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File No. 18613.00008

March 26, 2012

VIA EMAIL
JFarwell@waterboards.ca.gov

Division of Water Rights
State Water Resources Control Board
Attention: Jane Farwell
1001 I Street, 2nd Floor
Sacramento, CA 95814

Re: Statement of Surrebuttal Outlines and Statement of Qualifications

Dear Ms. Farwell:

Enclosed please find the outlines of surrebuttal witness testimony for Dr. Charles Hanson, Ms. Jean Baldrige and Dr. David Zoldoske. Statements of qualifications were previously made part of the record during the 2003 hearings for Dr. Hanson and Ms. Baldrige, thus, pursuant to Hearing Officer Doduc's Order of March 14, 2012, we are not resubmitting them at this time. A statement of qualifications for Dr. Zoldoske is enclosed, however, since his SOQ is not already part of the record.

Yours very truly,

Gregory K. Wilkinson
of BEST BEST & KRIEGER LLP
Attorneys for Santa Ynez River Water
Conservation District, Improvement District No. 1

Ernest a. Conant (lcp)

Ernest A. Conant
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Enclosures

cc: Cachuma Project Phase 2 Hearing Service List (attached)
Dana Heinrich, Esq.
David Rose, Esq.

**State Water Resources Control Board Cachuma Project Hearing**

**Surrebuttal Testimony of Charles H. Hanson**

## Qualifications

Certified Fishery Biologist

B.Sc., M.Sc., Ph.D in fishery science

More than 35 years of experience with salmonids, including steelhead

Conducted fishery investigation on the Santa Ynez River since 1993

NMFS Central Valley Salmonid Recovery Team

USFWS Native Delta Fish Recovery Team

Expert testimony in 2003 SWRCB Santa Ynez Water Right Hearing

## Issues Raised by Dr. W. Trush and D. Brumback in Rebuttal Testimony

***Issue:*** *Steelhead population status and trends in the Santa Ynez River are inconsistent with the FEIR's conclusion that flows implemented under the NMFS 2000 Biological Opinion will support continued survival of O. mykiss in the Santa Ynez River. Review and analysis of data demonstrate that flows implemented under the 2000 BO will threaten the continued survival of the Santa Ynez River steelhead population.*

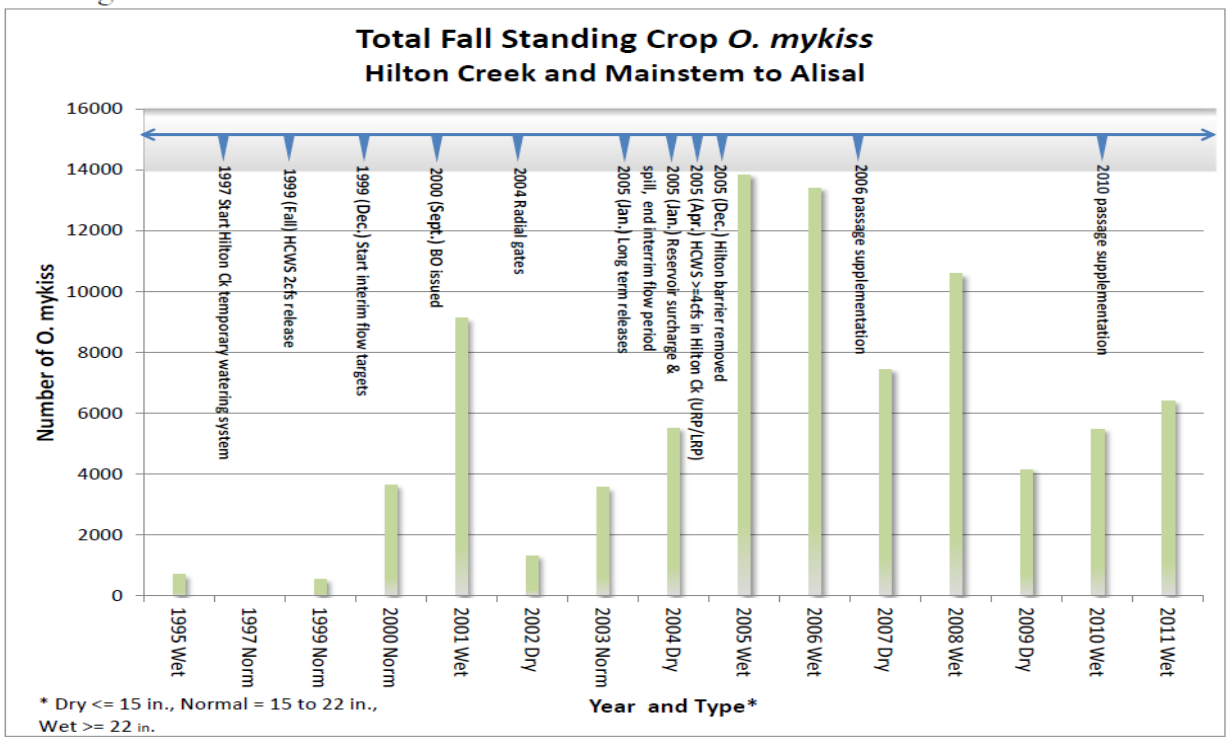
### Response

The Santa Ynez River Fish Management Plan includes a variety of actions designed to benefit *O. mykiss* that include, but are not limited to, instream flows. The Lower Santa Ynez River Fish Management Plan (August 2000) was used as the basis for the Biological Assessment developed by the Bureau of Reclamation and subsequent NMFS Biological Opinion, and all were incorporated into the FEIR's analysis of alternatives. Key elements of the Fish Management Plan incorporated into the 2000 BO and, subsequently, the alternatives analyzed in the FEIR include:

- Expansion of access to suitable habitat in the mainstem and tributaries (spatial diversity);
- Removal of passage barriers and impediments;
- Expansion of habitat in Hilton Creek using supplemental water supplies provided from Cachuma Project reservoir storage;
- Instream flows for spawning and juvenile rearing downstream of Bradbury Dam in concert with hydrologic conditions and constraints for sustainable instream flows within Hilton Creek and the mainstem;
- Instream flow supplementation for adult and juvenile migration in the mainstem in concert with watershed hydrologic conditions; and
- Fishery monitoring and evaluation.

Results of fishery monitoring conducted since 1995 demonstrate that, in contrast to the assertion by Dr. Trush that the program has not resulted in an increase in *O. mykiss* abundance, the available scientific data show the program has resulted in increased access by *O. mykiss* to suitable habitat, successful migration, successful reproduction, juvenile growth and juvenile survival resulting in increased *O. mykiss* abundance. Results of routine snorkel surveys within the mainstem and tributaries conducted each fall demonstrate the increase in *O. mykiss* abundance that has occurred since implementation of the program (Figure 1).

Figure 1.



The 2000 NMFS BO concluded that the instream flows and other actions implemented on the lower Santa Ynez River would not result in jeopardy to resident or anadromous *O. mykiss*. Results of intensive monitoring have shown only two occasions when Cachuma Project operations conducted under the NMFS BO resulted in direct mortality to *O. mykiss*. During the 2006 spill year and the year following (2007) the 1.5 cfs instream flow requirement at Alisal Bridge was triggered under the NMFS BO, three *O. mykiss* were stranded when a downstream pool became dewatered in 2007. As a direct result of this single event water management operations were modified to increase the release of water from Bradbury Dam to ensure that instream flows are sufficient to protect *O. mykiss* inhabiting the Alisal management reach. On a second occasion (2006) increased releases were made from the reservoir in response to anticipated storm activity within the watershed. The operational reduction in releases of water resulted in stranding *O. mykiss* in the mainstem. As a result of this incident, ramping rate criteria were established that are now applied to reservoir spill releases. These modifications to water operations remain in effect and have avoided further take of *O. mykiss*. Indeed, no further mortality of steelhead has occurred in the five years since these measures were adopted. These refinements to water operations are part of standard operating procedures and are expected to continue as part of implementing operations reflected in the FEIR alternatives. Results of extensive monitoring provide no evidence that current operations and actions to benefit *O. mykiss* are resulting in a threat to the continued existence of *O. mykiss* within the lower Santa Ynez River.

***Issue:*** *Steelhead population status and trends are inconsistent with the FEIR's conclusion that flows implemented under the 2000 BO have resulted in increased abundance of O. mykiss. Review and analysis of data demonstrate that O. mykiss abundance has not increased.*

**Response**

The available scientific data collected from fishery monitoring within the lower Santa Ynez River basin and shown in Figure 1 demonstrate the increase in *O. mykiss* abundance that has occurred in the lower Santa Ynez River and its tributaries between 1995 and 2011. The increase in *O. mykiss* abundance demonstrated by the results of the fall snorkel surveys, as well as the results of trapping within Hilton and Salsipuedes creeks and the mainstem river, reflects a variety of factors including improvements in access to suitable habitat, improvements in mainstem habitat for *O. mykiss*, successful reproduction, successful migration, and successful growth and survival of *O. mykiss* within the lower river and tributaries.

**While factors outside the control of the Fish Management Plan have a strong effect on the population response (e.g., change in population growth rate and abundance) that impacts the overall performance of the program of fishery management and conservation actions, the program carried out by Reclamation and the Cachuma Member Units in accordance with the 2000 BO Is producing substantial increases in suitable steelhead habitat and a related increase in juvenile steelhead production.**

Habitat and hydrologic conditions and other factors pose significant constraints on the actions that can be taken to improve steelhead abundance and that are sustainable over the long-term. As just one example, instream flow releases that result in a depletion of reservoir storage and water supplies can result in a complete loss of suitable fishery habitat and significant adverse population impacts. Similarly, ocean conditions may have a substantial adverse effect upon the number of returning adults despite a substantial increase in the production of juveniles.

Despite these factors, the available scientific data collected as part of the fishery monitoring in the Santa Ynez River and its tributaries show substantial increases in successful spawning and juvenile steelhead/rainbow trout production; substantial increases in steelhead smolt production; returns of adult anadromous steelhead to natal streams; the expansion of spatial habitat diversity; and, the expansion of access to suitable habitat for spawning and rearing within the mainstem and tributaries of the lower River. NMFS has established an annual average abundance criterion of 4,150 adults for recovery of the southern California steelhead populations (all basins combined). Although the numbers of adult steelhead returning to the Santa Ynez River is substantially less than the desired contribution of the river towards recovery, the trend in increasing abundance since the mid-1990s when the program started is very promising (Figure 1). The NMFS southern California steelhead recovery plan estimates that recovery of the populations may take 80 to 100 years after completion of the recovery actions.

***Issue:*** *Steelhead population status and trends are inconsistent with the FEIR's conclusion that flows required by the 2000 BO will protect steelhead as a public trust resource and restore steelhead to "good condition". Review and analysis of data demonstrate that the 2000 BO is not adequate to protect public trust or restore "good condition".*

**Response**

Actions taken to enhance and protect habitat for steelhead and other aquatic resources within the lower Santa Ynez River reflect an interdisciplinary approach to developing and

implementing a fishery management program that is based on consideration of conservation planning principals and site-specific opportunities and constraints. The program is designed to increase the availability and quality of suitable habitat for fish within the mainstem river and tributaries of the lower river. Results of fishery and habitat monitoring demonstrate that successful migration, reproduction, juvenile growth and survival are occurring, and there is an increasing trend in *O. mykiss* abundance. Although it is expected that full restoration of the *O. mykiss* population inhabiting the lower river will take decades to be fully achieved, the trends to date are consistent in demonstrating a positive trajectory of improving good habitat and species conditions.

**The 2000 Biological Opinion issued by NMFS is based directly upon the Santa Ynez Fish Management Plan (FMP) which was developed collaboratively by Santa Ynez River stakeholders including Reclamation, the Cachuma Member Units, NMFS, CDFG, Cal Trout, SWRCB and the United States Fish and Wildlife Service**

The 2000 Biological Opinion issued by the National Marine Fisheries Service is, to a significant degree, based upon the Lower Santa Ynez River Fish Management Plan (FMP), which was developed in furtherance of the SWRCB directive in Water Rights Order 94-5. This relationship is not surprising given that the FMP is a comprehensive program of fishery and habitat restoration actions developed collaboratively with substantial input from NMFS, CDFG, Cal Trout, USFWS, SWRCB, and others. The FMP examined the habitat expansion opportunities, the limiting factors, life history requirements for steelhead and other aquatic species, as well as the Primary Constituent Elements and Viable Salmonid Population principles applicable to steelhead and did so within the site-specific hydrological, access, and habitat constraints of the Santa Ynez River watershed.

**The structure and function of the Fish Management Plan and the related conservation actions for steelhead set forth in the 2000 BO and the alternatives evaluated in the FEIR are based upon well recognized concepts of Primary Constituent Elements of steelhead production and abundance and Viable Salmonid Population metrics**

The development and implementation of the Santa Ynez River Fish Management Plan is founded on standard conservation principles for fishery management and species recovery. These include:

**Primary Constituent Elements of steelhead production and abundance (PCEs)**

Freshwater spawning sites (e.g., providing suitable water temperatures and instream flows for successful spawning in the upstream reaches and tributaries)

Freshwater rearing sites (e.g., reducing and avoiding passage barriers and impediments to migration, suitable water quality and instream flows to support physical habitat, connectivity among habitats, and providing suitable food resources for juvenile rearing)

Freshwater migration corridors (e.g., reducing and avoiding passage barriers and impediments to migration, providing suitable water quality and instream flows to support access and connectivity for migration from upstream rearing habitat to coastal marine waters and access to seasonally inundated floodplain habitats)

Estuarine areas (e.g., providing migration and rearing opportunities within lagoon and estuarine habitats)

**Viable Salmonid Population (VSP) Metrics**

Abundance – number of fish in the population and variance over time (e.g., number of juvenile smolts, number of adult spawners)

Productivity – number of new spawners produced per parent spawner in the previous generation, number of juveniles produced per spawner, stock-recruitment relationships

Spatial structure – number and geographic distribution of population segments within the watershed or distinct population segments among watersheds

Diversity – variation in life history, habitat use, and genetic traits (e.g., genetic variation, relative proportion composed by different life history types, variation in migration timing, use of different habitat types, percentage of adult spawners that are wild)

**The foundation of the Fish Management Plan, the conservation actions of NMFS's BO, and the alternatives considered by the FEIR are consistent with the general approach and principles of the NMFS southern steelhead recovery plan for habitats downstream of a dam**

The population response to conservation actions (e.g., increased population abundance and resilience) and population growth rates are typically slow when initially rebuilding a stock. There are few, if any, quick fixes and the implementation of enhancement actions requires years to be successful, especially given the natural environmental and biological variability inherent in southern California coastal areas in general, and specifically within the Santa Ynez River watershed. The steelhead enhancement program being carried out pursuant to the FMP and NMFS BO is in the initial phase of population rebuilding. Continued monitoring over a long-term period will be required to evaluate performance and response of the steelhead population. As already noted, the Recovery Plan for Southern California steelhead developed by

NMFS recognizes that as many as 80 to 100 years may be required before the Southern California steelhead population may fully recover.

**The Lower Santa Ynez River Fish Management Plan is yielding substantial benefits to the steelhead and serves as a model for such programs in Southern California**

The Fish Management Plan undertaken by Reclamation and the Cachuma Member Units includes collaborative data collection and monitoring of the habitat conditions and steelhead/rainbow trout. It is a program that started in 1993 and has continued under the terms of the 2000 NMFS biological opinion. The program has improved the understanding of steelhead life history, habitat conditions, restoration and enhancement actions, water operations, and other facets of implementation and evaluation of the performance of fishery management in southern California. The program has also resulted in substantial increases in access to suitable steelhead habitat as well as a significant increase in the spawning and rearing of *O. mykiss*. It serves as a model for development and implementation of conservation actions to benefit steelhead in Southern California.

The fishery management program has been conducted for the past 11 years under the provisions of the 2000 NMFS BO. The program represents a significant local investment of water, staff, and financial resources in fishery habitat protection and enhancement. Water operations have been refined based on the experience gained and the monitoring conducted as part of the program. The current program is consistent with the management alternatives included in the FEIR. The Santa Ynez River steelhead population is in the initial phase of rebuilding and performance of the program will require long-term fishery, flow, water quality, and habitat monitoring. Additional elements of the program are planned for implementation to further benefit steelhead and other aquatic resources. Given its successes to date and it's forward looking character, it is reasonable for the FEIR to have developed alternatives based on the continued implementation of the program.

***Issue:*** *A Smolt-to-Adult Return curve predicts the chance of adult anadromous O. mykiss return as a function of smolt size. This analytical approach is applied to evaluate the significance of reported trapping, and other fish monitoring data from the lower Santa Ynez River.*

**Response**

Anadromous steelhead experience substantial natural mortality during their residence in coastal marine waters. Steelhead smolts emigrating from the lower Santa Ynez River are susceptible to predation mortality as well as variation in the availability of suitable food resources within the ocean. Based on the relatively high levels of natural mortality between

the smolt and returning adult life stage, the numbers of returning adult steelhead is dependent, in part, on the numbers of juvenile steelhead produced in a watershed and their growth rate and size when entering the ocean. One of the primary objectives of the Santa Ynez River habitat enhancement program is to increase access to suitable spawning and juvenile rearing habitat to increase the production of juveniles. The increasing trend in juvenile *O. mykiss* abundance (Figure 1) is consistent with the objective of increasing the numbers of adult steelhead returning to the river to spawn. Based on the level of juvenile production to date, the numbers of currently returning adult steelhead is expected to be low. As reflected in the NMFS recovery plan, it is expected to take up to 80 to 100 years for steelhead populations to rebuild and recover even after implementation of conservation actions like those that have already been completed on the lower Santa Ynez River. Based on the short time period that the actions have been in place, the influence of factors that are independent of the fishery program, natural variability in hydrologic and ocean conditions, and other factors it is not unexpected that the numbers of adult steelhead that have returned to the river in recent years is low. However, the increasing trend in *O. mykiss* abundance, the returns to date of anadromous adult steelhead, and continued improvements in access and habitat conditions within the lower watershed are all promising and consistent with the findings of the FEIR regarding its analysis of alternatives that reflect the operations and actions included in the Fish Management Plan and 2000 NMFS BO.

***Issue:*** *The basis for not prescribing ramping rates at the initiation of water right releases is no longer valid.*

**Response**

During water right releases from Bradbury Dam, instream flows are typically increased rapidly from a baseflow level to provide efficient movement of the water intended to be recharged downstream. In preparing the Biological Assessment and Biological Opinion the rate of water movement initially during a water right release was characterized as approximately 3 miles per day, assuming that the groundwater and substrate were dry prior to the release. Data developed during one water right release in 2007, after the upper basin groundwater and substrate were saturated as a result of previous instream flow releases made to support steelhead habitat, were observed to move at a rate of approximately 14 miles per day. The biological concern for juvenile steelhead is that an increase in flow (up ramping) may result in water velocities that are high and displace juvenile steelhead downstream into less suitable habitat areas.

Analyses of the data collected during the 2007 water right release (and other water right releases) are summarized in Table 1. Results of these analyses show that during the 2007 water

right release, the rate of downstream movement of the water was 14.8 miles per day which is equivalent to a water velocity of less than 1 ft/sec. Water right releases are typically made during the summer months when juvenile steelhead have a swimming performance that exceeds 1 ft/sec. In fact, velocities of 1 ft/sec are within the range considered to provide suitable habitat for juvenile steelhead and would not be sufficiently high to physically displace steelhead downstream. Based on the estimated water velocities during up-ramping of water right releases shown in Table 1 that are well within the swimming performance capability and suitable habitat conditions for juvenile steelhead, there is no evidence that ramping rates at the initiation of a water right release are displacing steelhead downstream or resulting in significant adverse impacts.

Table 1. **Wetted Front Velocity During Water Rights Releases**

| Date & Time WR Release Began[1)] | Flow at Solvang Bridge (cfs) | Date & Time Wetted Front Reached Solvang[2)] | Flow at Solvang Bridge (cfs) | Travel Time[3)] (hours) | Wetted Front Velocity[4)] (mile / day) | (feet / sec) |
|---|---|---|---|---|---|---|
| *Pre-fish MOU* | | | | | | |
| 5/26/89 8:00 AM | 0.0 | 6/2/89 9:15 PM | 4.5 | 181.3 | 1.4 | 0.08 |
| 9/3/89 8:00 AM | 0.0 | 9/9/89 6:00 AM | 5.0 | 142.0 | 1.8 | 0.11 |
| 8/23/90 8:00 AM | 0.0 | 9/1/90 7:30 PM | 3.3 | 227.5 | 1.1 | 0.07 |
| 6/6/91 8:00 AM | 0.0 | 6/10/91 2:30 AM | 0.7 | 90.5 | 2.8 | 0.17 |
| 9/26/91 8:00 AM | 0.0 | 10/5/91 10:00 PM | 1.8 | 230.0 | 1.1 | 0.07 |
| 8/20/92 8:00 AM | 0.0 | 8/23/92 4:15 AM | 0.6 | 68.3 | 3.7 | 0.23 |
| *Fish MOU and Interim BO* | | | | | | |
| 7/25/94 8:00 AM | 0.0 | 7/29/94 9:15 PM | 0.7 | 109.2 | 2.3 | 0.14 |
| 7/18/96 8:00 AM | 0.0 | 7/21/96 11:00 AM | 8.4 | 75.0 | 3.4 | 0.21 |
| 7/11/97 8:00 AM | 0.0 | 7/16/97 6:00 AM | 1.9 | 118.0 | 2.1 | 0.13 |
| 6/17/02 8:00 AM | NA | 6/24/02 8:30 AM | NA | 168.5 | 1.5 | 0.09 |
| 8/1/02 8:00 AM | 0.0 | 8/3/02 12:15 AM | 0.7 | 40.2 | 6.3 | 0.38 |
| 7/12/04 8:00 AM | 0.0 | 7/17/04 1:15 AM | 0.2 | 113.3 | 2.2 | 0.14 |
| *Long-term BO* | | | | | | |
| 7/23/07 8:00 AM | 4.5 | 7/24/07 1:00 AM | 15.0 | 17.0 | 14.8 | 0.91 |
| 8/2/10 8:00 AM | 0.0 | 8/3/10 7:30 PM | 3.3 | 35.5 | 7.1 | 0.43 |
| | | | ***Average*** | | | |
| | | | Pre-fish MOU | 156.6 | 2.0 | 0.12 |
| | | | Fish MOU and Interim BO | 104.0 | 3.0 | 0.18 |
| | | | Long-term BO | 26.2 | 11.0 | 0.67 |
| | | | All Releases | 115.4 | 3.7 | 0.23 |

**Notes**

1) Date and time water rights release began (all water rights releases assumed to begin at 8 AM).
2) Date based on gaged flow observations from the USGS gage at Solvang.
3) Time between the beginning of WR release and arrival of wetted front at the Solvang gage.
4) Wetted front velocity calculated based on a distance of 10.5 miles (55,440 feet) from Bradbury Dam to the Solvang gage.

# State Water Resources Control Board, Cachuma Project Hearing
# Jean Baldrige, Cardno ENTRIX, Surrebuttal Witness, Cachuma Member Units
# to NMFS Darren Brumback's Testimony

**QUALIFICATION:**

- M.Sc., in fishery science
- More than 30 years of experience with anadromous salmonids
- Conducted fishery investigations on the Santa Ynez River since 1990
- Author of the Cachuma Project Biological Assessment
- Project Manager for the Lower Santa Ynez River Management Plan
- Member of the Adaptive Management Committee for the Cachuma Project Biological Opinion
- Expert testimony in 2003 SWRCB Santa Ynez Water Right Hearing

**TESTIMONY OUTLINE:**

**1) Biological Opinion as basis for FEIR**

*"The Board's FEIR should not rely on the analysis and conclusions in NMFS' 2000 biological opinion to determine whether the endangered steelhead public trust is adequately protected."*

a. The FEIR relies on more than the 2000 Biological Opinion. It relies on the results of the monitoring data on fish and habitat conditions collected from in 1993 to 2010, the reports identifying the results of actions taken under the Biological Opinion and the Lower Santa Ynez River Fish Management Plan[1], 2008 Synthesis Report, 2004 Synthesis Report monitoring data in Appendix G, the Compliance binder, as well as reports completed on the tributary projects, and reports detailing additional conservation measures implemented (i.e. ramping, flow management, passage supplementation).

b. The Biological Opinion was issued in 2000 based on a proposed action primarily developed under the auspices of the State Water Resources Control Board to address public trust issues related to fishery resources in the Santa Ynez River under Water Rights Order No. 94-5. The Lower Santa Ynez River Fish Management Plan (FMP) was developed in furtherance of the State Board's directive in 94-5. It served as the basis for the Biological Assessment submitted to the National Marine Fisheries Service (NMFS) in 1999 and was developed in a collaborative process by the Santa Ynez River Technical Advisory Committee, chaired by California Dept of Fish and Game with participation by US Bureau of Reclamation, Cachuma Member Units, Santa Ynez River Water Conservation District, Santa Ynez River Water Conservation District No. 1, City of Solvang, City of Lompoc, National Marine Fisheries Service, U.S Forest Service, U.S. Natural Resources Conservation Service (formerly U.S. Soil Conservation Service) , Santa Barbara County Fish and Wildlife Commission, Cal Trout, Urban Creeks Council, landowners, and others.

[1] Santa Ynez River Technical Advisory Committee. 1999. Lower Santa Ynez River Fish Management Plan, Review Draft. Volume I and Volume II.

**2) Reinitiation of Consultation should not preclude the adoption of the FEIR**

*"The 2000 biological opinion specified that reinitiation would be triggered if certain restoration actions were not completed by 2005, not all of the actions were completed by that time."*

a. The statement implies that since Reasonable and Prudent Measure (RPM) 4 was not met, the FEIR is flawed. It is not. The Tributary Projects were included in the FMP and were part of the Proposed Action in the 1999 Biological Assessment[2]. Because of litigation over certain planned passage improvements, changes in project designs requested by NMFS (which, consequentially increased costs) and the unavailability of grant funding, it has taken longer than planned for certain tributary projects to be completed. Further, because of a continued threat of litigation against Cal Trans in one case and limited habitat benefits and very high costs (including tunneling under highway U.S. 101) in the other, two projects will not be pursued—as NMFS was informed in December, 2005. However, several other steelhead habitat improvement projects never identified in the 2000 Biological Opinion were identified, undertaken and completed including passage barrier removals on Salsipuedes, El Jaro and Quiota creeks that opened up important steelhead habitat not contemplated by the 2000 Biological Opinion. Further, substantial work on additional passage barrier removal on Quiota Creek is planned for 2012 and 2013.

b. The Biological Opinion contemplated that, approximately 15 miles of tributary habitat were to be made more accessible. In fact, the stream miles of newly available steelhead habitat opened up by projects already completed by Reclamation and the Cachuma Member units since adoption of the 2000 Biological Opinion is 13.9 miles. Additional stream habitat mileage associated with projects now underway or for which planning is complete is 1.1 miles. The commitment in the FMP and the 2000 Biological Opinion to open passage obstructions is being met. The authors of the FEIR reviewed the Tributary tradeoff analysis prepared by Cachuma Project Biologists and Reclamation[3]

[2] Reclamation. 1999. Biological Assessment for Cachuma project operations and the lower Santa Ynez River.

[3] Reclamation and Cachuma Project Biologists. 2010. Tributary project tradeoff analysis. Report to NMFS.

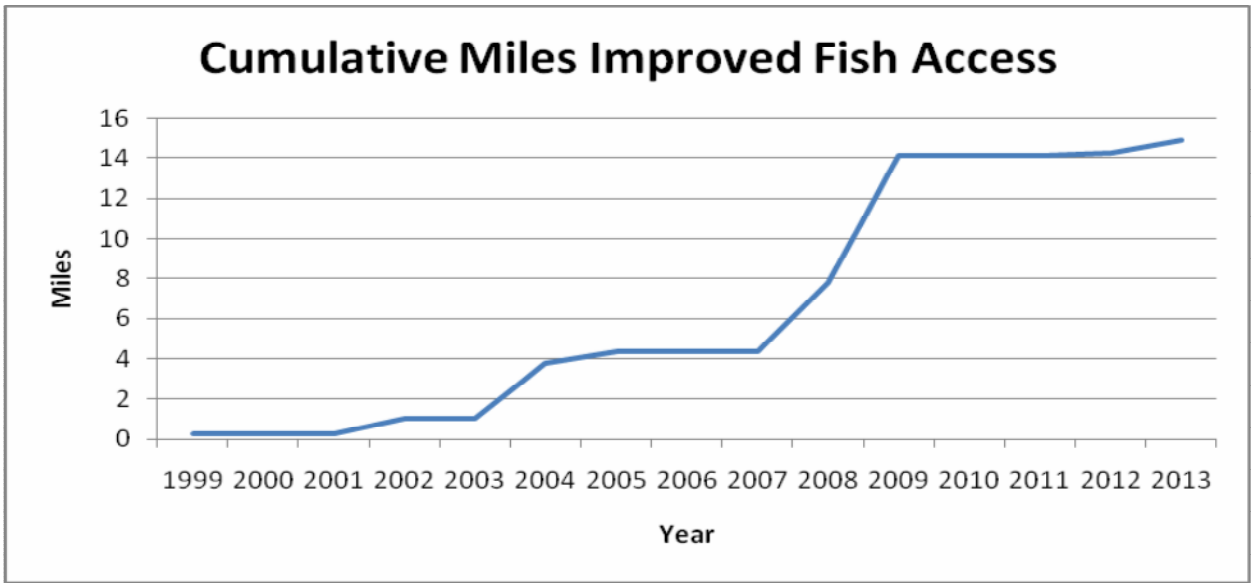



**Figure 1.** **Cumulative Stream miles with improved access due to tributary passage projects.**

**3) Exceedance of Incidental Take for capture and handling should not affect the EIR analysis.**

*"The amount of take specified in the annual monitoring program (trapping) has been exceeded."*

a. This statement is highly misleading. It implies that there is a danger to steelhead populations from the trapping program. The take that has been exceeded is associated with the *capture/handling* of steelhead during the trapping program. In fact, adult and juvenile steelhead mortality of the fish trapped is only 1.1 per cent for adults and 0.46 percent for juveniles. Further, the increased "take" from trapping is occurring because the target flows and habitat improvement projects undertaken by Reclamation and the Cachuma Member Units are producing a substantial increase in the number of young O*ncorhynchus mykiss* (*O. mykiss*) rearing within the tributaries of the Santa Ynez River. Figure 2 and 3 present the downstream migrant trapping data for the period from 1994 to 2011. Although not all migrants are captured in all years due to trap removal during high flows, it is clear that the number of migrants trapped in 2006 through 2011 far exceeds the migrants trapped from 1994 to 2004.

b. There are two categories of numerical "take" in the 2000 Biological Opinion associated with the monitoring program: (1) capture/handling and (2) mortalities.

- The take for capture/ handling fish take is 110 juveniles, 150 adults and 70 for recaptures.
- The take for mortality from the trapping program is 4 juveniles and 1 adult.

The take associated with capture/handling of juvenile steelhead has been exceeded in 9 out of 11 years. The take for capture/handling adults has been exceeded in only one year. Trapping mortalities were never exceeded for juveniles. Adult trapping mortalities exceeded take by 1 fish in 2001 and by 2 fish in 2006. However only one anadromous adult has been taken. This

fish was found washed into the downstream trap. Since this fish was found in the trap, it was reported as a trapping mortality, rather than a carcass collection.

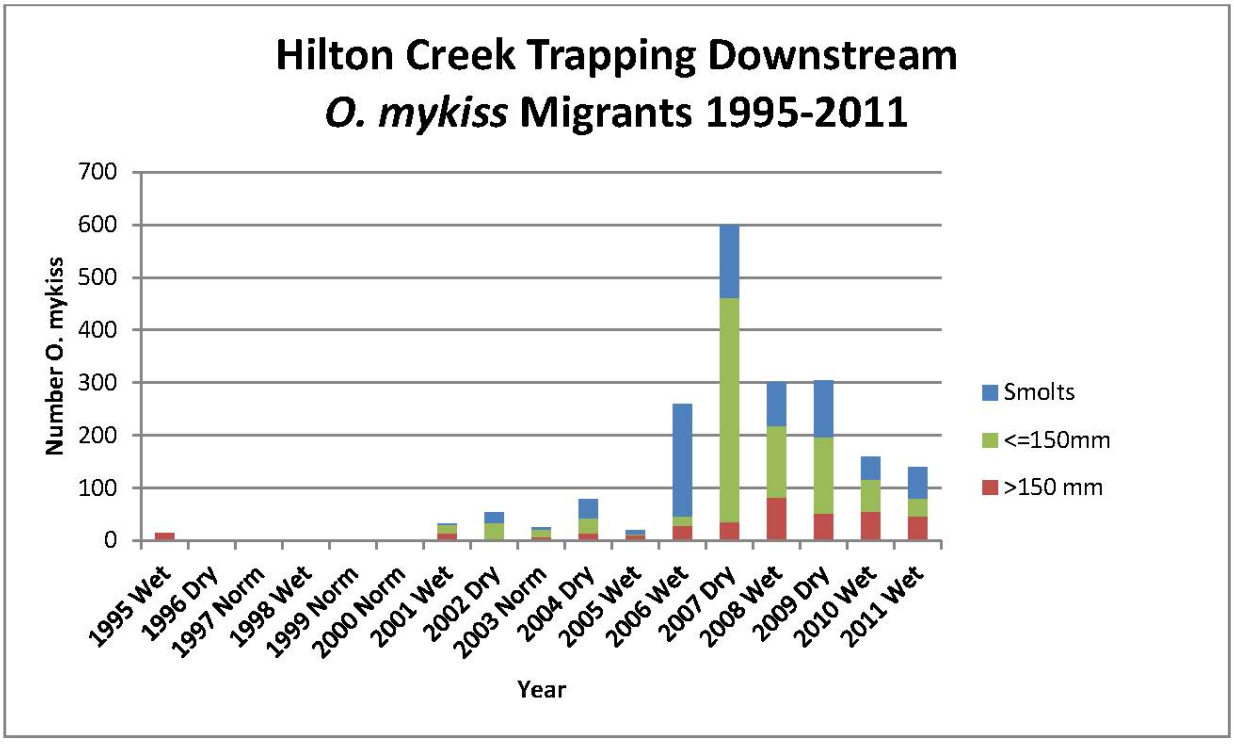



**Figure 2. Results of Downstream Trapping at Hilton Creek (1995 -2011).**

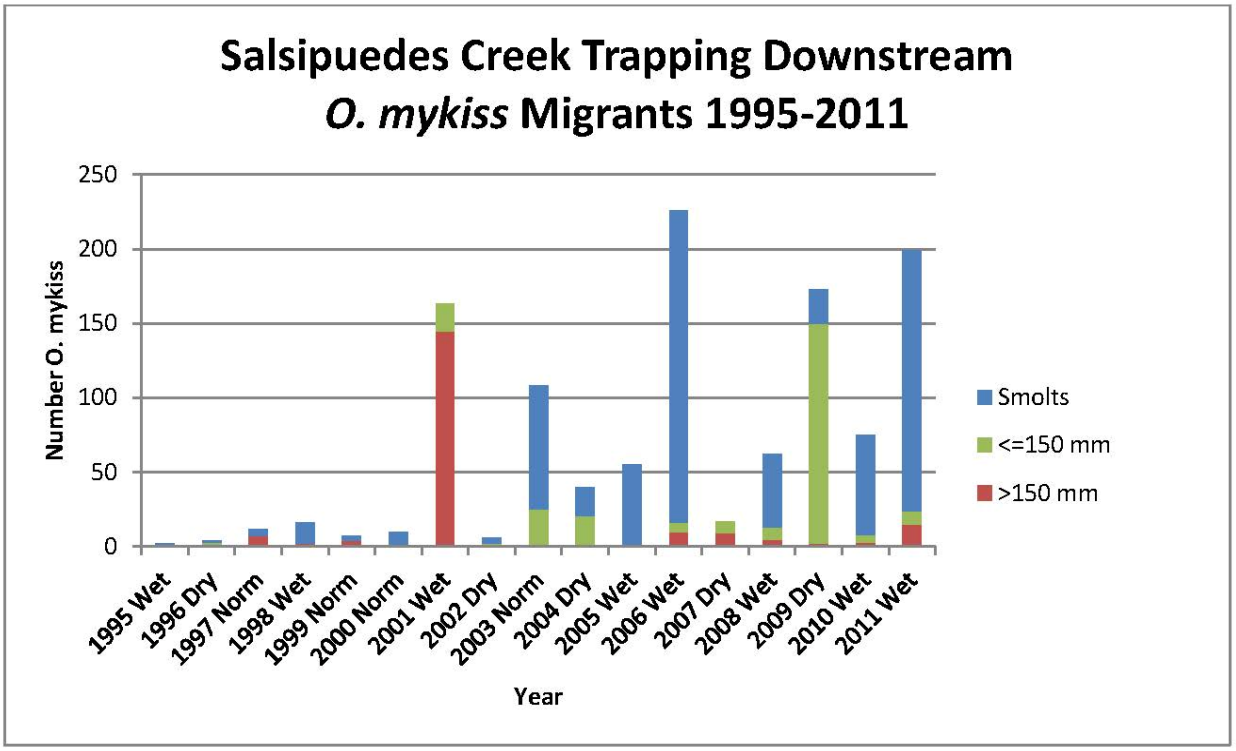



**Figure 3.** **Results of Downstream Trapping at Salsipuedes Creek (1995-2011).**

**Table 1. Steelhead Trapping Capture/Handling Take Summary**

| Year | Number of Juveniles[1] | | | Number of Adults | | |
|---|---|---|---|---|---|---|
| | BO Allowance[2] | Take[3] | Exceedance | BO Allowance[2] | Take[3] | Exceedance |
| 2001 | 110 | 200 | 90 | 150 | 44 | -- |
| 2002 | 110 | 111 | -- | 150 | 5 | -- |
| 2003 | 110 | 170 | 60 | 150 | 29 | -- |
| 2004 | 110 | 152 | 42 | 150 | 60 | -- |
| 2005 | 110 | 72 | -- | 150 | 38 | -- |
| 2006 | 110 | 506 | 396 | 150 | 113 | -- |
| 2007 | 110 | 632 | 522 | 150 | 36 | -- |
| 2008 | 110 | 412 | 302 | 150 | 151 | 1 |
| 2009 | 110 | 522 | 412 | 150 | 89 | -- |
| 2010 | 110 | 304 | 194 | 150 | 81 | -- |
| 2011 | 110 | 409 | 299 | 150 | 73 | -- |
| **Total** | **1,210** | **3,490** | **2,317** | **1,650** | **719** | **1** |

[1] Fish less than or equal to 10 inches are considered juvenile

[2] Allowance determined by Biological Opinion in 2000

[3] Take numbers are derived from the data sheets including upstream and downstream migrants

**Table 2. Steelhead Trapping Mortality Take Summary**

| Year | Juvenile[1] Mortalities | | | Adult Mortalities | | |
|---|---|---|---|---|---|---|
| | BO Allowance[2] | Take[3] | Exceedance | BO Allowance[2] | Take[3] | Exceedance |
| 2001 | 4 | 4 | -- | 1 | 2 | 1 |
| 2002 | 4 | 2 | -- | 1 | 0 | -- |
| 2003 | 4 | 0 | -- | 1 | 0 | -- |
| 2004 | 4 | 0 | -- | 1 | 0 | -- |
| 2005 | 4 | 0 | -- | 1 | 1 | -- |
| 2006 | 4 | 1 | -- | 1 | 3 | 2 |
| 2007 | 4 | 3 | -- | 1 | 0 | -- |
| 2008 | 4 | 3 | -- | 1 | 1 | -- |
| 2009 | 4 | 1 | -- | 1 | 0 | -- |
| 2010 | 4 | 1 | -- | 1 | 0 | -- |
| 2011 | 4 | 1 | -- | 1 | 1 | -- |
| **Total** | **44** | **16** | **0** | **11** | **8** | **3** |

[1] Fish less than or equal to 10 inches are considered juvenile

[2] Allowance determined by Biological Opinion in 2000

[3] Take numbers are derived from the data sheets including upstream and downstream migrants

**4) Accidental mortality of three fish five years ago should not affect the conclusions in the EIR**

*"Unauthorized take resulted from failure to meet flow targets at Alisal Bridge in 2007."*

a. This statement is also misleading. 2007 was a dry year, exacerbating difficulties in meeting flow targets at Alisal Road Bridge. When it became apparent that the flow target was not being met at Alisal Bridge, Reclamation released a refreshing flow of approximately 70 cfs. Unfortunately, the release did not reach Alisal Bridge before the take occurred. Reclamation notified NMFS of the mortalities and filed an incident report[4] to disclose the factors associated with the take. As a result of the incident, Reclamation and the Cachuma Member Units developed a procedure[5] for ensuring that the target flow at Alisal Road Bridge would be met in the future, which involves early detection and the release of greater flows from Bradbury Dam in drier years. The revised flow protocols were included in the Cachuma project operations manual and have not been objected to by NMFS. Flows at Alisal Road Bridge have met or exceeded the target flow since that time.

**5) Fish Passage Account is being managed as describe in Revised Proposed Action, the Biological Opinion and the modifications required by RPM 3 for the Biological Opinion.**

*"New information from Reclamation's January 2011 compliance Report referenced in the FEIR indicates that the capacity of the "fish passage account" to facilitate migration opportunities does not function as characterized in Reclamation's biological assessment."*

a. The fish passage account has been operated at all times since 2005 in accordance with the Revised Proposed Action (Reclamation 2000), the Biological Opinion, and the modification of the fish passage supplementation procedures described in the Revised Proposed Action (Reclamation 2000) as modified by the Biological Opinion and the Passage Supplementation Memo (Cachuma Adaptive Management Committee; Hydrologic Work Group Subcommittee 2003[6] and 2004[7]) that responded to RPM 3. The results of the Passage Supplementation program are reported by the Real Time Decision Group. Passage supplementation has occurred in two years (2006[8] and 2010[9]).

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[4] Cachuma Project Biology Staff. 2007. Incident Report, steelhead/rainbow trout mortalities at Alisal Road Bridge. Report to National Marine Fisheries Service.

[5] Stetson Engineers, Inc. 2009. Operating Guidelines for maintaining target flows of 1.5 cfs at Alisal Bridge

[6] Cachuma Project Adaptive Management Committee (AMC) Hydrologic Work Group. 2004. Revised Project Description for the Fish Passage Supplementation Criteria (Section 3.2.3.2.2) for Cachuma Project Operations. Prepared for Cachuma Project Adaptive Management Committee. October 6, 2003

[7] Cachuma Project Adaptive Management Committee (AMC) Hydrologic Work Group. 2004. Real-Time decision making and Adaptive Management of the Fish Passage Supplementation Program Revised Project Description (Section 3.2.3.2.3) for Cachuma Project Operations. Prepared for Cachuma Project Adaptive Management Committee. May 10, 2004.

[8] Real Time Decision Group (RTDG) and Cachuma Project Biology Staff (CPBS). 2007. Report on 2006 Fish Passage Supplementation. November 15. Transmitted to NMFS December 18, 2007.

b. These releases achieved the primary objectives stated in Reclamation's Revised Proposed Action for the Biological Assessment of providing at least 14 continuous days of flow above 25 cfs at Solvang Bridge by mimicking an average storm flow decay rate based on recession rates of Santa Ynez River flows upstream of the reservoir in normal years. According to the Revised Proposed Action, releases were expected to range from 300 to 1,800 acre-feet per storm event. The releases so far have ranged from 765 to 1,461 acre-feet per storm event.

c. RPM 3 required that Reclamation develop "a strategy to shift migration supplementation releases away from dry years when releases may not be helpful to steelhead populations in the Santa Ynez and review of storm decay curves and other methodologies for providing increased migration availability." The strategy was refined and approved by NMFS in October 2005[10]. The releases so far have occurred in two out of seven years and have successfully avoided supplementation in dry years. The Revised Proposed Action states that in years with passage supplementation releases there would be 11 additional days of passage per year, from 34 days (baseline conditions) to 45 days (with supplementation). The releases so far have created an additional 21 days of passage per year on average in years with passage supplementation releases, from 54 days (baseline conditions) to 75 days (with supplementation). These results exceed the number of passage days promised in the Revised Proposed Action for the Biological Assessment.

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[9] RTDG and CPBS. 2010. Report on the 2010 Fish Passage Supplementation Program. November 30, 2010. Transmitted to the AMC by email on November 30, 2010.

[10] McGinnis, Rodney, Regional Administrator, NMFS. October 11, 2005. Letter to Bill Luce, Area Manager, U.S. Bureau of Reclamation. Approval of Passage Supplementation Program

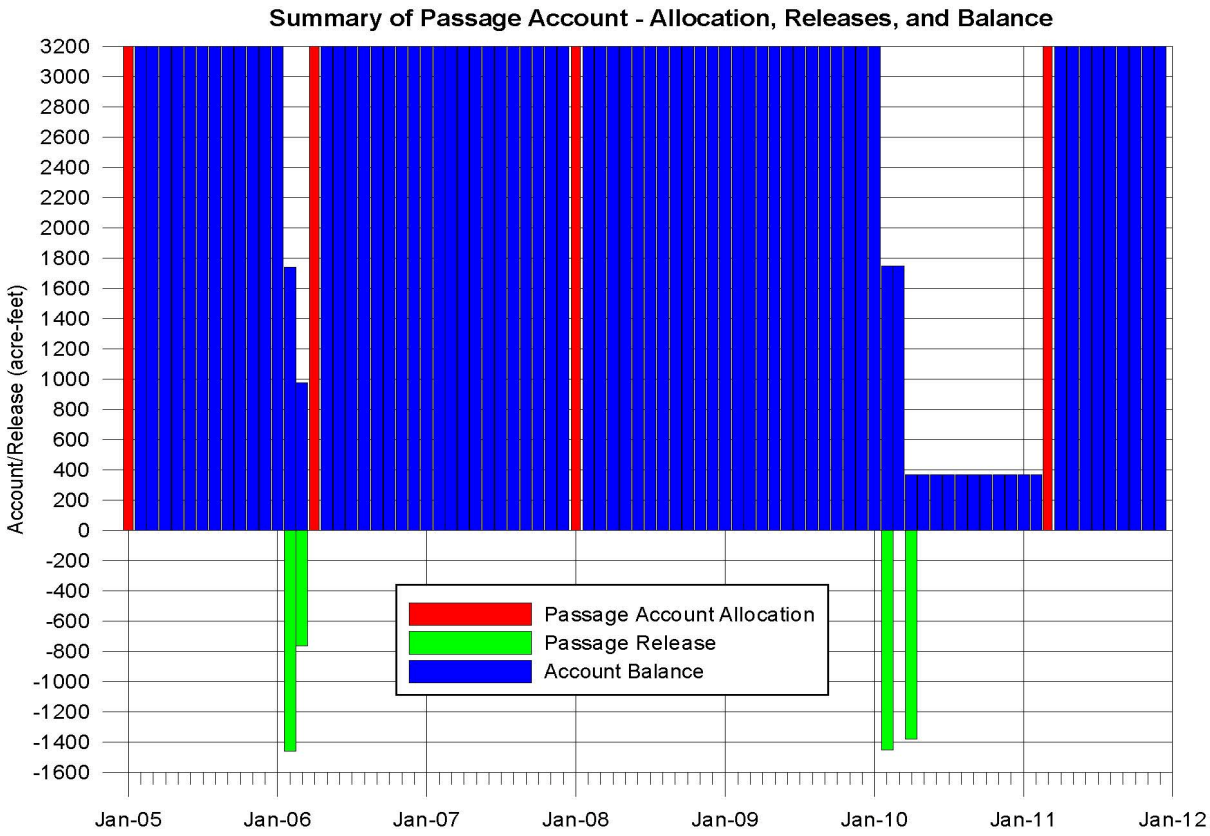
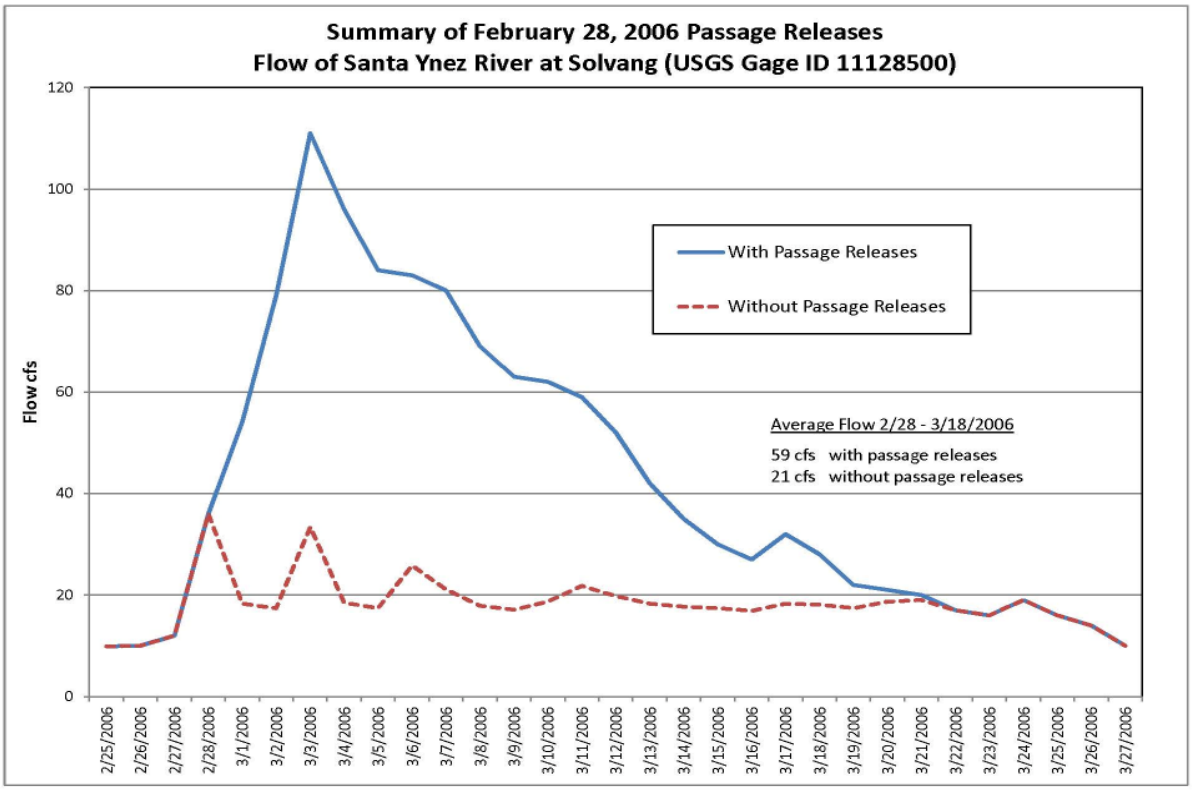



**Figure 4.** **Fish Passage Account Monthly Allocation, Operation and Release**



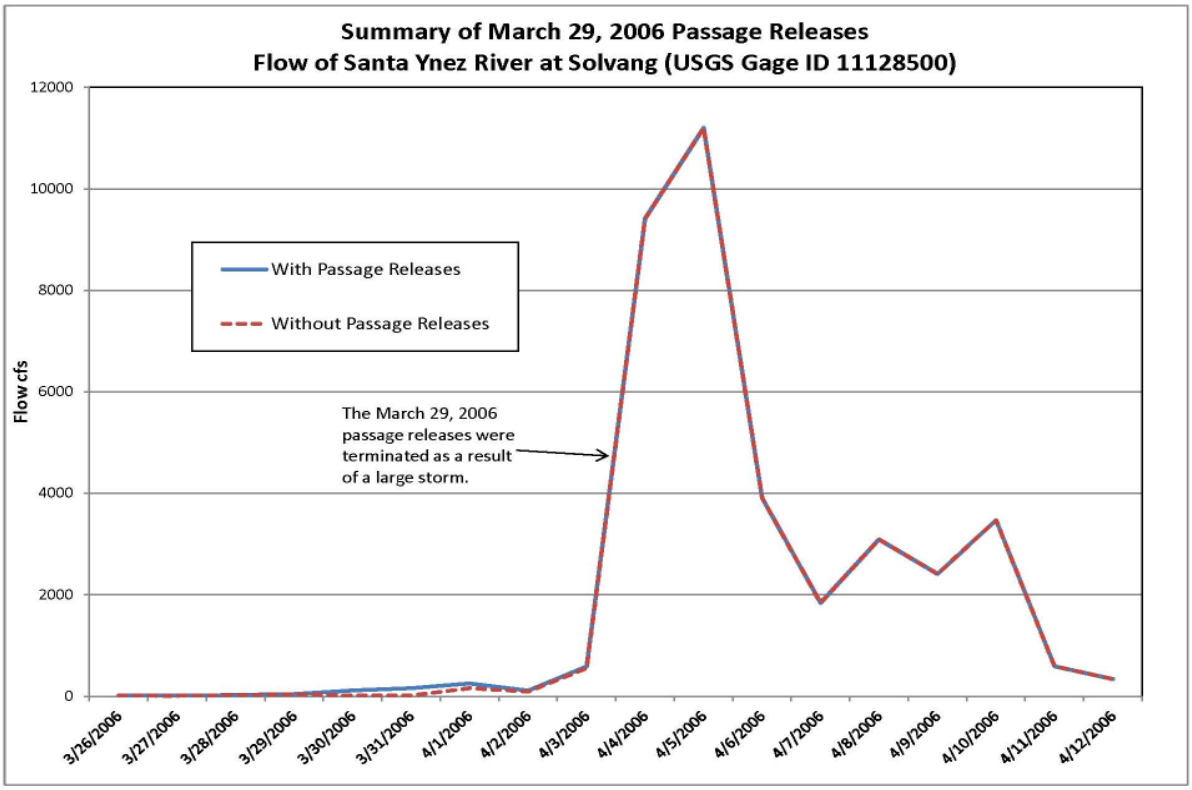
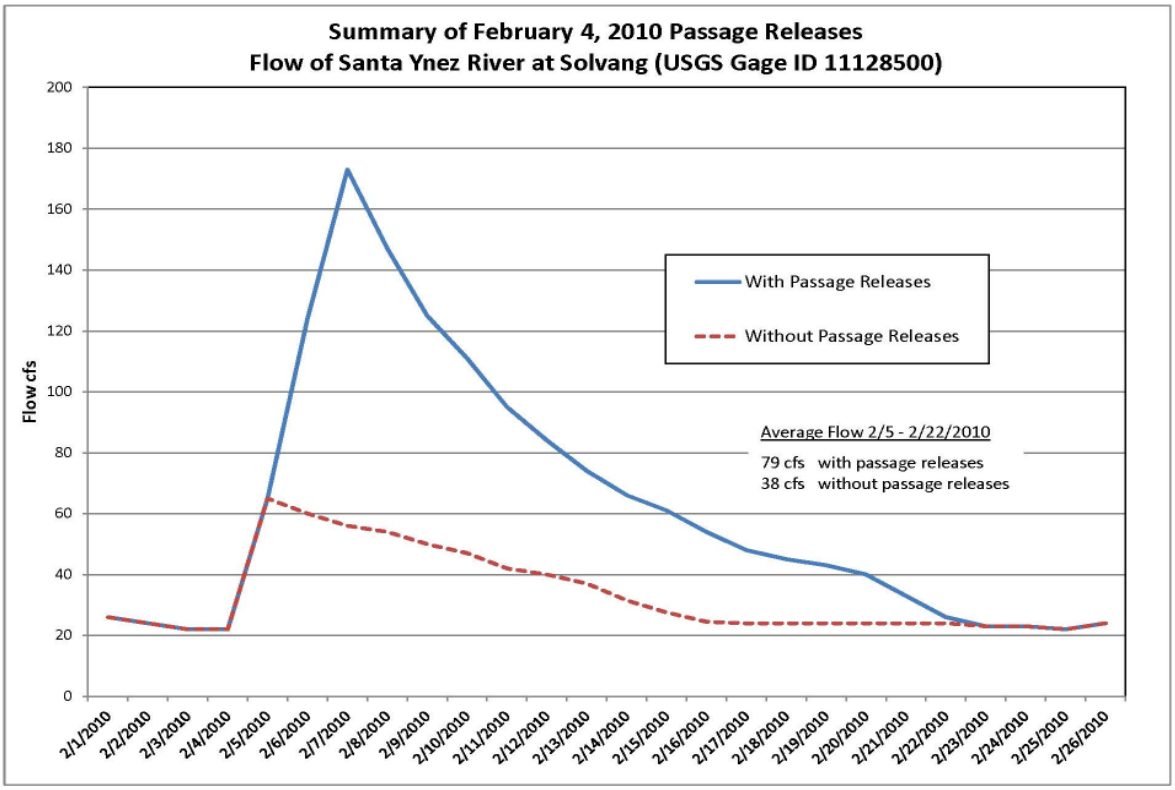




**Figure 5. Passage Releases in 2006**



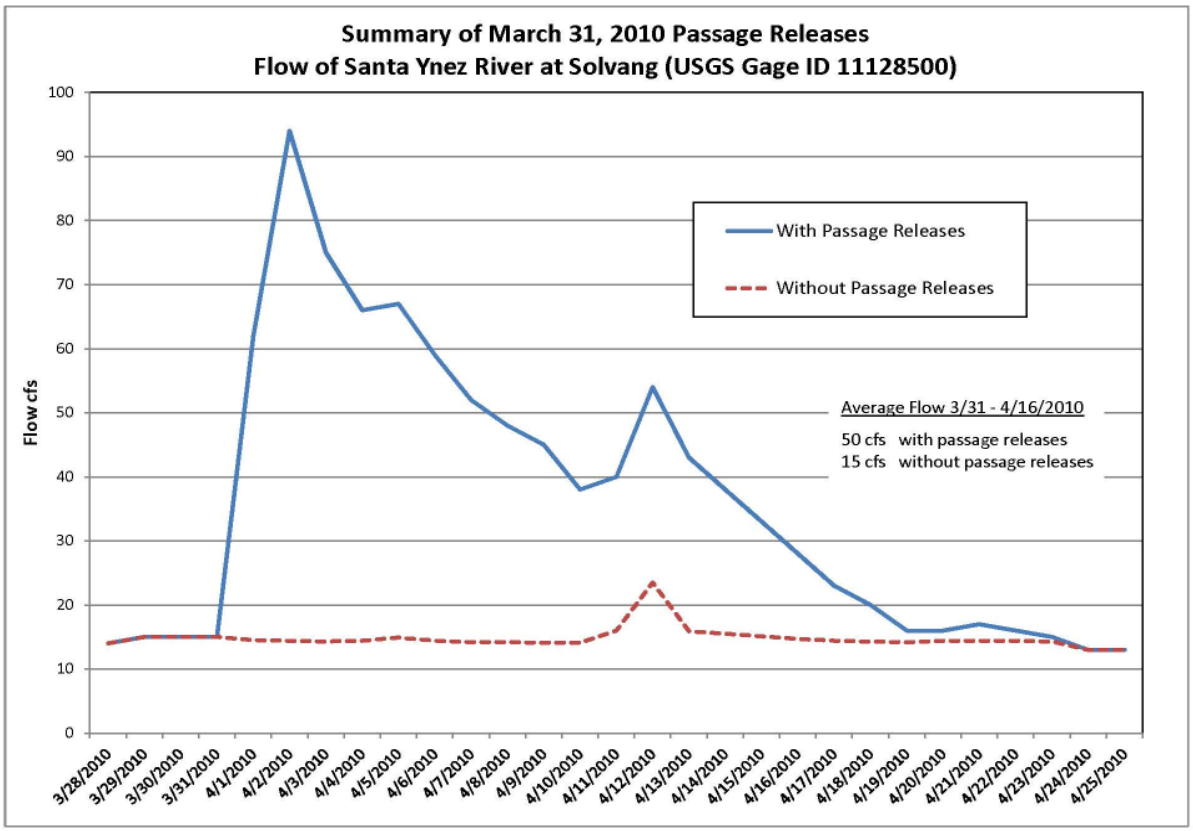




**Figure 6. Passage Releases in 2010**

**6) There have been appreciable increases in steelhead populations in the Santa Ynez River since 2000.**

*"The SWRCB acknowledges that the results of this implementation [2000 biological opinion have not been appreciable improvement in the steelhead population as anticipated. However, the populations have not shown a dramatic decline in numbers. As a consequence of not reaching the desired goals, NMFS and the Reclamation have initiated re-consultation on this public trust resource."*

a. There has been a significant increase in populations of *O. mykiss* as a result of activities carried out and funded by Reclamation and the Cachuma Member Units under the FMP and Biological Opinion. Please refer to the charts and tables above which demonstrate the improvement.

b. Second, while Reclamation initiated the re-consultation in December 2005 because it was not able to complete all of the tributary improvements projects by 2005 as called for in the 2000 Biological Opinion (as described above), it subsequently it became apparent that re-consultation would also be required because the increased number of *O. mykiss* was causing regular exceedance of the "take" limits for capture/handling of juveniles for the annual surveys. The status of the tributary passage projects was adequately addressed in the FEIR. The need for increased take to support the monitoring program indicates expanding O. mykiss abundances.

c. Reclamation and the Cachuma Member units are committed to the conservation of steelhead in the Santa Ynez River and the implementation of the Biological Opinion as portrayed in the FEIR. To this end, Reclamation and the Cachuma Member units have committed large sums of money to fund the actions required by the FMP and the Biological Opinion. They have consistently made choices to meet these commitments even if antecedent conditions were not met.

- When the dam modifications needed for the surcharge to take place were delayed, Reclamation and the Cachuma member units nonetheless agreed to implement the measures (long-term target flows) that were tied to that action.

- When the surcharge was limited by the County of Santa Barbara's facilities to only 2.47 ft instead of 3.0 ft, Reclamation and the Member Units declared that the surcharge was complete and allocated the full 3200 acres feet to the fish passage supplementation account.

- When the flow monitoring station was not able to be established at Hwy 154, Reclamation and the Member Units estimated the amount of water needed to meet target flows at 154 and Alisal. Conservative assumptions were included in the modeling which results in larger releases than needed to achieve the flow targets. All of this water comes out of project yield.

# OUTLINE OF TESTIMONY OF DAVID ZOLDOSKE

David Zoldoske's testimony will respond to the proposed testimony of Heather Cooley regarding the alleged failure of the FEIR to consider the potential for "new water" savings from irrigated agriculture.

Dr. Zoldoske will testify that a review of major crops grown in the area can be categorized into two major cropping types in the San Ynez Valley region. They are identified as wine grapes and vegetables. Plantings of lemons and avocados are also found in the Cachuma Project service in the South Coast.

1) Wine grapes are generally grown at slightly higher elevations and more towards the upper portion of the valley, on ground that can be typically classified as hilly or undulating terrain. Nearly 100% of the wine grape vineyards are already irrigated via the drip irrigation method. There may be a few limited acres of vineyard that are irrigated by the sprinkler method.
2) Vegetable and flower production is largely concentrated in the Lompoc area on relatively flat alluvial soils. Estimates are that 60-80% of the acreage is already irrigated by drip irrigation methods and the remainder irrigated by sprinklers. Some of the latter sprinkler method selection is driven by local groundwater quality concerns.
3) Lemons and avocados are grown elsewhere in the Cachuma Project service area and are predominately irrigated by the drip/micro method

Groundwater is a Major Source for Irrigation

1) Groundwater
    a. Groundwater as a sustainable source for irrigation is maintained by local recharge. Conditions are carefully monitored within the basin to keep this critical component in balance.
    b. Water quality varies widely within the region, with some areas having to manage accumulation of salts in the soil through irrigation practices and irrigation scheduling.

Irrigation Strategies and alleged Potential for Water Savings

Ms. Cooley will apparently testify that measurable water savings can be produced within the Cachuma Project Service area through one or more of the following:

*1)* Improvements in Irrigation Technology (irrigation system*)*
    a. The irrigation system application uniformity sets the potential upper level limits for efficiency. Drip and sprinkler systems generally have the highest potential

irrigation application uniformity. Other considerations may be relevant, including local energy costs.

*2)* Improvements in Irrigation Scheduling-
   a. This has to do with the timing and amount of water applied during each irrigation event.
   b. This activity is initiated by one or more indicators, which may include recent weather conditions (e.g. CIMIS), soil/water status (e.g. soil moisture reading), plant status (e.g. pressure bomb), or other relevant indicators

*3)* Increased use of Regulated Deficit Irrigation (RDI)
   a. RDI is a widely recognized method used by some growers in the wine grape industry to control vine vigor for the purpose affecting grape quality. However, there is also an inverse relationship, that is, as less than full irrigation is applied, there is commonly a corresponding reduction in yield, but with a potential gain in fruit quality. Thus, growers will knowingly decide if the market for their grapes is less tonnage and presumably higher priced wine, or more grapes producing cheaper wines.
   b. The use of RDI does not appear to be practiced in vegetable or cut-flower production. Cool season vegetable crops are typically short season (90 days or so) and are many times driven by consumer demand for size and color.
   c. It does not appear that RDI is being practiced on lemons or avocados.

Neither "improvements" in Irrigation Technology (item 1) nor Irrigation Scheduling (item 2) will likely produce any significant "new water" within the basin. Typically any excess irrigation water percolating betond the root zone will be returned to the groundwater aquifer and accounted for as part of the regional groundwater management plan. Moreover, both advanced irrigation methods and irrigation scheduling techniques are already extensively used within the Cachuma Project service area. Not only do the majority of growers in the Valley already use drip and/or sprinkler irrigation methods, but most growers also are aware of, and implement, some type of irrigation scheduling technique(s).

The use of RDI does offer the opportunity to produce new water, as any reduction in the consumptive demand of the crop will produce new water. However, this strategy is not typically applied to crops grown in the area, including vegetable, flower, citrus and avocado crops, with the notable exception of wine varietal grapes.

Nor is RDI likely to produce measurable water savings within the Santa Ynez Valley with respect to vines. This is true for two reasons.

1) First, many, if not most, vineyard owners are already practicing some level of RDI (applying less water than the plant desires) to achieve better quality grapes at the expense of maximum yield (practiced more with red varietal grapes),

2) Second, other growers have determined that the variety of grapes they grow is not conducive to quality increases by restricting water availability or they have determined that their production model is designed to obtain maximum yield and may target potentially a different price point for bottled wine. This is particularly true with white varietal grapes.

As a result, there are unlikely to be measurable water savings ("new water") from applying RDI to wine grapes within the Santa Ynez Valley. Instead, recent increased demand (and thus price) for wine grapes are more likely to push production toward higher yields to meet growing demand. Ultimately, this is a business decision by the grower and is unlikely to be satisfactorily determined by any level of regulatory control.

Publications

Canessa, Pete, S. Green, and D.F. Zoldoske. 2011. "Agricultural Water Use in California: A 2011 Update." Staff Report published by The Center for Irrigation Technology, California State University, Fresno. November 2011: 75 pp.

Canessa, Pete, S. Green, and D.F. Zoldoske. 2011. "Executive Summary Agricultural Water Use in California: A 2011 Update." Published by The Center for Irrigation Technology, California State University, Fresno. November 2011: 4 pp.

Canessa, Pete, S. Green, and D.F. Zoldoske. 2011. "Recoverable vs Irrecoverable Fractions Illustrated" from "Agricultural Water Use in California: A 2011 Update." Published by The Center for Irrigation Technology, California State University, Fresno. November 2011: 8 pp.

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- ✓ **Program Leadership**
- ✓ **Educational Development**
- ✓ **Technology Testing & Evaluation**
- ✓ **Agricultural Resource Issues**

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| Ed.D. Leadership | University of La Verne | La Verne, CA |
| M.S. Agriculture | California State University, Fresno | Fresno, CA |
| B.S. Agricultural Business | California State University, Fresno | Fresno, CA |

**EXPERIENCE:**

2008-Present **Executive Director**, Water Resources and Policy Initiatives (WRPI), California State University, Office of the Chancellor, Long Beach. Responsibilities include representing the California State University system on water issues within California. Activities include facilitating CSU faculty research efforts with water priorities within the State.

1994- Present **Director**, Center for Irrigation Technology (CIT), California State University, Fresno. Key mission of the CIT is to advance water use efficiency in irrigation. The position requires administration of all aspects of the management for the Center, including: planning and budgeting; promotion and public relations with community and industry; liaison with an advisory board; provide educational opportunities to the public; development of contracts and grants for applied research; hiring and supervision of staff; and training and publications efforts.

1993- Present **Lecturer/Adjunct Faculty**, Department of Plant Science, College of Agricultural Sciences and Technology, California State University, Fresno and Department of Agriculture, College of Sequoias. Developed and taught classes at both the community college and university level.

**HONORS AND RECOGNITION:**

Senior Fellow, California Council on Science and Technology, 2012.

Recognized nationally as one of 18 Environmental Stewards and Innovators in the Golf Industry by the Golfweek's Superintendent NEWS, October 26th, 2001.

Honorary Life Membership in the American Society of Irrigation Consultants, May 2001.

National Water and Energy Conservation Award presented to CIT by the Irrigation Association, 1998.

Roy Williams Memorial Award presented to CIT for service to the industry by the American Society of Irrigation Consultants, 1996.

Edwin J. Hunter Industry Achievement Award for service to the industry presented to CIT by Hunter Industries, 1994.

**PROFESSIONAL ACTIVITIES:**

Appointed Co-Chair (2011), California Department of Water Resources, strategic planning caucus for New Water Technology: Objective 11.

Appointed member (2010), A2 technical subcommittee to SBx7-7 Agriculture Stakeholder Committee, California Department of Water Resources.

President (2005) of the nationally based Irrigation Association. The mission of the IA is to promote efficient irrigation technologies, products and services.

Appointed Vice-Chair (2005) for the AB2717 State Task Force on Landscape Irrigation.

President (2002) of the American Society of Agronomy, California Chapter.

**INTERNATIONAL INVITATIONS:**

Keynote Address at Irrigation Australia 2008. The Irrigation Association of Australia, Ltd., Melbourne Exhibition Centre.

Project Director for the establishment of the Zimbabwe Irrigation Technology Center, Harare, Zimbabwe. Completed contract for design, training, and facility development, December, 1996.

USA delegate to ISO / TC23 / SC18 Committee, Tel Aviv, Israel, October 1993. Appointed by the American National Standards Institute (ANSI), represented the USA position in developing international equipment standards.

USA delegate to ISO / TC23 / SC18 Committee, Aix En Provence, France, September 1991. Appointed by the American National Standards Institute (ANSI), represented the USA position in developing international equipment standards.

Visiting Scholar to the Dzhambul Institute for Irrigation, Land Reclamation and Civil Engineering (DICI), located in Dzhambul, Kazakhstan. Agreement made to develop joint irrigation demonstration and educational plots in Dzhambul region, May 1991.

Keynote Address to the Fourth International Micro-Irrigation Congress, Albury-Wadonga, Australia. Presentation on the Role of an Independent Test Laboratory in Micro-Irrigation, October, 1988.

**BOOKS:**

Green, S., K. Vang, and **D.F. Zoldoske**. 2011. Conservation and Environmental Protection. Chapter 16, pages *In* Irrigation 6th Edition, edited by L.E. Stetson and B. Mecham. Handbook published by the Irrigation Association (IA), Alexandria, VA, 1120 p.

Cassel S., F., D. Goorahoo, **D. Zoldoske,** and D. Adhikari. 2009. Mapping Soil Salinity using Ground-Based Electromagnetic Induction Technique". *In G*. Metternicht and A. Zinck (eds.), *Remote Sensing of Soil Salinization: Impact on Land Management*, Chapter 11, CRC Press, Boca Raton, FL, p. 199-233.

Barrett, J., B. Vinchesi, R. Dobson, P. Roche, and **D.F. Zoldoske**, authors. 2003. "Golf Course Irrigation: Environmental Design and Management Practices," John Wiley and Sons, Inc., Hoboken, New Jersey: 452.

Norum, E.N., J.C Oliphant, K.H. Solomon and **D.F. Zoldoske**. 1995. "Manual for Operation and Maintenance of Testing Equipment." FAO Project ZIM / 91/ 005, February 1995: 66.

**Zoldoske, D.F**., and M.Y. Miyasaki, editors. 1986. "Micro Irrigation: Methods and Materials Update," CATI Publication No. 861103, Center

for Irrigation Technology, California State University, Fresno, CA: 295.

**COMPUTER SOFTWARE:**

Oliphant, J.C. and **D.F. Zoldoske**, 1989. "Sprinkler Profile And Coverage Evaluation (SPACE)", Software and Documentation, CATI Publication No. 890403, Center for Irrigation Technology, California State University, Fresno, CA, 39 p.

**SELECTED PUBLICATIONS:**

Canessa, P., S. Green and **D. Zoldoske**. 2011. Agricultural Water Use in California: A 2011 Update. Staff Report, Center for Irrigation Technology, California State University, Fresno. 80 pp.

Cassel S., F. and **D. Zoldoske**. 2011. Estimating crop evapotranspiration and soil salinity from remote sensing imagery. Final report, California Agricultural Technology Institute. 22 pp.

Longley, K., B. Haddix, S. Greeen, and **D. Zolodske,** *Unincorporated and Underserved: Proposed Center for Disadvantaged Community Water Assistance*, Water Efficiency, The Journal for Water Efficiency, May-June 2011. http://www.waterefficiency.net/index.aspx

**Zoldoske, D.,** S. Green, and S. Longville. 2009. "Capacity of CSU System for Assisting the Establishment of a Statewide Transparent Process for 20x2020 Goal". Presented to the Association of California Water Agencies (ACWA), California State University, p. 1-3, Apr. 24, 2009.

Burt, C., P. Canessa, L. Swankl, and **D. Zoldoske**. 2009. "Commentary: Widely Publicized Water-Conservation Report Drew Incorrect Conclusions". California Farm Bureau Federation, p. 1-2, Jan. 28, 2009.

St. Hilaire, R., M. Arnold, D. Wilkerson, D. Devitt, B. Hurd, B. Lesikar, V. Lohr, C. Martin, G. McDonald, R. Morros, D. Pittenger, D. Shaw, and **D. Zoldoske**. 2008. "Efficient Water Use in Residential Urban Landscapes", HortScience, Dec. 2008, 43: p. 2081-2092.

**Zoldoske, D**. 2008. "Irrigation Industry Challenges", Proceedings of the Desert Green XII conference, Las Vegas, NV, p. 1-5, Oct. 23, 2008.

Adhikari, D.D, **Zoldoske, D.F.** and Norum E. (2008). Featured in the AgAlert "Irrigation Technology: Smart water solution for state's farmers". AgAlert July 9th 2008.

Burt, C., P. Canessa, L. Swankl, and **D. Zoldoske**. 2008. "Agricultural Water Conservation and Efficiency in California-A Commentary", California State University, 13 pp., October 2008.

Huck, M.T. and **D.F. Zoldoske**. "Achieving High Efficiency in Water Application via Overhead Sprinkler Irrigation", Water Quality and Quantity Issues for Turfgrasses in Urban Landscapes, Council of Agricultural Science and Technology, Ames, Iowa, USA, 2008, pp. 223-242.

**Zoldoske, D.F.** 2007. "Sprinkler Systems Used for Frost Protection", Proceedings of the Workshop on Understanding and Preventing Freeze Damage in Vineyards, Institute for Continental Climate Viticulture and Enology, Columbia, MO. Dec. 5 and 6, 2007, pp 79-88.

**Zoldoske, D.** An Overview of Smart Water Application Technologies™ (SWAT™) and Achieving High Water Use Efficiency. California Plant and Soil Conference, Sacramento, CA., 2007, pp. 111-119.

Cassel S., F. and **D. Zoldoske**. Assessing canal seepage and soil salinity using the electromagnetic remote sensing technology. *In* G. Lorenzini and C.A Brebbia (eds) Sustainable Irrigation management, Technologies and Policies. WIT Press. 2006, p. 55-63.

Goorahoo D., D. Adhikari, G Carstensen and **D. Zoldoske**. Impact of Aerated Subsurface Irrigation Water on the Growth and Yield of Crops. Proceedings of the Irrigation Association (IA) conference, Tampa, Florida, November 2004.

Goorahoo D., F. Cassel, M.Rothberg, D. Adhikari, **D. Zoldoske** and E Norum. Potential use of a New Forage Grass (*Pennisetum Sp.)* in Best Management Practices Involving Irrigation with Food Processing and Dairy Wastewaters. Proceedings of the Irrigation Association (IA) conference, Tampa, Florida, November 2004.

Cassel S., F., B. Taylor, and **D. Zoldoske**. Electromagnetic Sensing of Salinity and Boron for Predicting Variable Seeding Zones. Agronomy Abstracts, Soil and environmental Quality Division. Annual Meetings, American Society of Agronomy-Crop Society of Agronomy-Soil Science Society of America, Madison, WI., November 2004.

Sanliang Gu, Guoqiang Du, **David F. Zoldoske**, Abdul Hakim, Robert Cochran, Kenneth Fugalsang, and Greg Jorgensen. "Effect of

irrigation amount on water relations, vegetative growth, yield and fruit composition of Sauvignon blanc grapevines in the San Joaquin Valley of California, USA." Journal of Horticultural Science and Biotechnology (2004) 79 (1) 26-33.

**Zoldoske, David F**., (technical advisor). "Wastewater Subsurface Drip Distribution, Peer-Reviewed Guidelines for Design, Operation, and Maintenance." Tennessee Valley Authority/Electric Power Research Institute, Report #1007406, 2004.

Cassel S., F., **D. Zoldoske,** E. Norum, and T. Jacobsen. "Detecting Canal Seepage using the Electromagnetic Induction Technique." Proceedings, Technical Conference of the Irrigation Association, San Diego, CA., November 2003.

Cassel S., F**., D. Zoldoske**, and M. Spiess. "Assessing Spatial and Temporal Variability of Soil Salinity on Farms Implementing Integrated Drainage Management Practices." Final Report. California Department of Water Resources, CALFED Agricultural Water Use Efficiency Program, Sacramento, CA: 35.

Cassel S., F., B. Taylor, B. Roberts, and **D. Zoldoske**. "Precision Farming Applications in Cotton Systems of California." Final Report, Cotton Incorporated, Cary, NC: 19.

**Zoldoske, David F**., "A Simple Step Toward Savings", Golf Course Management, Lawrence, KS 66049, January 2004, pp. 209-213.

**Zoldoske, David F**., "Improving Golf Course Irrigation Uniformity: A California Case Study". CATI Publication #030901, September 2003, 17 pp.

**Zoldoske, David F**., "Improving Golf Course Irrigation Uniformity: A California Case Study". On the Road-Quarterly Bulletin,Vol. 3, No. 2, Northern California Golf Association, p. 2.

Goorahoo D., G. Carstensen and **D. Zoldoske.** 2003. Evaluation of the addition of surfactant to irrigation water for improving irrigation on commercial turf systems. CATI/ARI Final Report: Surfactant #01-2-012-11.

Goorahoo D., G. Carstensen and **D. Zoldoske**, S Kostka, K. Mauser and M. Franklin 2002. "Addition of Surfactants to Improve Irrigation Efficiency in Turf Systems." Proceedings, Technical Conference of the Irrigation Association, October, 2002.

**Zoldoske, D.F**. "Choose the Right Drip for the Your Vineyard," Western Fruit Grower, March 2002, Vol. 122, No. 3, p16M.

Goorahoo, D., G. Carstensen, **D.F. Zoldoske**, E. Norum, and A. Mazzei. "Using Air in Sub-Surface Drip Irrigation (SDI) to Increase Yields in Bell Peppers," Proceedings, California Chapter of American Society of Agronomy, Energy and Agriculture: Now and in the Future 2002 conference, Fresno, CA., February 5th and 6th, 2002: 10-15.

**Zoldoske, D.F.** 2001. "The Water/Energy/Environmental Matrix." California Grower magazine, Vol. 25, No. 11, December 2001: 22.

**Zoldoske, D.F.** 2001. "Water, Energy and Education: Where Professionalism Does Make a Difference." Full Coverage Irrigation, The Newsletter of the American Society of Irrigation Consultants, Winter/Spring, 2001: 6-8.

**Zoldoske, D.F.** 2001. "How Will the Changing Drip/Micro Marketplace Affect the Grower?" California Grower magazine, Vol. 24, No. 5, May 2001: 16.

**Zoldoske, D.F.** 2001. "California at the Crossroads." California Grower magazine, Vol. 25, No. 4, April 2001: 20.

**Zoldoske, D.F**. 2000. "Subsurface Drip Irrigation: The Future of Irrigation Is Underground." The Western Chestnut, Published by the Western Chestnut Grower Association, Inc., Vol. 3, No. 1, Winter 2000: 6-7.

**Zoldoske, D.F.** 2000. "The Water Institute has its Beginning." California Grower magazine, Vol. 24, No. 10, November 2000:18, 20.

**Zoldoske, D.F.** 2000. "Whiskey is for Drinking and Water is for Fighting!" California Grower magazine, Vol. 24, No. 8, September 2000: 22.

**Zoldoske, D.F.** 2000. "Low Volume Irrigation: Design and Installation Guide." Technical editor, produced by the City of Albuquerque, New Mexico, April 2000: 24.

**Zoldoske, D.F.** 2000. "Water, Technology, and Our Future." California Grower magazine, Vol. 24, No. 3, March 2000: 26.

Gu, S., **D.F. Zoldoske**, S. Graves, and G.S. Jorgensen. 2000. "Effect of Partial Rootzone Drying on Vineyard Water Use, Vine Water Relation, Yield Components, and Fruit Composition in Field-Grown Mature Sauvignon blanc Grapevines-A Preliminary Evaluation in California." Proceedings of the 2000 California Plant and Soil Conference, January 19th and 20th, Stockton, CA: 75-80.

**Zoldoske, D.F**. 1999. "Irrigation Technology Improvements." Irrigation Journal, Vol. 23, No. 9, September/October 1999: 15-17.

**Zoldoske, D.F.** 1999. "Installing an Irrigation System Requires Up-Front Work." Grower Advocate, Published by the Napa County Farm Bureau and the Napa Valley Grape Growers Association, Vol. 1, No. 4, July 1999: 6-8.

**Zoldoske, D.F**. 1999. "Buried Drip and Root Intrusion," Irrigation Journal, Vol.49, No. 3, May/June 1999: 14-15.

**Zoldoske, D.F**. 1999. "Irrigated Viticulture in Australia: Wine Grapes, Soils, RDI and PRD," American Vineyard, Vol. 8, No. 4, April 1999: 43-45.

**Zoldoske, D.F.** 1999. "Selecting a Drip Irrigation System for Vineyards." Grape Grower, Vol. 31, No. 9, March 1999: 27, 33-35.

**Zoldoske, D.F.** 1999. "The Future of Irrigation Is Underground." American Small Farmer, Vol. 8, No. 3, March 1999: 16, 18-19.

**Zoldoske, D.F.,** S. Genito and G.S. Jorgensen. 1999. "Subsurface Drip Irrigation (SDI) on Turfgrass: A University Experience." International Water & Irrigation, January/February 1999, Vol. 19, No. 1, 1999: 18-19.

**Zoldoske, D.F.** 1998. "Irrigation Scheduling on the Web." Proceedings of the Irrigation Association's 19th Annual Conference, San Diego, CA, November 1-3: 289-91.

**Zoldoske, D.F.** 1998. "Irrigation Selection for Vineyards." American Vineyard magazine, August 1998, 7 (8): 26-30.

**Zoldoske, D.F.** 1997. "How to Select an Irrigation System." China Connect: Your Voice in China, December, GDS Publishing, Ltd, Beijing, China (published in Chinese): 2.

**Zoldoske, D.F.** and E.M. Norum. 1997. "A Case Study in the conversion of an Established Vineyard from Flood to Surface Drip and Subsurface Drip (SDI) Irrigation." CIT Project No. 1026 (3rd Draft), Center for Irrigation Technology, California State University, Fresno, Fresno, CA, February, 1997: 90.

**Zoldoske, D.F.** 1996. "Survey of Linear Irrigation Systems in California." CATI Publication No. 961102, Center for Irrigation Technology, California State University, Fresno, Fresno, CA, October 1996: 17.

Jorgensen, G.S., B.M. Escalera, D.R. Wineman, R.K. Striegler, **D.F. Zoldoske**, and C. Krauter. 1996. "Microsprayer Frost Protection in Vineyards." CATI Publication No. 960803, Center for Irrigation Technology, California State University, Fresno, Fresno, CA, August 1996: 10.

**Zoldoske, D.F.** 1996. "Teamwork Delivers: High-Efficiency Sprinkler Irrigation." Irrigation Journal, May / June 1996, 46 (5): 14 - 16.

**Zoldoske, D.F.** 1996. "Getting to the Root of the Problem." Western Fruit Grower, April 1996, 116 (4): 14, 43.

Norum, E.M. and **D.F. Zoldoske**. 1995. "Relating Agronomic Considerations to Sprinkler Performance to Improve Water Management Practices." Proceedings, Irrigation Association's International Irrigation Exposition and Technical Conference, Phoenix, Arizona, November 12 - 14, 1995: 11 - 17.

Norum, E.M., K.H. Solomon and **D.F. Zoldoske.** 1995. "A Proposed Method for Characterizing the Distribution Performance of Micro-Sprinklers." Proceedings, Irrigation Association's International Irrigation Exposition and Technical Conference, Phoenix, Arizona, November 12 - 14, 1995: 101 - 108.

**Zoldoske, D.F**. 1995. "Market Study on Selected Regions of the United States Irrigation Market for Polyethylene (PE) Tubing, Inline Emitters, and Drip Tape Products." Industry Report: 34.

**Zoldoske, D.F.** and E.M. Norum. 1995. "Impact of Water Storage on Irrigation Costs: Merritt Farms, A Case Study." Report for Southern California Edison: 26.

Solomon, K.H. and **D.F. Zoldoske.** 1995. "Back Flow Prevention and Safety Devices for Chemigation." Proceedings, Dahlia Gredinger International Symposium on Fertigation, March 27 - April 1, 1995, Haifa, Israel.

**Zoldoske, D.F.** 1994. "Initial Agricultural Experiences with Post Regulation Diesel Fuels." Report prepared for the Diesel Fuel Task Force, February 15, 1994: 11.

Solomon, K.H. and **D.F. Zoldoske.** 1994. "Field Determination of Agricultural Pumping Plant Electric Motor Efficiencies." CATI Publication No. 940805, Center for Irrigation Technology, California State University, Fresno, Fresno, CA: 250.

Solomon, K.H. and **D.F. Zoldoske.** 1994. "Establishing Irrigation Equipment Testing for Zimbabwe." World Agriculture 1994, Sterling Publications Ltd., London, January 1994: 96 - 98.

**Zoldoske, D.F.** 1993. "The Future of Irrigation." Proceedings, Micro Irrigation Workshop and Trade Show, Cachuma Resource Conservation District, Santa Maria, California, October 21, 1993.

**Zoldoske, D.F**. and G.S. Jorgensen. 1993. "Chemigation Guidelines." Arab World Agribusiness , 9(2): 20 - 21.

**Zoldoske, D.F.** 1992. "Nozzling for Efficiency: An Economical Approach." Turf West. January 1992, 2 (1): 20 - 21.

Solomon, K.H., **D.F. Zoldoske** and J.C. Oliphant. 1991. "Laser Optical Measurement of Sprinkler Drop Sizes." Proceedings, Automated Agriculture for the 21st Century Symposium, American Society of Agricultural Engineers, Chicago, Illinois, December 16 - 17, 1991.

Solomon, K.H., and **D.F. Zoldoske.** 1991. "Energy conservation: A Good Way to Do Business." Turf West. September 1991, 1(8): 26 - 27.

**Zoldoske, D.F**., and K.H. Solomon and J.C. Oliphant. 1991. "Perspective of an Independent Laboratory." ASAE Paper No. 91-2169, presented at the 1991 Summer Meeting of the American Society of Agricultural Engineers, Albuquerque, New Mexico, June 23 - 26, 1991.

**Zoldoske, D.F.** 1991. "Water Application: Calculating Irrigation Uniformity with Accuracy." Turf West. May 1991, 1 (4):20 - 21.

**Zoldoske, D.F**., and K.H. Solomon. 1991. "Selecting Equipment for Micro-Irrigation Systems." Agribusiness Worldwide.January / February 1991, 13 (1):10 - 12.

**Zoldoske, D.F**., J.C. Oliphant and K.H. Solomon. 1990. "Sprinkler Spacing Designs: From Rules of Thumb to Computer Analysis." Proceedings of the Third National Irrigation Symposium, *Visions of the Future* (American Society of Agricultural Engineers and The Irrigation Association), October 28 - November 1, 1990, Phoenix, AZ: 571 - 576.

**Zoldoske, D.F**. and G.S. Jorgensen, 1990. "Careful Chemigation Could Help Growers." Western Fruit Grower, April 1990, 110 (4): 26, 28.

Solomon, K.H., J.C. Batista, J.W. Hagen, G.S. Jorgensen and **D.F. Zoldoske**. 1989. "Ambient and Personal Motivational Factors Influencing the Irrigation Scheduling Decisions of California Westside Growers." Center for Irrigation Technology / Center for Agricultural Business, California State University, Fresno, CA: 36.

**Zoldoske, D.F**. and G.S. Jorgensen. 1989. "Moisture Sensors for Irrigation Management." Grounds Maintenance, April 1989, 24(4):IR-3,IR-18.

**Zoldoske, D.F**. and G.S. Jorgensen. 1989. "Measuring Soil Moisture." Western Fruit Grower, January 1989, 109(1): 56, 58.

**Zoldoske, D.F**. 1988. "The Role of an Independent Test Laboratory in Micro-Irrigation." Proceedings, Fourth International Micro-Irrigation Congress, October 23 - 28, 1988, Albury-Wadonga, Australia:
C1 - C7.

**Zoldoske, D.F**. 1988. "Computer Irrigation Scheduling." Western Fruit Grower, April 1988, 108(4):6 - 7.

**Zoldoske, D.F.** 1988. "CIT Offers Micro-Irrigation Testing Service." Irrigation News, April 1988, 7(2):5.

**Zoldoske, D.F.** and K.H. Solomon. 1987. "Micro-Irrigation Scheduling and Management." Western Fruit Grower, May 1987, 107(5):13 - 15.

**Zoldoske, D.F.** and K.H. Solomon. 1987. "Equipping Your Irrigation System." Western Fruit Grower, April 1987, 107(4):18, 20.

Solomon, K.H. and **D.F. Zoldoske.** 1987. "Select Your Water Source." Western Fruit Grower, March 1987, 107(3):41 - 43.

**Zoldoske, D.F.** 1987. "Sprinkler Pattern Research." Proceedings, Golf Course Superintendents Association of America 58th International Golf Course Conference and Show, January 26 – February 2, 1987, Phoenix, AZ: 21.

**Zoldoske, D.F.** and K.H. Solomon. 1986. "Coefficient of Uniformity: What It Tells Us." Proceedings, Irrigation Association 1986 International Irrigation Exposition and Technical Conference, December 7 - 10, San Antonio, TX: 50 - 56.

**Zoldoske, D.F**., and E.M. Norum. 1986. "Setting Drip Irrigation Standards." Wines and Vines, January, 1986: 23 - 26.

Norum, E.M. and **D.F. Zoldoske**. 1985. "Adapting Irrigation Systems to Solar (PV) Based Water Supplies." Proceedings, Third International Drip / Trickle Irrigation Congress (American Society of Agricultural Engineers), November 18 - 21, 1985, Fresno, CA: 459 - 464.

Petrucci, V.E., E. M. Norum, C.J. Muller, C.D. Clary, D. Pecchenino, **D.F. Zoldoske**, and R. Holsher. 1985. "Programmed Moisture Stress and Its Effects on Bunch Rot and Physiology of Drip Irrigated Chenin Blanc Grapes." Proceedings, Third International Drip/Trickle Irrigation Congress (American Society of Agricultural Engineers), November 18 - 21, 1985, Fresno, CA: 255 - 260.

Norum, E.M. and **D.F. Zoldoske**. 1985. "Design and Operation of Solar Powered (PV) Drip Irrigation Systems." Proceedings, Arid Lands: Today and Tomorrow Conference, October 20 - 25, 1985, Tucson, AZ: 183 - 187.

**Zoldoske, D.F.** 1984. "Analysis of High and Low Pressure Sprinkler Systems," Masters thesis topic. California State University, Fresno, CA: 68.

Krauter, C.F. and **D.F. Zoldoske.** 1982. "Energy Conservation Through the Use of Low Pressure Sprinklers in California." Proceedings, Joint Seminar on Modern Agricultural Science, Taichung, Taiwan: 211 - 219.