CVP) was initially authorized under the Act of October 26, 1937 (50 Stat. 844,850), and re-authorized under the Act of October 17, 1940 (54 Stat. 1198, 1199). The TCC at the time called the Tehama-Colusa Conduit), including all necessary damns, pumping plants and other appurtenant works, was a unit of the CVP, as authorized under State law prior to 1946 (Senate Document 113 1949). Senate Document 113 (1949), a report updating progress on the CVP, proposed for further investigations the Red Bluff-Dunnigan canal (similar in location to the TCC) and distribution system, with a cost of $22.4 million, length of 115 miles, and capacity of 3,000 cfs, for irrigation of 100,000 acres.

Although Senate Document 113 does not mention RBDD, it does state that flow for the Red Bluff-Dunnigan canal would be diverted by gravity from the west bank of the Sacramento River just below Red Bluff. A USFWS report included as part of Senate Document 113 recommended screens at the diversion point of the Red Bluff-Dunnigan canal, siphons on the canal at stream crossings to reduce impacts on salmon, and estimated water requirements of 55 cfs (40,000 acre-feet/year) for the Sacramento National Wildlife Refuge.

On September 26, 1950, Public Law 839 (81st Congress; 64 Stat. 1036) was approved by President Truman, authorizing the Sacramento Canals Unit of the CVP, and re-authorizing the entire CVP, for the purposes of "…regulating flow…controlling floods, providing for the storage and for the delivery of the stored waters thereof…for the reclamation of arid lands and…other beneficial uses" The features authorized in the 1950 legislation included the "Tehama-Colusa Conduit, to be located on the west side of the Sacramento River and equipped with all necessary pumping plants…beginning at the Sacramento River near Red Bluff, California, and extending southerly through Tehama, Glenn, and Colusa Counties…"

Section 5 of the 1950 legislation provided that no expenditure of funds would be made for construction of the Sacramento canals Unit until the Secretary of the Interior, with approval of the President, submitted to Congress a completed report finding the project feasible under provisions of the Federal reclamation laws. The selected plan for development presented in that report (House Document No. 73, 83rd Congress, 1st Session) provided for the Corning Canal, the TCC and RBDD.

1951 Preliminary Evaluation Report. USFWS issued a preliminary evaluation report on fish and wildlife resources affected by the Sacramento Canals Unit of the CVP. This report identified potential impacts, the need for fish passage and screening facilities, and the potential of incorporating fish spawning areas in the TCC as mitigation features of the canal complex. The service made an assessment of the project impacts that were based on the assumption that the RBDD gates would be open from November through March.

1963 Interim Evaluation Report. USFWS conducted further evaluation of the RBDD in conjunction with Reclamation and CDFG. This led to an interim report that contained updated assessment of project impacts and mitigation and enhancement recommendations. The report stated that there would be a considerable loss of downstream migrant salmon without effective screening of the TCC intake. In addition, there would be a loss of spawning habitat as a result of inundation from the impoundment of Lake Red Bluff. As part of the proposed mitigation, a dual-purpose salmon spawning and water conveyance channel, and downstream access channel to the dual-purpose spawning channel was designed as part of the facility.

Support for fishery spawning in the canal was not shared by Reclamation because of the many problems and unknowns associated with the design criteria, the construction, and the operation and maintenance of said facilities.

1967 Fish and Wildlife Coordination Act Report. A Fish and Wildlife Coordination Act Report (FWCA) was submitted by USFWS to Reclamation on January 5, 1967. The report described RBDD and TCC project features, identified fish and wildlife resources, and addressed project impacts. The report also estimated that releases of water to Thomes and Stony Creek from the TCC would result in salmon enhancement and compensation from the proposed project. The report supported the TCFF plan for compensating salmon impacts and taking advantage of large-scale enhancement opportunities. In addition, the report listed several mitigation measures to reduce project impacts.

1992 Appraisal Report. In 1992, together with the USFWS, NMFS, and CDFG, Reclamation created the Red Bluff Fish Passage Program (Program). The purpose and need for the Program was to improve fish passage capability at RBDD for salmon migrating upstream and downstream of the river. The Program was undertaken to develop solutions to identified causes of declines in anadromous fish populations attributed to RBDD. The primary objectives of the report included the following:

- Identify alternative solutions to the causes (items 1 through 4, above);
- Perform a preliminary comparative evaluation and screening of those alternatives;
- Determine if any of the alternatives are reasonable;
- Identify additional analyses required to perform a final comparative evaluation of the reasonable alternatives for the ultimate purpose of selecting a preferred plan.

The report summarized all of the proposed alternatives, and reviewed details of the 11 selected alternatives. Additional analysis of the selected alternatives included hydrology, design and costs, economic, social factors, recreation and water quality.

The report concluded that four of the eleven selected alternatives are reasonable to consider for further development.

1998 Supplemental Fish and Wildlife Coordination Act Report. The 1998 Supplemental Fish and Wildlife Coordination Act Report (Report) was a joint effort by Reclamation and USFWS. The purpose of the Report was to: 1) supplement the 1967 FWCA; 2) address previous and current impacts of RBDD and the TCC on fish and wildlife resources; 3) recommend interim mitigation actions that can be implemented in a short timeframe; and 4) provide recommendations to identify the long-term solution at RBDD. Based on historical and current data, the Report made several recommendations to Reclamation regarding short-term and long term procedural and operational changes. These recommendations were made to further mitigate previously identified RBDD/TCC specific impacts and also benefit fish and wildlife resources on a basin-wide scope.

Programs and Studies

Juvenile Salmon Marking Studies. Hallock (1980) examined losses of outmigrating yearling steelhead trout due to RBDD. Three consecutive brood years of yearling steelhead were marked with fin clips and released into the Sacramento River above (at Coleman Hatchery) and below RBDD in relative equal numbers. Adult returns of fish released at both sites were compared to estimate the loss of outmigrating yearling steelhead due to RBDD.

Hallock also examined the effects of RBDD on the survivial of outmigrating chinook salmon fingerlins in 1981. Marked fingerlings of fall-run chinook salmon from 1974, 1975, and 1976 brood years were released above and below RBDD. The relative survival of salmon released above and below the diversion dam was measured by the percent recovery of fingerlings in the lower Sacramento River, as well as marked adults captured in the ocean and returning as spawning stock.

In 1980, Hallock and Reisenbichler examined the contribution of winter-run chinook salmon from the Sacramento River to the sport and commercial fisheries along the Pacific Coast of California, Oregon, and Washington, and to the spawning stocks of the Sacramento river.

Predation Studies. In 1977, Hall conducted a study to assess squawfish predation on juvenile chinook salmon. Predation rates were estimated using population estimates and digestion rates measured for Northern squawfish, a close relative of the Sacramento squawfish.

In 1983, Vondracek and Moyle (1983) reexamined squawfish predation on juvenille chinook salmon at RBDD. The sampling periods were chosen to coincide with releases of juvenile chinook salmon from Coleman National Fish Hatchery. Daily consumption rates were calculated using ladder counts of squawfish, mean amount of food in the digestive tract, and the gastric evacuation rate for Sacramento squawfish.

Fish Passage Action Program Fishery Investigations. The Northern Central Valley Fish and Wildlife Office (NCVFWO) conducted a five-year study, starting in October 1983, to develop methods to improve upstream and downstream anadromous fish passage at RBDD (Vogel and Smith 1984, Vogel et al. 1987 and Vogel et al. 1988). The study focused on overall mortality estimates of downstream migrant salmon, delays in downstream passage of yearling salmon and steelhead, juvenile salmonid passage at RBDD, and the associated effect of predation. Additionally, effects on adult salmonid passage were evaluated. The study concluded that dam spill configuration and spill manipulations with RBDD Standard Operating Procedures were ineffective in improving fish passage conditions for adult salmonids. The principle recommendations of this study included construction of new, larger fish ladder on east side of RBDD, enlarging the size and flow capacity of the existing ladders, raising the dam gates during the non-irrigation season, and establishing a permanent program to ensure proper operation and maintenance of all fish passage facilities.

TCC Diversion and Fishery Problems. The NCVFWO conducted a six-year study, starting in 1982, to gather data on fish entrainment through the TCC headworks, and to determine factors (principally entrainment into the Corning Calnal and the TCC, predation, and spawning habitat) limiting chinook salmon production of the DPC portion of the TCFF (USFWS 1985a, Vogel 1984b, Vogel 1989). Entrainment into the Corning Canal was estimated using fyke nets covering the pump outlets (Vogel 1989). Results of this study and the fish Passage Action Program Fisheries Investigations provided the justification for the construction of the rotary drum screens at the TCC headworks.

Interim Action Program. The interim action program, developed in 1983, involved measures, which required little or no additional studies prior to implementation to reduce fish passage problems at RBDD and increase fish production of the TCFF (USBR 1985). These measures included: 1) conversion of the lower 1,000 feet of the SPCs into rearing ponds; 2) regrading of the spawning gravel in the DPC; 3) providing radio transmitting tags for adult salmon; 4) modification of the west-bank fish ladder; 5) installation of drum screens at the head end of each SPC; 6) installation of a temporary ladder in Gate 6; 7) turning off the lights at RBDD at night; 8) cleaning equipment for the fish ladder auxiliary water diffuser grates; 9) modification of the louver bypass terminal box; 10) squawfish control at RBDD; and 11) installation of a new flip gate on RBDD Gate 11.

All of these measures were implemented, with varying results and are summarized in the 1998 FWCA.

TCC Deer Study. Prior to the completion of the construction of the canal, CDFG expressed concern to Reclamation regarding anticipated deer losses along sections of the canal that would skirt foothill areas in Glenn, Colusa, and Yolo counties. Reclamation then initiated consultation with CDFG and USFWS to reduce deer losses in the already constructed reaches and the yet to be constructed reaches. The result of these consultations was the Reaches 5-8 would have a 6-foot fence, and evaluation of fencing needs for Reaches 3 and 4 would be requested from USFWS, and Reaches 1 and 2 would not need fencing because of low reported deer losses. By 1979, with high numbers of deer losses continuing in canal Reaches 1-4 fenced with standard stock fencing, and Reaches 5-8 fenced to 6 feet (approx. 56 miles), it was evident fencing was not excluding deer from the canal right-of-way.

Reclamation again worked with CDFG and USFWS, to develop a study that 1) analyzed the history of the deer losses in the canal; 2) attempted to correlate deer losses to characteristics along the canal; 3) reviewed all possible alternatives of reducing deer losses; and 4) provided recommendations for reducing existing and potential future deer losses in the canal. Several recommendations for rehabilitation projects resulted from the study. These recommendations were aimed at improving the integrity of the existing fences, construction of new fencing, and improving monitoring of deer and animal losses. Additionally, a multi-year evaluation program was suggested, and was implemented in 1983. This program assess the success of the improvements and compared the 8 foot test fence to the existing 6 foot fence.

In 1986, USFWS outlined a plan for reducing up to 96% of deer losses in the TCC. The plan subsequently developed into a comprehensive study and analysis of historical deer loss data with segments of the canal. The results of the study are detailed in the *USFWS Tehama-Colusa Canal Deer Study Report*, October 1989. The plan recommended the construction of new fencing, upgrading existing fencing, installation of deer crossings, and the placement of watering devices at selected locations along the exterior of the right-of-way fencing. Reclamation initiated this plan with the installation of additional 8 foot fencing in certain locations along the canal, and modification of a canal overshoot into a deer crossing. Implementation of the recommended improvements reduced deer losses along certain segments of the canal significantly (USBR 1993).

Other Developments

1960 Memorandum of Agreement. Reclamation and CDFG signed a Memorandum of Agreement (MOA) for the protection and preservation of fish and wildlife resources of the Sacramento River as affected by the operation of Shasta and Keswick dams. The MOA was formalized and signed on April 5, 1960 through a State Water Rights Board action. Article I of the MOA specified minimum flow releases into the Sacramento River from Keswick Dam for the maintenance of fish and wildlife resources. Table 1 shows the minimum flow releases from Keswick per the 1960 MOA.

TABLE 1
Minimum Flow Releases from Keswick Dam per the 1960 Memorandum of Agreement

Period	Baseline Releases	Critical Dry Year Releases
January 1 through February 28	2,600 cfs	2,000 cfs

TABLE 1
Minimum Flow Releases from Keswick Dam per the 1960 Memorandum of Agreement

Period	Baseline Releases	Critical Dry Year Releases
March 2 through August 31	2,300 cfs	2,300 cfs
September 1 through November 30*	3,900 cfs	2,800 cfs
December 1 through December 31	2,600 cfs	2,000 cfs

*An agreement was formed in 1981 between Reclamation and CDFG that modified the flow requirement to 3,250 cfs to eliminate the possibility of a dramatic decrease in instream flow on December 1 (CDFG 1981).

Releases of water from Keswick Dam during the period September 1 through December 31 will be made with a minimum of fluctuation or change to achieve the best possible conditions for salmon reproduction to the extent it is compatible with other operational requirements. In addition, Article IV provides for the renegotiation of this agreement if additional water development projects are constructed on the Sacramento River or its tributary streams below Shasta Dam.

1966 Intra-agency Agreement. A Memorandum of Agreement (MOU) was made on November 28, 1966 between USFWS and Reclamation to delegate responsibility and cost allocation for the RBDD, TCC and TCFF fish facilities. The MOU designated Reclamation responsible for all of the construction of the facilities such as the fish trap and visitor’s facilities on the east bank; canal headworks and louvers; settling basin; velocity barrier; trash rack; mechanical control mechanism for aquatic weed growth’ the spawning channel; monitoring equipment; cleaning system; spawned-out rack; drum screen and check structure for the DPC; the turnout; fish ladder; headquarters building; counting facilities at the head and terminus; provisions for fry collecting tanks; spawning channels for the SPC’s; turnout structures and channel improvements for Coyote, Thomes, and Stony Creeks; access roads and supplemental fresh water supply ponds and acquisition of land for fish facilities for Thomes and Stony Creeks; and a crossing for the GCID canal at Stony Creek.

USFWS was the take over subsequent operation, maintenance and replacement of these structures except the turnouts, access roads and fish channel on Thomes and Stony Creeks. Additionally, the MOU stipulated the following minimum flows in Thomes and Stony Creeks:

	Thomes Creek	Stony Creek
Oct 1 – Dec 31	250 cfs	500 cfs
Jan 1 – Apr 30	115 cfs	350 cfs
May 1 – Sep 30	50 cfs	100 cfs

USFWS was also responsible for maintaining necessary channel capacity in the DPC and for cleaning the DPC gravel without compromising the primary function of the DPC (to make adequate irrigation deliveries). In the SPCs, USFWS was to define, operate, maintain and replace any needed cleaning equipment. They are also responsible for acquiring and administering fishery enhancement features on Thomes and Stony creeks and at RBDD that would have public access. Mitigation costs were to include all of the headworks fish louver system and 7% of all other fish facility costs, with the remaining 93% of those costs allocated as enhancement. The service was to request direct appropriation of funds from Congress for operation, maintenance and replacement of all the facilities and furnish statements of estimated and actual costs to Reclamation twice a year.

1977 Intra-agency Agreement. On November 17, 1977, another agreement was reached between Reclamation and USFWS that limited the responsibility of the Service for operation, maintenance and replacement to the east and west bank fishways, east bank trash rake, trash rack and public visitation center, monitoring equipment and counting facilities in the DPC, the bypass channel, and the terminal complex. Operation, maintenance and replacement of the SPCs from the control gates to the Sacramento River and all facilities in the right-of-way except farm roads and the interceptor drain system, were also included in the Service's responsibilities, as was Coyote Creek from the wasteway turnout to the Sacramento River, and the Fish and Wildlife Headquarters area and support facilities.

The USFWS was also responsible for removing spawned-out salmon carcasses from the project facilities. Reclamation was responsible for all but the aforementioned facilities and for cleaning the gravel and controlling aquatic pests in the DPC. This was to be done upon annual request by the Service and at other times of mutual agreement but would not interfere with the TCC irrigation purposes or be detrimental to fishery activity. Responsibility for any further additional facilities would be determined by mutual agreement.

Establishment of the NCVFWO. The USFWS NCVFWO was established in Red Bluff in 1977 as the Red Bluff Fisheries Assistance Office. One of the main purposes for establishing the NCVFWO was to evaluate fishery problems associated with RBDD and the TCFF.

Legislative and Regulatory Influences Relevant to the Action

Endangered Species Act. The ESA, most recently amended in 1988 (16 USC 1536), establishes a national program for the conservation of threatened and endangered species of fish, wildlife, and plants and the preservation of the ecosystems upon which they depend. Section 7(a) of the ESA requires federal agencies to consult with USFWS and/or NMFS on any activities that may affect species listed as endangered or threatened. The federal co-leads will consult with USFWSand NMFS as appropriate.

California Endangered Species Act. The current version of the CESA was enacted in 1984 and patterned after the federal ESA. CDFG is responsible for CESA implementation. The CESA requires lead agencies to consult before implementing projects to ensure that any action carried out by the lead agency is not likely to jeopardize the continued existence of any listed threatened or endangered species, or destroy or adversely modify "essential habitat." Essential habitat is defined as habitat necessary for the continued existence of the species. Trinity County will consult with CDFG regarding impacts to state-listed endangered and threatened species as appropriate.

Fish and Wildlife Coordination Act. The FWCA requires consultation with USFWS when any water body is impounded, diverted, controlled, or modified for any purpose by any agency under a federal permit or license. USFWS and state agencies charged with managing fish and wildlife resources are to conduct surveys and investigations to determine the potential damage to fish and wildlife and the mitigation measures to be taken. USFWS may incorporate the concerns and findings of state agencies and other federal agencies. Compliance with the FWCA will be coordinated with consultation for ESA, as described above.

Magnuson-Stevens Fishery Conservation and Management Act. The Magnuson-Stevens Act was passed in 1976, and is the primary law dealing with fisheries resources and fishing activities in Federal waters. The primary function of the act was the conservation and management of United States fishery resources via the development of domestic fisheries, and the reduction, and eventual elimination of foreign fishing activities within Federal waters. The Act provided the National Marine Fisheries Service (NMFS) legislative authority for fisheries regulation in the United States, in the area between three-miles to 200 miles offshore and established eight "Regional Fishery Management Councils (Councils) that manage the harvest of the fish and shell fish resources in these waters.
In 1995, Congress re-authorized the act with a number of provisions that intended on addressing specific problems or perceived problems with current fisheries management or Council procedures. One of the notable provisions affecting the FPIP is to protect essential habitat for fish in the fishery for spawning, breeding, feeding or growth to maturity.

Description of the Proposed Action

Purpose and Need

The purpose of proposed action is twofold:

- To substantially improve the long-term ability to reliably pass anadromous fish and other species of concern, both upstream and downstream, past RBDD and,
- Substantially improve the long-term ability to reliably and cost effectively move sufficient water into the TC Canal and Corning Canal systems to meet the needs of the water districts served by the Tehama-Colusa Canal Authority (TCCA).

The need for the project is driven by the continued and well-documented fish passage and agricultural water diversion reliability problems associated with the operation of RBDD. Even with the current fish ladders in operation, RBDD continues to act as an impediment to fish passage during the gates-in period. The 4-month window of operation has constrained operation of the dam for diversion purposes to the point that TCCA cannot reliably meet the water needs of its customers when the gates are out.

Process of Selecting the Proposed Project

In the process of selecting a proposed project a series of screening criteria were developed. The initial alternative screening exercise concluded that alternatives requiring an increase in gates-in operations would not improve fish passage, and therefore would not meet the purpose of the project. Even with improvements to existing ladders, it was determined that maximum fish passage efficiency is achieved with gates out; therefore, an increase in gates-in operations would reduce fish passage by some degree. Therefore, all of the alternatives that were considered in greater detail 4-month-or-less-gates-in operations. This resulted in alternatives that were largely similar in their gate operation assumptions, but covered a wide variety of facility options for pumping water for agricultural deliveries or providing improved fish passage.

From these considerations three primary alternatives were developed:

- Alternative 1 – Current 4-months gate operation with fish passage facility improvements and 1,700-cfs total pumping capacity,
- Alternative 2 – A reduction in gate operation to the 2 months correlating with peak agricultural demand (July and August), fish passage facility improvements, and 2,000-cfs total pumping capacity,
- Alternative 3 – Elimination of gates-in operation and need for fish ladders; 2,500-cfs total pumping capacity.

Additionally, the California Environmental Quality Act (CEQA) requires that the preferred alternative be compared to an existing conditions baseline, whereas the National Environmental Policy Act (NEPA) requires comparison with a No Action Alternative. The No Action Alternative represents ongoing activities and operations and corresponds to the “No Project” definition as outlined in the state CEQA *Guidelines*, Section 15126, as a “condition that would be reasonably expected to occur if the project were not approved.”

Additional screening criteria were developed to narrow the list of potentially feasible alternatives. The express purpose was to identify facility options that would create alternatives that have the greatest likelihood of success. Facility options were compared and evaluated against the following criteria:

- Effectiveness – technology, management of water delivery, and biological requirements that combine to provide a high likelihood of long-term success,
- Implementation – practical execution, including potential public acceptance issues, permitting, and land use issues, and constructibility,
- Environmental – impacts to resources with emphasis on special-status species, including native fish species, including both short-term (construction-related) and long-term impacts,
- Cost – relative comparison of estimated life-cycle costs for each alternative, including initial capital costs and operation and maintenance (O&M) costs.

Following the full consideration of the facility options and gate operation restrictions the following alternatives were proposed for full environmental analysis and were analyzed in the Fish Passage Improvement Project Environmental Impact Study/Environmental Impact Report (EIS/EIR). The final alternatives selected are summarized in Table 2 below.

TABLE 2

Summary of Final Alternatives

	Gates-in Operation		Fish Passage Facilities			Gates-out Water Supply				
Name	**Duration**	**Timing**	**Right Bank (cfs)**	**Center (cfs)**	**Left Bank (cfs)**	**Research Pumping Plant (cfs)**	**Right Fish Ladder (cfs)**	**Mill Site (cfs)**	**Stony Creek (cfs)**	**Total (cfs)**
Existing Conditions	4 months	May 16-Sept 15	Existing 338	Existing 100	Existing 338	240	165		600	1,005
No Action Alternative	4 months	May 16-Sept 15	Existing 338	Existing 100	Existing 338	320	165			485
1A: 4-month Improved Ladder Alternative	4 months	May 16-Sept 15	New 800	Add if needed	New 831	320		1,380		1,700
1B: 4-month Bypass Alternative	4 months	May 16-Sept 15	New 800	Add if needed	Bypass channel 1,000; existing 338	320		1,380		1,700
2A: 2-month Improved Ladder Alternative	2 months	July 1-August 31	New 800	Add if needed	New 831	320		1,680		2,000
2B: 2-month with Existing Ladders Alternative	2 months	July 1-August 31	Existing 338	Existing 100	Existing 338	320		1,680		2,000
3: Gates-out Alternative	0 months					320		2,180		2,500

Following the secondary screening and the final selection of alternatives a request to the resource trustees was made by Reclamation to provide comments on the alternatives proposed by the TCCA. As a response to that request, the U. S. Department of Interior's Sacramento Fish and Wildlife Service (Service) Office began collaborations with California Department of Fish and Game (CDFG) and National Marine Fisheries Service biologists in preparation of a Planning Aid Memo (Memo) under the authority of provisions of Section 2(b) of the Fish and Wildlife Coordination Act (FWCA) 48 Stat. 401 as amended: 16 U.S.C. 661 et seq. The comments contained in the Memo were developed in coordination with the FWS's Red Bluff Fish and Wildlife Office (USFWS, 2001). In the Memo dated October 19, 2001, the Service provided a ranking of the proposed alternative based on the benefits to the fishery resources at RBDD. The Memo provided the list below ranking the alternatives (for alternative number and its description see Table 2 above) with the most benefit to fishery resources first and the alternative with the least benefit last:

- (1) Alternative 3
- (2) Alternative 2(b)*
- (3) Alternative 2(a)**
- (4) Alternative 1(a)
- (5) Alternative 1(b)

Letters to Reclamation from CDFG and NMFS dated October 23, 2001 and October 26, 2001 respectively, concurred with the Services's comments and rankings provided in the Planning Aid Memo dated October 19, 2001. In a letter to Reclamation, dated January 8, 2002, the California Department of Water Resources concurred with the comments contained in the Service's Planning Aid Memo (DWR, 2002) finding that either Alternative 3 or the 2 month gates-out alternatives [2(a) or 2(b)] would best meet the balance of fishery benefits and water supply needs. Finally, the Red Bluff-Tehama County Chamber of Commerce (RB-TCCC) has stated in a letter (dated January 3, 2002) to both the TCCA and Reclamation that they oppose any alternative that eliminates the seasonal impoundment of the Sacramento River behind the gates of the RBDD (RB-TCCC, 2002).

Proposed Project for the Purposes of Developing this Biological Assessment

To facilitate the timely review of the draft BA by the Authority and the preparation of the Biological Opinion by NMFS, the following project description was used:

- 2-month gates-in operation of the RBDD (July 1-August 31),
- 2,180 cubic feet per second (cfs) pump station footprint at the Mill Site with 1,680 cfs installed capacity,
- Existing fish ladders.

For the purposes of impacts assessment, and through discussions with the Technical Advisory Group over several months, the above project description represents the "worst-case likely project" and is the Proposed Project of this Biological Assessment.

Improved agricultural water deliveries would be achieved with operation of 2,000 cfs of pumping capacity (320 cfs at RPP; 1,680 cfs at Mill Site). Water would be conveyed via a pipeline from the Mill Site Diversion Facility across Red Bank Creek to the TC Canal Headworks. Improvements to fish passage would be achieved through the reduction in gate operations. Existing ladders would continue to be operated at the right and left abutments (right 338 cfs, left 338 cfs, for a total of 676 cfs) during the gates-in period (July-August). The current center fish ladder would not be installed in RBDD under this Proposed Alternative. Finally an Adaptive Management Program would be implemented to provide decision making guidance in future year's operations.

Implementation of the project is a five phase process. The five phases include: 1) Feasibility Study; 2) Preliminary Design and Environmental Documentation; 3) Final Design and Permit Coordination; 4) Construction; 5) Monitoring. Currently, the project is in the Environmental Documentation Phase (Phase 2). As of the 2002 Administrative Draft EIS/EIR construction is scheduled to be completed in late 2006. Timely completion of Phases 3, 4, and 5 depend primarily on funding, however other factors such as land and permit acquisition can also influence the schedule. Until such funding is found, and the Construction Phase (Phase 4) of the project has been completed, current operation of all RBDD and TCCA facilities, including diversions from Stony Creek, will continue uninterrupted.

Proposed Facilities

Mill Site Pump Station

The preferred pump station option is a conventional vertical propeller pump station at the Mill Site used in conjunction with the existing RPP to meet the water delivery needs. The Mill Site is located upstream from RBDD and Red Bank Creek.

The station site configuration consists of trashracks or fish screens, a forebay or intake piping, pump station, and conveyance facilities. A fish bypass system may be needed, depending on the length of the fish screens and the type of pumping system. There are several potential combinations of intake and pumping facility options.

For the vertical propeller pump option, the discharge piping would be routed to a new discharge outlet structure at the sedimentation basin. It is assumed that the drum screens would be removed under this option. When the gates are in, water would be diverted by gravity through the fish screens into the new forebay and would then bypass the pump station into the conveyance system for delivery to the sedimentation basin.

The Mill Site Pump Station facilities would include a fish screen along the river. The screens would be designed to provide a 0.33-fps approach velocity. The length of the screen depends on the the characteristics of the river (i.e., depth, channel geometry, flow volume, and velocity under various operating conditions) at the screen location, which would be determined during preliminary design. Because the pumpstation footprint will be designed to accommodate the full 2,180 cfs pumping capacity, the length of the screen would be approximately 1,100 feet. The screens would be installed in approximately 60 bays. Blowout panel(s) would be provided as an emergency hydraulic relief system in the event of differential heads between the river and the forebay. The top of bulkheads would be set at the 25-year flood elevation to limit the amount of debris in the forebay for most extreme flood events. A cofferdam would be constructed around the screens and the site dewatered to allow construction of the screens.

Water would flow through the fish screens into the pump station forebay and into the vertical propeller pump station. Approximately 6pumps would be required to achieve a pumping capacity of 1,680 cfs. The location of the pump station relative to the fish screens would be determined during preliminary design. Considerations for the location would include the cost of excavating the forebay versus piping, as well as the hydraulic flow characteristics entering the pump station.

The pumps would lift the water to the pump station outlet box. The water would flow by gravity from the outlet box through a siphon under Red Bank Creek. The water would discharge downstream of the fish drum screens in the sedimentation basin. The site plan area requirements and sizes of conveyance facilities are based on the pumping capacity requirement for 2,180 cfs pumping capacity.

The land where the pump station and conveyance facilities would be constructed is adjacent to land owned by the federal government for RBDD and is currently available for purchase. Power supply is nearby, and access is in place. Direct access to the pump station site from the existing RBDD site would likely require a bridge across Red Bank Creek.

Fish Screen Design Criteria

The objective of the fish screen design is to provide safe fish passage for juvenile fish (primarily salmon and steelhead) past TCCA water diversion facilities. This would be accomplished through the use of positive barrier on-river fish screens.

The required approach velocity of 0.33 fps would be used for on-river applications to meet CDFG criteria. The lengths and depths of the screens for each option were derived from preliminary hydrographic field surveys at each of the proposed pump station sites.

Fish Bypass System

A minimum of three internal fish bypasses would be required for the Mill Site vertical pump station option at the maximum 2,500-cfs pumping capacity, assuming the normal riverflow of 12,000 cfs during the irrigation season. A pumped bypass system would use the fish-friendly screw or helical pumps that have been tested at RPP over the past several years.

The fish bypass piping system would be sized to achieve a minimum velocity of 4 fps to convey fish back to the river and minimize sediment deposition in the pipeline. At the minimum bypass entrance velocity of 2 fps, the required flow for each bypass pipeline at normal river elevations is about 36 cfs. The fish bypass would outlet just below the downstream end of the fish screen in the river channel. Alternatively, the fish could be conveyed in a separate pipeline from the fish bypass pumps to the existing drum screen bypass system pipeline. This would require a piped bypass system paralleling the discharge conveyance system to the sedimentation basin, about ½ mile long. The pipeline would be constructed across the sedimentation basins and connect to the existing fish bypass pipe from the drum screen bypass.

Fish bypasses would be designed to limit the exposure along the fish screen to 120 seconds, which is the current exposure time criterion, assuming a variance would be granted by NMFS. Separate pipelines from the entrance of each fish bypass would convey water and fish to a screw/helical pump station located on the east side of the forebay. An exception to the current “no pumped fish bypass” criterion would be required from NMFS, or an exception to the maximum exposure time would be required to eliminate the need for the fish bypass system.

The fish bypass pump station would be similar to the existing RPP located downstream of the irrigation gates. Two 30- to 50-cfs pumps would be required for the 4 for the 1,680 cfs pumping capacity. The pumps would convey the water and fish back to the river upstream of the current gravity-flow intake gates.

Conveyance Facilities across Red Bank Creek

The conveyance system across Red Bank Creek would consist of pipes or culverts or a combination of both. The most advantageous combination would be considered in the preliminary design. The conveyance system would be sized for a maximum velocity of 8 fps at peak flow. The discharge structure at the sedimentation basin could be located anywhere along the westerly side of the sedimentation basin. The best apparent location and the specific design would be determined during the preliminary design.

A vehicle access bridge would most likely be constructed across Red Bank Creek to provide access for maintenance vehicles between the Mill Site and the existing TCCA facilities.

- Major project Benefits

Chapter 3 – Listed Species Potentially Affected by the Proposed Action

Species Found in Action Area that have status under ESA/CESA

The Sacramento River provides habitat for the freshwater life stages of chinook salmon as well as steelhead. Within California's Central Valley, the Sacramento River provides a corridor for the anadromous salmonid resources between upstream reaches and the tributaries to the Sacramento River and the Pacific Ocean. The Sacramento River is the largest river system in California with more than 90 percent of the Central Valley salmon spawning and rearing within the river system. The Sacramento River supports four runs (races) of chinook salmon: fall, late-fall, winter, and spring run. Life history characteristics for native anadromous species found near RBDD are shown in Table 3 .

The fall-run chinook salmon is the predominant salmon in the Central Valley. Fall-run steelhead are also found in the Central Valley with almost the entire population restricted to the Sacramento River watershed The number of chinook salmon and steelhead spawners estimated passing upstream of RBDD from 1960 through 1966 are summarized in Table 4.

TABLE 3
Life History Characteristics of for Anadromous Salmonid and Green Sturgeon found near RBDD

Name	Adult Immigration	Spawning	Incubation	Rearing	Juvenile Emigration
Fall Chinook Salmon	July-December	September-December	October-March	December-June	December-July
Late-fall Chinook Salmon	October-April	December-April	January-June	April-November	April-December
Spring Chinook Salmon	April-July	August-October	August-December	October-April	October-May
Winter Chinook Salmon	December-July	April-August	April-October	July-March	July-March
Steelhead	Year-round	December-April	December-June	Year-round (1-2 years)	January-December
Green sturgeon	February-June	March-July	Embryos planktonic	Larvae in river, juveniles in Delta	June-August

TABLE 4
Estimated adult salmonids passing RBDD from 1960-1966 (Hallock 1987)

Year	Winter-run	Spring-run	Fall-run	Late-fall-run	Steelhead

	Chinook	Chinook	Chinook	Chinook	
1960	183,529	45,760	244,705	78,306	21,289
1961	121,153	30,207	161,537	51,692	14,054
1962	115,346	28,759	153,794	49,214	7,771
1963	127,421	31,770	169,895	54,366	11.092
1964	124,094	30,941	165,459	52,947	14,752
1965	86,891	21,665	115,855	37,074	14,236
1966	95,461	23,801	127,281	40,730	15,803

Winter-run Chinook Salmon

Winter-run begin their migration up the Sacramento river in mid-December and may spawn from mid-April through mid-August. The egg incubation period extends from mid-April through mid-September. Historically, before the construction of Shasta and Keswick Dams and other barriers to fish migration on tributaries of the Sacramento River, winter-run chinook salmon (possibly more than 200,000) spawned in the upper reaches of the Little Sacramento, McCloud, Calaveras, and lower Pit Rivers (NMFS 1993a), tributaries of the Sacramento River upstream of Shasta Dam. Winter-run chinook were blocked from their historic spawning areas by the construction of Shasta and Keswick Dams in the early 1940's, but can reproduce in the Sacramento river downstream of Keswick Dam because of cooler summer water temperatures resulting from Shasta Reservoir releases.

In the 1960's, 98% of winter-run chinook salmon spawned in the upper Sacramento River (Hallock and Fry 1967). The other 2% were not accounted for, but no satisfactory escapement records are available for winter- or spring-run chinook before RBDD.

For Sacramento River winter-run chinook salmon, ESU critical habitat is designated to include the following: Sacramento River from Keswick Dam in Shasta County (River Mile [RM] 302) to Chipps Island (RM 0) at the westward margin of the Sacramento-San Joaquin Delta; all waters from Chipps Island westward to Carquinez Bridge including Honker Bay, Suisun Bay, and Carquinez Strait; all waters of San Pablo Bay westward of the Carquinez Bridge; and all waters of San Francisco Bay (north of the San Francisco/Oakland Bay Bridge) from San Pablo Bay to the Golden Gate Bridge. Major river basins containing spawning and rearing habitat for this ESU comprise approximately 9,329 square miles in California. The following counties lie partially or wholly within these basins: Butte, Colusa, Contra Costa, Glenn, Napa, Nevada, Placer, Plumas, Sacramento, Shasta, Solano, Sutter, Tehama, Trinity, Yolo, and Yuba.

Spring-run Chinook Salmon

Spring-run chinook salmon migrate upstream during the spring beginning in mid-March, hold over in deep pools during the summer months and spawn from mid-August through mid-October. Egg incubation occurs from mid-August to mid-January. Spring-run in the Sacramento river exhibit an ocean-type life history, emigrating as fry, subyearlings, and yearlings. Based on timing observations observed at RBDD, spring-run emigration from the upper Sacramento river typically occurs from November through April.

Prior to Keswick Dams, and other barriers to fish migration on tributaries of the Sacramento River, spring-run chinook salmon spawned in the upper reaches of the Sacramento River and its tributaries. Approximately 8% of spring-run chinook salmon passing RBDD spawns in tributaries of the Sacramento River, including Battle, Cottonwood, South Cow and Clear Creeks.

Spring-run chinook salmon run size estimates for the Sacramento river have declined substantially in recent years. Since 1991, adult spring-run population estimates have remained below 1,000 fish. Coded wire tag recoveries and genetic testing between fall/late-fall and spring-run chinook salmon from Feather River Hatchery have lead to speculation that these two runs may have hybridized in recent years (63 FR 11487). The remaining genetically pure spring-run chinook salmon are thought to occur only in Deer, Mill, and Butte Creeks. Spring-run chinook salmon population levels are described as sporadic in Battle Creek, Big Chico Creek, Antelope Creek, Cottonwood Creek, Yuba River and the Sacramento River (CDFG 1996).

Critical habitat for federal Central Valley spring-run chinook salmon ESU is designated to include all river reaches accessible to listed chinook salmon in the Sacramento River and its tributaries in California. Also included are adjacent riparian zones, as well as river reaches and estuarine areas of the Sacramento-San Joaquin Delta; all waters from Chipps Island westward to Carquinez Bridge including Honker Bay, Grizzly Bay, Suisun Bay, and Carquinez Strait; all waters of San Pablo Bay westward of the Carquinez Bridge; and all waters of San Francisco Bay (north of the San Francisco/Oakland Bay Bridge) from San Pablo Bay to the Golden Gate Bridge. Excluded are tribal lands and areas above specific dams or above longstanding, naturally impassable barriers (i.e., natural waterfalls in existence for at least several hundred years). Major river basins containing spawning and rearing habitat for this ESU comprise approximately 9,329 square miles in California. The following counties lie partially or wholly within these basins (or contain migration habitat for the species): Alameda, Butte, Colusa, Contra Costa, Glenn, Marin, Napa, Nevada, Placer, Sacramento, San Francisco, San Mateo, Shasta, Solano, Sonoma, Sutter, Tehama, Yolo, and Yuba.

Fall-run Chinook Salmon

The fall/late-fall runs constitute the largest population of chinook salmon in the river in recent years. Between 1967 and 1997, run size estimates have ranged from approximately 50,000 to over 200,000 adults. The fall/late-fall-run spawn from October through February and eggs may incubate in the gravel through the end of April. Due to the prolonged spawning and incubation period, juvenile rearing and emigration is dispersed nearly throughout the entire year.

It is estimated that 25 to 60% of the fall-run chinook salmon passing RBDD are Coleman National Fish Hatchery fish (USFWS 1993a), on Battle Creek. For example, in 1996 an estimated 110,000 fall-run chinook passed RBDD; approximately 73,000 (66%) escaped to Battle Creek of which 21,000 (19%) were taken by the hatchery and 52,000 (47%) spawned in

Battle Creek, the remainder spawned in the mainstem Sacramento River (30,000; 27%) and Clear Creek (6,000; 5%) (Rich Johnson, USFWS-NCVFWO).

The estimated number of fall-run chinook from 1956 to 1966, ranged from 61,887 to 292,704, with an average of 159,251 salmon (Hallock 1987).

Late-fall-run Chinook Salmon

Approximately 4% of the late-fall run chinook salmon passing RBDD spawn in Sacramento River tributaries, including Cottonwood, Cow, and Clear Creeks. For the period of 1967 to 1991, the average number of late-fall-run chinook naturally spawning upstream of RBDD was 14,159 fish based on escapement estimates and approximately 1,000 late-fall-run chinook salmon were spawned annually at the Coleman National Fish Hatchery from 1967-1991 (CDFG 1994).

Steelhead

Based on data from 1967 to 1974, 28% of the adult steelhead migrating past RBDD spawn in the upper reaches of Sacramento River tributaries, including Battle, Cottonwood, and Cow Creeks, between RBDD and Keswick Dam, and 28% are spawned at the Coleman National Fish Hatchery, while the remaining 46% are caught by sport anglers; very few, if any, steelhead spawn in the mainstem Sacramento River (Leidy et al. 1984).

Hallock (1989) gives calculated population estimates of steelhead in the Sacramento River above the Feather River from 1962 to 1970. Numbers of steelhead migrating upstream past RBDD for 1962 to 1966, as shown in table 2 below were calculated by multiplying the above population estimates by 42.8% (the average percentage, for 1967-70, of steelhead in the Sacramento River above the Feather River that passed RBDD). Based on the data for 1962-66, the number of steelhead passing RBDD was 8.7% of the number of fall-run. Thus, numbers of steelhead in the Sacramento River in 1960 and 1961, as shown in Table 2, were calculated by multiplying the number of fall-run in table 2 by 8.7%.

Critical habitat for Central Valley steelhead ESU is designated to include all river reaches accessible to listed steelhead in the Sacramento and San Joaquin Rivers and their tributaries in California. Also included are adjacent riparian zones, as well as river reaches and estuarine areas of the Sacramento-San Joaquin Delta; all waters from Chipps Island westward to Carquinez Bridge including Honker Bay, Grizzly Bay, Suisun Bay, and Carquinez Strait; all waters of San Pablo Bay westward of the Carquinez Bridge; and all waters of San Francisco Bay (north of the San Francisco/Oakland Bay Bridge) from San Pablo Bay to the Golden Gate Bridge. Excluded are areas of the San Joaquin River upstream of the Merced River confluence, tribal lands, and areas above specific dams or above longstanding, naturally impassable barriers (i.e., natural waterfalls in existence for at least several hundred years). Major river basins containing spawning and rearing habitat for this ESU comprise approximately 13,096 square miles in California. The following counties lie partially or wholly within these basins (or contain migration habitat for the species): Alameda, Amador, Butte, Calaveras, Colusa, Contra Costa, Glenn, Marin, Merced, Nevada, Placer, Sacramento, San Francisco, San Joaquin, Shasta, Solano, Sonoma, Stanislaus, Sutter, Tehama, Tuolumne, Yolo, and Yuba.

Green Sturgeon

Green sturgeon have been caught in saltwater from Ensanada, Mexico, to the Bering Sea (Miller and Lea, 1972). In California, green sturgeon have been recorded in lower reaches of the Sacramento-San Joaquin River system, the Eel River, Mad River, Klamath River, and Smith River (Moyle, 1976). In California, spawning has been confirmed only in the Sacramento River and the Klamath River (Moyle et al., 1995). After the construction of Keswick Dam and storage of the reservoir in 1948, the primary spawning areas were from Keswick Dam to Hamilton City (USFWS, 1998).

USFWS routinely observes adult sturgeon in the vicinity and downstream of RBDD when the dam gates are in (K. Brown, pers. com.).. It is unclear if all or the majority of these are green or white sturgeon (D. Killam, pers. com.). Green sturgeon have been observed downstream of RBDD at Dairyville, Tehama County (RM 234), in the 10-mile reach of the Sacramento River downstream of RBDD, and near Hamilton City, Glenn County (RM 197) (Moyle et al., 1995). Green sturgeon life history characteristics are summarized in Table 1.

The habitat requirements and characteristics for green sturgeon are poorly known, but spawning and larval ecology is likely similar to that of white sturgeon (Moyle et al., 1995). Green sturgeon are thought to require colder and cleaner water than do white sturgeon (Moyle et al., 1995). Spawning occurs between March and July when water temperatures reach between 46°C and 57°C (Moyle et al., 1995). Spawning takes place in swift, deep water (>10 feet) where eggs are broadcast over clean sand to large cobble substrates.

Following egg hatching, larvae drift passively downstream and reach juvenile stages beginning at about 2 cm in length. Juvenile sturgeon are routinely captured in traps at RBDD during the summer months (K. Brown, pers. com.).As indicated by trapping data, the majority of juveniles pass through the vicinity of RBDD from June through August. Juvenile green sturgeon are transported and rear in the Sacramento-San Joaquin Delta and Suisun-San Pablo Bay estuary for one or more years before entering the deeper San Francisco Bay and exiting into the ocean. They enter the ocean primarily during the summer and fall before they are 2 years old (Moyle et al., 1995).

Juvenile green sturgeon are transported and rear in the Sacramento-San Joaquin Delta and Suisun-San Pablo Bay estuary for one or more years before entering the deeper San Francisco Bay and exiting into the ocean primarily during the summer and fall before they are 2 years old (Moyle et al., 1995). Individual green sturgeon have been tagged in San Pablo Bay and recovered from Santo Cruz, California, to Gray's Harbor, Washington (Chadwick, 1959 and Miller, 1972 as cited by Moyle, 1995). Little is known about the age and growth of green sturgeon except that they are long lived and reach a maximum size of 2.3 meters fork length and 159 kilograms (Skinner, 1962).

Chapter 4 – Environmental Baseline

Introduction

This chapter on the environmental baseline describes the impacts of past and ongoing human and natural factors leading to the present status of the species and its habitat within the action area. The environmental baseline provides, in effect, a "snapshot" of the relevant species' health at a specified point in time (i.e. the present). It does not include the effects of the discretionary action proposed in the current consultation, but it does include past and present impacts of all federal, state, or private actions and other human activities in the action area. 50 CFR Section 402.02. For purposes of this BA, the current effects of all past activities including those associated with construction of the Project, historic operation of the Project, and the associated natural environment. The baseline also includes Federal, State, local, and private actions already affecting the species or habitat in the action area or actions that will occur contemporaneously with the consultation in progress. The environmental baseline assists both the action agency and the Services in determining the effects of the proposed action on the listed species.

Past and Present Impacts of Current Operations, all Federal, State, or Private Actions and Other Human Activities in the Action Area.

RBDD Operational Impacts

Impacts of current operations to Winter-run Chinook Salmon

Under current operations, approximately 15 percent of winter chinook adult spawners passing through the project area may be blocked or delayed by the current 4 months of gates-in operation. The percentages of entire adult population of winter-run chinook that are attempting to pass RBDD and may be impacted are listed by month as follows:

- Late May—4 percent of annual total
- June—4 percent of annual total
- July—10 percent of annual total

For winter chinook salmon, the earliest dispersing and outmigrating juveniles may be subjected to adverse effects from RBDD operations. Approximately 39 percent of winter chinook salmon are subjected to the operational effects of RBDD and its associated diversion facilities. The percentage of the annual juvenile winter-run chinook salmon passing RBDD that are presently subject to operational impacts are listed by month as follows:

- July—1 percent

- August—12 percent
- Early September—26 percent

Impacts of current operations to Central Valley ESU Spring-run Chinook Salmon

By far, the greatest effect of RBDD operations on adult salmonids is to spring-run chinook salmon. Approximately 75 percent of the annual adult spring chinook spawners passing through the project area must do so during the current gates-in operation. The approximate percentages of the annual adult population passing RBDD are listed by month as follows:

- Late May—22 percent
- June—38 percent
- July—9 percent
- August—2 percent

Impedance of these adult spring chinook by RBDD operations may adversely affect their ability to successfully pass upstream into and through the Sacramento River and into tributary streams and headwater reaches. It is in these headwater reaches in the tributaries and the most upstream portion of the mainstem Sacramento River that the majority of spring-run chinook salmon must hold throughout the summer months before spawning in the early fall. The biological consequences of blockage or passage delay at RBDD results in changes in spawning distribution, hybridization with fall chinook, increased adult pre-spawning mortality, and decreased egg viability, which result in the reduction of annual recruitment of this species.

Currently, it is difficult to precisely characterize the temporal distribution of adult spring-run chinook salmon as they past RBDD. This is because prior to mid-May the gates-out operations at RBDD preclude the use of the fish ladders and therefore the enumeration of adults as they pass RBDD. However, once the RBDD gates go in during in May, spring run chinook are identified as they pass. The exact effect of lowering the gates during this species peak immigration period is unknown but as this species is threatened, it is not be desirable to interrupt their migration.

For juvenile spring-run chinook salmon , approximately less than 1 percent of the annual number of juveniles passing RBDD are vulnerable to operations and facilities at RBDD.

Impacts of current operations to Central Valley ESU Fall/Late-Fall Run Chinook Salmon

Up to 25 percent of the annual run of adult fall chinook salmon may be affected by the current gates-in operation. The percentages of the annual population passing RBDD that may be impacted are listed by month as follows:

- July—2 percent
- August—13 percent
- Early September—10 percent

As previously stated adult late-fall chinook salmon are not presently blocked or impeded by operations of the RBDD.

The annual percentage of juvenile fall-run chinook salmon passing RBDD that are presently subject to operational impacts are listed by month as follows:

- Late May—2 percent
- June—3percent
- July—2 percent
- August—1 percent

The annual percentage of juvenile late-fall run chinook salmon passing RBDD that are presently subject to operational impacts are listed by month as follows:

- Late-May—4 percent
- June—4 percent
- July—7 percent
- August—14 percent
- Early September—5 percent

Impacts of current operations to Central Valley ESU Steelhead

For migrating adult steelhead, approximately 17 percent of the annual adult steelhead run may be affected by the current gates-in operation. The percentages of the annual run of adult steelhead passing RBDD that may be affected are listed by month as follows:

- June—1 percent
- July—1 percent
- August—5 percent
- Early September—10 percent

Approximately 36 percent of juvenile steelhead passing RBDD during the gates-in period subject to operational impacts are listed by month as follows:

- Late May—6 percent
- June—4 percent
- July—4 percent
- August—12 percent
- Early September—10 percent

Impacts of Current operations to Green Sturgeon

When the dam gates are placed in the river, a physical barrier is created that prevents passage of adult sturgeon. Currently, a large portion of the adult green sturgeon successfully passes RBDD unimpeded because they are immigrating during the period prior to May 15 when the RBDD gates go in. However, because sturgeon prefer lower water velocity and do not readily jump fish ladder weirs like salmonids, the existing fish ladders that operate during gates-in operations prevents any upstream passage of adult green sturgeon.

Under current operations, approximately 35 percent of adult green sturgeon spawners passing through the project area may be blocked by RBDD. The percentages of entire adult population of green sturgeon that are attempting to pass RBDD and may be impacted are listed by month as follows:

- Late May—approximately 15 percent
- June—approximately 20 percent of the annual upstream of RBDD

In addition, some adult green sturgeon are delayed in their down-river migration by RBDD after spawning occurs upstream of the dam prior to May 15 if these fish arrive at RBDD on or after May 16 when the dam gates go in.

During gates-in periods at RBDD, approximately 99 percent of the larval or juvenile life stages of anadromous green sturgeon that were spawned upstream of RBDD migrate downstream through the project facilities. During gates-in operation, existing pathways for these life stages includes passage under the dam gates or through the fish ladders and their auxiliary water systems, or they are subjected to impingement, entrainment, and passage through diversion bypass systems at RPP and TC Canal headworks. An additional effect of the existing operations of RBDD on larvae or juvenile green sturgeon includes predation by both fish and avian species while passing through Lake Red Bluff and downstream of the dam.

With the current gates-in operations, approximately 99 percent of annual juvenile green sturgeon passing RBDD are subjected to the operational effects of the dam and its associated diversion facilities. The annual percentage of juvenile green sturgeon passing RBDD that are presently subject to operational impacts are listed by month as follows:

- Late May—less than 1 percent
- June—37 percent
- July—50 percent
- August—11 percent

Impacts to Habitat

Chinook salmon spawn in waters with depths greater than 0.5 feet, with velocities just above the substrate of 1.5 to 2.5 ft/s, and with an uncompacted gravel substrate of one to 6-inches diameter. Eggs generally hatch after 40 to 60 days depending on water temperatures.

Pre-emergent fry incubate in the gravel for approximately 2 to 4 weeks before emerging from the redds.

The construction of Shasta and Keswick dams eliminated the major source of gravel recruitment (USFWS, 1997). Since the construction of Whiskeytown dam and extensive gravel extraction from Clear Creek the remaining source of spawning gravel is from the Cottonwood watershed (op. cite.). Loss of gravel recruitment is believed to be a major contributing factor to declining chinook salmon productivity in the upper Sacramento River below Keswick Dam. The Upper Sacramento River Fisheries and Riparian habitat Management Plan ranks restoration of spawning habitat third in a list of twenty action items to restore the salmon fishery (Upper Sacramento River Fisheries and Riparian Habitat Advisory Council 1989). The California Department of Water Resources (CDWR) began a gravel restoration project within the upper river in 1990. Through 1996 a total of 125,000 cubic yards of spawning gravel have been introduced into the upper Sacramento River at nine sites, two of which were upstream of the ACID diversion dam (Rectenwald pers comm as cited by NSR, 1999). Gravel introductions upstream of ACID diversion dam have substantially increased the amount of spawning habitat since 1987. Good and fair quality spawning habitat areas upstream of the ACID diversion now cover approximately 49% of the river bed (Bigelow 1996).

Flood control projects between Collinsville (Sacramento River RM 0) and Chico Landing (RM 194) have profoundly affected the quantity and quality of chinook salmon and steelhead habitats in the Sacramento Valley (NMF, 1997). Presently over 1,300 miles of levees, overflow weirs, pumps and bybass channels exist within this reach of the Sacramento River. Currently, riparian forests along the river constitutes approximately 3% (16,000 acres) of the historic riparian forest that bordered the river in 1850 (approximately 500,000 acres) (NMFS, 1997). The degradation and fragmentation of riparian habitats has resulted in losses of instream and above stream cover, elimination of slow and slack water areas, reduction in food production and raising of water temperature all detrimental to juvenile salmon and steelhead (op. cite.).

Similar to the discussion of the impacts of habitat modification and losses for chinook salmon it is likely that suitable flows and channel conditions in the Sacramento River and Delta for spawning and rearing of green sturgeon occur less frequently now than they once did (Moyle at al., 1995). Because Red Bluff Diversion Dam has apparently been a barrier to green sturgeon migration until recently, it is possible that they have been forced to spawn in suboptimal conditions in the lower Sacramento River (CDFG, Website).

Impacts to Water Quality/Temperature

Maximum survival of incubating eggs occurs at water temperatures between 40°F and 56°F, while maximum survival of pre-emergent fry occurs at water temperatures between 40°F and 58°F. Sublethal effects begin to occur to eggs and fry at temperatures greater than 56°F.

Water temperature is an important factor in controlling survival, development, and growth of fish during all life history stages, and is the only water quality constituent in the Sacramento River at RBDD that exceeds state water quality standards or objectives. According to the State Water Resources Control Board's Order 90-5, the temperature objective for the operation of CVP for the upper Sacramento River from Keswick Dam to RBDD is less than or equal to 56°F (CALFED Bay-Delta Program, 1999).

The water temperature objective that was stipulated by Order 90-5 was exceeded 85 percent of the time during the gates-in period for 1998 through 2000. The average temperature of Lake Red Bluff for the gates-in period during this interval was 56.7°F. Newly spawned and incubating eggs and fry are the most sensitive life stages to elevated temperatures (NMFS, 1997). Mortality of eggs begins at 56 °F. and is 100% at 62 °F. (numerous authors as cited by NMFS, 1997). The problem of inadequate water temperatures has occured over the last 2+ decades due to increased demand for CVP water. Since 1992, CVP operations have been modified due to water temperature needs for the protection of winter-run chinook salmon as required by the Endangered Species Act (ESA). Water temperatures in the middle and lower reaches of the Sacramento River are generally influenced by releases from Shasta (NMFS, 1997). Recent research has found that spring to early summer water temperatures in the Sacramento River may have risen from 2° to 7° F. since the late 1970's (op. cite.). It is thought that this temperature increase near Red Bluff, Butte City, and Grimes may be a result of streamflow reductions in this reach (op. cite.).

Pollution sources such as acid mine drainage containing large concentrations of copper, zinc, and cadmium from the Iron Mountain Mine near Redding are thought to be responsible for numerous fish kills since 1940 when Sasta Dam was being constructed. The State Water Resources Control Board has set Basis Plan objectives for metals in the upper Sacramento River which provide for the protection of early life stages of salmon. These objectives are: 5.6 ppb for copper, 16 ppb for zinc, and 0.22 ppb for cadmium (NMFS, 1997). These objectives are often exceeded in the Sacramento River downstream of Keswick (op. cite.). Continued implementation of the EPA's Superfund Program is expected to eventually remedy these heavy metal discharges and impacts to chinook salmon in the Sacramento River.

Impacts from Entrainment

Entrainment of juvenile fish has been identified as contributing to the decline in anadromous fish populations. A primary source of entrainment is unscreened or inadequately screened diversions. Entrainment of juvenile salmonids is one of the most ubiquitous causes of mortality in the Sacramento River and the Sacramento-San Joaquin Delta. (NMFS, 1997). According to the California Advisory Committee on Salmon an Steelhead Trout (CACSST) it was estimated that the were over 330 unscreened diversions on the Sacramento River between Redding and Sacramento (CACSST, 1987). A more recent survey found that there were approximately 350 unscreened diversions along the Sacramento River downstream of Hamilton City alone (NMFS, 1997). Additionally, over 2,000 unscreened diversions are estimated to be located in the Sacramento-San Joaquin Delta (op. cite.). The actual number of juvnile salmonids lost through entrainment into unsrceened diversions is unknown but Hallock (1987) estimated approximately 10 million juvenile salmonids may be lost annually in the Sacramento River. Numerous protective actions by resources agencies have been recently been implemented to reduce losses of juvenile salmonids at diversions along the Sacramento River and Delta.

Juvenile and occasionally adult green sturgeon are entrained in the South Delta fish facilities of the State Water Project and the Central Valley Project (Moyle, et al., 1995). The extent of the impact on their population is unknown, but it is likely that larval and juvenile green sturgeon are entrained into unscreened diversions throughout the Sacramento River and Delta when these lifestages encounter them.

Impacts from Migration Barriers

Following the closure of the RBDD gates in 1966, chinook salmon and steelhead counts have decreased dramatically (USFWS, 1998). Counts at RBDD have decreased approximately 3% per year for chinook salmon and 4.5% per year for steelhead (op. cite.). Principal factors associated with the declines of adult salmon and steelhead populations in the Sacramento River upstream of RBDD are attributed to the delay and blockage of spawning adults occurring at RBDD (Hallock et al., 1982, Vogel et al., 1988 as cited by USFWS, 1998). Other physical impediments that have measurably resulted in delay or blockage of adult chinook salmon in the Sacramento River include: Keswick Dam stilling basin; the A.C.I.D. diversion dam; reverse flows and attraction of adults into the eastern Delta; and the attraction of adults into the Suisun Marsh Salinity Control Structure (NMFS, 1997).

Delay, blockage and losses of juvenile chinook salmon are or have been attributed to the ineffective fish screens at the A.C.I.D. diversion in Redding; the disorientation and loss to predators RBDD in Red Bluff; diversion from the mainstem river channel and losses at the pumping plant at Glenn-Colusa Irrigation District's pumping plant near Hamilton City; the diversion into Sacramento Deepwater Ship Channel, near Sacramento and the Delta Cross Channel and Georgiana Sloughs near Walnut Grove; and dealy and blockage of juveniles at the Suisun Marsh Salinity Control Structure near Suisun. Collectively these structure have or had the capacity to delay, divert, or block juvenile salmonids during their downstream migration (NMFS, 1997).

Predation Impacts

Striped bass are present near RBDD from May through October. During this period, adult striped bass congregate downstream of RBDD to prey on any appropriately sized juvenile fish, including salmonids that pass through the diversion complex (under the dam gates, through the fish ladders, or through the diversion bypasses). In the case of the highly predatory Sacramento pikeminnow current RBDD gates-in operations result in large congregations of adults that are known to prey heavily on chinook salmon smolts as they pass through RBDD. Several investigators have conducted predation assessments on pikeminnows and have concluded that predation is a serious threat to juvenile salmonids passing RBDD.

In studies conducted by USFWS it was determined that predation is the primary cause of downstream migrant salmon mortalities at RBDD (Vogel, et al., 1988). This investigation estimated that losses from predation, primarily by pikeminnows, are substantial and may range up to 55 percent of smolts passing RBDD. Tucker et al. (1998) found that in their investigations, the relative abundance of predatory pikeminnows at RBDD was lower than previous estimates. However, from their studies, Tucker et al. (1998) determined that the highest densities of pikeminnows occurred in the spring and early summer months when RBDD gates are in and when pikeminnows were attempting to migrate upstream to spawn.

The stomach contents of pikeminnows captured near RBDD consisted predominately of juvenile salmonids but only during months when the RBDD gates were in (Tucker, et al., 1998).

Investigations to determine the abundance, food habitats, and life history of predatory Sacramento squawfish and striped bass were included in the RPP biological evaluations. Squawfish and striped bass were visually very abundant in the spring of 1994 below RBDD after the gates were lowered on May 2 (USFWS 1995d). In 1995, squawfish did not congregate in large numbers below the dam (USFWS 1995e). One possible explanation is that RBDD gates went in two weeks later (May 15) in 1995. Also, Sacramento squawfish may have migrated earlier in relation to high Sacramento River flows.

Given the accounts of squawfish congregating below RBDD and preying on juvenile salmonids in the past, compared with the reduced number of fish collected and recaptured in the RPP studies presently, suggests that the predation of downstream migratin juvenile salmonids has been greatly reduced following RBDD extended gates-up operations.

Reducing the time RBDD inundates Lake Red Bluff likewise reduces predation losses of outmigrating juvenile salmonids to levels similar to run-of-the-river conditions. Based on average run timing, approximately 36.5% (wet years) of fall-run (11% during dry years), 26% of late-fall run, 26% of the winter-run juvenile chinook populations and 5% of the juvenile steelhead population still migrate out of the upper Sacramento River when Lake Red Bluff exists (USFWS 1995a, SRWCSRT 1996).

Impacts from Stony Creek CHO Rediversions

Not only did the original enhancement feature associated with Stony Creek not get implemented, but under current operations, additional negative impacts to Stony Creek are occurring in relation to revised operations at RBDD. As part of the interim measures to provide supplemental water to the TCC service area during the early (September 15-October 29) and latter periods (April 1-May 15) of gates-up operation at RBDD, CVP water stored in Black Butte Reservoir ahs been diverted in increasing amounts since 1993. Existing SWRCB permit conditions (SWRCB 1996) limit CHO rediversions to 38,293 acre-feet per year.

Impacts related to CHO rediversions are detailed in 3 FWCA reports (USFWS 1993b, 1994c, 1996b) and 2 fishery study reports (Brown 1994d, 1995). No juvenile slamonids were collected during spring and fall entrainment studies. However, large numbers of native and introduced resident fish species were entrained. Entrainment losses were related primarily to diversion rates and seasonal differences in the spawning timing of fish species. Water availability in Black Butte Reservoir was low in 1994 when studies were conducted and fall CHO rediversion was limited to only 1,262 acre-feet which affected fyke net collection efficiency. Juvenile fish of springtime spawning fish were entrained at higher rates during spring CHO rediversions and likewise late-summer and fall spawning species were entrained at higher numbers during fall rediversions.

Water released for CHO rediversion "competes" with the use of this CVP water for fish and wildlife purposes. Fish and wildlife uses include the maintenance and stabilization of the water surface elevations and the conservation pool (20,000 acre-feet) in Black Butte Reservoir and Stony Creek instream flow releases below Black Butte Dam for the maintenance and/or enhancement of resident or anadromous fish species. One of the permitted purposes of CHO diverted water is for wildlife refuge use.

Anticipated impacts of all proposed federal actions in the action area that have already undergone early or formal section 7 consultation

CALFED Bay-Delta Program

The San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Bay-Delta) is the largest estuary on the West Coast. It consists of a maze of tributaries, sloughs, and islands and is a haven for plants, fish, and wildlife-supporting more than 750 plant and animal species. The Bay-Delta includes over 738,000 acres in five counties and is critical to California's economy, supplying drinking water for two-thirds of all Californians and irrigation water for over 7 million acres of the most highly productive agricultural land in the world. Although all agree on its importance for both habitat and as a reliable source of water, few have agreed on how to manage and protect this valuable resource.

The Bay-Delta Program, a cooperative State and Federal effort, was established to reduce conflicts in the system by solving problems in ecosystem quality, water quality, water supply reliability, and levee and channel integrity. The CALFED process includes representatives from agriculture, urban areas, environment, fishing, business and rural counties.

The Programmatic Endangered Species Act Section 7 Biological Opinions for both U.S. Fish and Wildlife and National Marine Fisheries Service was completed on August 28, 2000.

Central Valley Project Improvement Act (CVPIA)

The Central Valley Project Improvement Act (CVPIA) was created to implement major changes in the operation of the Central Valley Project water delivery system. One of the main goals of the CVPIA is to restore the Central Valley's anadromous fish populations by implementing provisions dedicating water to in-stream use for fish and wildlife.

Central Valley and State Water Projects

The Winter-run Chinook Salmon Biological Opinion (BO) for Long-Term Operation of the CVP and the California State Water Project by National Marine Fisheries Service was completed in February 1993. In this BO, NMFS identified numerous "Reasonable and Prudent Alternatives" to the Bureau of Reclamation to avoid jeopardy to the species. These included (but are not limited to) a 4-month gates-in operation at RBDD, a minimum Shasta carryover storage requirement, set minimum flow levels for the Sacramento River from Keswick, set water temperature requirements for the protection of eggs, alevins and fry lifestages, and operational guidelines in the Delta.

Impact of state or private actions that are contemporaneous with the consultation

State Water Project

See Central Valley Project Discussion above.

Proposition 13: Safe Drinking Water, Clean Water, Watershed Protection, and Flood Protection Act 2000 (Water Bond 2000)

In March 2000, California voters approved Water Bond 2000, which authorizes the State of California to sell $1.97 billion in general obligation bonds to support safe drinking, water quality, flood protection and water reliability projects throughout the state.

Proposition 204: Safe, Clean, Reliable, Water Supply Act

In 1996, Proposition 204 was approved. This authorized $995 million in general obligation bonds for Bay-Delta ecosystem restoration, Bay-Delta improvement projects, clean water and water recycling, water supply reliability, flood control and prevention.

Sacramento Valley Water Management Agreement

In April 2001, the Sacramento Valley water users, the California Department of Water Resources, the U.S. Bureau of Reclamation, and export water users developed the Sacramento Valley Water Management Agreement. This agreement was created as an effort to increase water supplies for farms, cities and the environment.

Current Baseline Condition Without the Proposed Action

Current operation of RBDD under the 1993 Winter-run Chinook salmon Biological Opinion (NMFS, 1993) includes a 4-month period of time (mid-May through mid-September) when the dam gates are placed in the river. When the gates are in-river velocity barrier and whitewater turbulence is created that delays, prevents or impedes adult salmon and steelhead passage. Placement of the dam gates into the river results in total blockage of migrating adult green sturgeon. Fish ladders are currently operational on the east and west ends and at the center of RBDD. Green sturgeon are not known to successfully use these ladders (K. Brown, pers. com.). These ladders operate during the gates-in period to provide upstream passage of adult salmonids. Currently adult late-fall chinook salmon pass unimpeded at RBDD because they immigrate during months (October through March) when the RBDD gates are out of the river and, therefore, no barrier exists.

During gates-in periods at RBDD, juvenile life stages of all anadromous salmonids migrate downstream (emigrate) through the project facilities. During gate-in operation, existing pathways for juvenile salmonids at RBDD include passage under the dam gates or through the fish ladders and their auxiliary water systems; or they are subjected to impingement, entrainment, and passage through diversion bypass systems at the Research Pumping Plant (RPP) and Tehama-Colusa Canal (TC Canal) headworks. The greatest threat to any of the juvenile salmonids passing through the project area are the direct losses related to passing under the RBDD gates and subsequent predation by Sacramento River pikeminnows and striped bass congregated immediately below the dam. Additionally, predation by avian and fish species within Lake Red Bluff may also be a significant threat to all juvenile life stages in the vicinity of RBDD.

All five of the anadromous salmonids that are present at RBDD during some period in their life history are either listed by the California Endangered Species Act (CESA) and/or the federal Endangered Species Act (ESA), or are listed as candidates under ESA.

Anadromous Salmonid Populations and Habitat

As shown on Figure 1, each of the five salmonid species have distinct periods when the adults are actively immigrating upstream through the project area. Factors that may affect the timing adult passage include water-year type, river flows, weather events, and RBDD operations.

Habitat needs of the four runs of salmon and steelhead are similar, but each species differs somewhat in its freshwater habitat requirements. These differences are important and have implications from a resource management standpoint. The habitat needs of salmon and steelhead include physical habitat for adult migration and holding, spawning and egg incubation, fry and juvenile rearing, and smolt emigration. Adequate flows, water temperatures, water depths and velocities, appropriate spawning and rearing substrates, and the availability of in-stream cover and food are critical for the propagation and survival of all salmonids in the Sacramento River.

Each of the life stages of these species has its own specific habitat requirements. Adult spawning and egg incubation requires suitable water velocity, temperature, depth, and substrate (gravel) size. Adult spring-run chinook salmon and steelhead have additional habitat needs for longer-term holding habitat, in which pool size and depth, temperature, cover, and proximity to cover and spawning areas are important requirements. Newly emerged fry and juvenile salmonids require rearing habitat where low velocities, open cobble substrate for predator refuge, cool water temperatures, and adequate food production are critical features. Emigration of smolts to the ocean and the immigration of spawning adults require adequate barrier-free passage, adequate transport flows, and adequate water depths and temperatures to complete those migrations.

In the vicinity of RBDD the Sacramento River acts primarily as a transport corridor for adults immigrating upstream, juvenile fry rearing and dispersing, and smolts emigrating downstream. In addition, fall-run chinook salmon and, to a lessor degree, the winter-run and other salmon species are known to spawn in the vicinity of RBDD both immediately upstream and, to a lessor degree, downstream of RBDD. Inundation of Lake Red Bluff may act to discourage these fish from spawning in the reach of the Sacramento River immediately upstream of RBDD because of inadequate velocities and excessive water depths during RBDD gates–in operations.

The periods when juveniles (fry, pre-smolt, and smolt salmon and fry, sub-yearling, and yearling steelhead) are migrating downstream past RBDD are shown on Figure 2. In addition to passage, fry, pre-smolt salmon, and sub-yearling, and yearling steelhead may rear or reside in the vicinity of RBDD. These life stages are particularly vulnerable to predation by either fish or avian predators as they pass through or reside in the project locale. Timing of smolt emigration is dependent on species, flow conditions, and water year.

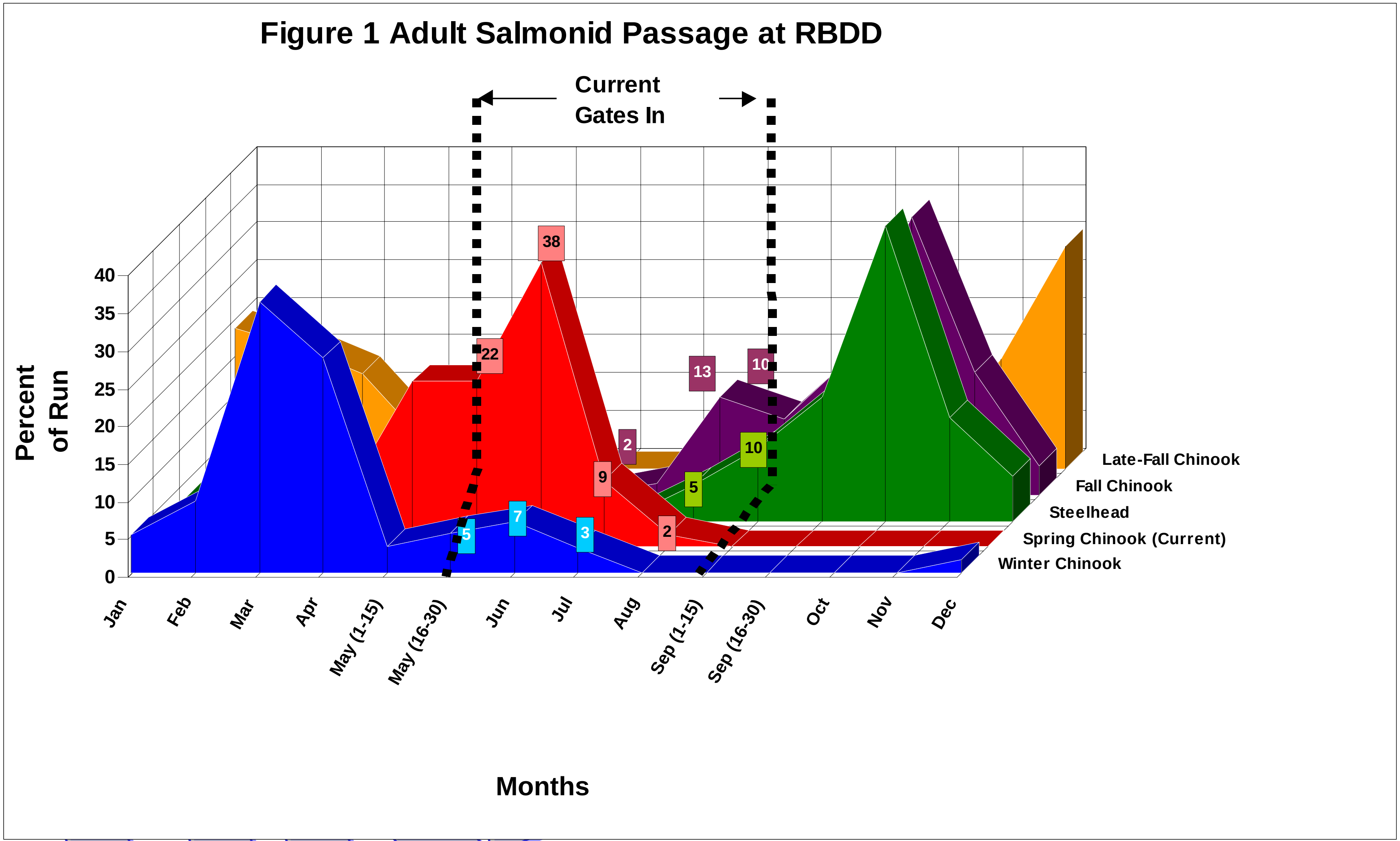


Figure 1 Adult Salmonid Passage at RBDD
Current
Gates In
Percent
of Run
40
35
30
25
20
15
10
5
0
38
22
13
10
2
9
10
5
2
7
5
3
Late-Fall Chinook
Fall Chinook
Steelhead
Spring Chinook (Current)
Winter Chinook
Jan
Feb
Mar
Apr
May (1-15)
May (16-30)
Jun
Jul
Aug
Sep (1-15)
Sep (16-30)
Oct
Nov
Dec
Months

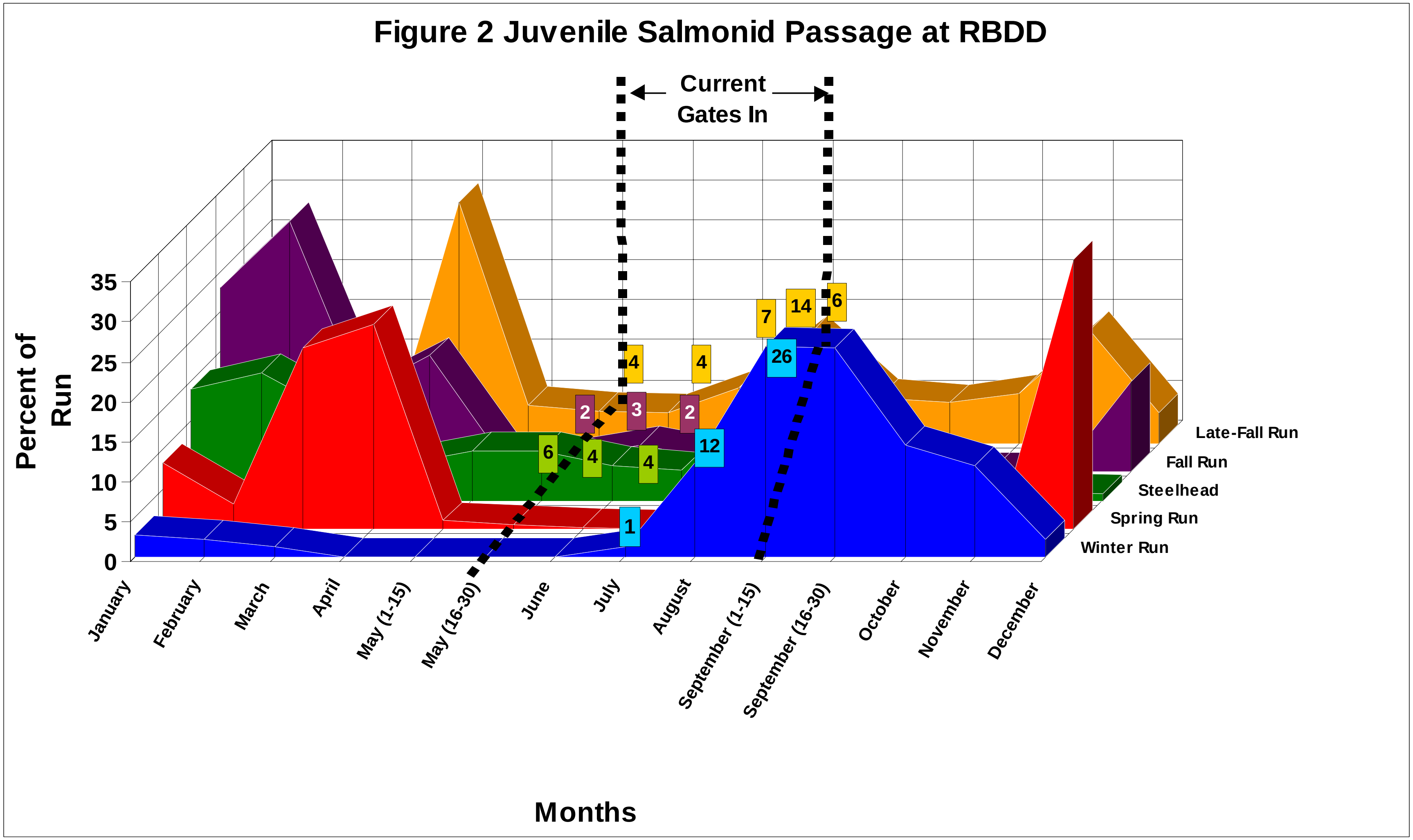


Figure 2 Juvenile Salmonid Passage at RBDD
Current
Gates In
Percent of
Run
35
30
25
20
15
10
5
0
January
February
March
April
May (1-15)
May (16-30)
June
July
August
September (1-15)
September (16-30)
October
November
December
Late-Fall Run
Fall Run
Steelhead
Spring Run
Winter Run
4
4
7
14
6
2
3
2
26
6
4
4
12
1
Months

TABLE 5
Estimated Chinook Salmon Spawning Escapement Upstream of RBDD (1970 to 2000)

Species	Average	Low (year)	High (year)
Fall	75,017	29,898 (1977)	205,487 (1997)
Late-fall	10,131	291(1994)	19,261 (1975)
Winter	10,783	189 (1994)	53,089 (1971)
Spring	6,960	163 (1998)	25,095 (1976)
Steelhead	4,189	104 (1998)	13,240 (1970)

Winter-Run Chinook Salmon

Annual winter-run chinook salmon escapement has also averaged approximately 10,000 adults upstream of RBDD. The annual escapement of winter-run upstream of RBDD has declined significantly over the 30 years since 1970 (Figure 3). As shown in Table 5, winter chinook salmon escapement upstream of RBDD in 1971 was greater than 53,000 adults. Also as shown on Figure 3, except for the year 1981, annual estimates of winter-run chinook passing RBDD since 1977 have never exceed 5,000 adults, a decrease greater than 10-fold over the last 30 years.

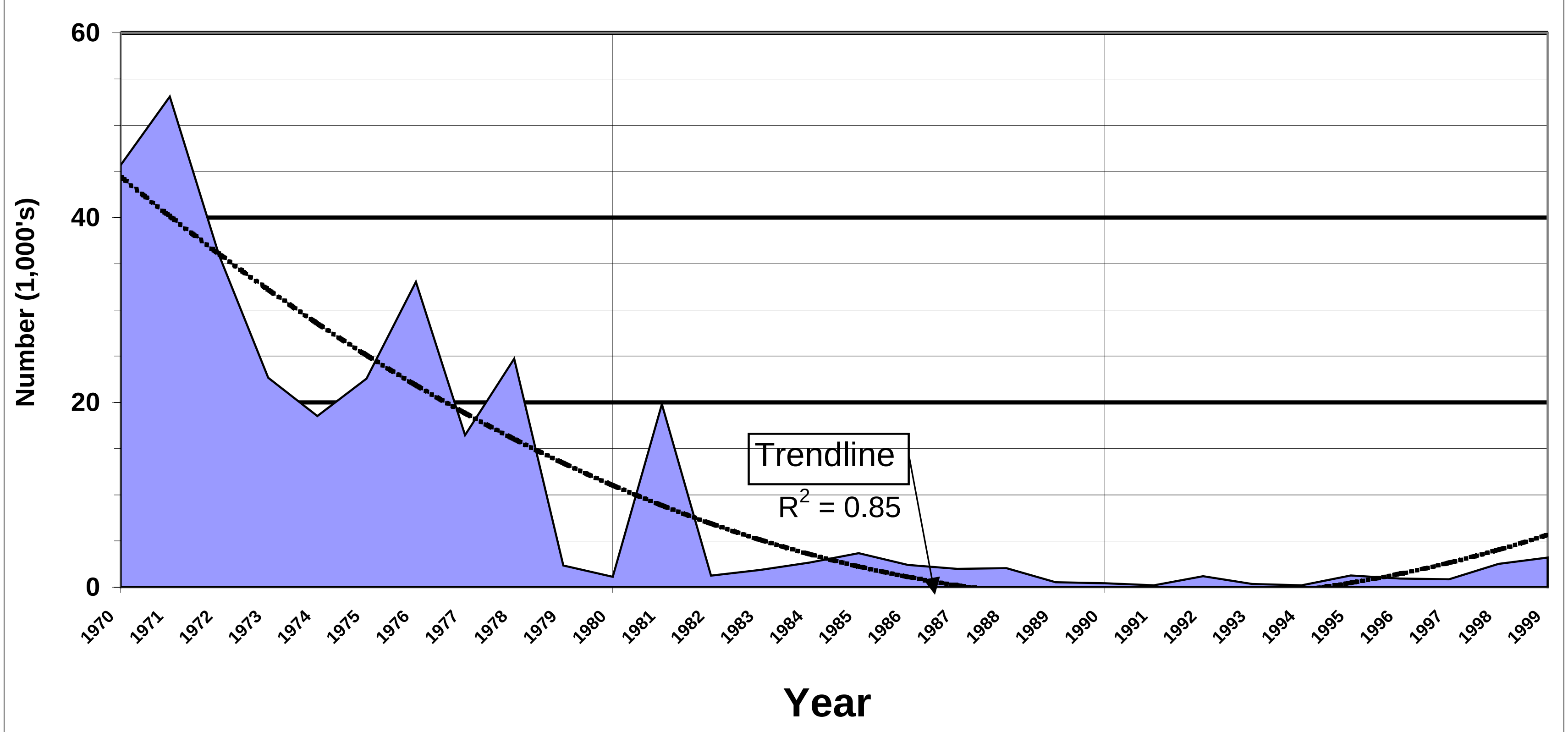
Winter-run were listed Federal Endangered on January 4, 1994 and California Endangered on September 22, 1989. Critical habitat for winter-run chinook salmon was designated on March 22, 1999

Central Valley ESU Spring-run Chinook Salmon

Spawning escapement of Central Valley spring-run chinook salmon has also varied since 1970 (Table 5). The annual spring-run chinook salmon escapement upstream of RBDD in the last 30 years has averaged less than 7,000 spawners and has ranged from greater than 25,000 in 1975 to less than 200 adults in 1998. Since 1990, spring-run chinook salmon spawning escapement upstream of RBDD has not exceeded 1,000 adults (Figure 4)..

Spring-run chinook salmon were listed as Federal Threatened on September 16,1999, and State Threatened on February 5, 1999. Critical Habitat for spring-run was designated on February 16, 2000.

Figure 3 Winter Run Chinook Salmon Spawning Escapement Upstream of RBDD(1970-1999)



Central Valley ESU Fall-run Chinook Salmon

Fall-run chinook salmon are the dominate salmon run in the watershed, and on the average over the 30-year period, escapement upstream of RBDD exceeded all other chinook runs by greater than 7-fold (Table 5). However, as shown on Figure 6, the annual escapement of fall chinook salmon upstream of RBDD has varied greatly over the last 30 years. The annual fall chinook escapement upstream of RBDD has ranged from over 205,000 (1997) to less than 30,000 (1977) with an increasing trend in escapement over that period (Figure 6).. The status of this species is summarized with late-fall run chinook salmon as discussed below.

Central Valley ESU Late-fall Run Chinook Salmon

Since 1970, late-fall-run chinook salmon escapement upstream of RBDD has averaged approximately 10,000 adults and has ranged from greater than 53,000 (1971) to less than 300 (1994) (Table 5). The trend for late-fall chinook escapement upstream of RBDD has been a gradual decline since 1970 (Figure 7).

Central Valley fall/late-fall chinook salmon ESUs were found to not warrant federal listing on September, 16,1999.However, the ESU is designated as a candidate for listing because of concerns over specific risk factors. The ESU includes all naturally spawned populations of fall-run (including Late-fall run) chinook salmon in the Sacramento and San Joaquin River Basins and their tributaries east of Carquinez Strait, California. Major river basins containing spawning and rearing habitat for this ESU comprise approximately 13,760 square miles in California. The following California counties lie partially or wholly within these basins: Alameda, Butte, Calaveras, Colusa, Contra Costa, Glenn, Mariposa, Merced, Napa, Nevada, Placer, Plumas, Sacramento, San Joaquin, Santa Clara, Shasta, Solano, Stanislaus, Sutter, Tehama, Trinity, Tuolumne, Yolo, and Yuba.

Figure 4 Spring Run Chinook Salmon Spawning Escapement Upstream of RBDD (1970-1999)

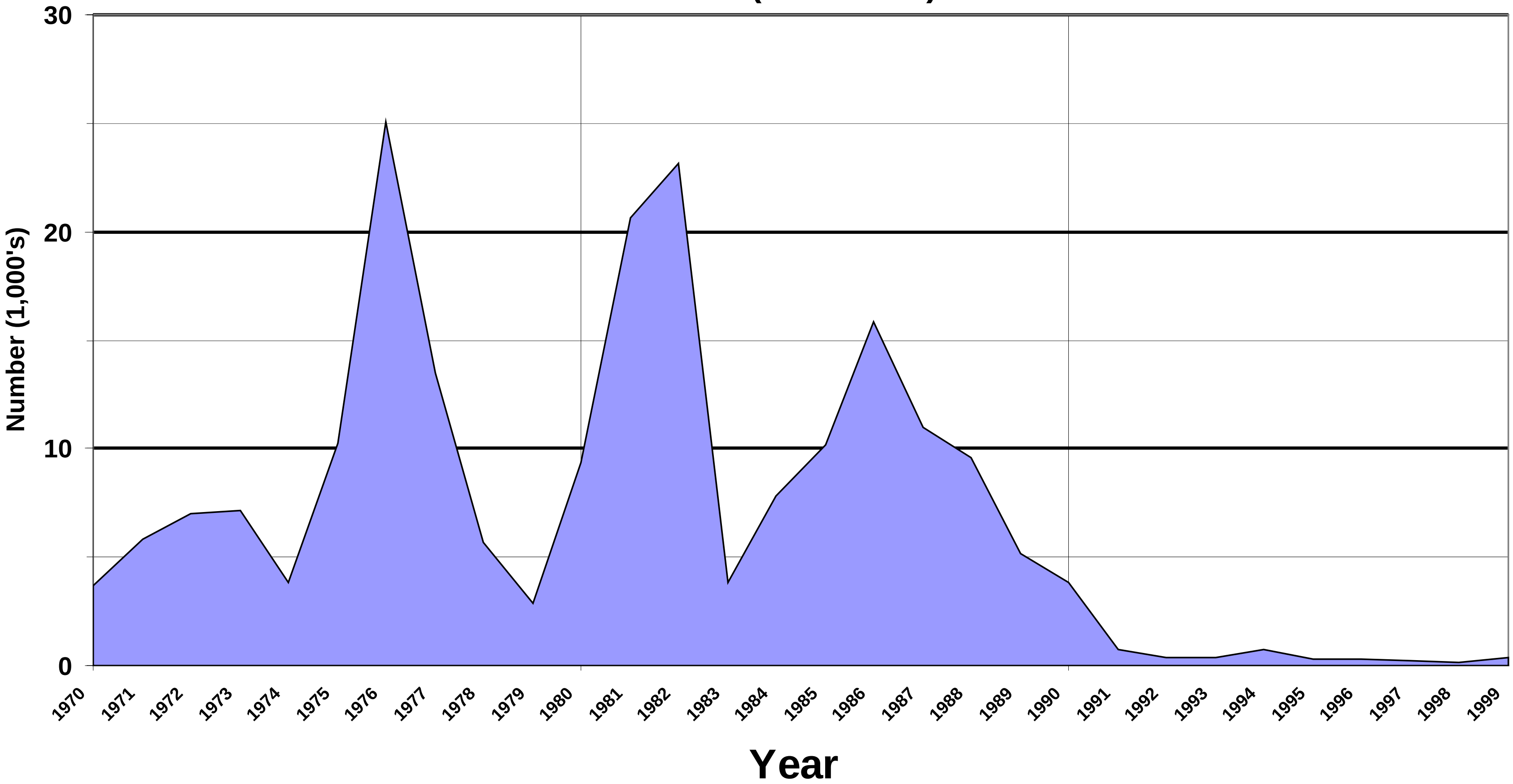


Figure 6 Fall Chinook Salmon Spawning Escapement Upstream of RBDD (1970-1999)

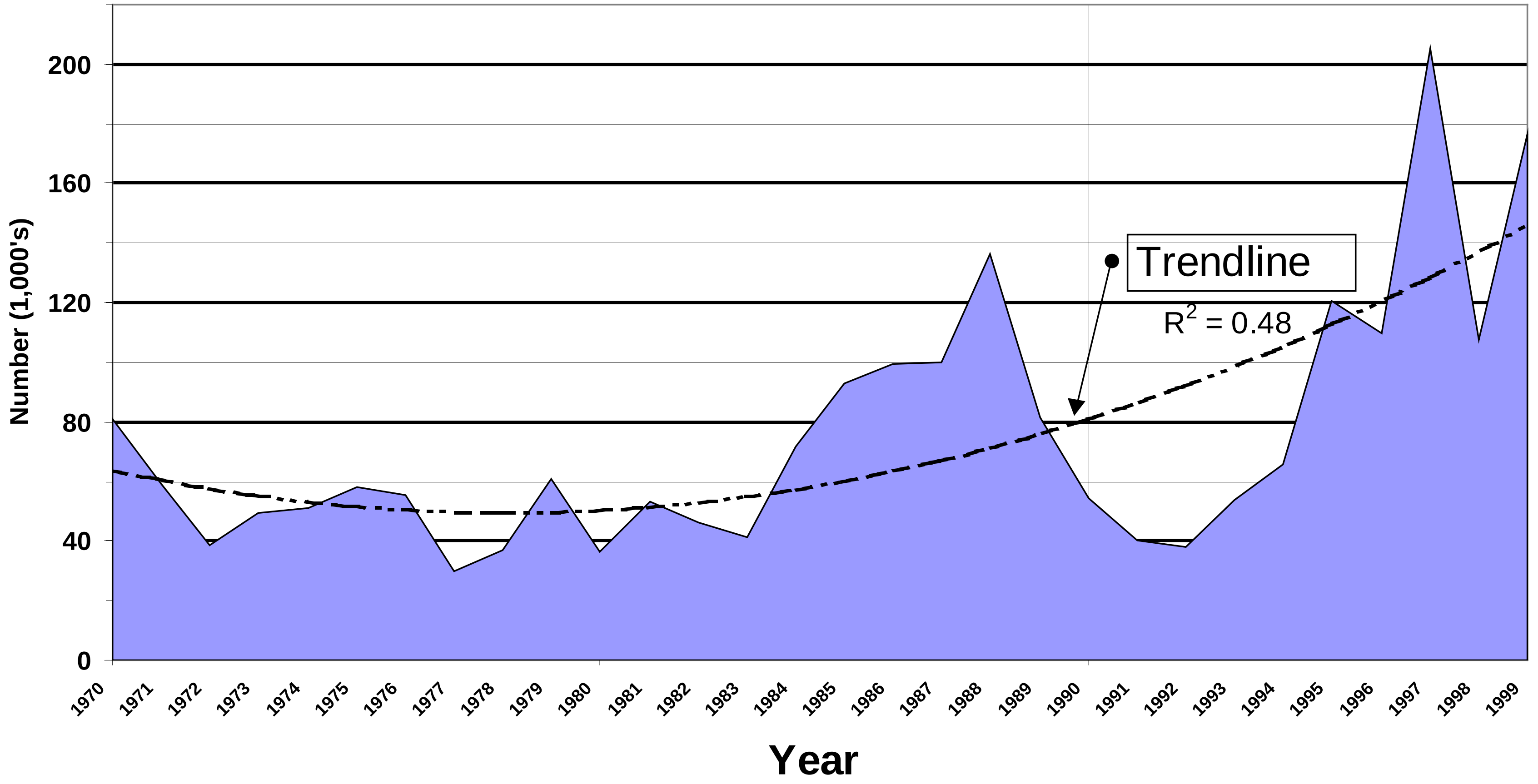
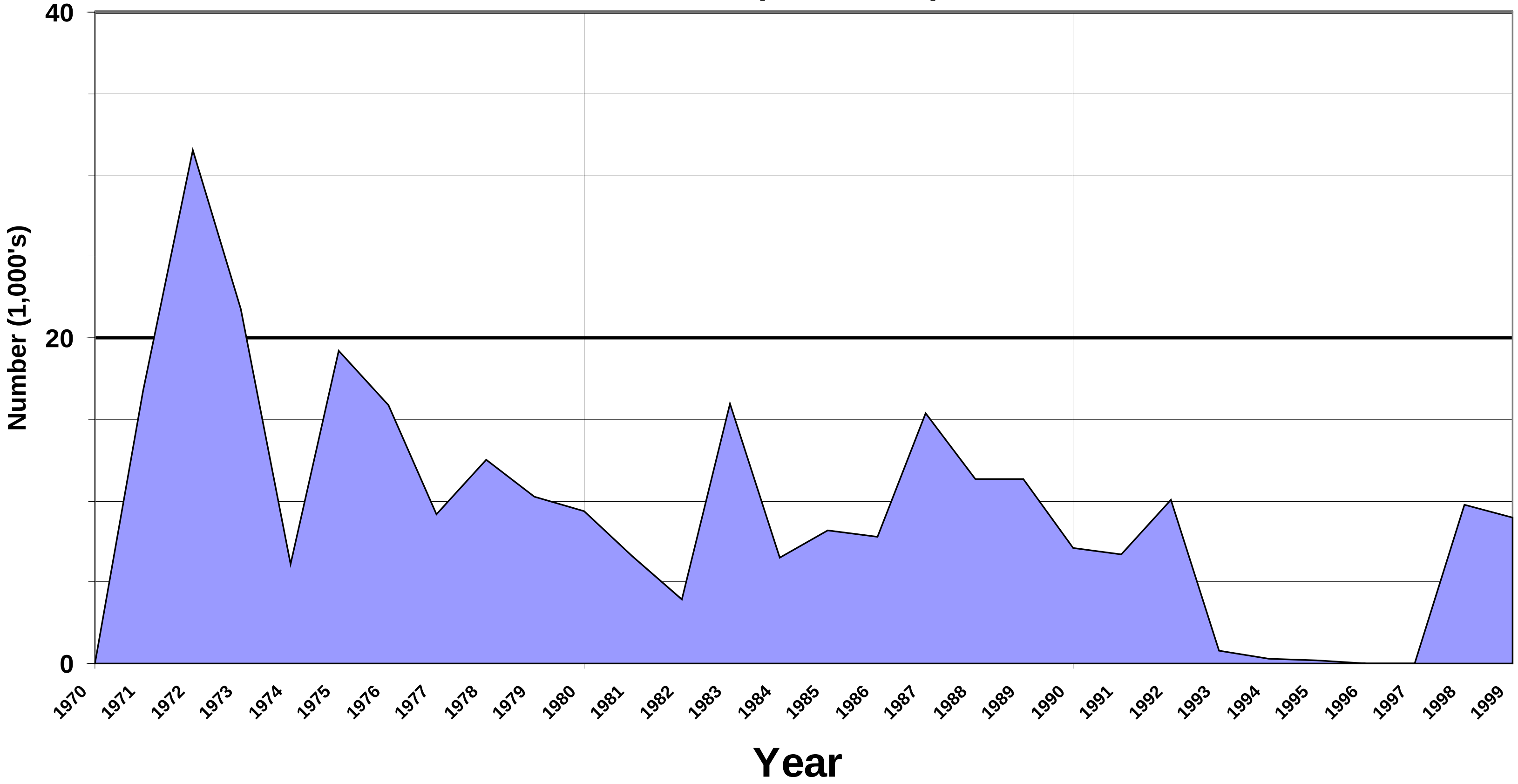


Figure 7 Late-Fall Chinook Salmon Spawning Escapement Upstream of RBDD (1970-1999)



Essential Fish Habitat for Chinook Salmon

Congress has determined that one of the greatest long-term threats to the viability of commercial and recreational fisheries was the continuing loss of marine, estuarine, and other aquatic habitats. They stated the habitat considerations should receive increased attention for the conservation and management of fishery resources of the United States (16 U.S.C. 1801 (A)(9)). The re-named Magnuson-Stevens Act mandated the identification of Essential Fish Habitat (EFH) for managed species as well as measures to conserve and enhance the habitat necessary to fish to carry out their life cycles. The Act requires cooperation among NMFS, the Fishery Management Councils, fishing participants, Federal and state agencies, and others in achieving EFH protection, conservation, and enhancement. Congress defined EFH as “those **waters** and **substrate necessary** to fish for spawning, breeding, feeding, or growth to maturity” (16 U.S.C. 1802(10)). Regulations interprets the EFH definition as follows:

- **Waters** include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate;
- **substrate** includes sediment, hard bottom, structures underlying the waters, and associated biological communities;
- **necessary** means the habitat required to support a sustainable fishery and the managed species’ contribution to a healthy ecosystem; and “spawning, breeding, feeding, or growth to maturity” covers a species’ full life cycle.

The National Oceanic and Atmospheric Administration’s (NOAA) National Marine Fisheries Service issued its final EFH regulations on January 17, 2002. The regulations provide guidelines to fishery management councils for developing the EFH sections of fishery management plans, and establish procedures to be used by NOAA Fisheries and other agencies to consult and coordinate regarding Federal and state agency actions that may adversely affect EFH. The Pacific Fisheries Management Council (PFMC) in 1999 provided Amendment 14 to the Pacific Coast Salmon Plan which identified Pacific salmon EFHs, provided descriptions of Pacific salmon EFHs and described adverse effects on Pacific salmon EFHs.

In summary the PFMC found that in estuaries and marine areas, salmon habitat extends from the shoreline to the 200-mile limit of the Economic Exclusion Zone (EEZ) (“200 miles limit”) and beyond. In freshwater, salmon EFH includes all the lakes, streams, ponds, rivers, wetlands, and other bodies of water that have been historically accessible to salmon. The description of essential habitat also includes areas above artificial barriers, except for certain barriers and dams that fish cannot pass. However, activities that occur above these barriers and that are likely to affect salmon below the barriers may be affected by EFH rulings. The PFMC is required to minimize the negative impacts of fishing activities on essential salmon habitat.

The ocean activities that the PFMC is concerned with include the effects of fishing gear, removal of salmon prey by other fisheries, and the effect of salmon fishing on reducing nutrients in streams due to fewer salmon carcasses in the spawning grounds. The PFMC may use gear restrictions, time and area closures, and harvest limits to reduce negative impacts on salmon EFH. The PFMC is also required to comment and make recommendations regarding other agencies' non-fishing activities and actions that may effect salmon EFH. This usually takes the form of endorsing an enhancement program or other type of program, requesting information and justification for actions that might effect salmon habitat; and promoting the needs of the salmon fisheries. The PFMC works with many other agencies to identify cumulative impacts on salmon habitat, to encourage conservation, and to take other actions to protect salmon habitat.

The PFMC (1999) has designated the EFH for Pacific coast salmon fishery to mean those waters and substrates necessary for salmon production needed to support a long-term sustainable fishery and salmon contributions to a healthy ecosystem. In freshwater, EFH must include all those streams, lakes, ponds, wetlands, and other currently viable water bodies and most of the habitat historically accessible to salmon in Washington, Oregon, Idaho, and California. The PFMC has defined the freshwater EFH as all viable waters within United States Geological Survey (USGS) hydrological units accessible to Pacific Salmon.

For chinook salmon, in the vicinity of the proposed project, the PFMC includes numerous USGS Hydrological Units for the upper Sacramento River and numerous Sacramento River tributaries as freshwater EFH (PFMC, 1999). The extent of the upstream access of chinook salmon within the Sacramento River is defined as Keswick Dam (PFMC, 1999). The PFMC (1999) further defines the four major components of chinook salmon EFH as:

- spawning and incubation habitat;
- juvenile rearing habitat;
- juvenile migration corridors and;
- adult migration corridors and adult holding habitats.

Central Valley ESU Steelhead

The annual steelhead spawning escapement upstream of RBDD since 1970 is summarized in Table 5. As shown in Table 5, the annual number of steelhead spawners has averaged approximately 4,000 adults. The trend over the last 30 years has indicated a steady decline in the annual numbers of spawners (Figure 5) from over 10,00 in the early 1970s to less than a thousand by the later 1990s (Figure 5). Furthermore, it is estimated that, currently, approximately 10 percent to 30 percent of adult steelhead in the Sacramento River are of natural (non-hatchery) origin (CDFG, 1996).

Central Valley steelhead were listed as Federal Threatened on March 19, 1998. Critical habitat was designated on February 16, 2000.

Green Sturgeon

The presumed timing of spawning green sturgeon passing in the vicinity of RBDD is shown on Figure 8. This figure illustrates that the adult green sturgeon pass RBDD during March though June. The presence of juvenile green sturgeon in the vicinity of RBDD as indicated by trapping data is shown on Figure 9. The majority of juveniles pass through the vicinity of RBDD from June through August (Figure 9).

Species Listed or Proposed for Listing under ESA

Green sturgeon was petitioned for listing under ESA on June 11, 2001) but NMFS has not yet issued findings of the review of the Petition for Listing. Green sturgeon are also a California State Species of Special Concern (SSC), Class 1 (Moyle, et al., 1995).

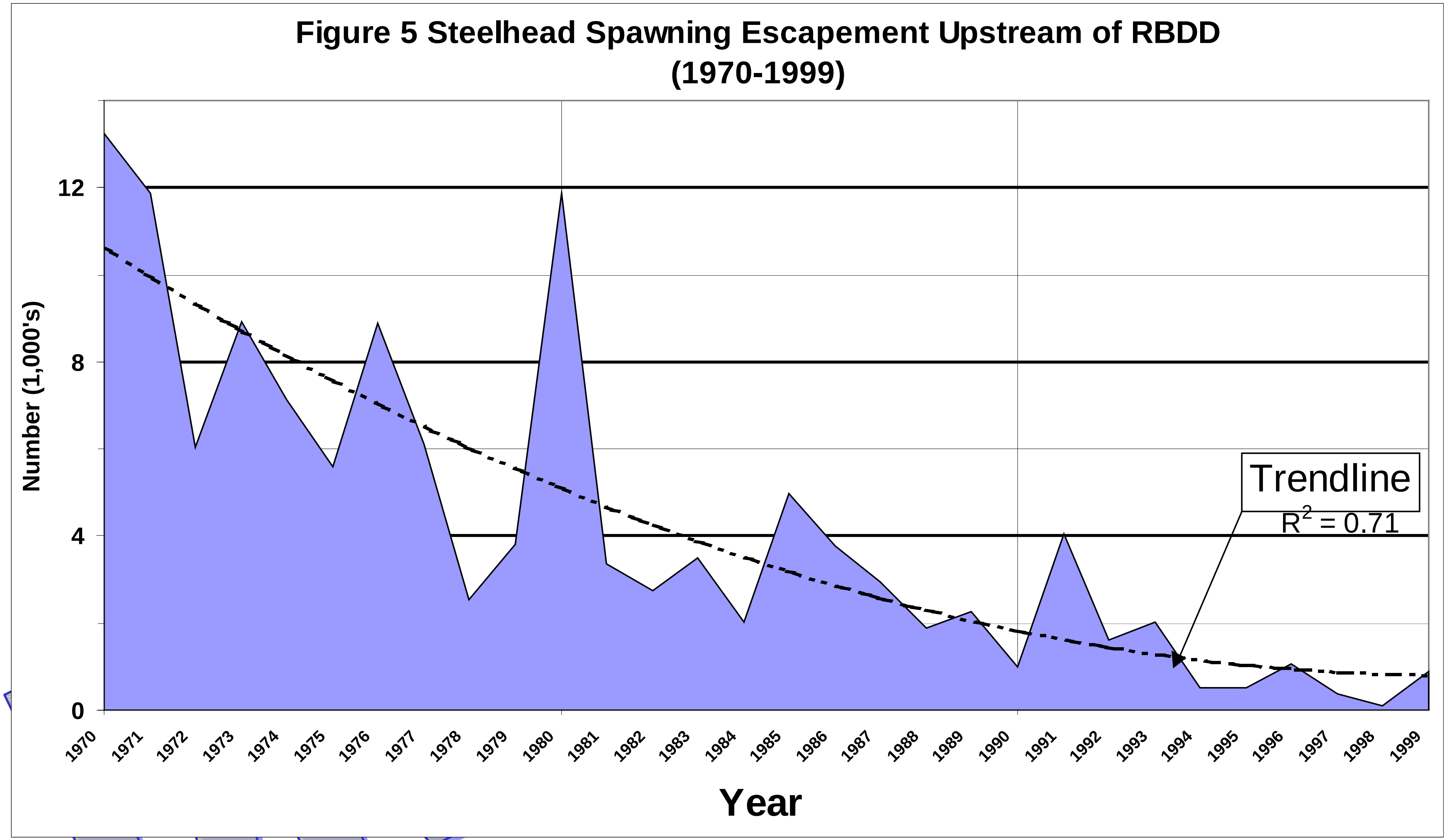


Figure 5 Steelhead Spawning Escapement Upstream of RBDD
(1970-1999)
Number (1,000's)
0
4
8
12
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
Year
Trendline
R^2 = 0.71

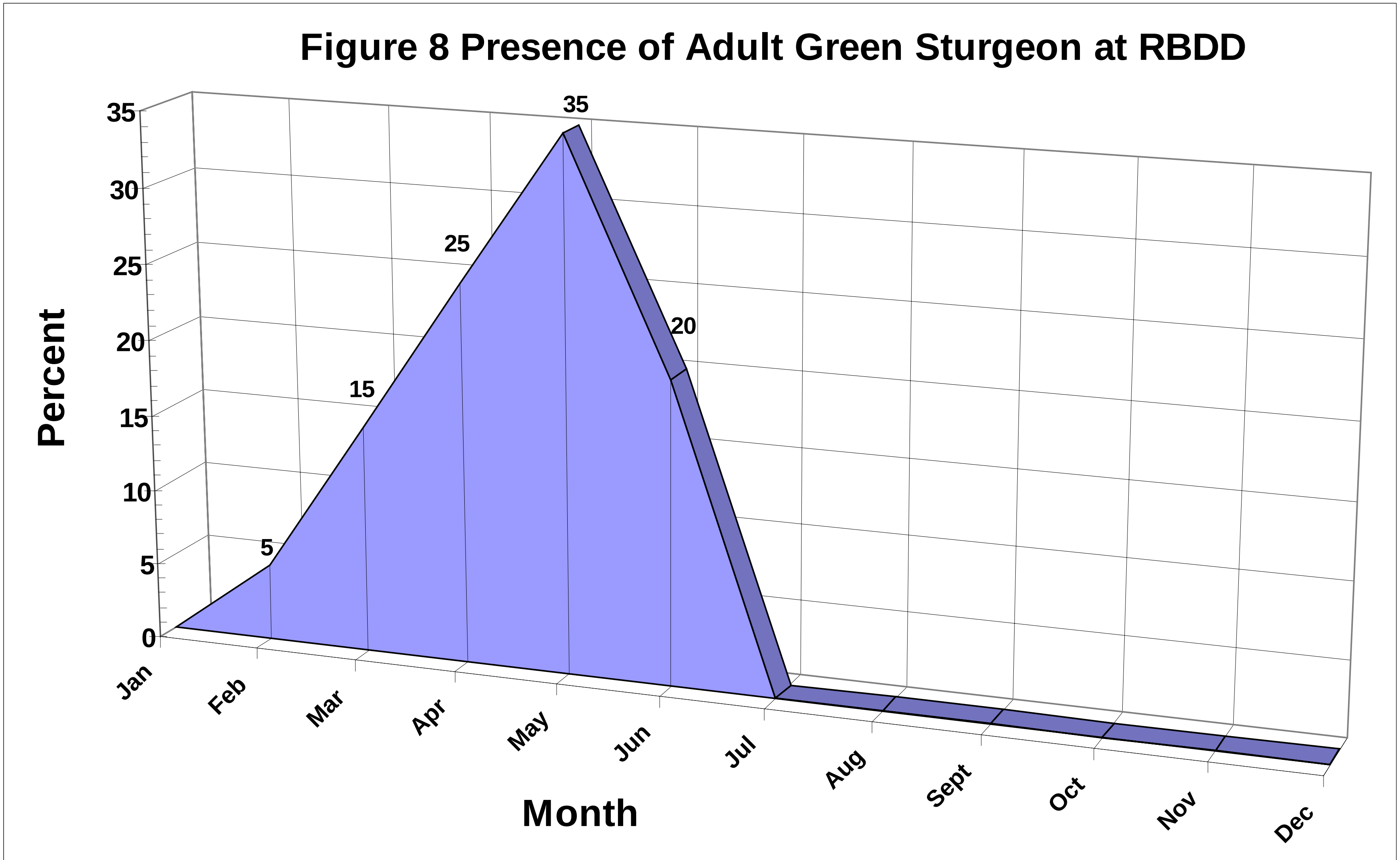


Figure 8 Presence of Adult Green Sturgeon at RBDD
Percent
35
30
25
20
15
10
5
0
5
15
25
35
20
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sept
Oct
Nov
Dec
Month

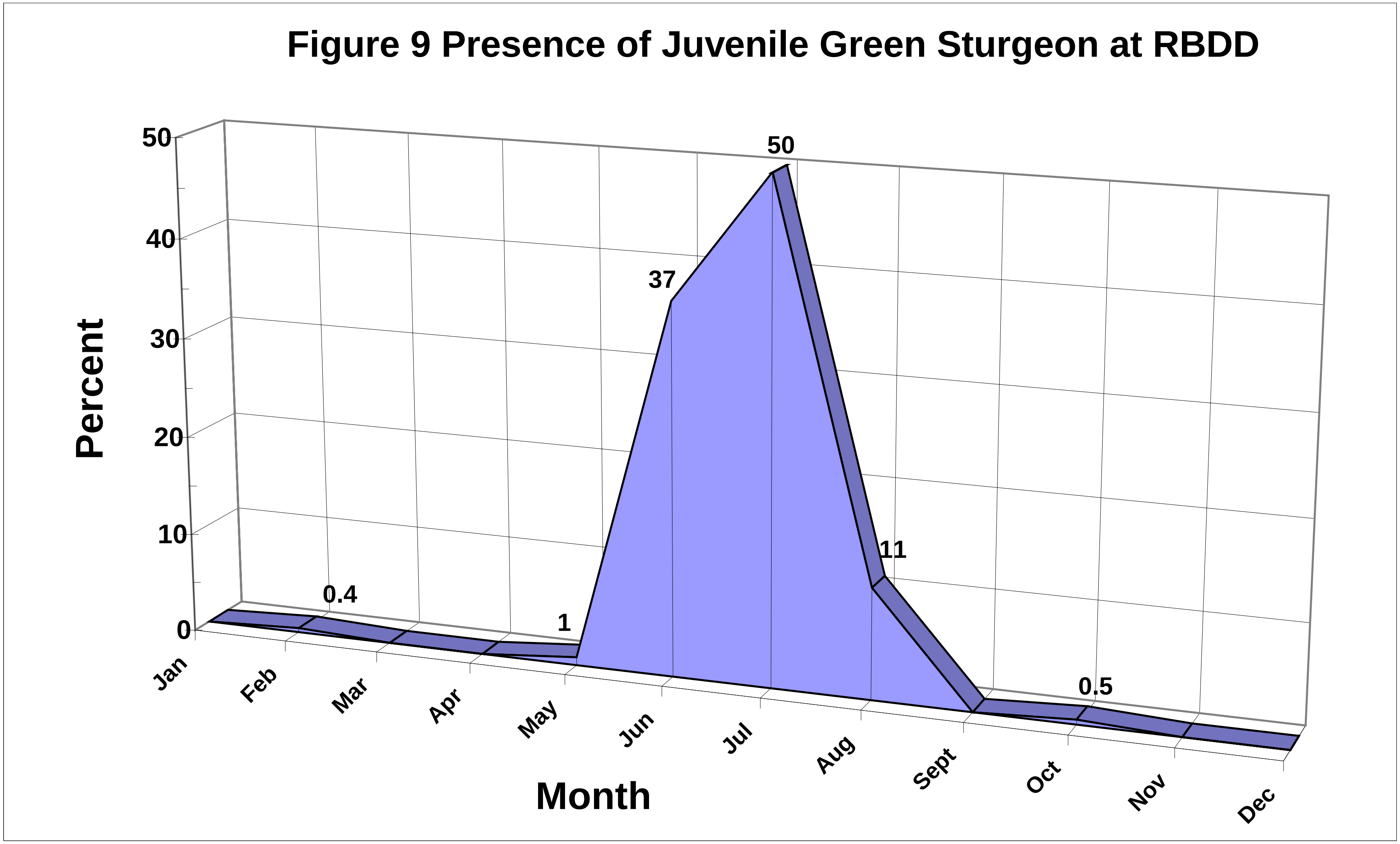


Figure 9 Presence of Juvenile Green Sturgeon at RBDD
Percent
50
40
30
20
10
0
0.4
1
37
50
11
0.5
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sept
Oct
Nov
Dec
Month

Hydrology

The following summarizes the streamflows measured in the Sacramento River in the vicinity of RBDD. The hydrologic data utilized in this analysis was derived from daily stream gage records collected by both DWR and U.S. Geological Survey (USGS) at the USGS gaging station on the Sacramento River at Bend Bridge upstream of the present RBDD. Accretion streamflows from tributary creeks and groundwater inflows between Bend Bridge and RBDD also contribute to the total flow of the Sacramento River. These flows were not quantified in this assessment.

Figure X provides a comparison of the minimum, average, and maximum recorded flows in the Sacramento River following construction of RBDD. These data are presented for the period 1980 to 2000, and as with the data presented for the period prior to dam construction, this information was also determined on a monthly basis. The time period from 1980 to 2000 was selected to coincide with the completion of Reach Eight, the final section of T-C Canal completed on May 30, 1980, and diversion of water to the reach. The average daily flow data were compiled by month to develop the statistical results presented on Figure X.

Water Quality

The following summarizes water quality data including temperature, dissolved oxygen, and turbidity for the Sacramento River in the vicinity of RBDD. These data were collected from a water quality monitoring station located immediately upstream of RBDD.

The range of temperatures measured by DWR at the RBDD monitoring station from January 1998 through December 2000 is presented on Figure X. The average year-round temperature during this period was 53.8°F, with roughly 38 percent of the data exceeding the 56°F water temperature standard. The highest temperature recorded during this period was 60.8°F (on September 18, 2000).

The trend in average daily temperature at RBDD, as shown on Figure 3.3-10, illustrates that temperatures have decreased since 1990. While temperatures in Lake Red Bluff peaked at 62°F to 63°F during the 1990 through 1992 gates-in period, temperatures recorded for the same period during more recent years have declined and peaked at 58°F to 59°F. Only three daily average measurements exceeded 60°F during the period of 1998 through 2000.

Average dissolved oxygen (DO) concentrations at RBDD do not exceed water quality criteria, and thus, do not pose a significant risk to the aquatic habitat in the Sacramento River.

The Regional Water Quality Control Board Basin Plan (Basin Plan) does not set specific turbidity levels for the Sacramento River, but rather, it prescribes limits that are based on incremental increases in turbidity over natural conditions. According to a review of water quality data and comparison to the limits in the Basin Plan, the turbidity of the Sacramento River is not a water quality concern, although it does contribute to sediment deposition upstream of RBDD.

Figure X Minimum, Average, and Maximum Monthly Sacramento River Flows Following RBDD Construction (1980 to 2000)

Figure 3.3-9 Average Daily Temperatures at Bend Bridge and RBDD

Since the Sacramento River consists mainly of discharge originating from Shasta and Keswick Reservoirs, flows from these sources are fairly low in sediment concentrations (less than 10 mg/L). However, the river receives tributary flows that have much greater sediment concentrations. In particular, Red Bank Creek, which enters the Sacramento River just upstream of RBDD, contributes a large amount of sediment to the river. The average annual contribution of sediment to the Sacramento River by Red Bank Creek is 41 acre-feet (66,000 CY) (USBR, 1992). Bedload sediment depths upstream of the RBDD foundation have been measured at 3 to 7 feet deep (Ken Iceman, 1999, personal communication).

Chapter 5 - Effects of the Proposed Action

Introduction

"Effects of the action" refers to the direct and indirect effects of a proposed action on listed species or critical habitat, together with the effects of other activities that are interrelated or interdependent with the action. These effects are considered along with the environmental baseline and the predicted cumulative effects to determine the overall effects on the species. 50 CFR Section 402.02.

For the purposes of this BA, effects on listed species and critical habitat are analyzed individually with respect to the proposed action (i.e. diversion, storage, and release or delivery of water). In accordance with the provisions of the ESA implementing regulations and the FWS Section 7 Handbook, Reclamation used the following definitions to makes it effects determinations for each listed species:

> **"Likely to adversely affect:"** Any adverse effect to listed species may occur as a direct or indirect result of the proposed action or its interrelated or interdependent actions, and the effect is not: discountable, insignificant, or beneficial (see definition of "is not likely to adversely affect"). In the event the overall effect of the proposed action is beneficial to the listed species, but is also likely to cause some adverse effects, then the proposed action "is likely to adversely affect" the listed species. If incidental take is anticipated to occur as a result of the proposed action, and "is likely to adversely affect" determination should be made.
>
> **"Not likely to adversely affect:"** Effects on listed species are expected to be discountable, insignificant, or completely beneficial. "Beneficial effects" are contemporaneous positive effects without any adverse effects to the species. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs. Discountable effects are those extremely unlikely to occur. Based on best judgement, a person would not: (1) be able to meaningfully measure, detect, or evaluate insignificant effects; or (2) expect discountable effects to occur.
>
> **"No effect:"** when the action agency determines its proposed action will not affect listed species or critical habitat.

As part of analyzing the effects of the proposed actions on the species, this section of the BA provides information about river conditions that will likely result from the proposed action. Reclamation has provided this information to help analyze the effects of the proposed action and to assist FWS and NMFS in developing coordinated biological opinions. The effects analysis compares the effects of the proposed action to the environmental baseline.

Effects of Construction on Listed Species Populations and Habitat

Impacts to listed or canditate species and their habitats would occur from constructing a new pump station at the “Mill Site”, and trenching for the installation of the diversion conveyance pipelines across Red Bank Creek. These impacts include the potential for direct losses, injury, and indirect impacts to adult or juvenile salmon, steelhead and green sturgeon and their habitats. At the “Mill Site”, impacts could occur from activities related to the grading of the site and excavation of the streambank, the installation of a large (up to approximately 1,400 lf) sheet pile cofferdam, and from stranding of fishes within the cofferdamed areas. At the Red Bank Creek crossing, impacts to fry and juvenile lifestages of all species would occur from activities related to site-grading and preperation, cofferdam installation, and stranding of fish within the cofferdamed areas. For the discussion below, “Adults” and “Juveniles” refers to all adult and juvenile salmonid and sturgeon species discussed in the BA.

Mill Site Pump Station

Adults

Impact A-1. Excavation and grading along the banks of the Sacramento River could result in soils entering the active channel and an increase in sediments and turbidity in the water column downstream of the construction areas. Excessive sedimentation and increased turbidity would reduce dissolved oxygen concentrations in the water column resulting in stress, egg mortality, and increased pre-spawning mortality due to suffocation. These impacts would be likely to adversely affect adult species, and would require conservation measures to reduce the impacts.

During sheetpile installation, adult salmon, steelhead and/or green sturgeon would likely avoid the areas where these cofferdams are being installed. Death or injury to adults would not likely occur from any percussion impacts, as these adults would disperse from the area affected. Similarly, death or injury to adults would not likely occur from heavy equipment operated within the active channel, as adults would avoid this area. Therefore, adults of these species would not be adversely affected by these activities.

Juveniles

Impact J-1. Excavation of the bank along the Sacramento River could result in soils entering the active channel and an increase in sediments and turbidity in the water column downstream of this activity. Excessive sedimentation and increases in turbidity would result in stress and possibly death from suffocation. Indirect effects of sedimentation could include smothering of benthic (bottom) habitat areas resulting in losses of macroinvertebrate food production utilized by fry and juvenile salmon and steelhead. Increased turbidity could reduce light penetration into the water column resulting in diminished phytoplankton and zooplankton production. These impacts would reduce food availability for larval and juvenile green sturgeon. These impacts would be likely to adversely affect juvenile species, and would require conservation measures to reduce the impacts.

Impact J-2. Impacts to fry or juvenile lifestages present in the vicinity of the “Mill Site” would occur during installation of cofferdams. Direct physical loss or injury and indirect impacts due to stress could occur during installation of sheetpile cofferdams. Juvenile salmon, steelhead or green sturgeon could be killed or injured from the percussion impacts during sheet pile installation. These impacts would be likely to adversely affect juvenile species, and would require conservation measures to reduce the impacts.

Impact J-3. Death or injury to juveniles may also occur from any heavy equipment operated within the active channel before, during sheetpile installation or during sheetpile removal. Impacts of heavy equipment operation to fry and or juvenile lifestages would be be likely to adversely affect juvenile species, and would require conservation measures to reduce the impacts.

Impact J-4. Direct losses, injuries, and stress to fry and juvenile lifestages could occur from isolation and stranding during the installation of cofferdams and from de-watering within the cofferdamed area. Within the cofferdamed areas water temperatures would increase, dissolved oxygen would diminish, and predation by avian and mammalian species would increase in areas isolated during sheetpile installation. These impacts would be likely to adversely affect juvenile species, and would require conservation measures to reduce the impacts.

Red Bank Creek

Adults

Impact A-2. Excavation and grading along the banks of the Red Bank Creek could result in soils entering the active channel and an increase in sediments and turbidity in the water column downstream of the construction area. Excessive sedimentation and increased turbidity would reduce dissolved oxygen concentrations in the water column resulting in stress, egg mortality, and increased pre-spawning mortality due to suffocation. These impacts would be likely to adversely affect adult species, and would require conservation measures to reduce the impacts.

During sheetpile installation, adult salmon, steelhead and/or green sturgeon would likely avoid the areas where these cofferdams are being installed. Death or injury to adults would not likely occur from any percussion impacts, as these adults would disperse from the area affected. Similarly, death or injury to adults would not likely occur from heavy equipment operated within the active channel, as adults would avoid this area. Therefore, adults of these species would not be adversely affected by these activities.

Juveniles

Impact J-5. Excavation and grading along the banks of Red Bank Creek could result in soils entering the active channel, an increase in sediments and in turbidity in the water column downstream of this activity. Excessive sedimentation and increases in turbidity would result in stress and possibly death to fry and juveniles from suffocation. Indirect effects of sedimentation could include smothering of benthic (bottom) habitat areas resulting in loss of macroinvertebrate food production utilized by fry and juvenile salmon and steelhead. Increased turbidity could reduce light penetration into the water column resulting in diminished phytoplankton and zooplankton production. These impacts would reduce food availability for larval and juvenile green sturgeon. These impacts would be likely to adversely affect juvenile species, and would require conservation measures to reduce the impacts.

Impact J-6. Impacts to fry or juvenile lifestages present in the vicinity of the conveyance crossing at Red Bank Creek could occur during installation of cofferdams. Direct physical loss or injury and indirect impacts due to stress could occur during installation of sheetpile cofferdams. Juvenile salmon, steelhead or green sturgeon could be killed or injured from the percussion impacts during sheet pile installation. Death or injury to juveniles may also occur from any heavy equipment operated within the active channel before, during sheetpile installation or during sheetpile removal. Impacts of sheetpile cofferdam installation to fry and or juvenile lifestages would be likely to adversely affect juvenile species, and would require conservation measures to reduce the impacts.

Impact J-7. Death or injury to juveniles may also occur from any heavy equipment operated within the active channel of Red Bank Creek before, during sheetpile installation or during sheetpile removal. Impacts of heavy equipment operation to fry and or juvenile lifestages would be likely to adversely affect juvenile species, and would require conservation measures to reduce the impacts.

Impact J-8. Direct losses, injuries, and stress to fry and juvenile lifestages could occur from isolation and stranding during the installation of cofferdams and from de-watering within the cofferdamed area. Within the cofferdamed areas water temperatures would increase, dissolved oxygen would diminish, and predation by avian and mammalian species would increase in areas isolated during sheetpile installation. These impacts would be likely to adversely affect juvenile species, and would require conservation measures to reduce the impacts.

Effects of Operations on Listed Species Populations and Habitats

Analysis Approach

A fish passage evaluation was conducted for preferred alternative using a spreadsheet tool developed expressly for the Fish Passage Improvement Project at the Red Bluff Diversion Dam (RBDD). The fish passage tool (informally referred to as "Fishtastic!") was used as a tool for evaluating RBDD Fish Passage Improvement Project alternatives against one another. Although the methodology is built upon biological data, it is not a biological evaluation of fish passage conditions at RBDD. It is intended solely to focus attention on aspects of the alternative that have the greatest potential for improving fish passage at RBDD and to provide a means for conducting sensitivity analyses on different assumptions.

Fishtastic! uses temporal species distribution to determine when different life stages of fish are expected to encounter RBDD. The "cost" or "effect" of encountering RBDD was assigned a score of zero to one (where zero is completely ineffective and one is totally effective) based on subjective assumptions about the relative effect of existing facilities compared to potential future facilities. The effects of the dam were separated into two distinct parts – upstream effect on adults and downstream effect on juveniles. A number of studies on the physical effects of the dam were reviewed and updated based on current investigations and professional judgement.

For adults, the primary effects are based on delay at the dam and ability to pass the existing ladders . For juveniles, the primary effects are the combined presence of predators below the dam and juveniles migrating downstream. Other factors considered included flow, size of the facilities, and physiology of different species of fish. The degree of effect for the various facilities were estimated using existing information and studies that have been conducted at the dam, peer reviewed research at other facilities and professional judgement. The results of the Fishtastic! analysis have been reviewed by the agency development team.

Fishtastic! results are characterized by the degree of effect the prefered alternative has on the annual percentage of fish species, both adult and juvenile, that passes the dam. When the dam gates are raised, there is no effect. When the gates are lowered, there is a variable amount of effect that depends on the physical characteristics of the fish, facility assumptions, and flows. The maximum fish passage index is 100, which would be interpreted as 100 percent of either adult or juvenile fish passing the dam with no effect.

Fishtastic! evaluated impacts to the four runs of chinook salmon (winter, spring, fall, and late-fall runs), anadromous steelhead, and green sturgeon. Results of the Fishtastic! analysis were compared to the passage indices for each species under the No Action Alternative and are summarized in Tables 6 and 7.

TABLE 6
Summary of the Results of the Fishtastic! Adult Passage Impact Assessment.

Adults	No Action Index	Preferred Alternative Index	Percent Improvement
Winter-run salmon	89	98	9
Spring-run salmon	52	93	77
Fall-run salmon	83	89	9
Late-fall-run salmon	100	100	0
Steelhead	89	96	8
Green sturgeon	65	100	54

TABLE 7
Summary of the Results of the Fishtastic! Juvenile Passage Impact Assessment.

Juveniles	No Action Index	Preferred Alternative Index	Percent Improvement
Winter-run salmon	96	99	3
Spring-run salmon	100	100	0
Fall-run salmon	97	100	2
Late-fall-run salmon	93	98	5
Steelhead	92	99	7
Green sturgeon	73	88	21

The information contained in this BA contains a summary of effects for the operation of the preferred alternative, and its affect on winter-run chinook salmon, spring-run chinook salmon, fall-run chinook salmon, late fall-run chinook salmon, steelhead, and green sturgeon. Overall, for the preferred alternative the passage indices for the species evaluated were greater than those calculated for the No-action Alternative. Therefore, there are no significant adverse impacts to either adults or juveniles of any species from the preferred alternative.

Effects of Operation of the Preferred Alternative on Winter-run Chinook Salmon

Adults

There is a modest improvement in the adult passage index for winter-run chinook. When compared to the No Action Alternative, the proposed project shows a 9 percent improvement of fish passage. The main benefit of the proposed project is from the removal of the gates during the early to mid-summer months. Operation of the proposed project is not likely to adversely affect adult winter-run salmon.

Juveniles

There is a modest improvement in the juvenile passage index for winter-run chinook salmon. When compared to the No Action Alternative, the proposed project shows a 3 percent improvement in juvenile passage. There would be a potentially small impingement impact to fry and/or juvenile winter-run salmon at the Pump Station fish protection screens but this impact would be less than significant. This impact would not require additional conservation measures. Operation of the proposed project facilities are not likely to adversely effect juvenile winter-run chinook salmon.

Effects of Operation of the Preferred Alternative on Spring-run Chinook Salmon

Adults

The principal benefit of the preferred alternative occurs for adult spring-run chinook salmon where there was a passage improvement of approximately 77 percent compared to No Action. The main benefit of the proposed project is from the removal of the gates during the early to mid-summer months. Operation of the proposed project is not likely to adversely affect adults of this species.

Juveniles

There is no measurable improvement in the juvenile passage index for spring-run chinook. When compared to the No Action Alternative, the proposed project shows a 0 percent improvement of fish passage. There would be a potentially small impingement impact to fry and/or juvenile spring-run chinook salmon at the Pump Station fish protection screens but this impact would be less than significant. This impact would not require additional conservation measures. Operation of the project will have no effect on juvenile spring-run chinook salmon.

Effects of Operation the Preferred Alternative on Fall-run Chinook Salmon

Adults

There is a modest improvement in the adult passage index for fall-run chinook. When compared to the No Action Alternative, the proposed project shows a 9 percent improvement of fish passage. The main benefit of the proposed project is from the removal of the gates during the early to mid-summer months. Operation of the proposed project is not likely to adversely affect adults of the species.

Juveniles

There is a modest improvement in the juvenile passage index for fall-run chinook. When compared to the No Action Alternative, the proposed project shows a 2 percent improvement of fish passage. There would be a potentially small impingement impact to fry and/or juvenile fall-run chinook salmon at the Pump Station fish protection screens but this impact would be less than significant. This impact would not require additional conservation measures. Operation of the proposed project is not likely to adversely affect juvenile fall-run chinook salmon.

Effects of Operation of the Preferred Alternative on Late-Fall-run Chinook Salmon

Adults

There is no change in the adult passage index for late-fall chinook salmon with this alternative. Because fish are not present during the early to mid-summer months, there will be no effect on adults of this species.

Juveniles

There is a modest improvement in the juvenile passage index for late-fall-run chinook. When compared to the No Action Alternative, the proposed project shows a 5 percent improvement of fish passage. There would be a potentially small impingement impact to fry and/or juvenile late-fall run chinook salmon at the Pump Station fish protection screens but this impact would be less than significant. This impact would not require additional conservation measures. Operation of the proposed project is not likely to adversely affect juvenile late-fall run chinook salmon.

Effects of Operation of the Preferred Alternative on Steelhead

Adults

There is a modest improvement in the adult passage index for steelhead. When compared to the No Action Alternative, the proposed project shows a 8 percent improvement of fish passage. The main benefit of the proposed project is from the removal of the gates during the early to mid-summer months. Operation of the proposed project is not likely to adversely affect the species.

Juveniles

There is a modest improvement in the juvenile passage index for steelhead. When compared to the No Action Alternative, the proposed project shows a 7 percent improvement of fish passage. There would be a potentially small impingement impact to fry and/or juvenile steelhead at the Pump Station fish protection screens but this impact would be less than significant. This impact would not require additional conservation measures. Operation of the proposed project is not likely to adversely affect juvenile steelhead.

Effects of Operation of the Preferred Alternative on Adult Green Sturgeon

Adults

There a large measurable improvement in the adult passage index for green sturgeon. When compared to the No Action Alternative, the proposed project shows a 54 percent improvement of fish passage. The main benefit of the proposed project is from the removal of the gates during the early to mid-summer months. Operation of the proposed project is not likely to adversely affect the species.

Juveniles

There is alarge measurable improvement in juvenile passage indes for green sturgeon. When compared to the No Action Alternative, the proposed project shows a 21 percent improvement of juvenile fish passage. Operation of the proposed project is not likely to adversely affect juvenile green sturgeon.

Effects of the Preferred Alternative on Water Quality

Impact WQ-1.

Construction activities will result in disturbances of soil during grading and bank excavation at the "Mill Site" and the conveyance crossing in Red Bank Creek. Soil will potentially enter the active channel as sediment discharges resulting in increased turbidity and violation of the State Water Quality Standards (Basin Plan for the Sacramento River). This impact is significant and will require measures to reduce this to less than significant.

Impact WQ-2.

Transport, storage, or spills of hazardous materials or spills from leaking or from re-fueling and servicing construction equipment on the bank or in the active channel may result in discharges of contaminants into the Sacramento River in violation of the State Water Quality Standards (Basin Plan for the Sacramento River). This impact is significant and will require measures to reduce this to less than significant.

Proposed Conservation Measures to Reduce Impacts

Measure A-1.

Impacts to adults of all listed and candidate species from sediments discharged into the active channel and from increases in turbidity as a result of site grading and bank excavation at the "Mill Site" construction area will be reduced through implementation of the following measures:

- Preparation of an erosion control plan as part of the Storm Water Pollution Prevention Plan (SWPPP);
- Control of sediment discharges through implementation of Best Management Practices (BMPs) including but not limited to:
    1. Slope grading,
    2. Temporary and or permanent seeding and mulching,
    3. Dust control measures,
    4. Installation of erosion control fabrics, and fiber rolls,
    5. Installation of temporary stream crossings,
    6. Installation of energy dissipaters, check dams, silt fences, and straw bale dikes,

       Installation of sediment basins, and sediment traps.
- Cofferdams will be placed to isolate construction activities that have the potential for discharging soils and sediments into the active stream channel.
- Bank excavation techniques will be implemented to minimize and prevent, to the greatest extent possible, soil material from entering the active channel.
- Turbidity will be monitored during cofferdam placement and construction so-as to ensured that all activities do not result in increased turbidity resulting in deleterious effects on listed or candidate species in the vicinity of the project location.

- Construction activities will cease when turbidity approaches and exceeds acceptable criteria established by the Central Valley Regional Water Quality Control Board (CV-RWQCB). Construction activities may resume only after turbidity levels downstream of the project construction site return to acceptable levels established by the CV-RWQCB.

Measure A-2.

Impacts to adults of all listed and candidate species from sediments discharged into the active channel and from increases in turbidity as a result of site grading and bank excavation at the diversion conveyance pipeline construction area at Red Bank Creek will be reduced through implementation of the measures outlined in Measure A-1 above.

Measure J-1.

Impacts to juveniles of all listed and candidate salmonid species and to larvae and juvenile green sturgeon from sediments discharged into the active channel and from increases in turbidity as a result of site grading and bank excavation at the "Mill Site" construction area will be reduced through implementation of the measures outlined in Measure A-1 above.

Measure J-2.

Losses, injuries, and or stress to fry and/or juvenile lifestages of listed or candidate species from the impacts of percussion from sheet pile installation at the "Mill Site" construction area will be reduced by avoiding critical periods of time when these lifestages are present. To avoid percussion impacts to sensitive lifestages the following sheet pile-driving schedule will be implemented:

- No sheet pile driving will occur during the months of July through October (inclusive),
- The preferred period for sheet pile driving with no restrictions is November through January (inclusive),
- Sheet pile driving may occur, with approval from NMFS and CDFG during February through June (inclusive).

Measure J-3.

Losses, injuries and stress to fry and juveniles of listed and candidate species resulting from operation of heavy equipment in the active stream channel at the "Mill Site" prior to, during or following the installation of cofferdams will be reduced through the implementation of the following conservation measures:

- Any heavy equipment necessary for installation or removal of sheetpile cofferdams will be operated from either a floating barge or from the top of stream bank,
- No more than one vehicle with tracks or wheels will be permited to enter or operate within any wet portion of the stream channel at any time,
- All vehicles operated within the wet portion of the stream channel will enter and exit the active channel via one location (access point),

- All other vehicle accessing work areas adjacent to and within the wet portion of the stream channel will be operated on existing roads, hardened access ramps, or within contained areas inside cofferdams,
- Any vehicle operated within the wet portion of the stream channel shall be free of petroleum residues and that any vehicle's fuel, lubricant, and/or fluids shall be contained within watertight reservoirs,
- Operation of any vehicle within the wet portion of the stream channel shall be minimized and only as necessary to accomplish construction related tasks.

Measure J-4.

Direct losses, injuries, and stress to fry and juvenile lifestages of salmonid species or larvae and juvenile green sturgeon occurring from isolation and stranding during the installation of cofferdams and from de-watering within the cofferdamed area would be through the following measures:

- Wet portions of the work area that become separated or isolated to the main river channel shall be immediately seined to salvage any fry and or juvenile lifestages present,
- All salvaged fish shall be captured and handled by experienced fisheries biologists and in a manner insuring minimizing injury and stress and maximizing survival rates,
- During salvage operations, captured fish shall be placed into suitable vessels containing adequate volumes and quality of receiving water,
- Salvaged fish shall be quickly transport and to released at locations downstream and out of the immediate vicinity of the construction site in the Sacramento River,
- Salvage will continue until no additional listed or candidate species are recovered,
- If additional areas become isolated and stranding listed or candidate species occurs, salvage and release shall continue until no additional listed or candidate species are recovered.

Measure J-5.

Impacts to juveniles of all listed and candidate salmonid species and to larvae and juvenile green sturgeon from sediments discharged into the active channel and from increases in turbidity as a result of site grading and bank excavation at the diversion conveyance pipeline construction area at Red Bank Creek will be reduced through implementation of the measures outlined in Measure A-1 above.

Measure J-6.

Losses, injuries, and or stress to fry and/or juvenile lifestages of listed or candidate species from the impacts of percussion from sheet pile installation at the diversion conveyance pipeline crossing location at the Red Bank Creek construction area will be by avoiding critical periods of time when these lifestages are present. To avoid percussion impacts to sensitive lifestages the sheet pile driving schedule shown in Measure J-2 above shall be implemented.

Measure J-7.

Losses, injuries and stress to fry and juveniles of listed and candidate species resulting from operation of heavy equipment in the active stream channel at the diversion conveyance pipeline at Red Bank Creek prior to, during or following the installation of cofferdams will be reduced through the implementation of the conservation measures shown in Measure J-3 above.

Measure J-8.

Direct losses, injuries, and stress to fry and juvenile lifestages of salmonid species or larvae and juvenile green sturgeon occurring from isolation and stranding during the installation of cofferdams will be reduced through the following measures:

- Installation of sheetpile cofferdams will occur during the period after September

15th and prior to any discharge within Red Bank Creek,

- Placement of cofferdams within Red Bank Creek during the period when no live channel is present will ensure no losses, injuries, or stress occurs to fry, and/or juvenile listed or candidate salmonid species or larvae and/or juvenile green sturgeon .

Measure WQ-1.

Impacts to water quality from discharges of soil, sediment and increased turbidity in violation of the State Water Quality Standards (Basin Plan for the Sacramento River) will be reduced through implementation of the conservation measures outlined in Measure A-1 above.

Measure WQ-2.

Impacts to water quality from hazardous construction materials, fuels, lubricants, and or hydraulic fluids leaking or spills from construction equipment resulting in discharges of contaminants in violation of the State Water Quality Standards will be by implementation of the following conservation measures:

- Preparation of construction materials handling, and vehicle maintenance, fueling, and spill prevention procedures as part of the Storm Water Pollution Prevention Plan (SWPPP),
- Implementation of BMPs for hazardous material storage, handling and disposal including but not limited to:
  1. Proper labeling,
  2. Proper disposal practices,
  3. Proper transport and storage of hazardous materials.
- Implementation of BMPs for fuel spill prevention and control, and vehicle service and maintenance including but not limited to:
  1. Designation of fueling areas,

2. Secondary fuel containment proceedures,
3. Fuel spill clean-up and disposal,
4. Maintaining vehicle service and maintenance areas,
5. Reporting hazardous materials spills.

Chapter 6 – Cumulative Effects

Introduction

Cumulative effects are those effects of future non-Federal (State, local governments, or private) activities on endangered and threatened species or critical habitat that are reasonable certain to occur within the action area of the Federal activity subject to consultation.

Safe Drinking Water, Clean Water, Watershed Protection, and Flood Protection Bond Act. (Water Bond 2000)

Water Bond 2000 provides for a bond issue of over $1.9 billion to provide funds for safe drinking water, water quality, flood protection, and water reliability programs. State agencies responsible for implementing programs funded by the Water Bond include the California Department of Water Resources, Reclamation Board, Resources Agency, California Department of Fish and Game, State Water Resources Control Board, and Department of Health Services. The State Water Resources Control Board will be allocating a portion of these funds (approximately 40%) to local projects throughout California.

Grants are used to develop local watershed management plans or to implement projects that are consistent with local watershed management and regional water quality control plans. Grants may be awarded for projects that implement methods for attaining watershed improvements or for a monitoring program described in a local watershed management plan. Eligible projects under this article may do any of the following:

- Reduce chronic flooding problems or control water velocity and volume using vegetation management or other nonstructural methods.
- Protect and enhance greenbelts and riparian and wetlands habitats.
- Restore or improve habitat for aquatic or terrestrial species.
- Monitor the water quality conditions and assess the environmental health of the watershed.
- Use geographic information systems to display and manage the environmental data describing the watershed.
- Prevent watershed soil erosion and sedimentation of surface waters.
- Support beneficial groundwater recharge capabilities.
- Otherwise reduce the discharge of pollutants to state waters from storm water or non-point sources.

There are several grant applications that are currently being processed under this act, however currently there are no completed project associated with the Water Bond.

Safe, Clean, Reliable, Water Supply Act (Proposition 204)

The Safe, Clean, Reliable, Water Supply Act provides funds for ongoing programs in the Bay-Delta watershed and for the administrative expenses of CALFED studies and planning activities. Programs that receive funding include: Central Valley Project Improvement Program, Bay-Delta Agreement Program (Category III projects), Delta-Levee Rehabilitation Program, South Delta Barriers Program, and CALFED Planning and Feasibility.

Also, the act provides loans and grants to improve water quality and promote water recycling reuse. These types of projects include:

- Clean Water Loans –assists local agencies with construction of waste water treatment plants with the goal of meeting applicable water quality standards.
- Small Community Grants – provides funds to local agencies with populations of 5,000 which have demonstrated financial hardships, to construct treatment facilities.
- Water Recycling Program – Provides loans to local agencies for design and construction of recycling projects, with the goal of providing a cost-effective way to stretch water supplies while meeting applicable water quality and public health requirements.
- Drainage Management – Provides loans to local agencies to construct facilities to treat agricultural drainage water and to remove or substantially reduce the level of pollutants, with preference given to source reduction projects and programs.
- Delta Tributary Watershed Program – Provides financing to develop watershed rehabilitation projects to reduce contaminants in drinking water, improve riparian and fisheries habitat, improve forest health, and increase the water retention capacity of watershed.
- Sea Water Intrusion Control – Provides loans to local agencies to combat sea water intrusion into coastal groundwater aquifers that provide water for municipal, industrial and agricultural use.
- Lake Tahoe Water Quality – Provides funds for construction of soil erosion control facilities and for the restoration and preservation of environmentally sensitive lands to improve Lake Tahoe's water quality.

The act also provides funding for statewide projects to enhance water supplies, improve water management, and improve the management of demand for water. Such projects include:

- Feasibility Projects – Provides funds to investigate concepts such as conveying waste water from the Bay Area to the Central Valley to use as irrigation, building a conveyance facility from Imperial Valley to San Diego, and creating off-stream water storage facilities in the Sacramento Valley.
- Water Conservation and Groundwater Recharge – Provides financing to acquire land and develop facilities for replenishing groundwater. Priority would be given to projects in over-drafted groundwater basins. Funds would also be used for capital investments in agricultural and urban water conservation facilities, resulting in a net saving of water.

- Local Projects – Provides loans for feasibility studies and projects to increase water supplies in rural counties, such as diversion from existing facilities.
- River Parkways Program – Provides funds to acquire land and develop parkways along river corridors under laws governing conditions for parkway development.
- Sacramento Valley Water Management and Habitat Protection – Provides funds for water management and habitat improvements in the Sacramento Valley, including conservation and fish protection projects.

Additionally, a portion of the bond money funded the CALFED Bay-Delta Ecosystem Restoration Program, and Flood Control Subvention Program.

Sacramento Valley Water Management Agreement

The Sacramento Valley Water Management Agreement (Agreement) is a collaborative effort to increase water supplies for farms, cities and the environment. The Agreement was created in April 2001, after a series of water right proceedings held by the State Water Resources Control Board (Control Board) to determine responsibility for meeting water quality standards set by the 1994 Bay-Delta Accord (Accord). Phases 1 through 7 of the water rights proceedings involved the San Joaquin Valley and other Delta issues. The controversial Sacramento Valley issues (Phase 8) was the final phase of these proceedings. Proceeding with Phase 8 could involve litigation and judicial review for nearly 10 years. In order to avoid the consequences of delay, the Sacramento Valley water users, the California Department of Water Resources, The U.S. Bureau of Reclamation, and export water users developed the Agreement. The Agreement provides the foundation for a regional strategy to ensure that local water needs are fully met while helping improve water supplies throughout the state.

To implement the Agreement, the parties involved are preparing joint workplans. The workplans will describe certain Sacramento Valley projects and will provide an estimate of the quantity of water or other water management benefits that can be realized by implementing these projects. The workplans will identify several voluntary water management measures that will lead to an integrated water management program. The program will include the coordinated use of storage facilities, management and recovery of tailwater through major drains, water conservation, conjunctive management of surface water and groundwater, and transfers and exchanges among Sacramento Valley water users and other water users in the state.

Some of the anticipated benefits of the Agreement include increased water supplies; development of additional supplies; sustainable water supply solutions; environmental restoration including benefits to fish and wildlife in the Sacramento River watershed; and meeting Control Board water quality standards.

Chinook Salmon Cumulative Effects

Activity

Activity

Chapter 7 – Determination of Effects

Introduction

The following determination of effects for the (Species) consider direct and indirect effects of the proposed action on the listed species together with the effect of other activities that are interrelated or interdependent with the action. These effects are considered along with the environmental baseline and the predicted cumulative effects.

Adult Winter-run Chinook Salmon

- Construction of the proposed project may affect, and is likely to adversely affect adult species. Measures will be implemented to reduce the impacts of construction activity.
- It is anticipated that modest improvements (approximately 9% increase) to adult passage will result from operation of the proposed project. Therefore, it is not likely to adversely affect the species.

Juvenile Winter-run Chinook Salmon

- Construction of the proposed project may affect, and is likely to adversely affect juvenile species. Measures will be implemented to reduce the impacts of construction activity.
- It is anticipated that modest improvements (approximately 3% increase) to juvenile passage will result from operation of the proposed project. Therefore, it is not likely to adversely affect the species.

Adult Spring-run Chinook Salmon

- Construction of the proposed project may affect, and is likely to adversely affect adult species. Measures will be implemented to reduce the impacts of construction activity.
- It is anticipated that large measurable improvements (approximately 77% increase) to adult passage will result from operation of the proposed project. Therefore, it is not likely to adversely affect the species.

Juvenile Spring-run Chinook Salmon

- Construction of the proposed project may affect, and is likely to adversely affect juvenile species. Measures will be implemented to reduce the impacts of construction activity.
- It is anticipated that no measurable improvement to juvenile passage will result from operation of the proposed project. Therefore, the project will have no affect on the species.

Adult Fall-run Chinook Salmon

- Construction of the proposed project may affect, and is likely to adversely affect adult species. Measures will be implemented to reduce the impacts of construction activity.

- It is anticipated that modest improvements (approximately 9% increase) to adult passage will result from operation of the proposed project. Therefore, it is not likely to adversely affect the species.

Juvenile Fall-run Chinook Salmon

- Construction of the proposed project may affect, and is likely to adversely affect juvenile species. Measures will be implemented to reduce the impacts of construction activity.
- It is anticipated that modest improvements (approximately 2% increase) to juvenile passage will result from operation of the proposed project. Therefore, it is not likely to adversely affect the species.

Adult Late-Fall-run Chinook Salmon

- Construction of the proposed project may affect, and is likely to adversely affect adult species. Measures will be implemented to reduce the impacts of construction activity.
- It is anticipated that no measurable improvement to adult passage will result from operation of the proposed project. Therefore, the project will have no affect on the species.

Juvenile Late-Fall-run Chinook Salmon

- Construction of the proposed project may affect, and is likely to adversely affect juvenile species. Measures will be implemented to reduce the impacts of construction activity.
- It is anticipated that modest improvements (approximately 5% increase) to juvenile passage will result from operation of the proposed project. Therefore, it is not likely to adversely affect the species.

Adult Steelhead

- Construction of the proposed project may affect, and is likely to adversely affect adult species. Measures will be implemented to reduce the impacts of construction activity.
- It is anticipated that modest improvements (approximately 8% increase) to adult passage will result from operation of the proposed project. Therefore, it is not likely to adversely affect the species.

Juvenile Steelhead

- Construction of the proposed project may affect, and is likely to adversely affect juvenile species. Measures will be implemented to reduce the impacts of construction activity.
- It is anticipated that modest improvements (approximately 7% increase) to juvenile passage will result from operation of the proposed project. Therefore, it is not likely to adversely affect the species.

Adult Green Sturgeon

- Construction of the proposed project may affect, and is likely to adversely affect adult species. Measures will be implemented to reduce the impacts of construction activity.

- It is anticipated that large measurable improvements (approximately 54% increase) to adult passage will result from operation of the proposed project. Therefore, it is not likely to adversely affect the species.

Juvenile Green Sturgeon

- Construction of the proposed project may affect, and is likely to adversely affect juvenile species. Measures will be implemented to reduce the impacts of construction activity.
- It is anticipated that large measurable improvements (approximately 21% increase) to juvenile passage will result from operation of the proposed project. Therefore, it is not likely to adversely affect the species.

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