ATTACHMENT "E"

Real-Time Decision Group
2006 Fish Passage Supplementation
DRAFT

MEMORANDUM

To: Adaptive Management Committee

From: Real-Time Decision Group and Cachuma Project Biology Staff

Date: August 28, 2007

Re: **Report on the 2006 Fish Passage Supplementation Events**

I. Introduction

The Fish Passage Supplementation Program was developed to increase the fish passage opportunities for steelhead in the Lower Santa Ynez River (LSYR). The program is structured to take advantage of rainfall events and supplement the recessional limb of the storm hydrograph. The program was proposed as part of reservoir operations in the section 7 consultation with National Marine Fisheries Service (NMFS) on the Cachuma Project (USBR, 2000). Additional analyses were requested by NMFS in the Cachuma Project Biological Opinion (BO) (NMFS, 2000). These investigations were conducted by the Adaptive Management Committee (AMC) and the proposed modifications were published as revisions to Sections 3.2.3.2.2 and 3.2.3.2.3 of the Biological Assessment (BA) (USBR, 2000; AMC, 2004). NMFS accepted the proposed modifications (NMFS, 2005) and the AMC created and charged the Real-Time Decision Group (RTDG) and U.S. Bureau of Reclamation (Reclamation) to conduct the modified supplementation program once Lake Cachuma was fully surcharged (2006). Specifically, the RTDG and Reclamation are responsible for conducting the supplementation program, recommending modifications of the passage releases, and reporting on the activities of the program to the AMC. Upon meeting the established criteria specified in the guidance documentation, passage supplementation is initiated by the RTDG during January and mid-April to the end of May (the end of the migration season) and by Reclamation, or whoever they designate (the RTDG in 2006), from February to mid-April. The objective of partitioning the potential supplementation period into three parts was to give the RTDG discretion during the beginning and end of the migration season to withhold supplementation if they feel it is in the best interest of the program even if the criteria have been met. In the middle or peak migration period, Reclamation would automatically supplement once the criteria had been met.

RTDG meetings are initiated by the Cachuma Project Biologist and conducted via conference call. Prior to any potential passage release, the Cachuma Project Biologist evaluates the hydrological and meteorological conditions and presents the findings to the RTDG to determine if the published criteria for passage supplementation have been met and a passage release should be called for and conducted by Reclamation. Members of the RTDG are the Chair of the AMC

(Mike Kinsey, U.S. Bureau of Reclamation), Civil Engineer for SCCAO Operations(Darrin Williams, U.S. Bureau of Reclamation - SCCAO-Operations Division), and Cachuma Project Biologist (Scott Engblom, Cachuma Project Biology Staff).

There were two storms during the winter and spring of 2006 (2/28/06 and 3/29/06) that met the established criteria for supplementation and releases were made to augment stormflow for fish migration. The results of the 2006 releases under the Fish Passage Supplementation Program are presented by storm, followed by a discussion of the results of the program, and recommendations for program improvements.

II. Purpose

This memorandum presents the annual report to the AMC from the RTDG following the close of the migration season that describes the actions and results of the Fish Passage Supplementation Program for the year 2006, as well as provide recommendations to the AMC for improvement of the supplementation program. This memorandum was prepared by the Cachuma Project Biology Staff (CPBS) and has been reviewed by the members of the RTDG. The report provides a mechanism for AMC evaluation of the program, specifically regarding the performance of the established criteria, RTDG and Reclamation execution of the program, and adequacy of the data gathered for program verification. Based on this information, the AMC may make recommendations for modification of the Fish Passage Supplementation Program if needed.

III. Background

The Cachuma Project Fish Passage Supplementation Program was developed as an experimental program to supplement passage opportunities for steelhead in the LSYR. The modifications developed by the AMC (AMC, 2004) specifically address the Terms and Conditions in the Biological Opinion (NMFS, 2000) and implements Reasonable and Prudent Measure No. 3 and the migration portion of Reasonable and Prudent Measure No. 15. Revisions were designed to: (1) modify the Fish Passage Supplementation Program during dry years; (2) better define the adaptive management program for upstream and downstream migration; and (3) outline a method to verify the effectiveness of the migration supplementation. Modifications to the Fish Passage Supplementation Program were approved by NMFS on October 11, 2005 (NMFS, 2005).

The overall purpose of the Fish Passage Supplementation Program is to extend migration opportunities for steelhead during the recessional limb of a storm hydrograph. Water for the releases comes from surcharged water in Lake Cachuma, specifically from the Fish Passage Account (3,200 acre-feet). Passage releases can only occur during the steelhead migration period, which is from January through May. To quote the BO:

> "To supplement migration flows, Reclamation proposes to establish a passage account that would provide flow releases during the steelhead migration season (winter and spring) at both the 1.8 and 3.0 foot surcharge level. Passage flow releases will utilize some of the surcharged water to extend the duration of flows, and in many cases increase flows in the Santa Ynez River directly following storms when steelhead are likely migrating. Releases will occur after most storms until the water set aside for migration support is exhausted. Once climate conditions allow the

reservoir to be surcharged again, migration supplementation will resume (NMFS, 2000)."

The key information needed in the implementation of the Fish Passage Supplementation Program is the data necessary to evaluate the required criteria, the implementation objectives, and the requisite real-time information for the RTDG as laid out in the guidance documentation for the program (NMFS, 2000; USBR, 2000; AMC, 2004). The components of each are described below.

Decision-making criteria to conduct passage supplementation:

The required decision-making criteria for passage supplementation are as follows:

I. Water releases will be made for passage supplementation for storms between January and May (the migration season).
II. Flows in the Santa Ynez River at the Solvang gage must be 25 cfs or greater (the established definition of a storm that produces measurable runoff and fish passage in the Lower Santa Ynez River).
III. Cumulative flow at the Salsipuedes Creek gage is equal to or greater than 1,000 acre-feet since December 1st. The purpose of the tributary trigger in Salsipuedes Creek is to help assess the hydrologic readiness of the lower watershed to support spawning and rearing. Cumulative flow is calculated beginning on December 1st at the Salsipuedes Creek U.S. Geological Survey (USGS) gage using daily average discharge. The use of this tributary trigger is to identify storms when fish passage supplementation should occur through avoidance of the driest water years when the action would be least effective.
IV. The sandbar at the mouth of the Santa Ynez River must be breached.
V. The first storm in January will not be supplemented, as this storm recharges the watershed, thus priming the watershed for future releases.
VI. All storms in the migration season will be supplemented unless (1) flows at Solvang reach 25 cfs within the 7 days following a prior migration flow release (the second storm will not be supplemented), (2) the AMC (or RTDG) determines that there is greater biological benefit not to supplement a particular storm (saving water to supplement later storms), or (3) there is no water left in the Fish Passage Account.

When these required conditions are met, a release can be called for by the RTDG from the Fish Passage Account during January and mid-April through May to supplement flows in the LSYR and aid steelhead migration below the dam. Reclamation would automatically supplement if the criteria were met from February to mid-April (Table 1). The RTDG can decide to withhold supplementation during January and mid April through May if they feel it is in the best interest of the program even if the criteria have been met. For example, if the supplementation criteria have been met, but the watershed is not ready to support returning fish to spawn, the RTDG can decide not to supplement a storm. On the other hand, if a storm occurs soon after a previous supplementation and the RTDG thinks that supplementation would be in the best interest of the program, they can choose to supplement. If they change from the established protocols of the program, they need to notify the AMC of the change and the reasons they took that action.

Table 1: Fish passage supplementation program summary schedule as presented in the AMC 2004 report, Table 3-8a.

Time Period	Type of Action	Responsible Party
January	• Real-time decision: to supplement or not; and • Criteria in Section 3.2.3.2.2 must be met	• Real-time Decision Group • U.S. Bureau of Reclamation
February to mid-April	Automatic supplementation, once criteria in Section 3.2.3.2.2 are met	U.S. Bureau of Reclamation
mid-April to end of May	• Real-time decision: to supplement or not; and • Criteria in Section 3.2.3.2.2 must be met	• Real-time Decision Group • U.S. Bureau of Reclamation
Summer	Annual evaluation of Fish Passage Supplementation Program (including criteria in Sections 3.2.3.2.2 and 3.2.3.2.3)	Adaptive Management Committee

Implementation objectives:

Upon calling for a supplementation release by the RTDG or Reclamation to enhance fish passage migration, the following procedural objectives should be met:

A. Enhance the storm hydrograph at the Solvang gage that will last approximately 14 days. All supplementation releases will be debited to the Fish Passage Account (3,200 acre-feet). Releases will be made from the reservoir through the outlet works and the Hilton Creek Supplemental Watering System (HCSWS) to mimic the average storm recession, referred to as the decay function (USBR, 2000), of the Los Laureles gage during normal water years at the Solvang gage location.

B. Follow a decay function for ramp-down (Figure 1) that was derived from an average of recession hydrographs from the Los Laureles gage above the reservoir (USBR, 2000). This was developed in the spirit of adaptive management and is subject to modification by the AMC and approval by NMFS. The average storm recession from 150 to 25 cfs takes 14 days during normal water years at the Los Laureles gage, hence is the objective for ramp-down at the Solvang gage.

C. Start flow releases when the un-supplemented storm hydrograph at Solvang recedes from its peak to 150 cfs.

D. In the event that storm peaks at the Solvang gage are less than 150 cfs but greater than 25 cfs, release water to provide a peak of 150 cfs at Solvang and then follow the decay function for ramp-down;

E. From 25 cfs to baseflow, follow the proposed mainstem ramp-down rate; and

F. Supplement fish passage in years following surcharge until there is no water left in the Fish Passage Account. The account will be reset to the full amount (3,200 acre-feet) once Bradbury Dam spills.

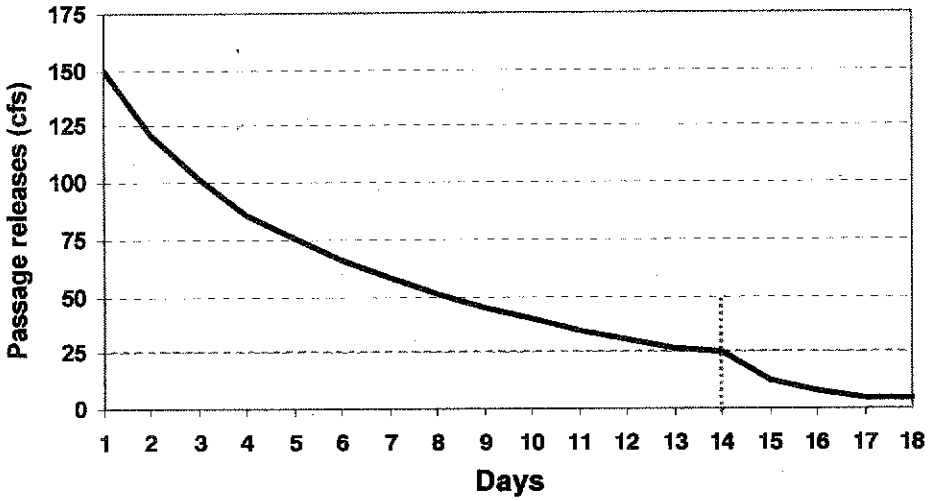

Figure 1: Decay function for supplementation release ramp-down as determined in the Section 3 of the BA from 150 to 25 cfs (USBR, 2000) and the BO from 25 to baseflow (HCSWS rearing flows only) (NMFS, 2000).

Data supplied to the RTDG:

The Cachuma Project Biologist is required to provide the RTDG the following information to facilitate and support their decision-making process (AMC, 2004):

1. Rainfall at Bradbury Dam, Solvang and/or Lompoc;
2. The predicted magnitude and occurrence of future storms using NOAA weather storm track reports;
3. Surface flow conditions in the tributaries/mainstem of the Santa Ynez River and runoff in response to previous storm events depicted on daily hydrographs of USGS gages on Hilton Creek, Salsipuedes Creek, and Santa Ynez River below the Long Pool and at the Solvang Bridge and Lompoc Narrows;
4. Weekly observations of surface water conditions at Quiota Creek and San Lucas Creek from public access points;
5. The current amount of water in the Fish Passage and Adaptive Management Accounts (before and after supplementation occurs);
6. Migrant trapping results to date at all sites for both upstream and downstream migrants including data on the number of migrants captured with locations and dates; and
7. Conditions at the lagoon mouth of the Santa Ynez River.

IV. Program Results

The first major storm of the runoff season to impact the Santa Ynez River watershed occurred on January 1-3 of 2006, which generated sufficient runoff throughout the basin to create favorable migration conditions for steelhead/rainbow trout. Because this was the first large storm of the Water Year (October through September), supplementation was not considered given the established criteria. No significant storms impacted the watershed for the remainder of January and most of February (Table 2 and Figure 2). No large ocean-going steelhead were captured

during that timeframe in the Salsipuedes Creek or Hilton Creek where migrant trapping operations were underway; only downstream migrating smolts and upstream migrating resident adults were captured in the tributaries. The mainstem trap was not deployed until the first passage release at the end of February (2/28/06) due to low flows. Mainstem trapping was done approximately 5 miles downstream of Bradbury Dam along the Refugio Reach (LYSR-5.6) in order to monitor fish movement as it related to both passage and non-passage releases and was continued until the reservoir spilled on April 3, when the traps were removed due to high flows. Mainstem trapping methodologies followed those utilized in the migrant trapping program in the tributaries.

There were two storms during the winter and spring of 2006 (2/28/06 and 3/29/06) that met the established criteria for supplementation. Table 3 evaluates whether the required criteria and implementation objectives were met and if the stipulated data were provided to the RTDG for both supplemented storms as established in the guidance documentation. Again, the criteria ensured that there was continuity in the Lower Santa Ynez River from the dam to the ocean and that the year type was not dry. Because these storms occurred in the months of February through mid-April, the established policy required Reclamation to initiate automatic supplementation (Table 1) (AMC, 2004). Given that this was the first year of the Supplementation Program, the RTDG initiated all supplementation events on behalf of Reclamation throughout the Water Year.

The first passage supplementation release was initiated in conjunction with the 2/28/06 storm. Supplementation releases ran from 2/28/06 through 3/17/06 with a total of 1,662 acre-feet (af) used in this first event, including releases through the HCSWS. There were 19 passage days (daily average flow greater than or equal to 25 cfs at the Solvang gage) during this period; 14 of those were during passage flow supplementation and five occurred after releases at Bradbury Dam were reduced below 25 cfs. The second supplementation event was associated with the 3/29/06 storm and releases were conducted from 3/29/06 through 4/3/06 with a total of 757 af released, including releases through the HCSWS. On April 3, Bradbury Dam spilled which ended the need for supplemental releases for the year. From 3/28/06 until 6/1/06 there were 64 passage days, 5 of those were during supplementation releases. The total number of passage days throughout Water Year 2006 was 92 days; 0 of those days occurred prior to the migration season (January through May), 88 days during the season, 4 days after the season, 5 days from 1/1/06 until the day before (2/27/06) the first supplementation event, and 0 days between the first and second supplementation events. Both supplemented storms were successful in meeting the required criteria (Table 3) by increasing the duration of migration from an estimated average of 3 days for each of the two storms without supplementation to over 14 days during the first storm and 5 days for the second prior to the dam spilling. Trapping efforts in the mainstem showed that both upstream migrating adult steelhead/rainbow trout and downstream migrating smolts moved during each passage release that would not have been possible without supplementation.

Table 2: Rainfall at Bradbury Dam from December through May of 2006. Peak flows at the Solvang gage and cumulative flows at Salsipuedes gage are also provided. Missing data were associated with storm damage to the gage or when daily discharge averages were only available from the USGS. The initiation of supplementation releases is denoted in bold. Peak flow dates were noted.

Storm Date	Rainfall[1] Bradbury Dam (in)	Qpeak[2] at Solvang Natural (cfs-date)	Qpeak[2] at Solvang Supplemented (cfs-date)	Qcum[3] at Salsipuedes (af)	Passage Supplementation
12/2/2005	0.53	-	-	7	-
12/26/2005	0.14	-	-	124	-
1/1/2006	7.54	-	-	192	no
1/14/2006	0.3	-	-	643	no
2/18/2006	0.53	-	-	851	no
2/28/2006	***2.53***	***81 - 2/28***	***88 - 3/2***	***1008***	***yes***
3/3/2006	0.78	124	-	1055	yes
3/6/2006	0.34	172	-	1134	yes
3/10/2006	0.82	134	-	1192	yes
3/18/2006	0.55	92	-	1317	no
3/21/2006	0.11	nd	-	1350	no
3/26/2006	0.18	21	-	1390	no
3/28/2006	***1.46***	***76 - 2/28***	***145 - 3/30***	***1485***	***yes (3/29)***
4/1/2006	0.24	321	-	1607	yes
4/4/2006	3.67	13450 - 4/5	-	3350	spill
4/11/2006	0.18	nd	-	3965	-
4/14/2006	0.57	nd	-	4070	-
4/26/2006	0.17	nd	-	4368	-
5/22/2006	1.54	nd	-	4777	-

1. Rainfall greater than 0.1 inches.
2. Qpeak - Peak flow.
3. Qcum - Cumulative flow prior to the storm.

nd - No data.

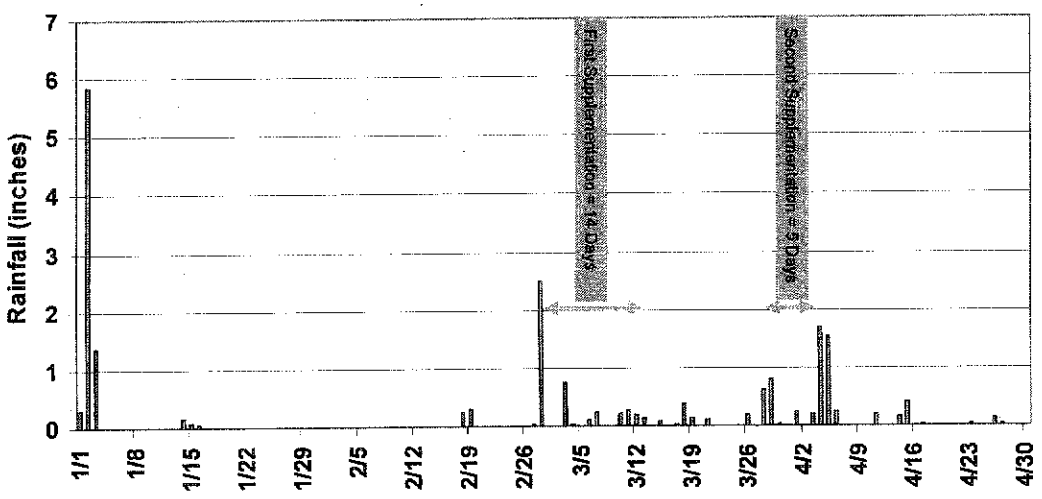

Figure 2: Rainfall amounts collected at Bradbury Dam from January 1 through April 30, 2006. Arrows denote the start and end of fish passage supplementation event.

Table 3: Summary of the implementation results of the Fish Passage Supplementation effort in Water Year 2006. The information is divided into required criteria, implementation objectives, and data supplied to the RTDG. Elements are listed in the same manner as presented in the Background section.

Implementation Results	Supplemented storms: 2/28/06	3/29/06
Required criteria for decision-making:		
I Storm falls between January through May	yes	yes
II Flows is greater than 25 cfs at Solvang	yes	yes
III Cumulative flow at Salsipuedes is greater than 1000 af since December in af	yes (1008)	yes (1485)
IV Santa Ynez River outlet lagoon breached	yes	yes
V Not the first storm in January	yes	yes
VI (1) Greater than 7 days since last supplemented storm	yes	yes
VI (2) AMC determines that there is greater benefit not to supplement	no	no
VI (3) Sufficient water in the Fish Passage Account (amount at initiation in af)	yes (3200)	yes (1538)
Implementation objectives:		
A Supplement to create passage flows (> 25 cfs) for 14 days	yes	no (spill)
B1 Rampdown decay curve used from Los Laureles	no	yes
B2 Recession mimicked Los Laureles flows at Solvang	no	yes
C Releases to start once Solvang recedes to 150 cfs	no (peak flows < 150 cfs)	no (peak flows < 150 cfs)
D If peak flow is less than 150 cfs, supplementation flows should be 150 cfs	yes	yes
E From 25 cfs to baseflow, use mainstem rampdown rate	no (linear)	no (spill)
F Supplementation to be done following a spill until Fish Passage Account is 0	yes	yes
Data supplied to the RTDG:		
1 Weekly rainfall totals prior to the event at Bradbury Dam (amount in inches)	yes (2.8 in)	yes (1.7 in)
2 Predicted magnitude/occurrence of storms using NOAA tracking reports	yes	yes
3 Flow conditions in the tributaries, Long Pool, Solvang, and the Narrows	yes	yes
4 Weekly observations of flow at Quiota and San Lucas creeks	yes	yes
5 Amount in the Fish Passage before/after supplementation (amount used) in af	3200/1538 (1662)	1538/3200-spill (398)
6 Migrant trapping data	yes	yes
7 Outlet lagoon conditions	open	open

First Passage Supplementation – the February 28 storm:

The RTDG used the available real-time data published on the USGS webpage and information provided by the Cachuma Project Biologist to evaluate the criteria and make the decision to call for a supplementation release. Real-time flow data, though, can be subject to error as high storm flows can damage the gage and cross-sectional channel area can be modified resulting in potential errors while implementing the established rating curve for the gaging site. The flow data are reviewed for accuracy by the USGS well after any stormflow event and corrected flow estimates are then inserted into the flow record. In the case of this storm, the data were corrected and reposted several weeks after the event; hence flows were different from the initial data used by the RTDG. For the purpose of this report, both the real-time (used for decision-making) and the corrected data are provided (Figure 3 and Table 4). Solvang (1) was the real-time data available through 3/6/06 and used by the RTDG to call for the release, whereas the Solvang (2) curve was the corrected discharge that was posted after 3/19/06. All hours of the day are presented in military time (i.e., 24 hours).

The storm that occurred during February 27-28 (the February 28 storm) met the established criteria for supplementation in all aspects (Table 3 and Figure 3). The storm was during the migration season (January – May). Cumulative flow since December at the Salsipuedes USGS gage was 1008 af, using the sum of the average daily flows. It should be noted that at the end of the day on February 27, the cumulative flow for Salsipuedes Creek was still below the 1000-af trigger (905 af) using the USGS daily average flow data, but the following day exceeded the

established cumulative discharge threshold and created ideal conditions for a supplementation event. The mainstem began rising at the Solvang gage in the afternoon of 2/27/06 prior to supplementation, reaching 25 cfs at 20:00 (21:00 corrected) and peaking at 03:00 on 2/28/06 at 127 cfs (81 cfs corrected). Finally, the lagoon was open at the mouth of the Santa Ynez River throughout the storm. The RTDG convened early on the morning of 2/28/06, reviewed the criteria, and concluded that the prior January storm sufficiently wetted the watershed, tributary connectivity had been established, all the required criteria had been met, and that the position in the migration season was favorable for a fish passage supplementation. As a result, a passage release was called for at 08:00 that day by the RTDG. The real-time data for the Solvang gage at that hour read 79 cfs (41 cfs corrected) and the objective of the RTDG decision was to increase natural flow to 150 cfs at the Solvang gage as required in the Fish Passage Supplementation Program. As a result, the RTDG requested a release of 80 cfs and Reclamation increased the total releases from the Dam to 83 cfs (77 cfs for passage supplementation from the outlet works and 6 from HCSWS). The smaller magnitude release was a communication lapse between the RTDG and Reclamation. Normal rearing flow releases through the HCSWS at 6 cfs were continued throughout the period.

Communication difficulties delayed the requested release until 14:30 at which point flows at the Solvang gage had receded to 62 cfs (29 cfs corrected). When the passage release reached the Solvang gage 13 hours later at 03:30 on 3/1/06, the flow rate had dropped to 45 cfs (18 cfs corrected). The flow then gradually increased to a peak flow of 136 cfs (88 cfs corrected) at 12:15 on 3/2/06, below the target discharge of 150 cfs.

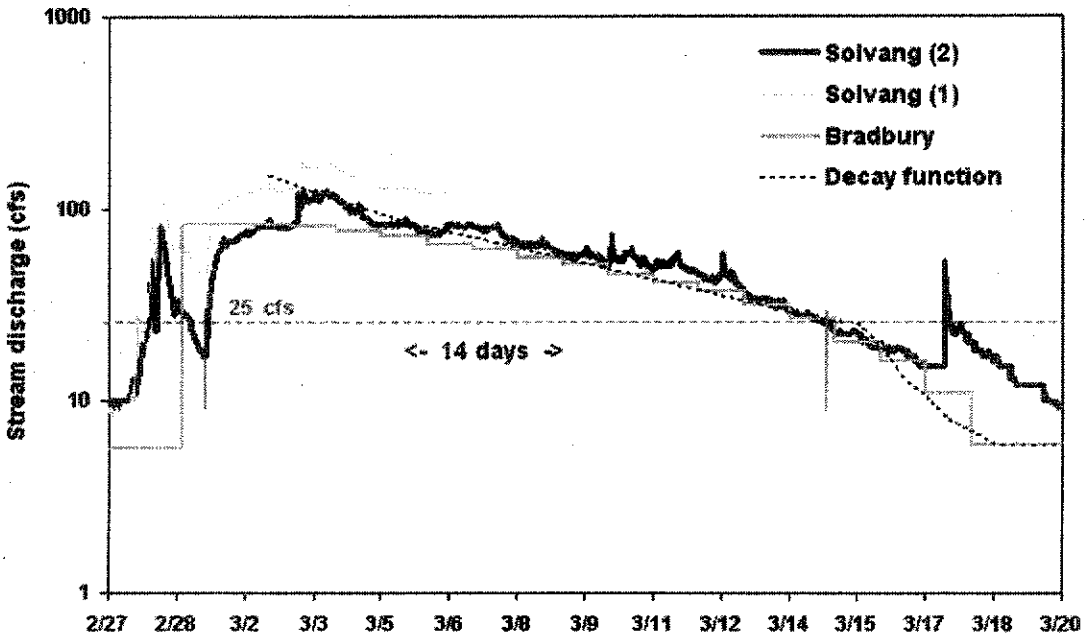

Figure 3: Storm hydrographs of the Solvang gaging stations showing runoff conditions prior, during, and after fish passage supplementation releases for the February 28 storm. The Solvang (1) curve in green was the real-time data and the Solvang (2) curve in blue was the corrected discharge. The decay function as described in the documentation was included for reference, although not implemented. Daily operations data for Bradbury releases were also included.

Table 4: Summary of the hydrologic conditions during the first supplementation event. Solvang (1) are the real-time and Solvang (2) the corrected data presented in Figure 3. Bradbury discharge data are given just for reference.

Date-time	Discharge (cfs):			Notes:
	Solvang (1)	*Solvang (2)*	*Bradbury*	
2/27/2006 12:00	9.9	11	*6*	Baseflow conditions at Solvang
2/27/2006 19:45	25	22	*6*	Solvang (1) at 25 cfs
2/27/2006 20:45	31	26	*6*	Solvang (2) at 25 cfs
2/28/2006 3:00	127	81	*6*	Natural peak flow at Solvang
2/28/2006 8:00	79	41	*6*	Flows at 8:00
2/28/2006 14:30	62	29	*83*	Flows at initiation of passage release
3/1/2006 3:30	45	18	*64*	Flows when passage release arrives
3/2/2006 12:15	136	88	*83*	Passage flow peak at Solvang
3/14/2006 17:15	nd	25	*26*	Solvang (2) back to 25 cfs

Supplementation resulted in a bimodal hydrograph at the Solvang gage that did not meet the objectives set forth in the Fish Passage Supplementation Program documentation in magnitude or timing. Corrected flows indicated that the recessional limb actually dropped below the critical passage flow of 25 cfs, in effect bifurcating the migration potential of the event. The call for the release by the RTDG was late in relation to the on-the-ground hydrologic conditions as it was well past peak flow, and the delay in the release further exacerbated the discrepancy. This issue will be further examined in the discussion below as well as the issue of obtaining accurate real-time data from the Solvang gage.

Operational procedures for implementing the established decay function for ramp-down of passage releases were not in place during this storm or at anytime during Water Year 2006. For this initial event, a linear ramp-down rate of approximately 5 cfs per day was used to gradually decrease the passage release from the dam' outlet works from 80 cfs to 0 cfs over the course of 18 days (Table 5). No change was made to the HCSWS releases throughout the period. Both the outlet and Hilton Creek releases were debited to the Fish Passage Account. Since the decay function was not available for operations by Reclamation, the RTDG decided to use a simple linear ramp-down to provide additional water for migration opportunities to offset the delay in initiating the supplementation release and results were evaluated for performance for matching a natural recessional pattern with the average recessional limb of the Los Laureles hydrograph for the event. The release, coupled with the natural flow and discharges from the HCSWS, provided a passage window for steelhead throughout the Lower Santa Ynez River at a rate greater than 25 cfs for 14 consecutive days, although it came well after a 50% reduction in flow from the natural hydrograph peak. Under "normal" hydrologic conditions, this linear ramp-down in flow from Bradbury Dam (approximately 6% per day) would not have matched the established decay function from the average recessional curve from the Los Laureles gage records which is closer to 10-15% per day during the first couple of days and reducing from there for the remaining days (Figure 1). However, during the passage release, several small storms influenced the region that kept flows at a more constant rate. None of the storms after the required 7 days since initiation of supplementation were of sufficient magnitude to trigger another passage release, but the extra precipitation served to lengthen out the recessional limb of the hydrograph at the mainstem and tributary gages. This resulted in a gradual decay of the recessional limb of the hydrograph at the Solvang gage during the passage release. Because of the additional precipitation, the linear

ramp-down mimicked the average Los Laureles recessional pattern for the period, which the RTGD thought was a success given the lack of the guidance documentation for ramp-down procedures. Linear ramp-down is not recommended for future supplemental due to higher water usage. The total amount of water released for this fish passage supplementation event was 1,662 af, including releases through the HCSWS. The initial implementation of the Fish Passage Supplementation Program achieved 14 days of passage flows for steelhead/rainbow trout in the LSYR, although various other program objectives were not met. It is estimated by looking at the natural recessional trend of the storm hydrograph that without supplementation for the February 28 storm, there may have only been one or two passage days and would have been too short a period of time to travel to and from the outlet lagoon or ocean.

Table 5: Ramp-down schedule used by Reclamation for the 2/28/06 storm supplementation.

	2/28/06 Storm:		
# of days	Date	Time	Release (cfs)
1	02/28/06	14:40	80
2	03/01/06	-	80
3	03/02/06	8:09	75
4	03/03/06	8:30	70
5	03/04/06	8:21	65
6	03/05/06	8:37	60
7	03/06/06	8:30	55
8	03/07/06	8:35	50
9	03/08/06	8:30	45
10	03/09/06	8:30	40
11	03/10/06	8:30	35
12	03/11/06	8:40	30
13	03/12/06	8:24	25
14	03/13/06	8:40	20
15	03/14/06	8:35	15
16	03/15/06	8:35	10
17	03/16/06	8:35	5
18	03/17/06	8:20	0

Second Passage Supplementation – the March 29 storm:

The RTDG used available real-time data to evaluate the potential for conducting a passage supplementation event. The accuracy issues with the real-time versus post-event corrected data were the same as described for the February 28 storm and will be presented as Solvang (1) for the real-time data used for decision-making and Solvang (2) for the corrected data downloaded well after the event.

A storm hit the region on 3/28/06 with the real-time peak flow recorded at the Solvang gage of 64 cfs at 03:15 on 3/29/06 (55 cfs corrected) (Figure 4 and Table 6). Corrected peak flow at Solvang (2) occurred at 18:00 on 3/28/06 at a maximum discharge of 76 cfs, 7 hours prior to the recorded real-time peak. At 7:30 on the morning of 3/29/06, the RTDG evaluated hydrological and meteorological conditions and the criteria were met to initiate a passage release (Table 3). A passage flow release was called for at 08:00 and Reclamation initiated a 99 cfs passage supplementation release from the outlet works at 08:30 that day (105 cfs total with HCSWS). Normal rearing flow releases through the HCSWS at 6 cfs were continued throughout the period. At that time, the flow at Solvang was at 59 cfs (48 cfs corrected) and by adding 99 cfs would have taken peak flows up to the target of 150 cfs at Solvang. It took approximately 12 hours for

the released water to reach the Solvang gage. The last real-time data value at Solvang (1) was 136 cfs (83 cfs corrected). Peak flows at the Solvang gage reached 145 cfs (corrected) at 12:15 on 3/30, just below the target flow value of 150 cfs. Passage flows were later augmented by another storm peaking on 4/1/06 at 321 cfs at 01:00.

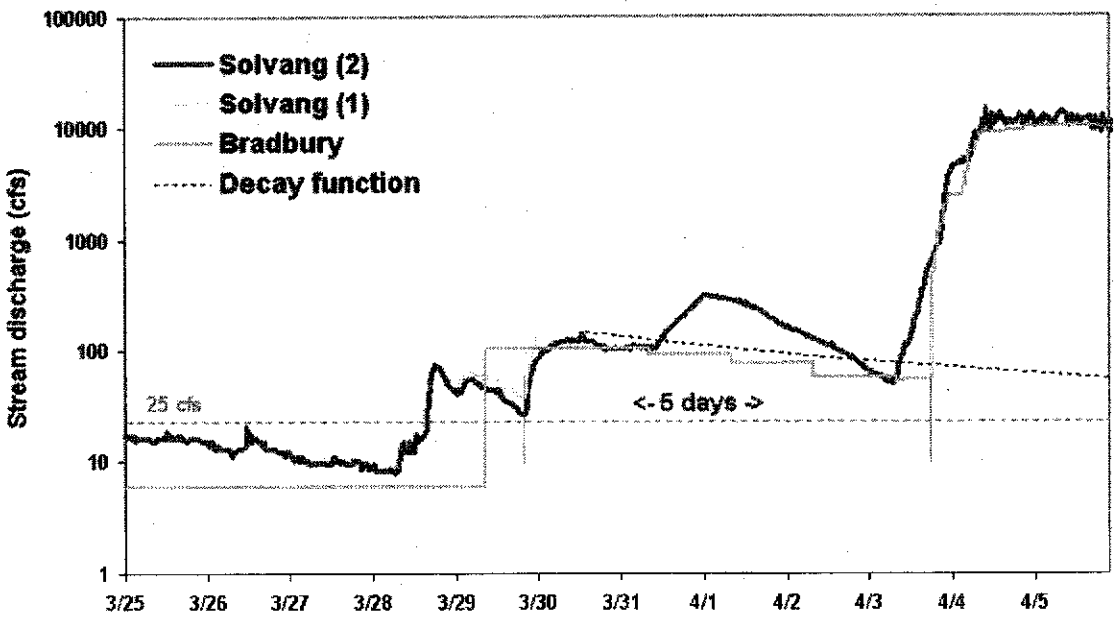

Figure 4: Hydrographs at the Solvang (1 – real-time, 2 – corrected) and Bradbury Dam gages before, during, and after the second passage supplementation (March 29 through April 6). The decay function as described in the documentation was included for reference, although not implemented for ramp-down. The availability of the Solvang gage data was sparse during stormflow events due to flood damage to the instrumentation. Bradbury Dam discharges are from the Daily Operation reports up until 4/3/06 when hourly data were available during the spill.

The ramp-down rate for this passage supplementation release followed a simple decay curve by percentage (Table 7) that was a rough interpretation of the decay function established in the revised Section 3 of the BA. The passage release from Bradbury Dam was proposed to be cut by 15% per day for the first three days, 10% per day for the next three days, 5% per day for the next 3 days, and 2% per day for the remaining 5 days. On 4/3/06, another strong storm hit the region that caused the flows into Lake Cachuma to rise sufficiently to spill Bradbury Dam at 18:00 that day. The ramp-down schedule from the dam generally mimicked the established decay function although the recessional limb at Solvang did not, given an increase in stream discharge from a subsequent storm on 4/1/06.

Table 6: Summary of the hydrologic conditions during the second supplementation event. Bradbury Dam discharge data are given for reference.

Date-time	Discharge (cfs):			Notes:
	Solvang (1)	*Solvang (2)*	*Bradbury*	
3/28/06 7:30	nd	8	6	Baseflow conditions at Solvang
3/28/06 15:45	nd	27	6	Solvang (2) at 25 cfs
3/28/06 18:00	nd	76	6	Peak flow at Solvang (2)
3/29/06 1:45	55	47	6	Peak flow at Los Laureles
3/29/06 3:15	64	55	6	Peak flow at Solvang (1)
3/29/06 8:00	59	48	6	RTDG calls for a passage release
3/29/06 8:30	59	48	105	Initiation of passage release
3/29/06 20:30	44	31	105	Passage release arrives at Solvang (12 hour)
3/29/06 23:30	136	83	105	Last real-time reading at Solvang (1)
3/30/06 12:15	nd	145	105	Passage peak at Solvang
4/1/06 1:00	nd	321	91	Passage and storm flow peak at Solvang
4/3/06 18:00	nd	638	488	Spill initiated at Bradbury
4/4/06 10:30	nd	10300	8654	Peak flow at Los Laureles
4/4/06 13:45	nd	13300	8675	Peak flow at Solvang (2)
4/4/06 21:00	nd	10500	10066	Peak spill at Bradbury
4/5/06 7:45	nd	13600	9953	Second peak flow at Solvang (2)

Table 7: Ramp-down schedule used by Reclamation for the 3/29/06 storm supplementation.

	3/29/06 Storm:			Proposed
# of days	*Date*	*Time*	*Release (cfs)*	Cut (%)
1	03/29/06	8:39	100	
2	03/30/06	8:30	85	15
3	03/31/06	8:30	70	15
4	04/01/06	8:47	55	15
5	04/02/06	8:54	50	10
-	04/02/06	9:50	45	-
6	04/03/06	8:36	35	10
7	04/04/06	8:18	0 (spill)	10
8	04/05/06	-	-	5
9	04/06/06	-	-	5
10	04/07/06	-	-	5
11	04/08/06	-	-	2
12	04/09/06	-	-	2
13	04/10/06	-	-	2
14	04/11/06	-	-	2
15	04/12/06	-	-	2
16	04/13/06	-	-	0

A total of only 757 af of water was used during the second passage supplementation, including releases through the HCSWS. Once the dam spilled, the Fish Passage Account was re-filled to its maximum of 3,200 af and there was no further need for storm supplementation in 2006. During the second supplemented storm, there were 5 additional passage days beyond 2 to 3 days of passage from natural storm flows greater than or equal to 25 cfs.

Migration results:

Mainstem migrant trapping was initiated on February 28 and continued until April 3 when the traps were pulled because of high flows (Table 8). Trapping results reflect both adult and juvenile steelhead/rainbow trout movement during and after supplementation releases. From this first passage release event, there were 3 downstream smolts captured in the mainstem trap ranging in size from 144-215 mm (5.7-8.6 inches), and one small downstream resident capture that was 102 mm (4.0 inches). These are the first smolts to be documented moving through the Lower Santa Ynez River since the 1940's beyond anecdotal information. No upstream ocean going steelhead adults were captured; however there was one resident juvenile/adult measuring 256 mm (10 inches) that was captured migrating upstream on March 3. Dam releases when migrating fish were captured varied from 31 to 83 cfs. One additional smolt measuring 222 mm (8.7 inches) was captured on March 19, 2 days following completion of the first supplementation when dam releases rates were 6.0 cfs.

Table 8: Migrant trapping data from the first and second supplemented storms with corresponding flow data. Bradbury Dam spilled on 4/3/06 and ended the Passage Supplementation Program for Water Year 2006. Although supplementation had begun at Bradbury at 8:30 on 3/29/06, passage releases had not arrived at Solvang at the time of capture on 3/29/06; higher flows that day were from storm flow. "nd" values for the real-time data (1) were from storm damage to the gage that were later estimated by the USGS (2).

Date-time	Size (mm)	Fish Type	Direction	Discharge (cfs): Bradbury	Solvang (1)	Solvang (2)	Supplemented
3/2/2006 7:45	144	Smolt	Down	83	127	81	Yes
3/3/2006 22:44	256	Resident	Up	81	172	118	Yes
3/4/2006 8:45	102	Resident	Down	76	149	100	Yes
3/7/2006 1:53	215	Smolt	Down	61	nd	81	Yes
3/13/2006 7:08	178	Smolt	Down	31	nd	33	Yes
3/19/2006 20:06	222	Smolt	Down	6	nd	10	No
3/29/06 23:53	215	Smolt	Down	105	nd	85	No (stormflow)
3/30/06 0:02	245	Smolt	Down	105	nd	88	Yes
3/30/06 0:20	186	Smolt	Down	105	nd	90	Yes
3/30/06 0:28	202	Smolt	Down	105	nd	92	Yes
3/30/06 0:35	246	Smolt	Down	105	nd	95	Yes
3/30/06 23:02	435	Adult - Res	Up	105	nd	105	Yes
3/31/06 11:13	288	Smolt	Down	91	nd	121	Yes
3/31/06 22:59	268	Smolt	Down	91	nd	291	Yes
4/3/06 6:27	234	Smolt	Down	57	nd	50	Yes
4/3/06 6:36	218	Smolt	Down	57	nd	50	Yes
4/3/06 14:00	Traps pulled						Spill

During the second passage supplementation event (3/29/06), there were 8 downstream smolts captured ranging in size from 186-246 mm (7.3-9.6 inches) and one adult resident 435 mm (17.1 inches) moving upstream (Table 6). One of those smolts measuring 215 mm (8.6 inches) was captured just after supplementations flows had reached the Solvang Bridge. The adult appeared to be a resident based upon its size, morphology, and appearance as well as preliminary scale analysis. Dam releases when migrating fish were captured ranged from 57 cfs to 105 cfs. Traps were removed on 4/3/06 just prior to the dam spilling and no migration data were available during high flows when fish may have moved throughout the LSYR basin.

V. Discussion

In general, the Fish Passage Supplementation Program succeeded in increasing the number of passage days for both supplemented storms. Trapping data supported this finding with increased downstream smolt and upstream adult migration, while also showing significantly less movement once supplemental flows ended. The established required criteria were followed as best as possible and proved to be useful guides in determining appropriate storms for supplementation (Table 3). Specific issues will be discussed below.

Timing of supplementation:
The timing of the two fish passage supplementation releases during Water Year 2006 was successful in relation to the fish migration opportunities prior to Bradbury Dam spilling on April 3rd. The early January storm wetted the watershed and primed the basin for the late February storm that produced migration conditions and triggered the first passage release with rainfall totaling 3.06 inches at Bradbury Dam. From March 1 through March 31, there were 17 days of measurable rain, ranging from 0.02 – 0.80 inches (at Bradbury Dam) with the largest event coming at the end of the month when the second supplementation event occurred. Rainfall totals for March were 4.31 inches with the triggering event producing just under an inch of precipitation (Figure 2). Rainfall throughout March was spread out and generally light in both intensity and magnitude, which resulted in passage conditions prior to the spill event throughout the mainstem and tributaries of the LSYR for both upstream migrating steelhead and downstream migrating smolts. The small storms that influenced the area generated relatively small amounts of runoff but served to sustain tributary runoff in the lower watershed that contributed to maintaining flows in the mainstem above what was being released from Bradbury Dam. In addition to the storm that was supplemented on March 29, one other storm (3/1/06) could have been supplemented prior to the dam spilling but wasn't because it occurred within 7 days of an existing passage supplementation as described in the criteria.

Meeting supplementation target flows and the timing with the natural storm peak:
In both cases of supplemented storms, the target flow of 150 cfs for passage supplementation was not met. Stream depletions, travel time from the dam to the Solvang gage, and implementation delays resulted in peak supplemented flows below the target of 150 cfs at Solvang for both storms, 136 cfs (88 cfs corrected) and 145 cfs (corrected). Timing of the supplemented flows caused a bimodal distribution of the storm hydrograph which was not an implementation objective. The low flow between the two runoff peaks during the first storm was well below the low flow critical passage level of 25 cfs, which should be avoided to maintain migration continuity. The important objective is to keep passage flows above 25 cfs while decaying the discharge rate to 25 cfs over 14 days. The criteria of creating 14 days of continuous passage for steelhead migration from peak supplementation, or 150 cfs, to the critical low flow velocity of 25 cfs was met during the first storm and interrupted during the second when Bradbury Dam spilled.

Ramp-down and release amounts:
Two separate ramp-down strategies were implemented; linear and decay by percentage ramp-down. The linear ramp-down was shown to provide a gradual decrease in the hydrograph at the Solvang gage; however, more water was used than was necessary. The decay by percentage ramp-down used during the second release if projected out, would have used several hundred af

less water than using a linear ramp-down, leaving more for future supplementations. Because of the 4/3/06 spill event, only 757 af were released. In both cases, the established decay function was not utilized and a passage supplementation operations table, referred to as the Interim Passage Supplementation Releases Tables that is being provided by Stetson Engineers, needs to be in place at Reclamation for the decay function as described in the revised Section 3 of the BA to be implemented. Interim refers to that the operations tables need to be calibrated after implementation is reviewed. Without implementation guidelines, the RTDG had no choice but to use the Los Laureles recessional limb for each storm as a performance measure for mimicking natural recession for the chosen ramp-down procedure. The Interim Passage Supplementation Releases Tables will also address the timing and magnitude of the target flow of 150 cfs at Solvang given observable conditions in the LYSR basin. Stetson Engineers has recently developed the Interim Passage Supplementation Releases Tables which are presented in Appendix A. Future ramp-down rates and procedures will follow that table and eliminate any real-time guess work or execution ambiguities. The Interim Passage Supplementation Releases Tables will assuredly need modification over time with implementation experience but will greatly facility the ramp-down process. Finally, ramp-down from 25 cfs to baseflow during the first supplemented storm did not follow the guidelines established for the mainstem ramp-down rate, a point that needs to be considered in future efforts to adhere to the established guidelines.

Steelhead migration opportunities:
Passage supplementation releases, from a fisheries management perspective, appeared to work as anticipated in allowing better migration opportunities for both adult upstream migration and juvenile smolt out-migration due to the increase in number of migration days. As the mainstem trapping data showed, the majority of migration occurred during dam release rates in excess of 50 cfs. Passage releases for the two storms along with the tributary flows provided 24 days of passage greater than 25 cfs for migrating steelhead compared to an estimate of only 3 to 5 days without supplementation for those particular storms. No upstream migrating ocean run steelhead were captured in the mainstem during the monitoring period, although, the traps were out of the river during high flows following the spill event. The releases did however facilitate the movement of 13 downstream migrating smolt as well as resident fish in the lower mainstem. If adult steelhead were present in the river below the traps, the releases likely allowed them to navigate the river at will.

Integrating trapping data (total upstream and downstream migrants captures) with flow for all three trapping sites (Hilton Creek, mainstem, and Salsipuedes Creek) suggested that mainstem supplementation benefited steelhead/rainbow trout migration throughout the LSYR basin (Figure 5). The elongated passage period after each supplemented storm (i.e., 14 days for the 2/28/06 storm and 5 days for the 3/29/06 storm) beyond the estimated two to three days under average conditions (i.e., 1 to 2 days, and 2 to 3 days, respectively) improved migration on the mainstem and access to the tributaries. Trend observation in relation to passage releases was complicated by natural storm runoff, particularly at Salsipuedes Creek which is in close proximity to the outlet of the Santa Ynez River and can have runoff patterns independent of the rest of the Santa Ynez River basin.

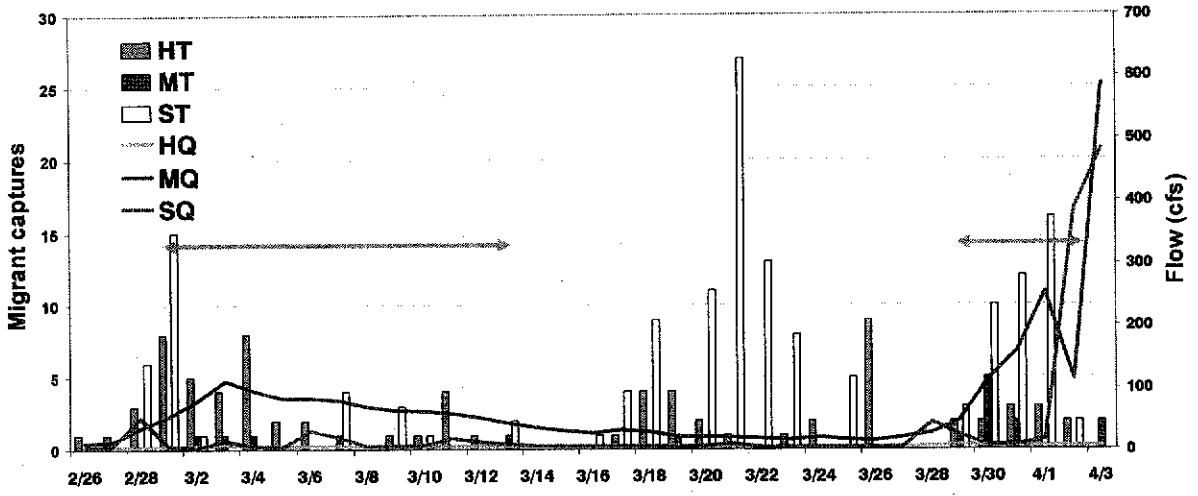

Figure 5: Migrant captures (upstream and downstream total) at the Hilton Creek (HT), Solvang on the mainstem (MT), and Salsipuedes Creek (ST) traps with their respective flows (HQ, MQ, and SQ). The first and second fish passage supplementation events are marked with orange arrows.

Program challenges:

Communication problems between the RTDG members occurred during the first event. This only happened at the beginning of the first storm and was to be expected when conducting a complicated management action for the first time. The situation was rectified by the second passage release and no communication problems occurred there after. Problems arose with the inaccuracy and reliability of the USGS gaging station at the Alisal Bridge in Solvang once flows began to increase. The gaging station at this location is recognized as being problematic for reasons described above and needs to be calibrated regularly during and after high flow events. Posted real-time data are often inaccurate, requiring correction multiple days after a storm event. This situation is likely to continue in the foreseeable future during high flows and needs to be taken into consideration by the RTDG. Cachuma Project Biology Staff should attempt to take frequent spot flow measurements at the Alisal gage to verify flows during critical decision-making periods. Also, bimodal storm hydrographs were produced because of the delay time between natural peak flows at the Solvang gage when flows are greater than 150 cfs or receding to 150 cfs on the falling limb of the storm hydrograph and the desired supplemented peak. Ideally the objective is to have one storm peak with an elongated recessional limb for fish migration. This would require anticipating a release prior to observing peak flows and should be evaluated through experience with subsequent supplementation efforts. The situation should improve with the implementation of the Interim Passage Supplementation Releases Tables with the decay function presented in Appendix A (Tables 9-12 and Figure 6). Migrant trapping efficiency of the mainstem needs to improve to better understand migration patterns during natural and supplemented runoff events as well as between storms. This issue has been addressed by establishing a permanent location for the mainstem trap and deploying the traps at the same time as the tributary traps. Accurate monitoring of fish migration during high storm flow events has not been possible given the trapping methodology, hence important data are missing. This is a long standing problem and the AMC should continue to look for alternative trapping methods that are possible during high flow periods.

VI. Conclusions

The Fish Passage Supplementation Program successfully supplemented two storms during Water Year 2006. Several of the program objectives were not met in this initial year of the program execution. The RTDG, on behalf of Reclamation, called for supplementation during appropriate times and did adhere to the required criteria where possible. Implementation after the call for supplementation releases will improve with experience, time, and the operations guidelines under development. The program should be continued and results should continue to be analyzed carefully. Several recommendations are described below.

Recommendations:

1. Have a meeting of the RTDG in December to review the criteria and implementation procedures for the Fish Passage Supplementation Program that year. This will ensure that everyone is in agreement and refreshed on the details of the program.
2. Implement the Interim Passage Supplementation Releases Tables and decay function as described in Appendix A (or the revised version upon completion from Stetson Engineers). These operation criteria should be incorporated into the guidelines for operations of Cachuma Reservoir. Copies of the operations guidelines should be given to Reclamation, specifically the operations chief and dam tender staff as well at the RTDG. Calibration of the decay function will be needed after every supplementation event and should be done in close proximity to the event such that operations and ramp-down protocols can continue to improve and best met program objectives in peak supplementation flows both in magnitude and timing.
3. Reclamation should identify the responsible party for implementing the Fish Passage Supplementation Program from February to mid-April. For consistency throughout the program, the RTDG is recommended as the designated party.
4. Evaluate the water release accounting for a passage supplementation event. At present, both outlet and HCSWS releases are debited to the Fish Passage Account during a supplementation event. Under question for accounting is whether the HCSWS releases should be included or not.
5. Initiate trapping activities in the tributaries and mainstem at the same time in December or January depending on the runoff season and baseflow conditions. CPBS have established a permanent location for the mainstem trap 7.3 miles downstream from the dam that will be active throughout the migration season except during high flows when trapping equipment could be washed downstream. This will allow better understanding of the variables influencing adult and juvenile steelhead/rainbow trout movement before, during, and after supplemental water releases and natural flows.
6. Establish better communication with the USGS regarding their flow data on the Lower Santa Ynez River. CPBS is working with USGS field staff to improve this situation so that the RTDG can be alerted to gage inaccuracies and obtain the corrected data as soon as possible.
7. Add a new criteria to incorporate clearing flows to assure open migration throughout the mainstem of the Lower Santa Ynez River prior to a supplementation event as beaver dams continuously block fish migration during low flows. Clearing flows could be 1) an early season storm that generate flows greater than 200 cfs at Solvang (the flow rate thought to be sufficient to fully washout beaver dams throughout the mainstem management reaches), or 2) high initial passage supplementation releases to cause the desired washouts. This could be a possible use of the Adaptive Management Account

(AMA). Without a clearing runoff event, connectivity for migration throughout the mainstem could be under question and could complicate trapping efforts because of debris movement downstream.

8. CPBS should take regular spot flow measurements when possible at the Solvang Bridge during critical decision-making periods in support of the RTDG for passage supplementation releases.
9. Continue to investigate methods to improve trapping efficiency during high flow events.

VII. References

AMC. 2004. Cachuma Project fish passage supplementation program: supplementation criteria, real-time decision making, and adaptive management. Prepared for the Cachuma Project Consensus Committee, Cachuma Project Adaptive Management Committee, Santa Barbara California.

NMFS. 2000. Cachuma Project Biological Opinion, U.S. Bureau of Reclamation operation and maintenance of the Cachuma Project on the Santa Ynez River in Santa Barbara County, California. National Marine Fisheries Service, Southwest Region.

NMFS. 2005. Approval letter regarding revisions to the Cachuma Project Fish Passage Supplementation Program. National Marine Fisheries Service, NOAA, Long Beach, CA.

Stetson Engineers. 2007. Operating guidelines for releases at Bradbury Dam under the Fish Passage Supplementation Program (draft).

USBR. 2000. Revised Section 3 (Proposed Project) of the Biological Assessment for Cachuma Project Operations and the Lower Santa Ynez River. Prepared for the National Marine Fisheries Service, U.S. Bureau of Reclamation, Fresno, CA.

Appendix A

Interim Passage Supplementation Releases Tables for a Fish Passage Supplementation Event

The following are draft tables and a figure that are proposed and under evaluation as guidance tools for dam operations to execute fish passage supplementation releases. Operations will need to be calibrated hence the interim or adaptive nature of the process. As revisions of these tables are received, updates will have to be incorporated.

Table 9: Passage supplementation target flows in the Santa Ynez River at the Solvang Bridge (USGS Gage ID No. 11128500) showing the average daily decay function for releases from Bradbury Dam (Stetson Engineers, 2007).

Day	Target Flow at Solvang Bridge cfs	Average Daily Decay from Previous Day
1	150	
2	122	-19%
3	102	-16%
4	86	-16%
5	75	-12%
6	66	-12%
7	58	-12%
8	51	-12%
9	45	-12%
10	40	-12%
11	35	-12%
12	31	-12%
13	27	-12%
14	25	-8%

Table 10: Interim passage supplementation releases from Bradbury Dam, Case 1: storm peak flow exceeds 150 cfs (Stetson Engineers, 2007).

Example Date (day)	Outlet Work cfs	af	Comment
1 8:00 AM	60	119.0	RTDG determines start time for release based on available real-time precipitation and flow data.
2 8:00 AM	55	109.1	
3 8:00 AM	50	99.2	
4 8:00 AM	44	87.3	
5 8:00 AM	38	75.4	
6 8:00 AM	32	63.5	A conservative decay rate is assumed for the next nine days until more knowledge gained.
7 8:00 AM	31	61.5	
8 8:00 AM	30	59.5	
9 8:00 AM	30	59.5	
10 8:00 AM	30	59.5	
11 8:00 AM	29	57.5	
12 8:00 AM	29	57.5	
13 8:00 AM	27	53.6	
14 8:00 AM	25	49.6	**Flows of 25 cfs or greater ensured on the 14th day**
15 8:00 AM	20	6.6	Ramp-down assumed from Table 11.
15 12:00 PM	15	5.0	
15 4:00 PM	10	3.3	
15 8:00 PM	7.5	7.4	
16 8:00 AM	5	1.7	
16 12:00 PM	3.5	1.2	
16 4:00 PM	2.5	0.8	

Table 11: Ramp-down rate as described in the Cachuma Project BO (2000).

Release Rate (cfs)	Ramping Increment (cfs)	Ramping Frequency (no more than once every ...)
30 to 10	5	4 hours
10 to 5	2.5	4 hours
5 to 3.5	1.5	4 hours
3.5 to 2.5	1	4 hours

Table 12: Interim passage supplementation release from Bradbury Dam, Case 2: storm peak flow below 150 cfs (Stetson Engineers, 2007).

Example Date (days)	Outlet Work cfs	af	Comments
1 8:00 AM	125	247.9	RTDG determines start time for release based on available real-time precipitation and flow data.
2 8:00 AM	110	218.2	
3 8:00 AM	90	59.5	
3 4:00 PM	80	105.8	Mid-day change may be necessary to avoid rapid ramping.
4 8:00 AM	74	146.8	
5 8:00 AM	65	128.9	
6 8:00 AM	57	113.1	
7 8:00 AM	50	99.2	
8 8:00 AM	43	85.3	
9 8:00 AM	37	73.4	
10 8:00 AM	32	63.5	
11 8:00 AM	30	59.5	A conservative decay rate is assumed for the next four days until more knowledge gained.
12 8:00 AM	29	57.5	
13 8:00 AM	27	53.6	
14 8:00 AM	25	49.6	**Flows of 25 cfs or greater ensured on the 14th day**
15 8:00 AM	20	6.6	Ramp-down assumed from Table 11.
15 12:00 PM	15	5.0	
15 4:00 PM	10	3.3	
15 8:00 PM	7.5	7.4	
16 8:00 AM	5	1.7	
16 12:00 PM	3.5	1.2	
16 4:00 PM	2.5	0.8	

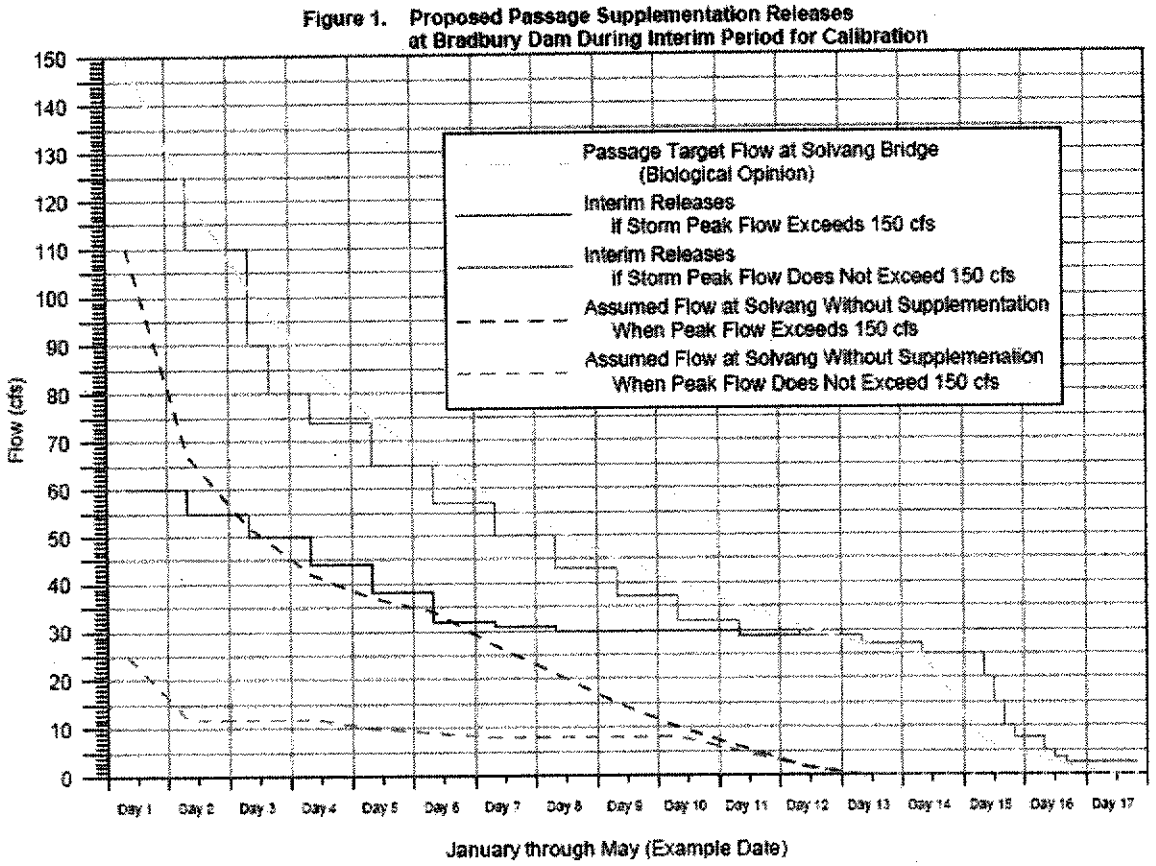

Figure 6: Proposed passage supplementation releases at Bradbury Dam during the interim period for calibration including hydrographs at the Solvang Bridge of target flows, flows without supplementation under the assumed worst-conditions for storm flows greater than and less than 150 cfs, and the proposed passage releases at Bradbury Dam during the calibration period. (Stetson Engineers, 2007).