UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802- 4213

MAY - 2 2008

Kimberly D. Bose, Secretary
Nathaniel J. Davis, Sr., Deputy Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, DC 20426

Re: Request for Rehearing of Order for the Don Pedro Project (P-2299), With Supplemental Information

Dear Ms. Bose and Mr. Davis:

Enclosed for filing in the above-referenced proceeding is the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NMFS) Request for Rehearing (Request) of the Federal Energy Regulatory Commission's (Commission) Order (dated April 3, 2008) on Ten-Year Summary Report Under Article 58 of the Don Pedro Project (P-2299) (Project) license, as amended. In addition to this Request (Attachment A), NMFS is enclosing other attachments that are explained in the Request and that are introduced in this letter below.

Anadromous fisheries resources have declined steadily and precipitously following the construction of Commission projects in the Central Valley. With regard to this Project on the Tuolumne River, the Commission must determine and address Project impacts to anadromous fisheries under NMFS' statutory authorities, including California Central Valley steelhead, Central Valley fall-run and late fall-run Chinook salmon, Central Valley spring-run Chinook salmon, and North American green sturgeon. Among other things, on May 2, 2003, NMFS reminded the Commission of its study entitled "Potential Cumulative Effects of Hydropower Projects in the Bay-Delta, California" (emphasis added):

> There are nine licensed projects (involving 22 storage reservoirs) where cumulative impacts are much more likely. These projects with direct impacts are located in three areas without large federal/state water projects: the Yuba and Bear rivers in the Sacramento Basin; the Mokelumne and Calaveras rivers in the Central Sierra Area; and the Tuolumne and Merced rivers in the San Joaquin Basin...

The Commission was also made aware of these impacts in its Final Environmental Impact Statement for the Project, dated July 1996, which included the following statement:

There are, however, no significant populations of rainbow/steelhead in the lower Tuolumne River, based on sampling by the Districts and others. The species (either anadromous or resident) may or may not have occurred there in the past; however, conditions in the lower river are not currently suitable for the species (primarily because of high water temperatures in summer).

Contrary to the Commission's conclusions in the subject Order, the record before the Commission demonstrates that Central Valley steelhead are present in the Tuolumne River and are adversely affected by Project impacts. As NMFS discusses in its Request, a recent study (Attachment C) even more clearly demonstrates Central Valley steelhead presence in the Tuolumne River.

We also discuss in the Request and submit a preliminary analysis of Central Valley fall-run Chinook salmon (*Oncorhynchus tshawytscha*), developed by Dr. Carl Mesick of the United States Fish and Wildlife Service (Attachment B). Dr. Mesick also recommends minimum flows for Chinook salmon (*O. tshawytscha*) and *O. mykiss* (including steelhead and rainbow trout) in a portion of the Tuolumne River. We consider that the flows recommended by this document are based on the best available scientific information, although these flows do not necessarily avoid or mitigate for all of the effects of the Don Pedro Project. Thus, the Commission should consider implementing these flows immediately in order to provide timely, interim relief to declining anadromous species impacted by the project. In addition, as explained in the Request and as previously requested by NMFS, the Commission should initiate formal consultation with NMFS under the Endangered Species Act (ESA) section 7(a)(2) regarding Project impacts to species listed under the ESA as a result of this Order under review.

As we discuss in this Request, we wish to correct the Commission's misinterpretation of recent information regarding the effects of ocean conditions on anadromous fisheries. On this issue, we have also included a recent news release from the Pacific Fishery Management Council (Attachment D).

If the Commission has comments or questions regarding this filing, please direct them to Mr. Eric Theiss at 916-930-3613, or Eric.Theiss@NOAA.Gov.

Sincerely,

Rodney R McInnis

Rodney R. McInnis
Regional Administrator

Enclosures
cc: Maria Rea, NMFS, Sacramento Area Office Supervisor
Service List

ATTACHMENT A

UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

Modesto Irrigation District Turlock Irrigation District Don Pedro Project	)))	FERC Project No. 2299-057

NATIONAL MARINE FISHERIES SERVICE'S REQUEST FOR REHEARING OF ORDER ON TEN-YEAR SUMMARY REPORT UNDER ARTICLE 58

Pursuant to 18 CFR § 385.713, and for the reasons described herein, the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NMFS) timely requests rehearing (Request) of the Federal Energy Regulatory Commission (Commission) Order on Ten-Year Summary Report Under Article 58 (123 FERC ¶ 62,012 (April 3, 2008)) (Order) of the license, as amended, for the Don Pedro Project (P-2299) (Project). On March 25, 2005, the Project licensees, Modesto Irrigation District and the Turlock Irrigation District (Districts), filed the Ten-Year Summary Report (Summary Report) pursuant to Article 58 of the license, as amended in 76 FERC ¶ 61,117 (1996).

I. BACKGROUND

The Project was licensed in 1964. Article 37 of the Project license established minimum flow releases for the first 20 years of project operations and provided that the Districts would study the Tuolumne River fishery during that time. In addition, the Commission reserved its authority to revise the minimum flow requirements. In December 1992, FERC initiated a proceeding pursuant to Article 37 to reopen the license and determine flows necessary to protect fishery resources in the Tuolumne River. Parties and participants entered into negotiations, and

the Districts filed a settlement agreement and request for license amendments on February 5, 1996. NMFS was not a party to the settlement agreement. On July 31, 1996, the Commission issued an order amending the Project license to implement the settlement agreement. 76 FERC ¶ 61,117 (1996) (License Amendment). The License Amendment amended Article 37 of the license to implement a minimum flow regime. This flow regime, although resulting in an incremental increase in flows, was based upon the life history requirements of Chinook salmon and failed to address the different life history requirements of steelhead which, unlike Chinook salmon, must reside in the Tuolumne River year round. In addition, the License Amendment amended Article 58 of the license to implement a program to monitor Chinook salmon populations and habitat in the Tuolumne River. This amendment of Article 58 resulted in the Summary Report.

Subsequent to the License Amendment, NMFS took several actions regarding steelhead pursuant to its authority under section 4 of the Endangered Species Act (ESA) that are relevant to this proceeding. On March 19, 1998, NMFS listed the California Central Valley Evolutionarily Significant Unit (ESU) of steelhead as threatened under the ESA, including all naturally spawned populations of steelhead (and their progeny) in the Sacramento and San Joaquin Rivers and their tributaries. 63 Fed. Reg. 13347. On July 10, 2000, NMFS issued protective regulations under section 4(d) of the ESA, which prohibit "take" of steelhead included in this ESU without authorization. 65 Fed. Reg. 42475. On September 2, 2005, NMFS designated critical habitat for the California Central Valley steelhead ESU within designated stream reaches, including reaches designated in the Tuolumne River. On January 5, 2006, NMFS issued a final rule, which reaffirmed that the California Central Valley Distinct Population Segment (DPS) of steelhead is threatened under the ESA and determined that no revision was necessary for the critical habitat designation. 71 Fed. Reg. 834.

NMFS has persistently and consistently notified and reminded the Commission and the licensees regarding NMFS' concerns about the effects of Project facilities and operations on listed steelhead. In letters dated June 11, and November 19, 2002, NMFS requested that the

Commission initiate consultation under section 7(a)(2) of the ESA regarding such effects. On May 2, 2003, NMFS filed with the Commission a petition for modifying the minimum flow provisions of Article 37 as necessary to protect both steelhead and Chinook salmon in the Tuolumne River, and NMFS again requested that FERC initiate consultation under section 7(a)(2) of the ESA regarding impacts of Project facilities and operations on listed steelhead. The Commission did not initiate formal consultation, but it designated the Districts as its non-Federal representatives for consultation. See Commission letter to NMFS, dated June 24, 2003. NMFS met with Commission staff and the Districts on August 6, 2003, as requested by the Commission, and NMFS reiterated its concerns regarding project impacts to listed steelhead in a letter dated September 2, 2003. On December 22, 2003, the Commission issued an order deferring action on NMFS' petition pending completion of informal ESA consultation. In a letter dated April 23, 2004, NMFS once again reiterated its concerns regarding project impacts to listed steelhead, and requested that certain studies be undertaken for purposes of the Summary Report to determine Project effects on Central Valley steelhead. In its notice of filing of the Summary Report (dated June 24, 2005), the Commission invited "comments on consideration of the Endangered Species Act issues involving Central Valley steelhead that were deferred pending completion of ongoing studies and informal consultation by order issued on December 22, 2003 (105 FERC 61,332)." On July 25, 2005, NMFS filed a request for stay of the proceeding on its petition to re-open the license. In that request, NMFS explained that the United States District Court for the Eastern District of California had filed an order in *Modesto Irrigation District v. Gutierrez* that precluded NMFS from commenting further on the ESA issues involving Central Valley steelhead that are the subject of NMFS' petition, and NMFS attached a copy of the court order. In a letter dated June 20, 2006, NMFS informed the Commission that the District Court proceeding in *Modesto Irrigation District v. Gutierrez* had been completed, there was a new listing decision in effect for Central Valley steelhead (71 Fed. Reg. 834, January 25, 2006), and NMFS' request for a stay of the petition to re-open the license was no longer necessary.[1] NMFS continued to reiterate its

[1] In that letter, NMFS also noted that the Commission must comply with its obligations under ESA section 7(a)(2)

concerns for Project effects on listed steelhead in that letter and letters dated July 30, 2007, and September 18, 2007.

NMFS has diligently participated in this Commission proceeding regarding the Summary Report. As the Commission noted in its Order, the Districts filed their Summary Report on March 25, 2005, the Commission noticed the Districts' filing of the Summary Report on June 24, 2005, and NMFS filed a timely motion to intervene and comments on the Summary Report on July 25, 2005 (except, as discussed in the preceding paragraph, NMFS informed the Commission that it was precluded by court order from commenting on ESA issues involving Central Valley steelhead). In addition, NMFS filed comments related to the Summary Report by letter dated June 26, 2006 (as discussed in the preceding paragraph). NMFS participated in a public meeting concerning the Summary Report and Article 58 requirements on July 25, 2006.

By letter dated December 20, 2006, the Commission summarized the meeting on July 25, 2006, and comments on the Summary Report and provided:

> Our general conclusion about the 10-Year Summary Report, as presented at the meeting, is that for most of the required monitoring, the data were insufficient to reach any valid conclusions about the effects of the modified streamflow releases and restoration efforts on the fisheries resources of the Tuolumne River. Some of the monitoring efforts were improperly designed or executed and could not, therefore, produce data that would allow valid conclusions. Some of the mitigative measures simply have not had sufficient time for the monitoring efforts to show any change, or the response was not great enough to detect.
>
> Therefore, we conclude that under Article 58 of the license, further monitoring studies are needed. Additional, well-designed and well-executed studies are necessary before the effectiveness of the revised flow schedule and the non-flow mitigative measures can be determined.

The Commission listed tasks to be included in the study plan related to instream flow, habitat restoration, fry survival, steelhead presence/absence, predator control, and river temperature. In addition, the Commission provided that the study plan should be developed in cooperation with various organizations, including NMFS. On March 7, 2007, the U.S. Fish and Wildlife Service

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related to Project impacts on the Central Valley spring-run Chinook salmon ESU (70 Fed. Reg. 37160, June 28, 2005)) and Southern DPS of North American green sturgeon (71 Fed. Reg. 17757 (April 7, 2006)), which had recently been listed as threatened under the ESA.

(FWS) filed joint comments of the FWS, California Department of Fish and Game (CDFG), and NMFS on the Districts' draft fisheries study plan required by the Commission in its letter dated December 20, 2006. By letter dated June 15, 2007, the Commission enclosed Commission staff's preliminary analysis of the Tuolumne River Fisheries Study Plan submitted by the Districts. In that analysis, Commission staff noted, "Staff's review of the 10-year Summary Report determined that the data were insufficient to conclude that implementation of the 1995 settlement agreement flow schedule had produced the intended benefits in salmon production." Commission staff analyzed the study plan and outlined necessary modifications for the study plan. On July 30, 2007, NMFS filed comments on the Commission staff's preliminary analysis. NMFS participated in a public meeting to discuss the Fisheries Study Plan on August 8, 2007, at which Commission staff solicited additional comments. On September 18, 2007, NMFS filed additional comments on the Fisheries Study Plan.

II. NMFS' INTEREST IN THE PROCEEDING

NMFS has statutory responsibility for the protection and enhancement of living marine resources, including anadromous fish and their supporting habitats, under the ESA, 16 U.S.C. §1531 et seq., Magnuson-Stevens Fishery Conservation and Management Act (MSA), 16 U.S.C. §1801 et seq., Fish and Wildlife Coordination Act (FWCA), 16 U.S.C. §661 et seq., and Reorganization Plan No. 4 of 1970, 84 Stat. 2090. The San Joaquin River Basin once supported a number of anadromous fish species, including Central Valley spring-run Chinook salmon (*Oncorhynchus tshawytscha*) and California Central Valley steelhead (*O. mykiss*), which are listed under the ESA as threatened. NMFS has found that impacts from hydropower development have contributed substantially to the decline of these fishes (63 Fed. Reg. 11482, March 9, 1998; 63 Fed. Reg. 13347, March 19, 1998; 64 Fed. Reg. 50394, September 16, 1999; 69 Fed. Reg. 33102, June 14, 2004; 70 Fed. Reg. 37160, June 28, 2005; and 71 Fed. Reg. 834, January 5, 2006). NMFS has designated critical habitat on the Tuolumne River for California

Central Valley steelhead (70 Fed. Reg. 52488, September 2, 2005). In addition, the San Joaquin River may have supported green sturgeon, the Southern DPS of North American green sturgeon (*Acipenser medirostris*) is listed under the ESA as threatened, and hydropower development contributed to the decline of this DPS (70 Fed. Reg. 17386, April 6, 2005; 71 Fed. Reg. 17757, April 7, 2006). Dams have also contributed to the decline of Central Valley fall and late fall-run Chinook salmon ESU, which is listed as a species of concern, including the San Joaquin River basin (64 Fed Reg. 50394, September 16, 1999; 71 Fed. Reg. 61022, October 17, 2006). The effects of dams on passage and flow conditions, habitat, water quality, and other effects on anadromous fish resources directly concern NMFS under the statutory authorities listed above.

III. STATEMENT OF ISSUES AND NMFS' POSITION ON THE ISSUES PRESENTED

The Commission erred in issuing the Order for the following reasons:

1) **In the basis for the Commission's conclusions related to steelhead, the Commission did not consider recent relevant evidence, failed to properly consider other evidence, failed to support its conclusions with substantial evidence, failed to properly consider recommendations of NMFS and other resource agencies, and failed to address Project impacts to critical habitat for steelhead**

In its Order, the Commission discussed some monitoring and studies that had been conducted related to steelhead in the Tuolumne River (Order at 19-20) and some of the evidence of steelhead presence in the Tuolumne River that NMFS provided to the Commission (Order at 24-25). The Commission noted that, at the public meeting on July 26, 2006, "the resource agencies and NGOs expressed the need to modify existing monitoring programs to include steelhead, to implement new monitoring programs related to steelhead, and to examine flows and temperatures necessary for the protection of steelhead." Order at 25. In addition, the Commission summarized information regarding steelhead that NMFS stated was needed. Order

at 25-26. The Commission then concluded:

> No *O. mykiss* anadromy has been identified in the Tuolumne River; however, reproductive contribution of non-anadromous parents to anadromous offspring can occur when the anadromous run size is small, suggesting a genetic compensation between the anadromous and non-anadromous life-history forms. [Footnote omitted.]
>
> It is apparent that monitoring efforts, to date, have been inconclusive in determining the presence or absence of steelhead populations in the Tuolumne River. The origin and nature of rainbow trout downstream of La Grange Dam is unclear, and it is unclear if steelhead occur in the Tuolumne River downstream of La Grange Dam.
>
> The Districts, therefore, should initiate a monitoring effort to determine if the Tuolumne River currently supports anadromous forms of rainbow trout. * * *
>
> Order at 26.

The Commission found no basis for requiring that additional instream flow studies be conducted for steelhead, because monitoring for *Oncorhynchus mykiss* should first be completed in order to determine if steelhead are present in the Tuolumne River. Order at 27.

These conclusions are not supported by substantial evidence as required by law. *See* 16 U.S.C. § 825l(b). In addition, these conclusions are arbitrary and capricious and are not in accordance with law in that the Commission did not consider or give proper consideration to relevant information and recommendations of NMFS and other resource agencies. *See* 16 U.S.C. § 803(j); *Wisconsin Power & Light Co. v. Federal Energy Regulatory Comm'n*, 363 F.3d 453, 461-466 (DC Cir. 2004).

a) The Commission did not take into account a recent study providing conclusive evidence that the anadromous form of *Oncorhynchus mykiss* (Central Valley steelhead, listed as threatened under the Endangered Species Act) is present in the Tuolumne River

On March 6, 2008, Zimmerman *et al.* published the paper entitled, "Maternal Origin and Migratory History of *Oncorhynchus mykiss* captured in rivers of the Central Valley, California," which is attached to this request for rehearing (Attachment C). In this study, otolith microchemistry was analyzed to determine the migratory history of *O. mykiss* captured on several Central Valley Rivers, including the Tuolumne River. An analysis of the strontium (Sr) to calcium (Ca) ratios (Sr:Ca) across the otolith of each fish was used to describe the migratory history of that fish between freshwater and saltwater, as the concentration of strontium is generally greater in saltwater. Further, comparison of Sr:Ca in the otolith primordia and freshwater growth region was used to determine maternal origin (resident or anadromous) based on the assumption that primordial composition reflects the environment in which yolk precursors develop (in the ocean for anadromous forms) (Kalish 1990; Volk et al. 2000; Zimmerman and Reeves 2002). The California Department of Fish and Game (CDFG) collected 146 wild *O. mykiss* from the Tuolumne River between 2001 and 2007 for otolith microchemistry analysis. Using this method, of the fish sampled (n=146) from the Tuolumne River, eleven were steelhead. These eleven fish were identified as having anadromous (steelhead) maternal origin, and one of these fish displayed an anadromous migratory history. The proper standard for review of conclusions by the Commission and NMFS (in providing recommendations to the Commission) is whether these conclusions are supported with substantial evidence. *See* 16 U.S.C. § 825l(b); *Wisconsin Power & Light Co.*, 363 F.3d 453, 461-466. Conclusive evidence is not the standard, as implied in the Commission's Order. See Order at 26. However, this study provides conclusive evidence that steelhead immigrate to the Tuolumne River and successfully spawn in the Tuolumne River; thus, it provides conclusive evidence of steelhead presence in the Tuolumne River.

Although this study was published before the Commission's Order, the Commission apparently relied on preliminary results that have been superseded, and the Commission did not consider this study in this Order. See Order at 18 ("The preliminary results from the CDFG otolith study indicated no anadromy was detected"). NMFS has attached this study to this

request for rehearing, and the Commission should consider it on rehearing. *See* 18 CFR 385.713(c)(3); *Dominion Cove Pont LNG, LP, Dominion Transmission, Inc.*, 118 FERC ¶ 61,007 (2007); *California Independent System Operator Corporation*, 120 FERC ¶ 61,271 (2007).

b) The Commission failed to properly consider evidence that NMFS and other resource agencies have provided to it regarding the presence of the anadromous form of *Oncorhynchus mykiss* (Central Valley steelhead, listed under the ESA as a threatened species) in the Tuolumne River

The Commission noted that NMFS has supplied evidence of presence of steelhead in the Tuolumne River, and the Commission summarized some of this evidence, but the Commission has not provided any substantial evidence to conclude that NMFS' evidence is inadequate. Order at 24-25. Notably, the Commission did not discuss why it did not consider evidence that NMFS provided the Commission in a letter dated November 19, 2002, and that NMFS submitted to the Commission again as an attachment to a letter dated June 20, 2006. This evidence includes a CDFG memorandum dated May 24, 2001, Central Valley Steelhead Genetics Study – Tuolumne River Sampling, in which a CDFG biologist discusses sampling conducted on the Tuolumne River and steelhead that were found during that sampling. In its Order, the Commission does not adequately explain why it has not considered the evidence that NMFS presented as evidence of steelhead presence, and the Commission has not provided substantial evidence that there are not steelhead present in the Tuolumne River.

In addition, the Commission noted, "Anecdotal reports persist of fish with adult steelhead characteristics in the Tuolumne River, but such reports have not been confirmed." Order at 24. For example, The Conservation Groups' Brief in Support of the Petition of the National Marine Fisheries Service for Modifying Project Structures and Operations (Accession number 200306065044, filed June 6, 2003), discusses and attaches such anecdotal reports. However, the Commission simply concludes that the reports "have not been confirmed." The Commission has not provided any analysis why it has not considered these anecdotal reports as evidence of presence of steelhead.

c) The Commission failed to provide substantial evidence to support its conclusions regarding the anadromous form of *Oncorhynchus mykiss* (Central Valley steelhead, listed under the ESA as a threatened species)

The Order often refers to *O. mykiss* in the Tuolumne River as "rainbow trout"; however, the Commission provides no biological or legal basis for the assumption that these fish are rainbow trout instead of the anadromous form of *O. mykiss* (Central Valley Steelhead). The Commission noted that NMFS has supplied evidence of presence of steelhead in the Tuolumne River (Order at 24-25), but the Commission has not provided any substantial evidence to conclude that NMFS' evidence is inadequate or that steelhead are not present in the Tuolumne River. The Commission's actions are based upon the assumption that there is insufficient evidence to conclude that Central Valley steelhead are present in the Tuolumne. This assumption is unwarranted based upon evidence previously provided to the Commission, and it is even more clear that this assumption is incorrect based upon Zimmerman *et al.* (2008) (see issue 1(a) of this Request above).

d) The Commission failed to properly consider recommendations by NMFS and other resource agencies regarding measures necessary for the anadromous form of *Oncorhynchus mykiss* (Central Valley steelhead, listed under the ESA as a threatened species)

In its Order, the Commission noted that resource agencies and others "expressed the need to modify existing monitoring programs to include steelhead, to implement new monitoring programs related to steelhead, and to examine flows and temperatures necessary for the protection of steelhead." Order at 25. In addition, the Commission summarized information regarding steelhead that NMFS stated was needed. Order at 25-26. However, based on the

incorrect conclusion that more information was necessary to determine steelhead presence in the Tuolumne River, the Commission did not follow the recommendations of NMFS and other resource agencies. The Commission must revise its conclusions based on issues 1(a) - (c) of this Request above, and it must revise the Order to follow the recommendations of NMFS and other resource agencies. *See* 16 U.S.C. § 803(j). Most recently, in its letter dated September 18, 2007, NMFS provided the Commission with recommendations for fisheries studies to include experimental flow releases to provide information needed to set flow requirements for Central Valley Steelhead, which the Commission should incorporate into its Order.

In its Order, the Commission also noted background information related to a petition that NMFS filed on May 3, 2003 (Petition), to amend the license to modify the minimum streamflows as necessary to protect both steelhead and Chinook salmon in the Tuolumne River. In the Petition, NMFS also reiterated its request that the Commission initiate consultation with NMFS pursuant to ESA section 7(a)(2) regarding the impacts of the Don Pedro project facilities and operation on Central Valley steelhead. The Commission concluded in this subject Order on the Summary Report, "The petition is currently pending before the Commission and will be addressed in a subsequent order." However, the Commission has essentially recognized the interrelationship between the subject Order on the Summary Report and the issues raised under the Petition. In its notice regarding the availability of the Summary Report, the Commission provided, "The Commission also invites comments on consideration of the Endangered Species Act issues involving Central Valley steelhead that were deferred pending completion of ongoing studies and informal consultation, by order issued on December 22, 2003 (105 FERC ¶ 61,332)." Therefore, in this Request, NMFS feels compelled to reiterate the positions that NMFS raised in the Petition to ensure that this Request is not interpreted as implicitly waiving any arguments

raised in the Petition and to highlight the interrelationship between the subject Order and the issues raised in the Petition.

In its Petition, NMFS provided its argument that current project operations adversely affect Central Valley steelhead. Essentially, NMFS discussed information supporting the conclusion that minimum releases stipulated in the license allow summer water temperatures in the Tuolumne River to rise to levels harmful to steelhead. NMFS noted that the Commission had recognized this adverse effect:

> Indeed, the Commission stated in its Final Environmental Impact Statement evaluating the effects on anadromous steelhead of the project operations as proposed in the Settlement and subsequently incorporated into the License: '[C]onditions in the lower river are not currently suitable for the species (primarily because of high water temperatures in the summer).' Final Environmental Impact Statement: *Reservoir Release Requirements at the New Don Pedro Project, California*, at 3-65. (FERC, Jul. 1996).

NMFS outlined in the Petition how the Commission had retained discretionary control in the license because the Commission's actions on the license required the continuing monitoring plan for Chinook salmon, and, based on the results of the monitoring, the Commission would determine whether to require changes in project structures and operations, such as minimum flows, to protect fishery resources in the Tuolumne River. In this Order on the Summary Report, the Commission has gone further by determining that no change is necessary to existing flow requirements under Article 37 of the license and determining certain monitoring studies that will and will not be required under the license. Under this Order, it is even clearer that the Commission is taking action, and, as described in the Petition, this action will adversely affect listed Central Valley steelhead. Thus, the Commission must initiate formal consultation with NMFS pursuant to ESA section 7(a)(2) regarding the impacts of the Don Pedro project facilities and operation on Central Valley steelhead.[2]

[2] Even if Central Valley steelhead were not present in the Tuolumne River, the Commission would need to

The circumstances for the Commission's Order here are easily distinguished from the circumstances addressed by the Ninth Circuit Court of Appeals in *California Sportfishing Protection Alliance v. Federal Energy Regulatory Comm'n*, 472 F.3d 593 (9th Cir. 2006). In fact, the reasoning in the Ninth Circuit's decision supports the need for the Commission to initiate formal consultation under ESA section 7 here. The circumstances in the *California Sportfishing* case involved ongoing operation of a 30-year license issued in 1980 for the DeSabla-Centerville hydroelectric project. *Id.* at 594. In 1999, NMFS listed the Central Valley spring-run Chinook salmon ESU as threatened under the ESA. Thus, there was no consultation with NMFS under ESA section 7 for issuance of the license. Fish died in Butte Creek in 2002 and 2003, and NMFS requested that the Commission initiate formal consultation regarding the project's effects on this listed Chinook ESU. The Commission did not initiate formal consultation. The California Sportfishing Protection Alliance petitioned the Commission to initiate formal consultation. The Commission denied the petition and a request for rehearing on that denial. *Id.* at 595. In determining whether consultation was required under ESA section 7(a)(2), the court focused on the triggering mechanism for consultation, which is an agency action, not the listing of a species under the circumstances. *Id.* at 597. The court noted that a private party, the licensee, operates the hydroelectric project, and the Commission "has proposed no affirmative act that would trigger the consultation requirement for current operations." *Id.* at 598. In addition, the court discussed the reopener provisions of the license. The court

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determine whether its action may affect Central Valley steelhead in all areas affected directly or indirectly by its action and not merely the immediate area, such as the Tuolumne River, involved in the action. See 50 CFR §402.02 (definition of "action area"). In addition, as NMFS will further discuss in this Request under issue 1(e), the Commission must determine whether its action may affect critical habitat of Central Valley steelhead, which is designated in the Tuolumne River. Finally, although NMFS' Petition related to Central Valley steelhead and this request for rehearing focuses on Central Valley steelhead, the Commission must determine whether its action may affect the listed Central Valley spring-run Chinook ESU and Southern DPS of North American green sturgeon in all areas to be affected directly or indirectly by its action and not merely the immediate area, such as the Tuolumne River, involved in the action.

concluded, "The reopener provisions in and of themselves are not sufficient to constitute any discretionary agency 'involvement or control' that might mandate consultation by FERC." *Id.* at 599. Finally, the court concluded, "There is no ongoing government action within the meaning of the ESA." Therefore, the court held that the Commission was "not required to initiate separate consultation with respect to [the licensee's] operation of the project under the existing, 1980 license agreement." *Id.* at 599.

The circumstances for this Order on the Summary Report in the Don Pedro Project are substantially different than those addressed in the *California Sportfishing* decision. Here, the Commission amended Article 58 of the license to implement a monitoring program and reserved the following specific authority related to the results of this monitoring program:

> Based on the information provided in the Licensees' study results to be filed by April 1, 2005, the Commission will determine whether to require further monitoring studies and changes in project structures and operations to protect fishery resources in the Tuolumne River, after notice and opportunity for hearing.
>
> 76 FERC ¶ 61,117 (1996), paragraph G.

After the Districts filed the Summary Report, the Commission provided notice, dated June 24, 2005, of filing of the Summary Report, including notice of "licensees' proposals for continuing their current monitoring program, consultation and reporting efforts, flow release schedule, flow fluctuation controls, and habitat restoration projects." This notice began a proceeding in which NMFS and other agencies and organizations have participated and provided numerous, substantial comments (see the Background section of this Request). Finally, in this Order under consideration, the Commission is taking "final agency action" (Order at 30, Paragraph E), which includes its determination that no change is necessary to existing flow requirements under Article 37 of the license and its determination regarding monitoring studies that will or will not be required under the license. In the language of the Commission's License Amendment order

quoted above, the Commission has determined "whether to require further monitoring studies and changes in project structures and operations to protect fishery resources in the Tuolumne River, after notice and opportunity for hearing." Unlike the circumstances addressed in the *California Sportfishing* decision, the action under consideration here is more than simply a private party's continuing action of operating the project under an existing license. The Commission has exercised its discretion under the license, it is authorizing the licensees to take certain actions under the license related to flows and monitoring, and it is taking "final agency action" in the Commission's own words. Therefore, the Commission's action triggers the consultation requirement under ESA section 7(a)(2). In addition, the Commission cannot continue the unreasonably prolonged, indefinite informal consultation that it apparently assumes is being conducted for this Project since its order on December 22, 2003, in which the Commission deferred action on NMFS' petition pending completion of informal ESA consultation. The subject Order, which will result in adverse effects to listed steelhead, triggers the requirement for formal consultation under ESA section 7(a)(2). *See* 50 CFR § 402.14.

e) The Commission failed to address Project impacts to critical habitat, which is designated in the Tuolumne River, for Central Valley steelhead

With its Order, the Commission failed to address the effects on Central Valley steelhead critical habitat resulting from this Order regarding the Project Article 37 flow schedule. The Commission found no basis for requiring that additional instream flow studies be conducted for steelhead, because monitoring for *Oncorhynchus mykiss* should first be completed in order to determine if steelhead are present in the Tuolumne River. Order at 27. However, the Commission provides no analysis of Project effects on critical habitat for Central Valley steelhead. NMFS designated critical habitat for Central Valley steelhead, which includes the

Tuolumne River from La Grange Dam to the confluence with the San Joaquin River (70 Fed. Reg. 52488 (September 2, 2005)). There are three Primary Constituent Elements (PCEs) related to freshwater steelhead habitat that are essential for the conservation of the species:

> 1. Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development. These features are essential to conservation because without them the species cannot successfully spawn and produce offspring.
>
> 2. Freshwater rearing sites with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks. These features are essential to conservation because without them juveniles cannot access and use the areas needed to forage, grow, and develop behaviors (*e.g.*,predator avoidance, competition) that help ensure their survival.
>
> 3. Freshwater migration corridors free of obstruction with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival. These features are essential to conservation because without them juveniles cannot use the variety of habitats that allow them to avoid high flows, avoid predators, successfully compete, begin the behavioral and physiological changes needed for life in the ocean, and reach the ocean in a timely manner. Similarly, these features are essential for adults because they allow fish in a nonfeeding condition to successfully swim upstream, avoid predators, and reach spawning areas on limited energy stores.
>
> 70 Fed. Reg. at 52521.

These PCEs are also important factors for Chinook salmon. In the proceedings related to the Petition and the Summary Report, NMFS and other organizations provided information indicating that the current habitat and flow conditions within the Tuolumne do not support these PCEs at a functioning level.[3] The Commission provides no evidence to the contrary. In

[3] See, e.g., March 5, 2007 letter to the Commission from the USFWS, CDFG, and NMFS, "Limiting Factor Analysis and Recommended Studies for Fall-Run Chinook Salmon and Rainbow Trout in the Tuolumne River" (Limiting

addition, and in relation to the discussion in issue 1(d) of this Request above, the Commission must determine whether its action may affect critical habitat of Central Valley steelhead and consult with NMFS under ESA section 7(a)(2) regarding adverse Project effects to critical habitat of Central Valley steelhead resulting from this Order. *See* 50 CFR § 402.14.

2) In the basis for the Commission's conclusions related to the adequacy of flows under Article 37, the Commission misinterpreted information, failed to support its conclusions with substantial evidence, and failed to adequately consider recommendations of NMFS and other resource agencies

In issue 1 of this Request above, NMFS addressed the reasons why the Commission's conclusions related to adequacy of flows under Article 37 for steelhead are in error. NMFS will not repeat those reasons here. Here, NMFS will address other reasons, which are not specifically related to steelhead, why the Commission's conclusions related to adequacy of flows under Article 37 are in error.

a) The Commission's conclusions regarding the adequacy of the flow requirements under Article 37 are based upon a misinterpretation of information

In the basis for its conclusions regarding the adequacy of flow requirements under Article 37 of the license, the Commission cited recent findings by both NMFS and the Pacific Fishery Management Council (PFMC) indicating that warmer waters in the Pacific Ocean during 2005 caused a decline in marine food production, thus contributing to the marked decline in returning Chinook and coho salmon populations along the entire West Coast in 2007/2008. Order at 22-23. With these findings, NMFS is not dismissing other potential causes (such as subsequent poor in-river conditions) for this year's low salmon return. Many biologists believe a combination of human-caused and natural factors will ultimately explain the collapse, including both marine conditions and freshwater factors such as in-stream water withdrawals, habitat alterations, dam

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Factors Analysis).

operations, construction, pollution, and changes in hatchery operations.[4] The ocean phase of the Chinook salmon life history is important for juvenile survival and growth to adulthood, but the time Chinook salmon spend in the ocean is just one part of their life cycle. The freshwater phase also comprises an essential part of the salmon life cycle. Chinook salmon spawning, egg incubation, rearing, smoltification, and juvenile migration life history stages all occur in freshwater. Poor ocean conditions in 2005 do not completely explain the declining salmon population numbers in the Tuolumne for a number of years and should not be taken out of context. Indeed, if baseline conditions are changing in the oceans, it becomes even more essential to provide minimum habitat requirements for the freshwater phase of the life cycle.

In addition, the Commission concludes that, because the other major San Joaquin River tributaries (Merced and Stanislaus Rivers) also experienced declining fall-run Chinook salmon escapement numbers during the 2000-2007 period, factors outside of the rivers were having an impact on the returns. This may be true, but it does not obviate poor instream conditions as contributing factors in the decline. CDFG, FWS, and NMFS provided the Commission with analyses and evidence of deleterious effects to Chinook salmon from the Project license flow schedule.[5][6] The Commission has not adequately considered this evidence and has misinterpreted NMFS' recent findings regarding poor ocean conditions as the sole reason for the decline in Chinook salmon in the Tuolumne River.

b) The Commission's conclusions regarding the adequacy of the flow requirements under Article 37 are not supported by substantial evidence

As NMFS provided immediately above, CDFG, FWS, and NMFS provided the Commission with analyses and evidence of deleterious effects to Chinook salmon from the Project license flow schedule. In the Limiting Factors Analysis, CDFG, FWS, and NMFS

[4] E.g., PFMC News Release, Record Low Salmon Fisheries Adopted, April 10, 2008, available at http://www.pcouncil.org/PFMC_FINAL_PressRel (attached to this request for rehearing as Attachment D)
[5] March 5, 2007 letter to the Commission from the USFWS, CDFG, and NMFS, "Limiting Factor Analysis and Recommended Studies for Fall-Run Chinook Salmon and Rainbow Trout in the Tuolumne River" (Limiting Factors Analysis).
[6] Evidence presented by CDFG and USFWS at the July 2006 public meeting.

discussed a wide range of factors limiting Chinook salmon and *O. mykiss* populations in the Tuolumne River, including the relationship of instream flow releases in the Tuolumne River to adult Chinook recruitment, evidence that winter flow affects the number of fry that survive to a smolt size in the Tuolumne River, and evidence that spring flow affects the number of smolts that survive their migration through the Tuolumne River and the Delta. In its Order, the Commission focuses mostly on another limiting factor - ocean conditions. However, ocean conditions are not the sole reason for the decline in Chinook salmon in the Tuolumne River, and the Commission provides no evidence to refute the evidence and analyses on the record indicating deleterious effects to Chinook salmon from the Project license flow schedule. The Commission cannot ignore evidence of deleterious project effects. The Commission must follow the recommendations of NMFS and other resource agencies to protect fisheries resources and mitigate these deleterious project effects. *See* 16 U.S.C. § 803(j).

c) The Commission's conclusions regarding the adequacy of the flow requirements under Article 37 failed to adequately consider recommendations of NMFS and other resource agencies

The Commission must revise its conclusions based on issues 2(a) and (b) of this Request above, and it must revise the Order to follow the recommendations of NMFS and other resource agencies regarding flow requirements. *See* 16 U.S.C. § 803(j). Dr. Carl Mesick, FWS, recently developed a preliminary analysis of Project effects on Chinook salmon in the Tuolumne River and recommended flow releases needed to sustain minimally viable salmon and *O. mykiss* (steelhead and rainbow trout) populations, which we have attached to this request for rehearing (Attachment B - Mesick, The High Risk of Extinction for the Natural Fall-Run Chinook Salmon Population in the Lower Tuolumne River due to Insufficient Instream Flow Releases, April 30, 2008). These analyses and recommendations are supported by substantial evidence and are based on the best currently available scientific information. Although the recommended flows do not necessarily avoid or mitigate for all of the effects of the Don Pedro Project, they do represent the best available information on flows and therefore, should be implemented

immediately in order to provide timely relief for declining salmon and steelhead in the Tuolumne River[7]. This is significant new information that the Commission should consider in this request for rehearing. *See* 18 CFR 385.713(c)(3); *Dominion Cove Pont LNG, LP, Dominion Transmission, Inc.*, 118 FERC ¶ 61,007 (2007); *California Independent System Operator Corporation*, 120 FERC ¶ 61,271 (2007).

3) In the basis for the Commission's conclusions related to fisheries studies, the Commission failed to support its conclusions with substantial evidence and failed to adequately consider recommendations of NMFS and other resource agencies

In issue 1 of this Request above, NMFS addressed the reasons why the Commission's conclusions related to fisheries studies for steelhead are in error. NMFS will not repeat those reasons here. Here, NMFS will address other reasons, which are not specifically related to steelhead, why the Commission's conclusions related to fisheries studies are in error.

a) The Commission failed to support its conclusions related to fisheries studies with substantial evidence

In its Order, the Commission provided very little discussion of reasoning and no discussion of evidence to support its decision related to the few studies that it is requiring the Districts to continue to perform. Order at 23-24. In addition, the Commission provides no basis for reversal of the conclusions it made related to fisheries studies in a letter dated December 20, 2006.

In its letter dated December 20, 2006, the Commission summarized the proceeding related to the Summary Report to that date, and the Commission concluded:

> Our general conclusion about the 10-Year Summary Report, as presented at the meeting, is that for most of the required monitoring the data were insufficient to reach any valid conclusions about the effects of the modified streamflow releases and restoration efforts on the fisheries resources of the Tuolumne River. Some of the monitoring efforts were improperly designed or executed and could not, therefore, produce data that would allow valid conclusions. Some of the mitigative measures

[7] *See Platte River Whooping Crane Critical Habitat Maintenance Trust v. FERC* (Platte River II), 962 F.2d 27 (D.C. Cir. 1992), *rehearing denied,* 972 F.2d 1362 (1992) (authorizing FERC to incorporate interim "rough and ready"conditions in annual license "if necessary and practical to limit adverse impacts on the environment").

> simply have not had sufficient time for the monitoring efforts to show any change, or the response was not great enough to detect.
>
> Therefore, we conclude that under Article 58 of the license, further monitoring studies are needed. Additional, well-designed and well-executed studies are necessary before the effectiveness of the revised flow schedule and the non-flow mitigative measures can be determined.

Although an agency is entitled to change its course or views, "it must supply a reasoned analysis justifying the reversal." *Babbitt v. Fund for Animals*, 903 F.Supp. 96, 116 (D. DC 1995) (citing *Motor Vehicle Manufacturers Ass'n, Inc. v. State Farm Mutual Auto. Insurance Co.*, 463 U.S. 19, 57, 103 S.Ct. 2856, 2874, 77 L.Ed.2d 443 (1983)); *see also Hatch v. Federal Energy Regulatory Comm'n*, 654 F.2d 825, 834-35 (D.C. Cir. 1981). In this Order, the Commission does not provide any reasoned analysis to justify the reversal of its conclusions in its December 20, 2006 letter.

b) The Commission failed to adequately consider recommendations of NMFS and other resource agencies in its conclusions related to fisheries studies

In the Background section of this Request, NMFS summarizes its substantial involvement, comments, and recommendations in this proceeding related to the Summary Report and subsequent study plan. NMFS will not repeat that information here. In summary, NMFS has consistently provided substantial information and provided reasons why the Summary Report and study plan are inadequate to provide the basis for the Commission's conclusion in this Order. The Commission has not adequately explained in this Order why it is not following NMFS' recommendations regarding fisheries studies. *See* 16 U.S.C. § 803(j).

IV. CONCLUSION

NMFS has provided the Commission with substantial evidence and clear support for its recommendations regarding fisheries studies and flows necessary to address deleterious Project effects on anadromous fishes that are within NMFS' statutory authorities described above. In its

Order, the Commission has not provided substantial evidence to support its conclusions, and it has not provided adequate reasoning why it is not following NMFS' recommendations. Although a new license is due to be issued eight years from now, the Commission has the discretion and opportunity in this Order under the current license articles to provide adequate protection and mitigation for adverse Project effects on these anadromous fishes. The Commission has not done so in this Order, and the Commission's actions in this Order will result in adding further, unreasonable delay in adequate protection and mitigation.

In addition, as NMFS has previously noted to the Commission and the Districts, the Commission has failed to consult with NMFS as required under ESA section 7(a)(2) regarding Project effect to listed species, and the flows and studies that NMFS has recommended through this proceeding will not necessarily protect the Commission and the Districts from liability under the ESA. Especially now that it has been even more clearly demonstrated that Central Valley steelhead are present in the Tuolumne River and are adversely affected by Project operations under the license, and the Commission is taking action under the license in this Order, the Commission must initiate formal consultation with NMFS under ESA section 7(a)(2) to ensure that the Commission's actions comply with the ESA. Neither the Commission nor the Districts have taken action under the ESA necessary to obtain authorization for any incidental take of listed species resulting from Project effects. Thus, they may be liable under the ESA for any unauthorized incidental take of listed species resulting from Project effects.

For the above-stated reasons, NMFS respectfully requests that this request for rehearing be granted.

DATED this 23rd day May, 2008, on behalf of the National Marine Fisheries Service.

Rodney R McInnis

Rodney R. McInnis
Regional Administrator

ATTACHMENT B

The High Risk of Extinction for the Natural Fall-Run Chinook Salmon Population in the Lower Tuolumne River due to Insufficient Instream Flow Releases

Carl Mesick, Ph.D.
Stockton Fishery Resource Office
US Fish and Wildlife Service
30 April 2008

The following preliminary analysis indicates that the Tuolumne River fall-run Chinook salmon (*Oncorhynchus tshawytscha)* population of naturally produced fish is at a high risk of extinction because the instream flow releases are too low. Lindley and others (2007) have characterized the risk of extinction for Chinook salmon populations in the Sacramento-San Joaquin Basin relative to population size, rates of population decline, catastrophes, and hatchery influence. Populations with a high risk of extinction (greater than 20 percent chance of extinction within 20 years) have a total escapement that is less than 250 spawners in three consecutive years (mean of 83 fish per year), a precipitous decline in escapement, a catastrophe defined as an order of magnitude decline within one generation occurring within the last 10 years, and a high hatchery influence. Populations with a low risk of extinction (less than 5 percent chance of extinction in 100 years) have a minimum total escapement of 2,500 spawners in three consecutive years (mean of 833 fish per year), no apparent decline in escapement, no catastrophic declines occurring within the last 10 years, and a low hatchery influence. The Tuolumne River fall-run Chinook salmon population is at a high risk of extinction because the population of naturally produced fish was probably less than 83 for three consecutive years (2005 to 2007), there was a precipitous decline, and the fall 2007 escapement was a catastrophe considering the spring 2005 wet year conditions. Dr. Steve Lindley[1] evaluated the Tuolumne River population estimates in Table 1 and confirmed these conclusions. The following summarizes the risk of extinction based on the four criteria presented by Lindley and others (2007).

Population Size

The effective population size criteria relates to the loss of genetic diversity (Lindley et al. 2007). The effective population consists of individuals that are reproductively successful. In Chinook salmon populations, not all individuals are reproductively successful and the mean ratio of the effective population size to total escapement over a three year period (N_e/N) has been estimated to be 0.20 based on genetic assessments from fish collected in over 100 populations from California to British Columbia (Waples et al. 2004 as cited in Lindley et al. 2007). A few examples of why adult salmon may not reproduce successfully in the Tuolumne River include: (1) fish that return as two-year-old males; (2) redd superimposition that destroys eggs; (3) spawning in habitats with excessive levels of fines; and (4) low survival rates for juveniles that migrate late when high water temperatures in the lower Tuolumne River are unsuitable for survival.

[1] Steven Lindley, Ph.D, National Marine Fisheries Service, Fisheries Ecology Division, 110 Shaffer Road, Santa Cruz, California 95060, phone (831) 420-3921.

Therefore based on population size, the Tuolumne River could be considered to be at high risk if annual escapement (N) drops below a mean of 83 fish for three consecutive years and at low risk if escapement remains above a mean of 833 fish for three consecutive years.

The analyses reported here are based on preliminary estimates of the number of naturally produced and hatchery produced adult fall-run Chinook salmon that have returned to the Tuolumne River between 1981 and 2005 (Table 1). The analyses should be considered as preliminary because the estimates for the returns of untagged adult Feather, Nimbus, and Mokelumne hatchery fish are based on relatively few tagged fish that were collected in the Tuolumne River during escapement surveys (see Methods Summary). These surveys were used to estimate the percentage of the millions of unmarked juvenile hatchery fish released from these hatcheries in the Delta and San Francisco Bay that would have returned to the Tuolumne River (see Methods Summary). The preliminary analyses used simple mean rates of adult returns to the Tuolumne River that were estimated by segregating the juvenile release data into three groups: (1) release location, (2) spring or fall releases, and (3) water year type (Merced and Mokelumne hatcheries only). The mean rates of return do not account for year to year variation due to other factors, such as ocean conditions and fall attraction flows, and the statistical level of confidence has not been evaluated.

Since the license was amended in 1996 to improve minimum instream flows, it is likely that the escapement of naturally produced fish has been less than 83 fish between fall 2005 and 2007 (3 consecutive years, Table 1). Therefore, the Tuolumne River would be considered to be at a high risk of extinction according to the recommended criteria by Lindley and others (2007).

Population Decline

Another serious threat to the viability of natural salmonid populations identified by Lindley and others (2007) is a precipitous decline in escapement, which has occurred on the Tuolumne River. Table 1 indicates that the escapement of natural spawners in the Tuolumne River has declined from about 16,000 adults in fall 2000 to few if any fish between fall 2005 through fall 2007. In addition, the abundance of natural Tuolumne River recruits at a given flow declined by about 50% at a statistically significant level between the 1980 to 1995 pre-Settlement Agreement period and the 1996 to 2004 post-Settlement Agreement period (Figure 2). These results provide additional evidence that the Tuolumne River natural salmon population would be considered to be at a moderate to high risk of extinction according to the recommended criteria by Lindley and others (2007). The studies that have been conducted by the Turlock Irrigation District and the Modesto Irrigation District to date are inadequate to explain the cause of the population's decline (*see* Analyses & Recommended Studies for Fall-run Chinook Salmon and Rainbow Trout in the Tuolumne River, e-Library no. 20070314-0089).

Catastrophe

Catastrophes are defined by Lindley and others (2007) as instantaneous declines in population size due to events that occur randomly in time that reflect a sudden shift from a low risk state to a higher one. The extremely low total escapement of 115 fish in Fall 2007 could be considered a catastrophe. Since the 1940s, fall-run Chinook salmon escapement to the Tuolumne River had been high two years following prolonged winter and spring flows during wet years. For example, during 1996 the mean flow near La Grange Dam was 3,652 cfs between February 1 and June 15 and natural fish escapement in fall 1998 was about 6,940 adult salmon (Table 1). In contrast, during 2005 the mean flow near La Grange Dam was 3,881 cfs between February 1 and June 15, but few if any naturally produced fish returned in fall 2007 (Table 1). Recent findings by the National Marine Fisheries Service (Peterson et al. 2006) indicate that warmer waters in the Pacific Ocean during 2005 caused a decline in marine food production, thus contributing to the marked decline in returning spring Chinook and coho salmon populations along the entire West Coast in 2007. The catastrophically low escapement in fall 2007 is another sign that the Tuolumne River naturally produced Chinook salmon population is at high risk of extinction.

Hatchery Influence

There are no data to directly assess the genetic impacts of adult hatchery fish on the naturally produced Chinook salmon population in the Tuolumne River. If there are impacts from the Feather, Nimbus, and Mokelumne hatchery releases, (an average total of about 570 adults in the Tuolumne River escapement from 1996 to 2005), then the minimum escapement needed to maintain a low risk of extinction would be substantially greater than 1,724 fish.

Minimum Flow Releases

The number of naturally produced adult salmon that return to the Tuolumne River is primarily a response of the juvenile salmon to the flows released at La Grange Dam during the winter and spring (Figure 1; Analyses & Recommended Studies for Fall-run Chinook Salmon and Rainbow Trout in the Tuolumne River, e-Library no. 20070314-0089). The assessment of the relationship between flows and adult salmon production utilizes estimates of adult recruitment, which are adult salmon that all belong to the same cohort and were either harvested in the ocean or returned to spawn in the escapement. Assuming that ocean harvest rates continue to be about 40 percent (mean 2000 to 2006), a recruitment of 1,388 fish would result in an escapement of 833 fish. The polynomial relationship between the average flows from February 1 through June 15 and Tuolumne River adult recruitment (Figure 1) suggests that when the average winter and spring flows are less than 1,330 cfs, the average adult recruitment of naturally produced salmon is less than 1,388 fish.

There is uncertainty regarding the precise duration and timing of the spring pulse flows needed to produce 1,388 adult Tuolumne River recruits. The correlations between flow releases and salmon recruitment are probably highest for the February 1 through June 15 period because extended floodplain inundation that occurs during wet years produces

good conditions for both rearing and migrating juveniles. The exponential increase in recruitment as flows increase above 2,000 cfs (Figure 1) probably reflects the importance of the extended floodplain inundation. Under typical dry and normal water year conditions, it is likely that high flows are primarily protecting outmigrating subyearling smolts in April and May. Therefore, it is likely that the 1,330 cfs pulse flows would have to occur when most of the smolt-sized fish are migrating and conditions are suitable for their survival in the Delta. Studies will be needed to determine the precise timing and duration of these pulse flows (*see* Analyses & Recommended Studies for Fall-run Chinook Salmon and Rainbow Trout in the Tuolumne River, e-Library no. 20070314-0089). In addition to spring pulse flows, it would be necessary to provide fall pulse flows to minimize the straying of adults to the Sacramento Basin and suitable year-round base flows for spawning, egg incubation, and rearing. A minimum flow schedule that should be able to sustain both naturally producing Chinook salmon and *O. mykiss* (steelhead and rainbow trout) populations includes the following three elements:

- Pulse flows of 1,330 cfs for 45 days during April and May to provide suitable conditions for migrating juvenile salmon and Central Valley steelhead.
- Fall pulse flows of 1,500 cfs for 10 days during mid-October to attract adult Chinook salmon to the Tuolumne River and minimize straying (Mesick 2001).
- Year round base flows of 235 cfs to provide suitable water temperatures throughout the summer in 12.4 miles of habitat for *O. mykiss* (unpublished results of real-time temperature management by Turlock Irrigation District and Modesto Irrigation District in 2002 and 2003) and suitable spawning and rearing conditions for fall-run Chinook salmon.

The total volume of water required for this flow schedule is 292,889 acre-feet (AF). In comparison, the volume of flow releases required in the Tuolumne River in the 1996 FERC order range from 94,000 AF in Critical and Below Normal Water Year Types to 165,002 AF in Median Below Normal water year types (Turlock Irrigation District and Modesto Irrigation District 2005). These relatively dry water year types cumulatively occur 50.7% of the time (Turlock Irrigation District and Modesto Irrigation District 2005). During the wetter water year types (49.3% of the time), the required flow release is 300,923 AF (Turlock Irrigation District and Modesto Irrigation District 2005).

Methods Summary

The analyses described here are based on trends in adult recruits, which are adult salmon that all belong to the same cohort and were either harvested in the ocean or returned to spawn in the escapement. Approximately 40% of the adult recruits have been harvested in the ocean between 2000 and 2006.

The number of recruits is estimated by first segregating the California Department of Fish and Game (CDFG) escapement estimates (GrandTab Excel file, February 20, 2008) into cohorts using an age analysis of fall-run Chinook salmon scales collected from the Tuolumne River between 1981 and 2002 that was conducted by CDFG. The abundance of recruits is then expanded by an index of the percentage of fish harvested in the ocean (Central Valley Index, Pacific Fisheries Management Council 2006). These methods are

described in greater detail in Mesick and Marston (2007) and Mesick, Marston, and Heyne (2007).

The escapement estimates for the lower Tuolumne River in the CDFG database are a combination of naturally produced and hatchery fish. To estimate the number of hatchery reared fish, it was necessary to expand the number coded-wire-tagged (CWT) hatchery adults that returned to the Tuolumne River (Table 2) as well as estimate the number of untagged hatchery fish that were reared in the Merced, Mokelumne, Nimbus (American River), and Feather river hatcheries and returned to the Tuolumne River as adults (Table 3). Expanding the number of CWT fish is a relatively simple computation based on the number of hatchery fish, which are identified with an adipose fin clip, that are observed during the escapement survey, the number of salmon examined for tags, and the total number of salmon in the escapement. These data are considered to be relatively accurate for the lower Tuolumne River. Expanding the number of unmarked fish assumes that the unmarked fish return to the Tuolumne River at the same rate that the marked fish return to the Tuolumne River.

Based on the CWT recoveries in the Tuolumne River, most of the unmarked fish originate from planting juvenile fish in the San Francisco Bay from the Mokelumne, Nimbus, and Feather River hatcheries, in the Delta from the Mokelumne River Hatchery, and in the Merced River from the Merced River Hatchery.

The number of unmarked fish released from each hatchery was obtained from the CDFG annual reports for the Feather, Nimbus, Mokelumne, and Merced hatcheries. Some of the Merced hatchery release data was obtained from planting release records. Expansions of the unmarked hatchery fish were based on the CWT return rates segregated by release location (e.g., river, Delta, or Bay) and whether releases were spring sub-yearling fish or fall yearlings. The expansions for Merced River, Mokelumne River, and Delta releases were also segregated into wet (San Joaquin Index > 3.1 million acre-feet) and dry year conditions (San Joaquin Index $\leq$ 3.1 million acre-feet); water year type did not substantially affect the return rates for juveniles planted in the Bay. The analyses were conducted using Microsoft Excel spreadsheets and data were sorted into the various release categories (e.g., River, Delta, and Bay) using pivot tables. The escapement of naturally produced salmon was computed by subtracting the estimated number of marked and unmarked hatchery fish that returned to the Tuolumne River from the CDFG escapement estimate.

Preliminary Results

Figure 1. The number of natural adult recruits relative to the average flow release from La Grange Dam from February 1 through June 15 when the cohorts migrated as juveniles toward the ocean from 1996 to 2004. The polynomial equation and the R^2 value computed by Excel are presented for the relationship.

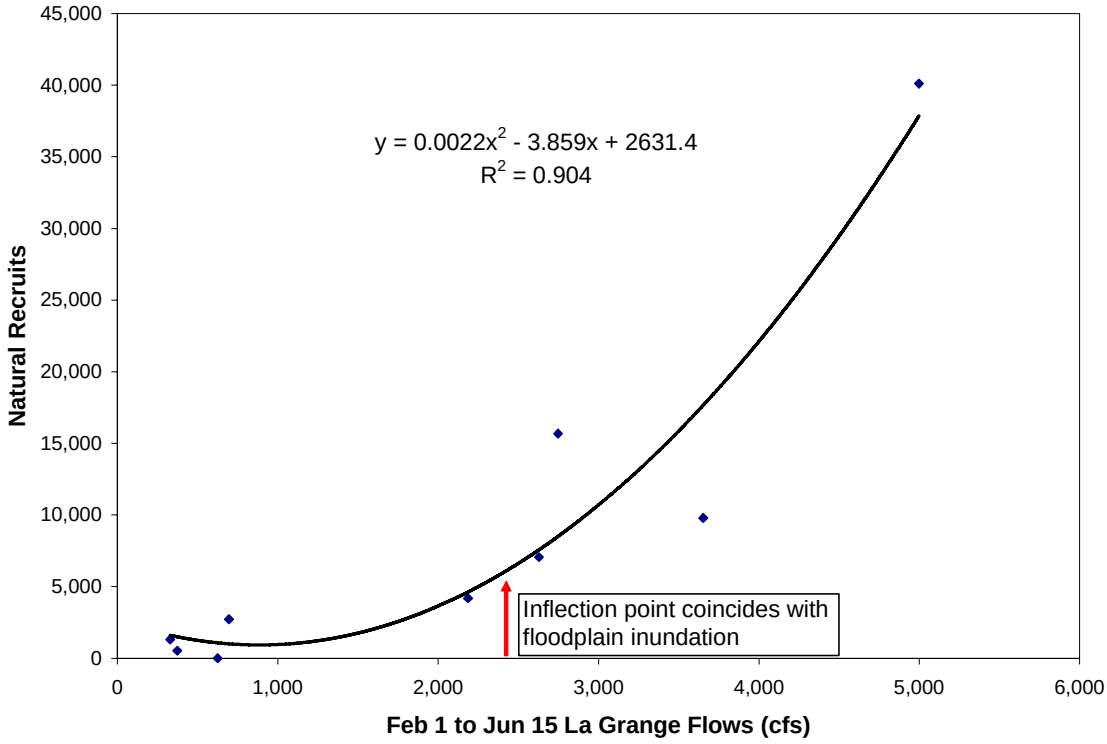

Figure 2. Tuolumne River natural fall-run Chinook salmon recruitment plotted with mean flow in the Tuolumne River at La Grange during February 1 through June 15 during two periods: 1980 to 1990 and from 1997 to 2003. Estimates were excluded when spawner abundance was less than 650 Age 3 equivalent fish to minimize the effect of spawner abundance on the relationship between flow and recruitment. An *F* test comparing the two data sets indicate that the elevations of the two regressions are significantly different ($P = 0.011$). The variance terms of the two data sets were not statistically different ($P = 0.301$), which is a condition required to compare the slopes and elevations of the two regressions, and the slopes were not significantly different ($P = 0.056$) (Snedecor and Cochran 1989, pages 390-393).

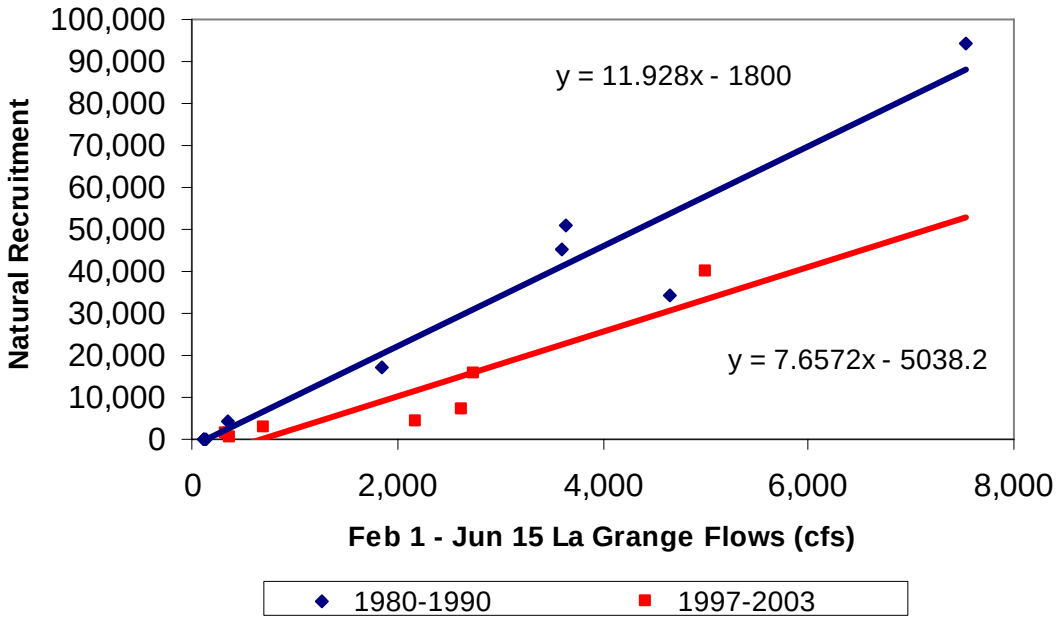

Table 1. The Department of Fish and Game estimated escapement of fall-run Chinook Salmon in the Tuolumne River (GrandTab), the estimated total number of marked (coded-wire tag and adipose clipped) adults that returned to the Tuolumne River, the estimated number of unmarked hatchery adults from the Mokelumne, Nimbus, Feather, and Merced river hatcheries that returned to the Tuolumne River, the estimated escapement of naturally produced adults, the escapement of hatchery produced adults, and the percent hatchery fish in the escapement from 1978 to 2007. The estimates of unmarked adults are based on bay releases from the Nimbus and Feather River hatchery, Delta and Bay releases from the Mokelumne Hatchery, and Merced River releases from the Merced River Hatchery. The estimates of natural escapement were truncated at zero. The estimates of natural escapement for 2006 and 2007 assume that the average number of out-of-basin hatchery strays that returned to the Tuolumne River between 1996 and 2005, which is 570 fish, also returned in 2006 and 2007.

			Unmarked Adults						
	Total Escapement	Marked Hatchery Fish	Mokelumne Hatchery	Nimbus Hatchery	Feather River Hatchery	Merced River Hatchery	Estimated Natural Escapement	Estimated Hatchery Escapement	Percent Hatchery
1981	14,253	0	57	1	80	9	14,106	147	1.0%
1982	7,126	30	94	22	83	0	6,897	229	3.2%
1983	14,836	430	82	60	143	0	14,121	715	4.8%
1984	13,689	31	91	69	187	0	13,312	377	2.8%
1985	40,322	208	105	66	195	0	39,747	575	1.4%
1986	7,404	143	75	68	247	1	6,871	533	7.2%
1987	14,751	1,619	74	71	372	43	12,571	2,180	14.8%
1988	5,779	270	104	75	406	105	4,819	960	16.6%
1989	1,275	175	133	71	430	59	407	868	68.1%
1990	96	98	160	68	410	5	0	741	100%
1991	77	20	188	69	332	5	0	613	100%
1992	132	23	173	65	277	4	0	542	100%
1993	471	118	161	59	229	3	0	569	100%
1994	506	107	199	57	432	1	0	797	100%

			Unmarked Adults						
	Total Escapement	Marked Hatchery Fish	Mokelumne Hatchery	Nimbus Hatchery	Feather River Hatchery	Merced River Hatchery	Estimated Natural Escapement	Estimated Hatchery Escapement	Percent Hatchery
1995	827	142	185	53	622	0	0	1,002	100%
1996	4,362	881	104	61	601	18	2,696	1,666	38.2%
1997	7,146	1,321	52	68	496	45	5,165	1,981	27.7%
1998	8,910	1,405	85	65	392	23	6,940	1,970	22.1%
1999	8,232	1,043	112	63	333	31	6,650	1,582	19.2%
2000	17,873	1,291	107	66	270	81	16,059	1,814	10.1%
2001	8,782	1,559	130	68	277	62	6,686	2,096	23.9%
2002	7,173	2,650	159	52	278	40	3,994	3,179	44.3%
2003	2,163	490	185	31	231	30	1,197	966	44.7%
2004	1,984	473	192	49	243	23	1,004	980	49.4%
2005	500	142	204	53	295	21	0	716	100%
2006	500	?	?	?	?	?	0	?	100%
2007	115	?	?	?	?	?	0	?	100%

Table 2. The number of coded-wire-tagged hatchery fish produced in the Feather River, Nimbus (American River), Mokelumne River, and Merced River hatcheries that returned to the Tuolumne River as adults from 1980 to 2005. The estimated number of returns to the Tuolumne River in Table 2 are included in the column "Marked Hatchery Fish" in Table 1.

Tagged Feather River Releases in San Francisco Bay					
Release Date	Cwt Number	Number Of Tagged Fish Releases	Number Of Untagged Fish Released	Release Location	Estimated Number Of Adult Returns To The Tuolumne River
06/05/1978	066203	164,766	18,183	Port Chicago	0
08/22/1978	065813	97,000	5,820	Port Chicago	3.02
06/10/1980	066209	88,700	4,375	Port Chicago	0
06/13/1980	066212	79,443	2,457	Port Chicago	0
08/14/1980	065817	77,700	15,538	Benicia	51.30
06/08/1981	066215	78,339	5,536	Port Chicago	91.55
06/09/1981	065821	41,917	4,354	Tiburon Net Pens	0
08/10/1985	065860	23,307	2,335	Emeryville Minor Pt	0
06/29/1988	063104	54,151	657	Port Chicago	0
05/04/1994	062517	102,991	1,467	Benicia	2.02
05/04/1994	062517	102,991	1,467	Benicia	3.73
05/31/1994	062518	101,125	5,455	Benicia	0
05/31/1994	063146	51,804	1,608	Benicia	0
07/18/1994	063805	98,795	4,010	Benicia	4.27
07/18/1994	063806	99,394	3,286	Benicia	3.80
06/30/1995	062531	55,498	845	Crockett	0
06/14/1996	062935	56,900	1,669	Monterey	0
06/16/1996	062933	139,443	13,559	Rodeo Minor Port	0
06/26/1996	062937	150,089	4,802	Rodeo Minor Port	0
06/26/1996	062938	149,440	6,232	Rodeo Minor Port	0
04/24/1997	062542	52,597	909	Feather River	0
05/05/1997	0601060215	24,766	3,764	Port Chicago	0
06/07/1999	062631	50,877	1,038	Wickland Oil	0
06/07/1999	062633	51,964	1,060	Wickland Oil	0
06/07/1999	062636	50,932	1,039	Wickland Oil	0
06/07/1999	062637	49,140	1,003	Wickland Oil	0
06/11/1999	062638	50,827	1,037	Wickland Oil	0
06/20/2000	062658	294,362	7,238	Wickland Oil	0
03/27/2001	062674	46,052	2,732	Rodeo Minor Port	0
03/27/2001	062676	44,021	3,010	Wickland Oil	0
03/27/2001	062678	46,052	2,732	Rodeo Minor Port	0
03/29/2001	062666	42,003	2,872	Wickland Oil	0
03/29/2001	062670	46,642	3,189	Wickland Oil	0

Tagged Feather River Releases in San Francisco Bay					
Release Date	Cwt Number	Number Of Tagged Fish Releases	Number Of Untagged Fish Released	Release Location	Estimated Number Of Adult Returns To The Tuolumne River
03/29/2001	062672	47,369	3,239	Wickland Oil	0
03/29/2001	062673	42,704	2,920	Wickland Oil	3.95
03/29/2001	062673	46,642	3,189	Wickland Oil	4.27
03/29/2001	062674	47,369	3,239	Wickland Oil	0
03/29/2001	062675	42,704	2,920	Wickland Oil	8.54
04/15/2001	062091	202,096	719,407	Wickland Oil	16.86
04/15/2001	062664	202,096	719,407	Wickland Oil	145.77
04/23/2001	062663	142,204	719,713	Wickland Oil	0
04/23/2001	062665	142,204	719,713	Wickland Oil	24.22
04/23/2001	062665	142,204	719,713	Wickland Oil	68.98
05/01/2001	062665	31,384	2,146	Wickland Oil	3.95
05/01/2001	062669	32,082	2,194	Wickland Oil	0
05/01/2001	062670	31,384	2,146	Wickland Oil	0
04/10/2002	060290	263,768	227,882	Wickland Oil	7.07
04/10/2002	060401	263,768	227,882	Wickland Oil	0
04/10/2002	060402	264,738	228,012	Wickland Oil	6.88
04/12/2002	062722	105,753	3,896	Wickland Oil	3.83
04/12/2002	062737	107,348	3,853	Wickland Oil	0
06/09/2003	062773	55,625	1,426	Crockett	0
06/09/2003	062774	53,377	1,369	Crockett	0

Tagged Nimbus Hatchery Releases in San Francisco Bay					
Release Date	Cwt Number	Number Of Tagged Fish Releases	Number Of Untagged Fish Released	Release Location	Estimated Number Of Adult Returns To The Tuolumne River
07/15/1986	065405	48,920	5,800	Berkeley Marina	0
07/16/1986	065406	53,072	70,528	Benicia	4.75
07/09/1987	065407	51,891	524	Berkeley Marina	0
06/20/1988	065411	36,325	220,389	Benicia	0
06/13/1989	065413	41,125	198,867	Benicia	0
06/14/1989	065414	49,848	220,365	Benicia	0
06/16/1989	065415	48,207	241,210	Benicia	26.20
06/21/1989	065412	49,400	283,181	Benicia	0
05/23/2001	065455	98,171	1,227,785	Wickland Oil	51.24
05/23/2001	065456	99,528	285,184	Wickland Oil	0
05/23/2001	065457	99,102	285,992	Wickland Oil	0
05/23/2001	065458	99,297	322,984	Wickland Oil	0
05/23/2001	065459	99,439	322,984	Wickland Oil	16.98

Tagged Nimbus Hatchery Releases in San Francisco Bay					
Release Date	Cwt Number	Number Of Tagged Fish Releases	Number Of Untagged Fish Released	Release Location	Estimated Number Of Adult Returns To The Tuolumne River
05/23/2001	065460	96,371	1,088,938	Wickland Oil	0
06/18/2002	062664	238,195	35,749	Wickland Oil	8.50
06/18/2002	062666	238,195	35,749	Wickland Oil	0
06/18/2002	062667	237,231	36,608	Wickland Oil	0
06/18/2002	062668	237,231	36,608	Wickland Oil	0
06/18/2002	062668	238,193	35,751	Wickland Oil	4.36

Tagged Mokelumne Hatchery Releases in San Joaquin Delta					
Release Date	Cwt Number	Number Of Tagged Fish Releases	Number Of Untagged Fish Released	Release Location	Estimated Number Of Adult Returns To The Tuolumne River
10/01/1976	060205	25,059	511	Brannan Island	0
02/01/1977	060206	26,912	1,995	Brannan Island	0
09/28/1977	064807	32,915	3,985	Brannan Island	0
10/01/1979	064812	43,370	0	Rio Vista	0
05/10/1994	064803	53,606	487	Thornton	0
05/10/1994	064804	49,864	352	Thornton	0
05/23/1994	064801	51,314	414	Thornton	4.14
05/23/1994	064801	51,314	414	Thornton	6.82
05/23/1994	064802	51,518	415	Thornton	0
04/18/1995	060211	48,345	4,898	Thornton	0
04/18/1995	060212	49,531	5,019	Thornton	4.52
04/25/1995	060213	49,837	4,511	Thornton	0
04/25/1995	060214	49,625	4,492	Thornton	0
05/15/1995	060210	51,757	719,462	Thornton	0
05/15/1996	060216	49,946	3,415	Thornton	0
05/15/1996	060217	52,123	1,282	Thornton	0
05/20/1996	060218	50,832	1,898	Jersey Point	4.26
05/20/1996	060218	50,832	1,898	Jersey Point	7.19
05/20/1996	060218	50,832	1,898	Jersey Point	0
05/20/1996	060219	52,389	636	Jersey Point	8.31
04/30/1997	064912	52,022	0	Jersey Point	0
04/30/1997	064913	51,978	130	Jersey Point	0
04/28/1998	060234	51,227	1,046	Jersey Point	0
04/28/1998	060235	52,127	1,065	Jersey Point	0
05/21/1999	054115	49,740	860	Sherman Island	0
05/21/1999	060247	51,366	2,140	Sherman Island	4.16
05/21/1999	060248	49,740	860	Sherman Island	4.07
05/21/1999	064920	25,162	514	Sherman Island	8.16

Tagged Mokelumne Hatchery Releases in San Joaquin Delta					
Release Date	Cwt Number	Number Of Tagged Fish Releases	Number Of Untagged Fish Released	Release Location	Estimated Number Of Adult Returns To The Tuolumne River
05/21/1999	064921	25,200	514	Sherman Island	0
05/21/1999	064922	25,121	513	Sherman Island	4.08
05/21/1999	064923	25,579	522	Sherman Island	4.08
05/01/2000	055113	50,445	1,560	Sherman Island	0
05/01/2000	060248	51,167	867	Sherman Island	0
05/01/2000	060253	50,445	1,560	Sherman Island	20.60
05/01/2000	060254	51,167	867	Sherman Island	16.26
04/24/2001	060268	51,207	206	Jersey Point	11.14
04/24/2001	060269	51,746	0	Jersey Point	3.70
04/24/2001	060270	51,207	206	Jersey Point	4.01
04/24/2001	060271	51,746	0	Jersey Point	3.79
04/24/2001	060271	51,746	0	Jersey Point	19.98
04/26/2001	062675	25,384	128	West Sacramento	3.72
04/26/2001	062677	25,872	130	West Sacramento	0
04/26/2001	062716	25,384	128	West Sacramento	0
04/26/2001	062717	25,872	130	West Sacramento	4.02
05/09/2001	062708	25,201	1,009	West Sacramento	0
05/09/2001	062709	24,527	982	West Sacramento	0
04/09/2002	062716	25,661	259	Jersey Point	0
04/09/2002	062717	25,600	0	Jersey Point	0
04/09/2002	062722	25,661	259	Jersey Point	0
04/09/2002	062723	25,600	0	Jersey Point	18.97
04/23/2002	064453	25,500	0	Jersey Point	11.38
04/23/2002	065459	25,245	255	Jersey Point	0
04/23/2002	065863	25,245	255	Jersey Point	15.33
10/07/2002	064930	25,981	0	Sherman Island	7.59
10/08/2002	060277	50,387	253	Beaver Slough,	0
10/15/2002	064931	25,811	261	Sherman Island	3.83
10/23/2002	064928	25,240	127	Sherman Island	15.25
10/30/2002	064929	25,912	130	Sherman Island	11.44

Tagged Mokelumne Hatchery Releases in the San Francisco Bay					
Release Date	Cwt Number	Number Of Tagged Fish Releases	Number Of Untagged Fish Released	Release Location	Estimated Number Of Adult Returns To The Tuolumne River
04/12/1995	060208	49,769	1,912	Crockett	3.60
05/22/1995	060208	49,769	1,912	Crockett	0
06/06/1996	060229	52,704	745,388	Rodeo Minor Port	0
06/02/1997	060230	50,235	948,965	Rodeo Minor Port	0

Tagged Mokelumne Hatchery Releases in the San Francisco Bay					
Release Date	Cwt Number	Number Of Tagged Fish Releases	Number Of Untagged Fish Released	Release Location	Estimated Number Of Adult Returns To The Tuolumne River
06/12/1998	060240	51,059	352,416	Carquinez Strait	65.33
06/12/1998	060241	51,427	352,426	Carquinez Strait	64.92
06/15/1999	060215	95,203	782,097	Crockett	0
05/08/2000	060250	51,389	437,894	Wickland Oil	76.10
05/08/2000	060251	51,765	438,256	Wickland Oil	75.66
04/27/2001	062706	25,550	128	Benicia	0

Tagged Merced Hatchery Releases in the Merced River					
Release Date	Cwt Number	Number Of Tagged Fish Releases	Number Of Untagged Fish Released	Release Location	Estimated Number Of Adult Returns To The Tuolumne River
10/01/1978	064610	49,498	1,113	MRH	0
09/26/1979	064611	16,059	874	Gallo	0
10/15/1981	064612	40,760	15,445	Gallo	0
04/22/1982	064617	49,217	2,590	Gallo	0
11/10/1982	064626	23,804	36,756	MRH	0
11/10/1982	064627	23,804	25,636	MRH	0
10/01/1983	064629	41,143	8,857	MRH	0
10/19/1984	064638	49,649	1,273	Gallo	0
10/17/1985	064644	35,535	33,660	Gallo	0
11/10/1982	0601110101	25,357	72,217	Merced River	0
11/10/1982	0601110102	25,276	1,786	Merced River	0
11/14/1991	064512	29,653	1,681	MRH	0
11/14/1991	064513	29,653	1,681	MRH	0
11/14/1991	064514	29,653	1,681	MRH	0
03/04/1992	064515	22,815	12,210	Merced River	9.59
02/18/1993	064651	14,946	1,850	MRH	2.24
02/18/1993	064651	14,946	1,850	MRH	3.13
02/18/1993	064651	14,946	1,850	MRH	35.10
11/05/1993	064517	35,064	283	MRH	2.01
11/05/1993	064518	13,145	106	MRH	3.71
11/05/1993	064620	521	4	MRH	0
11/05/1993	064621	2,364	19	MRH	0
11/12/1993	064516	32,891	265	MRH	0
11/12/1993	064517	35,064	283	MRH	0
04/22/1994	0601020112	48,943	2,576	MRH	0
04/22/1994	0601110210	24,946	252	MRH	3.72
04/22/1994	0601110210	24,946	252	MRH	6.84
04/22/1994	0601110211	24,946	252	MRH	3.72
04/22/1994	0601110212	24,946	252	MRH	0
04/22/1994	0601110213	24,946	252	MRH	3.72
04/22/1994	0601110214	24,349	701	Merced River	0
04/22/1994	0601110215	27,349	701	Merced River	0

Tagged Merced Hatchery Releases in the Merced River					
Release Date	Cwt Number	Number Of Tagged Fish Releases	Number Of Untagged Fish Released	Release Location	Estimated Number Of Adult Returns To The Tuolumne River
	0601110301	27,349	701	Merced River	0
11/17/1994	0601020112	48,943	2,576	MRH	7.12
11/17/1994	0601020112	48,943	2,576	MRH	7.74
11/17/1994	064624	10,021	528	MRH	7.74
11/17/1994	064625	8,904	469	MRH	2.10
11/28/1994	0601020111	48,889	5,241	Merced River	0
11/28/1994	064516	32,891	265	MRH	2.01
11/28/1994	064622	7,600	458	Merced River	0
11/28/1994	064623	7,586	458	Merced River	0
05/03/1995	0601110401	28,349	579	MRH	3.75
05/03/1995	0601110401	28,349	579	MRH	62.15
05/03/1995	0601110402	27,961	571	MRH	7.51
05/03/1995	0601110402	27,961	571	MRH	27.62
05/03/1995	0601110403	26,839	548	MRH	6.91
05/03/1995	0601110404	28,141	574	MRH	4.19
05/03/1995	0601110404	28,141	574	MRH	7.51
05/03/1995	0601110404	28,141	574	MRH	20.72
05/04/1995	0601110402	27,961	571	MRH	0
05/04/1995	0601110405	27,317	1,066	Merced River	4.27
05/04/1995	0601110405	27,317	1,066	Merced River	15.29
05/04/1995	0601110405	27,317	1,066	Merced River	42.19
05/04/1995	0601110406	27,642	1,079	Hatfield State Park	4.27
05/04/1995	0601110406	27,642	1,079	Hatfield State Park	15.29
05/04/1995	0601110406	27,642	1,079	Hatfield State Park	42.19
05/04/1995	0601110407	28,052	1,095	Hatfield State Park	15.29
05/04/1995	0601110407	28,052	1,095	Hatfield State Park	49.22
04/25/1996	0601110410	22,637	4,902	MRH	0
04/25/1996	0601110411	21,691	1,698	MRH	0
04/26/1996	0601110504	22,018	4,768	Merced River	0
04/26/199	0601110505	20,613	4,464	Merced River	0
04/20/1997	0601110511	26,045	3,131	MRH	0
04/20/1997	0601110512	27,683	3,316	MRH	0
04/20/1997	0601110513	31,930	3,828	MRH	0
04/20/1997	0601110514	24,880	2,969	MRH	0
04/22/1997	0601110515	24,398	5,495	Hatfield State Park	0
04/22/1997	0601110601	29,011	6,547	Hatfield State Park	0
04/22/1997	0601110602	25,761	5,817	Hatfield State Park	0
04/22/1997	0601110603	25,317	5,705	Hatfield State Park	0
05/14/1997	0601110614	33,064	4,511	MRH	0
05/14/1997	0601110615	28,294	3,861	Hatfield State Park	0
05/14/1997	0601110702	5,856	796	Hatfield State Park	0
04/12/1998	062520	27,973	1,664	MRH	3.67
04/12/1998	064523	35,800	2,129	MRH	3.67
04/12/1998	064524	36,289	2,158	MRH	17.52

Tagged Merced Hatchery Releases in the Merced River					
Release Date	Cwt Number	Number Of Tagged Fish Releases	Number Of Untagged Fish Released	Release Location	Estimated Number Of Adult Returns To The Tuolumne River
04/14/1998	062521	34,805	5,872	Hatfield State Park	5.68
04/14/1998	062521	34,805	5,872	Hatfield State Park	8.10
04/14/1998	062522	30,857	5,206	Hatfield State Park	8.10
04/14/1998	062522	30,857	5,206	Hatfield State Park	38.65
04/14/1998	062523	8,447	1,425	Hatfield State Park	0
05/03/1998	0601110709	28,248	257	MRH	16.68
05/03/1998	0601110710	25,482	232	MRH	9.80
05/03/1998	0601110711	25,220	230	MRH	7.00
05/03/1998	0601110711	25,220	230	MRH	9.80
05/03/1998	0601110712	25,046	228	MRH	0
05/04/1998	0601110710	25,482	232	MRH	25.03
05/04/1998	0601110711	25,220	230	MRH	0
05/05/1998	0601110502	49,873	866	Hatfield State Park	4.94
05/05/1998	0601110502	49,873	866	Hatfield State Park	33.64
05/05/1998	0601110713	25,314	439	Hatfield State Park	4.94
05/05/1998	0601110713	25,314	439	Hatfield State Park	7.05
05/05/1998	0601110713	25,314	439	Hatfield State Park	33.64
05/05/1998	0601110801	25,923	1,198	MRH	0
05/05/1998	0601110802	23,868	1,103	MRH	0
04/14/1999	064528	25,462	628	MRH	0
04/14/1999	064529	25,445	628	MRH	0
04/14/1999	064530	25,221	622	MRH	0
04/16/1999	064531	24,123	1,493	Hatfield State Park	25.79
04/16/1999	064532	24,640	1,525	Hatfield State Park	4.24
04/16/1999	064532	24,640	1,525	Hatfield State Park	5.16
05/05/1999	0601110714	24,075	1,112	MRH	0
05/05/1999	0601110801	25,923	1,198	MRH	0
05/05/1999	0601110802	23,868	1,103	MRH	0
05/05/1999	0601110803	23,936	1,106	MRH	4.18
05/07/1999	064534	24,337	2,390	Hatfield State Park	0
05/07/1999	064535	23,215	2,281	Hatfield State Park	5.33
05/07/1999	064536	23,436	2,302	Hatfield State Park	0
04/12/2000	064487	25,507	869	Snelling	0
04/12/2000	064488	25,318	862	Snelling	0
04/12/2000	064539	25,313	862	Snelling	0
04/12/2000	064540	25,395	865	Snelling	0
04/12/2000	064541	24,490	1,369	Hatfield State Park	0
04/12/2000	064542	24,432	1,366	Hatfield State Park	0
04/12/2000	064543	24,525	1,371	Hatfield State Park	0
04/12/2000	064544	24,490	1,369	Hatfield State Park	0
04/12/2000	064545	24,432	1,366	Hatfield State Park	0
04/27/2000	064552	26,189	0	Hatfield State Park	0
04/27/2000	064553	25,794	0	Hatfield State Park	11.99
04/27/2000	064554	26,189	0	Hatfield State Park	0

Tagged Merced Hatchery Releases in the Merced River					
Release Date	Cwt Number	Number Of Tagged Fish Releases	Number Of Untagged Fish Released	Release Location	Estimated Number Of Adult Returns To The Tuolumne River
	064555	25,444	0	Hatfield State Park	4.00
04/28/2000	064549	25,794	0	Hatfield State Park	0
04/21/2001	064412	25,029	908	MRH	3.83
04/21/2001	064414	24,077	873	MRH	7.66
04/21/2001	064415	24,342	883	MRH	0
04/21/2001	064416	24,034	872	MRH	3.83
04/21/2001	064417	24,342	883	MRH	0
04/21/2001	064418	24,034	872	MRH	0
04/23/2001	064419	24,925	483	Hatfield State Park	0
04/26/2001	064417	24,925	483	Hatfield State Park	0
04/26/2001	064418	24,958	483	Hatfield State Park	0
04/26/2001	064419	24,885	482	Hatfield State Park	0
04/26/2001	064420	24,958	483	Hatfield State Park	0
04/26/2001	064421	24,885	482	Hatfield State Park	0
05/08/2001	064420	24,722	479	MRH	0
05/08/2001	064421	24,121	467	MRH	0
05/08/2001	064422	24,722	479	MRH	0
05/08/2001	064424	25,972	503	MRH	0
05/10/2001	052418	24,401	1,017	Merced River	7.70
05/11/2001	064423	23,038	2,195	Hatfield State Park	0
05/11/2001	064424	23,227	2,213	Hatfield State Park	0
05/11/2001	064426	23,428	164,233	MRH	0
05/11/2001	064427	23,227	2,213	Hatfield State Park	0
05/11/2001	064428	23,428	164,233	MRH	0
04/03/2002	064443	24,380	1,065	Hatfield State Park	19.29
04/03/2002	064444	24,228	1,059	Hatfield State Park	19.30
04/03/2002	064451	24,380	1,065	Hatfield State Park	0
04/03/2002	064548	24,890	1,087	Hatfield State Park	0
04/05/2002	064544	24,890	1,087	Hatfield State Park	0
04/21/2002	064484	23,140	2,449	MRH	0
04/21/2002	064485	22,183	2,347	MRH	0
04/26/2002	064480	23,363	2,010	Hatfield State Park	0
04/26/2002	064481	23,639	2,033	Hatfield State Park	0
04/26/2002	064486	23,349	2,009	Hatfield State Park	0
04/26/2002	064487	23,363	2,010	Hatfield State Park	0
04/26/2002	064488	23,639	2,033	Hatfield State Park	0
04/13/2003	064489	22,677	3,389	MRH	0
04/13/2003	064490	22,817	3,409	MRH	0
04/13/2003	064491	22,945	3,429	MRH	0
04/13/2003	064492	21,725	3,246	MRH	0
04/16/2003	064493	23,274	1,883	Hatfield State Park	3.07
04/16/2003	064493	23,274	1,883	Hatfield State Park	4.10
04/16/2003	064494	23,872	1,932	Hatfield State Park	0
04/16/2003	064495	23,833	1,929	Hatfield State Park	0

Tagged Merced Hatchery Releases in the Merced River					
Release Date	Cwt Number	Number Of Tagged Fish Releases	Number Of Untagged Fish Released	Release Location	Estimated Number Of Adult Returns To The Tuolumne River
04/25/2003	064496	24,231	1,539	MRH	0
04/25/2003	064498	23,758	1,508	MRH	0
04/29/2003	064564	24,544	1,023	Hatfield State Park	0
04/29/2003	064565	24,484	1,020	Hatfield State Park	0
04/29/2003	064566	24,358	1,015	Hatfield State Park	2.96
04/29/2003	064566	24,358	1,015	Hatfield State Park	3.95
05/04/2003	062777	23,591	1,892	MRH	0
05/04/2003	062778	23,862	1,914	MRH	0
05/04/2003	064449	23,512	1,886	MRH	0
05/04/2003	064450	24,330	1,952	MRH	0
05/07/2003	064546	22,605	2,937	Hatfield State Park	0
05/07/2003	064547	22,715	2,952	Hatfield State Park	0
05/07/2003	064572	22,650	2,943	Hatfield State Park	0
04/20/2004	064595	23,038	2,588	Hatfield State Park	0
04/28/2004	064667	25,306	649	Hatfield State Park	0
05/09/2004	064669	24,418	755	MRH	0
05/12/2004	064599	24,769	900	Hatfield State Park	0

Table 3. The number of unmarked hatchery juveniles produced in the Feather and Nimbus hatcheries that were released in the San Francisco Bay, Mokelumne hatchery that were released in the San Joaquin Delta and San Francisco Bay, and Merced hatchery that were released in the Merced River from 1978 to 2004. The estimated total numbers of adult returns to the Tuolumne River from these unmarked releases are presented in the columns identified as "Unmarked Adults" in Table 1.

Untagged Feather River Hatchery Releases in the San Francisco Bay. Mean Return Rate to the Tuolumne River = 0.00540%			
Release Date	Release Location	Number Released	Estimated Number Of Adult Returns To The Tuolumne River
06/01/1978	Tiburon Net Pens	150,500	8.1
07/01/1979	Bodega Bay	12,040	0.6
08/01/1979	Tiburon Net Pens	35,950	1.9
07/01/1980	Carquinez Strait	42,000	2.3
05/01/1981	Benicia	793,981	42.8
06/01/1981	Benicia	282,300	15.2
06/01/1981	Benicia	1,057,300	57.1
07/01/1981	Benicia	814600	44.0
08/01/1981	Benicia	343,850	18.6
09/01/1981	Benicia	190,510	10.3
04/01/1982	Benicia	860,900	46.5
05/01/1982	Benicia	110,220	5.9
05/01/1982	Benicia	498,930	26.9

Untagged Feather River Hatchery Releases in the San Francisco Bay. Mean Return Rate to the Tuolumne River = 0.00540%			
Release Date	Release Location	Number Released	Estimated Number Of Adult Returns To The Tuolumne River
06/01/1982	Benicia	1,220,200	65.8
07/01/1982	Benicia	173,600	9.4
08/01/1982	Benicia	256,425	13.8
09/01/1982	Benicia	9,600	0.5
09/01/1982	Benicia	24,700	1.3
02/01/1983	Feather River	2,558,400	138.1
06/01/1983	Benicia	743,200	40.1
07/01/1983	Benicia	599,700	32.4
07/01/1983	Tiburon Net Pens	49,300	2.7
07/01/1983	Vallejo	48,600	2.6
08/01/1983	Tiburon Net Pens	48,000	2.6
08/01/1983	Vallejo	44,800	2.4
09/01/1983	Vallejo	42,700	2.3
10/01/1983	Tiburon Net Pens	21,000	1.1
10/01/1983	Tiburon Net Pens	23,200	1.3
06/01/1984	Benicia	63,000	3.4
06/01/1984	Vallejo	42,750	2.3
06/01/1984	Port Chicago	44,100	2.4
07/01/1984	Benicia	634,550	34.2
08/01/1984	Berkeley Marina	230,200	12.4
08/01/1984	Benicia	1,051,175	56.7
09/01/1984	Berkeley Marina	100,200	5.4
09/01/1984	Benicia	476,650	25.7
01/01/1985	Feather River	182,400	9.8
04/01/1985	Benicia	943,050	50.9
05/01/1985	Feather River	22,000	1.2
05/01/1985	Benicia	465,500	25.1
05/01/1985	Benicia	479,077	25.9
05/01/1985	Port Chicago	53,100	2.9
05/01/1985	Berkeley Marina	52,700	2.8
06/01/1985	Tiburon Net Pens	28,500	1.5
06/01/1985	Benicia	465,500	25.1
07/01/1985	Benicia	2,412,575	130.2
08/01/1985	Benicia	2,190,825	118.2
09/01/1985	Benicia	1,718,380	92.7
10/01/1985	Benicia	112,800	6.1
04/01/1986	Feather River	14,400	0.8
05/01/1986	Feather River	8,400	0.5
05/01/1986	Benicia	573,750	31.0
06/01/1986	Benicia	313,200	16.9
06/01/1986	Tiburon Net Pens	50,000	2.7
07/01/1986	Benicia	1,136,800	61.3
08/01/1986	San Francisco Bay	1,829,275	98.7
09/01/1986	San Francisco Bay	686,150	37.0

Untagged Feather River Hatchery Releases in the San Francisco Bay. Mean Return Rate to the Tuolumne River = 0.00540%			
Release Date	Release Location	Number Released	Estimated Number Of Adult Returns To The Tuolumne River
10/01/1986	Feather River	1,451,450	78.3
04/01/1987	Benicia	821,300	44.3
05/01/1987	Benicia	926,500	50.0
06/01/1987	Benicia	2,382,800	128.6
07/01/1987	Benicia	2,477,075	133.7
08/01/1987	Benicia	1,860,400	100.4
09/01/1987	Benicia	435,850	23.5
03/01/1988	Benicia	129,200	7.0
04/01/1988	Benicia	827,600	44.7
05/01/1988	Benicia	704,850	38.0
06/01/1988	Tiburon Net Pens	50,050	2.7
06/01/1988	Benicia	1,525,450	82.3
07/01/1988	Benicia	2,701,750	145.8
12/01/1988	Feather River	538,400	29.1
01/01/1989	Feather River	371,800	20.1
04/01/1989	Benicia	685,500	37.0
05/01/1989	Benicia	537,000	29.0
06/01/1989	Benicia	972,100	52.5
06/01/1989	Tiburon Net Pens	43,500	2.3
07/01/1989	Benicia	911,400	49.2
08/01/1989	Benicia	1,075,900	58.1
05/01/1990	Benicia	882,000	47.6
06/01/1990	Benicia	3,414,050	184.2
07/01/1990	Benicia	1,214,800	65.6
08/01/1990	Benicia	1,449,650	78.2
09/01/1990	Benicia	549,200	29.6
05/01/1991	Tiburon Net Pens	55,900	3.0
01/01/1992	Feather River	1,400,000	75.5
03/01/1992	Feather River	1,655,440	89.3
04/01/1992	Monterey	35,000	1.9
04/01/1992	Feather River	768,995	41.5
05/01/1992	Benicia	465,500	25.1
05/01/1992	Monterey	59,850	3.2
05/01/1992	Monterey	26,500	1.4
05/01/1992	Ventura	4,600	0.2
05/01/1992	Benicia	1,173,850	63.3
06/01/1992	Benicia	1,314,900	71.0
07/01/1992	Benicia	1,634,100	88.2
08/01/1992	Benicia	1,186,400	64.0
09/01/1992	Benicia	443,100	23.9
10/01/1992	Benicia	276,160	14.9
01/01/1993	Feather River	1,920,000	103.6
02/01/1993	Feather River	160,000	8.6
05/01/1993	Tiburon Net Pens	54,000	2.9

Untagged Feather River Hatchery Releases in the San Francisco Bay. Mean Return Rate to the Tuolumne River = 0.00540%			
Release Date	Release Location	Number Released	Estimated Number Of Adult Returns To The Tuolumne River
05/01/1993	Monterey	77,400	4.2
05/01/1993	Benicia	1,836,000	99.1
06/01/1993	Benicia	3,077,270	166.1
07/01/1993	Benicia	1,848,518	99.7
12/01/1993	Feather River	264,000	14.2
01/01/1994	Feather River	4,995,200	269.5
03/01/1994	Feather River	120,000	6.5
04/01/1994	Benicia	712,642	38.5
05/01/1994	Benicia	2,632,217	142.0
06/01/1994	Monterey	24,000	1.3
06/01/1994	Tiburon Net Pens	51,150	2.8
06/01/1994	Benicia	1,548,320	83.5
07/01/1994	Benicia	250,400	13.5
07/01/1994	Wickland Oil	518,300	28.0
07/01/1994	Unocal	627,000	33.8
01/01/1995	Feather River	674,786	36.4
02/01/1995	Feather River	3,142,258	169.6
03/01/1995	Feather River	219,200	11.8
03/01/1995	Feather River	750,075	40.5
04/01/1995	Benicia	269,152	14.5
05/01/1995	Unocal	103,400	5.6
05/01/1995	Benicia	396,952	21.4
05/01/1995	Wickland Oil	593,080	32.0
05/01/1995	Feather River	200,007	10.8
06/01/1995	Oceangraph Center	47,600	2.6
06/01/1995	Unocal	89,700	4.8
06/01/1995	Benicia	225,100	12.1
06/01/1995	Wickland Oil	907,432	49.0
07/01/1995	Wickland Oil	179,400	9.7
07/01/1995	Wickland Oil	1,365,575	73.7
01/01/1996	Feather River	156,000	8.4
03/01/1996	Feather River	652,000	35.2
04/01/1996	Wickland Oil	388,700	21.0
04/01/1996	Benicia	556,400	30.0
05/01/1996	Montezuma Slough	24,986	1.3
05/01/1996	Montezuma Slough	24,990	1.3
05/01/1996	Montezuma Slough	24,999	1.3
05/01/1996	Feather River	25,000	1.3
05/01/1996	Unocal	126,500	6.8
05/01/1996	Wickland Oil	527,850	28.5
05/01/1996	Benicia	545,100	29.4
06/01/1996	Wickland Oil	24,000	1.3
06/01/1996	Tiburon Net Pens	49,400	2.7
06/01/1996	Wickland Oil	179,200	9.7

Untagged Feather River Hatchery Releases in the San Francisco Bay. Mean Return Rate to the Tuolumne River = 0.00540%			
Release Date	Release Location	Number Released	Estimated Number Of Adult Returns To The Tuolumne River
07/01/1996	Wickland Oil	48,000	2.6
07/01/1996	Unocal	73,364	4.0
07/01/1996	Wickland Oil	96,000	5.2
07/01/1996	Wickland Oil	146,728	7.9
07/01/1996	Wickland Oil	147,200	7.9
07/01/1996	Wickland Oil	184,000	9.9
07/01/1996	Wickland Oil	202,400	10.9
07/01/1996	Wickland Oil	213,900	11.5
07/01/1996	Wickland Oil	282,900	15.3
07/01/1996	Wickland Oil	345,904	18.7
07/01/1996	Wickland Oil	460,000	24.8
07/01/1996	Wickland Oil	635,652	34.3
05/01/1997	Benicia	25,200	1.4
05/01/1997	Wickland Oil	36,830	2.0
05/01/1997	Tiburon Net Pens	52,650	2.8
05/01/1997	Monterey	58,000	3.1
06/01/1997	Wickland Oil	55,000	3.0
06/01/1997	Moss Landing	60,140	3.2
06/01/1997	Bennett's Marina	62,100	3.4
06/01/1997	Benicia	66,700	3.6
06/01/1997	Wickland Oil	67,500	3.6
06/01/1997	Port San Lucas	71,300	3.8
06/01/1997	Benicia	80,500	4.3
06/01/1997	Bennett's Marina	93,800	5.1
06/01/1997	Benicia	105,300	5.7
06/01/1997	Benicia	121,900	6.6
06/01/1997	Wickland Oil	131,100	7.1
06/01/1997	Bennett's Marina	135,700	7.3
06/01/1997	Wickland Oil	168,200	9.1
06/01/1997	Benicia	177,100	9.6
06/01/1997	Wickland Oil	210,600	11.4
06/01/1997	Wickland Oil	222,400	12.0
06/01/1997	Wickland Oil	239,200	12.9
06/01/1997	Wickland Oil	393,600	21.2
06/01/1997	Wickland Oil	487,600	26.3
06/01/1997	Wickland Oil	542,800	29.3
07/01/1997	Wickland Oil	55,200	3.0
07/01/1997	Bennett's Marina	78,200	4.2
07/01/1997	Wickland Oil	115,000	6.2
07/01/1997	Wickland Oil	156,400	8.4
07/01/1997	Wickland Oil	188,600	10.2
07/01/1997	Bennett's Marina	218,400	11.8
07/01/1997	Wickland Oil	297,250	16.0
07/01/1997	Wickland Oil	326,600	17.6

Untagged Feather River Hatchery Releases in the San Francisco Bay. Mean Return Rate to the Tuolumne River = 0.00540%			
Release Date	Release Location	Number Released	Estimated Number Of Adult Returns To The Tuolumne River
07/01/1997	Wickland Oil	345,000	18.6
07/01/1997	Wickland Oil	384,100	20.7
07/01/1997	Wickland Oil	407,100	22.0
07/01/1997	Wickland Oil	806,400	43.5
07/01/1997	Wickland Oil	95,800	5.2
05/01/1998	Wickland Oil	2,392,200	129.1
06/01/1998	Wickland Oil	388,800	21.0
06/01/1998	Wickland Oil	411,700	22.2
06/01/1998	Wickland Oil	443,400	23.9
05/01/1999	San Francisco Bay	791,670	42.7
06/01/1999	San Francisco Bay	845,725	45.6
06/01/1999	San Francisco Bay	1,780,858	96.1
06/01/1999	San Francisco Bay	2,307,282	124.5
05/01/2000	Monterey	182,850	9.9
05/01/2000	San Francisco Bay	478,180	25.8
05/01/2000	San Francisco Bay	959,850	51.8
05/01/2000	San Francisco Bay	1,971,010	106.4
06/01/2000	San Francisco Bay	74,100	4.0
06/01/2000	Benicia	486,100	26.2
06/01/2000	San Francisco Bay	1,467,050	79.2
04/01/2001	Shore Terminal	170,200	9.2
04/01/2001	Shore Terminal	397,900	21.5
05/01/2001	Benicia	60,000	3.2
05/01/2001	Benicia	80,500	4.3
05/01/2001	Monterey	107,810	5.8
05/01/2001	Benicia	1,566,350	84.5
05/01/2001	Benicia	491,500	26.5
06/01/2001	Benicia	487,600	26.3
03/01/2002	Benicia	162,800	8.8
04/01/2002	Benicia	2,773,538	149.7
05/01/2002	Benicia	117,200	6.3
05/01/2002	Monterey	120,000	6.5
05/01/2002	Benicia	1,283,800	69.3
06/01/2002	Benicia	422,050	22.8
05/01/2003	Benicia	54,000	2.9
05/01/2003	Bennett's Marina	904,000	48.8
05/01/2003	Benicia	1,320,700	71.3
05/01/2003	Benicia	968,900	52.3
06/01/2003	Benicia	8,360	0.5
06/01/2003	San Francisco Bay	133,400	7.2
06/01/2003	Benicia	531,000	28.7
06/01/2003	Benicia	1,163,800	62.8
05/01/2004	Benicia	589,788	31.8
05/01/2004	Benicia	3,436,200	185.4

Untagged Feather River Hatchery Releases in the San Francisco Bay. Mean Return Rate to the Tuolumne River = 0.00540%			
Release Date	Release Location	Number Released	Estimated Number Of Adult Returns To The Tuolumne River
06/01/2004	Benicia	854,800	46.1
06/01/2004	Benicia	2,377,800	128.3
08/01/1988	Benicia	1,595,220	86.1
09/01/1988	Benicia	109,000	5.9
08/01/1993	Benicia	2,615,660	141.1
09/01/1993	Benicia	309,500	16.7

Untagged Nimbus Hatchery Releases in the San Francisco Bay. Mean Return Rate to the Tuolumne River = 0.00157%			
Release Date	Release Location	Number Released	Estimated Number Of Adult Returns To The Tuolumne River
09/01/1980	Benicia	270281	4.26
04/01/1981	Benicia	335699	5.29
04/01/1981	Pittsburg	1536048	24.19
05/01/1981	Benicia	877820	13.82
06/01/1981	Benicia	60550	0.95
06/01/1981	Benicia	1276700	20.10
07/01/1981	Benicia	1739360	27.39
07/01/1982	Benicia	1458625	22.97
08/01/1982	Benicia	1457905	22.96
12/01/1982	Cosumnes River	599040	9.43
04/01/1983	Benicia	615000	9.68
04/01/1983	Vallejo	1012500	15.94
05/01/1983	Benicia	391400	6.16
06/01/1983	Benicia	87000	1.37
06/01/1983	Benicia	516300	8.13
07/01/1983	Benicia	1915200	30.16
08/01/1983	Benicia	49940	0.79
08/01/1983	Berkeley Marina	50000	0.79
08/01/1983	Port Chicago	50350	0.79
05/01/1984	Benicia	180000	2.83
06/01/1984	Benicia	862650	13.58
07/01/1984	Fort Baker	50600	0.80
07/01/1984	Berkeley Marina	50675	0.80
07/01/1984	Port Chicago	50710	0.80
07/01/1984	Benicia	2826300	44.50
05/01/1985	Benicia	228500	3.60
05/01/1985	Benicia	463900	7.30
06/01/1985	Benicia	1027100	16.17
06/01/1985	Benicia	1960600	30.87
07/01/1985	Berkeley Marina	25500	0.40
07/01/1985	Benicia	846100	13.32
05/01/1986	Benicia	209300	3.30
05/01/1986	Benicia	288490	4.54

Untagged Nimbus Hatchery Releases in the San Francisco Bay.
Mean Return Rate to the Tuolumne River = 0.00157%

Release Date	Release Location	Number Released	Estimated Number Of Adult Returns To The Tuolumne River
06/01/1986	Benicia	2850750	44.89
07/01/1986	Benicia	1717270	27.04
05/01/1987	Benicia	492000	7.75
05/01/1987	Benicia	818975	12.90
06/01/1987	Benicia	372600	5.87
06/01/1987	Benicia	2221400	34.98
07/01/1987	Benicia	375150	5.91
05/01/1988	Benicia	264000	4.16
06/01/1988	Benicia	1364200	21.48
06/01/1988	Benicia	2130400	33.54
07/01/1988	Benicia	182200	2.87
07/01/1988	Benicia	398500	6.27
06/01/1989	Benicia	1789517	28.18
07/01/1989	Benicia	2629870	41.41
05/01/1990	Benicia	338800	5.33
06/01/1990	Benicia	376200	5.92
06/01/1990	Benicia	2714150	42.74
07/01/1990	Benicia	1001650	15.77
03/01/1991	Cosumnes River	97920	1.54
05/01/1991	Benicia	1029300	16.21
06/01/1991	Benicia	791000	12.45
06/01/1991	Benicia	801700	12.62
07/01/1991	Benicia	443100	6.98
05/01/1992	Benicia	2664950	41.96
06/01/1992	Benicia	1557000	24.52
07/01/1992	Benicia	177200	2.79
02/01/1993	Cosumnes River	200380	3.16
07/01/1993	Unocal	110000	1.73
07/01/1993	Benicia	490600	7.72
07/01/1993	Wickland Oil	639800	10.07
01/01/1994	Cosumnes River	206800	3.26
06/01/1994	Unocal	78000	1.23
06/01/1994	Benicia	1565900	24.66
06/01/1994	Wickland Oil	2509100	39.51
07/01/1994	Benicia	36600	0.58
02/01/1995	Cosumnes River	200720	3.16
06/01/1995	Unocal	484000	7.62
06/01/1995	Benicia	874450	13.77
06/01/1995	Wickland Oil	973650	15.33
07/01/1995	Benicia	187000	2.94
07/01/1995	Unocal	204000	3.21
07/01/1995	Wickland Oil	1500600	23.63
05/01/1996	Unocal	253000	3.98
05/01/1996	Benicia	538600	8.48
05/01/1996	Wickland Oil	1078600	16.98
06/01/1996	Unocal	67200	1.06

Untagged Nimbus Hatchery Releases in the San Francisco Bay.
Mean Return Rate to the Tuolumne River = 0.00157%

Release Date	Release Location	Number Released	Estimated Number Of Adult Returns To The Tuolumne River
06/01/1996	Wickland Oil	200000	3.15
06/01/1996	Wickland Oil	884600	13.93
06/01/1996	Benicia	1008450	15.88
05/01/1997	Benicia	367600	5.79
05/01/1997	Wickland Oil	1003800	15.81
06/01/1997	Wickland Oil	283600	4.47
06/01/1997	Wickland Oil	336300	5.30
06/01/1997	Wickland Oil	2063500	32.49
04/01/1998	Monterey	60720	0.96
05/01/1998	Monterey	60200	0.95
05/01/1998	Monterey	70210	1.11
05/01/1998	Wickland Oil	108000	1.70
05/01/1998	Wickland Oil	264000	4.16
05/01/1998	Benicia	570400	8.98
06/01/1998	Tiburon Net Pens	52000	0.82
06/01/1998	Bennett's Marina	132000	2.08
06/01/1998	Wickland Oil	2693254	42.41
05/01/1999	Monterey	60200	0.95
05/01/1999	Monterey	61600	0.97
05/01/1999	Benicia	120000	1.89
05/01/1999	Wickland Oil	896900	14.12
06/01/1999	Tiburon Net Pens	52008	0.82
06/01/1999	Monterey	70000	1.10
06/01/1999	San Francisco Bay	217500	3.42
06/01/1999	Benicia	509208	8.02
06/01/1999	Wickland Oil	2741792	43.17
05/01/2000	Wickland Oil	129600	2.04
05/01/2000	Benicia	356200	5.61
05/01/2000	Wickland Oil	1605900	25.29
06/01/2000	Wickland Oil	144000	2.27
06/01/2000	Wickland Oil	1616000	25.44
05/01/2001	Monterey	142200	2.24
06/01/2002	Tiburon Net Pens	50400	0.79
06/01/2002	Monterey	60016	0.94
06/01/2002	Wickland Oil	576000	9.07
06/01/2002	Wickland Oil	1738800	27.38
07/01/2002	Wickland Oil	512000	8.06
07/01/2002	Wickland Oil	1224850	19.29
05/01/2003	Wickland Oil	480000	7.56
06/01/2003	Treasure Island USCG Station	502300	7.91
06/01/2003	Wickland Oil	994300	15.66
06/01/2003	Wickland Oil	2384700	37.55
08/01/1993	Benicia	362000	5.70
08/01/1993	Wickland Oil	604200	9.51

Untagged Mokelumne Hatchery Releases in the Sacramento River Delta.
Mean Rates of Return to the Tuolumne River
Wet Years, spring releases = 0.01148%
Wet Years, fall releases = 0.01760%
Dry Years, spring releases = 0.00507%

Release Date	Release Location	Number Released	Estimated Number of Adult Returns to the Tuolumne River
11/01/1978	Rio Vista	9,076	1.60
11/01/1978	Rio Vista	93,000	16.36
01/01/1979	Rio Vista	30,000	3.44
01/01/1979	Rio Vista	45,000	5.17
10/01/1979	Rio Vista	174,200	30.65
11/01/1979	Rio Vista	19,167	3.37
10/01/1980	Rio Vista	194,250	34.18
10/01/1980	Rio Vista	478,500	84.19
11/01/1980	Rio Vista	38,500	6.77
11/01/1980	Rio Vista	50,000	8.80
12/01/1980	Rio Vista	12,100	2.13
12/01/1980	Rio Vista	13,200	2.32
12/01/1980	Rio Vista	15,400	2.71
11/01/1982	Rio Vista	6,050	1.06
11/01/1982	Rio Vista	152,880	26.90
11/01/1982	Rio Vista	170,765	30.05
11/01/1982	Rio Vista	186,450	32.81
12/01/1982	Rio Vista	40,000	7.04
10/01/1983	Rio Vista	337,500	59.38
10/01/1983	Rio Vista	367,500	64.66
06/01/1984	Thornton	15,250	1.75
04/01/1993	Tracy Pumping Plant	3,658	0.42
04/01/1993	Byron	15,000	1.72
05/01/1993	Tracy Pumping Plant	7,630	0.88
04/01/1998	Jersey Point	105,450	12.10
02/01/1999	Tracy Pumping Plant	500	0.06
03/01/1999	Tracy Pumping Plant	752	0.09
04/01/1999	Tracy Pumping Plant	744	0.09
05/01/1999	Tracy Pumping Plant	800	0.09
05/01/1999	Jersey Point	205,072	23.54
09/01/1999	Antioch Boat Ramp	9,600	1.10
10/01/1999	Antioch Boat Ramp	206,620	23.72
04/01/2000	Lighthouse Marina	52,632	6.04
05/01/2000	Jersey Point	104,039	11.94
11/01/1983	Rio Vista	25,200	4.43
11/01/1983	Rio Vista	27,440	4.83
10/01/1981	Rio Vista	51,940	2.63
10/01/1981	Rio Vista	212,803	10.79
11/01/1981	Rio Vista	220,500	11.18
11/01/1981	Rio Vista	366,405	18.57
12/01/1981	Rio Vista	56,200	2.85
10/09/1985	Rio Vista	27,300	1.38

04/01/1988	Clifton Court	18,000	0.91
05/01/1988	Clifton Court	19,250	0.98
03/01/1992	Clifton Court	5,100	0.26
04/01/1992	Byron	36,050	1.83
04/01/1992	Rio Vista	472,840	23.97
06/01/1994	Sacramento River	514,350	26.07
04/01/2001	Jersey Point	103,073	5.22
02/01/2002	Jersey Point	102,609	5.20
10/01/2002	Jersey Point	103,219	5.23
05/01/2003	Antioch Boat Ramp	575	0.03
04/01/2004	Thornton	4,000	0.20
04/01/2004	Thornton	1,009,700	51.18
05/01/2004	Clifton Court	3,000	0.15
05/01/2004	Thornton	2,488,857	126.15
06/01/2004	Thornton	210,800	10.68

Untagged Mokelumne Hatchery Releases in the San Francisco Bay.
Mean Rates of Return to the Tuolumne River = 0.00622%

Release Date	Release Location	Number Released	Estimated Number of Adult Returns to the Tuolumne River
08/13/1984	Benicia	42,000	2.61
08/13/1984	Benicia	56,350	3.51
08/14/1984	Benicia	42,000	2.61
08/14/1984	Benicia	63,250	3.94
08/15/1984	Benicia	48,000	2.99
08/15/1984	Benicia	64,400	4.01
08/16/1984	Benicia	51,600	3.21
08/16/1984	Benicia	69,230	4.31
08/17/1984	Benicia	52,200	3.25
08/17/1984	Benicia	70,035	4.36
08/20/1984	Benicia	33,750	2.10
08/20/1984	Benicia	42,500	2.64
08/21/1984	Benicia	20,250	1.26
08/21/1984	Benicia	25,500	1.59
06/25/1986	Benicia	50,400	3.14
06/26/1986	Benicia	56,000	3.48
06/27/1986	Benicia	66,000	4.11
07/01/1986	Benicia	1,000,400	62.24
08/01/1986	Benicia	39,600	2.46
08/01/1986	Berkeley Marina	170,100	10.58
09/01/1986	Bennett's Marina	50,600	3.15
09/01/1986	Benicia	191,500	11.91
05/01/1993	Benicia	437,500	27.22
06/01/1993	Benicia	1,547,500	96.28
07/01/1993	Benicia	1,026,600	63.87
05/01/1996	Benicia	983,494	61.19

Untagged Mokelumne Hatchery Releases in the San Francisco Bay. Mean Rates of Return to the Tuolumne River = 0.00622%			
Release Date	Release Location	Number Released	Estimated Number of Adult Returns to the Tuolumne River
06/01/1996	Benicia	850,700	52.93
04/01/1997	Benicia	254,200	15.82
05/01/1997	Benicia	636,000	39.57
06/01/1997	Benicia	858,000	53.38
07/01/1997	Wickland Oil	58,800	3.66
07/01/1997	Bennett's Marina	140,000	8.71
06/01/1998	Wickland Oil	453,500	28.22
07/01/1998	Wickland Oil	596,900	37.14
08/01/1998	Wickland Oil	144,900	9.02
06/01/1999	Wickland Oil	738,407	45.94
07/01/1999	Wickland Oil	440,200	27.39
10/01/1999	Wickland Oil	297,600	18.52
04/01/2000	Benicia	181,800	11.31
04/01/2000	Bennett's Marina	185,300	11.53
04/01/2000	Wickland Oil	463,700	28.85
05/01/2000	Wickland Oil	792,050	49.28
06/01/2000	Wickland Oil	642,925	40.00
09/11/1985	Benicia	24,000	1.49
09/12/1985	Benicia	24,000	1.49
09/16/1985	Benicia	26,000	1.62
09/17/1985	Benicia	23,100	1.44
09/18/1985	Benicia	23,100	1.44
09/19/1985	Benicia	27,300	1.70
09/20/1985	Benicia	13,000	0.81
09/24/1985	Benicia	13,300	0.83
09/25/1985	Benicia	27,930	1.74
09/26/1985	Benicia	48,400	3.01
09/27/1985	Benicia	46,200	2.87
09/30/1985	Benicia	33,600	2.09
10/01/1985	Benicia	51,200	3.19
10/02/1985	Benicia	100,800	6.27
10/03/1985	Benicia	103,700	6.45
10/04/1985	Benicia	159,800	9.94
10/07/1985	Benicia	92,400	5.75
10/08/1985	Benicia	93,800	5.84
10/09/1985	Benicia	59,800	3.72
10/10/1985	Benicia	74,100	4.61
10/11/1985	Benicia	28,600	1.78
10/17/1985	Benicia	24,200	1.51
10/18/1985	Benicia	35,200	2.19
10/21/1985	Benicia	44,200	2.75
10/22/1985	Benicia	42,000	2.61
04/01/1987	Benicia	601,665	37.43
05/01/1987	Benicia	398,700	24.81

Untagged Mokelumne Hatchery Releases in the San Francisco Bay. Mean Rates of Return to the Tuolumne River = 0.00622%			
Release Date	Release Location	Number Released	Estimated Number of Adult Returns to the Tuolumne River
06/01/1987	Benicia	208,050	12.94
06/01/1987	Benicia	259,900	16.17
06/01/1987	Bennett's Marina	391,100	24.33
07/01/1987	Benicia	135,050	8.40
07/01/1987	Mare Island	216,250	13.45
08/01/1987	Benicia	130,620	8.13
04/01/1988	Berkeley Marina	524,500	32.63
05/01/1988	Benicia	316,300	19.68
05/01/1988	Berkeley Marina	638,400	39.72
05/01/1988	Bennett's Marina	690,400	42.96
06/01/1988	Benicia	133,300	8.29
05/01/1989	Benicia	92,400	5.75
05/01/1989	Bennett's Marina	896,800	55.80
06/01/1989	Bennett's Marina	1,066,900	66.38
07/01/1989	Berkeley Marina	149,320	9.29
07/01/1989	Bennett's Marina	476,700	29.66
08/01/1989	Bennett's Marina	761,800	47.40
09/01/1989	Bennett's Marina	37,200	2.31
06/01/1990	Bennett's Marina	517,500	32.20
06/01/1990	Benicia	649,825	40.43
07/01/1990	Benicia	459,700	28.60
07/01/1990	Bennett's Marina	650,500	40.47
08/01/1990	Bennett's Marina	488,900	30.42
05/01/1991	Bennett's Marina	821,400	51.11
06/01/1991	Bennett's Marina	771,400	47.99
07/01/1991	Benicia	390,600	24.30
04/01/1992	Benicia	39,000	2.43
05/01/1992	Benicia	967,537	60.20
06/01/1992	Benicia	1,091,873	67.93
07/01/1992	Benicia	1,164,100	72.43
08/01/1992	Benicia	213,800	13.30
05/01/1994	Benicia	136,800	8.51
06/01/1994	Benicia	1,107,570	68.91
04/01/2001	Benicia	51,520	3.21
04/01/2001	Shore Terminal	1,464,200	91.10
05/01/2001	Shore Terminal	1,398,452	87.01
02/01/2002	Shore Terminal	1,160,079	72.18
05/01/2002	Monterey	140,500	8.74
05/01/2002	Shore Terminal	1,980,300	123.21
04/01/2003	Conoco Phillips	2,175,025	135.33
05/01/2003	Tiburon Net Pens	50,600	3.15
05/01/2003	Monterey	142,800	8.88
05/01/2004	Tiburon Net Pens	51,700	3.22
05/01/2004	Moss Landing	123,000	7.65

Untagged Mokelumne Hatchery Releases in the San Francisco Bay. Mean Rates of Return to the Tuolumne River = 0.00622%			
Release Date	Release Location	Number Released	Estimated Number of Adult Returns to the Tuolumne River
05/01/2004	Monterey	140,000	8.71
05/01/2004	Benicia	1,792,400	111.52
06/01/2004	Benicia	216,800	13.49

Untagged Merced River Hatchery Releases in the Merced River.
Mean Rates of Return to the Tuolumne River
Dry Years, spring releases = 0.00621%
Dry Years, fall releases = 0.00493%

Release Date	Release Location	Number Released	Estimated Number of Adult Returns to the Tuolumne River
10/14/1985	MRH	63,000	3.11
10/19/1987	MRH	254,842	12.57
04/18/1988	MRH	3,200	0.20
10/24/1988	MRH	1,000	0.05
10/06/1989	MRH	10,285	0.51
10/06/1989	MRH	41,184	2.03
10/06/1989	MRH	44,865	2.21
10/07/1989	MRH	36,673	1.81
10/07/1989	MRH	46,175	2.28
10/21/1991	Merced River	8,190	0.40
10/21/1991	Merced River	9,945	0.49
10/21/1991	Merced River	10,637	0.52
10/21/1991	Merced River	23,400	1.15
10/21/1991	Merced River	25,740	1.27
10/21/1991	Merced River	26,910	1.33
01/18/2001	Hagaman Park	1,000	0.06
01/18/2001	Hagaman Park	1,000	0.06
01/26/2001	Hagaman Park	1,010	0.06
01/31/2001	Gallo	507	0.03
01/31/2001	Gallo	633	0.04
02/01/2001	Hagaman Park	2,029	0.13
02/06/2001	Hagaman Park	1,070	0.07
03/01/2001	Gallo	810	0.05
03/07/2001	Hagaman Park	2,014	0.13
03/19/2001	Gallo	651	0.04
03/19/2001	Gallo	746	0.05
03/22/2001	Hagaman Park	2,016	0.13
03/29/2001	Hagaman Park	2,014	0.13
04/02/2001	Gallo	300	0.02
04/02/2001	Gallo	400	0.02
04/02/2001	Gallo	600	0.04
04/03/2001	Hagaman Park	24	0.00
04/06/2001	Hagaman Park	2,016	0.13
04/16/2001	Gallo	672	0.04

Untagged Merced River Hatchery Releases in the Merced River.
Mean Rates of Return to the Tuolumne River
Dry Years, spring releases = 0.00621%
Dry Years, fall releases = 0.00493%

Release Date	Release Location	Number Released	Estimated Number of Adult Returns to the Tuolumne River
04/16/2001	Gallo	708	0.04
04/16/2001	Gallo	717	0.04
04/16/2001	Robinson Ranch	3,043	0.19
04/18/2001	Hagaman Park	2,008	0.12
04/18/2001	Hagaman Park		0.00
04/22/2001	Gallo	702	0.04
04/22/2001	Gallo	718	0.04
04/22/2001	Gallo	784	0.05
04/22/2001	Robinson Ranch	3,150	0.20
04/25/2001	Gallo	327	0.02
04/25/2001	Gallo	462	0.03
04/26/2001	Hagaman Park	2,053	0.13
04/26/2001	Hagaman Park		0.00
04/27/2001	Gallo	375	0.02
05/02/2001	Hagaman Park	2,055	0.13
05/02/2001	Hagaman Park		0.00
05/04/2001	Gallo	360	0.02
05/04/2001	Gallo	487	0.03
05/09/2001	Gallo	711	0.04
05/09/2001	Gallo	738	0.05
05/09/2001	Robinson Ranch	3,021	0.19
05/10/2001	Hagaman Park	2,017	0.13
05/10/2001	Hagaman Park		0.00
05/11/2001	MRH	78,120	4.85
05/11/2001	MRH		0.00
05/11/2001	MRH	83,880	5.21
05/11/2001	MRH		0.00
05/14/2001	MRH	40,964	2.54
05/14/2001	MRH		0.00
05/14/2001	MRH		0.00
05/14/2001	MRH		0.00
05/16/2001	Hagaman Park	2,050	0.13
05/16/2001	Hagaman Park		0.00
05/21/2001	Gallo	802	0.05
05/21/2001	Gallo	806	0.05
05/21/2001	Gallo	807	0.05
05/21/2001	Robinson Ranch	3,249	0.20
05/24/2001	Hagaman Park	2,020	0.13
05/26/2001	Gallo	600	0.04
05/31/2001	Hagaman Park	1,618	0.10
02/07/2002	Hagaman Park	20	0.00
02/13/2002	Hagaman Park	1,859	0.12
02/20/2002	Gallo	687	0.04
02/23/2002	Gallo	1,268	0.08

Untagged Merced River Hatchery Releases in the Merced River.
Mean Rates of Return to the Tuolumne River
Dry Years, spring releases = 0.00621%
Dry Years, fall releases = 0.00493%

Release Date	Release Location	Number Released	Estimated Number of Adult Returns to the Tuolumne River
02/27/2002	Hagaman Park	2,224	0.14
03/06/2002	Gallo	764	0.05
03/06/2002	Hagaman Park	2,015	0.13
03/13/2002	Hagaman Park	2,075	0.13
03/19/2002	Gallo	1,881	0.12
03/20/2002	Hagaman Park	2,018	0.13
03/27/2002	Hagaman Park	2,068	0.13
03/30/2002	Hagaman Park	893	0.06
03/30/2002	Hagaman Park	1,130	0.07
04/02/2002	MRH	5,928	0.37
04/03/2002	Hagaman Park	2,042	0.13
04/04/2002	Gallo	2,067	0.13
04/04/2002	Robinson Ranch	3,050	0.19
04/10/2002	Hagaman Park	2,024	0.13
04/12/2002	Gallo	2,596	0.16
04/16/2002	MRH	7,100	0.44
04/17/2002	Hagaman Park	2,022	0.13
04/18/2002	Gallo	2,044	0.13
04/18/2002	Robinson Ranch	3,006	0.19
04/21/2002	Gallo	2,500	0.16
05/01/2002	MRH	7,019	0.44
05/01/2002	MRH	178,001	11.05
05/01/2002	MRH	183,140	11.37
05/02/2002	Hagaman Park	2,025	0.13
05/03/2002	Gallo	1,086	0.07
05/03/2002	Gallo	2,028	0.13
05/03/2002	Robinson Ranch	3,088	0.19
05/04/2002	Gallo	1,246	0.08
05/08/2002	Hagaman Park	2,116	0.13
05/14/2002	Hagaman Park	2,014	0.13
05/15/2002	MRH	7,149	0.44
05/17/2002	Gallo	2,008	0.12
05/17/2002	Robinson Ranch	3,025	0.19
05/20/2002	Gallo	2,400	0.15
05/22/2002	Hagaman Park	2,077	0.13
05/29/2002	Hagaman Park	2,048	0.13
02/22/2003	Gallo	800	0.05
03/12/2003	Gallo	1,652	0.10
03/22/2003	MRH	17,400	1.08
03/26/2003	Gallo	20,500	1.27
04/02/2003	Hagaman Park	100	0.01
04/03/2003	Gallo	2,000	0.12
04/03/2003	MRH	20,800	1.29
04/03/2003	Robinson Ranch	3,000	0.19

Untagged Merced River Hatchery Releases in the Merced River.
Mean Rates of Return to the Tuolumne River
Dry Years, spring releases = 0.00621%
Dry Years, fall releases = 0.00493%

Release Date	Release Location	Number Released	Estimated Number of Adult Returns to the Tuolumne River
04/04/2003	MRH	19,800	1.23
04/05/2003	MRH	17,500	1.09
04/03/2003	MRH	29,900	1.86
04/03/2003	Shaffer Bridge	21,375	1.33
04/06/2003	Shaffer Bridge	26,250	1.63
04/08/2003	Hagaman Park	101	0.01
04/08/2003	Hagaman Park	2,000	0.12
04/13/2003	MRH	11,625	0.72
04/14/2003	MRH	10,000	0.62
04/15/2003	Hagaman Park	2,000	0.12
04/16/2003	Gallo	2,000	0.12
04/16/2003	Robinson Ranch	3,000	0.19
04/22/2003	Hagaman Park	2,040	0.13
04/23/2003	MRH	10,209	0.63
04/25/2003	Gallo	2,000	0.12
04/25/2003	Robinson Ranch	3,000	0.19
04/29/2003	Hagaman Park	2,016	0.13
04/30/2003	MRH	1,807	0.11
05/02/2003	Hagaman Park	2,021	0.13
05/05/2003	MRH	9,979	0.62
05/06/2003	Hagaman Park	2,015	0.13
05/07/2003	Gallo	2,185	0.14
05/07/2003	Robinson Ranch	3,000	0.19
05/12/2003	MRH	7,550	0.47
05/12/2003	MRH	35,550	2.21
05/13/2003	Hagaman Park	2,009	0.12
04/05/2004	MRH	10,200	0.63
04/07/2004	Gallo	2,000	0.12
04/07/2004	Robinson Ranch	3,000	0.19
04/19/2004	MRH	10,200	0.63
04/21/2004	Gallo	2,032	0.13
04/21/2004	Robinson Ranch	3,003	0.19
05/03/2004	MRH	10,200	0.63
05/05/2004	Gallo	2,010	0.12
05/05/2004	MRH	9,156	0.57
05/05/2004	MRH	29,547	1.83
05/05/2004	MRH	44,012	2.73
05/05/2004	MRH	82,715	5.13
05/05/2004	Robinson Ranch	3,027	0.19
05/17/2004	MRH	10,200	0.63
05/19/2004	Gallo	2,000	0.12
05/19/2004	MRH	11,402	0.71
05/19/2004	MRH	36,088	2.24
05/19/2004	MRH	47,490	2.95

Untagged Merced River Hatchery Releases in the Merced River.
Mean Rates of Return to the Tuolumne River
Dry Years, spring releases = 0.00621%
Dry Years, fall releases = 0.00493%

Release Date	Release Location	Number Released	Estimated Number of Adult Returns to the Tuolumne River
05/19/2004	Robinson Ranch	3,017	0.19

Untagged Merced River Hatchery Releases in the Merced River.
Mean Rates of Return to the Tuolumne River
Wet Years, spring releases = 0.03181%
Wet Years, fall releases = 0.00127%

Release Date	Release Location	Number Released	Estimated Number of Adult Returns to the Tuolumne River
06/21/1978	MRH	100,000	0.32
09/29/1978	MRH	195,000	2.48
10/17/1984	MRH	73,600	0.93
03/08/1986	MRH	15,876	0.05
03/14/1986	MRH	20,448	0.07
03/18/1986	MRH	88,830	0.28
03/20/1986	MRH	38,762	0.12
03/26/1986	MRH	14,544	0.05
04/03/1986	MRH	49,298	0.16
04/08/1986	MRH	12,760	0.04
05/30/1986	MRH	351,250	1.12
06/18/1986	MRH	24,960	0.08
04/14/1995	Shaffer Bridge	2,430	0.01
05/02/1995	MRH	138,000	0.44
05/03/1995	Hagaman Park	1,000	0.00
05/03/1995	MRH	74,800	0.24
05/10/1995	MRH	130,050	0.41
05/10/1995	MRH	146,400	0.47
05/10/1995	MRH	276,450	0.88
04/01/1998	Hagaman Park	1,500	0.00
04/06/1998	Hagaman Park	2,010	0.01
04/13/1998	Hagaman Park	2,000	0.01
04/20/1998	Hagaman Park	2,000	0.01
04/27/1998	Hagaman Park	2,008	0.01
05/04/1998	Hagaman Park	2,000	0.01
05/12/1998	Hagaman Park	2,001	0.01
05/13/1998	MRH	113,500	0.36
05/18/1998	MRH	113,450	0.36
05/19/1998	Hagaman Park	1,001	0.00
05/19/1998	Hagaman Park	2,006	0.01
05/27/1998	Hagaman Park	1,000	0.00
05/27/1998	Hagaman Park	2,000	0.01
05/27/1998	MRH	60,546	0.19
05/29/1998	MRH	107,900	0.34
05/31/1998	MRH	84,945	0.27

Untagged Merced River Hatchery Releases in the Merced River.
Mean Rates of Return to the Tuolumne River
Wet Years, spring releases = 0.03181%
Wet Years, fall releases = 0.00127%

Release Date	Release Location	Number Released	Estimated Number of Adult Returns to the Tuolumne River
06/03/1998	Hagaman Park	1,000	0.00
06/03/1998	Hagaman Park	2,004	0.01
06/08/1998	Hagaman Park	2,000	0.01
06/17/1998	Hagaman Park	150	0.00
06/17/1998	Hagaman Park	850	0.00
06/17/1998	Hagaman Park	2,037	0.01
06/24/1998	MRH	24,480	0.08
06/25/1998	Hagaman Park	20	0.00
03/04/1999	Hagaman Park	1,005	0.00
03/17/1999	Hagaman Park	1,501	0.00
03/30/1999	Hagaman Park	2,000	0.01
04/06/1999	Hagaman Park	2,002	0.01
04/13/1999	Hagaman Park	2,007	0.01
04/21/1999	Gallo	421	0.00
04/21/1999	Gallo	442	0.00
04/21/1999	Hagaman Park	2,000	0.01
04/28/1999	Gallo	500	0.00
05/06/1999	Hagaman Park	2,008	0.01
05/11/1999	MRH	44,500	0.14
05/12/1999	Gallo	300	0.00
05/12/1999	Hagaman Park	2,000	0.01
05/17/1999	Robinson Ranch	5,000	0.02
05/18/1999	Gallo	500	0.00
05/18/1999	Gallo	501	0.00
05/18/1999	Hagaman Park	2,012	0.01
05/19/1999	Gallo	265	0.00
05/19/1999	Gallo	266	0.00
05/21/1999	Gallo	265	0.00
05/21/1999	Gallo	275	0.00
05/21/1999	Gallo	20,340	0.06
05/23/1999	Gallo	268	0.00
05/23/1999	Gallo	271	0.00
05/25/1999	Gallo	265	0.00
05/25/1999	Gallo	279	0.00
05/25/1999	Hagaman Park	1,000	0.00
05/25/1999	Hagaman Park	1,017	0.00
05/25/1999	Hagaman Park	1,024	0.00
05/27/1999	Hagaman Park	2,025	0.01
05/27/1999	Robinson Ranch	5,001	0.02
05/27/1999	Robinson Ranch	5,025	0.02
No Date	Robinson Ranch	5,001	0.02
No Date	Robinson Ranch	5,025	0.02
03/08/2000	Merced River	2,038	0.01
03/13/2000	Merced River	1,152	0.00

Untagged Merced River Hatchery Releases in the Merced River.
Mean Rates of Return to the Tuolumne River
Wet Years, spring releases = 0.03181%
Wet Years, fall releases = 0.00127%

Release Date	Release Location	Number Released	Estimated Number of Adult Returns to the Tuolumne River
03/14/2000	Merced River	346	0.00
03/14/2000	Merced River	360	0.00
03/15/2000	Hagaman Park	2,002	0.01
03/21/2000	Hagaman Park	2,000	0.01
03/28/2000	Hagaman Park	2,117	0.01
04/03/2000	Gallo	500	0.00
04/04/2000	Hagaman Park	2,028	0.01
04/05/2000	Robinson Ranch	2,001	0.01
04/12/2000	Gallo	2,038	0.01
04/13/2000	Hagaman Park	2,008	0.01
04/24/2000	Gallo	2,004	0.01
04/25/2000	Snelling	5,000	0.02
04/26/2000	Hagaman Park	2,000	0.01
04/29/2000	Gallo	509	0.00
05/12/2000	Gallo	393	0.00
05/12/2000	Gallo	503	0.00
05/14/2000	MRH	152,438	0.48
05/15/2000	Gallo	3,003	0.01
05/15/2000	Snelling	5,002	0.02
05/16/2000	Hagaman Park	2,026	0.01

References

Lindley S.T., R.S. Schick, E. Mora, P.B. Adams, J.J. Anderson, S. Greene, C. Hanson, B.P. May, D.R. McEwan, R.B. MacFarlane, C. Swanson, and J.G. Williams. 2007. Framework for assessing viability of threatened and endangered salmon and steelhead in the Sacramento- San Joaquin Basin. *San Francisco Estuary and Watershed Science* Volume 5, Issue 1 [February 2007], article 4. Available at: http://repositories.cdlib.org/jmie/sfews/vol5/iss1/art4

Mesick, C.F. 2001. The effects of San Joaquin River flows and Delta export rates during October on the number of adult San Joaquin Chinook salmon that stray. In: Brown, R.L., editor. Fish Bulletin 179: Contributions to the biology of Central Valley salmonids. Volume 2. Sacramento (CA): California Department of Fish and Game. Pages 139-161.

Mesick, C.F. Marston, D. and T. Heyne. 2007. Provisional Draft: San Joaquin River East-side Tributary Fall-run Chinook Salmon Age Cohort Reconstruction.

Mesick, C.F. and D. Marston. 2007. Provisional Draft: Relationships between fall-run Chinook salmon recruitment to the major San Joaquin River tributaries and streamflow, Delta exports, the Head of the Old River Barrier, and tributary restoration projects from the early 1980s to 2003.

Pacific Fisheries Management Council. 2006. Preseason Report I: stock abundance analysis for 2005 ocean salmon fisheries. Chapter II - Chinook salmon assessment. February 2006. Portland, OR.

Snedecor, G.W. and W.G. Cochran. 1989. Statistical Methods. Iowa State University Press. Ames. 503 pp.

Turlock Irrigation District and Modesto Irrigation District. 2005. 2005 Ten Year Summary Report pursuant to Paragraph (G) of the 1996 FERC Order issued July 31, 1996. Report on the Don Pedro Project (FERC Project No. 2299-024) prepared for the Federal Energy Regulatory Commission. April 1, 2005.

Waples RS, Teel D, Myers JM, Marshall A. 2004. Life history divergence in chinook salmon: historic contingency and parallel evolution. Evolution 58:386–403.

ATTACHMENT C

Maternal Origin and Migratory History of *Oncorhynchus mykiss* captured in rivers of the Central Valley, California

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Abstract

Analysis of otolith strontium-to-calcium (Sr:Ca) ratios was used to determine maternal origin (anadromous v. non-anadromous) and migratory history (anadromous v. non-anadromous) of rainbow trout (*Oncorhynchus mykiss*) collected in tributaries of the Sacramento-San Joaquin River system in the Central Valley of California between 2001 and 2007. Listed as *threatened* under the Endangered Species Act, little is known about the distribution of anadromous rainbow trout in Central Valley streams or the relation of sympatric anadromous and non-anadromous life history types. Ambient water chemistry of streams studied was sufficiently low in Sr:Ca ratios to allow discrimination of maternal origin and migratory history with mean Sr:Ca ratios ranging from 2.89 to 4.51 $mmol \cdot mol^{-1}$, although one site along the migration corridor of the San Joaquin River was as high as 8.05 $mmol \cdot mol^{-1}$. Of 964 otoliths examined, 224 were determined to be from fish who were the progeny of anadromous rainbow trout (i.e., steelhead) females and 740 were the progeny of non-anadromous rainbow trout females. Progeny of steelhead maternal origin were present at all sites sampled but the proportion of steelhead progeny varied among sites (0.04 to 0.74). Based on transects of otolith Sr:Ca ratios, only five fish were confirmed to be adult steelhead but, due to conservation concerns, sampling of adult steelhead was not our intention. The remaining 214 fish > age-4 were non-anadromous. Sixteen of the 214 fish > age-4 determined to be non-anadromous adults were the progeny of steelhead females.

Introduction

The Central Valley of California is drained by the Sacramento and San Joaquin Rivers and was once home to large runs of Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (*O. mykiss*) (Yoshiyama et al. 2000). Steelhead, the anadromous form of rainbow trout, were historically distributed throughout the Sacramento-San Joaquin River system in the Central Valley of California (Busby et al. 1996; McEwan 2001). Reduction of spawning and rearing habitats throughout the Central Valley has resulted in declines of steelhead returning to these streams (McEwan 2001; Lindley et al. 2006) and, in 1998, steelhead populations in the Central Valley were listed as *threatened* under the Endangered Species Act. Despite their popularity as a game fish and status as a threatened species, little is known about the biology, status, and life history of steelhead populations in the Central Valley. Lindley et al. (2007) recommend that in order to assess the risk of extinction or develop effective recovery actions for steelhead in the Central Valley, determining the distribution of steelhead and assessing the relationship between resident and anadromous forms of *O. mykiss* is a fundamental need. Lindley et al. (2007) stress that any quantitative assessment of population viability would be inadequate unless the role resident fish play in population maintenance and persistence of *O. mykiss* in the Central Valley is known.

Similar to other regions, Central Valley rivers contain both anadromous and non-anadromous (resident) life history forms of rainbow trout. How these two phenotypes are related and interact is of concern to both resource managers and researchers. Foote et al. (1989) identified three possible genetic relationships between life history forms of salmonids. First, alternative life history forms are genetically isolated and represent separate reproductively isolated populations. Second, alternative life history forms are not genetically distinct. Third, alternative life history forms are genetically distinct within a local area but are more similar to one another than they are to their respective life history forms outside the local area. Whether sympatric life history forms are treated as single populations exhibiting polyphenism or as reproductively isolated populations has profound implications in decisions related to protection and recovery of species (Zimmerman and Reeves 2000).

In assessing the relation of resident and anadromous rainbow trout, no single answer has emerged to describe population structure of rainbow trout. Neave (1944) first examined the relation of anadromous and non-anadromous rainbow trout in the Cowichan River of British Columbia using meristic analyses and rearing-release experiments. Neave (1944) concluded that the two life history forms should be treated as different reproductively isolated populations and that migratory behavior was hereditary. Zimmerman and Reeves (2000) used otolith microchemistry and spawning surveys to examine potential reproductive isolation between anadromous and non-anadromous rainbow trout in the Deschutes River, Oregon. Differences in the timing of spawning and spawning locations suggested that anadromous rainbow trout (steelhead) were reproductively isolated from non-anadromous rainbow trout. Further, Zimmerman and Reeves (2000) used otolith microchemistry to test maternal origin of adult steelhead and non-anadromous rainbow trout finding that no adult steelhead were the progeny of resident female rainbow trout and no adult rainbow trout were the progeny of steelhead females. As a result, Zimmerman and Reeves (2000) concluded that the two life history forms were acting as biological species in the Deschutes River. Conversely, steelhead of resident rainbow trout maternal origin and resident rainbow trout of steelhead maternal origin were detected in the Babine River, British Columbia (Zimmerman and Reeves 2000). Using genetic methods, Narum et al. (2004) identified genetic divergence and reproductive isolation between anadromous and non-anadromous rainbow trout in the Walla Walla River, Washington. Collectively, these results suggest that the relation of resident and anadromous rainbow trout varies among locations. Introductions of non-anadromous rainbow trout stocks derived from Sacramento River populations to Argentina gave rise to anadromous life history forms (Pascual et al. 2001), indicating that non-anadromous forms found in the Sacramento River system may contribute to anadromous populations in some circumstances. To date, however, little work exists to describe the relationship of steelhead and resident rainbow trout in Central Valley streams.

Analysis of otolith microchemistry provides two important tools in the study of migratory polyphenism in salmonids. First, the chemical composition of otoliths can be used to describe migration in anadromous fishes (Kalish 1990; Secor 1992; Zimmerman

et al. 2003). Strontium (Sr), an element with similar binding characteristics to calcium (Ca), is substituted for calcium in the calcium carbonate matrix of otoliths at levels relative to the concentration of strontium in the environment (Kalish 1990; Zimmerman 2005). The concentration of strontium is generally greater in seawater than in freshwater. As a result, analysis of Sr:Ca ratios across the otolith of a fish can be used to describe the migratory history of that fish between freshwater and seawater (Howland et al. 2001; Zimmerman 2005). Further, comparison of Sr/Ca ratios in the primordia and freshwater growth region can be used to determine maternal origin (resident or anadromous) based on the assumption that primordia composition reflects the environment in which yolk precursors develop (in the ocean for anadromous forms) (Kalish 1990; Volk et al. 2000; Zimmerman and Reeves 2002).

Although steelhead are monitored in some Central Valley streams, such as the American and Feather Rivers, in some streams of the Central Valley the occurrence of anadromous rainbow trout has not been documented in recent years. Anecdotal evidence and reports from anglers, however, suggests that they are present in these locations. We used analysis of otolith composition to determine maternal origin (steelhead versus resident) and migratory history of rainbow trout captured in seven Central Valley streams. Based on our determination of the maternal origin and migratory history of rainbow trout we determined the occurrence of steelhead progeny in Central Valley streams to better define the distribution of anadromous rainbow trout to aid in development of monitoring and recovery efforts.

Methods

Otolith Collection

Otolith samples were collected from wild rainbow trout/steelhead found in the anadromous reaches of six Central Valley streams: the Sacramento River, Deer Creek, Yuba River, Calaveras River, Stanislaus River and Tuolumne River between 2001 and 2007 (Figure 1). These streams are representative of the two major river basins that are found in the Central Valley, the Sacramento and San Joaquin rivers. A small number of samples was also obtained from fish in the Merced and San Joaquin rivers. Collections were made primarily by the California Department of Fish and Game. Other agencies that contributed rainbow trout otoliths for this study were the United States Fish and

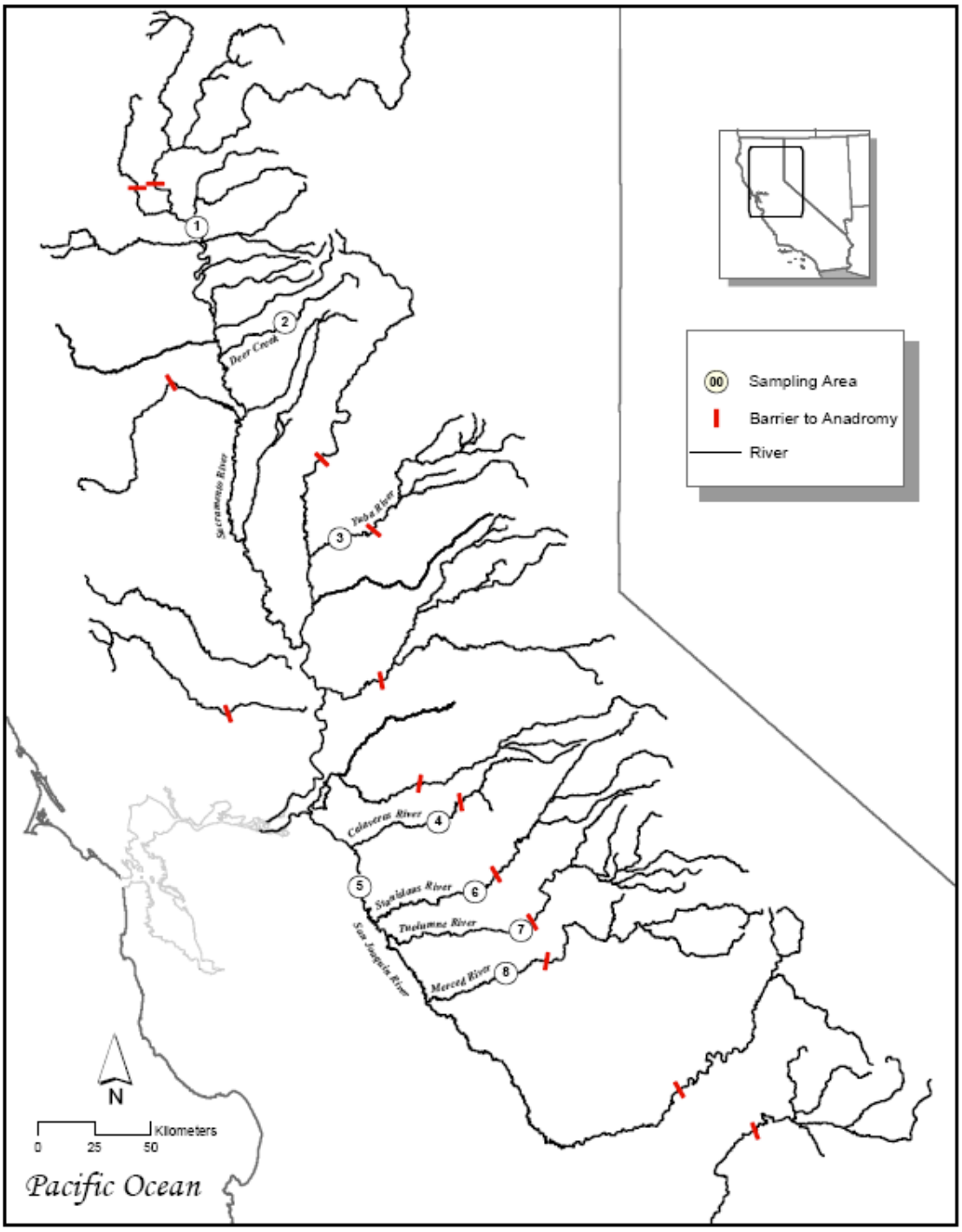

Figure 1. Central Valley streams and rivers, locations of otolith sampling, and barriers to anadromy.

Wildlife Service (USFWS) and NOAA Fisheries. Some samples were also provided by consultants under contract to USFWS (Stanislaus River) and water districts (Calaveras and Yuba rivers) working on these streams.

Fish and otolith collection efforts concentrated on the upper anadromous reaches of most streams, in the spawning and rearing areas where rainbow trout were most likely to be found. An exception to this was the San Joaquin River, where only six juvenile rainbow trout were collected from a smolt trap. Sampling was primarily conducted during the months of October through May coinciding with the anadromous adult rainbow trout migration and juvenile emigration. Sampling was limited during summer months because warm water temperatures (greater than 21 °C) could result in excessive mortality of fish during capture. Fish were captured by beach seining, rotary screw traps, electrofishing, carcass surveys, and hook and line. Adults with mature gonads were not sacrificed for otoliths. Each fish was measured (fork length) and otoliths were removed, cleaned, and stored dry in plastic vials. Where possible, otolith samples were obtained from archives, incidental mortalities from ongoing projects, and carcass surveys in order to reduce the impact on Central Valley steelhead, which are listed as *threatened* under the Endangered Species Act.

Otolith Preparation and Microchemical Analysis

Prior to preparation for chemical analyses, otoliths were immersed in water on a black background and reflected light was used to accentuate the presumed annuli. The age of each fish was determined by counting alternating translucent and opaque regions. Under reflected light, annuli correspond to the translucent zone (Kalish et al. 1995). Fish were aged and grouped by age class: young-of-year, age-1, age-2, and age-3. Fish age-4 and greater were lumped into a single age category.

One sagittal otolith from each fish was mounted sulcus side down with Crystal Bond 509 on a microscope cover slip attached on one edge to a standard microscope slide. The otolith was ground with 2000-grit sandpaper in the sagittal plane to the level of the nucleus. The mounting medium was heated and the otolith turned sulcus side up. The otolith was then ground with 2000-grit sandpaper in the sagittal plane to the level of the primordia and polished with a slurry of 0.05-µm alumina paste. The cover slip was

then cut with a scribe so that several prepared otoliths could be mounted on a petrographic slide for chemical analyses.

Two methods of analysis were used to measure chemical composition of otoliths. First, a wavelength dispersive electron microprobe was used to determine maternal origin of each fish following the methods of Zimmerman and Reeves (2000; 2002) and Zimmerman and Nielsen (2003). Prior to analysis, slides and otoliths were carbon coated. A 15-kV, 50-nA, 10-µm diameter beam was used for these analyses. Strontiantite and calcite were used as standards for Sr and Ca, respectively. The two elements were analyzed simultaneously and a counting time of 40 s was used to maximize precision (Toole and Nielsen 1992). Sr:Ca ratios were measured in a minimum of 4 points adjacent to primordia and in an equal number of points along a transect in the first summer of growth. A fish was determined to be of anadromous maternal origin if the mean Sr:Ca ratio of the primordia associated points (hereafter referred to as core region) was significantly higher than that in the first-summer growth region based on an unpaired one-tailed *t*-test with $\alpha = 0.05$. Based on these results, each fish was classified as the progeny of an anadromous (steelhead) or non-anadromous female parent.

After determination of maternal origin, the slides were polished to remove the carbon coat. Migratory history (anadromous or non-anadromous) was determined for each fish by measuring Sr:Ca ratios along a standard axis from the center of the otolith core to the edge of the otolith using a laser ablation system (New Wave 213 nm) coupled to an Agilent 7500c quadropole inductively coupled plasma mass spectrometer (LA-ICPMS) following the methods of Arai et al. (2007) and Brenkman et al. (2007). Laser transects were conducted at a pulse rate of 10 hz and a beam diameter of 30 µm. Calibration was conducted using standardized reference materials (NIST 612). Calcium was used as an internal standard. Core to edge transects of Sr:Ca ratios were visually examined for significant increases in otolith Sr:Ca indicating migration to higher salinity environments.

Water Chemistry

Because some freshwaters are high in ambient strontium, it is important to confirm water chemistry of locations where otoliths are collected (Rieman et al. 1994; Zimmerman 2005). Water samples were collected from a central location within each

stream reach where otoliths were collected in March, July, and November in 2003, 2004, and 2005. Ca and Sr were analyzed using standard methods SM311B and SM3113, respectively (APHA et al. 1992). Mean elemental concentrations and molar ratios of Sr:Ca were calculated to characterize water chemistry at each location.

Results

Maternal Origin and Migratory History

A total of 964 otoliths was examined to determine age, maternal origin, and migratory history. Young-of-year (or age-0) fish were collected from only three sites: Deer Creek, Yuba River, and Calaveras River (Table 1). Age composition of samples analyzed varied among locations (Table 1). Similarly, length composition of fish analyzed varied among locations (Table 1; Figure 2). Mean length at age varied among locations (Table 1).

Mean (± SD) otolith Sr:Ca ratios (reported as atomic ratios) in the first summer growth region (freshwater growth region) ranged from 0.0005 ± 0.0002 to 0.0016 ± 0.0002 (Appendix 1). Mean otolith Sr:Ca ratios in freshwater growth regions were positively correlated with ambient water Sr:Ca ratios ($r^2 = 0.75$, n = 7, $P = 0.01$; Figure 3). Mean otolith Sr:Ca in the freshwater growth regions, however, was weakly correlated with mean ambient water Sr concentrations ($r^2 = 0.11$, n = 7) indicating that it is the Sr:Ca ratio of the water, rather than Sr concentration, that controls otolith Sr:Ca ratios. Because only six fish were collected in the San Joaquin River, it was excluded from this regression.

Mean otolith Sr:Ca ratios in core regions ranged from 0.0003 ± 0.0003 to 0.0024 ± 0.0001 (Appendix 1). The difference between core and freshwater growth region Sr:Ca ratios were of a bimodal distribution with modes corresponding to determined maternal origin (Figure 4). Of the 964 otoliths examined, 224 were classified as steelhead progeny and 740 were classified as progeny of non-anadromous females (Appendix 1). The proportion of steelhead progeny ranged from 0.04 in the Merced River to 0.74 in Deer Creek (Figure 5). Of the six juvenile fish captured in the San Joaquin River at Mossdale, presumed to be steelhead smolts based on location and date of capture, coloration, and size, two fish were of anadromous maternal origin and four fish were of non-anadromous maternal origin.

Table 1. Mean fork length ± SD (mm) and sample size (n) in parentheses of wild steelhead/rainbow trout collected for otolith analyses in rivers of the Central Valley between 2001 and 2007.

	Age Class				
Location	0	1	2	3	≥ 4
Sacramento River		216 ± 12 (8)	294 ± 34 (12)	367 ± 21 (32)	488 ± 52 (102)
Deer Creek	81 ± 8 (49)	142 ± 28 (74)	208 ± 15 (30)	297 ± 28 (2)	
Yuba River	68 ± 24 (26)	228 ± 2 (5)	271 ± 24 (27)	348 ± 25 (40)	424 ± 29 (43)
Calaveras River	115 ± 22 (16)	190 ± 9 (29)	251 ± 28 (84)	335 ± 29 (43)	479 ± 104 (8)
San Joaquin River			238 ± 37 (6)		
Stanislaus River		175 ± 20 (18)	253 ± 28 (77)	342 ± 27 (47)	474 ± 74 (15)
Tuolumne River		178 ± 14 (37)	251 ± 36 (36)	356 ± 23 (36)	444 ± 36 (38)
Merced River			235 ± 25 (5)	348 ± 25 (5)	520 ± 99 (13)

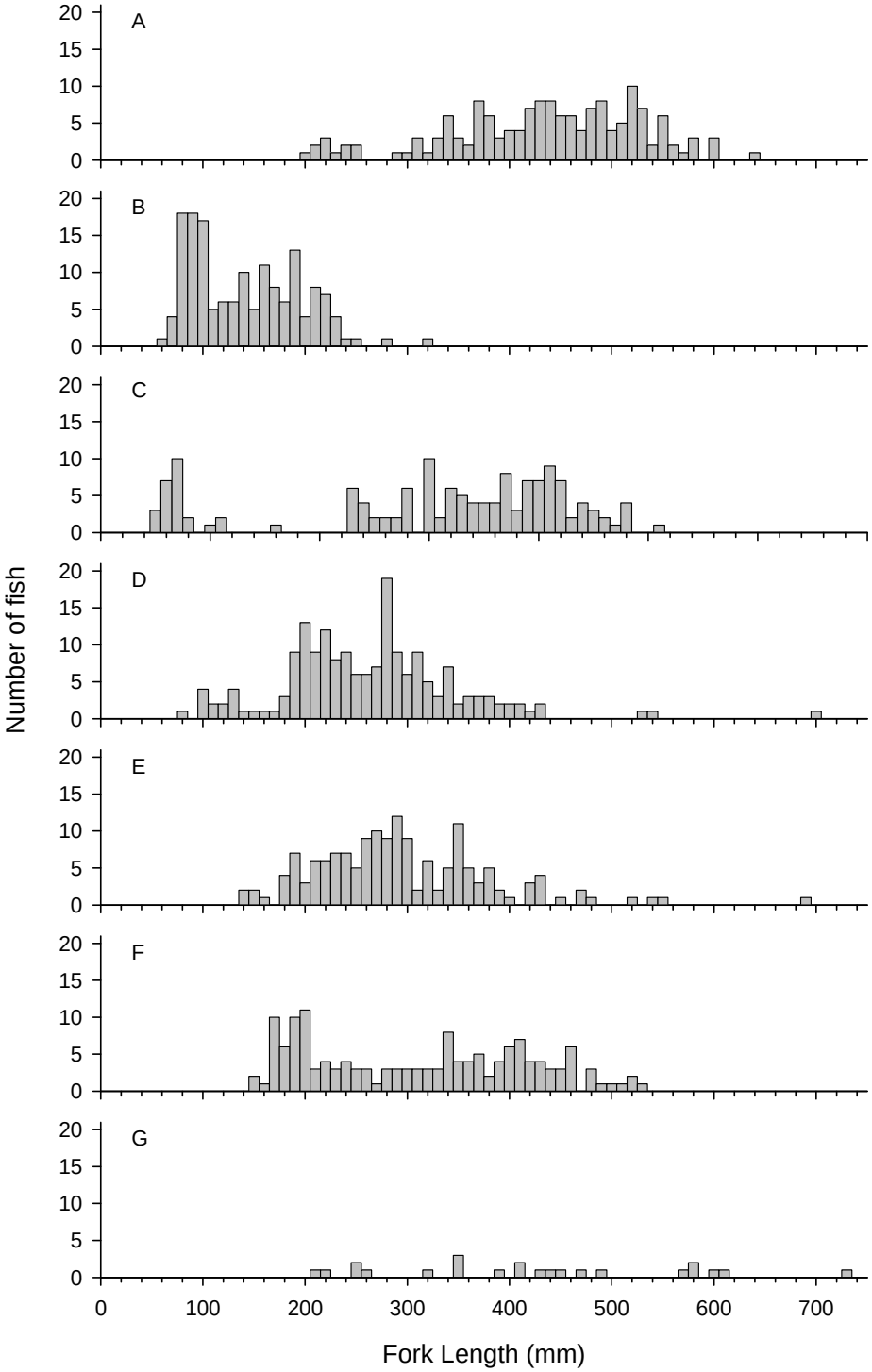

Figure 2. Frequency distribution of fork length (mm) of wild steelhead/rainbow trout collected for otolith analyses: (A) Sacramento River, (B) Deer Creek, (C) Yuba River, (D) Calaveras River, (E) Stanislaus River, (F) Tuolumne River, and (G) Merced River.

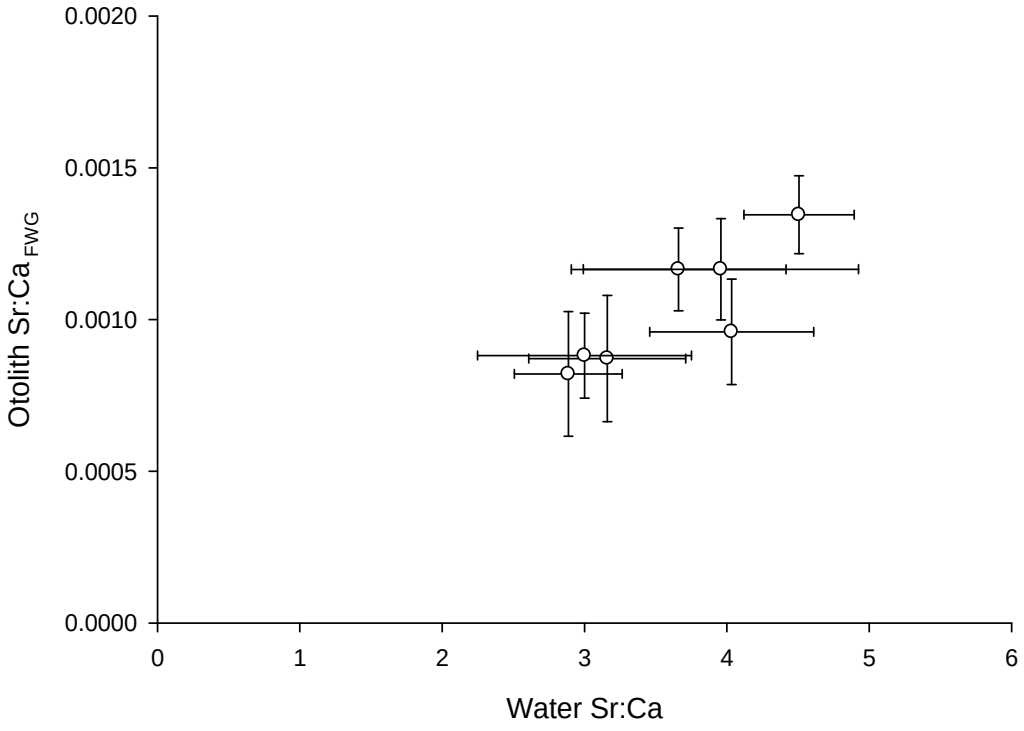

Figure 3. Mean water Sr:Ca ratios and mean otolith Sr:Ca ratios measured in freshwater growth regions of wild steelhead/rainbow trout collected from Central Valley streams, California.

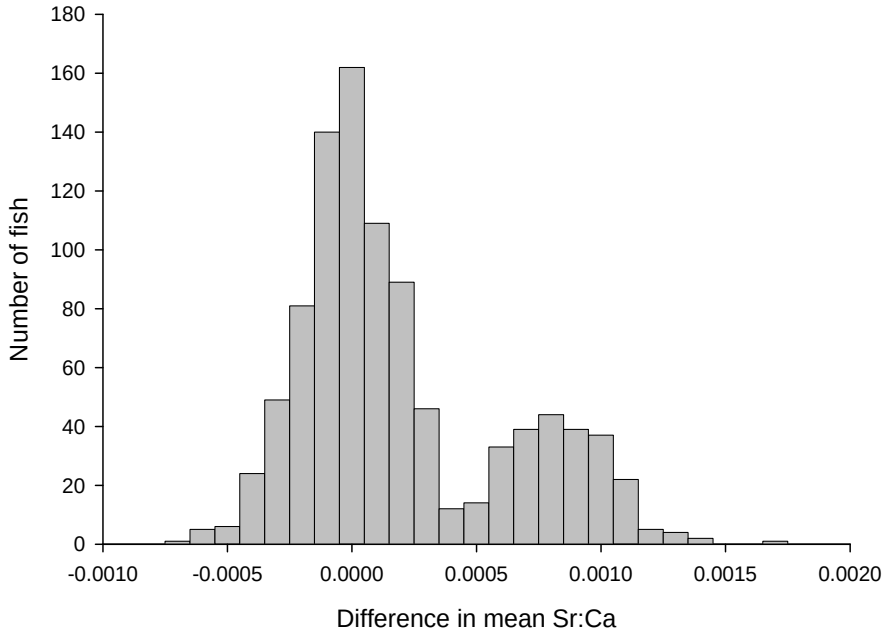

Figure 4. Frequency distribution of the difference between mean core Sr:Ca ratios and mean freshwater growth region Sr:Ca ratios for 964 wild steelhead/rainbow trout captured in Central Valley streams, California between 2001 and 2007.

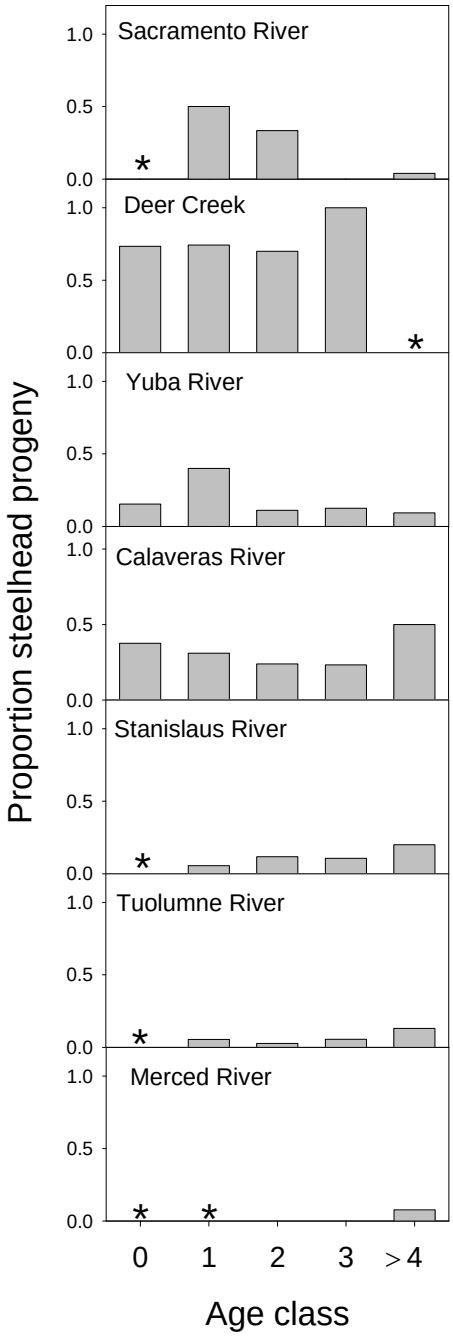

Figure 5. Proportion of steelhead/rainbow trout of steelhead maternal origin by age-class in streams of the Central Valley, California. Age-class 4 includes fish age-4 and greater and asterisks indicate no fish in this age-class.

Otolith Sr:Ca ratios along transects of otoliths from 959 fish were low and consistent with patterns expected for resident fish (Figure 6). Five fish were characterized by increased Sr:Ca ratios in the older otolith growth regions indicating migration to high Sr:Ca ratio (presumably marine) environments (Figure 7) and were classified as anadromous adults (steelhead). Fork length of anadromous fish ranged from 455 to 700 mm and all anadromous fish were age-4 or older. Two adult steelhead were detected in the Calaveras River (FL = 535 and 700 mm). One steelhead each was detected in the Sacramento River (FL = 460 mm), Stanislaus River (FL = 690 mm), and Tuolumne River (FL = 455 mm). Three rainbow trout greater than 600 mm were collected in the Merced River, but none of these were characterized by increased otolith Sr:Ca ratios indicating that they had not migrated to saltwater. Similarly, several fish of 570 to 600 mm were captured in the Sacramento River and were all classified as freshwater residents. Two fish were classified as "unknown" migratory history because otolith transects were measured through vateritic regions and a reliable migratory history could not be determined.

Water Chemistry

Mean Sr concentrations at all sites were less than 1 ppm and mean Ca concentrations ranged from 4.54 to 33.58 ppm (Table 2). Sr:Ca ratios of ambient stream water ranged from 2.1 to 8.1 $mmol \cdot mol^{-1}$ among the sampling sites and dates and mean Sr:Ca ratios ranged from 2.88 to 6.74 $mmol \cdot mol^{-1}$ (Table 2). San Joaquin River was characterized by Sr:Ca ratios ranging from 5.5 to 8.1 $mmol \cdot mol^{-1}$, which are approaching values observed in marine waters (Bruland 1983). Donohoe et al. (in press) determined that discrimination of steelhead versus non-anadromous progeny using otolith Sr:Ca core values is appropriate in streams with water Sr:Ca < 5 $mmol \cdot mol^{-1}$ but limited at higher values. Using this criterion, water chemistry among all locations, with the exception of the San Joaquin River, are low enough to allow discrimination of maternal origin.

Discussion

Steelhead progeny were detected in all Central Valley streams examined but because otolith based analyses are lethal, we were unable to collect sufficient samples to determine the actual composition of anadromous (steelhead) and non-anadromous rainbow trout progeny at any one point in time. Simply documenting the occurrence of

Table 2. Elevation (m), distance from Golden Gate (km), mean Ca concentration (± SD), mean Sr concentration (± SD), and Sr:Ca ratio ($mmol \cdot mol^{-1}$) in Central Valley rivers, California. Numbers correspond to sample area identifiers in Figure 1.

	Location	Elevation (m)	Distance (km)	Ca (ppm)	Sr (ppb)	Sr:Ca ($mmol \cdot mol^{-1}$)
1	Sacramento River	115	550	13.5 ± 4.0	91 ± 43	3.00 ± 0.75
2	Deer Creek	606	499	9.1 ± 0.9	73 ± 18	3.66 ± 0.75
3	Yuba River	61	301	9.8 ± 0.8	62 ± 11	2.89 ± 0.38
4	Calaveras River	76	217	20.5 ± 3.3	140 ± 22	3.16 ± 0.55
5	San Joaquin River	4	186	33.6 ± 12.8	503 ± 204	6.74 ± 1.11
6	Stanislaus River	98	310	7.6 ± 1.5	74 ± 15	4.51 ± 0.39
7	Tuolumne River	55	317	4.5 ± 0.9	39 ± 12	3.96 ± 0.97
8	Merced River	91	366	5.6 ± 3.2	48 ± 25	4.03 ± 0.57

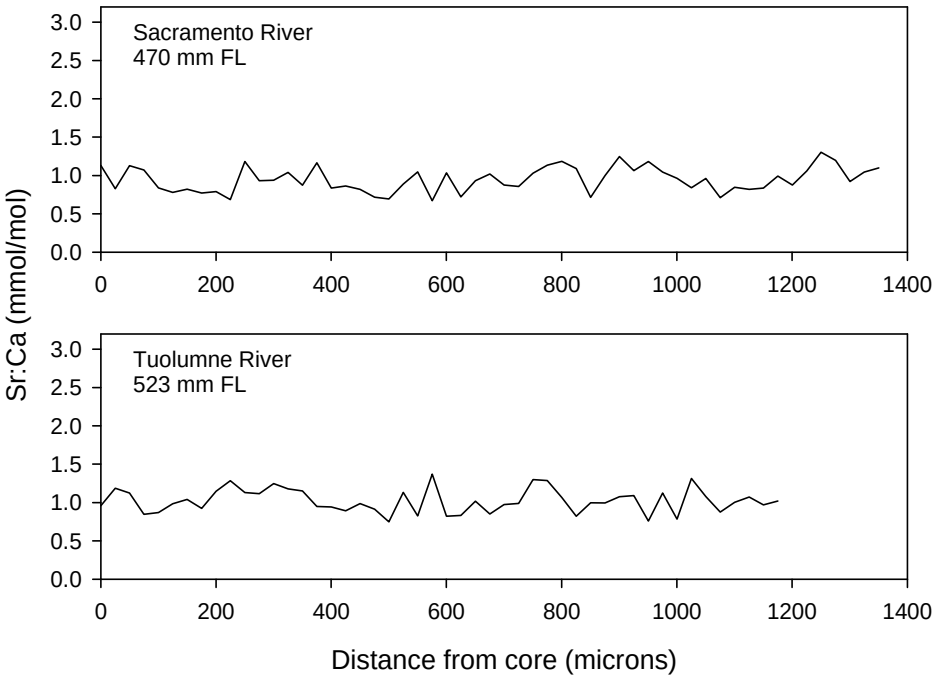

Figure 6. Representative transects of otolith Sr:Ca ratios for fish classified as resident rainbow trout from Central Valley rivers, California.

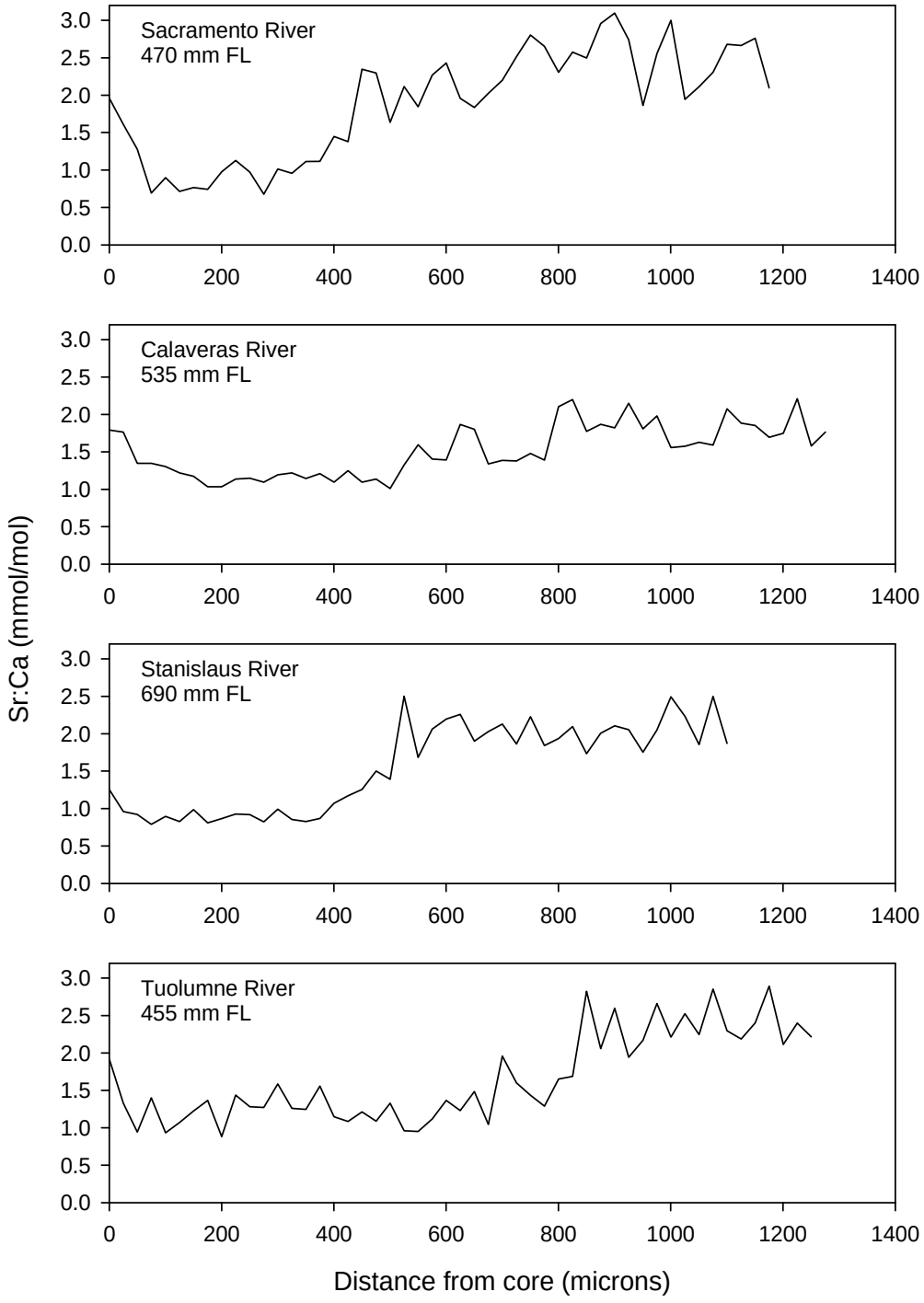

Figure 7. Representative transects of otolith Sr:Ca ratios for fish classified as anadromous rainbow trout (steelhead) from Central Valley rivers, California.

steelhead progeny in some of these sites is significant, however. Due to limited monitoring of steelhead in Central Valley streams, little information exists concerning the distribution of steelhead spawning. These results begin to address this gap in our knowledge of steelhead distribution and life history within the Central Valley.

Our estimates of steelhead occurrence should be viewed as conservative estimates. Donohoe et al. (in press) and Volk et al. (2000) demonstrate that otolith core Sr:Ca ratios may be reduced in progeny of anadromous females with protracted residence in freshwater before spawning such as observed in summer steelhead and steelhead with long migrations, as maternal signals can be lost through dilution effects. Presumably, winter steelhead (the form found in Central Valley streams) do not hold sufficiently long in freshwater to result in significant dilution, but Donohoe et al. (in press) found evidence of such dilution effects when coupled with higher ambient Sr:Ca ratios in some streams. Donohoe et al. (in press), therefore, suggested that determination of maternal origin should be limited fish coming from streams with Sr:Ca ratios less than 5.5 $mmol \cdot mol^{-1}$. All tributary sites we examined were below this value (Table 2). Donohoe et al. (in press) provide a model approach to use in place of methods used by Zimmerman and Reeves (2002). Zimmerman and Reeves (2002) used *t*-tests to compare mean Sr:Ca ratios in primordia with those in the freshwater growth region (as we did in this study); if mean primordia values were significantly higher than mean freshwater growth region values, the fish was classified as the progeny of an anadromous female. The method presented by Donohoe et al. (in press) uses core Sr:Ca values, migration difficulty index (elevation · distance from ocean), and ambient water Sr:Ca ratios to distinguish progeny of anadromous and non-anadromous rainbow trout. We used the equations provided by Donohoe et al. (in press) to calculate predicted otolith core Sr:Ca ratios for resident and anadromous progeny in our study sites. Observed mean core Sr:Ca ratios for progeny classified as resident and anadromous were similar to those predicted by the Donohoe et al. (in press) model indicating that both methods are appropriate for assessing maternal origin for fish from these streams (Figure 8). Deer Creek, however, stands out as an outlier with greater observed mean core Sr:Ca ratios than predicted using the Donohoe et al. (in press) models. Given the distance and elevation of Deer Creek, the Donohoe et al. (in press) model predicts that we should be unable to use core Sr:Ca ratios to discriminate

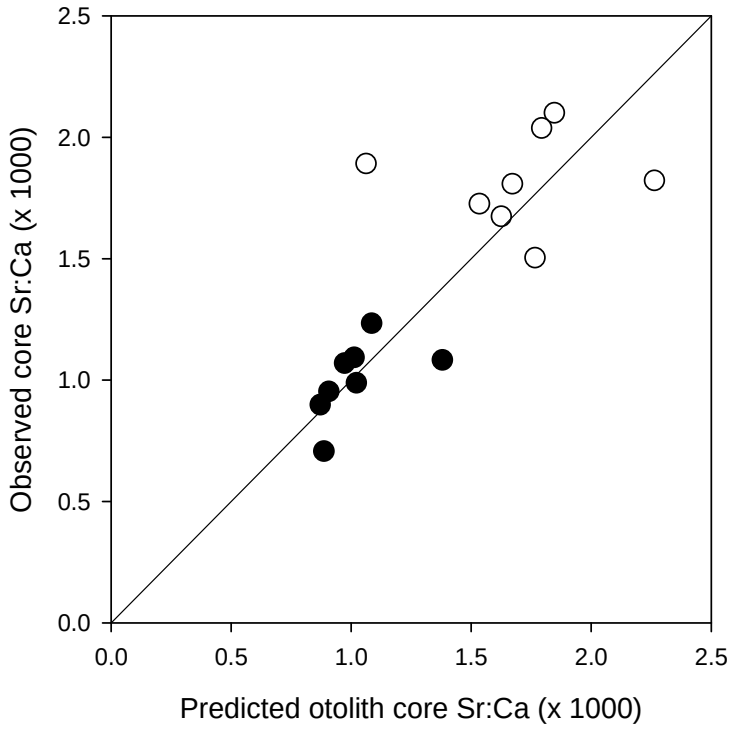

Figure 8. Predicted otolith core Sr:Ca ratios using Donohoe et al. (in press) model versus mean Sr:Ca ratios observed in fish classified as resident rainbow trout (solid circles) and anadromous rainbow trout (open circles) progeny from Central Valley rivers, California. The line represents a 1:1 relationship.

anadromous and non-anadromous progeny. It is unclear why this population stands out with greater core Sr:Ca ratios than predicted.

Otoliths collected from juvenile rainbow trout in the San Joaquin River at Mossdale (Location 5 in Figure 1) were presumed to be steelhead smolts but included fish of both anadromous maternal origin and non-anadromous maternal origin suggesting that resident rainbow trout can produce smolts in the Central Valley. With such a small sample size we are unable to draw too many conclusions about the contribution of progeny of non-anadromous females to the emigration of smolts. Similarly, in presumed steelhead smolts collected in an estuary of a small central California coastal stream, juveniles of both steelhead and non-anadromous maternal origin were present (Zimmerman, unpublished data). Further work is needed to assess the contribution of non-anadromous progeny as smolts and the fate of these fish compared to smolts of anadromous maternal origin.

Our results do suggest that the proportional occurrence of steelhead progeny may vary among locations (and presumably among years). Deer Creek, for example, is dominated by steelhead progeny while the Tuolumne and Stanislaus rivers were dominated by resident rainbow trout progeny. In the Sacramento River, progeny of steelhead were present in samples of age-1 and age-2 fish but rare in age 3 and older samples. Since steelhead in the Sacramento River predominately smolt at age-2 (Hallock 1989), it is likely that the reduction in the occurrence of steelhead progeny in older ages is a result of smolt emigration. Further work is needed to better assess the contribution of steelhead and rainbow trout to the anadromous population of *O. mykiss* in streams throughout the Central Valley. Tagging studies of smolts and pedigree studies such as that described by Seamons et al. (2004) and suggested by Hendry et al. (2004) could provide an opportunity to address the relation of anadromous and non-anadromous rainbow trout and the role of environmental variables in controlling life history. Studies of this sort could use hypervariable microsatellite markers to assess lifetime reproductive success of individuals that adopt different life histories (resident v. anadromous) across a range of stream conditions and individual characteristics such as growth, size, energy density, and age (Hendry et al. 2004). Although studies of this type would be difficult and costly, they offer the promise of better understanding the relation of anadromous and

non-anadromous life history forms as requested by Lindley et al. (2007). Paired studies built upon existing monitoring efforts across the range of environmental conditions observed in Central Valley streams (such as Deer Creek and the Stanislaus River) provide ample opportunity for studies of this type.

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References

APHA (American Public Health Association), American Water Works Association, and Water Pollution Control Federation. 1992. Standard methods for the examination of water and wastewater, 18th edition. APHA, Washington, D.C.

Arai, T., T. Hirata, and Y. Takagi. 2007. Application of laser ablation ICPMS to trace the environmental history of chum salmon *Oncorhynchus keta*. Marine Environmental Research. 63:55-66.

Brenkman, S.J., S.C. Corbett, and E.C. Volk. 2007. Use of otolith chemistry and radiotelemetry to determine age-specific patterns of anadromous bull trout in the Hoh River, Washington. Transaction of the American Fisheries Society. 136:1-11.

Bruland, K. 1983. Trace elements in seawater. In Riley, J.P., and R. Chester (eds.), Chemical Oceanography, Vol. 8. pp. 157-220. Academic Press, London.

Busby, P.J., T.C. Wainwright, G.J. Bryant, L.J. Lierheimer, R.S. Waples, F.W. Waknitz, K. Neely, and I.V. Lagomarsino. 1996. Status review of west coast steelhead from Washington, Idaho, Oregon, and California. U.S. Department of Commerce. NOAA Tech Memo. NMFS-NWFSC-27.

Donohoe, C.J., P.B. Adams, and C.F. Royer. In press. Influence of water chemistry and migratory distance on ability to distinguish progeny of sympatric resident and anadromous rainbow trout (*Oncorhynchus mykiss*). Canadian Journal of Fisheries and Aquatic Sciences.

Foote, C.J., C.C. Wood, and R.E. Withler. 1989. Biochemical genetic comparison of sockeye salmon and kokanee, the anadromous and nonanadromous forms of *Oncorhynchus nerka*. Canadian Journal of Fisheries and Aquatic Sciences. 46:149-158.

Hallock, R.J. 1989. Upper Sacramento River steelhead, (*Oncorhynchus mykiss*), 1952 – 1988. Report to the Fish and Wildlife Service. 85 p.

Hendry, A.P., T. Bohlin, B. Jonsson, and O. Berg. 2004. To sea or not to sea? Anadromy versus non-anadromy in salmonids. pp. 93 – 125 *in* Hendry A.P. and S.C. Stearns [eds.]. Evolution illuminated: salmon and their relatives. Oxford University Press.

Howland, K.L, W.M, Tonn, J.A. Babaluk, and R.F. Tallman. 2001. Identification of freshwater and anadromous inconnu in the Mackenzie River system by analysis of otolith strontium. Transactions of the American Fisheries Society. 130:725-741

Kalish, J.M. 1990. Use of otolith microchemistry to distinguish the progeny of sympatric anadromous and non-anadromous salmonids. Fishery Bulletin. 88:657-666.

Kalish, J.M., R.J. Beamish, E.B. Brothers, J.M. Casselman, R.I.C.C. Francis, H. Mosegaard, J. Panfili, E.D. Prince, R.E. Thresher, C.A. Wilson, and P.J. Wright. 1995. Glossary for otolith studies. *In* Recent developments in fish otolith research. Edited by D.H. Secor, J.M. Dean, and S.E. Campana. Belle W. Baruch Libr. Mar. Sci. No. 19. pp. 723 – 729.

Lindley, S.T., R.S. Schick, B. May, J.J. Anderson, S. Greene, C. Hanson, A. Low, D. McEwan, R.B. MacFarlane, C. Swanson, and J.G. Williams. 2006. Historical population structure of Central Valley steelhead and its alteration by dams. San

Francisco Estuary and Watershed Science [online]. Vol. 4, Issue 1, Article 2. Available at: http://www.estuaryandwatershedscience.org/vol4/issue1/art2.

Lindley, S.T., R.S. Schick, E. Mora, P.B. Adams, J.J. Anderson, S. Greene, C. Hanson, B.P. May, D.R. McEwan, R.B. MacFarlane, C. Swanson, and J.G. Williams. 2007. Framework for assessing viability of threatened and endangered Chinook salmon and steelhead in the Sacramento-San Joaquin Basin. San Francisco Estuary and Watershed Science [online]. Vol. 5, Issue 1, Article 4. Available at: http://www.estuaryandwatershedscience.org/vol5/issue1/art4.

McEwan, D.R. 2001. Central Valley steelhead. pp. 1-43 *In* Brown, R.L. [ed.] Contributions to the biology of Central Valley salmonids. Volume 1. California Department of Fish and Game Fish Bulletin 179.

Narum, S.R., C. Contor, A. Talbot, and M.S. Powell. 2004. Genetic divergence of sympatric resident and anadromous forms of *Oncorhynchus mykiss* in the Walla Walla River, USA. Journal of Fish Biology. 65:471-488.

Neave, F. 1944. Racial characteristics and migratory habits in *Salmo gairdneri*. Journal of the Fishery Research Board of Canada. 6:245-251.

Pasqual, M.A., P. Bentzen, C.M. Riva Rossi, G. Mackey, M. Kinnison, and R. Walker. 2001. First documented case of anadromy in a population of introduced rainbow trout in Patagonia, Argentina. Transactions of the American Fisheries Society. 130:53-67.

Rieman, B.E., D.L. Myers, and R.L. Nielsen. 1994. Use of otolith microchemistry to discriminate *Oncorhynchus nerka* of resident and anadromous origin. Canadian Journal of Fisheries and Aquatic Sciences. 51:68-77.

Seamons, T.R., P. Bentzen, and T.P. Quinn. 2004. The mating system of steelhead, *Oncorhynchus mykiss*, inferred by molecular analysis of parents and progeny. Environmental Biology of Fishes. 69:333-344.

Secor, D.H. 1992. Application of otolith microchemistry analysis to investigate anadromy in Chesapeake Bay striped bass *Morone saxatilis*. Fishery Bulletin. 90: 798-806.

Toole, C.L., and R.L. Nielsen. 1992. Effects of microprobe precision on hypotheses related to otolith Sr:Ca ratios. Fishery Bulletin. 90:421-427.

Volk, E.C., A. Blakley, S.L. Schroder, and S.M. Kuehner. 2000. Otolith chemistry reflects migratory characteristics of Pacific salmonids: Using core chemistry to distinguish maternal associations with sea and freshwaters. Fisheries Research. 46:251-266.

Yoshiyama, R.M., E.R. Gerstung, F.W. Fisher, and P.B. Moyle. 2000. Chinook salmon in the California Central Valley: an assessment. Fisheries. 25:6-20.

Zimmerman, C.E. 2005. Relationship of otolith strontium-to-calcium ratios and salinity: experimental validation for juvenile salmonids. Canadian Journal of Fisheries and Aquatic Sciences. 62:88-97.

Zimmerman, C.E., and G.H. Reeves. 2000. Population structure of sympatric anadromous and non-anadromous *Oncorhynchus mykiss*: evidence from spawning surveys and otolith microchemistry. Canadian Journal of Fisheries and Aquatic Sciences. 57:2152-2162.

Zimmerman, C.E., and G.H. Reeves. 2002. Identification of steelhead and resident rainbow trout progeny in the Deschutes River, Oregon revealed with otolith microchemistry. Transactions of the American Fisheries Society. 131:986-993.

Zimmerman, C.E., and R.L. Nielsen. 2003. Effect of analytical conditions in wavelength dispersive electron microprobe analysis on the measurement of strontium-to-calcium (Sr/Ca) ratios in otoliths of anadromous salmonids. Fishery Bulletin. 101:712-718.

Zimmerman, C.E., R. W. Stonecypher, and M.C. Hayes. 2003. Migration of precocious male hatchery chinook salmon in the Umatilla River, Oregon. North American Journal of Fisheries Management. 23:1007-1015.

Appendix 1. ID Code, location, fork length (mm), age class, mean Sr:Ca ratios ± SD in primordia and freshwater growth regions (FWG), maternal origin, and migratory history of wild steelhead/rainbow trout collected from rivers in the Central Valley, California.

CDFG No	Location	Length (mm)	Age	Mean Sr:Ca ± SD		Maternal Origin	Migratory History
				Primordia	FWG		
cvr001031502100	Calaveras River	405	4	0.0007 ± 0.0004	0.0007 ± 0.0003	Resident	Resident
cvr001051006001	Calaveras River	371	3	0.0008 ± 0.0003	0.0007 ± 0.0001	Resident	Resident
cvr001051006002	Calaveras River	305	3	0.0023 ± 0.0004	0.0014 ± 0.0002	Steelhead	Resident
cvr001051006004	Calaveras River	392	3	0.0009 ± 0.0003	0.0009 ± 0.0003	Resident	Resident
cvr001051006005	Calaveras River	342	3	0.0010 ± 0.0003	0.0010 ± 0.0002	Resident	Resident
cvr001051006006	Calaveras River	320	3	0.0007 ± 0.0003	0.0009 ± 0.0002	Resident	Resident
cvr001051006007	Calaveras River	289	2	0.0008 ± 0.0002	0.0007 ± 0.0001	Resident	Resident
cvr001051006008	Calaveras River	304	3	0.0008 ± 0.0003	0.0007 ± 0.0001	Resident	Resident
cvr001051006009	Calaveras River	253	2	0.0010 ± 0.0003	0.0011 ± 0.0002	Resident	Resident
cvr001051006010	Calaveras River	250	2	0.0010 ± 0.0003	0.0010 ± 0.0003	Resident	Resident
cvr001051006012	Calaveras River	220	2	0.0012 ± 0.0005	0.0008 ± 0.0004	Resident	Resident
cvr001051006013	Calaveras River	272	2	0.0010 ± 0.0003	0.0008 ± 0.0002	Resident	Resident
cvr001052306002	Calaveras River	275	2	0.0018 ± 0.0002	0.0008 ± 0.0003	Steelhead	Resident
cvr001052306003	Calaveras River	270	2	0.0008 ± 0.0003	0.0008 ± 0.0002	Resident	Resident
cvr001052306004	Calaveras River	372	3	0.0009 ± 0.0003	0.0009 ± 0.0002	Resident	Resident
cvr001052306005	Calaveras River	398	3	0.0007 ± 0.0001	0.0011 ± 0.0003	Resident	Resident
cvr001052306006	Calaveras River	276	2	0.0007 ± 0.0004	0.0011 ± 0.0002	Resident	Resident
cvr001052306007	Calaveras River	312	3	0.0014 ± 0.0004	0.0011 ± 0.0002	Resident	Resident
cvr001052306008	Calaveras River	281	2	0.0007 ± 0.0003	0.0008 ± 0.0003	Resident	Resident
cvr001052306009	Calaveras River	233	2	0.0011 ± 0.0003	0.0006 ± 0.0002	Resident	Resident
cvr001052306011	Calaveras River	280	2	0.0018 ± 0.0002	0.0011 ± 0.0002	Steelhead	Resident
cvr001052306013	Calaveras River	275	2	0.0019 ± 0.0004	0.0008 ± 0.0002	Steelhead	Resident
cvr001052306016	Calaveras River	290	2	0.0008 ± 0.0004	0.0008 ± 0.0002	Resident	Resident
cvr001052306017	Calaveras River	278	2	0.0007 ± 0.0002	0.0013 ± 0.0003	Resident	Resident
cvr001052306018	Calaveras River	275	2	0.0007 ± 0.0003	0.0013 ± 0.0003	Resident	Resident
cvr001052306019	Calaveras River	215	2	0.0008 ± 0.0004	0.0008 ± 0.0004	Resident	Resident
cvr001070203001	Calaveras River	107	0	0.0010 ± 0.0003	0.0010 ± 0.0003	Resident	Resident
cvr001070203003	Calaveras River	91	0	0.0016 ± 0.0004	0.0008 ± 0.0003	Steelhead	Resident
cvr001070203004	Calaveras River	121	0	0.0018 ± 0.0003	0.0008 ± 0.0002	Steelhead	Resident
cvr001070203005	Calaveras River	116	0	0.0017 ± 0.0004	0.0007 ± 0.0001	Steelhead	Resident
cvr001070203006	Calaveras River	123	0	0.0007 ± 0.0001	0.0007 ± 0.0004	Resident	Resident
cvr001070203007	Calaveras River	98	0	0.0007 ± 0.0003	0.0009 ± 0.0004	Resident	Resident
cvr001070203009	Calaveras River	204	2	0.0013 ± 0.0003	0.0011 ± 0.0002	Resident	Resident
cvr001070203010	Calaveras River	226	2	0.0013 ± 0.0002	0.0011 ± 0.0004	Resident	Resident
cvr001070203012	Calaveras River	216	2	0.0012 ± 0.0004	0.0007 ± 0.0004	Resident	Resident

CDFG No	Location	Length (mm)	Age	Mean Sr:Ca ± SD		Maternal Origin	Migratory History
				Primordia	FWG		
cvr001070203013	Calaveras River	226	2	0.0022 ± 0.0004	0.0013 ± 0.0005	Steelhead	Resident
cvr001070203014	Calaveras River	233	2	0.0019 ± 0.0003	0.0009 ± 0.0002	Steelhead	Resident
cvr001070203016	Calaveras River	262	2	0.0011 ± 0.0002	0.0012 ± 0.0002	Resident	Resident
cvr002070203001	Calaveras River	310	3	0.0008 ± 0.0002	0.0008 ± 0.0003	Resident	Resident
cvr002070203002	Calaveras River	214	2	0.0008 ± 0.0004	0.0009 ± 0.0004	Resident	Resident
cvr002070203003	Calaveras River	218	2	0.0007 ± 0.0003	0.0009 ± 0.0004	Resident	Resident
cvr002070203006	Calaveras River	128	0	0.0009 ± 0.0003	0.0006 ± 0.0002	Resident	Resident
cvr002070203009	Calaveras River	91	0	0.0011 ± 0.0005	0.0012 ± 0.0003	Resident	Resident
cvr002070203025	Calaveras River	76	0	0.0008 ± 0.0003	0.0009 ± 0.0003	Resident	Resident
cvr002070203027	Calaveras River	122	0	0.0015 ± 0.0002	0.0008 ± 0.0003	Steelhead	Resident
cvr002070203032	Calaveras River	203	1	0.0010 ± 0.0003	0.0009 ± 0.0002	Resident	Resident
cvr002070203034	Calaveras River	215	2	0.0011 ± 0.0003	0.0007 ± 0.0002	Resident	Resident
cvr002070203036	Calaveras River	223	2	0.0014 ± 0.0002	0.0007 ± 0.0002	Resident	Resident
cvr002070203038	Calaveras River	210	2	0.0019 ± 0.0003	0.0013 ± 0.0004	Steelhead	Resident
cvr002070203040	Calaveras River	366	3	0.0009 ± 0.0002	0.0006 ± 0.0002	Resident	Resident
cvr002070203041	Calaveras River	115	0	0.0012 ± 0.0001	0.0011 ± 0.0004	Resident	Resident
cvr002070203043	Calaveras River	110	0	0.0018 ± 0.0003	0.0007 ± 0.0001	Steelhead	Resident
cvr002070203049	Calaveras River	99	0	0.0010 ± 0.0002	0.0010 ± 0.0002	Resident	Resident
cvr002120506001	Calaveras River	279	2	0.0009 ± 0.0003	0.0007 ± 0.0002	Resident	Resident
cvr002120506002	Calaveras River	318	3	0.0009 ± 0.0003	0.0010 ± 0.0003	Resident	Resident
cvr003102802001	Calaveras River	368	3	0.0010 ± 0.0002	0.0009 ± 0.0003	Resident	Resident
cvr003102802002	Calaveras River	324	3	0.0014 ± 0.0002	0.0006 ± 0.0003	Steelhead	Resident
cvr003102802003	Calaveras River	324	3	0.0005 ± 0.0003	0.0007 ± 0.0002	Resident	Resident
cvr003102802004	Calaveras River	355	3	0.0010 ± 0.0003	0.0007 ± 0.0003	Resident	Resident
cvr003102802005	Calaveras River	527	4	0.0018 ± 0.0003	0.0007 ± 0.0001	Steelhead	Resident
cvr003102802006	Calaveras River	419	4	0.0008 ± 0.0003	0.0008 ± 0.0002	Resident	Resident
cvr006111303004	Calaveras River	176	1	0.0010 ± 0.0002	0.0008 ± 0.0002	Resident	Resident
cvr006111303006	Calaveras River	135	0	0.0010 ± 0.0003	0.0011 ± 0.0003	Resident	Resident
cvr007011805001	Calaveras River	535	4	0.0018 ± 0.0003	0.0009 ± 0.0001	Steelhead	Steelhead
cvr007030106001	Calaveras River	337	3	0.0013 ± 0.0002	0.0007 ± 0.0004	Resident	Resident
cvr007030106002	Calaveras River	235	2	0.0008 ± 0.0003	0.0007 ± 0.0003	Resident	Resident
cvr007030106003	Calaveras River	303	3	0.0023 ± 0.0004	0.0007 ± 0.0002	Steelhead	Resident
cvr007050306002	Calaveras River	276	2	0.0010 ± 0.0004	0.0013 ± 0.0003	Resident	Resident
cvr007050306003	Calaveras River	301	3	0.0019 ± 0.0003	0.0012 ± 0.0002	Steelhead	Resident
cvr007050306004	Calaveras River	355	3	0.0008 ± 0.0004	0.0011 ± 0.0003	Resident	Resident

CDFG No	Location	Length (mm)	Age	Mean Sr:Ca ± SD		Maternal Origin	Migratory History
				Primordia	FWG		
cvr007050306005	Calaveras River	346	3	0.0014 ± 0.0004	0.0012 ± 0.0004	Resident	Resident
cvr007050306006	Calaveras River	291	2	0.0012 ± 0.0003	0.0008 ± 0.0002	Resident	Resident
cvr007050306007	Calaveras River	284	2	0.0011 ± 0.0004	0.0009 ± 0.0003	Resident	Resident
cvr007050306008	Calaveras River	275	2	0.0010 ± 0.0003	0.0009 ± 0.0004	Resident	Resident
cvr007050306009	Calaveras River	278	2	0.0008 ± 0.0003	0.0007 ± 0.0002	Resident	Resident
cvr007050306010	Calaveras River	266	2	0.0009 ± 0.0002	0.0007 ± 0.0002	Resident	Resident
cvr007050306011	Calaveras River	196	1	0.0008 ± 0.0003	0.0007 ± 0.0002	Resident	Resident
cvr007050306011	Calaveras River	196	1	0.0008 ± 0.0003	0.0007 ± 0.0002	Resident	Resident
cvr007050306012	Calaveras River	250	2	0.0019 ± 0.0003	0.0007 ± 0.0003	Steelhead	Resident
cvr007050306013	Calaveras River	260	2	0.0009 ± 0.0005	0.0008 ± 0.0002	Resident	Resident
cvr007050306014	Calaveras River	278	2	0.0011 ± 0.0004	0.0008 ± 0.0004	Resident	Resident
cvr007050306015	Calaveras River	199	1	0.0011 ± 0.0003	0.0011 ± 0.0002	Resident	Resident
cvr007050306016	Calaveras River	421	4	0.0019 ± 0.0004	0.0007 ± 0.0002	Steelhead	Resident
cvr007050306017	Calaveras River	382	3	0.0016 ± 0.0002	0.0007 ± 0.0002	Steelhead	Resident
cvr007050306018	Calaveras River	289	2	0.0007 ± 0.0003	0.0007 ± 0.0003	Resident	Resident
cvr007050306019	Calaveras River	298	3	0.0013 ± 0.0003	0.0008 ± 0.0002	Resident	Resident
cvr007050306020	Calaveras River	290	2	0.0011 ± 0.0003	0.0013 ± 0.0003	Resident	Resident
cvr007050306021	Calaveras River	340	3	0.0009 ± 0.0003	0.0009 ± 0.0004	Resident	Resident
cvr007050306022	Calaveras River	300	3	0.0008 ± 0.0003	0.0007 ± 0.0003	Resident	Resident
cvr007050306023	Calaveras River	270	2	0.0008 ± 0.0003	0.0007 ± 0.0003	Resident	Resident
cvr007050306024	Calaveras River	289	2	0.0007 ± 0.0003	0.0007 ± 0.0002	Resident	Resident
cvr007050306025	Calaveras River	270	2	0.0017 ± 0.0001	0.0007 ± 0.0001	Steelhead	Resident
cvr007050306026	Calaveras River	265	2	0.0014 ± 0.0002	0.0008 ± 0.0003	Resident	Resident
cvr007050306027	Calaveras River	260	2	0.0019 ± 0.0003	0.0008 ± 0.0002	Steelhead	Resident
cvr007050306028	Calaveras River	245	2	0.0008 ± 0.0003	0.0011 ± 0.0002	Resident	Resident
cvr007050306029	Calaveras River	216	2	0.0010 ± 0.0003	0.0009 ± 0.0003	Resident	Resident
cvr007050306030	Calaveras River	215	2	0.0018 ± 0.0003	0.0007 ± 0.0002	Steelhead	Resident
cvr007051006001	Calaveras River	385	3	0.0008 ± 0.0003	0.0007 ± 0.0004	Resident	Resident
cvr007051006002	Calaveras River	355	3	0.0008 ± 0.0003	0.0007 ± 0.0004	Resident	Resident
cvr007051006003	Calaveras River	276	2	0.0007 ± 0.0004	0.0007 ± 0.0002	Resident	Resident
cvr007051006004	Calaveras River	340	3	0.0007 ± 0.0002	0.0008 ± 0.0003	Resident	Resident
cvr007051006005	Calaveras River	260	2	0.0009 ± 0.0003	0.0008 ± 0.0002	Resident	Resident
cvr007051006007	Calaveras River	277	2	0.0020 ± 0.0002	0.0010 ± 0.0002	Steelhead	Resident
cvr007051006008	Calaveras River	280	2	0.0009 ± 0.0003	0.0009 ± 0.0003	Resident	Resident
cvr007051006009	Calaveras River	290	2	0.0008 ± 0.0003	0.0007 ± 0.0002	Resident	Resident

CDFG No	Location	Length (mm)	Age	Mean Sr:Ca ± SD		Maternal Origin	Migratory History
				Primordia	FWG		
cvr007051006010	Calaveras River	300	3	0.0006 ± 0.0005	0.0007 ± 0.0003	Resident	Resident
cvr007051006011	Calaveras River	240	2	0.0019 ± 0.0003	0.0007 ± 0.0003	Steelhead	Resident
cvr007051006012	Calaveras River	250	2	0.0012 ± 0.0003	0.0007 ± 0.0004	Resident	Resident
cvr007051006013	Calaveras River	269	2	0.0018 ± 0.0003	0.0012 ± 0.0002	Steelhead	Resident
cvr007051006016	Calaveras River	236	2	0.0006 ± 0.0003	0.0009 ± 0.0003	Resident	Resident
cvr007051006017	Calaveras River	238	2	0.0020 ± 0.0004	0.0007 ± 0.0002	Steelhead	Resident
cvr007051006018	Calaveras River	223	2	0.0014 ± 0.0004	0.0006 ± 0.0002	Resident	Resident
cvr007051006019	Calaveras River	215	2	0.0011 ± 0.0003	0.0011 ± 0.0003	Resident	Resident
cvr007051006020	Calaveras River	340	3	0.0011 ± 0.0003	0.0010 ± 0.0004	Resident	Resident
cvr007051006021	Calaveras River	325	3	0.0010 ± 0.0003	0.0009 ± 0.0002	Resident	Resident
cvr007051006022	Calaveras River	340	3	0.0009 ± 0.0002	0.0007 ± 0.0002	Resident	Resident
cvr007051006023	Calaveras River	374	3	0.0016 ± 0.0004	0.0006 ± 0.0002	Steelhead	Resident
cvr007111303001	Calaveras River	205	2	0.0013 ± 0.0003	0.0010 ± 0.0002	Resident	Resident
cvr007111303002	Calaveras River	227	2	0.0017 ± 0.0002	0.0009 ± 0.0002	Steelhead	Resident
cvr007111303003	Calaveras River	235	2	0.0012 ± 0.0002	0.0010 ± 0.0004	Resident	Resident
cvr007111303005	Calaveras River	198	1	0.0014 ± 0.0003	0.0011 ± 0.0003	Resident	Resident
cvr007111303006	Calaveras River	201	1	0.0013 ± 0.0005	0.0010 ± 0.0002	Resident	Resident
cvr007111303007	Calaveras River	172	1	0.0016 ± 0.0003	0.0009 ± 0.0002	Steelhead	Resident
cvr007111303010	Calaveras River	185	1	0.0016 ± 0.0003	0.0007 ± 0.0003	Steelhead	Resident
cvr007111303011	Calaveras River	184	1	0.0020 ± 0.0003	0.0007 ± 0.0002	Steelhead	Resident
cvr007111303016	Calaveras River	190	1	0.0017 ± 0.0004	0.0013 ± 0.0004	Steelhead	Resident
cvr007120506001	Calaveras River	318	3	0.0007 ± 0.0004	0.0013 ± 0.0002	Resident	Resident
cvr007120506002	Calaveras River	274	2	0.0007 ± 0.0004	0.0012 ± 0.0002	Resident	Resident
cvr007120506003	Calaveras River	255	2	0.0010 ± 0.0003	0.0008 ± 0.0003	Resident	Resident
cvr007120506004	Calaveras River	335	3	0.0018 ± 0.0003	0.0009 ± 0.0002	Steelhead	Resident
cvr007120506005	Calaveras River	278	2	0.0008 ± 0.0003	0.0009 ± 0.0003	Resident	Resident
cvr007120506006	Calaveras River	332	3	0.0006 ± 0.0003	0.0007 ± 0.0002	Resident	Resident
cvr007120506007	Calaveras River	405	4	0.0012 ± 0.0003	0.0007 ± 0.0004	Resident	Resident
cvr007120506008	Calaveras River	304	3	0.0011 ± 0.0003	0.0007 ± 0.0002	Resident	Resident
cvr007120506009	Calaveras River	281	2	0.0017 ± 0.0004	0.0007 ± 0.0002	Steelhead	Resident
cvr007120506010	Calaveras River	296	2	0.0008 ± 0.0003	0.0010 ± 0.0004	Resident	Resident
cvr007120506011	Calaveras River	315	3	0.0017 ± 0.0003	0.0010 ± 0.0002	Steelhead	Resident
cvr007120506012	Calaveras River	219	2	0.0007 ± 0.0005	0.0007 ± 0.0003	Resident	Resident
cvr007120506013	Calaveras River	280	2	0.0018 ± 0.0003	0.0006 ± 0.0003	Steelhead	Resident
cvr007120506014	Calaveras River	202	1	0.0014 ± 0.0003	0.0011 ± 0.0003	Resident	Resident

CDFG No	Location	Length (mm)	Age	Mean Sr:Ca ± SD		Maternal Origin	Migratory History
				Primordia	FWG		
cvr007120506015	Calaveras River	308	3	0.0015 ± 0.0003	0.0010 ± 0.0003	Resident	Resident
cvr007120506017	Calaveras River	249	2	0.0016 ± 0.0001	0.0007 ± 0.0002	Steelhead	Resident
cvr007120506018	Calaveras River	191	1	0.0007 ± 0.0003	0.0007 ± 0.0002	Resident	Resident
cvr007120506019	Calaveras River	222	2	0.0009 ± 0.0003	0.0007 ± 0.0002	Resident	Resident
cvr007120506020	Calaveras River	233	2	0.0015 ± 0.0003	0.0008 ± 0.0003	Resident	Resident
cvr007120506021	Calaveras River	198	1	0.0016 ± 0.0004	0.0013 ± 0.0004	Steelhead	Resident
cvr007120506022	Calaveras River	197	1	0.0007 ± 0.0004	0.0014 ± 0.0002	Resident	Resident
cvr007120506023	Calaveras River	192	1	0.0007 ± 0.0004	0.0008 ± 0.0003	Resident	Resident
cvr007120506024	Calaveras River	170	1	0.0009 ± 0.0003	0.0007 ± 0.0002	Resident	Resident
cvr008011805001	Calaveras River	300	3	0.0014 ± 0.0003	0.0007 ± 0.0002	Resident	Resident
cvr008030106001	Calaveras River	245	2	0.0009 ± 0.0003	0.0008 ± 0.0002	Resident	Resident
cvr008030106002	Calaveras River	211	2	0.0008 ± 0.0002	0.0014 ± 0.0004	Resident	Resident
cvr008030106003	Calaveras River	368	3	0.0008 ± 0.0002	0.0007 ± 0.0002	Resident	Resident
cvr008041302001	Calaveras River	700	4	0.0008 ± 0.0002	0.0007 ± 0.0002	Resident	Steelhead
cvr009042505001	Calaveras River	194	1	0.0007 ± 0.0003	0.0007 ± 0.0003	Resident	Resident
cvr009042505002	Calaveras River	190	1	0.0017 ± 0.0002	0.0009 ± 0.0004	Steelhead	Resident
cvr009042505003	Calaveras River	176	1	0.0009 ± 0.0003	0.0014 ± 0.0003	Resident	Resident
cvr009102504001	Calaveras River	195	1	0.0020 ± 0.0004	0.0009 ± 0.0003	Steelhead	Resident
cvr009102504004	Calaveras River	310	3	0.0017 ± 0.0004	0.0007 ± 0.0002	Steelhead	Resident
cvr009102504007	Calaveras River	220	2	0.0009 ± 0.0003	0.0009 ± 0.0002	Resident	Resident
cvr009102504008	Calaveras River	199	1	0.0010 ± 0.0003	0.0011 ± 0.0002	Resident	Resident
cvr009102504009	Calaveras River	199	1	0.0012 ± 0.0003	0.0009 ± 0.0002	Resident	Resident
cvr010102504001	Calaveras River	188	1	0.0011 ± 0.0003	0.0008 ± 0.0002	Resident	Resident
cvr011020706001	Calaveras River	210	2	0.0010 ± 0.0004	0.0007 ± 0.0004	Resident	Resident
cvr011030106001	Calaveras River	158	0	0.0008 ± 0.0005	0.0007 ± 0.0002	Resident	Resident
cvr011030106002	Calaveras River	182	1	0.0016 ± 0.0003	0.0007 ± 0.0002	Steelhead	Resident
cvr011051506001	Calaveras River	423	4	0.0016 ± 0.0003	0.0008 ± 0.0004	Steelhead	Resident
cvr020042005001	Calaveras River	306	3	0.0020 ± 0.0004	0.0010 ± 0.0002	Steelhead	Resident
cvr020042005002	Calaveras River	255	2	0.0020 ± 0.0002	0.0009 ± 0.0002	Steelhead	Resident
cvr020042005003	Calaveras River	223	2	0.0018 ± 0.0003	0.0008 ± 0.0002	Steelhead	Resident
cvr020042005004	Calaveras River	228	2	0.0007 ± 0.0002	0.0008 ± 0.0002	Resident	Resident
cvr020042005005	Calaveras River	200	1	0.0012 ± 0.0003	0.0007 ± 0.0002	Resident	Resident
cvr020042005006	Calaveras River	205	2	0.0011 ± 0.0003	0.0012 ± 0.0003	Resident	Resident
cvr020042005007	Calaveras River	206	2	0.0007 ± 0.0003	0.0008 ± 0.0002	Resident	Resident
cvr020042005008	Calaveras River	232	2	0.0009 ± 0.0002	0.0009 ± 0.0002	Resident	Resident

CDFG No	Location	Length (mm)	Age	Mean Sr:Ca ± SD		Maternal Origin	Migratory History
				Primordia	FWG		
cvr020042005009	Calaveras River	189	1	0.0010 ± 0.0003	0.0010 ± 0.0003	Resident	Resident
cvr020042005010	Calaveras River	182	1	0.0018 ± 0.0004	0.0007 ± 0.0003	Steelhead	Resident
cvr020042005011	Calaveras River	185	1	0.0009 ± 0.0003	0.0006 ± 0.0003	Resident	Resident
cvr020042005012	Calaveras River	150	0	0.0017 ± 0.0002	0.0012 ± 0.0003	Steelhead	Resident
cvr021102406001	Calaveras River	273	2	0.0008 ± 0.0001	0.0011 ± 0.0004	Resident	Resident
der001070703001	Deer Creek	125	1	0.0008 ± 0.0001	0.0010 ± 0.0005	Resident	Resident
der001070703005	Deer Creek	93	0	0.0011 ± 0.0003	0.0013 ± 0.0004	Resident	Resident
der001070703008	Deer Creek	140	1	0.0019 ± 0.0002	0.0012 ± 0.0003	Steelhead	Resident
der001070703011	Deer Creek	160	1	0.0011 ± 0.0003	0.0013 ± 0.0003	Resident	Resident
der001070703012	Deer Creek	160	1	0.0012 ± 0.0003	0.0011 ± 0.0003	Resident	Resident
der001070703013	Deer Creek	115	1	0.0006 ± 0.0003	0.0013 ± 0.0004	Resident	Resident
der001070703014	Deer Creek	110	1	0.0011 ± 0.0003	0.0013 ± 0.0004	Resident	Resident
der001070703015	Deer Creek	114	1	0.0021 ± 0.0003	0.0011 ± 0.0004	Steelhead	Resident
der001070703016	Deer Creek	100	1	0.0011 ± 0.0003	0.0012 ± 0.0001	Resident	Resident
der001070703017	Deer Creek	81	0	0.0008 ± 0.0001	0.0010 ± 0.0005	Resident	Resident
der001070703018	Deer Creek	83	0	0.0010 ± 0.0003	0.0012 ± 0.0002	Resident	Resident
der001070703019	Deer Creek	93	0	0.0011 ± 0.0003	0.0010 ± 0.0002	Resident	Resident
der001070703019	Deer Creek	93	0	0.0020 ± 0.0003	0.0010 ± 0.0002	Steelhead	Resident
der001r030105001	Deer Creek	219	2	0.0020 ± 0.0002	0.0012 ± 0.0003	Steelhead	Resident
der001r030305002	Deer Creek	183	1	0.0017 ± 0.0003	0.0009 ± 0.0002	Steelhead	Resident
der001r030305003	Deer Creek	184	1	0.0017 ± 0.0004	0.0012 ± 0.0002	Steelhead	Resident
der001r030305003	Deer Creek	184	1	0.0017 ± 0.0004	0.0012 ± 0.0002	Steelhead	Resident
der001r030305004	Deer Creek	171	1	0.0018 ± 0.0003	0.0009 ± 0.0002	Steelhead	Resident
der001r032405005	Deer Creek	244	2	0.0018 ± 0.0004	0.0011 ± 0.0002	Steelhead	Resident
der001r033105006	Deer Creek	204	2	0.0019 ± 0.0004	0.0011 ± 0.0004	Steelhead	Resident
der001r033105007	Deer Creek	228	2	0.0019 ± 0.0002	0.0009 ± 0.0003	Steelhead	Resident
der001r033105008	Deer Creek	180	1	0.0021 ± 0.0003	0.0013 ± 0.0003	Steelhead	Resident
der001r033105009	Deer Creek	160	1	0.0018 ± 0.0003	0.0012 ± 0.0003	Steelhead	Resident
der001R040405010	Deer Creek	181	1	0.0012 ± 0.0003	0.0013 ± 0.0004	Resident	Resident
der001R040405011	Deer Creek	190	2	0.0021 ± 0.0003	0.0013 ± 0.0003	Steelhead	Resident
der001R040405012	Deer Creek	208	2	0.0019 ± 0.0003	0.0011 ± 0.0003	Steelhead	Resident
der001R040405013	Deer Creek	191	2	0.0015 ± 0.0003	0.0013 ± 0.0002	Steelhead	Resident
der001r040505014	Deer Creek	205	2	0.0019 ± 0.0003	0.0013 ± 0.0002	Steelhead	Resident
der001r040505015	Deer Creek	205	2	0.0010 ± 0.0003	0.0012 ± 0.0003	Resident	Resident
der001r040705016	Deer Creek	199	2	0.0017 ± 0.0003	0.0011 ± 0.0002	Steelhead	Resident

CDFG No	Location	Length (mm)	Age	Mean Sr:Ca ± SD		Maternal Origin	Migratory History
				Primordia	FWG		
der001r041205017	Deer Creek	215	2	0.0018 ± 0.0004	0.0012 ± 0.0002	Steelhead	Resident
der001r041205018	Deer Creek	152	1	0.0018 ± 0.0003	0.0011 ± 0.0003	Steelhead	Resident
der001r041305019	Deer Creek	193	2	0.0020 ± 0.0004	0.0010 ± 0.0006	Steelhead	Resident
der001r041505020	Deer Creek	227	2	0.0019 ± 0.0003	0.0012 ± 0.0002	Steelhead	Resident
der002070803001	Deer Creek	184	1	0.0018 ± 0.0003	0.0012 ± 0.0003	Steelhead	Resident
der002070803003	Deer Creek	107	1	0.0012 ± 0.0003	0.0013 ± 0.0002	Resident	Resident
der002070803005	Deer Creek	205	2	0.0012 ± 0.0003	0.0012 ± 0.0003	Resident	Resident
der002070803007	Deer Creek	181	1	0.0019 ± 0.0002	0.0012 ± 0.0004	Steelhead	Resident
der002070803009	Deer Creek	100	1	0.0018 ± 0.0004	0.0013 ± 0.0004	Steelhead	Resident
der002070803010	Deer Creek	102	1	0.0017 ± 0.0003	0.0012 ± 0.0002	Steelhead	Resident
der002070803011	Deer Creek	122	1	0.0010 ± 0.0003	0.0009 ± 0.0002	Resident	Resident
der002070803012	Deer Creek	98	1	0.0010 ± 0.0004	0.0012 ± 0.0002	Resident	Resident
der003091103003	Deer Creek	185	2	0.0010 ± 0.0003	0.0012 ± 0.0002	Resident	Resident
der003091103004	Deer Creek	222	2	0.0019 ± 0.0004	0.0010 ± 0.0003	Steelhead	Resident
der004091103001	Deer Creek	163	1	0.0010 ± 0.0004	0.0011 ± 0.0003	Resident	Resident
der004091103002	Deer Creek	221	2	0.0011 ± 0.0003	0.0013 ± 0.0002	Resident	Resident
der005091003001	Deer Creek	156	1	0.0019 ± 0.0003	0.0013 ± 0.0004	Steelhead	Resident
der005091003002	Deer Creek	158	1	0.0018 ± 0.0001	0.0012 ± 0.0001	Steelhead	Resident
der006091003001	Deer Creek	204	2	0.0019 ± 0.0002	0.0013 ± 0.0002	Steelhead	Resident
der006091003002	Deer Creek	187	2	0.0020 ± 0.0003	0.0013 ± 0.0003	Steelhead	Resident
der006091003003	Deer Creek	161	1	0.0020 ± 0.0003	0.0015 ± 0.0004	Steelhead	Resident
der006092705001	Deer Creek	180	1	0.0020 ± 0.0003	0.0013 ± 0.0003	Steelhead	Resident
der006092705002	Deer Creek	138	1	0.0020 ± 0.0003	0.0011 ± 0.0002	Steelhead	Resident
der006092705003	Deer Creek	136	1	0.0011 ± 0.0005	0.0011 ± 0.0003	Resident	Resident
der006092705004	Deer Creek	119	1	0.0020 ± 0.0003	0.0013 ± 0.0003	Steelhead	Resident
der006092705005	Deer Creek	172	1	0.0010 ± 0.0004	0.0011 ± 0.0002	Resident	Resident
der006092705006	Deer Creek	190	2	0.0016 ± 0.0003	0.0009 ± 0.0002	Steelhead	Resident
der006092705007	Deer Creek	140	1	0.0019 ± 0.0002	0.0014 ± 0.0004	Steelhead	Resident
der006092705008	Deer Creek	159	1	0.0017 ± 0.0003	0.0012 ± 0.0003	Steelhead	Resident
der006092705009	Deer Creek	126	1	0.0020 ± 0.0003	0.0012 ± 0.0002	Steelhead	Resident
der006092705010	Deer Creek	158	1	0.0011 ± 0.0004	0.0011 ± 0.0002	Resident	Resident
der006092705011	Deer Creek	167	1	0.0013 ± 0.0003	0.0014 ± 0.0003	Resident	Resident
der006092705012	Deer Creek	161	1	0.0020 ± 0.0003	0.0013 ± 0.0003	Steelhead	Resident
der006092705013	Deer Creek	205	2	0.0009 ± 0.0005	0.0011 ± 0.0002	Resident	Resident
der006092705014	Deer Creek	277	3	0.0020 ± 0.0003	0.0009 ± 0.0001	Steelhead	Resident

CDFG No	Location	Length (mm)	Age	Mean Sr:Ca ± SD		Maternal Origin	Migratory History
				Primordia	FWG		
der006092705015	Deer Creek	317	3	0.0018 ± 0.0003	0.0011 ± 0.0003	Steelhead	Resident
der007091003001	Deer Creek	216	2	0.0012 ± 0.0003	0.0013 ± 0.0002	Resident	Resident
der007091003002	Deer Creek	161	1	0.0020 ± 0.0003	0.0011 ± 0.0002	Steelhead	Resident
der007091003004	Deer Creek	194	2	0.0019 ± 0.0002	0.0011 ± 0.0002	Steelhead	Resident
der007091003006	Deer Creek	183	1	0.0019 ± 0.0002	0.0010 ± 0.0003	Steelhead	Resident
der007091003007	Deer Creek	153	1	0.0019 ± 0.0003	0.0012 ± 0.0002	Steelhead	Resident
der007091003009	Deer Creek	234	2	0.0011 ± 0.0003	0.0012 ± 0.0002	Resident	Resident
der007091003010	Deer Creek	144	1	0.0019 ± 0.0003	0.0010 ± 0.0002	Steelhead	Resident
der007091003012	Deer Creek	144	1	0.0019 ± 0.0003	0.0013 ± 0.0003	Steelhead	Resident
der007091003013	Deer Creek	218	2	0.0011 ± 0.0003	0.0013 ± 0.0003	Resident	Resident
der007092605002	Deer Creek	84	0	0.0021 ± 0.0004	0.0012 ± 0.0002	Steelhead	Resident
der007092605006	Deer Creek	72	0	0.0011 ± 0.0002	0.0010 ± 0.0004	Resident	Resident
der007092605007	Deer Creek	84	0	0.0019 ± 0.0003	0.0014 ± 0.0001	Steelhead	Resident
der007092605008	Deer Creek	93	0	0.0019 ± 0.0003	0.0013 ± 0.0002	Steelhead	Resident
der007092605009	Deer Creek	79	0	0.0020 ± 0.0002	0.0011 ± 0.0003	Steelhead	Resident
der007092605011	Deer Creek	72	0	0.0013 ± 0.0003	0.0012 ± 0.0002	Resident	Resident
der007092605011	Deer Creek	72	0	0.0011 ± 0.0003	0.0013 ± 0.0004	Resident	Resident
der007092605012	Deer Creek	88	0	0.0011 ± 0.0003	0.0011 ± 0.0002	Resident	Resident
der007092605013	Deer Creek	74	0	0.0020 ± 0.0002	0.0011 ± 0.0002	Steelhead	Resident
der007092605014	Deer Creek	68	0	0.0019 ± 0.0003	0.0014 ± 0.0003	Steelhead	Resident
der007092605015	Deer Creek	69	0	0.0019 ± 0.0003	0.0013 ± 0.0003	Steelhead	Resident
der007092605016	Deer Creek	132	1	0.0012 ± 0.0003	0.0014 ± 0.0002	Resident	Resident
der007092605017	Deer Creek	131	1	0.0019 ± 0.0003	0.0013 ± 0.0002	Steelhead	Resident
der007092605018	Deer Creek	88	0	0.0020 ± 0.0004	0.0014 ± 0.0004	Steelhead	Resident
der007092605019	Deer Creek	83	0	0.0011 ± 0.0003	0.0012 ± 0.0004	Resident	Resident
der007092605020	Deer Creek	88	0	0.0022 ± 0.0003	0.0014 ± 0.0001	Steelhead	Resident
der007092605022	Deer Creek	85	0	0.0019 ± 0.0004	0.0013 ± 0.0002	Steelhead	Resident
der007092605023	Deer Creek	108	1	0.0018 ± 0.0003	0.0012 ± 0.0002	Steelhead	Resident
der007092605024	Deer Creek	113	1	0.0019 ± 0.0002	0.0014 ± 0.0002	Steelhead	Resident
der007092605026	Deer Creek	139	1	0.0019 ± 0.0003	0.0014 ± 0.0002	Steelhead	Resident
der007092605027	Deer Creek	136	1	0.0016 ± 0.0002	0.0009 ± 0.0002	Steelhead	Resident
der007092605028	Deer Creek	144	1	0.0020 ± 0.0004	0.0011 ± 0.0002	Steelhead	Resident
der007092605029	Deer Creek	215	2	0.0016 ± 0.0002	0.0011 ± 0.0003	Steelhead	Resident
der007092605029	Deer Creek	215	2	0.0019 ± 0.0002	0.0011 ± 0.0003	Steelhead	Resident
der007092605030	Deer Creek	100	1	0.0021 ± 0.0003	0.0012 ± 0.0003	Steelhead	Resident

CDFG No	Location	Length (mm)	Age	Mean Sr:Ca ± SD		Maternal Origin	Migratory History
				Primordia	FWG		
der007092605031	Deer Creek	85	0	0.0019 ± 0.0004	0.0012 ± 0.0003	Steelhead	Resident
der007092705001	Deer Creek	75	0	0.0019 ± 0.0004	0.0009 ± 0.0004	Steelhead	Resident
der007092705003	Deer Creek	91	0	0.0019 ± 0.0004	0.0011 ± 0.0003	Steelhead	Resident
der007092705004	Deer Creek	92	0	0.0022 ± 0.0003	0.0012 ± 0.0002	Steelhead	Resident
der007092705004	Deer Creek	92	0	0.0021 ± 0.0003	0.0012 ± 0.0002	Steelhead	Resident
der007092705005	Deer Creek	86	0	0.0018 ± 0.0003	0.0010 ± 0.0002	Steelhead	Resident
der007092705006	Deer Creek	87	0	0.0020 ± 0.0003	0.0012 ± 0.0003	Steelhead	Resident
der007092705008	Deer Creek	76	0	0.0017 ± 0.0003	0.0009 ± 0.0003	Steelhead	Resident
der007092705009	Deer Creek	110	1	0.0010 ± 0.0003	0.0012 ± 0.0002	Resident	Resident
der007092705010	Deer Creek	77	0	0.0017 ± 0.0002	0.0011 ± 0.0003	Steelhead	Resident
der007092705011	Deer Creek	78	0	0.0018 ± 0.0003	0.0009 ± 0.0003	Steelhead	Resident
der007092705012	Deer Creek	78	0	0.0019 ± 0.0003	0.0013 ± 0.0002	Steelhead	Resident
der007092705014	Deer Creek	73	0	0.0011 ± 0.0003	0.0011 ± 0.0003	Resident	Resident
der007092705016	Deer Creek	81	0	0.0020 ± 0.0001	0.0012 ± 0.0004	Steelhead	Resident
der007092705017	Deer Creek	78	0	0.0019 ± 0.0003	0.0012 ± 0.0002	Steelhead	Resident
der007092705018	Deer Creek	73	0	0.0020 ± 0.0002	0.0014 ± 0.0002	Steelhead	Resident
der007092705019	Deer Creek	86	0	0.0012 ± 0.0003	0.0013 ± 0.0004	Resident	Resident
der007092705020	Deer Creek	59	0	0.0019 ± 0.0003	0.0011 ± 0.0002	Steelhead	Resident
der007092705021	Deer Creek	91	0	0.0011 ± 0.0004	0.0014 ± 0.0002	Resident	Resident
der007092705022	Deer Creek	79	0	0.0018 ± 0.0002	0.0012 ± 0.0002	Steelhead	Resident
der007092705023	Deer Creek	127	1	0.0020 ± 0.0003	0.0011 ± 0.0002	Steelhead	Resident
der007092705024	Deer Creek	217	2	0.0019 ± 0.0003	0.0012 ± 0.0003	Steelhead	Resident
der007092705025	Deer Creek	181	1	0.0019 ± 0.0003	0.0012 ± 0.0002	Steelhead	Resident
der007092705026	Deer Creek	177	1	0.0021 ± 0.0003	0.0014 ± 0.0003	Steelhead	Resident
der007092705027	Deer Creek	202	2	0.0019 ± 0.0002	0.0011 ± 0.0004	Steelhead	Resident
der007092705028	Deer Creek	147	1	0.0019 ± 0.0003	0.0011 ± 0.0002	Steelhead	Resident
der007092705029	Deer Creek	168	1	0.0019 ± 0.0002	0.0011 ± 0.0002	Steelhead	Resident
der007092705030	Deer Creek	163	1	0.0021 ± 0.0003	0.0012 ± 0.0002	Steelhead	Resident
der007092705031	Deer Creek	155	1	0.0019 ± 0.0005	0.0013 ± 0.0003	Steelhead	Resident
der007092705032	Deer Creek	172	1	0.0020 ± 0.0003	0.0010 ± 0.0004	Steelhead	Resident
der007092705033	Deer Creek	168	1	0.0017 ± 0.0003	0.0010 ± 0.0003	Steelhead	Resident
der007092705034	Deer Creek	151	1	0.0010 ± 0.0002	0.0009 ± 0.0003	Resident	Resident
der007092705035	Deer Creek	142	1	0.0020 ± 0.0003	0.0012 ± 0.0002	Steelhead	Resident
der007092705036	Deer Creek	140	1	0.0011 ± 0.0003	0.0012 ± 0.0002	Resident	Resident
der007092705037	Deer Creek	134	1	0.0018 ± 0.0005	0.0011 ± 0.0003	Steelhead	Resident

CDFG No	Location	Length (mm)	Age	Mean Sr:Ca ± SD		Maternal Origin	Migratory History
				Primordia	FWG		
der007092705038	Deer Creek	113	1	0.0019 ± 0.0003	0.0013 ± 0.0001	Steelhead	Resident
der007092705040	Deer Creek	128	1	0.0019 ± 0.0004	0.0012 ± 0.0003	Steelhead	Resident
der007092705041	Deer Creek	97	1	0.0020 ± 0.0004	0.0013 ± 0.0002	Steelhead	Resident
der007092705042	Deer Creek	122	1	0.0020 ± 0.0003	0.0013 ± 0.0002	Steelhead	Resident
der007092705043	Deer Creek	87	0	0.0018 ± 0.0003	0.0012 ± 0.0003	Steelhead	Resident
der007092705045	Deer Creek	115	1	0.0020 ± 0.0003	0.0010 ± 0.0002	Steelhead	Resident
der007092705047	Deer Creek	97	1	0.0021 ± 0.0005	0.0013 ± 0.0003	Steelhead	Resident
der007092705050	Deer Creek	75	0	0.0020 ± 0.0003	0.0012 ± 0.0002	Steelhead	Resident
der007092705051	Deer Creek	76	0	0.0018 ± 0.0003	0.0010 ± 0.0003	Steelhead	Resident
der007092705052	Deer Creek	83	0	0.0018 ± 0.0004	0.0010 ± 0.0003	Steelhead	Resident
der007092705053	Deer Creek	89	0	0.0016 ± 0.0004	0.0010 ± 0.0002	Steelhead	Resident
der007092705054	Deer Creek	80	0	0.0019 ± 0.0003	0.0012 ± 0.0002	Steelhead	Resident
der007092705055	Deer Creek	98	1	0.0017 ± 0.0003	0.0009 ± 0.0002	Steelhead	Resident
der007092705056	Deer Creek	98	1	0.0016 ± 0.0003	0.0011 ± 0.0001	Steelhead	Resident
der007092705057	Deer Creek	66	0	0.0010 ± 0.0004	0.0008 ± 0.0003	Resident	Resident
der007092705058	Deer Creek	94	1	0.0017 ± 0.0003	0.0010 ± 0.0002	Steelhead	Resident
der007092705059	Deer Creek	63	0	0.0018 ± 0.0003	0.0010 ± 0.0001	Steelhead	Resident
der007092705060	Deer Creek	73	0	0.0018 ± 0.0003	0.0011 ± 0.0003	Steelhead	Resident
der007092705061	Deer Creek	82	0	0.0018 ± 0.0002	0.0011 ± 0.0002	Steelhead	Resident
der008041905001	Deer Creek	189	2	0.0010 ± 0.0004	0.0008 ± 0.0003	Resident	Resident
stn001021704005	Stanislaus River	350	3	0.0012 ± 0.0003	0.0013 ± 0.0002	Resident	Resident
stn001022206001	Stanislaus River	259	2	0.0009 ± 0.0004	0.0012 ± 0.0001	Resident	Resident
stn001022206002	Stanislaus River	245	2	0.0014 ± 0.0002	0.0015 ± 0.0003	Resident	Resident
stn001022206004	Stanislaus River	225	2	0.0011 ± 0.0003	0.0013 ± 0.0005	Resident	Resident
stn001110503002	Stanislaus River	311	3	0.0011 ± 0.0002	0.0013 ± 0.0005	Resident	Resident
stn001110503003	Stanislaus River	342	3	0.0013 ± 0.0006	0.0012 ± 0.0004	Resident	Resident
stn001110503004	Stanislaus River	182	1	0.0022 ± 0.0002	0.0013 ± 0.0002	Steelhead	Resident
stn001110905001	Stanislaus River	185	1	0.0012 ± 0.0002	0.0013 ± 0.0003	Resident	Resident
stn001110905002	Stanislaus River	420	4	0.0012 ± 0.0003	0.0013 ± 0.0004	Resident	Resident
stn001110905003	Stanislaus River	331	3	0.0014 ± 0.0003	0.0014 ± 0.0002	Resident	Resident
stn001110905004	Stanislaus River	142	1	0.0012 ± 0.0002	0.0014 ± 0.0002	Resident	Resident
stn001110905005	Stanislaus River	190	1	0.0012 ± 0.0002	0.0013 ± 0.0004	Resident	Resident
stn001110905006	Stanislaus River	174	1	0.0015 ± 0.0002	0.0015 ± 0.0004	Resident	Resident
stn001111606001	Stanislaus River	428	4	0.0020 ± 0.0004	0.0013 ± 0.0004	Steelhead	Resident
stn001111606002	Stanislaus River	314	3	0.0014 ± 0.0003	0.0015 ± 0.0001	Resident	Resident

CDFG No	Location	Length (mm)	Age	Mean Sr:Ca ± SD		Maternal Origin	Migratory History
				Primordia	FWG		
stn001111606003	Stanislaus River	295	2	0.0009 ± 0.0004	0.0012 ± 0.0002	Resident	Resident
stn001111606004	Stanislaus River	298	2	0.0009 ± 0.0003	0.0011 ± 0.0003	Resident	Resident
stn001111606005	Stanislaus River	284	2	0.0010 ± 0.0004	0.0012 ± 0.0002	Resident	Resident
stn001111606006	Stanislaus River	380	3	0.0016 ± 0.0005	0.0016 ± 0.0003	Resident	Resident
stn001111606011	Stanislaus River	235	2	0.0009 ± 0.0002	0.0012 ± 0.0003	Resident	Resident
stn001111606012	Stanislaus River	319	3	0.0015 ± 0.0001	0.0015 ± 0.0003	Resident	Resident
stn001111606013	Stanislaus River	281	2	0.0013 ± 0.0002	0.0015 ± 0.0003	Resident	Resident
stn001111606014	Stanislaus River	373	3	0.0011 ± 0.0004	0.0012 ± 0.0004	Resident	Resident
stn001111606015	Stanislaus River	334	3	0.0015 ± 0.0002	0.0015 ± 0.0002	Resident	Resident
stn001111606016	Stanislaus River	237	2	0.0009 ± 0.0004	0.0012 ± 0.0002	Resident	Resident
stn001111606017	Stanislaus River	285	2	0.0022 ± 0.0004	0.0015 ± 0.0003	Steelhead	Resident
stn001111606018	Stanislaus River	262	2	0.0012 ± 0.0004	0.0013 ± 0.0003	Resident	Resident
stn001111606019	Stanislaus River	262	2	0.0019 ± 0.0002	0.0012 ± 0.0002	Steelhead	Resident
stn002022206001	Stanislaus River	330	3	0.0009 ± 0.0003	0.0012 ± 0.0004	Resident	Resident
stn002022206002	Stanislaus River	295	2	0.0014 ± 0.0004	0.0014 ± 0.0004	Resident	Resident
stn002031506001	Stanislaus River	234	2	0.0024 ± 0.0004	0.0014 ± 0.0005	Steelhead	Resident
stn002031506002	Stanislaus River	445	4	0.0010 ± 0.0004	0.0012 ± 0.0004	Resident	Resident
stn002031506003	Stanislaus River	221	2	0.0016 ± 0.0002	0.0016 ± 0.0005	Resident	Resident
stn002060705001	Stanislaus River	290	2	0.0011 ± 0.0002	0.0012 ± 0.0004	Resident	Resident
stn002110503001	Stanislaus River	340	3	0.0015 ± 0.0002	0.0012 ± 0.0002	Resident	Resident
stn003110503002	Stanislaus River	225	2	0.0017 ± 0.0005	0.0012 ± 0.0002	Steelhead	Resident
stn003110503003	Stanislaus River	216	2	0.0023 ± 0.0003	0.0014 ± 0.0002	Steelhead	Resident
stn003110905001	Stanislaus River	183	1	0.0013 ± 0.0002	0.0013 ± 0.0004	Resident	Resident
stn003110905002	Stanislaus River	208	2	0.0012 ± 0.0004	0.0013 ± 0.0002	Resident	Resident
stn003110905003	Stanislaus River	158	1	0.0011 ± 0.0002	0.0013 ± 0.0003	Resident	Resident
stn003110905004	Stanislaus River	177	1	0.0013 ± 0.0002	0.0015 ± 0.0002	Resident	Resident
stn004110503001	Stanislaus River	215	2	0.0014 ± 0.0004	0.0015 ± 0.0002	Resident	Resident
stn004110503003	Stanislaus River	190	1	0.0016 ± 0.0004	0.0015 ± 0.0002	Resident	Resident
stn004110503004	Stanislaus River	190	1	0.0011 ± 0.0002	0.0012 ± 0.0001	Resident	Resident
stn005022206001	Stanislaus River	279	2	0.0009 ± 0.0002	0.0012 ± 0.0001	Resident	Resident
stn005022206002	Stanislaus River	260	2	0.0015 ± 0.0002	0.0015 ± 0.0002	Resident	Resident
stn005110503001	Stanislaus River	195	1	0.0011 ± 0.0002	0.0014 ± 0.0002	Resident	Resident
stn005110503002	Stanislaus River	198	1	0.0013 ± 0.0002	0.0013 ± 0.0002	Resident	Resident
stn006110503001	Stanislaus River	206	2	0.0009 ± 0.0002	0.0016 ± 0.0003	Resident	Resident
stn006110503001	Stanislaus River	206	2	0.0009 ± 0.0002	0.0016 ± 0.0003	Resident	Resident

CDFG No	Location	Length (mm)	Age	Mean Sr:Ca ± SD		Maternal Origin	Migratory History
				Primordia	FWG		
stn007031506001	Stanislaus River	260	2	0.0013 ± 0.0002	0.0013 ± 0.0002	Resident	Resident
stn007031506002	Stanislaus River	253	2	0.0010 ± 0.0002	0.0012 ± 0.0004	Resident	Resident
stn007031506003	Stanislaus River	233	2	0.0010 ± 0.0003	0.0012 ± 0.0003	Resident	Resident
stn007110905012	Stanislaus River	398	3	0.0023 ± 0.0003	0.0015 ± 0.0002	Steelhead	Resident
stn007110905013	Stanislaus River	253	2	0.0013 ± 0.0003	0.0014 ± 0.0001	Resident	Resident
stn007110905014	Stanislaus River	312	3	0.0012 ± 0.0005	0.0013 ± 0.0003	Resident	Resident
stn007110905015	Stanislaus River	295	2	0.0016 ± 0.0001	0.0016 ± 0.0004	Resident	Resident
stn007110905016	Stanislaus River	305	3	0.0011 ± 0.0004	0.0012 ± 0.0001	Resident	Resident
stn009110905007	Stanislaus River	290	2	0.0024 ± 0.0002	0.0015 ± 0.0004	Steelhead	Resident
stn009110905008	Stanislaus River	315	3	0.0013 ± 0.0002	0.0013 ± 0.0004	Resident	Resident
stn009110905009	Stanislaus River	220	2	0.0009 ± 0.0002	0.0012 ± 0.0002	Resident	Resident
stn009110905010	Stanislaus River	320	3	0.0014 ± 0.0002	0.0015 ± 0.0002	Resident	Resident
stn009110905011	Stanislaus River	370	3	0.0012 ± 0.0003	0.0014 ± 0.0003	Resident	Resident
stn009110905013	Stanislaus River	205	2	0.0012 ± 0.0002	0.0013 ± 0.0005	Resident	Resident
stn010110905001	Stanislaus River	140	1	0.0016 ± 0.0003	0.0016 ± 0.0002	Resident	Resident
stn010110905002	Stanislaus River	350	3	0.0009 ± 0.0002	0.0012 ± 0.0002	Resident	Resident
stn010110905003	Stanislaus River	220	2	0.0013 ± 0.0002	0.0014 ± 0.0001	Resident	Resident
stn012110905017	Stanislaus River	350	3	0.0011 ± 0.0001	0.0013 ± 0.0004	Resident	Resident
stn012110905018	Stanislaus River	250	2	0.0011 ± 0.0002	0.0012 ± 0.0002	Resident	Resident
stn012110905019	Stanislaus River	285	2	0.0011 ± 0.0004	0.0012 ± 0.0002	Resident	Resident
stn012110905020	Stanislaus River	200	2	0.0013 ± 0.0005	0.0014 ± 0.0002	Resident	Resident
stn012110905021	Stanislaus River	190	1	0.0014 ± 0.0003	0.0014 ± 0.0005	Resident	Resident
stn012110905022	Stanislaus River	345	3	0.0011 ± 0.0004	0.0013 ± 0.0002	Resident	Resident
stn012110905024	Stanislaus River	380	3	0.0025 ± 0.0002	0.0016 ± 0.0005	Steelhead	Resident
stn013060705001	Stanislaus River	230	2	0.0010 ± 0.0005	0.0012 ± 0.0003	Resident	Resident
stn013060705002	Stanislaus River	412	4	0.0014 ± 0.0002	0.0015 ± 0.0004	Resident	Resident
stn013110905004	Stanislaus River	365	3	0.0013 ± 0.0003	0.0013 ± 0.0004	Resident	Resident
stn013110905005	Stanislaus River	210	2	0.0012 ± 0.0005	0.0013 ± 0.0004	Resident	Resident
stn013110905006	Stanislaus River	233	2	0.0011 ± 0.0002	0.0012 ± 0.0002	Resident	Resident
stn014060705001	Stanislaus River	265	2	0.0022 ± 0.0004	0.0015 ± 0.0002	Steelhead	Resident
stn016021704001	Stanislaus River	224	2	0.0021 ± 0.0003	0.0014 ± 0.0003	Steelhead	Resident
stn016021704002	Stanislaus River	290	2	0.0012 ± 0.0002	0.0013 ± 0.0002	Resident	Resident
stn016022206001	Stanislaus River	322	3	0.0015 ± 0.0004	0.0016 ± 0.0003	Resident	Resident
stn016022206002	Stanislaus River	230	2	0.0012 ± 0.0001	0.0013 ± 0.0004	Resident	Resident
stn016111606001	Stanislaus River	267	2	0.0012 ± 0.0002	0.0014 ± 0.0002	Resident	Resident

CDFG No	Location	Length (mm)	Age	Mean Sr:Ca ± SD		Maternal Origin	Migratory History
				Primordia	FWG		
stn016111606002	Stanislaus River	300	3	0.0020 ± 0.0002	0.0014 ± 0.0004	Steelhead	Resident
stn016111606003	Stanislaus River	347	3	0.0011 ± 0.0005	0.0012 ± 0.0004	Resident	Resident
stn016111606004	Stanislaus River	335	3	0.0009 ± 0.0004	0.0012 ± 0.0002	Resident	Resident
stn016111606005	Stanislaus River	344	3	0.0013 ± 0.0002	0.0014 ± 0.0002	Resident	Resident
stn016111606006	Stanislaus River	359	3	0.0013 ± 0.0003	0.0014 ± 0.0002	Resident	Resident
stn016111606007	Stanislaus River	337	3	0.0020 ± 0.0002	0.0013 ± 0.0002	Steelhead	Resident
stn016111606008	Stanislaus River	282	2	0.0016 ± 0.0002	0.0015 ± 0.0002	Resident	Resident
stn016111606009	Stanislaus River	342	3	0.0013 ± 0.0002	0.0013 ± 0.0004	Resident	Resident
stn016111606010	Stanislaus River	280	2	0.0013 ± 0.0003	0.0014 ± 0.0003	Resident	Resident
stn016111606011	Stanislaus River	385	3	0.0013 ± 0.0004	0.0014 ± 0.0004	Resident	Resident
stn023022206001	Stanislaus River	261	2	0.0011 ± 0.0003	0.0013 ± 0.0004	Resident	Resident
stn023022206002	Stanislaus River	249	2	0.0013 ± 0.0003	0.0014 ± 0.0004	Resident	Resident
stn023022206003	Stanislaus River	347	3	0.0012 ± 0.0002	0.0013 ± 0.0004	Resident	Resident
stn024022206004	Stanislaus River	255	2	0.0009 ± 0.0002	0.0012 ± 0.0003	Resident	Resident
stn024022206005	Stanislaus River	220	2	0.0016 ± 0.0001	0.0016 ± 0.0002	Resident	Resident
stn024031506001	Stanislaus River	300	3	0.0010 ± 0.0002	0.0012 ± 0.0003	Resident	Resident
stn026021704005	Stanislaus River	278	2	0.0013 ± 0.0002	0.0015 ± 0.0002	Resident	Resident
stn026022706001	Stanislaus River	220	2	0.0012 ± 0.0005	0.0013 ± 0.0002	Resident	Resident
stn027022206002	Stanislaus River	345	3	0.0010 ± 0.0002	0.0012 ± 0.0002	Resident	Resident
stn027022206003	Stanislaus River	355	3	0.0019 ± 0.0002	0.0012 ± 0.0002	Steelhead	Resident
stn027022206004	Stanislaus River	359	3	0.0013 ± 0.0001	0.0015 ± 0.0002	Resident	Resident
stn027022206005	Stanislaus River	242	2	0.0012 ± 0.0004	0.0014 ± 0.0002	Resident	Resident
stn027031506001	Stanislaus River	180	1	0.0013 ± 0.0002	0.0013 ± 0.0005	Resident	Resident
stn028022206001	Stanislaus River	307	3	0.0014 ± 0.0004	0.0015 ± 0.0002	Resident	Resident
stn031020305001	Stanislaus River	260	2	0.0011 ± 0.0003	0.0013 ± 0.0002	Resident	Resident
stn031020805001	Stanislaus River	275	2	0.0013 ± 0.0003	0.0014 ± 0.0004	Resident	Resident
stn031021005001	Stanislaus River	252	2	0.0013 ± 0.0005	0.0013 ± 0.0002	Resident	Resident
stn031021705001	Stanislaus River	140	1	0.0011 ± 0.0003	0.0013 ± 0.0005	Resident	Resident
stn031022805002	Stanislaus River	274	2	0.0011 ± 0.0002	0.0012 ± 0.0003	Resident	Resident
stn031030105001	Stanislaus River	239	2	0.0013 ± 0.0004	0.0014 ± 0.0002	Resident	Resident
stn031030105003	Stanislaus River	247	2	0.0014 ± 0.0004	0.0015 ± 0.0005	Resident	Resident
stn031030105004	Stanislaus River	300	3	0.0012 ± 0.0002	0.0013 ± 0.0003	Resident	Resident
stn031030505001	Stanislaus River	263	2	0.0015 ± 0.0002	0.0016 ± 0.0004	Resident	Resident
stn031032405010	Stanislaus River	251	2	0.0012 ± 0.0004	0.0013 ± 0.0002	Resident	Resident
stn031032505001	Stanislaus River	286	2	0.0014 ± 0.0002	0.0014 ± 0.0004	Resident	Resident

CDFG No	Location	Length (mm)	Age	Mean Sr:Ca ± SD		Maternal Origin	Migratory History
				Primordia	FWG		
stn031040505001	Stanislaus River	273	2	0.0010 ± 0.0002	0.0012 ± 0.0005	Resident	Resident
stn032021705001	Stanislaus River	271	2	0.0016 ± 0.0004	0.0016 ± 0.0002	Resident	Resident
stn032021705002	Stanislaus River	261	2	0.0013 ± 0.0002	0.0013 ± 0.0002	Resident	Resident
stn032021705003	Stanislaus River	270	2	0.0014 ± 0.0002	0.0015 ± 0.0003	Resident	Resident
stn032021905001	Stanislaus River	264	2	0.0009 ± 0.0002	0.0012 ± 0.0003	Resident	Resident
stn032022405001	Stanislaus River	263	2	0.0009 ± 0.0002	0.0011 ± 0.0003	Resident	Resident
stn032030105004	Stanislaus River	272	2	0.0012 ± 0.0005	0.0013 ± 0.0002	Resident	Resident
stn032030205001	Stanislaus River	229	2	0.0013 ± 0.0005	0.0013 ± 0.0002	Resident	Resident
stn032032405001	Stanislaus River	202	2	0.0012 ± 0.0002	0.0013 ± 0.0004	Resident	Resident
stn032032505001	Stanislaus River	277	2	0.0013 ± 0.0003	0.0013 ± 0.0004	Resident	Resident
stn032040505001	Stanislaus River	287	2	0.0017 ± 0.0002	0.0011 ± 0.0003	Steelhead	Resident
stn036022406001	Stanislaus River	520	4	0.0011 ± 0.0002	0.0013 ± 0.0002	Resident	Resident
stn072602625	Stanislaus River	290	2	0.0012 ± 0.0005	0.0012 ± 0.0005	Resident	Resident
stn072602626	Stanislaus River	300	3	0.0013 ± 0.0003	0.0014 ± 0.0002	Resident	Resident
stn072602633	Stanislaus River	360	3	0.0011 ± 0.0001	0.0013 ± 0.0002	Resident	Resident
stn080701629	Stanislaus River	290	2	0.0012 ± 0.0006	0.0011 ± 0.0004	Resident	Resident
stn111402634	Stanislaus River	470	4	0.0014 ± 0.0004	0.0014 ± 0.0004	Resident	Resident
stn111502635	Stanislaus River	420	4	0.0013 ± 0.0003	0.0013 ± 0.0003	Resident	Resident
stn120302621	Stanislaus River	475	4	0.0014 ± 0.0002	0.0013 ± 0.0002	Resident	Resident
stn120302622	Stanislaus River	380	3	0.0015 ± 0.0003	0.0013 ± 0.0003	Resident	Resident
stn120602632	Stanislaus River	370	3	0.0011 ± 0.0002	0.0011 ± 0.0001	Resident	Resident
stn121102623	Stanislaus River	250	2	0.0009 ± 0.0004	0.0013 ± 0.0004	Resident	Resident
stnDFG724	Stanislaus River	429	4	0.0015 ± 0.0003	0.0015 ± 0.0002	Resident	Resident
STNDFG725	Stanislaus River	425	4	0.0013 ± 0.0002	0.0014 ± 0.0002	Resident	Resident
STNDFG726	Stanislaus River	535	4	0.0020 ± 0.0004	0.0013 ± 0.0002	Steelhead	Unknown
STNDFG733	Stanislaus River	470	4	0.0014 ± 0.0002	0.0015 ± 0.0002	Resident	Resident
STNDFG734	Stanislaus River	180	1	0.0012 ± 0.0002	0.0013 ± 0.0003	Resident	Resident
STNDFG735	Stanislaus River	240	2	0.0013 ± 0.0002	0.0014 ± 0.0004	Resident	Resident
STNDFG736	Stanislaus River	150	1	0.0013 ± 0.0002	0.0013 ± 0.0002	Resident	Resident
stndfg812	Stanislaus River	350	3	0.0011 ± 0.0002	0.0013 ± 0.0002	Resident	Resident
STNDFG813	Stanislaus River	430	4	0.0016 ± 0.0004	0.0016 ± 0.0002	Resident	Resident
STNDFG815	Stanislaus River	300	3	0.0011 ± 0.0005	0.0012 ± 0.0002	Resident	Resident
STNDFG816	Stanislaus River	545	4	0.0013 ± 0.0004	0.0014 ± 0.0003	Resident	Resident
STNDFG818	Stanislaus River	390	3	0.0013 ± 0.0002	0.0013 ± 0.0002	Resident	Resident
STNDFG820	Stanislaus River	380	3	0.0009 ± 0.0002	0.0011 ± 0.0002	Resident	Resident

CDFG No	Location	Length (mm)	Age	Mean Sr:Ca ± SD		Maternal Origin	Migratory History
				Primordia	FWG		
STNDFG821	Stanislaus River	360	3	0.0012 ± 0.0003	0.0014 ± 0.0003	Resident	Resident
STNDFG839	Stanislaus River	690	4	0.0020 ± 0.0004	0.0013 ± 0.0003	Steelhead	Steelhead
tou001052405002	Tuolumne River	287	2	0.0010 ± 0.0004	0.0011 ± 0.0002	Resident	Resident
tou001052405003	Tuolumne River	400	4	0.0010 ± 0.0004	0.0008 ± 0.0002	Resident	Resident
tou001052405004	Tuolumne River	440	4	0.0018 ± 0.0003	0.0010 ± 0.0002	Steelhead	Resident
tou001102803002	Tuolumne River	294	2	0.0011 ± 0.0003	0.0014 ± 0.0002	Resident	Resident
tou002102803001	Tuolumne River	188	1	0.0011 ± 0.0004	0.0014 ± 0.0002	Resident	Resident
tou002102803005	Tuolumne River	174	1	0.0010 ± 0.0003	0.0011 ± 0.0003	Resident	Resident
tou002111306001	Tuolumne River	474	4	0.0022 ± 0.0001	0.0011 ± 0.0004	Steelhead	Resident
tou002111306002	Tuolumne River	290	2	0.0010 ± 0.0004	0.0012 ± 0.0004	Resident	Resident
tou002111306003	Tuolumne River	430	4	0.0011 ± 0.0003	0.0011 ± 0.0002	Resident	Resident
tou002111306004	Tuolumne River	365	3	0.0019 ± 0.0004	0.0009 ± 0.0004	Steelhead	Resident
tou002111306005	Tuolumne River	490	4	0.0012 ± 0.0005	0.0011 ± 0.0003	Resident	Resident
tou002111306006	Tuolumne River	220	2	0.0012 ± 0.0003	0.0013 ± 0.0002	Resident	Resident
tou002111306007	Tuolumne River	192	1	0.0012 ± 0.0003	0.0014 ± 0.0002	Resident	Resident
tou002111306013	Tuolumne River	296	2	0.0011 ± 0.0003	0.0014 ± 0.0003	Resident	Resident
tou002111705001	Tuolumne River	523	4	0.0013 ± 0.0003	0.0011 ± 0.0001	Resident	Resident
tou002111705002	Tuolumne River	405	4	0.0011 ± 0.0003	0.0013 ± 0.0003	Resident	Resident
tou002111705003	Tuolumne River	363	3	0.0010 ± 0.0004	0.0014 ± 0.0002	Resident	Resident
tou002111705004	Tuolumne River	453	4	0.0011 ± 0.0003	0.0014 ± 0.0004	Resident	Resident
tou002111705005	Tuolumne River	205	2	0.0010 ± 0.0004	0.0013 ± 0.0001	Resident	Resident
tou002111705006	Tuolumne River	455	4	0.0010 ± 0.0004	0.0012 ± 0.0004	Resident	Resident
tou002111705009	Tuolumne River	515	4	0.0011 ± 0.0003	0.0011 ± 0.0002	Resident	Resident
tou002111705010	Tuolumne River	310	2	0.0012 ± 0.0001	0.0011 ± 0.0004	Resident	Resident
tou003021506001	Tuolumne River	229	2	0.0012 ± 0.0003	0.0010 ± 0.0003	Resident	Resident
tou003021506002	Tuolumne River	258	2	0.0010 ± 0.0002	0.0008 ± 0.0003	Resident	Resident
tou003021506003	Tuolumne River	398	3	0.0009 ± 0.0002	0.0012 ± 0.0004	Resident	Resident
tou003101905002	Tuolumne River	210	2	0.0011 ± 0.0004	0.0010 ± 0.0003	Resident	Resident
tou003102803001	Tuolumne River	195	1	0.0011 ± 0.0003	0.0014 ± 0.0003	Resident	Resident
tou003102803002	Tuolumne River	188	1	0.0011 ± 0.0003	0.0014 ± 0.0004	Resident	Resident
tou003102803004	Tuolumne River	204	2	0.0012 ± 0.0003	0.0012 ± 0.0002	Resident	Resident
tou003102803005	Tuolumne River	228	2	0.0011 ± 0.0005	0.0011 ± 0.0003	Resident	Resident
tou003102803005	Tuolumne River	228	2	0.0010 ± 0.0002	0.0014 ± 0.0004	Resident	Resident
tou003102803007	Tuolumne River	255	2	0.0011 ± 0.0003	0.0009 ± 0.0001	Resident	Resident
tou003102803008	Tuolumne River	246	2	0.0012 ± 0.0003	0.0012 ± 0.0003	Resident	Resident

CDFG No	Location	Length (mm)	Age	Mean Sr:Ca ± SD		Maternal Origin	Migratory History
				Primordia	FWG		
tou003102803009	Tuolumne River	248	2	0.0011 ± 0.0003	0.0010 ± 0.0003	Resident	Resident
tou004102605001	Tuolumne River	405	4	0.0011 ± 0.0001	0.0010 ± 0.0001	Resident	Resident
tou004102605002	Tuolumne River	460	4	0.0011 ± 0.0002	0.0010 ± 0.0002	Resident	Resident
tou004111306008	Tuolumne River	459	4	0.0011 ± 0.0003	0.0014 ± 0.0002	Resident	Resident
tou004111306009	Tuolumne River	480	4	0.0021 ± 0.0002	0.0012 ± 0.0003	Steelhead	Resident
tou004111306010	Tuolumne River	338	3	0.0011 ± 0.0002	0.0011 ± 0.0004	Resident	Resident
tou004111306011	Tuolumne River	332	3	0.0010 ± 0.0002	0.0014 ± 0.0003	Resident	Resident
tou004111306012	Tuolumne River	359	3	0.0011 ± 0.0003	0.0010 ± 0.0003	Resident	Resident
tou004111306012	Tuolumne River	359	3	0.0011 ± 0.0003	0.0010 ± 0.0003	Resident	Resident
tou004111306014	Tuolumne River	385	3	0.0012 ± 0.0004	0.0010 ± 0.0001	Resident	Resident
tou004111306015	Tuolumne River	305	2	0.0011 ± 0.0003	0.0013 ± 0.0002	Resident	Resident
tou004111306016	Tuolumne River	325	3	0.0011 ± 0.0003	0.0013 ± 0.0004	Resident	Resident
tou008111705001	Tuolumne River	218	2	0.0013 ± 0.0003	0.0011 ± 0.0002	Resident	Resident
tou008111705002	Tuolumne River	360	3	0.0010 ± 0.0002	0.0010 ± 0.0004	Resident	Resident
tou008111705003	Tuolumne River	420	4	0.0011 ± 0.0003	0.0011 ± 0.0002	Resident	Resident
tou008111705004	Tuolumne River	145	1	0.0010 ± 0.0003	0.0008 ± 0.0001	Resident	Resident
tou008111705005	Tuolumne River	219	2	0.0011 ± 0.0004	0.0012 ± 0.0003	Resident	Resident
Tou009111705006	Tuolumne River	275	2	0.0011 ± 0.0003	0.0009 ± 0.0003	Resident	Resident
Tou009111705007	Tuolumne River	376	3	0.0011 ± 0.0003	0.0010 ± 0.0002	Resident	Resident
Tou009111705008	Tuolumne River	196	1	0.0011 ± 0.0003	0.0011 ± 0.0002	Resident	Resident
tou009111705009	Tuolumne River	401	4	0.0011 ± 0.0003	0.0013 ± 0.0002	Resident	Resident
Tou009111705010	Tuolumne River	232	2	0.0012 ± 0.0004	0.0011 ± 0.0002	Resident	Resident
Tou009111705011	Tuolumne River	236	2	0.0011 ± 0.0003	0.0013 ± 0.0001	Resident	Resident
Tou009111705012	Tuolumne River	200	2	0.0011 ± 0.0003	0.0011 ± 0.0002	Resident	Resident
tou033021506001	Tuolumne River	233	2	0.0011 ± 0.0003	0.0009 ± 0.0002	Resident	Resident
tou033021506002	Tuolumne River	330	3	0.0011 ± 0.0003	0.0014 ± 0.0003	Resident	Resident
tou033021506003	Tuolumne River	310	2	0.0019 ± 0.0003	0.0009 ± 0.0002	Steelhead	Resident
tou033021506004	Tuolumne River	511	4	0.0010 ± 0.0003	0.0011 ± 0.0003	Resident	Resident
tou033021506005	Tuolumne River	254	2	0.0012 ± 0.0003	0.0014 ± 0.0003	Resident	Resident
tou033021506006	Tuolumne River	237	2	0.0010 ± 0.0005	0.0011 ± 0.0003	Resident	Resident
tou033021506007	Tuolumne River	365	3	0.0011 ± 0.0003	0.0013 ± 0.0003	Resident	Resident
Tou033102605001	Tuolumne River	409	4	0.0011 ± 0.0003	0.0013 ± 0.0004	Resident	Resident
Tou033102605002	Tuolumne River	190	1	0.0009 ± 0.0003	0.0010 ± 0.0003	Resident	Resident
Tou033102605003	Tuolumne River	169	1	0.0010 ± 0.0004	0.0013 ± 0.0002	Resident	Resident
Tou033102605004	Tuolumne River	200	2	0.0011 ± 0.0003	0.0010 ± 0.0002	Resident	Resident

CDFG No	Location	Length (mm)	Age	Mean Sr:Ca ± SD		Maternal Origin	Migratory History
				Primordia	FWG		
tou034021506001	Tuolumne River	275	2	0.0010 ± 0.0002	0.0012 ± 0.0002	Resident	Resident
Tou034102605001	Tuolumne River	182	1	0.0012 ± 0.0001	0.0014 ± 0.0002	Resident	Resident
Tou034102605002	Tuolumne River	215	2	0.0011 ± 0.0003	0.0011 ± 0.0003	Resident	Resident
Tou034102605003	Tuolumne River	158	1	0.0010 ± 0.0003	0.0013 ± 0.0003	Resident	Resident
Tou034102605004	Tuolumne River	175	1	0.0009 ± 0.0002	0.0012 ± 0.0004	Resident	Resident
Tou034102605005	Tuolumne River	176	1	0.0011 ± 0.0005	0.0010 ± 0.0002	Resident	Resident
Tou034102605006	Tuolumne River	200	2	0.0012 ± 0.0001	0.0011 ± 0.0004	Resident	Resident
Tou034102605007	Tuolumne River	163	1	0.0011 ± 0.0003	0.0013 ± 0.0002	Resident	Resident
Tou034102605008	Tuolumne River	168	1	0.0010 ± 0.0003	0.0011 ± 0.0002	Resident	Resident
Tou034102605009	Tuolumne River	185	1	0.0022 ± 0.0004	0.0010 ± 0.0002	Steelhead	Resident
Tou034102605012	Tuolumne River	196	1	0.0010 ± 0.0003	0.0011 ± 0.0002	Resident	Resident
Tou034102605013	Tuolumne River	199	1	0.0011 ± 0.0003	0.0011 ± 0.0004	Resident	Resident
Tou034102605014	Tuolumne River	183	1	0.0011 ± 0.0003	0.0011 ± 0.0002	Resident	Resident
Tou034102605015	Tuolumne River	180	1	0.0010 ± 0.0003	0.0011 ± 0.0002	Resident	Resident
Tou034102605016	Tuolumne River	181	1	0.0010 ± 0.0002	0.0012 ± 0.0003	Resident	Resident
Tou034102605017	Tuolumne River	193	1	0.0012 ± 0.0003	0.0012 ± 0.0002	Resident	Resident
Tou034102605018	Tuolumne River	161	1	0.0010 ± 0.0004	0.0012 ± 0.0002	Resident	Resident
Tou034102605019	Tuolumne River	197	1	0.0009 ± 0.0003	0.0013 ± 0.0004	Resident	Resident
tou035021506001	Tuolumne River	409	4	0.0019 ± 0.0003	0.0012 ± 0.0003	Steelhead	Resident
tou035021506002	Tuolumne River	261	2	0.0011 ± 0.0003	0.0010 ± 0.0002	Resident	Resident
tou035102605001	Tuolumne River	169	1	0.0011 ± 0.0003	0.0013 ± 0.0003	Resident	Resident
tou035102605002	Tuolumne River	180	1	0.0011 ± 0.0003	0.0009 ± 0.0003	Resident	Resident
tou035102605003	Tuolumne River	416	4	0.0009 ± 0.0004	0.0011 ± 0.0003	Resident	Resident
tou035102605004	Tuolumne River	381	3	0.0011 ± 0.0003	0.0010 ± 0.0002	Resident	Resident
tou035102605005	Tuolumne River	400	4	0.0013 ± 0.0003	0.0012 ± 0.0002	Resident	Resident
tou035102605006	Tuolumne River	190	1	0.0012 ± 0.0004	0.0013 ± 0.0002	Resident	Resident
tou035102605007	Tuolumne River	194	1	0.0012 ± 0.0002	0.0013 ± 0.0002	Resident	Resident
tou035102605008	Tuolumne River	169	1	0.0011 ± 0.0003	0.0013 ± 0.0002	Resident	Resident
tou035102605009	Tuolumne River	150	1	0.0011 ± 0.0004	0.0011 ± 0.0003	Resident	Resident
tou035102605010	Tuolumne River	164	1	0.0011 ± 0.0002	0.0011 ± 0.0002	Resident	Resident
tou035102605011	Tuolumne River	172	1	0.0011 ± 0.0004	0.0013 ± 0.0002	Resident	Resident
tou035102605012	Tuolumne River	183	1	0.0022 ± 0.0003	0.0014 ± 0.0004	Steelhead	Resident
tou035102605013	Tuolumne River	183	1	0.0011 ± 0.0003	0.0008 ± 0.0002	Resident	Resident
tou035102605014	Tuolumne River	450	4	0.0010 ± 0.0003	0.0013 ± 0.0002	Resident	Resident
tou035111306001	Tuolumne River	333	3	0.0021 ± 0.0002	0.0011 ± 0.0002	Steelhead	Resident

CDFG No	Location	Length (mm)	Age	Mean Sr:Ca ± SD		Maternal Origin	Migratory History
				Primordia	FWG		
tou035111306003	Tuolumne River	332	3	0.0013 ± 0.0003	0.0013 ± 0.0002	Resident	Resident
tou035111306004	Tuolumne River	363	3	0.0011 ± 0.0003	0.0011 ± 0.0002	Resident	Resident
tou035111306005	Tuolumne River	390	3	0.0011 ± 0.0002	0.0014 ± 0.0004	Resident	Resident
tou035111306006	Tuolumne River	350	3	0.0010 ± 0.0003	0.0013 ± 0.0003	Resident	Resident
tou035111306007	Tuolumne River	386	3	0.0010 ± 0.0002	0.0014 ± 0.0002	Resident	Resident
tou035111306008	Tuolumne River	394	3	0.0011 ± 0.0003	0.0011 ± 0.0004	Resident	Resident
tou035111306009	Tuolumne River	161	1	0.0010 ± 0.0003	0.0013 ± 0.0003	Resident	Resident
tou035111306010	Tuolumne River	411	4	0.0011 ± 0.0003	0.0014 ± 0.0002	Resident	Resident
tou036021506001	Tuolumne River	248	2	0.0011 ± 0.0003	0.0013 ± 0.0003	Resident	Resident
tou038111306001	Tuolumne River	340	3	0.0010 ± 0.0004	0.0012 ± 0.0002	Resident	Resident
tou038111306003	Tuolumne River	338	3	0.0011 ± 0.0004	0.0013 ± 0.0002	Resident	Resident
tou038111306004	Tuolumne River	170	1	0.0010 ± 0.0003	0.0011 ± 0.0002	Resident	Resident
tou038111306005	Tuolumne River	342	3	0.0011 ± 0.0003	0.0015 ± 0.0002	Resident	Resident
tou038111306006	Tuolumne River	395	3	0.0010 ± 0.0003	0.0009 ± 0.0003	Resident	Resident
tou038111306008	Tuolumne River	285	2	0.0010 ± 0.0003	0.0015 ± 0.0002	Resident	Resident
tou038111306009	Tuolumne River	315	2	0.0011 ± 0.0004	0.0008 ± 0.0002	Resident	Resident
tou038111306010	Tuolumne River	170	1	0.0011 ± 0.0003	0.0014 ± 0.0002	Resident	Resident
tou038111306011	Tuolumne River	368	3	0.0010 ± 0.0003	0.0011 ± 0.0002	Resident	Resident
tou038111306012	Tuolumne River	275	2	0.0011 ± 0.0002	0.0008 ± 0.0002	Resident	Resident
tou038111306013	Tuolumne River	374	3	0.0011 ± 0.0003	0.0013 ± 0.0002	Resident	Resident
tou038111306014	Tuolumne River	299	2	0.0013 ± 0.0003	0.0011 ± 0.0002	Resident	Resident
tou038111306015	Tuolumne River	337	3	0.0012 ± 0.0003	0.0014 ± 0.0004	Resident	Resident
tou038111306016	Tuolumne River	348	3	0.0010 ± 0.0004	0.0009 ± 0.0002	Resident	Resident
tou038111306017	Tuolumne River	391	3	0.0010 ± 0.0004	0.0009 ± 0.0003	Resident	Resident
tou111500029	Tuolumne River	424	4	0.0010 ± 0.0005	0.0012 ± 0.0003	Resident	Resident
tou111500030	Tuolumne River	405	4	0.0011 ± 0.0002	0.0011 ± 0.0003	Resident	Resident
tou111500030	Tuolumne River	405	4	0.0011 ± 0.0002	0.0010 ± 0.0003	Resident	Resident
tou112200032	Tuolumne River	415	4	0.0012 ± 0.0004	0.0012 ± 0.0001	Resident	Resident
tou112200033	Tuolumne River	440	4	0.0010 ± 0.0004	0.0015 ± 0.0002	Resident	Resident
tou112900034	Tuolumne River	430	4	0.0010 ± 0.0003	0.0011 ± 0.0002	Resident	Unknown
tou11302028	Tuolumne River	350	3	0.0010 ± 0.0003	0.0007 ± 0.0004	Resident	Resident
tou120298015	Tuolumne River	340	3	0.0011 ± 0.0002	0.0012 ± 0.0003	Resident	Resident
tou120399017	Tuolumne River	320	3	0.0011 ± 0.0003	0.0011 ± 0.0002	Resident	Resident
tou120799019	Tuolumne River	320	3	0.0012 ± 0.0002	0.0014 ± 0.0004	Resident	Resident
tou120899020	Tuolumne River	430	4	0.0014 ± 0.0003	0.0013 ± 0.0002	Resident	Resident

CDFG No	Location	Length (mm)	Age	Mean Sr:Ca ± SD		Maternal Origin	Migratory History
				Primordia	FWG		
tou121002602	Tuolumne River	500	4	0.0011 ± 0.0002	0.0013 ± 0.0002	Resident	Resident
tou121100042	Tuolumne River	473	4	0.0011 ± 0.0003	0.0010 ± 0.0004	Resident	Resident
tou121100043	Tuolumne River	455	4	0.0010 ± 0.0004	0.0009 ± 0.0003	Resident	Resident
tou121800037	Tuolumne River	355	3	0.0011 ± 0.0004	0.0014 ± 0.0003	Resident	Resident
tou122700038	Tuolumne River	455	4	0.0020 ± 0.0002	0.0013 ± 0.0002	Steelhead	Steelhead
tou122700041	Tuolumne River	501	4	0.0011 ± 0.0004	0.0010 ± 0.0005	Resident	Resident
tou122800035	Tuolumne River	443	4	0.0010 ± 0.0004	0.0011 ± 0.0004	Resident	Resident
tou122800036	Tuolumne River	446	4	0.0010 ± 0.0002	0.0010 ± 0.0005	Resident	Resident
TOUDFG04t0128	Tuolumne River	330	3	0.0010 ± 0.0003	0.0011 ± 0.0001	Resident	Resident
toudfg101905001	Tuolumne River	440	4	0.0010 ± 0.0002	0.0013 ± 0.0004	Resident	Resident
yub001022305001	Yuba River	406	4	0.0008 ± 0.0001	0.0006 ± 0.0004	Resident	Resident
yub001032105001	Yuba River	157	0	0.0009 ± 0.0004	0.0007 ± 0.0002	Resident	Resident
yub001032105002	Yuba River	240	2	0.0010 ± 0.0003	0.0011 ± 0.0001	Resident	Resident
yub001061004001	Yuba River	102	0	0.0012 ± 0.0003	0.0012 ± 0.0003	Resident	Resident
yub001061604001	Yuba River	325	3	0.0009 ± 0.0002	0.0007 ± 0.0002	Resident	Resident
yub001071104001	Yuba River	54	0	0.0017 ± 0.0003	0.0008 ± 0.0002	Steelhead	Resident
yub001071206001	Yuba River	420	4	0.0006 ± 0.0004	0.0005 ± 0.0003	Resident	Resident
yub001071206002	Yuba River	385	3	0.0010 ± 0.0003	0.0008 ± 0.0002	Resident	Resident
yub001071206003	Yuba River	350	3	0.0008 ± 0.0003	0.0006 ± 0.0003	Resident	Resident
yub001071206004	Yuba River	350	3	0.0018 ± 0.0003	0.0008 ± 0.0003	Steelhead	Resident
yub001071206005	Yuba River	330	3	0.0008 ± 0.0003	0.0008 ± 0.0001	Resident	Resident
yub001071206006	Yuba River	280	2	0.0009 ± 0.0003	0.0006 ± 0.0004	Resident	Resident
yub001071206007	Yuba River	229	1	0.0007 ± 0.0003	0.0008 ± 0.0003	Resident	Resident
yub001071206008	Yuba River	432	4	0.0010 ± 0.0002	0.0007 ± 0.0002	Resident	Resident
yub001071206009	Yuba River	335	3	0.0009 ± 0.0003	0.0011 ± 0.0002	Resident	Resident
yub001071302001	Yuba River	92	0	0.0012 ± 0.0003	0.0013 ± 0.0004	Resident	Resident
yub001071404001	Yuba River	68	0	0.0012 ± 0.0003	0.0011 ± 0.0003	Resident	Resident
yub001071404002	Yuba River	72	0	0.0007 ± 0.0003	0.0005 ± 0.0003	Resident	Resident
yub001072004001	Yuba River	63	0	0.0014 ± 0.0004	0.0005 ± 0.0002	Steelhead	Resident
yub001072204001	Yuba River	352	3	0.0013 ± 0.0003	0.0012 ± 0.0003	Resident	Resident
yub001072302005	Yuba River	57	0	0.0009 ± 0.0003	0.0007 ± 0.0003	Resident	Resident
yub001072602001	Yuba River	105	0	0.0012 ± 0.0004	0.0013 ± 0.0003	Resident	Resident
yub001072902001	Yuba River	61	0	0.0009 ± 0.0003	0.0007 ± 0.0003	Resident	Resident
yub001072902002	Yuba River	62	0	0.0008 ± 0.0002	0.0006 ± 0.0003	Resident	Resident
yub001072902004	Yuba River	33	0	0.0012 ± 0.0003	0.0011 ± 0.0002	Resident	Resident

CDFG No	Location	Length (mm)	Age	Mean Sr:Ca ± SD		Maternal Origin	Migratory History
				Primordia	FWG		
yub001080302005	Yuba River	53	0	0.0018 ± 0.0003	0.0010 ± 0.0004	Steelhead	Resident
yub001080502001	Yuba River	70	0	0.0008 ± 0.0003	0.0006 ± 0.0002	Resident	Resident
yub001080502002	Yuba River	58	0	0.0008 ± 0.0002	0.0010 ± 0.0003	Resident	Resident
yub001082804001	Yuba River	324	3	0.0006 ± 0.0004	0.0005 ± 0.0002	Resident	Resident
yub001090404001	Yuba River	405	4	0.0005 ± 0.0003	0.0005 ± 0.0003	Resident	Resident
yub001100605001	Yuba River	388	3	0.0010 ± 0.0003	0.0007 ± 0.0002	Resident	Resident
yub001100605002	Yuba River	510	4	0.0007 ± 0.0003	0.0007 ± 0.0002	Resident	Resident
yub001102606001	Yuba River	315	3	0.0013 ± 0.0003	0.0012 ± 0.0002	Resident	Resident
yub001102606002	Yuba River	445	4	0.0018 ± 0.0003	0.0009 ± 0.0004	Steelhead	Resident
yub001102606003	Yuba River	294	2	0.0009 ± 0.0002	0.0010 ± 0.0004	Resident	Resident
yub001102606004	Yuba River	298	2	0.0006 ± 0.0002	0.0006 ± 0.0002	Resident	Resident
yub001102606005	Yuba River	301	3	0.0013 ± 0.0003	0.0012 ± 0.0003	Resident	Resident
yub001112205001	Yuba River	410	4	0.0010 ± 0.0003	0.0008 ± 0.0004	Resident	Resident
yub002012704001	Yuba River	267	2	0.0009 ± 0.0004	0.0008 ± 0.0001	Resident	Resident
yub002022206001	Yuba River	319	3	0.0016 ± 0.0003	0.0007 ± 0.0004	Steelhead	Resident
yub002071104001	Yuba River	236	2	0.0008 ± 0.0003	0.0007 ± 0.0002	Resident	Resident
yub002080402001	Yuba River	66	0	0.0009 ± 0.0005	0.0006 ± 0.0003	Resident	Resident
yub002081402001	Yuba River	60	0	0.0019 ± 0.0002	0.0007 ± 0.0002	Steelhead	Resident
yub002081402002	Yuba River	65	0	0.0011 ± 0.0004	0.0011 ± 0.0002	Resident	Resident
yub002081502001	Yuba River	45	0	0.0008 ± 0.0004	0.0006 ± 0.0003	Resident	Resident
yub002082202002	Yuba River	62	0	0.0006 ± 0.0003	0.0005 ± 0.0001	Resident	Resident
yub002082202003	Yuba River	56	0	0.0009 ± 0.0003	0.0008 ± 0.0002	Resident	Resident
yub002082202004	Yuba River	47	0	0.0008 ± 0.0002	0.0010 ± 0.0001	Resident	Resident
yub002082502001	Yuba River	56	0	0.0008 ± 0.0003	0.0010 ± 0.0002	Resident	Resident
yub002082902001	Yuba River	65	0	0.0010 ± 0.0003	0.0007 ± 0.0002	Resident	Resident
yub002090502001	Yuba River	61	0	0.0007 ± 0.0003	0.0007 ± 0.0002	Resident	Resident
yub002091502001	Yuba River	73	0	0.0008 ± 0.0002	0.0008 ± 0.0003	Resident	Resident
yub003012704001	Yuba River	313	3	0.0011 ± 0.0003	0.0007 ± 0.0002	Resident	Resident
yub003012704002	Yuba River	417	4	0.0012 ± 0.0003	0.0006 ± 0.0002	Resident	Resident
yub003012704004	Yuba River	475	4	0.0010 ± 0.0002	0.0007 ± 0.0004	Resident	Resident
yub003020905003	Yuba River	425	4	0.0009 ± 0.0003	0.0009 ± 0.0003	Resident	Resident
yub003022305001	Yuba River	405	4	0.0019 ± 0.0003	0.0009 ± 0.0003	Steelhead	Resident
yub003022305002	Yuba River	478	4	0.0009 ± 0.0003	0.0008 ± 0.0002	Resident	Resident
yub003041305001	Yuba River	403	4	0.0010 ± 0.0002	0.0009 ± 0.0002	Resident	Resident
yub003041305002	Yuba River	434	4	0.0007 ± 0.0003	0.0008 ± 0.0002	Resident	Resident

CDFG No	Location	Length (mm)	Age	Mean Sr:Ca ± SD		Maternal Origin	Migratory History
				Primordia	FWG		
yub003051205001	Yuba River	411	4	0.0009 ± 0.0004	0.0011 ± 0.0003	Resident	Resident
yub003051205003	Yuba River	441	4	0.0013 ± 0.0004	0.0012 ± 0.0002	Resident	Resident
yub003051205005	Yuba River	297	2	0.0011 ± 0.0003	0.0012 ± 0.0002	Resident	Resident
yub003071603001	Yuba River	228	1	0.0011 ± 0.0003	0.0009 ± 0.0001	Resident	Resident
yub003071603003	Yuba River	350	3	0.0008 ± 0.0003	0.0008 ± 0.0002	Resident	Resident
yub003071603004	Yuba River	413	4	0.0009 ± 0.0001	0.0008 ± 0.0003	Resident	Resident
yub003102606001	Yuba River	295	2	0.0007 ± 0.0004	0.0007 ± 0.0002	Resident	Resident
yub003102606002	Yuba River	364	3	0.0010 ± 0.0003	0.0007 ± 0.0002	Resident	Resident
yub003102606003	Yuba River	274	2	0.0007 ± 0.0003	0.0007 ± 0.0002	Resident	Resident
yub003102606004	Yuba River	291	2	0.0008 ± 0.0003	0.0006 ± 0.0002	Resident	Resident
yub003102606005	Yuba River	400	4	0.0008 ± 0.0003	0.0008 ± 0.0003	Resident	Resident
yub003112806002	Yuba River	480	4	0.0008 ± 0.0003	0.0010 ± 0.0002	Resident	Resident
yub003112806004	Yuba River	380	3	0.0008 ± 0.0002	0.0007 ± 0.0004	Resident	Resident
yub003112806005	Yuba River	410	4	0.0008 ± 0.0003	0.0006 ± 0.0001	Resident	Resident
yub003112806006	Yuba River	338	3	0.0008 ± 0.0003	0.0009 ± 0.0002	Resident	Resident
yub003112806007	Yuba River	332	3	0.0012 ± 0.0004	0.0013 ± 0.0003	Resident	Resident
yub003112806008	Yuba River	370	3	0.0010 ± 0.0002	0.0008 ± 0.0002	Resident	Resident
yub003112806009	Yuba River	370	3	0.0007 ± 0.0005	0.0006 ± 0.0003	Resident	Resident
yub003112806010	Yuba River	400	4	0.0006 ± 0.0003	0.0007 ± 0.0002	Resident	Resident
yub003112806012	Yuba River	390	4	0.0009 ± 0.0004	0.0009 ± 0.0002	Resident	Resident
yub003112806013	Yuba River	435	4	0.0012 ± 0.0002	0.0012 ± 0.0002	Resident	Resident
yub004082603001	Yuba River	260	2	0.0006 ± 0.0002	0.0007 ± 0.0003	Resident	Resident
yub004082603002	Yuba River	292	2	0.0008 ± 0.0004	0.0008 ± 0.0003	Resident	Resident
yub004082603003	Yuba River	279	2	0.0008 ± 0.0003	0.0006 ± 0.0003	Resident	Resident
yub004082603004	Yuba River	225	1	0.0017 ± 0.0003	0.0007 ± 0.0002	Steelhead	Resident
yub004082603005	Yuba River	267	2	0.0011 ± 0.0004	0.0010 ± 0.0004	Resident	Resident
yub004091506006	Yuba River	360	3	0.0008 ± 0.0004	0.0006 ± 0.0002	Resident	Resident
yub004091506014	Yuba River	229	1	0.0015 ± 0.0004	0.0012 ± 0.0004	Steelhead	Resident
yub004101400019	Yuba River	317	3	0.0008 ± 0.0003	0.0008 ± 0.0002	Resident	Resident
yub004101400022	Yuba River	227	1	0.0010 ± 0.0003	0.0010 ± 0.0002	Resident	Resident
yub004101400024	Yuba River	389	3	0.0014 ± 0.0003	0.0009 ± 0.0002	Steelhead	Resident
yub004122100001	Yuba River	319	3	0.0009 ± 0.0003	0.0008 ± 0.0002	Resident	Resident
yub004122100004	Yuba River	320	3	0.0009 ± 0.0003	0.0008 ± 0.0004	Resident	Resident
yub004122100006	Yuba River	395	4	0.0011 ± 0.0003	0.0011 ± 0.0004	Resident	Resident
yub004122100008	Yuba River	271	2	0.0009 ± 0.0004	0.0009 ± 0.0006	Resident	Resident

CDFG No	Location	Length (mm)	Age	Mean Sr:Ca ± SD		Maternal Origin	Migratory History
				Primordia	FWG		
yub005062604001	Yuba River	470	4	0.0009 ± 0.0004	0.0008 ± 0.0004	Resident	Resident
yub005091204001	Yuba River	292	2	0.0009 ± 0.0003	0.0010 ± 0.0002	Resident	Resident
yub006020905002	Yuba River	335	3	0.0016 ± 0.0003	0.0007 ± 0.0002	Steelhead	Resident
yub006100603001	Yuba River	257	2	0.0009 ± 0.0002	0.0007 ± 0.0003	Resident	Resident
yub006100603002	Yuba River	360	3	0.0015 ± 0.0004	0.0007 ± 0.0002	Steelhead	Resident
yub006100603003	Yuba River	371	3	0.0008 ± 0.0003	0.0007 ± 0.0003	Resident	Resident
yub006100603005	Yuba River	236	2	0.0022 ± 0.0002	0.0012 ± 0.0002	Steelhead	Resident
yub006100603006	Yuba River	386	3	0.0010 ± 0.0002	0.0009 ± 0.0003	Resident	Resident
yub006100603008	Yuba River	365	3	0.0006 ± 0.0003	0.0005 ± 0.0003	Resident	Resident
yub006100603010	Yuba River	247	2	0.0009 ± 0.0004	0.0010 ± 0.0002	Resident	Resident
yub006100603011	Yuba River	272	2	0.0010 ± 0.0003	0.0009 ± 0.0002	Resident	Resident
yub006100603012	Yuba River	327	3	0.0009 ± 0.0004	0.0009 ± 0.0002	Resident	Resident
yub006100603013	Yuba River	368	3	0.0006 ± 0.0003	0.0005 ± 0.0004	Resident	Resident
yub006100603014	Yuba River	400	4	0.0008 ± 0.0005	0.0008 ± 0.0004	Resident	Resident
yub006100603014	Yuba River	400	4	0.0008 ± 0.0005	0.0008 ± 0.0004	Resident	Resident
yub006100603015	Yuba River	367	3	0.0009 ± 0.0003	0.0010 ± 0.0002	Resident	Resident
yub006100603016	Yuba River	474	4	0.0009 ± 0.0003	0.0006 ± 0.0002	Resident	Resident
yub006100603017	Yuba River	417	4	0.0008 ± 0.0003	0.0007 ± 0.0002	Resident	Resident
yub006100603018	Yuba River	442	4	0.0007 ± 0.0003	0.0011 ± 0.0003	Resident	Resident
yub006100603019	Yuba River	364	3	0.0007 ± 0.0002	0.0008 ± 0.0002	Resident	Resident
yub006100603021	Yuba River	390	4	0.0009 ± 0.0003	0.0007 ± 0.0003	Resident	Resident
yub006100603022	Yuba River	341	3	0.0008 ± 0.0003	0.0008 ± 0.0002	Resident	Resident
yub006100603023	Yuba River	425	4	0.0008 ± 0.0003	0.0009 ± 0.0002	Resident	Resident
yub006100603024	Yuba River	324	3	0.0009 ± 0.0001	0.0009 ± 0.0003	Resident	Resident
yub006100603025	Yuba River	453	4	0.0005 ± 0.0003	0.0006 ± 0.0003	Resident	Resident
yub006100603026	Yuba River	379	3	0.0009 ± 0.0003	0.0008 ± 0.0002	Resident	Resident
yub006100603027	Yuba River	400	4	0.0010 ± 0.0003	0.0011 ± 0.0002	Resident	Resident
yub006100603028	Yuba River	408	4	0.0010 ± 0.0003	0.0006 ± 0.0002	Resident	Resident
yub006100603029	Yuba River	410	4	0.0008 ± 0.0003	0.0007 ± 0.0001	Resident	Resident
yub006100603030	Yuba River	390	4	0.0017 ± 0.0003	0.0005 ± 0.0003	Steelhead	Resident
yub006100603031	Yuba River	393	4	0.0008 ± 0.0003	0.0007 ± 0.0003	Resident	Resident
yub006100603032	Yuba River	410	4	0.0009 ± 0.0004	0.0009 ± 0.0002	Resident	Resident
yub006100603033	Yuba River	307	3	0.0012 ± 0.0003	0.0012 ± 0.0002	Resident	Resident
yub006100603034	Yuba River	297	2	0.0009 ± 0.0005	0.0008 ± 0.0003	Resident	Resident
yub006100603036	Yuba River	241	2	0.0010 ± 0.0004	0.0011 ± 0.0002	Resident	Resident

CDFG No	Location	Length (mm)	Age	Mean Sr:Ca ± SD		Maternal Origin	Migratory History
				Primordia	FWG		
yub006100603037	Yuba River	271	2	0.0016 ± 0.0003	0.0006 ± 0.0003	Steelhead	Resident
yub006100603038	Yuba River	298	2	0.0008 ± 0.0002	0.0007 ± 0.0003	Resident	Resident
yub006100603039	Yuba River	230	2	0.0006 ± 0.0002	0.0008 ± 0.0003	Resident	Resident
yub006100603040	Yuba River	233	2	0.0017 ± 0.0001	0.0008 ± 0.0004	Steelhead	Resident
yub008012704001	Yuba River	370	3	0.0010 ± 0.0004	0.0007 ± 0.0004	Resident	Resident
yub008012704002	Yuba River	360	3	0.0008 ± 0.0003	0.0008 ± 0.0002	Resident	Resident
yub008012704003	Yuba River	418	4	0.0014 ± 0.0004	0.0005 ± 0.0002	Steelhead	Resident
yub008012704004	Yuba River	416	4	0.0016 ± 0.0003	0.0008 ± 0.0002	Resident	Resident
yub008012704005	Yuba River	431	4	0.0010 ± 0.0003	0.0008 ± 0.0002	Resident	Resident
yub008012704006	Yuba River	296	2	0.0013 ± 0.0003	0.0012 ± 0.0003	Resident	Resident
yub008012704007	Yuba River	455	4	0.0008 ± 0.0003	0.0006 ± 0.0004	Resident	Resident
mer020597534	Merced River	730	4	0.0015 ± 0.0004	0.0011 ± 0.0002	Resident	Resident
mer032599016	Merced River	440	4	0.0011 ± 0.0003	0.0009 ± 0.0002	Resident	Resident
mer081500581	Merced River	410	4	0.0015 ± 0.0003	0.0009 ± 0.0002	Resident	Resident
mer081500584	Merced River	465	4	0.0012 ± 0.0002	0.0007 ± 0.0005	Resident	Resident
mer081500585	Merced River	350	3	0.0007 ± 0.0002	0.0010 ± 0.0001	Resident	Resident
mer081500586	Merced River	430	4	0.0010 ± 0.0002	0.0010 ± 0.0002	Resident	Resident
mer081500588	Merced River	205	2	0.0007 ± 0.0001	0.0006 ± 0.0003	Resident	Resident
mer081500589	Merced River	250	2	0.0009 ± 0.0002	0.0009 ± 0.0001	Resident	Resident
mer081500591	Merced River	212	2	0.0007 ± 0.0004	0.0007 ± 0.0003	Resident	Resident
mer081500592	Merced River	250	2	0.0010 ± 0.0003	0.0008 ± 0.0002	Resident	Resident
mer081500593	Merced River	405	4	0.0009 ± 0.0002	0.0010 ± 0.0003	Resident	Resident
mer081500594	Merced River	346	3	0.0009 ± 0.0003	0.0010 ± 0.0003	Resident	Resident
mer101902640	Merced River	445	4	0.0009 ± 0.0003	0.0010 ± 0.0003	Resident	Resident
mer102601564	Merced River	600	4	0.0013 ± 0.0003	0.0009 ± 0.0002	Resident	Resident
mer102601580	Merced River	260	2	0.0008 ± 0.0002	0.0009 ± 0.0001	Resident	Resident
mer102999023	Merced River	385	3	0.0007 ± 0.0004	0.0010 ± 0.0002	Resident	Resident
mer110302620	Merced River	610	4	0.0015 ± 0.0002	0.0011 ± 0.0003	Steelhead	Resident
mer110899658	Merced River	345	3	0.0008 ± 0.0003	0.0009 ± 0.0002	Resident	Resident
mer111302636	Merced River	580	4	0.0013 ± 0.0002	0.0014 ± 0.0004	Resident	Resident
mer111302636	Merced River	580	4	0.0013 ± 0.0002	0.0013 ± 0.0003	Resident	Resident
mer111501563	Merced River	570	4	0.0008 ± 0.0001	0.0010 ± 0.0004	Resident	Resident
mer112099522	Merced River	314	3	0.0010 ± 0.0002	0.0009 ± 0.0004	Resident	Resident
mer122302619	Merced River	490	4	0.0009 ± 0.0004	0.0011 ± 0.0003	Resident	Resident
usfws04-1501	Sacramento River	460	4	0.0006 ± 0.0001	0.0008 ± 0.0004	Resident	Resident

CDFG No	Location	Length (mm)	Age	Mean Sr:Ca ± SD		Maternal Origin	Migratory History
				Primordia	FWG		
usfws04-1502	Sacramento River	376	3	0.0008 ± 0.0003	0.0008 ± 0.0004	Resident	Resident
usfws04-1503	Sacramento River	440	4	0.0004 ± 0.0004	0.0008 ± 0.0002	Resident	Resident
usfws04-1504	Sacramento River	450	4	0.0007 ± 0.0003	0.0008 ± 0.0001	Resident	Resident
usfws04-1505	Sacramento River	520	4	0.0006 ± 0.0004	0.0010 ± 0.0002	Resident	Resident
usfws04-1506	Sacramento River	530	4	0.0009 ± 0.0003	0.0007 ± 0.0002	Resident	Resident
usfws04-1507	Sacramento River	310	2	0.0006 ± 0.0004	0.0009 ± 0.0002	Resident	Resident
usfws04-1508	Sacramento River	490	4	0.0006 ± 0.0004	0.0010 ± 0.0002	Resident	Resident
usfws04-1509	Sacramento River	510	4	0.0018 ± 0.0004	0.0009 ± 0.0003	Steelhead	Resident
usfws04-1511	Sacramento River	385	3	0.0007 ± 0.0003	0.0007 ± 0.0003	Resident	Resident
usfws04-1515	Sacramento River	465	4	0.0006 ± 0.0003	0.0010 ± 0.0003	Resident	Resident
usfws04-1516	Sacramento River	440	4	0.0007 ± 0.0003	0.0010 ± 0.0002	Resident	Resident
usfws04-1517	Sacramento River	430	4	0.0007 ± 0.0004	0.0008 ± 0.0003	Resident	Resident
usfws04-1518	Sacramento River	390	3	0.0008 ± 0.0005	0.0009 ± 0.0003	Resident	Resident
usfws04-1519	Sacramento River	396	3	0.0005 ± 0.0003	0.0011 ± 0.0002	Resident	Resident
usfws04-1520	Sacramento River	410	4	0.0008 ± 0.0004	0.0008 ± 0.0004	Resident	Resident
usfws04-1521	Sacramento River	513	4	0.0007 ± 0.0003	0.0007 ± 0.0002	Resident	Resident
usfws04-1522	Sacramento River	480	4	0.0010 ± 0.0005	0.0009 ± 0.0002	Resident	Resident
usfws04-1523	Sacramento River	460	4	0.0007 ± 0.0004	0.0008 ± 0.0003	Resident	Resident
usfws04-1524	Sacramento River	538	4	0.0010 ± 0.0004	0.0010 ± 0.0002	Resident	Resident
usfws04-1528	Sacramento River	500	4	0.0007 ± 0.0004	0.0007 ± 0.0002	Resident	Resident
usfws04-1530	Sacramento River	430	4	0.0006 ± 0.0003	0.0010 ± 0.0004	Resident	Resident
usfws04-1531	Sacramento River	460	4	0.0016 ± 0.0003	0.0007 ± 0.0003	Steelhead	Steelhead
USFWS04-1532	Sacramento River	430	4	0.0006 ± 0.0003	0.0010 ± 0.0002	Resident	Resident
usfws04-1534	Sacramento River	430	4	0.0008 ± 0.0003	0.0008 ± 0.0004	Resident	Resident
usfws04-1535	Sacramento River	490	4	0.0005 ± 0.0004	0.0010 ± 0.0003	Resident	Resident
usfws04-1536	Sacramento River	380	3	0.0011 ± 0.0003	0.0010 ± 0.0002	Resident	Resident
usfws04-1537	Sacramento River	471	4	0.0005 ± 0.0003	0.0010 ± 0.0003	Resident	Resident
usfws04-1538	Sacramento River	460	4	0.0008 ± 0.0003	0.0006 ± 0.0002	Resident	Resident
usfws04-1539	Sacramento River	440	4	0.0008 ± 0.0002	0.0010 ± 0.0004	Resident	Resident
usfws04-1540	Sacramento River	550	4	0.0010 ± 0.0003	0.0010 ± 0.0002	Resident	Resident
usfws04-1541	Sacramento River	510	4	0.0006 ± 0.0003	0.0011 ± 0.0002	Resident	Resident
usfws04-1542	Sacramento River	350	3	0.0007 ± 0.0003	0.0010 ± 0.0002	Resident	Resident
usfws04-1543	Sacramento River	497	4	0.0010 ± 0.0003	0.0010 ± 0.0003	Resident	Resident
usfws04-1544	Sacramento River	450	4	0.0006 ± 0.0003	0.0008 ± 0.0001	Resident	Resident
usfws04-1545	Sacramento River	520	4	0.0006 ± 0.0002	0.0007 ± 0.0003	Resident	Resident

CDFG No	Location	Length (mm)	Age	Mean Sr:Ca ± SD		Maternal Origin	Migratory History
				Primordia	FWG		
usfws04-1546	Sacramento River	515	4	0.0005 ± 0.0003	0.0009 ± 0.0002	Resident	Resident
usfws04-1547	Sacramento River	365	3	0.0006 ± 0.0002	0.0010 ± 0.0003	Resident	Resident
usfws04-1548	Sacramento River	480	4	0.0007 ± 0.0004	0.0010 ± 0.0001	Resident	Resident
usfws04-1549	Sacramento River	490	4	0.0006 ± 0.0003	0.0010 ± 0.0003	Resident	Resident
usfws04-1550	Sacramento River	370	3	0.0009 ± 0.0003	0.0011 ± 0.0002	Resident	Resident
usfws04-1551	Sacramento River	440	4	0.0005 ± 0.0003	0.0009 ± 0.0003	Resident	Resident
usfws04-1552	Sacramento River	600	4	0.0007 ± 0.0003	0.0011 ± 0.0002	Resident	Resident
usfws04-1554	Sacramento River	400	3	0.0006 ± 0.0005	0.0010 ± 0.0003	Resident	Resident
usfws04-1556	Sacramento River	480	4	0.0006 ± 0.0003	0.0007 ± 0.0002	Resident	Resident
usfws04-1558	Sacramento River	420	4	0.0005 ± 0.0003	0.0008 ± 0.0002	Resident	Resident
usfws04-1559	Sacramento River	490	4	0.0008 ± 0.0004	0.0009 ± 0.0003	Resident	Resident
usfws04-1560	Sacramento River	480	4	0.0019 ± 0.0003	0.0010 ± 0.0003	Steelhead	Resident
USFWS04-1561	Sacramento River	460	4	0.0008 ± 0.0003	0.0009 ± 0.0002	Resident	Resident
usfws04-1562	Sacramento River	400	3	0.0006 ± 0.0002	0.0008 ± 0.0003	Resident	Resident
usfws04-1563	Sacramento River	580	4	0.0006 ± 0.0004	0.0008 ± 0.0002	Resident	Resident
usfws04-1564	Sacramento River	410	4	0.0008 ± 0.0002	0.0010 ± 0.0003	Resident	Resident
usfws04-1565	Sacramento River	510	4	0.0008 ± 0.0003	0.0009 ± 0.0001	Resident	Resident
usfws04-1566	Sacramento River	430	4	0.0007 ± 0.0004	0.0007 ± 0.0002	Resident	Resident
usfws04-1569	Sacramento River	441	4	0.0010 ± 0.0003	0.0010 ± 0.0003	Resident	Resident
usfws04-1572	Sacramento River	440	4	0.0007 ± 0.0001	0.0010 ± 0.0002	Resident	Resident
usfws04-1573	Sacramento River	330	2	0.0006 ± 0.0004	0.0009 ± 0.0003	Resident	Resident
usfws04-1574	Sacramento River	410	4	0.0005 ± 0.0003	0.0009 ± 0.0002	Resident	Resident
usfws04-1575	Sacramento River	440	4	0.0003 ± 0.0003	0.0007 ± 0.0002	Resident	Resident
usfws05-2001	Sacramento River	530	4	0.0008 ± 0.0003	0.0010 ± 0.0002	Resident	Resident
usfws05-2002	Sacramento River	290	2	0.0007 ± 0.0003	0.0010 ± 0.0002	Resident	Resident
usfws05-2003	Sacramento River	475	4	0.0008 ± 0.0004	0.0007 ± 0.0003	Resident	Resident
usfws05-2004	Sacramento River	450	4	0.0007 ± 0.0003	0.0007 ± 0.0002	Resident	Resident
usfws05-2005	Sacramento River	420	4	0.0003 ± 0.0003	0.0008 ± 0.0004	Resident	Resident
usfws05-2006	Sacramento River	370	3	0.0009 ± 0.0002	0.0010 ± 0.0004	Resident	Resident
usfws05-2007	Sacramento River	600	4	0.0007 ± 0.0001	0.0008 ± 0.0001	Resident	Resident
usfws05-2009	Sacramento River	330	2	0.0005 ± 0.0002	0.0007 ± 0.0004	Resident	Resident
usfws05-2010	Sacramento River	340	3	0.0006 ± 0.0003	0.0009 ± 0.0003	Resident	Resident
usfws05-2011	Sacramento River	352	3	0.0010 ± 0.0004	0.0009 ± 0.0003	Resident	Resident
usfws05-2012	Sacramento River	500	4	0.0006 ± 0.0004	0.0010 ± 0.0002	Resident	Resident
usfws05-2013	Sacramento River	500	4	0.0006 ± 0.0003	0.0009 ± 0.0002	Resident	Resident

CDFG No	Location	Length (mm)	Age	Mean Sr:Ca ± SD		Maternal Origin	Migratory History
				Primordia	FWG		
usfws05-2014	Sacramento River	510	4	0.0007 ± 0.0002	0.0006 ± 0.0002	Resident	Resident
usfws05-2016	Sacramento River	420	4	0.0008 ± 0.0003	0.0007 ± 0.0004	Resident	Resident
usfws05-2017	Sacramento River	360	3	0.0004 ± 0.0003	0.0007 ± 0.0003	Resident	Resident
usfws05-2019	Sacramento River	470	4	0.0006 ± 0.0003	0.0010 ± 0.0003	Resident	Resident
usfws05-2020	Sacramento River	430	4	0.0007 ± 0.0003	0.0007 ± 0.0001	Resident	Resident
usfws05-2022	Sacramento River	420	4	0.0015 ± 0.0003	0.0007 ± 0.0002	Steelhead	Resident
usfws05-2023	Sacramento River	428	4	0.0005 ± 0.0003	0.0007 ± 0.0004	Resident	Resident
usfws05-2024	Sacramento River	470	4	0.0010 ± 0.0003	0.0011 ± 0.0004	Resident	Resident
usfws05-2025	Sacramento River	380	3	0.0006 ± 0.0005	0.0010 ± 0.0003	Resident	Resident
usfws05-2026	Sacramento River	480	4	0.0006 ± 0.0003	0.0010 ± 0.0002	Resident	Resident
usfws05-2027	Sacramento River	370	3	0.0006 ± 0.0003	0.0008 ± 0.0002	Resident	Resident
usfws05-2028	Sacramento River	490	4	0.0007 ± 0.0003	0.0008 ± 0.0002	Resident	Resident
usfws05-2029	Sacramento River	335	3	0.0007 ± 0.0004	0.0011 ± 0.0002	Resident	Resident
usfws05-2030	Sacramento River	350	3	0.0007 ± 0.0003	0.0008 ± 0.0002	Resident	Resident
usfws05-2033	Sacramento River	415	4	0.0007 ± 0.0003	0.0010 ± 0.0003	Resident	Resident
usfws05-2034	Sacramento River	402	4	0.0007 ± 0.0003	0.0007 ± 0.0002	Resident	Resident
usfws05-2036	Sacramento River	335	3	0.0008 ± 0.0003	0.0009 ± 0.0002	Resident	Resident
usfws05-2046	Sacramento River	453	4	0.0009 ± 0.0001	0.0013 ± 0.0004	Resident	Resident
usfws05-2056	Sacramento River	333	3	0.0007 ± 0.0002	0.0008 ± 0.0002	Resident	Resident
usr001031704001	Sacramento River	243	2	0.0007 ± 0.0003	0.0007 ± 0.0003	Resident	Resident
usr001031704002	Sacramento River	315	2	0.0020 ± 0.0002	0.0009 ± 0.0002	Steelhead	Resident
usr001031704003	Sacramento River	235	1	0.0014 ± 0.0003	0.0009 ± 0.0002	Steelhead	Resident
usr001031704004	Sacramento River	304	2	0.0007 ± 0.0003	0.0006 ± 0.0002	Resident	Resident
usr001101503001	Sacramento River	218	1	0.0008 ± 0.0002	0.0009 ± 0.0002	Resident	Resident
usr001101503002	Sacramento River	207	1	0.0018 ± 0.0004	0.0013 ± 0.0006	Steelhead	Resident
usr001101503003	Sacramento River	216	1	0.0006 ± 0.0003	0.0010 ± 0.0003	Resident	Resident
usr002101603002	Sacramento River	302	2	0.0016 ± 0.0004	0.0010 ± 0.0003	Steelhead	Resident
usr002101603003	Sacramento River	238	2	0.0019 ± 0.0003	0.0009 ± 0.0003	Steelhead	Resident
usr002101603005	Sacramento River	366	3	0.0008 ± 0.0003	0.0010 ± 0.0002	Resident	Resident
usr002101603006	Sacramento River	375	3	0.0006 ± 0.0003	0.0009 ± 0.0002	Resident	Resident
usr002101603007	Sacramento River	300	2	0.0006 ± 0.0003	0.0009 ± 0.0002	Resident	Resident
usr002101603008	Sacramento River	220	1	0.0018 ± 0.0003	0.0008 ± 0.0002	Steelhead	Resident
usr002101603010	Sacramento River	210	1	0.0010 ± 0.0003	0.0009 ± 0.0003	Resident	Resident
usr003031704001	Sacramento River	327	2	0.0007 ± 0.0003	0.0010 ± 0.0003	Resident	Resident
usr004031704001	Sacramento River	242	2	0.0016 ± 0.0003	0.0007 ± 0.0003	Steelhead	Resident

CDFG No	Location	Length (mm)	Age	Mean Sr:Ca ± SD		Maternal Origin	Migratory History
				Primordia	FWG		
usr005031704001	Sacramento River	228	1	0.0009 ± 0.0003	0.0011 ± 0.0001	Resident	Resident
usr006031704001	Sacramento River	198	1	0.0018 ± 0.0003	0.0008 ± 0.0003	Steelhead	Resident
usr0320022	Sacramento River	530	4	0.0006 ± 0.0003	0.0009 ± 0.0002	Resident	Resident
usr0320031	Sacramento River	450	4	0.0009 ± 0.0002	0.0008 ± 0.0004	Resident	Resident
usr0320033	Sacramento River	530	4	0.0007 ± 0.0002	0.0010 ± 0.0003	Resident	Resident
usr0320034	Sacramento River	490	4	0.0010 ± 0.0003	0.0010 ± 0.0002	Resident	Resident
usr0320038	Sacramento River	520	4	0.0007 ± 0.0002	0.0009 ± 0.0003	Resident	Resident
usr0320040	Sacramento River	520	4	0.0011 ± 0.0003	0.0007 ± 0.0003	Resident	Resident
usr0320041	Sacramento River	420	4	0.0006 ± 0.0003	0.0008 ± 0.0002	Resident	Resident
usr0320042	Sacramento River	520	4	0.0007 ± 0.0004	0.0010 ± 0.0002	Resident	Resident
usr0320044	Sacramento River	370	3	0.0004 ± 0.0003	0.0008 ± 0.0003	Resident	Resident
usr0320045	Sacramento River	380	3	0.0008 ± 0.0004	0.0012 ± 0.0004	Resident	Resident
usr0320047	Sacramento River	380	3	0.0005 ± 0.0004	0.0008 ± 0.0004	Resident	Resident
usr0320051	Sacramento River	450	4	0.0007 ± 0.0001	0.0009 ± 0.0004	Resident	Resident
usr0320053	Sacramento River	420	4	0.0008 ± 0.0003	0.0008 ± 0.0002	Resident	Resident
usr0320055	Sacramento River	370	3	0.0008 ± 0.0003	0.0008 ± 0.0003	Resident	Resident
usr0320060	Sacramento River	340	3	0.0007 ± 0.0002	0.0009 ± 0.0002	Resident	Resident
usr0320061	Sacramento River	370	3	0.0009 ± 0.0003	0.0009 ± 0.0004	Resident	Resident
usr032403002	Sacramento River	520	4	0.0008 ± 0.0003	0.0009 ± 0.0003	Resident	Resident
usr032403003	Sacramento River	435	4	0.0005 ± 0.0002	0.0010 ± 0.0004	Resident	Resident
usr032403004	Sacramento River	440	4	0.0004 ± 0.0002	0.0007 ± 0.0001	Resident	Resident
usr032503005	Sacramento River	344	3	0.0007 ± 0.0002	0.0010 ± 0.0003	Resident	Resident
usr032503006	Sacramento River	430	4	0.0007 ± 0.0003	0.0008 ± 0.0004	Resident	Resident
usr040103007	Sacramento River	550	4	0.0006 ± 0.0002	0.0010 ± 0.0004	Resident	Resident
usr040103008	Sacramento River	573	4	0.0005 ± 0.0003	0.0007 ± 0.0003	Resident	Resident
usr040703009	Sacramento River	544	4	0.0009 ± 0.0002	0.0012 ± 0.0002	Resident	Resident
usr050102sh03	Sacramento River	490	4	0.0008 ± 0.0003	0.0010 ± 0.0003	Resident	Resident
usr050402sh01	Sacramento River	640	4	0.0006 ± 0.0002	0.0007 ± 0.0003	Resident	Resident
usr050402sh02	Sacramento River	580	4	0.0005 ± 0.0002	0.0006 ± 0.0003	Resident	Resident
usr050402sh03	Sacramento River	540	4	0.0008 ± 0.0003	0.0010 ± 0.0004	Resident	Resident
usr051002sh01	Sacramento River	600	4	0.0008 ± 0.0002	0.0009 ± 0.0001	Resident	Resident
usr051102sh01	Sacramento River	550	4	0.0009 ± 0.0002	0.0007 ± 0.0002	Resident	Resident
usr051302sh02	Sacramento River	550	4	0.0008 ± 0.0002	0.0006 ± 0.0002	Resident	Resident
usr051402sh03	Sacramento River	390	3	0.0005 ± 0.0003	0.0009 ± 0.0002	Resident	Resident
usr051602sh01	Sacramento River	530	4	0.0008 ± 0.0002	0.0006 ± 0.0002	Resident	Resident

CDFG No	Location	Length (mm)	Age	Mean Sr:Ca ± SD		Maternal Origin	Migratory History
				Primordia	FWG		
usr052202sh03	Sacramento River	520	4	0.0007 ± 0.0002	0.0010 ± 0.0004	Resident	Resident
usr052802sh02	Sacramento River	570	4	0.0006 ± 0.0002	0.0010 ± 0.0005	Resident	Resident
usr052802sh03	Sacramento River	340	3	0.0007 ± 0.0003	0.0007 ± 0.0003	Resident	Resident
usr052902sh02	Sacramento River	470	4	0.0008 ± 0.0003	0.0008 ± 0.0004	Resident	Resident
usr052902sh03	Sacramento River	550	4	0.0007 ± 0.0002	0.0010 ± 0.0004	Resident	Resident
usr060102sh01	Sacramento River	490	4	0.0006 ± 0.0004	0.0010 ± 0.0003	Resident	Resident
usr060902sh02	Sacramento River	560	4	0.0010 ± 0.0002	0.0009 ± 0.0003	Resident	Resident
usr060902sh03	Sacramento River	510	4	0.0010 ± 0.0008	0.0008 ± 0.0002	Resident	Resident
usr071302sh01	Sacramento River	530	4	0.0007 ± 0.0002	0.0007 ± 0.0003	Resident	Resident
usr081402sh01	Sacramento River	530	4	0.0010 ± 0.0002	0.0009 ± 0.0003	Resident	Resident
usr081502sh02	Sacramento River	520	4	0.0009 ± 0.0001	0.0006 ± 0.0003	Resident	Resident
usr081702sh01	Sacramento River	400	3	0.0006 ± 0.0003	0.0008 ± 0.0003	Resident	Resident
usr69529	Sacramento River	555	4	0.0007 ± 0.0004	0.0009 ± 0.0002	Resident	Resident
sjr040202609	San Joaquin River	235	2	0.0018 ± 0.0002	0.0012 ± 0.0003	Steelhead	Resident
sjr041202604	San Joaquin River	275	2	0.0018 ± 0.0002	0.0012 ± 0.0002	Steelhead	Resident
sjr043002607	San Joaquin River	191	2	0.0011 ± 0.0002	0.0013 ± 0.0003	Resident	Resident
sjr051002606	San Joaquin River	288	2	0.0011 ± 0.0002	0.0014 ± 0.0003	Resident	Resident
sjr051002608	San Joaquin River	211	2	0.0007 ± 0.0003	0.0013 ± 0.0003	Resident	Resident
sjr052202610	San Joaquin River	230	2	0.0014 ± 0.0002	0.0012 ± 0.0002	Resident	Resident

ATTACHMENT D

Pacific Fishery Management Council ***NEWS RELEASE***

FOR IMMEDIATE RELEASE : Thursday, April 10, 2008

Contact: Ms. Jennifer Gilden, Communications Officer, 503-820-2280
Dr. Donald McIsaac, Executive Director, 503-820-2280

RECORD LOW SALMON FISHERIES ADOPTED

SEATTLE, Wash – The Pacific Fishery Management Council today adopted the most restrictive salmon fisheries in the history for the West Coast, in response to the unprecedented collapse of Sacramento River fall Chinook and the exceptionally poor status of coho salmon from Oregon and Washington. The recommendation will be forwarded to the National Marine Fisheries Service for approval by May 1, 2008.

"This is a disaster for West Coast salmon fisheries, under any standard," said Council chairman Don Hansen. "There will be a huge impact on the people who fish for a living, those who eat wild-caught king salmon, those who enjoy recreational fishing, and the businesses and coastal communities dependent on these fisheries."

The Council adopted a complete closure of commercial and sport Chinook fisheries off California and most of Oregon and allowed only a 9,000 fishery for hatchery coho only off Central and southern Oregon. Salmon fisheries off California and Oregon typically have been large – involving seasons that span from May 1 to October 31 and averaged over 800,000 Chinook caught per year from 2000 to 2005.

"The reason for the sudden decline of Sacramento River fish is a mystery at this time," said Council Executive Director Don McIsaac. "The only thing that can be done in the short term is to cut back the commercial and recreational fishing seasons to protect the remaining fish. The longer-term solution will involve a wide variety of people, agencies, and organizations. But for now, unfortunately, those involved in the salmon fisheries are paying the price."

Fisheries north of Cape Falcon will also be severely restricted. Coho quotas are less than 20 percent of the 2007 season for non-Indian fisheries and about 50 percent of 2007 levels for treaty-Indian fisheries. Although Chinook quotas in this area are similar to 2007 and Chinook stocks are generally more abundant, depressed natural coho stocks are constraining access of commercial fisheries to Chinook stocks. Sport fisheries, many of which depend primarily on coho, are even more restricted.

Background

The closures south of Cape Falcon, in northern Oregon, are due to a sudden, unprecedented decline in the number of Sacramento River fall Chinook returning to the river this year. The stock is the driver of commercial and recreational salmon fisheries off California and most of Oregon. The minimum conservation goal for Sacramento fall Chinook is 122,000 – 180,000

spawning adult salmon (this is the number of salmon needed to return to the river to maintain the health of the run). As recently as 2002, 775,000 adults returned to spawn. This year, even with all ocean salmon fishing closures, the return of fall run Chinook to the Sacramento is projected to be only 54,000.

Social and Economic Impacts

"The salmon fishing culture that has been a cornerstone of the coastal communities has reached a low ebb point in 2008 for the collective three West Coast states," said Mark Cedergreen, Council Vice Chairman. "This was the responsible thing to do, but it will hurt, particularly south of Cape Falcon, Oregon."

The economic implications of the low abundance of Sacramento River fall Chinook salmon will be substantial for commercial, recreational, marine and freshwater fisheries. In California and Oregon south of Cape Falcon, where Sacramento fish stocks have the biggest impact, the commercial and recreational salmon fishery had an average economic value of $103 million per year between 1979 and 2004. From 2001 to 2005, average economic impact to communities was $61 million ($40 million in the commercial fishery and $21 million in the recreational fishery).

The record low seasons are devastating news to beleaguered salmon fleets on the west coast. California and Oregon ocean salmon fisheries are still recovering from a poor fishing season in 2005 and a disastrous one in 2006, when Klamath River fall Chinook returns were below their spawning escapement goal. The catch of salmon in 2007 in these areas was also well below average, as the first effects of the Sacramento River fall Chinook stock collapse was felt.

Causes

The reason for the sudden collapse of the Sacramento fall Chinook stock is not readily apparent, although both natural and hatchery-produced fish have been similarly affected. However, it is clear that overfishing did not cause the depressed condition, as the parent spawning populations were all above the goal. The National Marine Fisheries Service has suggested ocean temperature changes, and a resulting lack of upwelling, as a possible cause of the sudden decline.[1] Many biologists believe a combination of human-caused and natural factors will ultimately explain the collapse, including both marine conditions and freshwater factors such as in-stream water withdrawals, habitat alterations, dam operations, construction, pollution, and changes in hatchery operations.

The Council has requested a multi-agency task force led by the National Marine Fisheries Service's West Coast Science Centers to research about 50 potential causative factors and report back to the Council at the September meeting in Boise, Idaho.

Process

The Council reached this decision after several weeks spent reviewing three season options. The review process included input by federal and state fishery scientists, fishing industry members, public testimony, and three public hearings in coastal communities. The Council

[1] http://swr.nmfs.noaa.gov/news/030308.salmon_decline.final.pdf.

received additional scientific information and took public testimony before taking final action. The decision will be forwarded to the National Marine Fisheries Service for approval and implementation into federal regulations.

In addition, the coastal states will decide on compatible freshwater fishery regulations at their respective Commission hearings.

Press Packet and Briefing Materials Available

A press packet with contacts, background information, a map of affected areas, and acronyms is available on the Council website at http://www.pcouncil.org/newsreleases/sal_presspacket.html.

Council Role

The Pacific Fishery Management Council is one of eight regional fishery management councils established by the Magnuson Fishery Conservation and Management Act of 1976 for the purpose of managing fisheries 3-200 miles offshore of the United States of America coastline. The Pacific Council recommends management measures for fisheries off the coasts of California, Oregon, and Washington.

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On the Web

Pacific Fishery Management Council: http://www.pcouncil.org

Options for 2008 salmon management: http://www.pcouncil.org/salmon/salcurr.html#saloptions08

Schedule of hearings: http://www.pcouncil.org/events/2008/salproc08.html#hearings

Geographical points used in salmon management: http://www.pcouncil.org/facts/geosalmon.pdf

Online press packet: http://www.pcouncil.org/newsreleases/sal_presspacket.html

UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

Turlock Irrigation District	)	Project No. P-2299
Modesto Irrigation District	)	
Don Pedro Project	)	
	)	

CERTIFICATE OF SERVICE

I hereby certify that I have this day served, by first class or electronic mail, the National Marine Fisheries Service's Request for Rehearing under Project No. P-2299, with cover letter and attachments, to Secretary Bose and Deputy Secretary Davis of the Federal Energy Regulatory Commission, along with this Certificate of Service, upon each person designated on the official service list compiled by the Commission in the above-captioned proceeding.

Dated this 2nd day of May, 2008

Eric Theiss
Fisheries Biologist

Service List for P-2299-000
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