Juvenile Salmonid Out-migration Monitoring at Caswell Memorial State Park in the Lower Stanislaus River, California

2012 Annual Report

Prepared by:

Clark Watry, Kirsten Sellheim, Bill Beckett, and Joseph Merz

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SUMMARY

As part of the U.S. Fish and Wildlife Service's Comprehensive Assessment and Monitoring Program (CAMP), we operated two rotary screw traps (RSTs) from 26 December 2011 to 3 July 2012 in the lower Stanislaus River, California, at Caswell Memorial State Park (N 37°42'7.533", W 121°10'44.882"; river kilometer 13.8). Cramer Fish Sciences has conducted annual operations at this location since 1996 to monitor juvenile fall-run Chinook salmon *Oncorhynchus tshawytscha* and steelhead trout *O. mykiss* as they emigrate to the San Joaquin River. The objectives of this project are to estimate the annual production (i.e., the estimated abundance of individuals passing the RST during the sampling period) of juvenile salmon out-migrants in the lower Stanislaus River and gather data to determine and evaluate patterns of salmonid emigration timing, size, and life history relative to flow and other environmental conditions. In 2012, two traps were operated with the primary trap positioned in the thalweg so that it sampled >30% of the channel flow by volume when flows were less than 7.1 m^3/s (250 ft^3/s). Daily catch and recapture data from only the primary trap were used to determine daily salmon passage estimates. The secondary trap was operated during increased flow periods to collect additional information on the out-migrant population (i.e., fish size, life history composition) and secure additional individuals to determine the efficiency of the primary trap when hatchery fish were not available. We determined trap efficiency in 2012 with six mark-recapture tests by tagging and releasing salmon upstream of the primary trap. In 2012, a predictive logistic regression model was developed using efficiency data from all previous years and the results of six efficiency tests conducted in 2012. During the 2012 sampling period, we captured 1,198 juvenile Chinook salmon and two *O. mykiss*. As in previous years, we developed annual production estimates for out-migrating salmon using our trap efficiency model and cumulative catch data; no production estimates were made for *O. mykiss* due to low catch. The production estimate of juvenile salmon passing Caswell in 2012 was 105,821 (95% CI = 75,669 – 154,525) compared to a low of 8,704 (95% CI = 6,442 – 16,053) in 2009. Monitoring at Caswell Memorial State Park continues to provide critical data on salmonid life history diversity and population abundance in the Stanislaus River, and helps the Anadromous Fish Restoration Program (AFRP) and CAMP track success of habitat restoration activities in the Stanislaus River.

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INTRODUCTION

Chinook salmon *Oncorhynchus tshawytscha* and steelhead (the anadromous component of the steelhead/rainbow trout complex) *O. mykiss* populations in California's Central Valley are at the southernmost extent of their range in North America, and are among numerous native fish species undergoing widespread decline (Moyle et al. 2008). Chinook salmon and steelhead/rainbow trout have important economic as well as cultural and ecological value, and both historically supported robust fisheries (CDFG 2001; Merz and Moyle 2006). Precipitous declines in the past century are linked to a variety of anthropogenic impacts, including mining (e.g., gold, gravel, and copper), over-harvest, logging, hydropower development, flood protection, introduced species, hatchery fish interactions, pollution, and corresponding urban and agriculture development (Nehlsen et al. 1991; Yoshiyama et al. 2001; Williams 2006; NMFS 2009). Dams and other impediments have prevented passage to important staging areas and spawning grounds, with greater relative impacts to spring-run Chinook salmon and steelhead populations that historically made extensive use of higher elevation habitats (Moyle 2002; May and Brown 2002). Hatchery supplementation has compounded the problem by compressing run timing and stock complexity (Lichatowich 1999; Augerot et al. 2005; Bottom et al. 2005), and likely has significant management implications in the Central Valley (Barnett-Johnson et al. 2007). Moyle et al. (2008) identified inadequate flows, habitat reduction and elimination, and genetic degradation from hatchery supplementation as the primary stressors affecting salmonid populations in California.

In late 2007, the commercial fishery for Chinook salmon on the West Coast was declared a failure under Emergency Action of the Magnusson-Stevens Act due to historically low returns (NOAA 2008). According to the National Oceanic and Atmospheric Administration (NOAA), changing ocean conditions (i.e., shifting ocean temperatures and food sources) may have been a causal factor contributing to poor juvenile salmon survival (NOAA 2008). Additionally, the report stated that cumulative impacts to freshwater habitats had "made salmon populations more susceptible to the occasional poor ocean conditions." The abundance of returning salmon continued to decline in fall 2008. The Pacific Fishery Management Council (PFMC) reported 66,264 salmon adults returned to the Sacramento River in 2008, well below the 90,000 in 2007 (PFMC 2009). Commercial ocean harvest and recreational fisheries for Central Valley Chinook salmon remained closed through 2009 (CDFG 2009; PMFC 2009). Beginning in 2009, new regulations designated Central Valley rivers and streams, including the San Joaquin River and its tributaries, closed to salmon fishing year-round and prohibited catch and release fishing that intentionally targeted salmon (CDFG 2009). These regulations remained in effect through 2010.

The National Marine Fisheries Service (NMFS) finalized a biological and conference opinion (Opinion) in June 2009 after reviewing the proposed long-term operations of the Central Valley Project (CVP) and the State Water Project (SWP) (NMFS 2009). The Opinion discussed the effects the CVP/SWP operations might have on listed anadromous fishes and marine mammals in accordance with Section 7 of the Endangered Species Act of 1973 (ESA). The Opinion included two main objectives for the Stanislaus River: 1) Provide sufficient definition of operational criteria to ensure the viability of the steelhead population on the Stanislaus River, including freshwater migration routes to and from the Delta; and 2) halt or reverse adverse modifications of steelhead critical habitat (Available: http://swr.nmfs.noaa.gov/ocap.htm).

The 1992 Central Valley Project Improvement Act (CVPIA) granted authority to the U.S. Fish and Wildlife Service (USFWS) to develop and implement a series of restoration programs, with the goal of doubling the natural production of anadromous fish in Central Valley streams. The U.S. Bureau of Reclamation and USFWS are responsible for implementing provisions outlined in the CVPIA (Available: http://www.usbr.gov/mp/cvpia/title_34/index.html). To support this goal, USFWS established the Anadromous Fish Restoration Program (AFRP) and the Comprehensive Assessment and Monitoring Program (CAMP). These programs set anadromous fish production targets, recommended fishery restoration actions for Central Valley streams, and formed a juvenile Chinook salmon and *O. mykiss* monitoring program to assess the relative effectiveness of fishery restoration actions. The two programs support informed feedback on population dynamics of target species that allow adjustments or improvements to adaptive management plans and approaches.

The Stanislaus River, a major tributary to the San Joaquin River, still provides valuable spawning and rearing habitat for Central Valley fall-run Chinook salmon, considered a species of concern, and the steelhead component of *O. mykiss*, listed as threatened, under the federal ESA (NOAA 2004). Additionally, multiple habitat improvement projects have been implemented, with others still in development. Juvenile out-migration monitoring is an important component of fisheries habitat restoration and management in the Stanislaus River. Since 1996, the USFWS has funded Cramer Fish Sciences (CFS) to monitor juvenile salmonid out-migration in the Stanislaus River. The current monitoring program determines annual juvenile Chinook salmon production using RSTs at Caswell Memorial State Park (Caswell) in the lower Stanislaus River (river kilometer [rkm] 13.8), and quantifies emigrants to the San Joaquin River. Because of the difficulty in separating anadromous and non-anadromous *O. mykiss* and their low capture rates within the Stanislaus River, RST monitoring provides general information on *O. mykiss* emigration timing and taxa presence. This long-term data set provides a valuable source of information for evaluating fish responses to in-river management actions.

The objectives of this project were as follows:

1) Estimate annual production of juvenile Chinook salmon out-migrants in the lower Stanislaus River using RSTs operated near Caswell; and

2) Determine and evaluate patterns of emigration timing, fish size, and life history for juvenile Chinook salmon and *O. mykiss* relative to river flow and other environmental conditions.

In this report we provide catch details from RST operations, determine trap efficiency, develop annual passage estimates, and describe life history characteristics for juvenile Chinook salmon in 2012. A more detailed analysis of juvenile Chinook salmon population dynamics in relation to environmental variation requires more years of out-migration data and is beyond the scope of this annual report.

This juvenile salmonid monitoring program helps CAMP address their goals to track population dynamics, evaluate the results of past and future habitat restoration efforts, and to understand the impacts of instream flow schedules and management on fall-run Chinook salmon and *O. mykiss* populations. This annual report details results from 2012 RST operations at Caswell in the lower Stanislaus River and provides critical details to address these goals.

STUDY AREA

The Stanislaus River, a major tributary to the San Joaquin River, flows southwest from the western slopes of the Sierra Nevada Mountains with a drainage area of approximately 2,400 km^2 and approximately 40% of its basin above snowline (Kondolf et al. 2001) (Figure 1). The confluence of the Stanislaus and San Joaquin rivers is located near the southern end of the Sacramento-San Joaquin River Delta. The basin has a Mediterranean climate with dry summers and about 90% of the annual precipitation occurs between November and April (Schneider et al. 2003). More than 40 dams exist on the Stanislaus River. Collectively, these dams have the capacity to store 240% of the average annual runoff in the basin. Approximately 85% of this total storage capacity is in New Melones Reservoir (Schneider et al. 2003). Dams control the Stanislaus River for flood protection, power generation, irrigation, and municipal water. The river is also used for whitewater recreation and off-channel gravel mining. Goodwin Dam (GDW), located at rkm 94, is the upstream migration barrier to adult Chinook salmon (see Figure 1; Appendix 1). Most salmon spawning in the Stanislaus River is by fall-run Chinook salmon and occurs in the 29-km reach below GDW; however, spawning has been observed as far downstream as rkm 53.1. Additionally, rare observations of early-migrating (i.e., May to June) adult Chinook salmon in the Stanislaus River do exist (Anderson et al. 2007); however, their origin is unclear. Little work has occurred on migration timing, abundance, or spawning parameters of *O. mykiss* within the Stanislaus River to date (CFS 2009). A complete species list is given in Appendix 2.

FIGURE 1. Map of the Stanislaus River below Goodwin Dam in relationship to other San Joaquin River tributaries and selected landmarks.

METHODS

Trap Operations

In 2012, we continued out-migration monitoring operations in the Stanislaus River at Caswell Memorial State Park (N 37°42'7.533", W 121°10'44.882") near Ripon, CA. This site was selected as the farthest downstream location with suitable channel characteristics and access to install and monitor traps. Due to low flow and changes to channel conditions at the site, we relocated the trapping operation at the beginning of the 2009 field season to a location ~50 m downstream of the position where trapping was conducted between 1996 and 2008 (Watry et al. 2009), and used the same trap location in 2010, 2011, and 2012. Beginning in 2009, only the primary trap (Trap 1) was used to track juvenile salmonid out-migration, and develop annual passage estimates for Chinook salmon. The secondary trap (Trap 2) was operated during increased flow periods to collect additional information on the out-migrant population (i.e., fish size, life stage composition) and secure additional individuals to increase mark-release group sizes, when hatchery fish were not available, for determining the efficiency of Trap 1. Traps were secured with 6.35-mm galvanized steel cable leaders fastened to large trees, and State Park permits allowed CFS access to the trap by land or boat as necessary. We monitored trap operation following guidelines outlined in standard protocols (CAMP 2008; Gray et al. 2012). Similar to our primary objectives, several authors have used this methodology to monitor population dynamics and abundance for salmonid out-migrations (e.g., Thedinga et al. 1994; Fleming 1997; Roper and Scarnecchia 1998; Sparkman 2001; Workman 2002–2006; Seesholtz et al. 2004; Bottom et al. 2005; Rayton 2006; Johnson and Rayton 2007; Workman et al. 2007). Trap rotations were enumerated by a mechanical counter (Redington Counters, Inc.; Model 29) secured to the pontoon adjacent to the leading edge of the trap cone. Trap cones were raised and non-operational on days when sampling did not occur. We terminated sampling when at least seven consecutive days of trapping yielded no juvenile Chinook salmon during June or July, typically the end of emigration (Gray et al. 2012).

Safety Measures

All trap personnel were trained in RST operational safety, and warning signs were posted to advise river users and park visitors to stay away from the potentially hazardous traps and rigging. We placed signs in conspicuous places at the trap site and on each side of the trap, and upstream of the trap. The upstream sign stated “Danger Ahead – Stay Left” with a large arrow pointing in the direction of the best side of the river channel for boaters to pass the traps. Flashing lights and flagging were placed on the traps and along the rigging. All signs were in English and Spanish.

Fish Handling and Data Collection

We generally checked traps once a day, or twice a day and more often if required by changing conditions (e.g., in response to high debris loads due to freshets or increased flows from upstream dams). Fish handling procedures used during trap sampling followed the methods of Gray et al. (2012). We used tricaine methanesulfonate (Tricaine-S; Western Chemical, Inc.) to anesthetize fish for safe handling. To limit handling injury and stress, all captured fish were anesthetized in groups of 5 to 10 individuals immediately prior to handling using a solution of river water and Tricaine-S at a 26.4-mg/L concentration. The solution was cooled with bottles of frozen river water to reduce thermal stress in captured fish. Litmus strips were used to check pH, and baking soda was added to reduce the acidity of the solution. The effectiveness of Tricaine-S varies with changes in temperature and fish density; therefore, all solutions were tested with a few fish to determine potency and adjusted if necessary. StressCoat (Aquarium Pharmaceuticals, Inc.), which helps fish to replace their slime coating and thus ameliorates adverse effects caused by scale loss, was added to the Tricaine-S solution and recovery buckets at a rate of 2.5 ml per 9.5 L. Processed fish were returned to a bucket filled with fresh river water to recover prior to their release. Water temperature and dissolved oxygen (DO) concentration were monitored and maintained above critical levels (Gray et al. 2012). Life stage was determined by assigning a smolt index value based on morphological characteristics (Table 1). For Chinook salmon and *O. mykiss*, we recorded fork length (FL, mm), weight (g), and life stage for 25 randomly selected fish each day; any additional fish were counted. The silvery parr designation was only used for *O. mykiss*; it was not applied to juvenile Chinook salmon (CAMP 2008). All captured fish were released approximately 150 m downstream of the traps below a large, deep pool in an attempt to decrease risk of predation and prevent recapture. Night check procedures were identical to daytime checks, with the exception of only measuring the first 20 fish of each species and counting the remainder.

TABLE 1. Smolt index rating adapted from CAMP (2008).

Smolt Index	Life Stage	Criteria
1	Yolk-sac fry	-Newly emerged with visible yolk sac
2	Fry	-Recently emerged with sac absorbed; pigment undeveloped
3	Parr	-Darkly pigmented with distinct parr marks; no silvery coloration; scales firmly set
4*	Silvery parr	-Parr marks visible but faded, or completely absent; intermediate degree of silvering
5	Sub-yearling smolt	-Parr marks highly faded or absent; bright silver or nearly white coloration; scales easily shed; black trailing edge of caudal fin; more slender body
Yearling	Yearling smolt	-All the same characteristics as a sub-yearling smolt; generally larger than 110 mm FL

**Silvery parr life stage was only used for O. mykiss.*

Environmental Variables

We measured physical variables once each day at the trap site. We recorded instantaneous water temperature and dissolved oxygen using an YSI Handheld Dissolved Oxygen Instrument (YSI; Model 550A). We measured instantaneous water velocity using a Marsh-McBirney flow meter (Global Water Instrumentation, Inc.; Model FP101) in front of the trap cone to monitor local flow conditions affecting trap rotations. Instantaneous turbidity was measured in Nephelometric Turbidity Units (NTUs) using a turbidity meter (LaMott Company; Model 2020). We obtained average daily flow data from three U.S. Geological Survey (USGS) gauging stations from the

California Data Exchange Center (CDEC), including Goodwin Dam (GDW; rkm 94), Orange Blossom Bridge (OBB; rkm 75.5), and Ripon (RIP; rkm 25.4). We determined trap effort by measuring the rate of cone revolutions during each trap check and recording the number of revolutions between checks from counters. Our results were summarized in tables, and data for flow were used in our analysis of fish passage abundance.

Catch

We recorded and summarized data on daily catch of juvenile Chinook salmon and *O. mykiss* captured in both traps, but determined recaptures from trap efficiency tests using only the primary trap. We identified and enumerated non-target species and measured the first 20 individuals of each species each day. We developed a length histogram from our data to evaluate size classes, and compared the histogram with catch date to assess emigration timing and life history patterns. Species composition charts were developed to demonstrate the relative abundance of all fish caught. We summarized our weekly catch by life stage (smolt index) and size.

Trap Efficiency

In order to derive accurate estimates of abundance, it was first necessary to determine the catch rates (or efficiencies) for the RST. Similar to most years, we determined trap efficiency with mark and recapture of juvenile Chinook salmon to estimate the number of natural migrants passing the Caswell traps (passage). At the beginning of the 2009 field season, the traps were relocated relative to where they had been deployed between 1996 and 2008 because of changes to the old trap site; however, low flow conditions at the new location prevented the consistent operation of two traps through an entire season. As a result, the primary trap was always positioned in the thalweg and operated continuously through each season. To standardize counts in years with inconsistent operations, daily catch and recapture data from only the primary trap (Trap 1) were used to estimate trap efficiency and abundance from 2009 to 2012.

In 2012, different marks were used for each release group due to the close time proximity of releases and subsequent overlapping recaptures. Fish were dye-marked using a photonic marking gun (Meda-E-Jet; A1000) with pink dye on the caudal or anal fin (Figure 2). Releases occurred approximately 430 m upstream of the traps from the north bank at a narrow (~20 m) and deep area of the river. Fish releases occurred approximately one hour after dark in small groups (5 – 10 individuals) to encourage mixing with natural (unmarked) Chinook salmon in the river, reduce extent of schooling, and mimic pulses in natural passage during nighttime migration. Marked fish transported in a non-motorized boat were released across the channel at various points away from the bank. Traps were processed one hour after completing release activities. Additional recaptures were recorded with the subsequent days' catch.

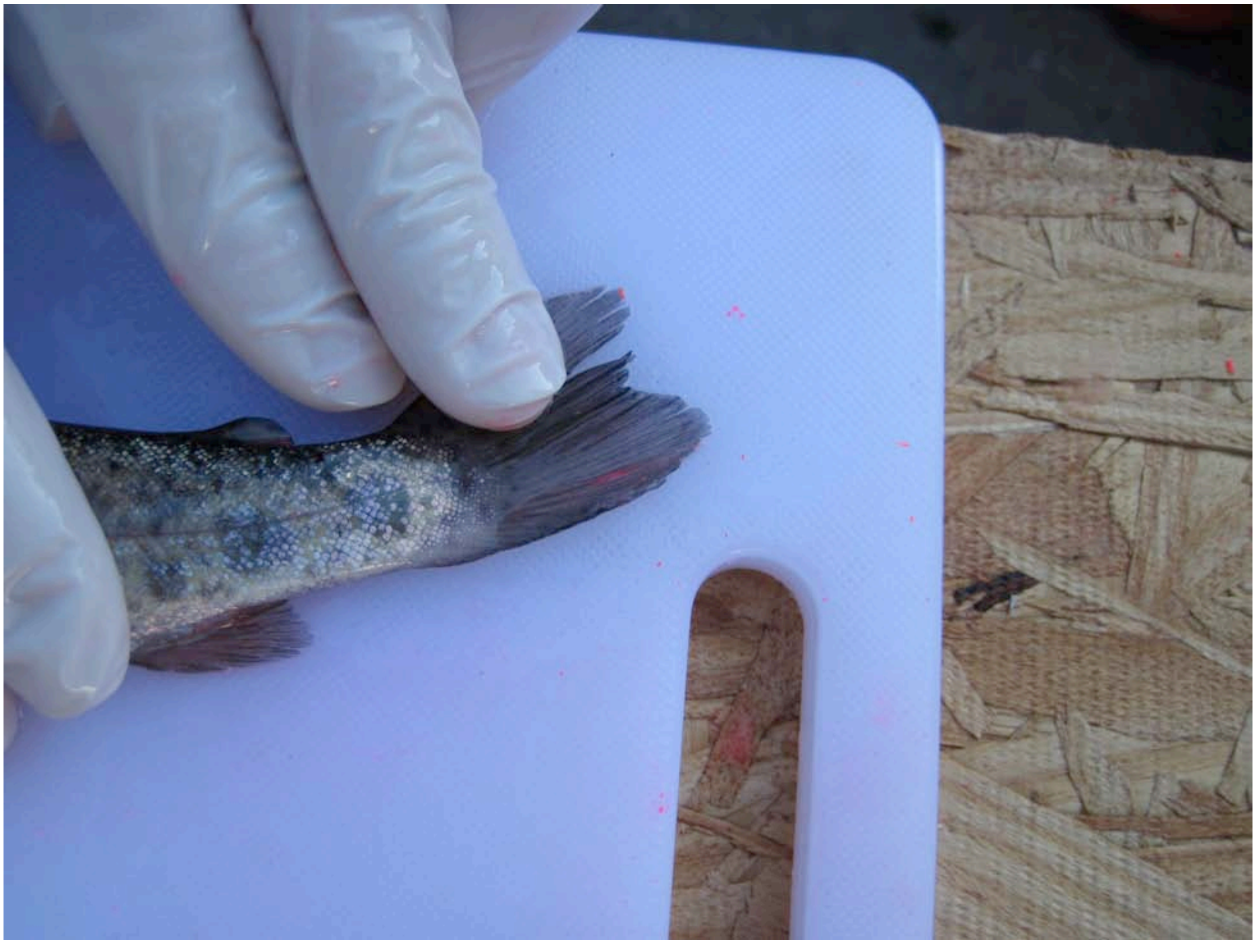

FIGURE 2. Juvenile salmon with pink photonic dye mark on lower lobe of caudal fin.

Following methods from previous years (Watry et al. 2007, 2008, 2009, 2012), we utilized our 138 experimental mark-recapture release groups across all years (1996 – 2012) and used a logistic regression to develop a predictive model to determine daily trap efficiencies at Caswell (Appendix 3). From 2009 through 2012, efficiency estimates were developed using only recaptures from the primary trap; for all other years (1996 – 2008), efficiency results were developed using recaptures from both traps. Environmental factors that were originally considered in our analyses included the natural log of flow (denoted log(flow)), temperature, and turbidity. We considered the natural logarithm of flow as previous work has shown non-linear effects of flow on similar parameters, such as migration speed and survival (Kjelson and Brandes 1989; Williams and Matthews 1995; Newman and Rice 2002; Newman 2003). Fork length at release was also considered, as was the categorical variable 'year', to control for between year differences in trap efficiency (e.g., due to differences in trap placement, channel morphology, bank vegetation, etc.). We used a backward stepwise regression procedure to determine the 'best fitting' model, which was then used to estimate daily trap efficiencies. Logistic regression is used for predicting the probability of occurrence of an event by fitting data to a logistic curve (Zar 1999). It is essentially a generalized linear model that is applicable to binomial data (McCullagh and Nelder 1989; Dobson 2002); in this case, binomial data would refer to the potential outcomes of fish collection (i.e., either the fish is caught or not). Like many forms of regression analysis, it makes use of several predictor variables that may be either numerical or categorical. Here, the binomial probability of interest is the observed trap efficiency (q):

(1) $$q = \frac{m}{R},$$

where m is number of observed recaptures (a binomial variable) of a given release group of size R. The logistic model with n explanatory variables (x) can be expressed in linear form as:

(2) $$y = \beta_0 + \beta_1 x_1 + \ldots + \beta_n x_n,$$

where y is the "logit" transform of the observed trap efficiency (q):

(3) $$y = \text{logit}(q) = \log\left(\frac{q}{1-q}\right).$$

The coefficients (β), which are estimated via maximum likelihood, provide predicted values of trap efficiency ($\hat{q}$) via the following back-transformation of the logit function:

(4) $$\hat{q} = \frac{\exp(y)}{1+\exp(y)}.$$

In the first step, a model was fit with an intercept (β_0), and then each explanatory variable was entered one at a time. The variable with the greatest explanatory power was then included in the model, and the remaining variables were again entered one at a time. The procedure was terminated when none of the remaining variables had a statistically significant effect on survival at the $\alpha = 0.05$ significance level. An alternative approach to model selection was also examined, in which the "best fitting" model was determined using the Akaike Information Criterion (AIC), adjusted for over-dispersion (Burnham and Anderson 2002). However, the stepwise regression and AIC procedures provided the same "best" model in all analyses. The statistical significance of explanatory variables in the "best fitting" model was tested using analysis of deviance (McCullagh and Nelder 1989; Venables and Ripley 1999). Under the binomial assumption, a logistic model that adequately explains variability in trap efficiencies will have a deviance roughly equal to the residual degrees of freedom. However, in our analyses, model deviances were much greater than expected due to binomial sampling error alone. Such extra-binomial variation, which may arise from either over-dispersion or inadequate model structure (i.e., when key processes affecting trap efficiencies are missing from the model), must be accounted for when testing variables and estimating confidence intervals. Extra-binomial variation is represented by a dispersion parameter, Φ, which is a scalar of the assumed binomial variance. To conduct statistical tests and compute confidence intervals, we multiplied the variance-covariance matrix for the logistic coefficients by the dispersion parameter, which is easily estimated from the fit of a logistic regression (Venables and Ripley 1999).

Passage Estimates

The daily passage abundance (n) of migrating juvenile Chinook salmon was estimated as follows:

$$\hat{n} = \frac{c}{\hat{q}} \quad (5)$$,

where *c* was observed daily count and $\hat{q}$ was the estimated trap efficiency for that day based on the "best" logistic model. From 2009 through 2012, daily abundance and efficiency estimates were developed using only catch and recaptures from the primary trap; for all other years (1996 – 2008), daily abundance and efficiency results were developed using catch and recaptures from both traps. Annual passage was estimated by summing the daily abundance estimates. Standard errors (SE) and confidence intervals for measures of total monthly and annual passage were computed using the methods described in Watry et al. (2008). During some years, there were periods when traps were not fished. To estimate a missing value of daily count (*c*) within a sampling period, we used the weighted average of all observed counts for the five days before and five days after the missing value. The weights were equal to one through five, where values that were directly adjacent to the missing day were weighted as five, values that were two days before and after the missing day were weighted as four, and so on.

RESULTS

Trap Operations

For the 2012 season, sampling began on 26 December 2011 after the trap was installed on 22 December; operations were terminated on 3 July 2012 at the end of the migration period. We sampled seven days a week for the majority of the season, which resulted in a total of 176 trapping days during the 194 day field season. Overall, the primary trap was stopped on 49 days and the secondary trap on 54 days; most stoppages occurred during the high flow period beginning in early April. Of those stoppages, there were fewer than 1,440 revolutions (equivalent to one revolution per min) on 21 days for the primary trap and on 25 days for the secondary trap. In general, stoppages were associated with medium to heavy debris loads.

Environmental Variables

In 2012, mean daily flow at RIP ranged from 333 to 1,900 ft^3/s (9.4 – 53.8 m^3/s) during the season (Appendix 4). Daily temperature ranged from 6.5°C to 19.9°C (43.7°F – 67.8°F). Turbidity was generally less than 10 NTUs, but peaked at 238 NTUs on 8 March. Instantaneous DO never measured below 8.84 mg/L in 2012. Managed high flow releases from dam operations were effective from early April to late May 2012 (Figure 3).

Catch

Salmonids

During the 2012 trapping season, we captured a total of 1,198 natural (unmarked) Chinook salmon (Figure 4) and two *O. mykiss* in the Caswell RSTs (Appendix 6). The first Chinook salmon was observed on 12 January 2012 and the last was observed on 30 June 2012. Peak weekly Chinook salmon catches (range, 167 – 180 fish) at the Caswell RST occurred from 7 to 27 May (both traps in operation). The overall mortality rate was 2.67% (n = 32) of the total juvenile Chinook salmon catch. No *O. mykiss* mortalities were observed.

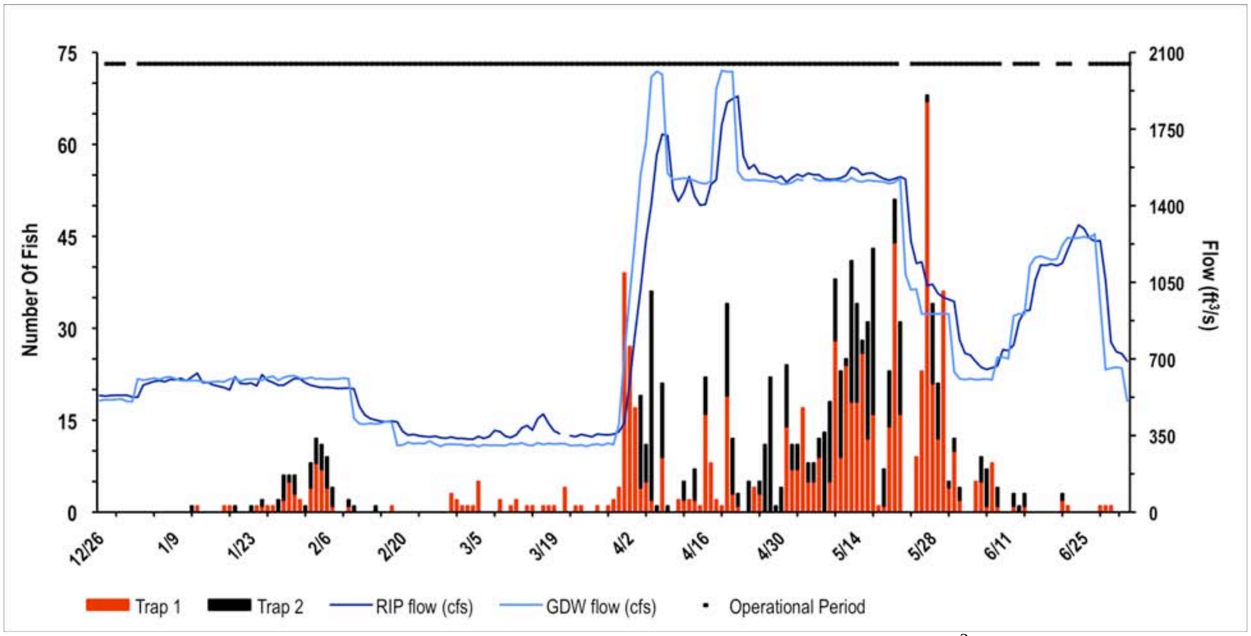

FIGURE 3. Daily catch of Chinook salmon in the Caswell rotary screw traps, and flows (ft^3/s) at Ripon (RIP) and Goodwin (GDW) during 2012. The operational period includes all days when traps were checked, regardless of trap function. Catch summaries for each trap are given in Appendix 5.

Non-Target Species

In 2012, we captured 254 incidental (non-target) fish of 16 identifiable species, including the following families: Petromyzontidae (lamprey), Centrarchidae (sunfishes and black bass), Poeciliidae (western mosquitofish *Gambusia affinis*), Catostomidae (Sacramento sucker *Catostomus occidentalis*), Embiotocidae (Tule perch *Hysterocarpus traski*), Cyprinidae (Sacramento pikeminnow *Ptychocheilus grandis* and other minnows), Ictaluridae (catfishes), and Cottidae (sculpin) (Figure 4; Appendix 2). We observed 10 black bass (*Micropterus* spp.) and 106 lamprey (*Lampetra* spp.) that were not identified to species due to difficulties using phenotypic characteristics in the field.

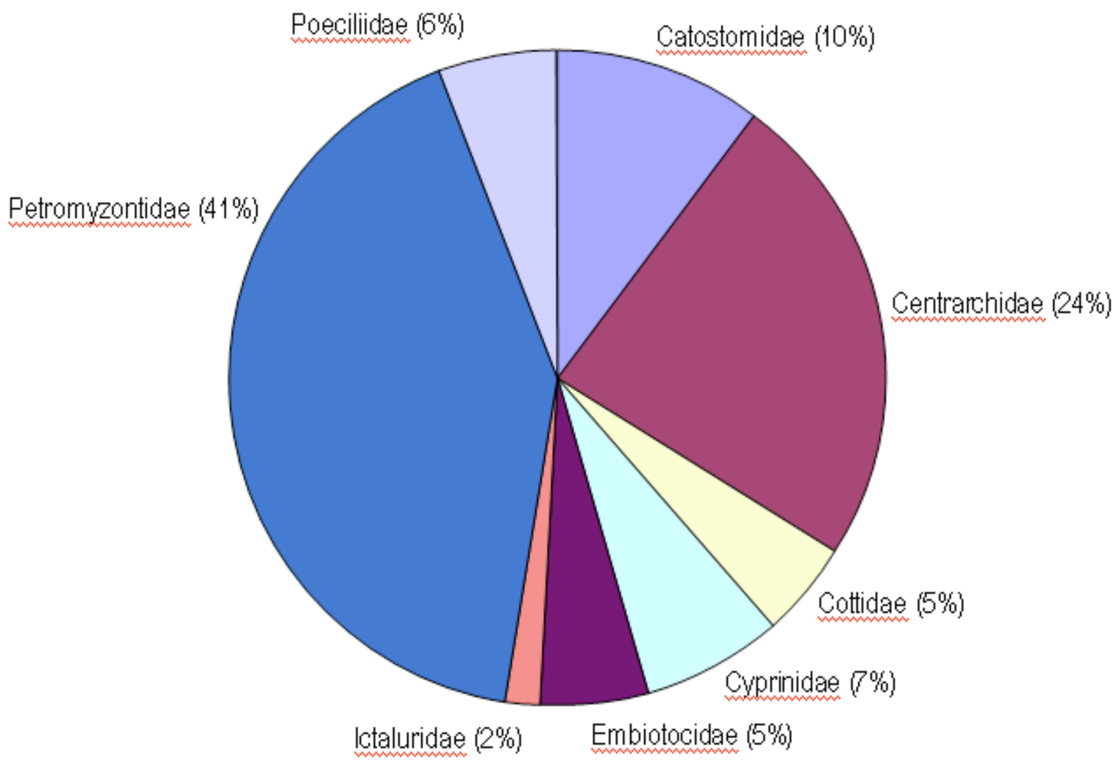

FIGURE 4. Relative abundance of all non-salmonid taxonomic groups captured in the Caswell rotary screw traps in 2012.

Summary of Life Stage Data

We observed three juvenile Chinook salmon life stages during the 2012 sampling period (fry, parr, and sub-yearling smolt) (Table 2). Fall-run Chinook salmon emigration was generally represented by two groups of fish present from mid-January though late February (yolk-sac fry, fry) and from April through May (parr, sub-yearling smolt) as evidenced by increasing growth over the sampling period (Figures 5 and 6). The majority of the out-migration catch was composed of sub-yearling smolts (88.6%); meanwhile, the fry and parr life stages contributed minimally to the total migrant population in 2012 (9.2% and 2.3%, respectively). Each life stage has different size distributions and timing patterns (Table 2; Figures 6 and 7).

TABLE 2. Percent of juvenile Chinook salmon catch by life stage (according to smolt index) from the Caswell RSTs, 2012. Note, totals do not include "plus-counted" fish where size and life stage by smolt index was not recorded.

Life Stage	Number*	Percent of Catch	Date Range	Median Passage	Mean FL (mm) ± 95% CI
Yolk-sac fry	0	0%	-	-	-
Fry	109	9.2%	12 Jan to 11 May	12 Mar	35.5±0.6
Parr	27	2.3%	3 Mar to 16 Apr	17 Apr	61.7±5.4
Sub-yearling smolt	1055	88.6%	29 Mar to 30 Jun	14 May	83.3±0.5
Yearling smolt	0	0%	-	-	-
Cumulative Total	1191		12 Jan to 30 Jun 2012		

**7 Chinook salmon were plus-counted and not measured or assigned a smolt index value in 2012*

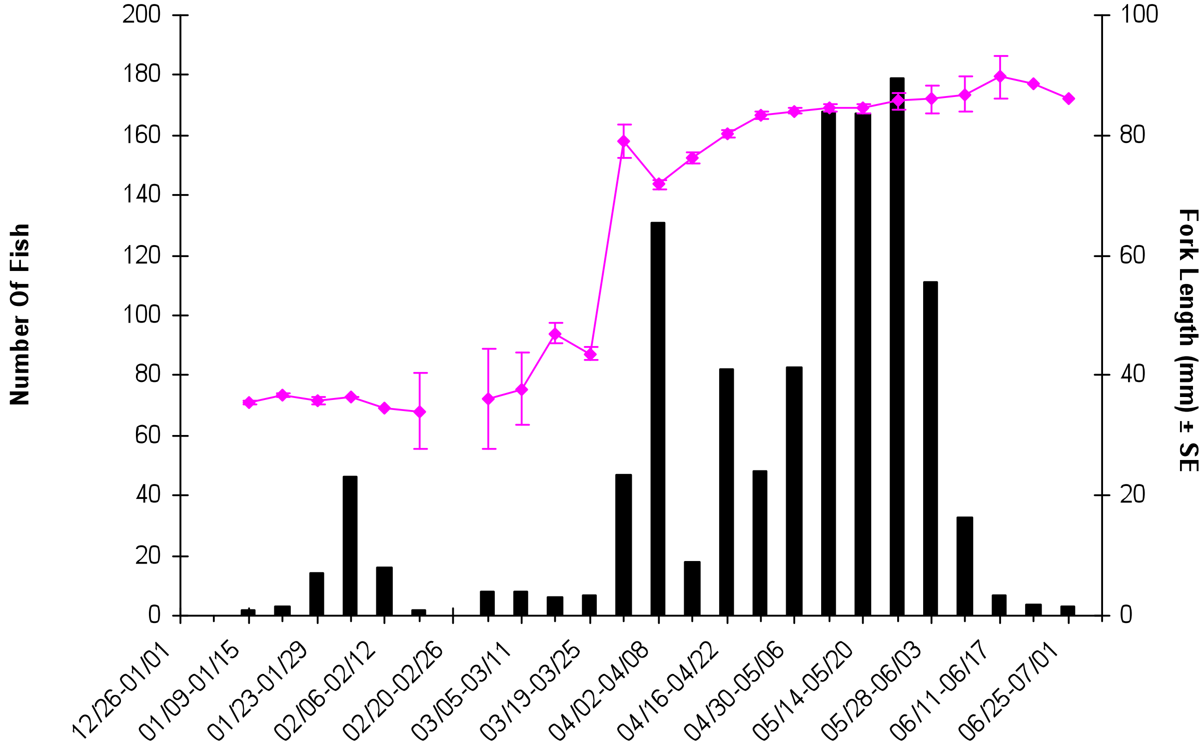

FIGURE 5. Weekly catch (bar graph) and mean weekly fork length (line graph) for juvenile Chinook salmon caught in the Caswell rotary screw traps during 2012. Error bars indicate ± 1 SE.

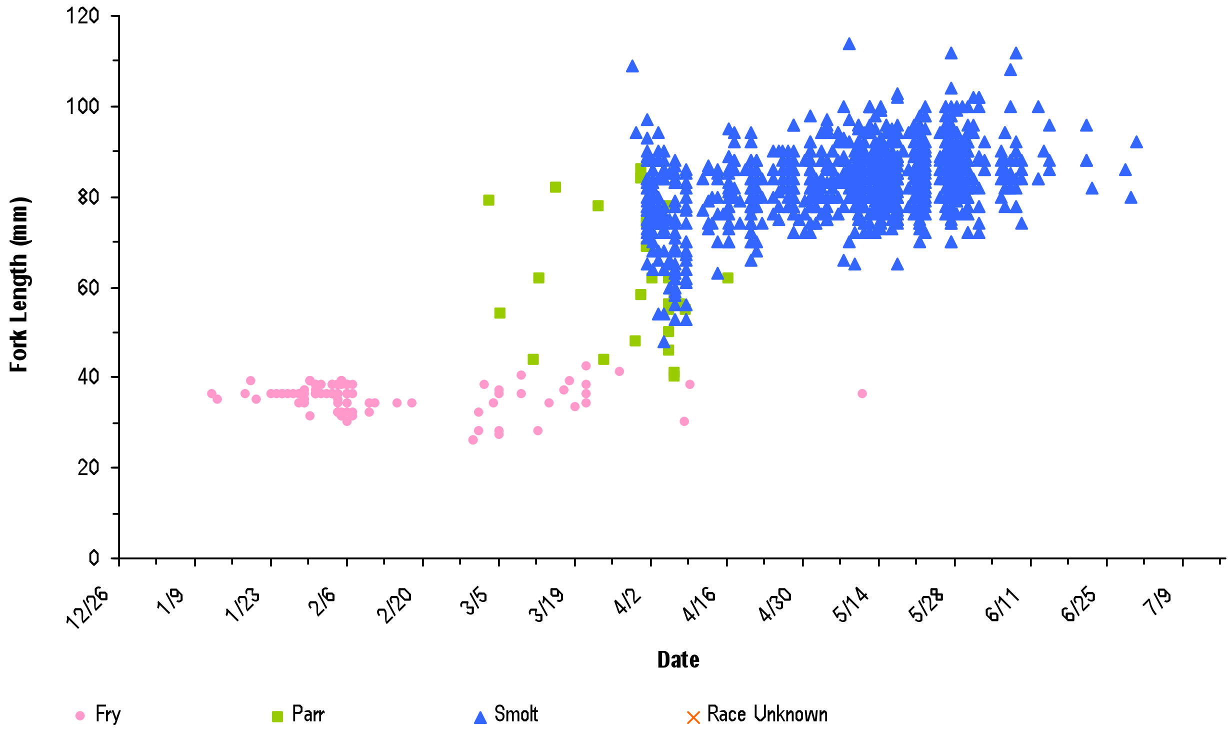

FIGURE 6. Fork length distributions of fry, parr, and smolt life stages of Chinook salmon caught in the Caswell RSTs during 2012.

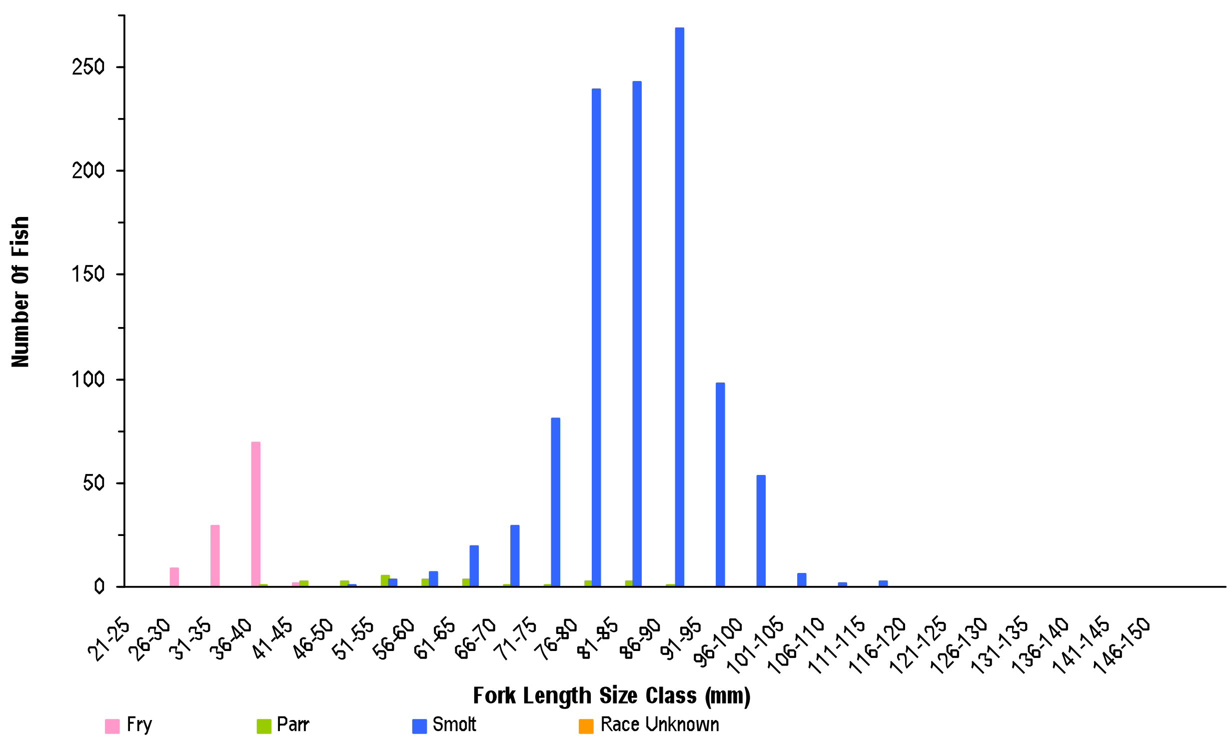

FIGURE 7. Fork length distributions of fry, parr, and smolt life stages of Chinook salmon caught in the Caswell rotary screw traps during 2012.

Trap Efficiency

In 2012, between 319 and 738 fish were released in six separate groups for a total of 2,720 dye-marked hatchery Chinook salmon (Table 3). Recaptures varied from 2 to 12 fish, resulting in estimated efficiencies of 0.4% to 2.4%.

TABLE 3. Summary of RST efficiency releases at Caswell, 2012.

Date	Flow (m^3/s)*	Release Code	Mark Code**	Origin of fish	Avg. FL (mm)	SD	No. Released	No. Recap	Efficiency (%)
02/01/2012	17.4	C1	CFP	hatchery	37.0	2.4	319	7	2.2
02/16/2012	11.9	C2	CFP	hatchery	43.0	4.2	263	2	0. 8
03/05/2012	9.43	C3	TCP	hatchery	57.7	4.5	493	12	2.4
04/24/2012	44.5	C4	BCP	hatchery	105.0	4.2	497	2	0. 4
05/01/2012	43.3	C5	TCP	hatchery	98.1	12.0	410	7	1.7
05/10/2012	42.8	C6	AFP	hatchery	106.0	4.5	738	6	0.8
Overall							2720	36	1.3

** Instantaneous river flow at Ripon measured at 18:00 hr. **AFP = anal fin pink; CFP = caudal fin pink; BCP = bottom caudal pink; TCP = top caudal pink.*

For the Caswell site, the best-fit model for predicting trap efficiencies used a total of 138 trap efficiency tests (including six from 2012) and included the following variables: log(flow), fork length (at release), and year. We observed a strong inverse pattern between trap efficiencies and flow at the Caswell site across all years of trapping (1996 – 2012) (Figure 8; Table 4). An inverse pattern was also apparent between trap efficiencies and average fish length. However, there was no significant association between trap efficiencies and temperature ($p = 0.094$) or turbidity ($p > 0.094$).

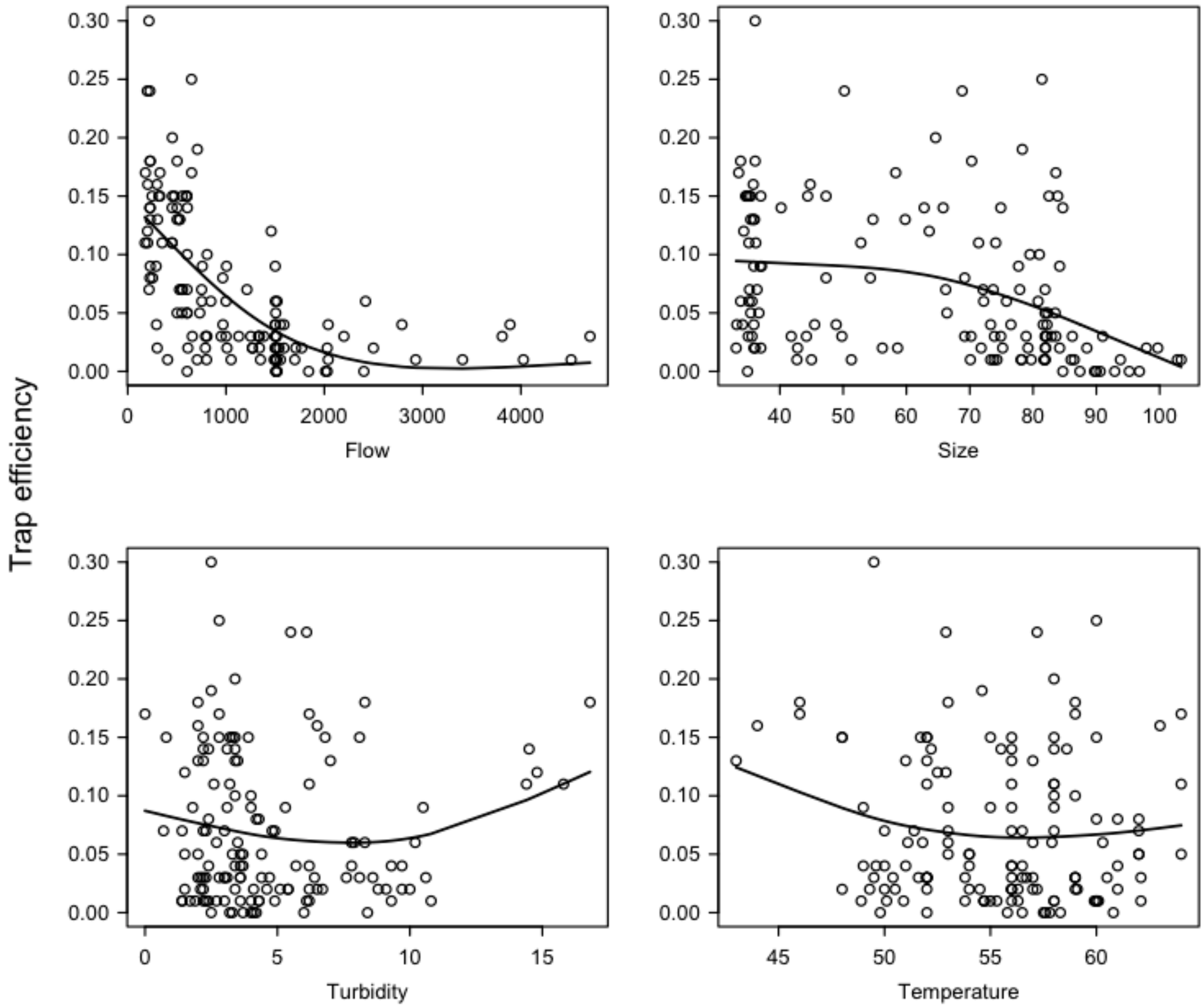

FIGURE 8. Trap efficiency as a function of flow (ft^3/s), fish size at time of efficiency test release (fork length, mm), turbidity (NTUs), and temperature (°C) for 138 mark-recapture releases at the Caswell rotary screw traps during 1996 – 2012. Solid lines are exploratory fits of smoothing splines (see Table 4 for related statistics).

The logistic regression analysis indicated trap efficiencies were significantly related to the variables log(flow), length, and year (Table 4). The dominant explanatory variable was log(flow), accounting for 78.5% of the total deviance. Fish length at release, which accounted for 8.7% of the deviance, had a moderate negative effect on trap efficiencies. The categorical variable 'year' accounted for 12.7% of the deviance.

TABLE 4. Analysis of deviance for the logistic model fit to trap efficiencies of 138 mark-recapture release events at the Caswell trap site during 1996-2012. Df, degrees of freedom.

Variable	Df	Deviance	Residual Df	Residual Deviance	***F*-value**	Pr (***F***)
Intercept	-	-	137	5660.8	-	-
log(flow)	1	3505.2	136	2155.5	365.89	< 0.0001
Length	1	389.9	135	1765.7	40.70	< 0.0001
Year	16	568.3	119	1197.4	3.71	< 0.0001
Total	18	4463.4	390	5118.6		

Passage Estimates

During the sampling period from 26 December 2011 through 30 June 2012 an estimated 105,821 (95% CI: 30,152 – 260,346) juvenile Chinook salmon passed Caswell. The 5% and 95% relative passage dates at Caswell (based on the operational period) were 5 February and 1 June, respectively; the median passage date was 16 May 2012 (Figure 9).

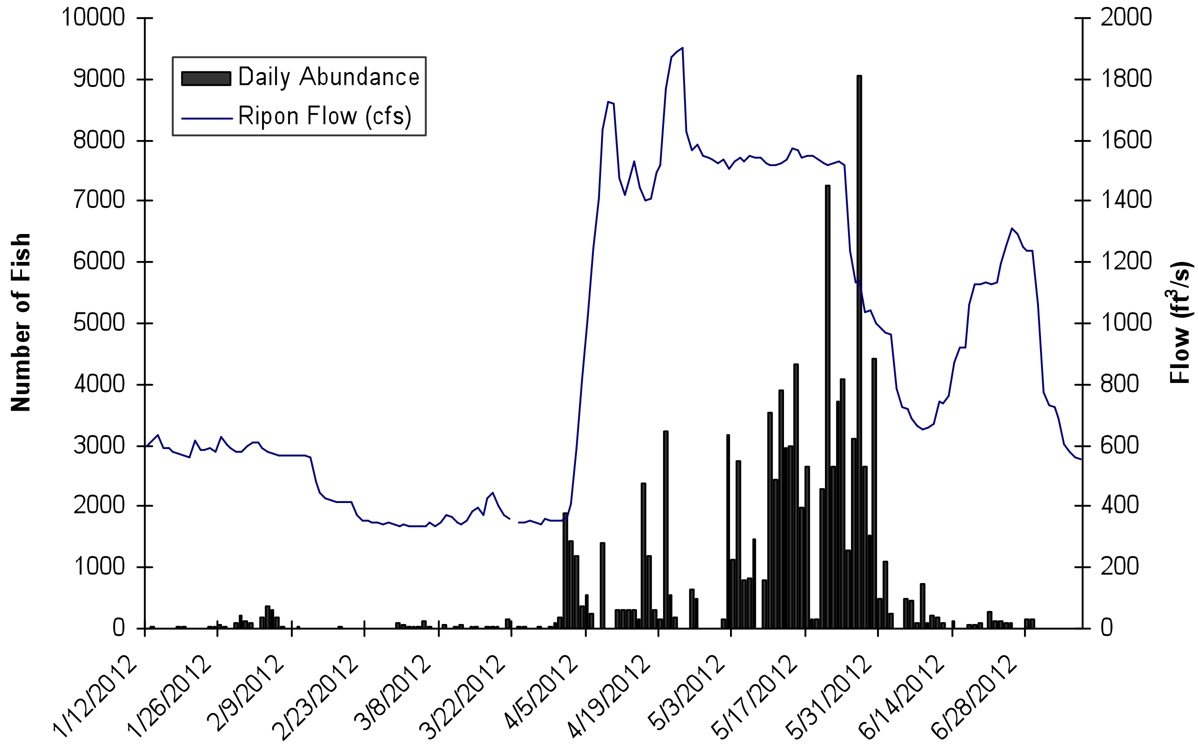

FIGURE 9. Estimated daily passage of juvenile Chinook salmon at Caswell and flow at Ripon in the Stanislaus River during 2012.

Estimates of juvenile Chinook salmon total annual passage for all sample years from 1996 to 2012 ranged from 8,704 to 2,060,282 (mean = 366,229), with the lowest passage occurring in 2009 and highest in 2000 (Table 5 and Figure 10). Since 2009, abundance has steadily increased to 105,821 (95% CI: 30,152 – 260,346) in 2012 (Figure 10).

TABLE 5. Estimated total number of juvenile Chinook salmon passing Caswell during 1996-2012. SE, standard error of the estimate; CV, coefficient of variation; CI, confidence interval of the mean. 95% confidence intervals are reported for both normal and lognormal error distributions.

Year	Passage Estimate	Median	SE	CV	Lower 95% CI	Upper 95% CI
1996	70,885	70,277	8,548	12.06%	55,433	88,863
1997*	98,287	95,306	24,907	25.34%	59,624	154,837
1998	1,152,154	1,140,226	192,648	16.72%	822,168	1,562,021
1999	1,457,859	1,432,806	247,367	16.97%	1,042,192	2,014,381
2000	2,060,282	2,039,184	299,090	14.52%	1,522,002	2,707,256
2001	178,557	177,236	24,267	13.59%	136,038	232,348
2002	78,505	77,424	11,881	15.13%	57,863	104,808
2003	119,654	118,156	16,737	13.99%	91,290	156,707
2004	327,083	320,594	59,424	18.17%	232,872	462,123
2005	266,763	263,539	39,405	14.77%	200,171	354,374
2006*	156,185	142,322	66,984	42.89%	66,100	315,249
2007	69,959	58,024	43,790	62.59%	20,514	182,513
2008	17,833	16,045	8,716	48.88%	6,717	40,506
2009**	8,704	7,083	6,025	69.22%	2,262	24,757
2010**	26,242	17,542	27,333	104.16%	3,979	102,359
2011**	31,113	19,570	37,189	119.53%	3,337	134,291
2012**	105,821	91,668	61,856	58.45%	30,152	260,346

**Trap only operated during part of the out-migration due to high water conditions, estimates are not comparable.*
***Trap efficiency and abundance estimates based on data collected from the primary trap only.*

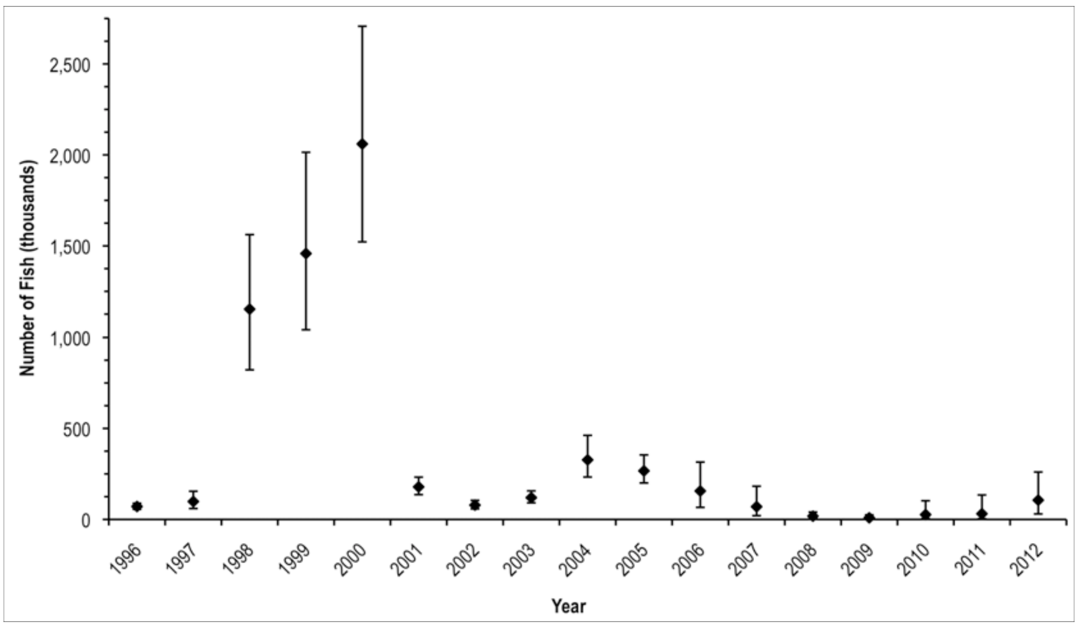

FIGURE 10. Estimated juvenile Chinook salmon passage at Caswell from 1996 through 2012. Error bars indicate 95% confidence intervals. Estimates from 1996 and 2006 are incomplete, while estimates from 2009 to 2012 were derived using data from the primary trap only.

DISCUSSION

Catch for the 2012 out-migration monitoring season was slightly higher compared to recent years. We captured 1,198 Chinook salmon and two *O. mykiss*, and estimated juvenile Chinook salmon passage as 105,821 (± 61,856 SE). Passage timing was also generally similar to other years, as peaks in passage generally corresponded with flow pulses and the descending limb of the hydrograph. Smolts were again more abundant than other life stages; although no yearling smolts were captured. Record low juvenile abundances in 2009 (8,704 ± 6,025 SE) correspond to the second lowest adult fall-run Chinook salmon escapement on record for the Stanislaus River. However, since 2009, annual juvenile abundances in the lower Stanislaus River have steadily increased to current levels, mirroring increases in adult escapement (CDFG, unpublished data).

Analyses of the influence of environmental variables on juvenile out-migration population dynamics is beyond the scope of this annual report. However, this work does provide additional foundation for such analyses to be completed. Results from the 2012 monitoring season provide critical information to CAMP, AFRP and other natural resource management agencies. These data coupled with previous years' datasets provide information to better understand and improve conditions for Chinook salmon and *O. mykiss* within the lower Stanislaus River.

Sample Size Determination

In 2012, as in 2009 to 2011, efficiency and abundance estimates were based on data collected only from the primary trap due to an inability to operate a second trap on a consistent basis through the entire season. Since trap efficiency is a function of recaptures relative to the number of marked fish released, as long as only catch and recaptures from the same trap(s) is used for a given year, estimates will be relative across all years. Inconsistent operation of one trap could grossly under represent trap efficiency, thereby inflating abundance estimates and associated error. As a result, the primary trap is always oriented in the thalweg and operated continuously to standardize sampling effort for years since 2009 when the trapping site was relocated to a more favorable location. Despite these efforts, the passage estimates remain relatively imprecise.

The coefficient of variation (CV) provides a relative measure of precision for the estimate and is an indicator of reliability. Since CV equals the standard error divided by the estimate, higher relative standard errors indicate that the passage estimate is less precise. As such, relative measures of precision (i.e., CV) were poor for years 2006 – 2012 compared to 1996 –2005 (2006 operations started late and are not representative of seasonal abundances). Low Chinook salmon catches between 2008 and 2011 resulted in fewer efficiency tests, while those tests that were performed were often made up of small release group sizes, with few recaptures. Although hatchery fish were used for releases in 2008, lower than normal velocities contributed to poor trapping conditions at the old site and resulted in extremely low efficiency rates (Watry et al. 2008). Then in 2009 and 2010, hatchery fish were not available, further complicating efforts to improve trap efficiency estimates. In 2011, when a limited number of hatchery fish were obtained from California Department of Fish and Wildlife (CDFW) for releases in May, insufficient release group sizes and high flow conditions (1,542 – 2,018 ft^3/s) likely contributed to tests with no fish recaptured, increasing error estimates in that year. In 2012, hatchery fish were available and release group sizes were increased, though we still only performed six efficiency releases. Although the 2012 abundance estimate had relatively low precision (CV = 58.45%), the CV was reduced to the lowest level since 2008 (Table 5) indicating that increasing release group sizes can effectively improve efficiency and passage estimates. In general, small release group sizes (< 100 fish), low number of recaptures (< 10 fish), and the low number of replicate tests (< 10) all likely contributed to the relatively low precision attributed to passage estimates since 2006.

To improve efficiency results in subsequent years, we used the program SampleSize (version 2.0.9; Lady et al. 2011) to determine the relative precision of efficiency estimates based on different sample sizes for release groups. The software provides the 'margin of error' for combined capture and survival probabilities in relation to sample size. We used a range of likely capture probabilities (i.e., 0.01, 0.02, 0.05, and 0.10) and fixed survival at two levels (i.e., 95% for fry and 97.5% for parr/smolts). According to previous analyses (Watry et al. 2008, 2009, and 2012), we established negative relationships between efficiency and flow and fish size. In general, low flow conditions and smaller fish yield relatively high efficiencies (≥ 0.05) whereas high flow and larger fish yield lower efficiencies (< 0.05). This makes intuitive sense since the absolute volume of water sampled by a RST is more or less fixed, meaning the volume of river water sampled per unit effort is proportionately lower with increasing flow conditions. Furthermore, low flow conditions tend to be coincidental with smaller fish (fry) during winter, while high flow and larger fish (parr and smolts) tend to be coincidental with the spring period. Because low flows increase travel times (Demko et al. 2002) and smaller fish are more susceptible to predation, we applied two separate survival probabilities to develop more conservative estimates of precision.

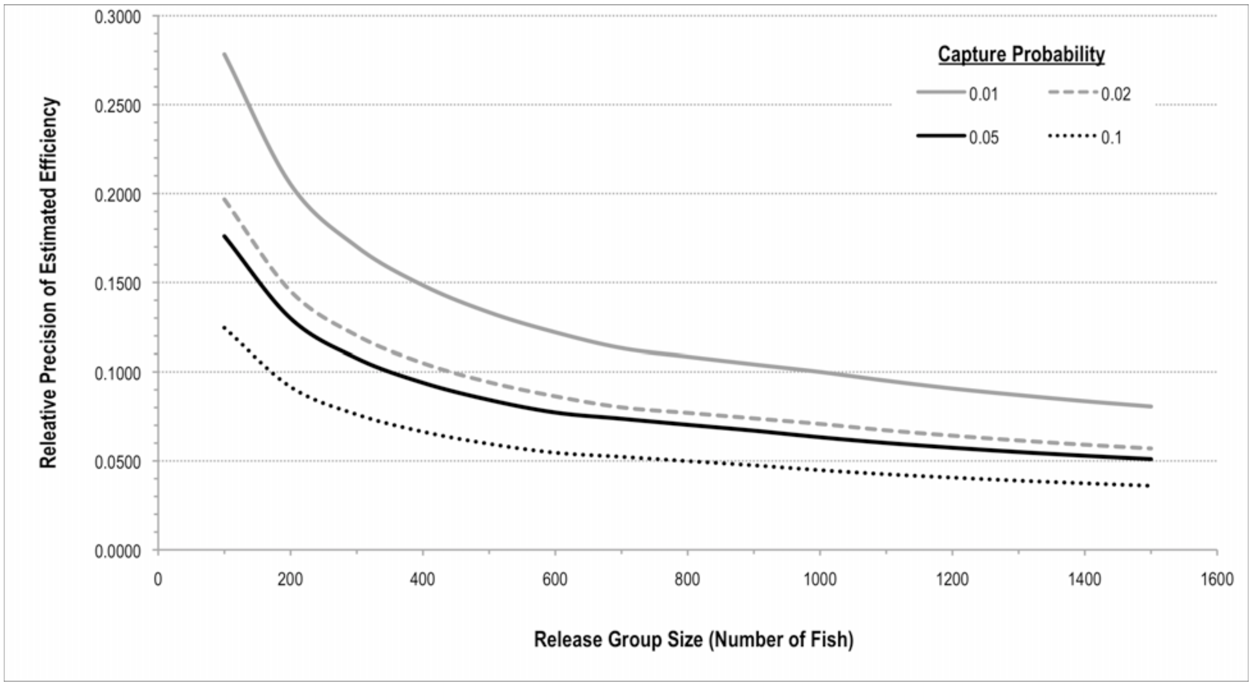

FIGURE 10. Release group sizes and the corresponding relative precision of the efficiency estimate using fixed capture probabilities and survival estimates.

For a given capture probability, the SampleSize software provides an estimated precision ('margin of error'). Basically, the number of fish required per release group to detect a change in the salmon passage estimate is proportional to the relative precision of estimated efficiency. For example, at a capture probability of 0.05 (i.e., 5% trap efficiency), it would require a trap efficiency release of approximately 300 fish to detect a change of 10% in the production estimate or an efficiency release of 1,500 fish to detect a 5% change in the production estimate. Similarly, at a capture probability of 0.01 (i.e., 1% trap efficiency), it would require approximately 1,000 fish to detect a change of 10% in the estimate, or over 3,000 fish to detect a 5% change in the estimate. As illustrated in Figure 10, there is a certain level of diminishing returns in regards to narrowing (improving) the precision as release group sizes increase.

As a result, we selected the sample size (100 fish increments) at which the difference in precision was less than 0.005 (i.e., 0.5%). For minimum sample sizes during the fry period, we used the 0.10 (i.e., 10%) capture probability to establish a minimum sample size of 600 fish per release group with a relative precision of approximately 6%. For minimum sample sizes during the parr/smolt period, we used the 0.01 (i.e., 1%) capture probability to establish a minimum sample size of 1,000 fish per release group with a relative precision of approximately 10%. To further strengthen our approach, we propose to conduct five release events using these release group sizes during each period for a total of 10 tests during a season. As such, we will require up to 8,000 fish total to conduct RST calibrations (i.e., 3,000 fish during the fry period and 5,000 fish during the parr/smolt period) to improve RST efficiency estimates using this approach.

Fish Health Update

In 2012, we continued our qualitative fish health assessments by working with AFRP and the USFWS CA-NV Fish Health Center (Anderson, CA) to monitor and document suspected episodes of poor fish health. Although we encountered fish mortalities, the majority (~91%) of dead juvenile Chinook salmon occurred from late April through early June when flows were high. The high flows and associated high debris loads possibly caused fish mortality when fish were impinged within the trap. However, no instances of poor fish health or condition were observed when handling fish. Since 2007, there have been two years when dead fish were collected and tested for numerous causes. An outbreak of columnaris (infection by *Flavobacterium columnare*) was suspected in 2007 (Watry et al. 2007), whereas signs of increased urine flow (i.e., diuresis) were detected in 2009 even though no definitive cause for morbidity was found (Watry et al. 2009). Although speculative, diuresis might occur following exposure to elevated ammonia concentrations, especially if return flows contaminated with fertilizer compounds from irrigated croplands are allowed to enter the lower Stanislaus River. More information is required to determine and track episodes of poor fish health and evaluate potential causes in the lower Stanislaus River.

RECOMMENDATIONS

We continue to work closely with CAMP and the Juvenile Monitoring Project Work Team to make recommendations and adapt our operational protocols to be consistent with program objectives. In addition to the previously implemented protocol changes (Gray et al. 2012), we suggest the following:

1) Continue operation of a single trap at the current trapping location. Trap efficiencies with a single trap operating under typical flow conditions were improved compared to 2006 – 2008 at the upstream trap location using the tandem trap configuration. These results indicate that a single trap can be effectively operated at this site;

2) Improve passage estimation and reduce error by performing a greater number of replicate mark-capture releases with group sizes of 600 to 1,000 individuals to provide a better foundation for determining trap efficiency. We will request hatchery fish from CDFG well in advance of the trapping season; and,

3) Continue to evaluate fish health and water quality standards at Caswell.

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APPENDIX 1: STANISLAUS RIVER POINTS OF INTEREST

Point	Purpose/Significance	Operator	rkm (RM)
New Melones Dam	Constructed in 1978; Flood control, water supply, power generation, recreation	U.S. Bureau of Reclamation	96.6 (60)
Tulloch Dam	Constructed in 1957; Flood control, water supply, recreation	TriDam	88.5 (55)
Goodwin Dam	Constructed in 1913; Irrigation water diversion canals	U.S. Bureau of Reclamation	93.9 (58.4)
Knights Ferry Covered Bridge	Historic feature	Army Corps of Engineers	87.4 (54.3)
Knights Ferry Gravel Augmentation	Habitat improvement	CDFG	87.4 – 86.6 (54.3 – 53.8)
Orange Blossom Bridge	Temperature gauging station	CA Dept of Water Resources	75.5 (46.9)
Oakdale Rotary Screw Traps	Juvenile salmonid abundance and out-migration timing	Oakdale Irrigation District	64.5 (40.1)
Stanislaus River Weir	Adult passage and timing	AFRP/TriDam	49.9 (31)
Hwy 99 Bridge (Ripon)	Temperature, discharge and DO	USGS	25.4 (15.8)
Caswell Memorial State Park	Juvenile salmonid abundance and out-migration timing	AFRP	13.8 (8.6)
Two Rivers Trailer Park	San Joaquin-Stanislaus confluence	—	0 (0)

APPENDIX 2: STANISLAUS RIVER FISH SPECIES LIST

Common Name	Species Name	Native? (Yes or No)	Predator* (Yes or No)	Number Captured 2012
Bigscale logperch	*Percina macrolepida*	No	No	0
Bluegill sunfish	*Lepomis macrochirus*	No	Yes	27
Brown bullhead	*Ameiurus nebulosus*	No	Yes	2
Chinook salmon	*Oncorhynchus tshawytscha*	Yes	Yes	1198
Common carp	*Cyprinus carpio*	No	No	4
Golden shiner	*Notemigonus crysoleucas*	No	No	0
Goldfish	*Carassius auratus*	No	No	5
Green sunfish	*Lepomis cyanellus*	No	Yes	0
Hardhead	*Mylopharodon conocephalus*	Yes	No	0
Largemouth bass	*Micropterus salmoides*	No	Yes	3
Pacific lamprey	*Lampetra tridentate*	Yes	No	0
Prickly sculpin	*Cottus asper*	Yes	Yes	12
Rainbow trout/steelhead	*Oncorhynchus mykiss*	Yes	Yes	2
Redear sunfish	*Lepomis microlophus*	No	Yes	0
Sacramento pikeminnow	*Ptychochelius grandis*	Yes	Yes	7
Sacramento sucker	*Catostomus occidentalis*	Yes	No	26
Smallmouth bass	*Micropterus dolomieu*	No	Yes	9
Spotted bass	*Micropterus punctulatus*	No	Yes	0
Threadfin shad	*Dorosoma petenense*	No	Yes	0
Tule Perch	*Hysterocarpus traski*	No	No	13
Western mosquitofish	*Gambusia affinis*	No	No	15
White catfish	*Ictalurus catus*	No	Yes	2
White crappie	*Pomoxis annularis*	No	Yes	0
Unidentified sunfish	*Lepomis* spp.	No	Yes	11
Unidentified bass	*Micropterus* spp.	No	Yes	10
Unidentified catfish	*Ictalurus* spp.	No	Yes	0
Unidentified lamprey	*Lampetra* spp.	Yes	No	106
Unidentified minnow	Cyprinidae spp.	n/a	No	0

**Native fish and salmonid predator designations developed from Moyle (2002)*

APPENDIX 3: ANNUAL MARK-RECAPTURE SUMMARY OF RESULTS AT THE CASWELL ROTARY SCREW TRAPS, 1996 – 2012

Year	Release Groups	Average Number Released / Group	Total Released	Total Recaptures
1996	8	2,904	23,232	997
1997	3	2,260	6,781	186
1998	7	3,813	26,693	446
1999	8	1,964	15,713	408
2000	15	1,011	15,166	456
2001	12	1,085	13,014	1,257
2002	11	800	8,804	962
2003	17	225	3,823	496
2004	8	255	2,039	263
2005	6	634	3,802	493
2006	6	1,017	6,102	57
2007	8	87	697	2830
2008	7	626	4,383	59
2009*	5	36	182	23
2010*	4	48	190	13
2011*	7	114	798	12
2012*	6	453	2,720	36
Total	138	972	134,139	6,194

**Only recaptures from the primary trap were used.*

APPENDIX 4: WEEKLY MEASUREMENTS OF SELECTED ENVIRONMENTAL VARIABLES IN THE STANISLAUS RIVER DURING 2012

	Daily Flow (ft³/s)*		Daily Water Temperature (°C)			DO (mg/L)		Turbidity (NTUs)	
Week	Min	Max	Min	Max	Average	Min	Average	Max	Average
12/26-01/01	530	534	6.7	8.2	7.3	10.77	11.22	1.55	1.35
01/02-01/08	525	601	7.9	8.2	8.1	10.70	10.91	1.66	1.35
01/09-01/15	592	635	7.5	7.7	7.6	10.82	11.01	2.39	1.61
01/16-01/22	559	618	6.5	9.0	7.4	10.31	11.07	3.94	2.47
01/23-01/29	577	628	8.7	10.3	9.4	10.20	10.60	3.08	2.05
01/30-02/05	574	611	8.8	10.0	9.4	10.30	10.63	2.34	1.86
02/06-02/12	563	570	9.0	11.0	10.3	10.20	10.41	2.41	1.81
02/13-02/19	413	483	9.4	10.6	10.1	9.85	10.30	2.60	1.84
02/20-02/26	344	412	10.2	12.5	11.1	9.70	9.97	2.16	1.89
02/27-03/04	334	347	9.7	12.1	10.5	9.84	10.07	2.89	1.80
03/05-03/11	333	373	10.6	14.0	11.9	9.37	9.91	238.00	36.84
03/12-03/18	341	448	12.7	12.9	12.8	9.26	9.46	9.00	5.41
03/19-03/25	345	405	-	-	-	-	-	5.94	4.47
03/26-04/01	344	367	13.0	13.0	13.0	-	-	4.57	4.01
04/02-04/08	408	1633	10.3	13.0	11.7	-	-	7.54	5.11
04/09-04/15	1420	1726	10.2	12.0	10.9	-	-	6.67	4.79
04/16-04/22	1402	1888	12.0	15.3	13.6	9.67	9.99	4.21	3.81
04/23-04/29	1536	1900	13.4	14.8	14.0	9.66	10.40	4.53	3.63
04/30-05/06	1507	1548	13.0	14.8	14.1	10.74	10.87	3.96	3.14
05/07-05/13	1520	1541	13.0	15.0	13.8	-	-	3.58	3.15
05/14-05/20	1523	1575	13.0	15.2	14.0	10.39	10.77	4.88	3.53
05/21-05/27	1137	1532	14.3	15.7	15.1	9.57	10.71	9.37	4.11
05/28-06/03	788	1041	15.4	17.8	16.6	9.67	10.17	4.45	3.65
06/04-06/10	652	726	16.0	18.5	17.2	9.50	9.93	5.10	4.73
06/11-06/17	738	1059	18.3	19.9	18.8	8.84	9.79	4.26	3.74
06/18-06/24	1126	1256	16.8	18.3	17.6	9.44	10.16	2.47	2.29
06/25-07/01	776	1312	16.2	18.6	16.8	9.31	10.35	4.21	3.54
07/02-07/08	553	733	19.2	19.5	19.4	9.24	9.41	4.57	4.51

** mean daily flow data was obtained from gauge data provided by the California Data Exchange Center (CDEC) for the Stanislaus River at Ripon, CA (RIP).*

APPENDIX 5: WEEKLY CATCH OF JUVENILE SALMONIDS AT THE CASWELL ROTARY SCREW TRAPS DURING 2012

Sample Week	Number of Days Trapped		Weekly Catch		Catch by Life History Type					*O. mykiss*
	Trap 1	Trap 2	Total Chinook Salmon	Trap 1 (Trap 2)	Fry	Parr	Sub-yearling smolt	Yearling smolt	Not assigned	
12/26-01/01	5	5	0	0	0	0	0	0	0	0
01/02-01/08	7	7	0	0	0	0	0	0	0	0
01/09-01/15	7	7	2	1 (1)	2	0	0	0	0	0
01/16-01/22	7	7	3	2 (1)	3	0	0	0	0	0
01/23-01/29	7	7	14	6 (8)	14	0	0	0	0	0
01/30-02/05	7	7	46	29 (17)	46	0	0	0	0	0
02/06-02/12	7	7	16	6 (10)	16	0	0	0	0	0
02/13-02/19	7	7	2	1 (1)	2	0	0	0	0	0
02/20-02/26	7	7	0	0	0	0	0	0	0	0
02/27-03/04	7	2	8	8 (0)	7	1	0	0	0	0
03/05-03/11	7	0	8	8 (0)	6	2	0	0	0	0
03/12-03/18	7	0	6	6 (0)	4	2	0	0	0	0
03/19-03/25	7	0	7	7 (0)	5	2	0	0	0	0
03/26-04/01	7	0	47	47 (0)	1	7	39	0	0	0
04/02-04/08	7	6	132	64 (68)	1	12	118	0	1	0
04/09-04/15	7	7	19	9 (10)	1	0	17	0	0	0
04/16-04/22	7	7	81	50 (31)	0	1	81	0	0	0
04/23-04/29	7	6	48	7 (41)	0	0	48	0	0	0
04/30-05/06	7	7	83	55 (28)	0	0	83	0	0	0
05/07-05/13	7	7	170	93 (77)	1	0	167	0	2	0
05/14-05/20	7	7	167	88 (79)	0	0	167	0	0	0
05/21-05/27	5	5	181	159 (23)	0	0	178	0	3	1
05/28-06/03	6	6	111	85 (27)	0	0	110	0	1	1
06/04-06/10	6	6	33	20 (13)	0	0	33	0	0	0
06/11-06/17	5	5	7	2 (5)	0	0	7	0	0	0
06/18-06/24	3	3	4	3 (1)	0	0	4	0	0	0
06/25-07/01	6	6	3	3(0)	0	0	3	0	0	0
07/02-07/08	2	2	0	0	0	0	0	0	0	0
12/26/2011 – 7/03/2012	178	143	1,198	757(441)	109	27	1055	0	7	2