# Juvenile Salmonid Emigration Monitoring in the Lower Stanislaus River at Caswell Memorial State Park, California

February – June 2017


Prepared By:

Krista Bouton

Kassie Hickey


Prepared for:

U.S. Fish and Wildlife Service, Comprehensive Assessment and Monitoring Program and California Department of Fish and Wildlife by the

Pacific States Marine Fisheries Commission

The suggested citation for this report is:

Bouton, K. and K. Hickey. 2017. Juvenile Salmonid Emigration Monitoring in the Lower Stanislaus River at Caswell Memorial State Park, California February – June 2017. Unpublished report prepared for the U.S. Fish and Wildlife Service and California Department of Fish and Wildlife, Sacramento, California. 50 pp.

# Table of Contents

## List of Figures

## List of Figures (continued)

## List of Tables

## Abstract

Operation of the rotary screw traps on the lower Stanislaus River at Caswell Memorial State Park in 2017 is part of the U.S Fish and Wildlife Service's AFRP and CAMP under the NMFS RPA actions and CVPIA. The primary objective of the trapping operations is to collect data that can be used to estimate the production of juvenile fall-run Chinook salmon (*Oncorhynchus tshawytscha*) and quantify the raw catch of steelhead/rainbow trout (*Oncorhynchus mykiss*). Secondary objectives of the trapping operations focus on collecting fork length and weight data for juvenile salmonids and gathering environmental data that will eventually be used to develop models that correlate environmental parameters with salmonid size, temporal presence, abundance, and production.

For the 2017 survey season, two 2.4 meter (8 foot) rotary screw traps (RSTs) were operated at Caswell Memorial State Park on the lower Stanislaus River in California. Sampling occurred on 116 of the 143 days between 1 February 2017 and 23 June 2017. A total of 8,246 fall-run juvenile Chinook salmon was captured. The passage of juvenile fall-run Chinook salmon peaked when 42.80 percent of the total (n = 3,529) were captured between 9 February and 13 February. The majority of the captured juvenile Chinook salmon belonged to the fry life stage; fewer numbers of the yolk-sac fry, parr, silvery parr, and smolt life stages were also collected. Five trap efficiency trials were used to estimate the production of juvenile fall-run Chinook salmon. Trap efficiencies during those five trials ranged from 0.00 to 7.07 percent, with an average efficiency of 2.57 percent. The number of juvenile fall-run Chinook salmon that were estimated to have emigrated past the Caswell trap site on the Stanislaus River during the 2017 survey season was 613,144 individuals (95 percent confidence intervals = 217,351 to 831,859). Finally, 474 individuals belonging to 20 different identifiable non-salmonid species were caught, as well as 17 non-salmonid individuals that were identified to family but were unable to be identified to species.

This annual report also includes seven appendices. Four of those appendices describe different environmental variables and studies related to the trap site or rotary screw trap operations during the 2017 survey season.

## Introduction

The Stanislaus River is a tributary to the San Joaquin River, one of two main stem rivers of California's Central Valley watershed. This watershed once supported large populations of Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (*Oncorhynchus mykiss*), the anadromous form of rainbow trout. However, over the past decade, these populations have undergone a widespread decline. The construction of impassable dams throughout the valley has reduced habitat availability for these fish populations by disrupting the natural gravel supply and distribution downstream. Additionally, hydraulic mining, over-harvest, hydropower implementation, introduced species, water diversions and other factors have contributed to the decline of these fish populations (Yoshiyama et al 2000, Lindley et al 2006, NMFS 2009). As a result, Chinook salmon and steelhead were listed as threatened under the Endangered Species Act (ESA) by NOAA's National Marine Fisheries Service (NMFS 2016).

In order to help protect, restore, mitigate and improve the natural production of juvenile Chinook salmon and steelhead in the Central Valley, the Central Valley Project Improvement Act (CVPIA) was established in 1992. The Fish Resource Area of the CVPIA includes all provisions under section 3406(b) to improve natural production of anadromous fish in Central Valley rivers and streams. The CVPIA Science Integration Team (SIT) was developed to use current data in decision support models (DSMs) and recommend Fish Resource Area priorities. As described in the 2017 CVPIA annual work plan, specific projects, programs or monitoring activities, based on SIT recommended priorities, include the rotary screw trap monitoring program, Migratory Corridor Rehabilitation and Salmonid Spawning and Rearing Habitat Restoration on the Stanislaus River (CVPIA 1992, USBR 2016).

In 2009 NMFS completed their biological and conference opinion (NMFS BiOp) based on the U.S. Bureau of Reclamation's (USBR) proposed long-term operations of the Central Valley Project (CVP) and State Water Project (SWP), leading to Reasonable and Prudent Alternatives (RPA) intended to reduce the threat on ESA-listed species and negative impacts on crucial habitat. The RPA actions from the NMFS BiOp established requirements related to Stanislaus River operations which involve flow management and temperature control, restoration of freshwater migratory habitat, and adult escapement and juvenile monitoring for the Central Valley steelhead.

To meet flow management and temperature control requirements, as put forth in NMFS BiOp Appendix 2-E, the Stanislaus Operations Group (SOG) and USBR maintain a flow schedule that includes Vernalis Adaptive Management Plan (VAMP) fall and spring pulse flows. The fall pulse flows are meant to provide suitable temperatures to migrating and holding adult steelhead in October and November. After 1 March, spring pulse flows are initiated to protect incubating eggs, cue out-migrating juveniles, and signal incoming adult, potentially spring-run, Chinook salmon (NMFS 2009).

Recommended Central Valley stream restoration actions, outlined in the NMFS RPA and supported by the CVPIA's Anadromous Fish Restoration Program (AFRP), have resulted in multiple gravel restoration efforts to restore and create spawning and rearing habitat in the Stanislaus River. For example, in 2007 the Lover's Leap Restoration Project was completed where approximately 25,000 tons of gravel and cobble was placed within the 25.5 mile salmonid spawning reach (KDH 2008). Restoration also occurred at Lancaster Road where over 2 acres of floodplain and nearly 640 feet of side-channel habitat were restored (Cramer 2012). Restoration Projects still in progress include the Two Mile Bar Salmonid Habitat, creating a spawning side channel through a high floodplain, as well as other proposed projects.

Despite all efforts that have already been completed, continuous restoration, management and monitoring activities are needed to further aid the recovery of Chinook salmon and steelhead populations. To this end, NOAA Fisheries adopted a new ESA recovery plan in 2014 for Central Valley steelhead as well as Central Valley spring-run Chinook salmon and Sacramento River winter-run Chinook salmon. Additionally, in 2016 a 5-year status review was completed by NMFS, determining that Chinook salmon and steelhead would remain threatened under the ESA (NMFS 2016), requiring the continuation of restoration and management activities. As the Stanislaus River is a top priority for steelhead reintroduction and a candidate for reintroduction of spring-run Chinook salmon, continued monitoring is important in determining how restoration activities and flow management affect the current salmonid populations.

There are two sites where rotary screw trap monitoring efforts occur on the lower Stanislaus River; Oakdale (river mile (RM) 40.1) and Caswell (RM 8.6). These sampling efforts, defined by the CVPIA and NMFS RPA actions, monitor juvenile salmonids to provide current and relevant data to the SIT and have been conducted since 1993 by California Department of Fish and Wildlife (CDFW), U.S. Fish and Wildlife Service (USFWS), Cramer Fish Sciences (Cramer) or Pacific States Marine Fisheries Commission (PSMFC). This report describes efforts to determine the timing and abundance of emigrating juvenile salmonids using rotary screw traps (RSTs) on the lower Stanislaus River at Caswell Memorial State Park in 2017 as part of a larger effort to determine if habitat restoration activities and flow management regulations are improving Chinook salmon production. Furthermore, this report presents data that describe the size and abundance of other native and non-native fish species in relation to the time of year, river discharge, and environmental conditions.

The primary objective of the lower Stanislaus River trapping operations is to collect data that can be used to estimate the production of juvenile fall-run Chinook salmon and observe abundance of steelhead. Secondary objectives of the trapping operations focus on collecting fork length and weight data for juvenile salmonids and gathering environmental data that will eventually be used to develop models that correlate environmental parameters with salmonid size, temporal presence, and abundance/production. An ancillary objective of the trapping operations is to collect non-salmonid fish species data that can be used to characterize the fish community in the Stanislaus River in the vicinity of the RSTs.

## Study Area

The Stanislaus River headwaters begin on the western slope of the Sierra Nevada mountain range and cover an area of about 980 square miles (USBR 2017). The upper Stanislaus River consists of three forks (North, Middle and South) and tributaries which flow southwest into New Melones Reservoir. The lower Stanislaus River, located in Tuolumne, Calaveras and Stanislaus counties, is a major tributary to the San Joaquin River, which is the southern portion of California's Central Valley watershed. The San Joaquin River flows north and joins the Sacramento River in the Sacramento-San Joaquin Delta. The lower Stanislaus River is approximately 96.6 river kilometers (rkm) long from the base of Goodwin Dam to the confluence of the San Joaquin River and provides spawning and rearing habitat for fall-run Chinook salmon and Central Valley steelhead. The primary spawning habitat is relegated between Goodwin Dam (rkm 94) and Riverbank (rkm 54.7) (KDH 2008).

The lower Stanislaus River is regulated by three dams; New Melones Dam, Tulloch Dam and Goodwin Dam (Figure 1). These dams are operated by the USBR and the Tri-Dam Project to provide flood control, irrigation and agricultural use, power generation, and temperature regulation, and are also used to meet flow management requirements. Goodwin Dam is equally and jointly owned by the Oakdale (OID), South San Joaquin (SSJID), and the Stockton East Water irrigation districts (SEWID). The construction of the Melones Dam in 1926 and New Melones Dam in 1966, was believed to have been a factor in the extirpation of the spring-run Chinook salmon historically supported by the Stanislaus River.

The trapping site at Caswell Memorial State Park (rkm 13.8) was determined in 1993 to be the furthest location from the spawning area that allowed for trap deployment and access, and maintained flows consistent enough to operate rotary screw traps (Cramer 2006). Two 8 foot rotary screw traps were positioned in the thalweg of the channel near the Northern most corner of the State Park (Figure 2). The traps were designated as Trap 1 and Trap 2, with Trap 1 set closer to the southwestern bank of the river and Trap 2 set closer to the northeastern bank of the river (Figure 3). Access to the trapping site was gained through a private road held by a

**Figure 1: Map of the Stanislaus River and rotary screw trap sites at Caswell Memorial State Park and Oakdale. Inset map illustrates the Stanislaus River in the state of California.**

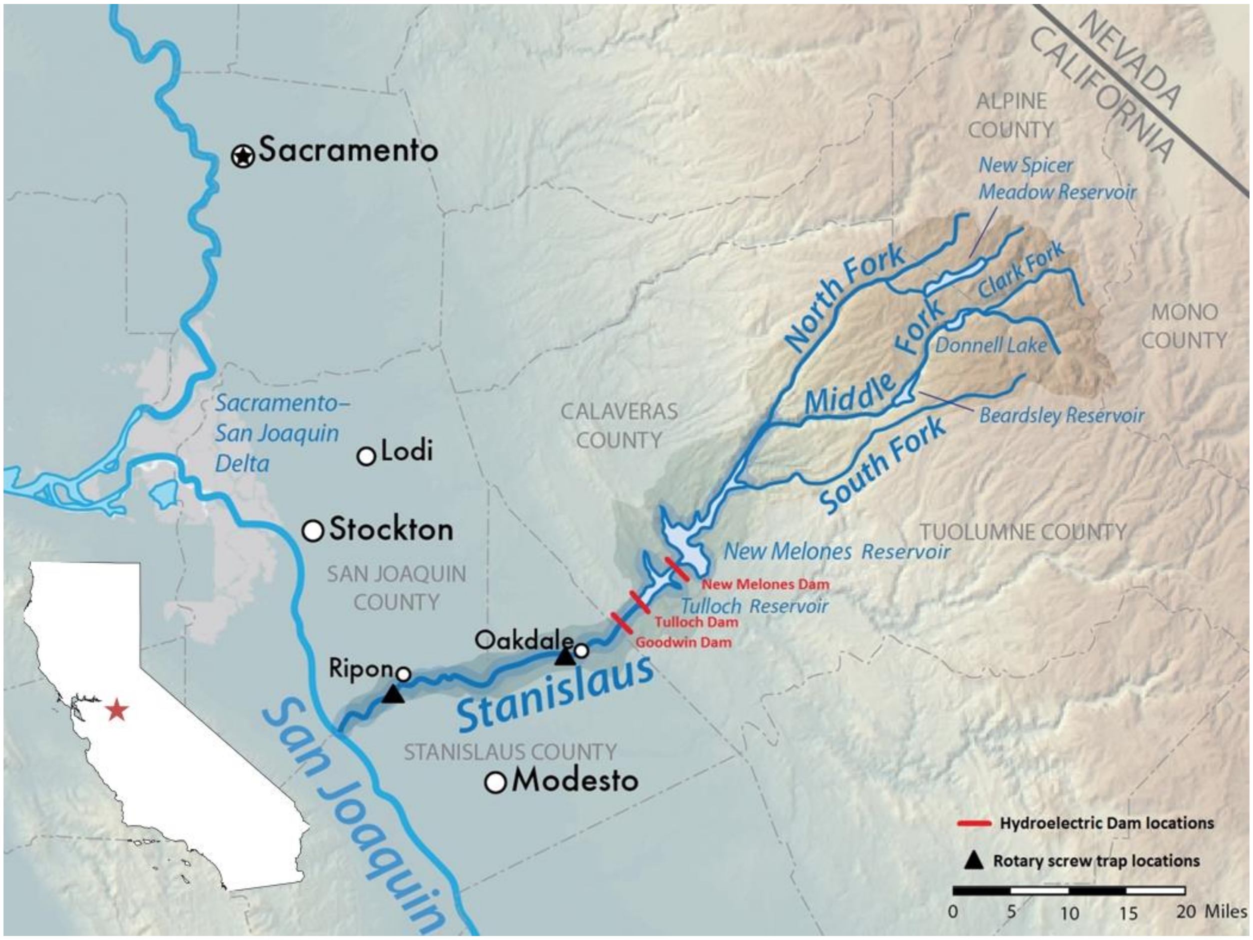
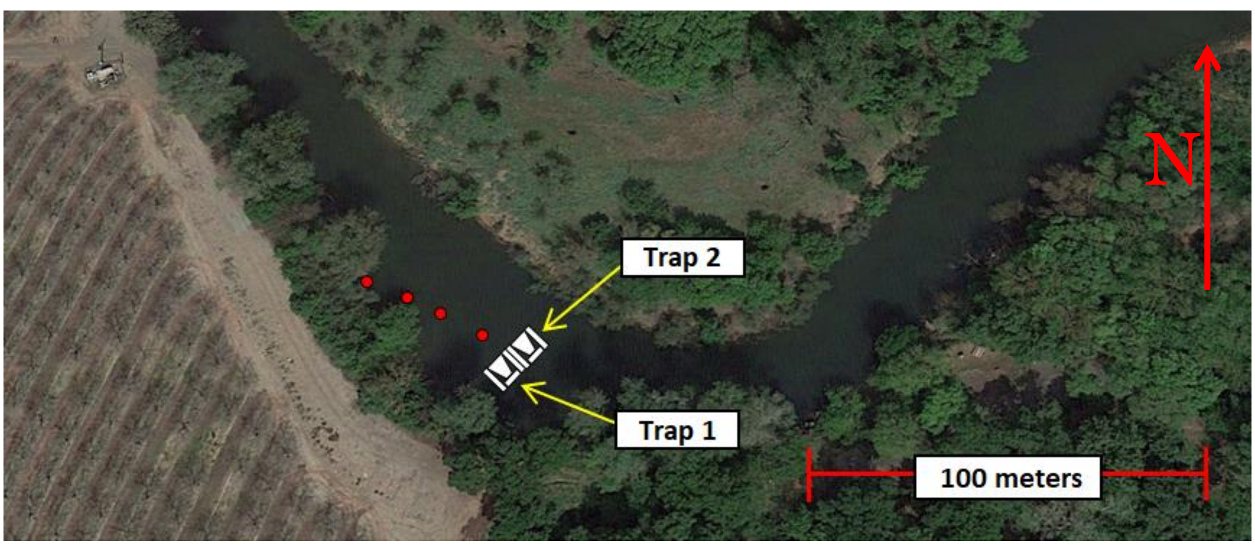


**Figure 2: Rotary screw trap operations map for the Stanislaus River Salmon Project.**


**Figure 3: Stanislaus River rotary screw trap site at Caswell Memorial State Park.**



# Methods

## Trapping Operations

Sampling for the 2017 survey season started on 1 February 2017 and ended on 23 June 2017. The two 2.4 meter (8 foot) diameter RSTs were fished in a side-by side configuration anchored in two separate locations. A ¼ inch galvanized cable, affixed with orange buoys and was secured to a tree upstream with a cable bridle attached to the outermost pontoon of each trap. An additional anchor rope was attached to the southwestern bank, allowing for in-channel adjustments. In order for the crew to board the traps, this anchor rope was also used to pull the traps to shore. Once crew members and field sampling gear were on board, the traps were then released back out into the thalweg to continue trapping while environmental data were collected and live wells were cleared.

Trap checks were conducted at least once every 24 hours when traps were fishing in a cone-down configuration. During large storm events or measurable river flow increases, trap functionality could be hindered by larger sized or higher quantities of debris, creating a high potential for fish mortality. Therefore, to help prevent fish mortality, additional day-time trap checks or supplementary night-time checks were conducted during peak emigration weeks, or when field conditions suggested the potential for high debris load. Night checks were primarily used to clear debris and to keep the traps functioning properly; typically fish were not processed during these checks. In cases where a storm or flow increase was deemed severe enough, traps were taken out of service for an indefinite amount of time until the conditions improved. When traps were out of service, trap cones were raised, live well screens were pulled, and sampling was temporarily suspended.

The number of cone rotations between trap visits was monitored using a mechanical lever actuated counter (Trumeter Company Inc.) attached to the port side pontoon on each trap; this data was used to determine how well traps functioned between trap visits. The effect of debris buildup on trap cone rotation rates was quantified by counting the number of revolutions per minute (RPM) before and after each cone was cleaned each day. Cleaning of the cones relied on the use of a scrub brush to clear off algae and other vegetation, or stopping a trap cone to remove larger debris. For each trap visit, the extent of cone intake obstruction caused by debris was assigned a category of “none”, “partially blocked”, “completely blocked”, or “backed up into cone.”

## Safety Measures

All crew members were trained on RST safety and personal flotation devices were worn at all times when members were on the RSTs. For night operations, crew members were required to affix a strobe light to their personal flotation devices that turned on automatically when submerged in water. Two 12-volt, 1260 lumens, LED flood lights were affixed to each trap.

A variety of devices were installed to keep the public safe and away from the traps. "Keep Away" signs in English and Spanish were installed on the traps. A flashing amber construction light was attached to the outermost railings on the traps to alert the public at night that there was a potential navigation hazard. Orange or reflective buoys were placed on the anchor cable and bridal. Signs were installed upstream and downstream of the traps, warning river users of the proximity to the trap location.

## Environmental Parameters

During every trap visit when fish were processed, environmental data were recorded. Temperature and dissolved oxygen were measured using a YSI dissolved oxygen meter (YSI EcoSense DO200A), velocity in front of each cone was recorded using a Global Water flow probe, and turbidity was measured using a Eutech portable turbidity meter (Eutech; Model TN-100). When river depth was 300 cm or less, a depth rod was used to measure water depth underneath the trap to the nearest centimeter on the port and starboard sides of the 2-trap array, in line with the front of the trap cones. Average daily river discharge and average daily temperature for the Stanislaus River was determined using data from the U.S. Geological Survey's Stanislaus River at Ripon monitoring station (USGS station number 11303000).

## Catch and Fish Data Collection

After environmental data was collected, the process of clearing out each RST's live well and fish work-up began. First, debris was removed from the live well and placed into 68.14 liter (L) tubs which crew members sifted through, setting aside or enumerating any fish, alive or dead, and enumerating debris volume by gallon. After all debris was removed, an assessment of debris type and volume was recorded. Next, the crew netted any remaining fish from the live well and placed them in 18.93 L buckets with lids, segregating salmonids from non-salmonids or potential predators. During periods of hot weather, fish were placed in buckets with aerators to provide them with oxygen and an ice pack to keep the water temperature at a safe level. If fish were held in buckets for a prolonged amount of time, oxygen depleted water was regularly exchanged with fresh river water.

On days when less than 100 Chinook salmon were caught in a trap, the fork length of each salmon from each trap was measured to the nearest one millimeter (mm), their life stage was assessed using the smolt index rating (Table 1), the presence of marks used during trap efficiency trials or absence of adipose fin clips were noted, and their mortality status (live vs. dead) was assessed. If Chinook salmon were ≥ 40 mm in fork length, the first 25 were weighed to the nearest 0.1 gram (g).

When more than 100 Chinook salmon were caught in a trap, a random sample of 100 live salmon from each trap was collected. The fork length, life stage, mark status, and fin clip status for each of the 100 salmon was assessed. If the individuals were ≥ 40 mm in fork length, the first 25 were weighed to the nearest 0.1 g after they were measured and assessed for life stage. Because dead salmon are difficult to accurately measure and identify to life stage due to varying stages of decomposition that alter body size, weight, and color, live salmon were preferentially used for the random sample of 100, when possible. In those cases, mortalities were considered "mort plus-count;" an unassigned life stage category.

The random sample was achieved by placing a net full of Chinook salmon from the live well into a 68.14 L tub. Debris was removed from the tub with salad tongs/probes, leaving only the subsampled salmon in the tub. After removing the debris from the tub, a random net full of salmon was taken from the 68.14 L tub and placed in an 18.93 L bucket designated for Chinook salmon subsampling. From the subsampled bucket, 100 Chinook salmon were randomly selected for analysis. Additional fall-run Chinook salmon in excess of the 100 that were present in the tub or trap live well were not measured and weighed, but each of these salmon were checked for marks, enumerated, and recorded on data sheets as a "live plus-count tally," or "mort plus-count tally." A "plus-count tally" was defined as the total number of fish that were caught in a trap on a given day, and that were not measured, weighed, or assigned a life stage.

If steelhead were captured, each individual was counted, fork lengths were measured to the nearest 1 mm, life stage was assessed using the smolt index rating in Table 1, and mortality status was assessed. In addition, each steelhead was checked for the presence or absence of a mark (i.e., adipose fin clipped) and the weights of each individual ≥ 40 mm in fork length were recorded.

All other individuals belonging to non-salmonid taxa were enumerated and identified to species. For each trap, fork lengths of up to 50 randomly selected individuals of each species were recorded to the nearest mm and their mortality status was assessed. Because multiple entities in the Central Valley have a special interest in juvenile lamprey, an effort was made to distinguish between river lamprey and Pacific lamprey. To distinguish between the two species, the number of lateral circumorals in the mouth was observed. River lampreys have three lateral circumorals, while Pacific lampreys have four (Reid 2012). Because the lateral circumorals in the larval stage of ammocoetes are not well developed, they were not identifiable to species.

**Table 1: Smolt index rating for assessing life stage of Chinook salmon and steelhead.**

| Smolt Index | Life Stage | Morphological Criteria |
|---|---|---|
| 1 | Yolk-sac fry | * Newly emerged with visible yolk-sac |
| 2 | Fry | * Recently emerged with yolk sac absorbed (button-up fry)<br>* Seam along mid-ventral line visible<br>* Pigmentation undeveloped |
| 3 | Parr | * Seam along mid-ventral line not visible<br>* Scales firmly set<br>* Darkly pigmented with distinct parr marks<br>* No silvery coloration |
| 4 | Silvery Parr | * Parr marks visible but faded<br>* Intermediate degree of silvering |
| 5 | Smolt | * Parr marks highly faded or absent<br>* Bright silver or nearly white coloration<br>* Scales easily shed (deciduous)<br>* Black trailing edge on caudal fin<br>* Body/head elongating |
| 6 | Adult | * $\geq$ 300mm |

Prior to collecting fish fork lengths and weights, individuals were anesthetized with sodium bicarbonate tablets (Alka-Seltzer Gold) to reduce stress as they were processed. One Alka-Seltzer tablet was added to one liter of water. Approximately eight to 10 fish, depending on size and crew manageability, were placed in a solution of river water and Alka-Seltzer, then measured and weighed. The crew routinely observed the gill activity of fish immersed in the solution; reduced gill activity was an indication fish were ready to be processed. After fish were measured and weighed, they were placed in an 18.93 L bucket with a mixture of fresh river water and stress coat additive (Poly-Aqua) to help replenish their slime coat as the fish recovered from the anesthetic. As soon as it was determined that the fish had fully recovered from anesthesia, all fish were released well downstream of the traps to prevent recapture.

If Chinook salmon captured were larger than that day's average fork length, 1 to 2 mm samples were commonly taken from the upper caudal fin. These samples were then sent to the staff at the U.S. Fish and Wildlife Service's Abernathy Fish Technology Center to perform genetic run assignments using the panel of single-nucleotide polymorphism (SNP) markers described by Clemento et al. (2014). This panel of SNPs was developed by NOAA Fisheries, and is now used for several applications by the U.S. Fish and Wildlife Service and several partner groups (Christian Smith, USFWS, pers. comm.). Detailed methods for DNA extraction, genotyping, and run assignment are described in Abernathy Fish Technology Center Standard Operating Procedure #034.

## Trap Efficiency

Trap efficiency trials were conducted to quantify the proportion of the emigrating fall-run Chinook salmon that were passing through the river and were collected by the RSTs; these data were then used to estimate the total number of fall-run Chinook salmon migrating past the RSTs. Trap efficiencies were assessed using a pigment dye marking method.

Pigment dye marking consisted of dying the whole body of a fall-run Chinook salmon with Bismarck Brown Y (BBY) stain. At least 500 salmon were needed to conduct trials with BBY stain. When < 500 Chinook salmon were caught on a given day, they were held overnight and salmon caught the next day were added to achieve the minimum number of Chinook salmon required for a trap efficiency trial.

Once enough in-river produced Chinook salmon were available to conduct a trap efficiency trial, they were placed in a 68.14 L tub and stained using a solution of 0.6 g of BBY for every 20 L of river water. The actual amount of stain used varied depending on water turbidity and the number of salmon being stained. Salmon were stained for approximately two hours, and their condition was monitored during the staining process. After staining, salmon were rinsed with fresh river water and placed in a 75.71 L live cart, held overnight, and released at twilight the following day using the technique described below.

To evaluate the potential for a difference in size distribution between salmon released during a trap efficiency trial and associated recaptured salmon, 100 fork lengths from the released salmon were used to produce an average release length and compared with the average length of the recaptured salmon.

The release site was approximately 0.5 rkm upstream of the traps, located at the upper of two irrigation pumps. At river flows of less than approximately 3,500 CFS, a kayak was used to release salmon. Position in the river was maintained by a rope tied from shore to shore. To avoid schooling when Chinook salmon were released, they were scattered across the width of the river channel using small dip nets. At flows of greater than approximately 4,000 CFS, safety concerns did not allow for the distribution of salmon across the width of the river, and fish were distributed in small groups from the western bank of the river, as far into the channel as safety would allow. Every release of marked Chinook salmon occurred close to twilight to mimic natural migration patterns and avoid predation.

In visits following each trap efficiency release, the RST live-wells were carefully observed for any marked fish. A random sample of 100 recaptured Chinook salmon from each trap efficiency trial were measured for fork lengths, assessed for life stage, and evaluated for mortality status. If more than 100 recaptures from a trap efficiency trial were found in a RST live well, the marked salmon in excess of 100 were enumerated and classified as a "live recap plus-count tally" or "mort recap plus-count tally".

After each efficiency trial, a determination was made whether to include or exclude that trial from analysis. Factors that influenced this decision included success of fishing based on trap functionality, or other factors that might have adversely affected catch and therefore biased the resultant efficiency. If excluded from analysis, the trial was not used in the development of the generalized additive model (GAM) and did not influence overall trap efficiency. The calculation of the GAM is described below.

## Passage Estimates

Fall-run Chinook salmon passage estimates were developed using a generalized additive model (GAM). Passage estimates were not developed for the other Chinook salmon runs because these runs are not known to spawn in the Stanislaus River. Passage estimates were also not developed for steelhead because Central Valley steelhead fry are believed to rear in-river for one to three years before they immigrate to the ocean as smolts (Moyle et al. 2008), at which point they become more difficult to capture, as their larger size increases their ability to avoid the traps.

The GAM incorporated two elements in the development of the salmon passage estimates; the number of salmon caught by trap *i* on day *j*, and the estimated efficiency of trap *i* on day *j*.

Salmon passage at trap *i* on day *j*, $\hat{N}_{ij}$, was calculated as:

$$\hat{N}_{ij} = \frac{\hat{c}_{ij}}{\hat{e}_{ij}}$$

where $\hat{c}_{ij}$ was either the enumerated or estimated catch of unmarked salmon of a certain life stage at trapping location *i* during the 24-hour period j. For example, $c_{23}$ was the estimated catch at the second trapping location during day three; and

$\hat{e}_{ij}$ was the estimated trap efficiency at trapping location *i* for a certain life stage during the 24-hour period *j.* For example, $e_{23}$ was the estimated efficiency at the second trapping location during day three.

### Estimation of $\hat{c}_{ij}$

The estimate of catch, $\hat{c}_{ij}$, was computed in one of the following ways. The method used was typically selected in the order listed below, e.g., if a trap fished for more than 22 hours within a 24-hour period, the catch using Method #1 was used to calculate a trap's salmon production estimate. If the trap fished for less than 22 hours within a 24-hour period, Method #2 was used.

Additionally, if the 24-hour period between day *j* and day *j*-1 contained more than two hours of sampling excluded from analysis, as described in the Retention in Analysis section below, this length of time excluded from analysis was treated as a gap in sampling, and Method #2 was used.

Method #1: If the interval between day *j* and day *j* – 1 was 22 hours or more and the trap fished for the entire period, $\hat{c}_{ij}$ was the total catch of unmarked fish for day *j*.

Method #2: If the trap fished for less than 22 hours in the 24-hour period between day *j* and day *j* – 1, the fish count for day *j* was adjusted using a GAM. This model smoothed observed catch rates (fish per hour) through time much like a moving average. The prediction from this model was multiplied by the number of hours the trap was not sampling during the 24-hour period to estimate catch for the day. For example, if the trap fished for 10 hours in the 24-hour period between day j and day j-1, catch for the 14 hours not fished was calculated using the GAM, and added to the catch for the 10 hours fished to estimate $\hat{c}_{ij}$.

### Estimation of $\hat{e}_{ij}$

Efficiency estimates at trapping location *i* on day *j* were computed from a binomial GAM unless sufficient efficiency trials (≥ 3 per week) had been performed. Thus, if sufficient efficiency trials had been conducted (≥ 3 per week), efficiency from the most recent trial was used for $\hat{e}_{ij}$. When the most recent efficiency was not appropriate (i.e., < 3 trials per week), a binomial GAM was fitted to past and current efficiency trials and used to compute $\hat{e}_{ij}$. The additive portion of this GAM model was:

$$\log\left(\frac{E[\hat{e}_{ij}]}{1-E[\hat{e}_{ij}]}\right) = s(j)$$

where $s(j)$ was a smooth (spline) function of the day index (i.e., smooth function of Julian date).

On sampling days during the portion of the year when trap efficiency trials were not conducted, or if less than 10 efficiency trials were included in analysis, a GAM was not used to estimate trap efficiency, and $\hat{e}_{ij}$ was the average efficiency for the trap efficiency trials that were conducted during the survey season and that were included in analysis. For example, if a survey season occurred between 1 January and 30 June and trap efficiency trials were conducted between 1 February and 30 May, a GAM was used to develop the estimated trap efficiencies and expand the daily trap catches between 1 February and 30 May, and the average trap efficiency for the survey season was used to expand the daily trap catches before 1 February and after 30 May. If less than 10 efficiency trials were conducted during the survey season or less than 10 efficiency trials were included in analyses, the average trap efficiency for the survey season was used to expand the daily trap catches.

## Estimation of $\hat{N}_{ij}$

Once $\hat{c}_{ij}$ and $\hat{e}_{ij}$ were estimated, abundance estimates for the site were computed by summing over trap locations. The total number of fish passing a particular site on day *j* was computed as:

$$\hat{N}_j = \sum_{t=1}^{n_{ij}} \hat{N}_{ij}$$

where $n_{ij}$ was the number of trap locations sampled at site *i* during day *j*. Passage on day *j* was then summed over a week, month, or year to produce weekly, monthly, or annual estimates of abundance.

## Retention in Analysis

For every sampling period, a determination was made whether to include or exclude that period from analysis. Factors that influenced this decision included success of fishing based on trap functionality, or other factors that might have adversely affected catch.

If fishing was unsuccessful, a calculation was conducted using the clicker total and after cleaning RPMs to determine the amount of time the trap had been functioning normally. If this calculation indicated the trap had been functioning normally for at least 70 percent of the sampling period, the sampling period was kept in analysis. If the trap was determined to have been functioning normally for less than 70 percent of the sampling period, the period was excluded from analysis. Sampling periods excluded from analysis were treated by the CAMP platform like periods not fished and a catch estimate was produced based on Method #2, as described above. This estimated catch was then compared to the actual catch encompassing that sampling period. Under the assumption that abnormal trap function adversely affects catch, the higher of the two was considered to more accurately represent what would have been caught under normal trap function. Therefore any period with abnormal trap function was only excluded from analysis if the catch estimate produced was higher than what had actually been caught. Furthermore, if an unsuccessful trapping period was the first or last of the season, the CAMP platform was unable to impute catch. Therefore, the actual catch was assumed to be more accurate and the period was included in analysis.

## Confidence Intervals

Confidence intervals were computed using parametric bootstrap or Monte Carlo methods as described in the "Feasibility of Unified Analysis Methods for Rotary Screw Trap Data in the California Central Valley," by McDonald and Banach (2010).

## Fulton's Condition Factor

Fall-run Chinook salmon condition was assessed using the Fulton's condition factor. The first 25 Chinook salmon larger than 40 mm captured each day were measured for weight and fork lengths. The ratio of the two was used to calculate their condition factor:

$$K = \left(\frac{W}{FL^3}\right) 100{,}000,$$

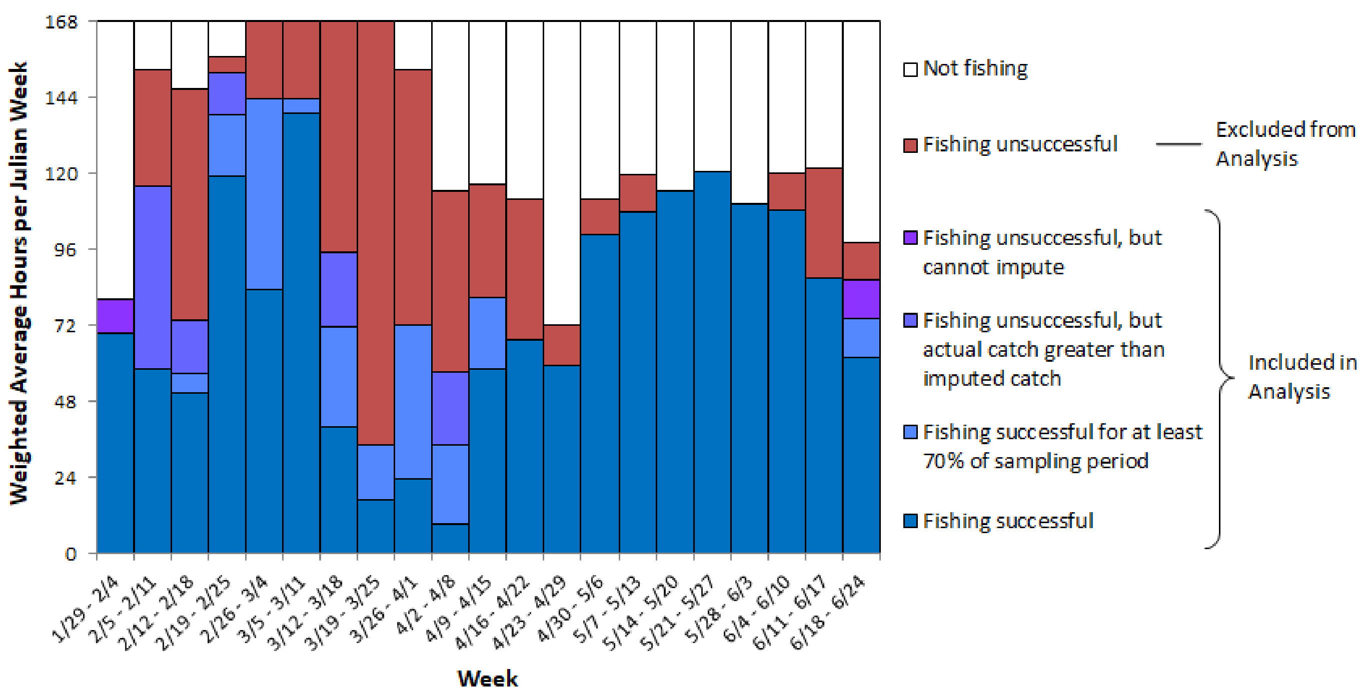
where *K* was the Fulton's condition factor, *W* was the weight in grams, and *FL* was the fork length in mm.

# Results

## Trap Operations

For the 2017 survey season, two 8ft RSTs were deployed in the Stanislaus River at the Caswell Memorial State Park and began sampling on 1 February 2017 at river flows of approximately 350 CFS. Continuous sampling occurred until 11 February when trapping was temporarily suspended to limit fish mortality. Sampling resumed on 12 February, continued until 1 April, and was then reduced to a maximum of five days a week. Trap operations for the 2017 survey season ended on 23 June. As a result, sampling took place on 116 of the 143 days between 1 February and 23 June. During this time, the traps fished unsuccessfully (defined as a period of time during which the trap was fishing, but catch was determined to be adversely affected by abnormal trap function) for approximately 840 hours. Traps fished successfully for approximately 1856 hours and did not fish for approximately 709 hours (Figure 4). Of the 840 hours of unsuccessful fishing, 157 were included in analysis despite abnormal trap function, following the process described in the Methods section of this report. As a result, a total of 2,013 hours of fishing were included in analysis and used to calculate the GAM, and 682 hours of fishing were not included in analysis (Figure 4).

**Figure 4: Weighted average hours per Julian week that both traps fished successfully, fished unsuccessfully, or did not fish during the 2017 Stanislaus River rotary screw trap survey season.**

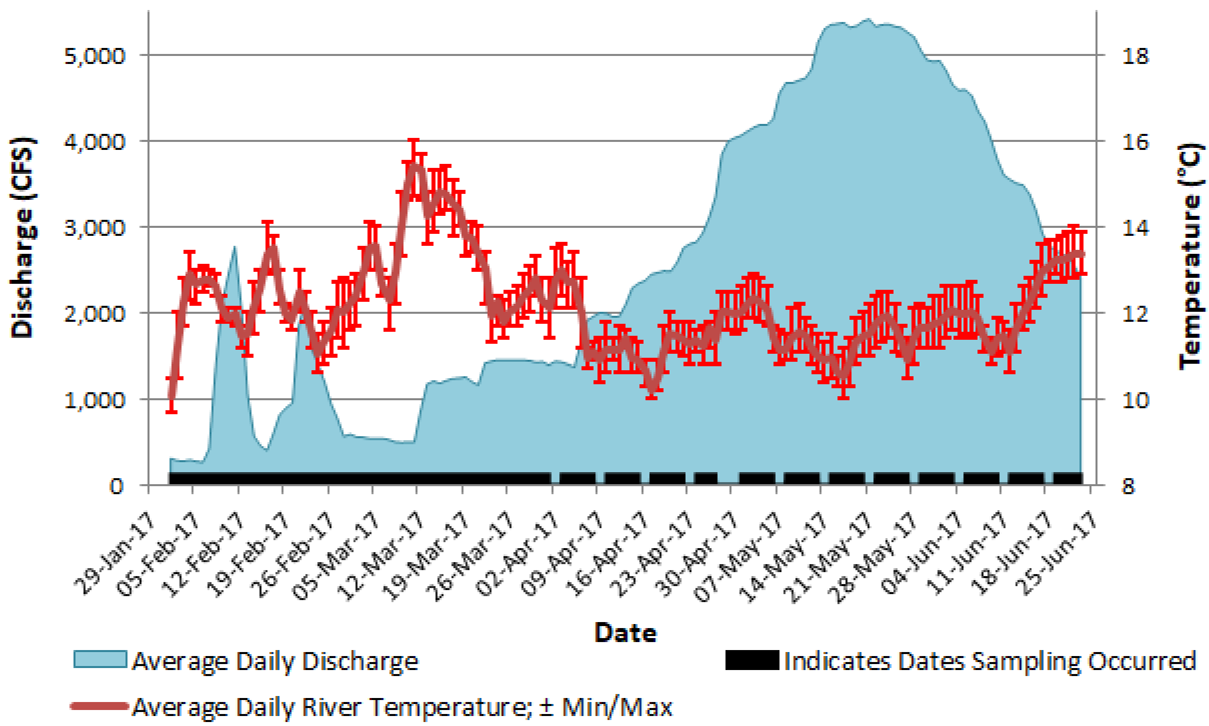


## Environmental Summary

Appendix 2 provides a summary of the overall environmental conditions during the 2017 survey season, averaged by Julian week.

River discharge and temperature data, recorded in 15 minute increments, were acquired from the USGS station 11303000 on the Stanislaus River at Ripon, 12.5 rkm upstream of the RSTs. River discharge ranged from a low of 263 CFS on 6 February to a high of 5,440 CFS on 21 May (Figure 5). River temperature began at a low of 9.7° Celsius (C) on 1 February, to a high of 16.0° C on 11 March (Figure 5).

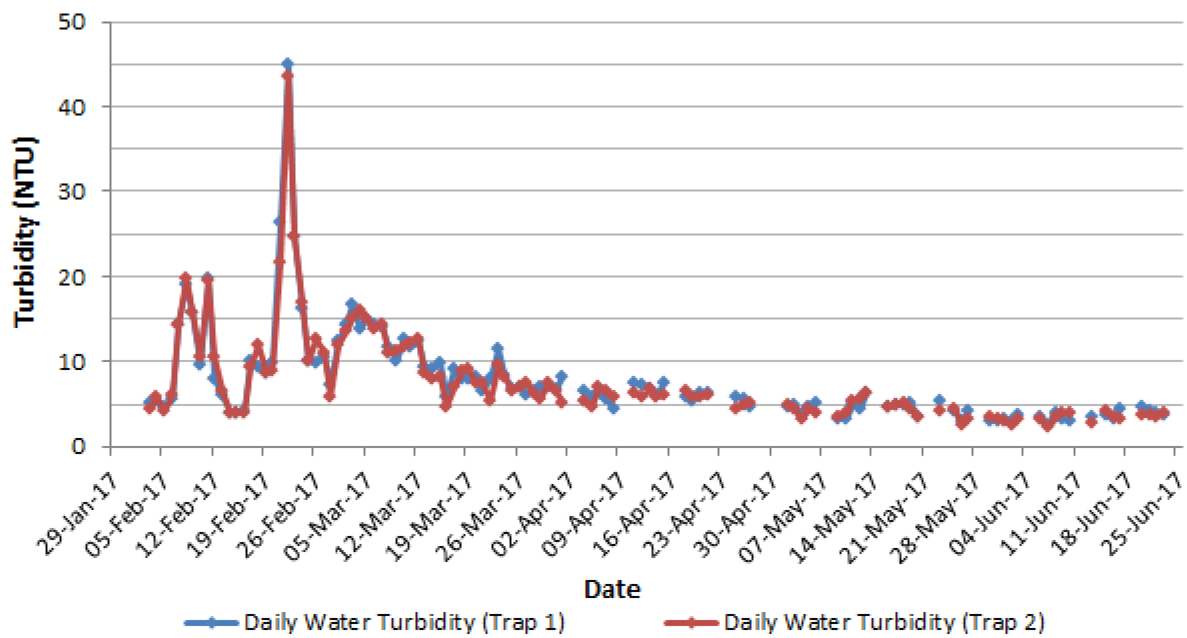
**Figure 5: Average daily discharge (CFS) and average daily water temperature (°C), measured at Ripon, during the 2017 Stanislaus River rotary screw trap survey season.**




Note: Discharge and water temperature data for the 1 February to 23 June time period were acquired from the USGS website at **http://waterdata.usgs.gov/ca/nwis/uv**

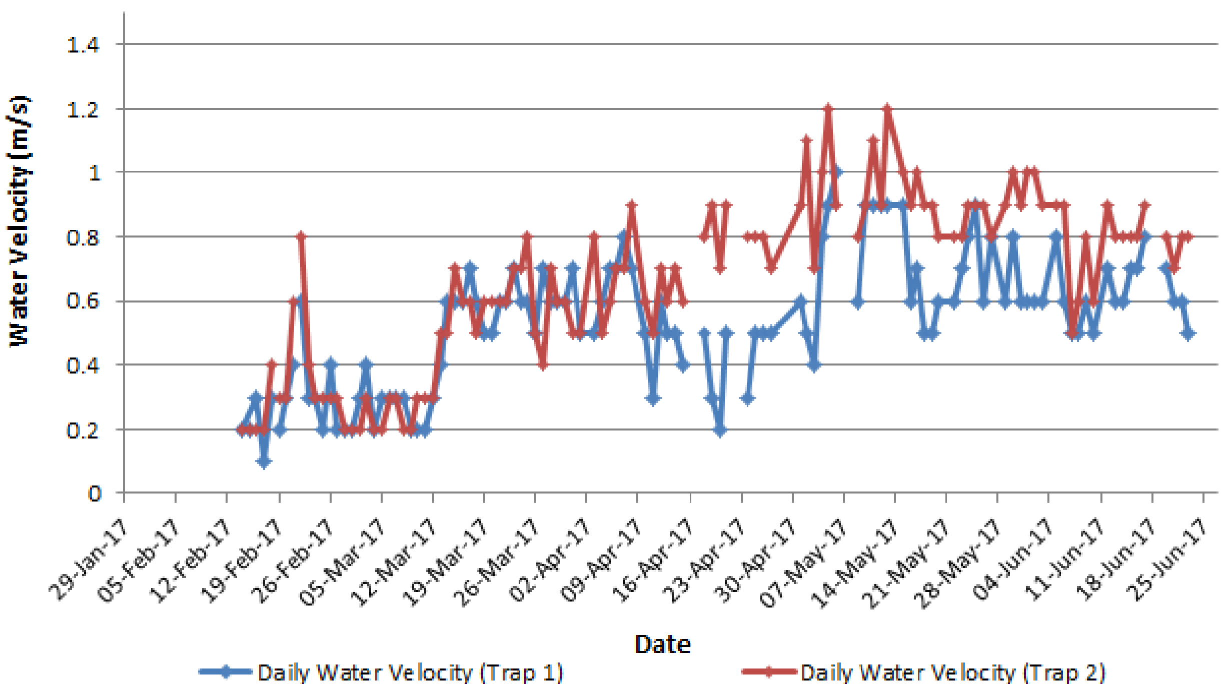
River turbidity was measured in the field, from water samples taken daily from each trap. Turbidity did not vary considerably between traps (Figure 6), but on average was slightly higher for Trap 1 (southwest side) than for Trap 2 (northeast side). Turbidity for both traps reached a season maximum on 22 February, with 44.9 Nephelometric Turbidity Units (NTU) for Trap 1 and 43.5 NTU for Trap 2. Turbidity for both traps reached a season low on 7 June, with 2.5 Nephelometric Turbidity Units (NTU) for Trap 1 and 2.3 NTU for Trap 2. Weekly average turbidity across both traps, averaged by Julian week, is shown in Appendix 2. Weekly average turbidity reached a high of 20.3 NTU during the week of 19 February and declined to a weekly average low of 3.1 NTU during the week of 28 May.

**Figure 6: Comparison of daily turbidity measured in the field during the 2017 Stanislaus River rotary screw trap survey season.**



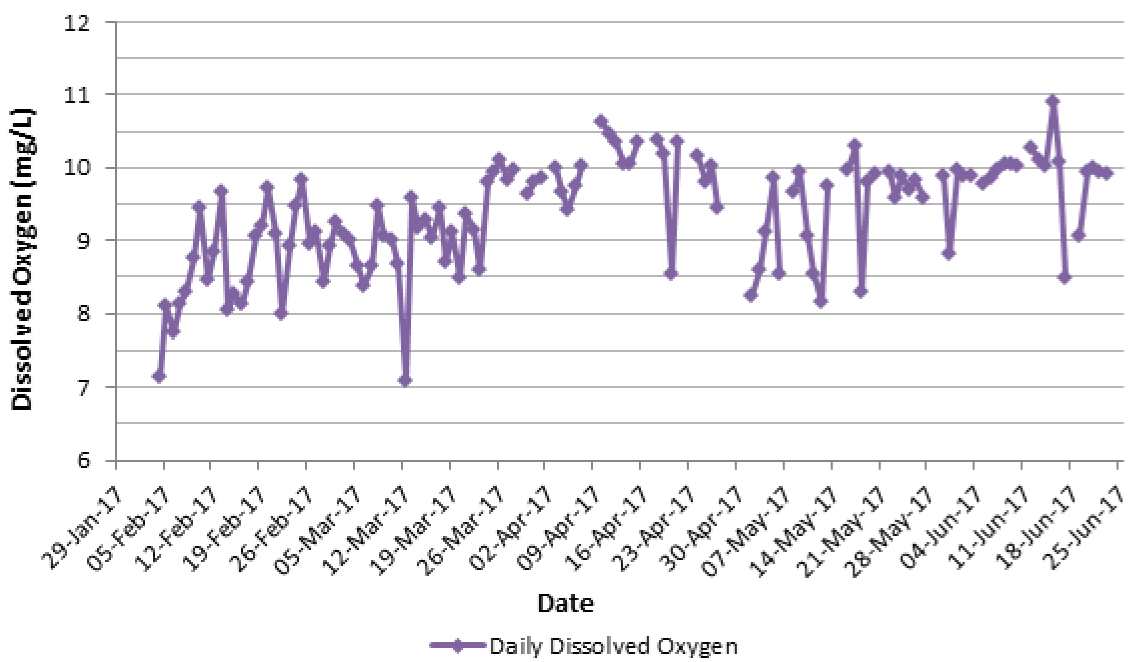
Water velocities (Figure 7) were also measured for each trap on a daily basis, and were taken from in front of each cone. Water velocities in front of Trap 2 (northeast side) were on average higher than for Trap 1 (southwest side). Water velocities in front of Trap 2 reached a low of 0.2 meters per sec (m/s) on 11 days between 14 February and 9 March, and reached a high of 1.2 m/s on 5 May and 13 May. Water velocities in front of Trap 1 ranged from a low of 0.1 m/s on 17 February to a high of 1 m/s on 6 May. Weekly water velocity averaged across both traps by Julian week, is shown in Appendix 2. Weekly average water velocity ranged from a low of 0.2 m/s the week of 12 February to a high of 0.9 m/s the week of 7 May.

**Figure 7: Comparison of water velocities measured in the field in front of each trap during the 2017 Stanislaus River rotary screw trap survey season.**



Dissolved oxygen (DO) in the river water (Figure 8), taken in the field as a single daily measurement, ranged from a low of 7.1 milligrams per liter (mg/l) on 12 March to a high of 10.9 mg/l on 15 June. Weekly average DO (Appendix 2), averaged by Julian week, began at a low of 7.2 mg/l during the first week of the 2017 survey season, and increased to a weekly average high of 10.4 mg/L during the week of 9 April.

**Figure 8: Daily dissolved oxygen content measured in the field during the 2017 Stanislaus River rotary screw trap survey season.**



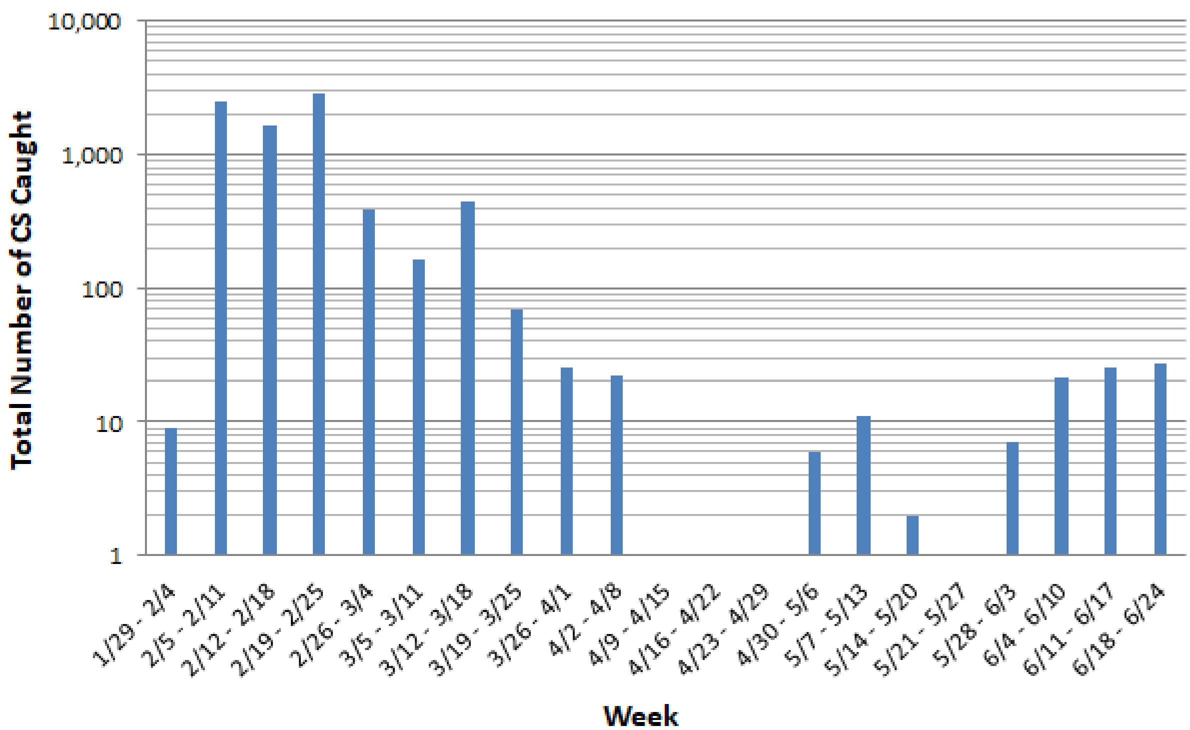

## Catch

The two rotary screw traps deployed during the 2017 survey season captured a total of 8,720 fish. Trap 1 (south western side) captured 32.76 percent (n = 2,857) of these fish, and Trap 2 (north eastern side) captured 65.40 percent (n = 5,863). Fall-run Chinook salmon were the only salmonid species captured. Twenty identified non-salmonid species and five unidentified non-salmonid species (Appendix 3) were also captured.

### Fall-run Chinook salmon

Of the 8,720 fish captured during the 2017 survey season, a total of 8,246 of these were in-river produced, unmarked fall-run Chinook salmon (Figure 9). Catch of in-river produced, unmarked fall-run Chinook salmon peaked between 9 February and 13 February, when 42.80 percent of that total (n = 3,529) was captured. A secondary peak in catch occurred between 22 February and 25 February when 33.01 percent (n = 2,722) was captured. The single day with the highest catch of fall-run Chinook salmon was 24 February, when 1,124 fall-run Chinook salmon were captured.

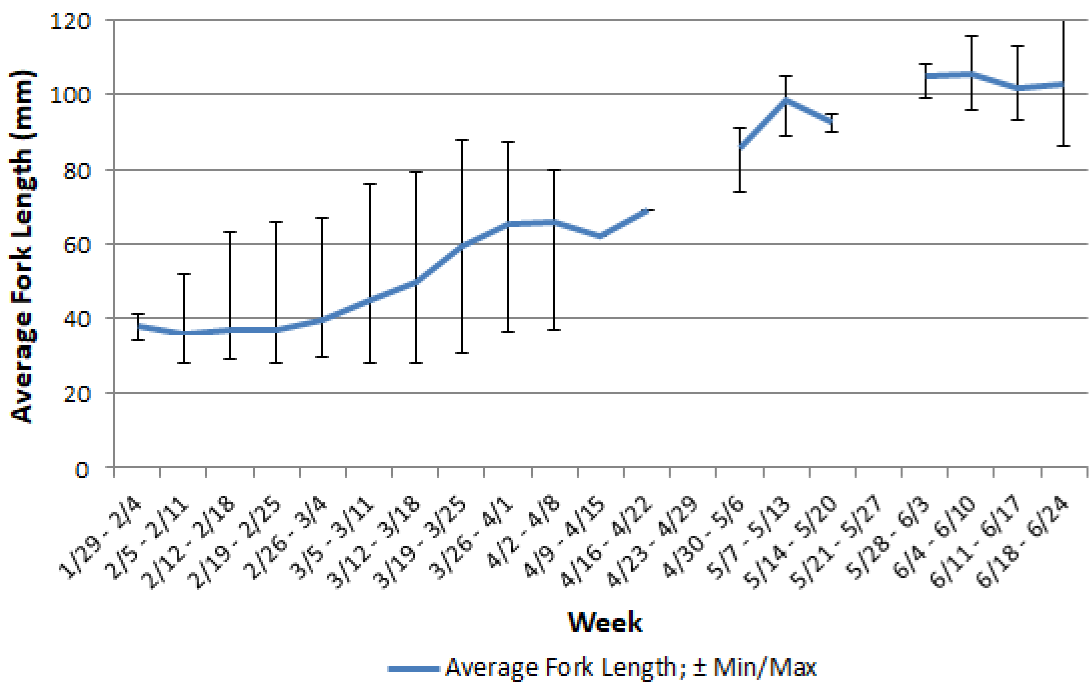
**Figure 9: Weekly catch distribution of in-river produced, unmarked fall-run Chinook salmon during the 2017 Stanislaus River rotary screw trap survey season.**




Note: Since the *y*-axis scale is logarithmic, weeks where one Chinook salmon was captured are not indicated in the graph. These are listed as follows: one salmon was captured the week of 9 April and one salmon was captured the week of 16 April. Plus-counted Chinook salmon and mortalities are included in the graph.

A total of 3,265 of the 8,246 in-river produced, unmarked fall-run Chinook salmon captured were measured for fork length. The weekly average fork length (Figure 10 and Table 2) began at 38 mm during the first week of sampling, decreased to a season low of 36 mm the week of 5 February, then increased to a season high of 106 mm the week of 4 June. During the week of 18 June when trapping was terminated for the season, the weekly average fork length was 103 mm.

**Figure 10: Average weekly fork length for fall-run Chinook salmon during the 2017 Stanislaus River rotary screw trap survey season.**




Note: No salmon were captured the weeks of 23 April and 21 May.

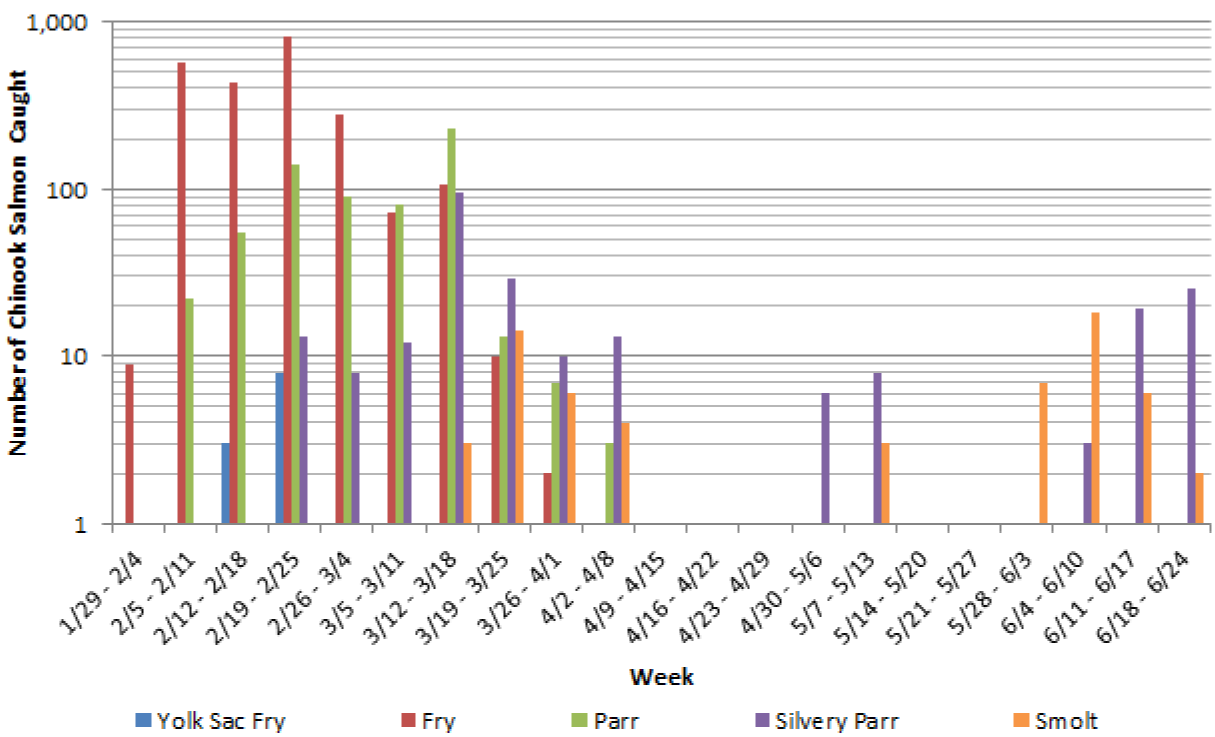
**Table 2: Average, minimum, maximum and standard deviations of fork lengths (mm) per week for fall-run Chinook salmon during the 2017 Stanislaus River rotary screw trap survey season.**

| Julian Week | Fork Length | | | |
|---|---|---|---|---|
| | Average | Min | Max | St. Dev. |
| 1/29 - 2/4 | 38 | 41 | 41 | 13.82 |
| 2/5 - 2/11 | 36 | 28 | 52 | 2.89 |
| 2/12 - 2/18 | 37 | 29 | 63 | 3.76 |
| 2/19 - 2/25 | 37 | 28 | 66 | 4.98 |
| 2/26 - 3/4 | 40 | 30 | 67 | 5.89 |
| 3/5 - 3/11 | 45 | 28 | 76 | 8.96 |
| 3/12 - 3/18 | 49 | 28 | 79 | 10.11 |
| 3/19 - 3/25 | 60 | 31 | 88 | 14.03 |
| 3/26 - 4/1 | 65 | 36 | 87 | 12.52 |
| 4/2 - 4/8 | 66 | 37 | 80 | 11.17 |
| 4/9 - 4/15 | 62 | 62 | 62 | - |
| 4/16 - 4/22 | 69 | 69 | 69 | - |
| 4/23 - 4/29 | | | | |
| 4/30 - 5/6 | 86 | 74 | 91 | 6.22 |
| 5/7 - 5/13 | 99 | 89 | 105 | 4.58 |
| 5/14 - 5/20 | 93 | 90 | 95 | 3.54 |
| 5/21 - 5/27 | | | | |
| 5/28 - 6/3 | 105 | 99 | 108 | 3.02 |
| 6/4 - 6/10 | 106 | 96 | 116 | 5.66 |
| 6/11 - 6/17 | 102 | 93 | 113 | 5.38 |
| 6/18 - 6/24 | 103 | 86 | 120 | 9.19 |

Note: No salmon were captured the weeks of 23 April and 21 May.

Of the in-river produced, unmarked fall-run Chinook salmon measured for fork length, a total of 3,260 were also assessed for life stage (Figure 11 and Table 3). The majority of this was salmon identified as fry life stage, which accounted for 70.52 percent (n = 2,299) of the assessed catch. Salmon identified as yolk sac fry comprised 0.37 percent (n = 12), parr were 19.63 percent (n = 640), silvery parr were 7.52 percent (n = 245), and smolt were 1.96 percent (n = 64).

**Figure 11: In-river produced, unmarked fall-run Chinook salmon catch by life stage during the 2017 Stanislaus River rotary screw trap survey season.**




Note: Since the *y*-axis scale is logarithmic, weeks where one Chinook salmon of a given life stage was captured do not appear in the graph. These are listed as follows: one salmon identified as yolk-sac fry was captured the week of 26 February; one fry was captured the week of 2 April; one silvery parr was captured the weeks of 12 February, 9 April, 16 April and 14 May; and one smolt was captured the week of 14 May. Plus-counted fall-run Chinook salmon are not included in the graph.

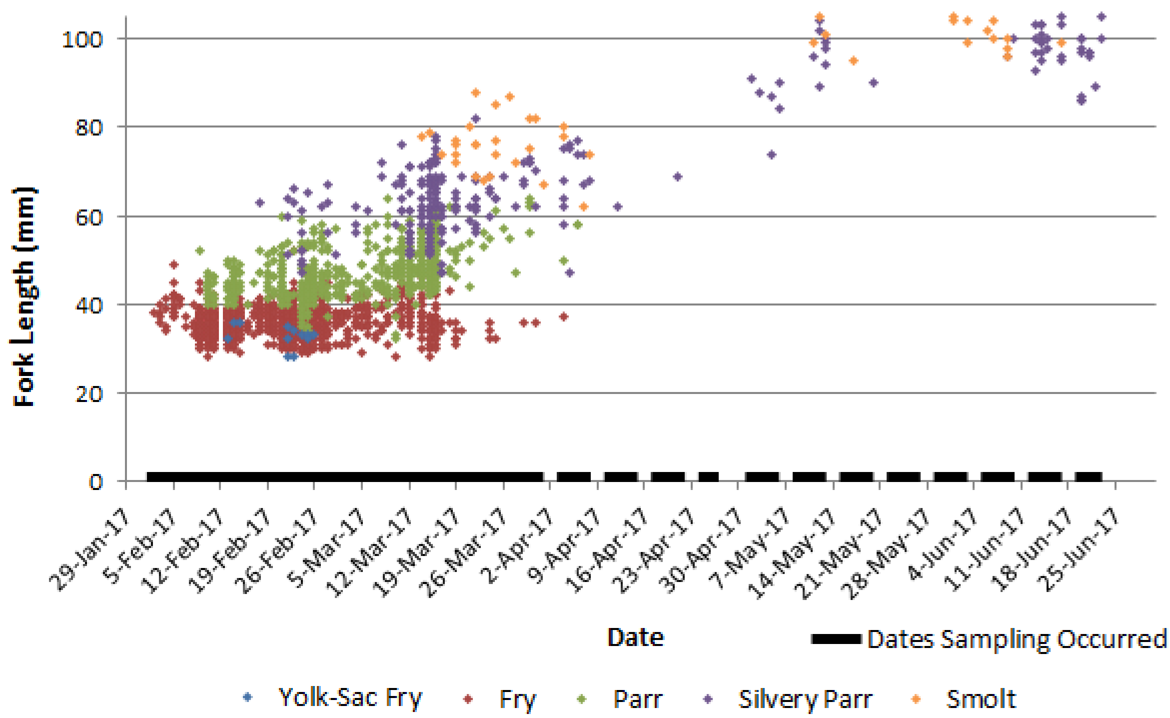
**Table 3: Total of in-river produced, unmarked fall-run Chinook salmon by life stage or unassigned life stage during the 2017 Stanislaus River rotary screw trap survey season.**

| Julian Week | Yolk Sac Fry | Fry | Parr | Silvery Parr | Smolt | Unassigned Life Stage | Total |
|---|---|---|---|---|---|---|---|
| 1/29 - 2/4 | 0 | 9 | 0 | 0 | 0 | 0 | 9 |
| 2/5 - 2/11 | 0 | 572 | 22 | 0 | 0 | 1,887 | 2,481 |
| 2/12 - 2/18 | 3 | 438 | 55 | 1 | 0 | 1,144 | 1,641 |
| 2/19 - 2/25 | 8 | 813 | 140 | 13 | 0 | 1,922 | 2,896 |
| 2/26 - 3/4 | 1 | 277 | 91 | 8 | 0 | 13 | 390 |
| 3/5 - 3/11 | 0 | 72 | 80 | 12 | 0 | 2 | 166 |
| 3/12 - 3/18 | 0 | 105 | 229 | 95 | 3 | 14 | 446 |
| 3/19 - 3/25 | 0 | 10 | 13 | 29 | 14 | 3 | 69 |
| 3/26 - 4/1 | 0 | 2 | 7 | 10 | 6 | 0 | 25 |
| 4/2 - 4/8 | 0 | 1 | 3 | 13 | 4 | 1 | 22 |
| 4/9 - 4/15 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 4/16 - 4/22 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 4/23 - 4/29 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4/30 - 5/6 | 0 | 0 | 0 | 6 | 0 | 0 | 6 |
| 5/7 - 5/13 | 0 | 0 | 0 | 8 | 3 | 0 | 11 |
| 5/14 - 5/20 | 0 | 0 | 0 | 1 | 1 | 0 | 2 |
| 5/21 - 5/27 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5/28 - 6/3 | 0 | 0 | 0 | 0 | 7 | 0 | 7 |
| 6/4 - 6/10 | 0 | 0 | 0 | 3 | 18 | 0 | 21 |
| 6/11 - 6/17 | 0 | 0 | 0 | 19 | 6 | 0 | 25 |
| 6/18 - 6/24 | 0 | 0 | 0 | 25 | 2 | 0 | 27 |
| Total | 12 | 2,299 | 640 | 245 | 64 | 4,986 | 8,246 |

Note: Unassigned life stage includes plus-counts.

As shown in Figure 12, Chinook salmon identified as yolk-sac fry life stage were captured between 13 February and 26 February, Chinook salmon identified as fry life stage were captured between 2 February and 4 April, and salmon identified as parr life stage were caught between 9 February and 6 April. Chinook salmon identified as silvery parr life stage were captured starting 18 February to the last day of the season on 23 June, and salmon identified as smolt life stage were caught between 14 March and 21 June.

**Figure 12: Daily fall-run Chinook salmon fork lengths during the 2017 Stanislaus River rotary screw trap survey season.**




Note: No salmon were captured the weeks of 23 April and 21 May.

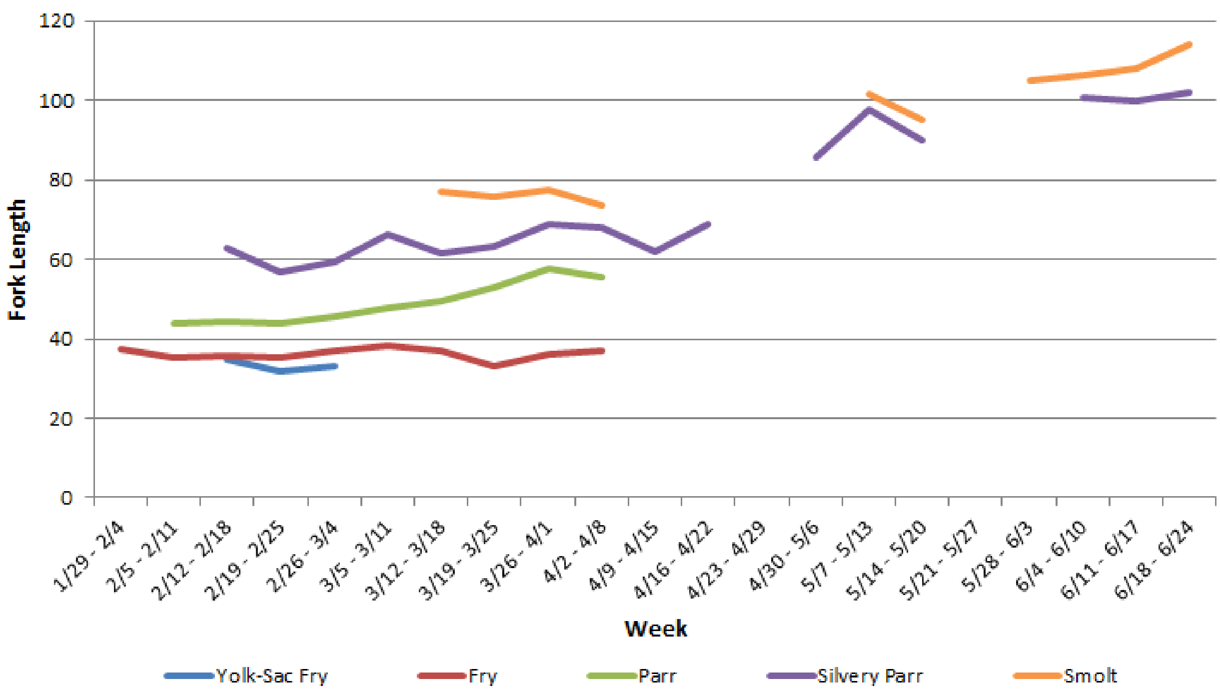
For each identified life stage of measured fall-run Chinook salmon, fork length distributions varied (Table 4). Salmon identified as yolk-sac fry life stage had a fork length distribution between 28 mm and 36 mm, while fry ranged from 28 mm to 52 mm. Parr life stage ranged from 32 mm to 64 mm, and silvery parr ranged between 47 mm and 120 mm. Smolt life stage ranged from 62 mm to 116 mm.

**Table 4: Average, minimum and maximum fork lengths (mm) per week for each stage of fall-run Chinook salmon during the 2017 Stanislaus River rotary screw trap survey season.**

| Julian Week | Yolk-Sac Fry | | | Fry | | | Parr | | | Silvery Parr | | | Smolt | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ave | Min | Max | Ave | Min | Max | Ave | Min | Max | Ave | Min | Max | Ave | Min | Max |
| 1/29 - 2/4 | | | | 38 | 34 | 41 | | | | | | | | | |
| 2/5 - 2/11 | | | | 35 | 28 | 49 | 44 | 40 | 52 | | | | | | |
| 2/12 - 2/18 | 35 | 32 | 36 | 36 | 29 | 41 | 44 | 40 | 52 | 63 | 63 | 63 | | | |
| 2/19 - 2/25 | 32 | 28 | 35 | 35 | 29 | 52 | 44 | 34 | 60 | 57 | 47 | 66 | | | |
| 2/26 - 3/4 | 33 | 33 | 33 | 37 | 30 | 45 | 46 | 37 | 58 | 59 | 51 | 67 | | | |
| 3/5 - 3/11 | | | | 38 | 28 | 47 | 48 | 32 | 64 | 66 | 58 | 76 | | | |
| 3/12 - 3/18 | | | | 37 | 28 | 47 | 50 | 40 | 62 | 62 | 47 | 78 | 77 | 74 | 79 |
| 3/19 - 3/25 | | | | 33 | 31 | 36 | 53 | 44 | 62 | 63 | 56 | 82 | 76 | 68 | 88 |
| 3/26 - 4/1 | | | | 36 | 36 | 36 | 58 | 47 | 64 | 69 | 62 | 73 | 78 | 67 | 87 |
| 4/2 - 4/8 | | | | 37 | 37 | 37 | 55 | 50 | 58 | 68 | 47 | 77 | 74 | 62 | 80 |
| 4/9 - 4/15 | | | | | | | | | | 62 | 62 | 62 | | | |
| 4/16 - 4/22 | | | | | | | | | | 69 | 69 | 69 | | | |
| 4/23 - 4/29 | | | | | | | | | | | | | | | |
| 4/30 - 5/6 | | | | | | | | | | 86 | 74 | 91 | | | |
| 5/7 - 5/13 | | | | | | | | | | 98 | 89 | 104 | 102 | 99 | 105 |
| 5/14 - 5/20 | | | | | | | | | | 90 | 90 | 90 | 95 | 95 | 95 |
| 5/21 - 5/27 | | | | | | | | | | | | | | | |
| 5/28 - 6/3 | | | | | | | | | | | | | 105 | 99 | 108 |
| 6/4 - 6/10 | | | | | | | | | | 101 | 96 | 106 | 106 | 96 | 116 |
| 6/11 - 6/17 | | | | | | | | | | 100 | 93 | 108 | 108 | 99 | 113 |
| 6/18 - 6/24 | | | | | | | | | | 102 | 86 | 120 | 114 | 112 | 116 |

Weekly average fork lengths increased by life stage progression with yolk-sac fry life stage having the lowest weekly average fork lengths, and smolt life stage having the largest weekly average fork lengths (Figure 13). Overall average fork length for each life stage also increased according to life stage progression. Salmon identified as yolk-sac life stage had a season average fork length of 33 mm and fry had an average folk length of 36 mm. Salmon identified as parr life stage had an average of 47 mm, silvery parr had an average of 72 mm and smolt had an average of 93 mm.

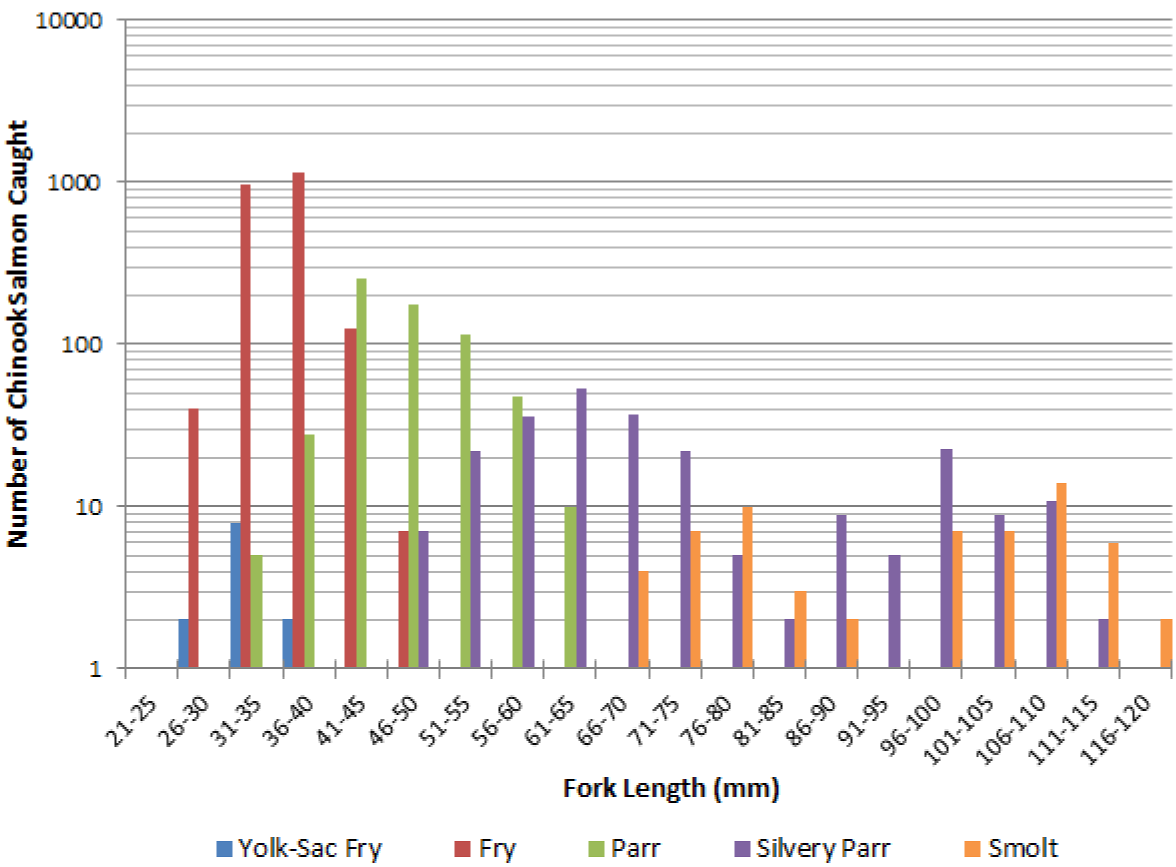
**Figure 13: Average weekly fork length by life stage for fall-run Chinook salmon during the 2017 Stanislaus River rotary screw trap survey season.**




Note: No salmon were captured the weeks of 23 April and 21 May.

Catch totals distributed by 5 mm fork length size classes are shown in Figure 14 and Table 5. Chinook salmon measured to be between 31 mm and 40 mm were captured most frequently, with the size class between 36 mm and 40 mm comprising 36.20 percent (n = 1180) of the 2017 survey season's total catch, and the size class between 31 mm and 35 mm comprising 30.37 percent (n =990). Both of these size classes included Chinook salmon identified as yolk-sac fry, fry and parr life stages.

**Figure 14: Distribution of fall-run Chinook salmon life stage by fork length during the 2017 Stanislaus River rotary screw trap survey season.**




Note: Plus-counted fall-run Chinook salmon are not included in the graph. Since the *y*-axis scale is logarithmic, fork length categories containing only one salmon are not shown in the graph. These are listed as follows: one fall-run Chinook salmon fry was captured at 52 mm, one silvery parr was captured at 120 mm, one smolt was captured at 62 mm and one smolt was captured at 95 mm.

**Table 5: Distribution of fall-run Chinook salmon life stage by fork length size class during the 2017 Stanislaus River rotary screw trap survey season.**

| Fork Length Size Class | Yolk-Sac | Fry | Parr | Silvery Parr | Smolt | Total |
|---|---|---|---|---|---|---|
| 21 - 25 | 0 | 0 | 0 | 0 | 0 | 0 |
| 26 - 30 | 2 | 40 | 0 | 0 | 0 | 42 |
| 31 - 35 | 8 | 977 | 5 | 0 | 0 | 990 |
| 36 - 40 | 2 | 1,150 | 28 | 0 | 0 | 1,180 |
| 41 - 45 | 0 | 124 | 257 | 0 | 0 | 381 |
| 46 - 50 | 0 | 7 | 178 | 7 | 0 | 192 |
| 51 - 55 | 0 | 1 | 114 | 22 | 0 | 137 |
| 56 - 60 | 0 | 0 | 48 | 36 | 0 | 84 |
| 61 - 65 | 0 | 0 | 10 | 54 | 1 | 65 |
| 66 - 70 | 0 | 0 | 0 | 37 | 4 | 41 |
| 71 - 75 | 0 | 0 | 0 | 22 | 7 | 29 |
| 76 - 80 | 0 | 0 | 0 | 5 | 10 | 15 |
| 81 - 85 | 0 | 0 | 0 | 2 | 3 | 5 |
| 86 -90 | 0 | 0 | 0 | 9 | 2 | 11 |
| 91 - 95 | 0 | 0 | 0 | 5 | 1 | 6 |
| 96 - 100 | 0 | 0 | 0 | 23 | 7 | 30 |
| 101 - 105 | 0 | 0 | 0 | 9 | 7 | 16 |
| 106 - 110 | 0 | 0 | 0 | 11 | 14 | 25 |
| 111 - 115 | 0 | 0 | 0 | 2 | 6 | 8 |
| 116 - 120 | 0 | 0 | 0 | 1 | 2 | 3 |

Fulton's condition factor (K) for in-river produced, unmarked fall-run Chinook salmon captured in 2017 displayed a slightly increasing trend in condition throughout the survey season (Appendix 5). The overall trend line exhibited a positive slope of 0.0022. The condition factors of each life stage had positively sloped trend lines as well; fall-run Chinook salmon identified with a life stage of fry showed the greatest increase in condition with a trend line slope of 0.0087, parr had a trend line slope of 0.0065, smolt had a trend line slope of 0.0012, and silvery parr displayed the smallest increase with a trend line slope of 0.0009. Yolk-sac fry captured in 2017 were unable to be accessed for Fulton's condition factor as every fish identified with this life stage measured below 40 mm and was therefore not weighed.

## Trap Efficiency

Seven mark-recapture trap efficiency trials were conducted throughout the 2017 survey season, five of which were included in analysis and used by the CAMP platform to determine passage estimates, and two of which were excluded from analysis (Table 6). These trials used a total of 4,849 fall-run Chinook salmon, all marked with BBY whole body stain. Of that total, 1,463 were in-river produced salmon that were collected with the RSTs, and 3,386 were from Merced Fish Hatchery. A total of 83 released salmon was recaptured. For the six trials in which fish were recaptured, the average fork length of recaptured fish was approximately 1 mm larger than the average fork length of released fish, and per trial ranged from a difference of approximately 1 mm larger to 1 mm smaller. The average trap efficiency of the five trials kept in analysis and used to determine passage estimates was 2.57 percent.

**Table 6: Trap efficiency data for mark and recapture trials during the 2017 Stanislaus River rotary screw trap survey season.**

| BBY STAINING | | | | | RELEASE | | | | RECAPTURES for All Traps Combined | | | | | | | RECAPTURE SUMMARY | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Fish Origin | Mark Color | Release ID Code | Included in Analysis | Date | Time | Average FL (mm) | Total Released | Day 1 | Day 2 | Day 3 | Day 4 | Day 5 | Day 6 | Day 7 | Total Recaptured | Average FL (mm) | Trap Efficiency | FLOW (CFS) Time of Release |
| 2/14/2017 | Natural | Brown | 303 | Yes | 2/15/2017 | 5:00 PM | 36 | 954 | 5 | 1 | 1 | 0 | 0 | 0 | 0 | 7 | 35 | 0.73% | 443 |
| 3/2/2017 | Natural | Brown | 304 | Yes | 3/2/2017 | 5:21 PM | 39 | 509 | 28 | 4 | 3 | 1 | 0 | 0 | 0 | 36 | 40 | 7.07% | 555 |
| 3/14/2017 | Hatchery | Brown | 305 | No | 3/15/2017 | 6:52 PM | 49 | 697 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 49 | 0.29% | 1120 |
| 3/28/2017 | Hatchery | Brown | 306 | Yes | 3/28/2017 | 7:30 PM | 46 | 697 | 19 | 10 | 1 | 1 | - | - | - | 31 | 45 | 4.45% | 1440 |
| 4/11/2017 | Hatchery | Brown | 307 | No | 4/11/2017 | 7:50 PM | 56 | 700 | 3 | 0 | 0 | 0 | - | - | - | 3 | 56 | 0.43% | 1940 |
| 5/2/2017 | Hatchery | Brown | 308 | Yes | 5/2/2017 | 7:11 PM | 78 | 684 | 4 | 0 | 0 | 0 | - | - | - | 4 | 78 | 0.58% | 4120 |
| 5/16/2017 | Hatchery | Brown | 309 | Yes | 5/16/2017 | 7:30 PM | 86 | 608 | 0 | 0 | 0 | 0 | - | - | - | 0 | - | 0.00% | 5370 |

Note: Fall-run Chinook salmon were used for all the salmon trap efficiency trials.

Natural = Stanislaus River.

Hatchery = Merced Fish Hatchery.

BBY = Bismark brown Y whole body stain.

Release ID Code: This code is associated with the CAMP RST platform used to store RST data.

Included in Analysis: indicates if the trial was used by the CAMP RST platform to determine passage estimates.

Flow (CFS) is the discharge acquired from the USGS station 11303000 on the Stanislaus River at Ripon, 12.5 rkm upstream of the RSTs at the day and time of the trap efficiency release.

### Passage Estimate for Fall-run Chinook salmon

According to the CAMP platform "run_passage" report, a total of 613,144 in-river produced fall-run Chinook salmon were estimated to have emigrated past the Caswell Memorial State Park rotary screw trap location on the Stanislaus River during the 2017 survey season. The 95 percent confidence interval for this estimate was from 217,351 to 831,859 individuals. The CAMP platform "lifestage_passage" report, which subdivides a passage estimate by life stage, estimated 508,211 fry (including both yolk-sac fry and fry life stages), 77,856 parr (including both parr and silvery parr life stages), and 3,996 smolts to have emigrated past the trap location during the 2017 survey season.

A comparison of weekly passage estimates to weekly discharge at the USGS monitoring station at Ripon is displayed in Figure 15 and Table 7.

**Figure 15: Daily passage estimate of fall-run Chinook salmon and daily discharge at Ripon during the 2017 Stanislaus River rotary screw trap survey season.**

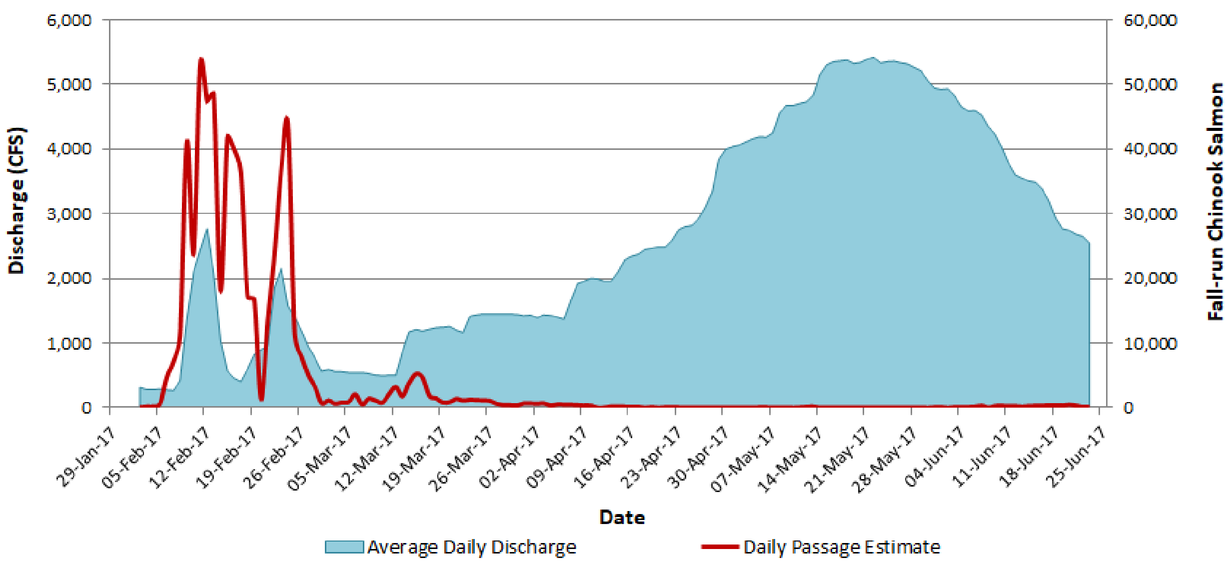


**Table 7: Weekly passage estimate of fall-run Chinook salmon and weekly discharge at Ripon during the 2017 Stanislaus River rotary screw trap survey season.**

| Date | Discharge (CFS) | Passage Estimate |
|---|---|---|
| 1/29 - 2/4 | 293 | 431 |
| 2/5 - 2/11 | 1,381 | 141,776 |
| 2/12 - 2/18 | 852 | 249,627 |
| 2/19 - 2/25 | 1,434 | 146,959 |
| 2/26 - 3/4 | 649 | 19,677 |
| 3/5 - 3/11 | 517 | 8,946 |
| 3/12 - 3/18 | 1,163 | 22,109 |
| 3/19 - 3/25 | 1,339 | 7,867 |
| 3/26 - 4/1 | 1,433 | 4,226 |
| 4/2 - 4/8 | 1,595 | 3,583 |
| 4/9 - 4/15 | 2,091 | 1,241 |
| 4/16 - 4/22 | 2,513 | 517 |
| 4/23 - 4/29 | 3,262 | 179 |
| 4/30 - 5/6 | 4,141 | 251 |
| 5/7 - 5/13 | 4,760 | 385 |
| 5/14 - 5/20 | 5,347 | 83 |
| 5/21 - 5/27 | 5,337 | 20 |
| 5/28 - 6/3 | 4,933 | 359 |
| 6/4 - 6/10 | 4,296 | 1,249 |
| 6/11 - 6/17 | 3,377 | 1,882 |
| 6/18 - 6/24 | 2,633 | 1,777 |

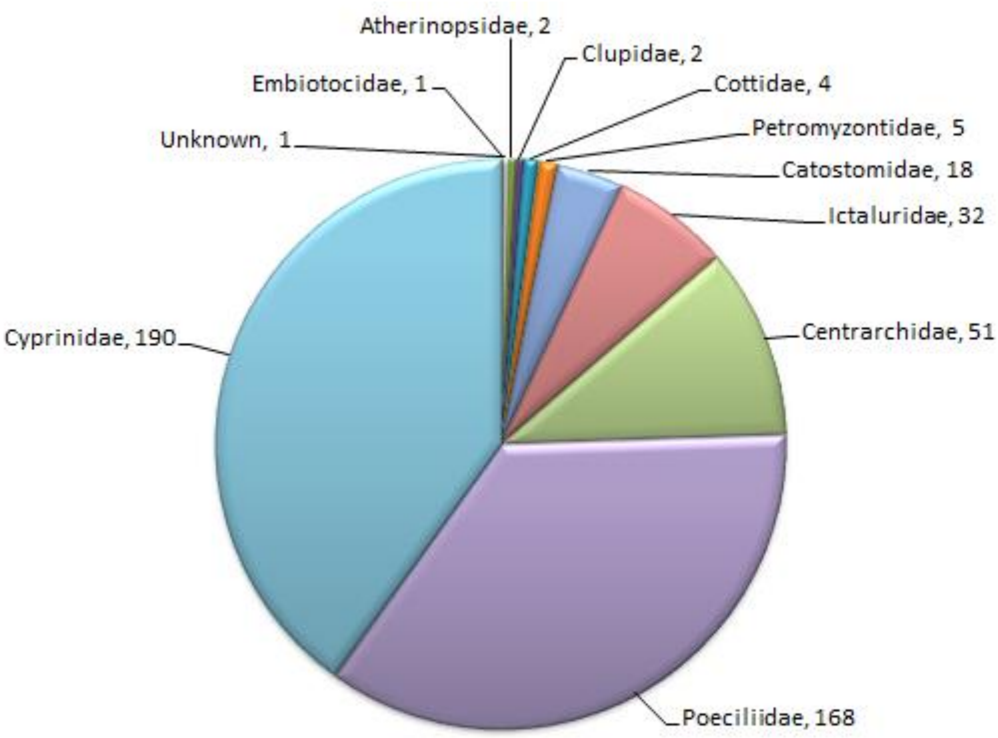
## Genetic Analysis

During the 2017 survey season genetic analysis was conducted on a total of 41 samples taken from in-river produced juvenile Chinook salmon. Analyses using SNP genetic markers from these samples indicated that all 41 of these individuals were fall-run Chinook salmon. The SNP panel's "Genetic Call to three lineages" probabilities for each of the 41 samples exceeded a 50 percent threshold; the final salmon run assignments for those salmon were therefore made based on genetic data. A complete accounting of the final salmon run assignments made using genetic markers is provided in Appendix 4.

### Non-salmonid Species

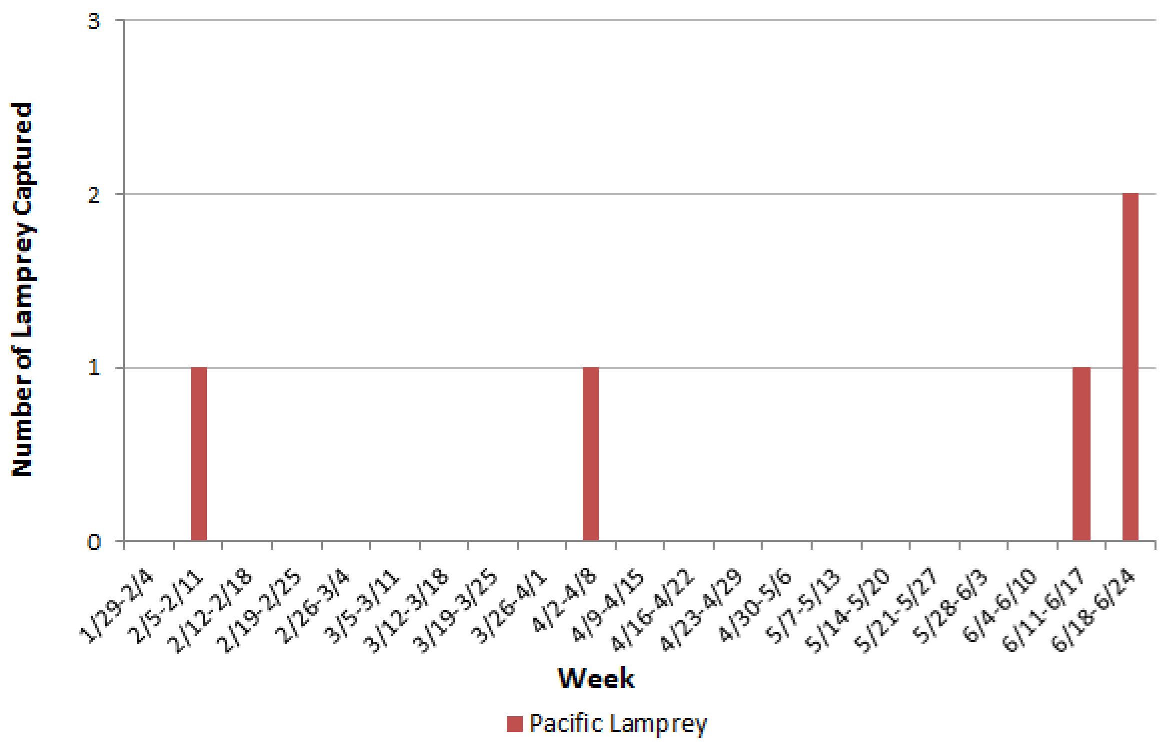
In addition to the salmon, 474 non-salmonid fish were captured during the 2017 survey season. The majority (n = 456, or 96.20 percent) of these fish belonged to 20 identified species in the following families: *Atherinopsidae* (silverside), *Catostomidae* (sucker), *Centrarchidae* (sunfish/black bass), *Clupeidae* (shad), *Cottidae* (sculpin), *Cyprinidae* (minnow), *Embiotocidae* (Tule perch), *Ictaluridae* (bullhead/catfish), *Petromyzontidae* (lamprey), and *Poeciliidae* (mosquitofish) (Figure 16). A total of 17 (3.59 percent) were not able to be identified to species level, but belonged to the following families: *Centrarchidae, Cottidae*, *Cyprinidae*, and *Ictaluridae*. The remaining individual was not able to be identified to family level. Of the non-salmonid fish captured in 2017, a total of 126 (26.58 percent) are of species native to Central Valley watersheds, and a total of 343 (72.36 percent) are of non-native species. A complete list of non-salmonid species captured in the 2017 survey season is presented in Appendix 3.

**Figure 16: Non-salmonid catch totals for families of fish species collected during the 2017 Stanislaus River rotary screw trap survey season.**



Of the 474 non-salmonid fish captured in 2017, 1.05 percent (n = 5) were lamprey, identified to species as Pacific lamprey (Figure 17). Three of these were identified as adult life stage, and were captured on 17 June, 20 June, and 22 June. The individuals identified as adult life stage ranged in total length from 443 to 490 mm. The remaining two lamprey individuals were identified as juvenile life stage and were captured on 8 February and 8 April. Those identified as juveniles ranged in total length from 127 to 138 mm. No lamprey individuals captured in 2017 were identified as river lamprey or identified as ammocoete life stage.

**Figure 17: Total weekly lamprey catch during the 2017 Stanislaus River rotary screw trap survey season.**



## Discussion

When interpreting the data collected during the 2017 survey season and the juvenile Chinook salmon passage estimate produced from that data, several influential factors must be considered. One of the most significant of these may have been environmental factors, especially fluctuating river flow levels. During the 2017 survey season, both high and low flows were experienced, both of which may have hindered the ability to collect consistent and high quality data by reducing the successful operation of the traps, or by limiting the number of trap efficiency tests that could be performed. In addition, the flow increases experienced during the beginning of the 2017 survey season may have influenced the timing of the salmon passage and may have been a contributing factor to when the peak of salmon catch occurred.

In 2017 California experienced the wettest year on record, with New Melones Reservoir and the Stanislaus River accumulating higher inflow and precipitation than in 1983, which had been the previous wettest year on record (USBR 2017). California experienced continuous storms from the landfall of several atmospheric rivers which resulted in above average precipitation and snowpack, filling many of California's major reservoirs to above average historic levels (USGS 2017, DWR 2017). These reservoirs included New Melones Reservoir, which had increased to a capacity that exceeded the historical average by the end of February. Consequently, to manage reservoir storage and control for flooding, flows were increased at Goodwin Dam on the Stanislaus River throughout much of the survey season. Discharge on the Stanislaus River peaked mid-May reaching over 5,000 CFS at the Ripon gauge, compared to a peak of 2,880 CFS at the Ripon gauge in 2016 and a peak of 1,310 CFS at the Ripon gauge in 2015.

Increased flows, like those seen during the 2017 survey season, increase the amount of debris in the water column, which can affect the successful operation of the rotary screw traps by stopping the rotation of the cone or can increase the potential for damage to traps and sampling equipment. Increased debris associated with high flows can also cause fish mortality by crushing fish within the debris or by causing fish trapped within a stopped cone to become pummeled by incoming water. To mitigate the potential for fish mortality or equipment damage due to increased debris loads, night checks were implemented during the 2017 survey season and occurred between 13 February and 21 February. When debris loads were judged too high to be managed even by performing nights checks in addition to day checks, the RST cones were raised and pulled out of the thalweg until debris load was reduced to a manageable level. This occurred twice during the 2017 survey season; cones were raised for approximately 30 hours between 11 February and 12 February and for approximately 11 hours between 21 February and 22 February. As data cannot be collected when the cones are raised, the CAMP platform was used to estimate potential catch during gaps in sampling less than seven days in duration, as described in the Methods section of this report. With the understanding that the smaller the gap in sampling, the more confidence can be had in the accuracy of the estimated catch, and when it was necessary to cease sampling entirely, an effort was made to lower the RST cones and resume trapping as soon as possible.

Despite the high water year, lower flows were also experienced during the 2017 survey season. Between 14 February and 17 February Stanislaus River flows were reduced and ranged from approximately 800 CFS to 400 CFS, resulting in a lowered river velocity that also hindered the ability of the rotary screw traps to rotate normally. Despite the reduced functionality, a trap efficiency trial conducted during this week resulted in recaptures which demonstrated that the traps were still able to capture Chinook salmon and served to quantify trap efficiency during these lower flows.

Furthermore, river flows affect trap efficiency trials. Since trap efficiencies are inversely affected by the river discharge, trap efficiency trials rely heavily on a consistent river discharge throughout the entire trial period in order to accurately determine efficiencies. During the 2017 survey season, an attempt was made to conduct trap efficiency trials when river flows were stabilized, with the goal of conducting as many trap efficiency trials as possible. However, the fluctuating river discharge, including lower flows and increased debris loads associated with high flows, were problematic in maintaining consistent trap efficiency trials. Despite efforts to maintain successful operation of the rotary screw traps, at least one trap was stopped or not functioning normally during almost every trial. Of the seven trials conducted, five were determined to more accurately represent true catch, and were kept in analysis. However, since even the five trials kept in analysis contained periods of unsuccessful trap operation, the trap efficiencies for the 2017 survey season were likely an underestimate of what the traps would have recaptured under normal function, and the 2017 trap efficiencies were therefore likely biased low. Since trap efficiencies are used to develop passage estimates for the in-river produced fall-run Chinook salmon, a low bias in the trap efficiencies may have resulted in a high bias for the passage estimate.

The total number of in-river produced fall-run Chinook salmon estimated to have emigrated past the rotary screw trap location on the Stanislaus River at Caswell Memorial State Park was 613,144 individuals, with 95 percent confidence intervals ranging from 217,351 to 831,859 individuals. This large confidence interval width is likely due to the greater distribution of daily catch totals throughout the 2017 survey season.

It is important to note that this passage estimate was not calculated entirely from actual catch. The 2017 passage estimate includes multiple days of estimated catch which may reduce the accuracy of the passage estimate. Days for which catch was estimated include gaps in sampling and days that were excluded from analysis due to unsuccessful fishing, as described in the Methods section of this report. It is also important to note that this passage estimate only includes the salmon estimated to have emigrated past the rotary screw trap location between 1 February and 23 June. It does not include any salmon that may have emigrated past the trap location during January, which is typically considered to be the start of the fall-run juvenile Chinook salmon emigration period. However, the 2017 survey season may still have encompassed the majority of the juvenile fall-run Chinook salmon emigration period. Out of the 8,246 Chinook salmon captured in the 2017 survey season, only 32 were captured during the first seven days of sampling, comprising only 0.39 percent of the total season catch of Chinook salmon, but comprising 3.92 (n = 24,043) percent of the total passage estimate. During the last seven days of sampling, 27 salmon were captured, consisting of 0.33 percent of the total catch and 0.35 percent (n = 2,162) of the total passage estimate.

The peak in unmarked juvenile fall-run Chinook salmon catch was seen during the third week of sampling, with a secondary peak in catch occurring during the fourth week of sampling. The timing of these peaks may have also been influenced by the fluctuating river flows seen in the 2017 survey season. During the first few weeks of the survey, the lower Stanislaus River flows were increased for Tulloch Reservoir storage management purposes, and scheduled outflow changes from Goodwin Dam beginning on 6 February increased river flows from 200 CFS to 2,250 CFS. This flow increase coincided with the first peak of catch seen between 9 February and 12 February where 3,529 salmon were captured (42.80 percent of the total captured) and 165,626 Chinook salmon were estimated to have out-migrated past the rotary screw trap location (27.01 percent of the total passage estimate). Beginning on 16 February, scheduled outflow changes from Goodwin Dam combined with runoff from precipitation events increased river flows from 500 CFS to 2,280 CFS which coincided with the second peak of unmarked fall-run juvenile Chinook salmon catch between 22 February and 25 February. During this second peak, 2,722 salmon were captured (33.01 percent of the total captured) and 165,626 Chinook salmon were estimated to have out-migrated past the rotary screw trap location (18.84 percent of the total passage estimate).

In 2017, no spring-run Chinook salmon were estimated to have emigrated past the Caswell RST location on the Stanislaus River. Despite releases of spring-run into the upper San Joaquin River since 2014, as an experimental study to support reintroduction (NOAA 2014), no spring-run juveniles were believed to have been captured at the Caswell RST site. A total of 41 genetic samples were taken from captured Chinook salmon with a fork length greater than the daily average, but genetic analysis of the samples taken indicated that all were from fall-run Chinook salmon. However, further genetic analyses should be conducted on both juvenile and adult Chinook salmon to determine if spring-run Chinook salmon currently utilize the Stanislaus River for spawning or rearing habitat.

Furthermore, no steelhead were captured during the 2017 survey season at Caswell Memorial State Park, unlike in previous survey seasons, during which small numbers of steelhead smolts were caught at the Caswell and Oakdale rotary screw trap locations (NMFS 2017). The relatively low steelhead population numbers in combination with the reduced trap efficiencies seen during 2017 survey season are likely factors contributing to the absence of steelhead in the 2017 Caswell RSTs catch.

## Management Implications

In order to determine if efforts made by AFRP and others to increase the abundance of Chinook salmon and steelhead on the lower Stanislaus River have been successful, additional monitoring of juvenile salmonid emigration is required. There should also be continued management of river flows and water temperature to maintain favorable river conditions for the anadromous fish populations in the Stanislaus River. The 2017 data is of particular interest as it was collected during one of the wettest years on record and can be compared to data collected during the prior 5-year drought. This data can then be used to guide water management modifications including timing of pulse flows which may influence juvenile Chinook salmon emigration.

## Acknowledgements

The funding for this project was provided by the USFWS's Comprehensive Assessment and Monitoring Program (CAMP). The Stanislaus River Salmon Project would like to thank Doug Threloff, Cesar Blanco and the staff at USFWS CAMP for their technical support. Thank you also to the Pacific States Marine Fisheries Commission staff: Stan Allen for management support and Amy Roberts and Kathy Ameral for administrative support and purchasing. In addition, recognition goes to the Stanislaus RST Project crew members Brandon Demuth, Lee Scheffler, Dylan Whitaker, Brian Crabill, Nicole Dunkley, Luis Santana, Joel Llamas, Albert Liwanag, and Edina Meiners for their hard work and assistance in collecting the data for this report. Additional thanks goes to the PSMFC staff at the Central Valley Steelhead Monitoring Project and Yuba River Monitoring Program for lending their assistance with data collection and field work support. The CDFW La Grange office staff, Tim Heyne, Domenic Giudice, and Steve Tsao also deserve special thanks for their collaborative effort. Furthermore, gratitude goes to Lea Koerber and the scientific aides in the CDFW's Tissue Archive Lab for their assistance in processing our fin-clip samples for further genetic analyses. The project thanks the staff at the Abernathy Fish Technology Center, such as Christian Smith and Jennifer Von Bargen for their assistance with genetic analyses of our Chinook salmon fin-clips. Additional gratitude goes to Mary Serr and staff at the Merced River Hatchery for setting aside 4,000 fall-run Chinook salmon for use in trap efficiency trials. The project also thanks Leslie Alber from CDFW for assisting with the issuance of our scientific collecting permit. Finally, thanks goes to Oakdale Wastewater Treatment Plant for providing space to store our RST equipment and Brocchini Farms and staff for providing continued access to the levee road adjacent to the RST location.

## References


California Department of Water Resources (DWR). 2017. Water Year 2017: What a Difference a Year Makes.

Cramer Fish Sciences (Cramer). 2006. Stanislaus River Data Report.

Cramer Fish Sciences (Cramer). 2012. Lancaster Road Flood Plain and Side-Channel Restoration Project. Web. July 2017. http://www.fishsciences.net/projects/lancaster/index.php

Cramer Fish Sciences (Cramer). 2012. Juvenile Salmonid Out-migration Monitoring at Caswell Memorial State Park in the Lower Stanislaus River, California. 2012 Annual Report. Prepared for the U.S. Fish and Wildlife Service Comprehensive Assessment and Monitoring Program. Grant No. 813326G008. 32 pp Central Valley Project Improvement Act (CVPIA). 1992. Public Law 102-575, Title 34.

KDH Environmental Services (KDH). 2008. Lover's Leap Restoration Project: Salmon Habitat Restoration in the Lower Stanislaus River.

Lindley et al. 2006. Historical Population Structure of Central Valley Steelhead and its Alteration by Dams. San Francisco Estuary and Watershed Science. Vol 4, Iss.1 [February 2006], Art. 3

Moyle, P. B., J. A. Israel, S. E. Purdy. 2008. Salmon, Steelhead, and Trout in California: Status of an Emblematic Fauna. Commissioned by California Trout. Web. Nov 2017. https://watershed.ucdavis.edu/pdf/SOS-Californias-Native-Fish-Crisis-Final-Report.pdf

National Marine Fisheries Service (NMFS). 2009. Biological Opinion and Conference Opinion on the Long-Term Operations of the Central Valley Project and State Water Project. NMFS, Southwest Region. 844 pp

National Marine Fisheries Service (NMFS). 2014. Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-run Chinook Salmon and Central Valley Spring-run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead. California Central Valley Area Office. July 2014.

National Marine Fisheries Service (NMFS). 2016. 2016 5-Year Review: Summary and Evaluation of California Coastal Chinook Salmon and Northern California Steelhead. NMFS, West Coast Region. April 2016. 54 pp.

National Oceanic and Atmospheric Administration (NOAA). 2014. Administrative Record (AR) for the designation of a Nonessential Population of Central Valley Spring-run Chinook Salmon Below Friant Dam in the San Joaquin River, California and the AR for the Biological

Opinion on the Long-term Operation of the Central Valley Project and State Water Project (CVP/SWP Opinion)

Nature Conservancy. 2017. California Salmon Snapshots: Stanislaus River. Web. July 2017 http://www.casalmon.org/salmon-snapshots/restoration/stanislaus-river

Stanislaus Operations Group (SOG). 2016. Annual Report of Activities, Water Year 2016. 29 pp plus appendices.

U.S. Bureau of Reclamation (USBR). 2017. Daily Central Valley Project Water Supply Report.

U.S. Bureau of Reclamation (USBR). 2017. New Melones Unit Project. Web. July 2017. https://www.usbr.gov/projects/index.php?id=365

U.S. Bureau of Reclamation (USBR). 2016. Central Valley Project Improvement Act Title 34 of Public Law 102-575 2017 Annual work Plan.

Yoshiyama, R.M, E. R. Gerstung, F. W. Fisher, and P. B. Moyle. 2000. Chinook Salmon in the California Central Valley: an Assessment. Fisheries Management. Vol. 25, No.2

Yoshiyama, R.M, E. R. Gerstung, F. W. Fisher, and P. B. Moyle. 2001. Historical and Present Distribution of Chinook Salmon in the Central Valley Drainage of California. Contributions to the Biology of Central Valley Salmonids, Fish Bulletin 179:1.

**Appendix 1:** Points of interest on the Stanislaus River.

| Point of Interest | Significance | Operator | River Mile (rkm) |
|---|---|---|---|
| New Melones Dam | Constructed 1978; Flood control, power generation, water supply, recreation. | U.S. Bureau of Reclamation | 60 (96.6) |
| Tulloch Dam | Constructed 1957; Flood control, power generation, water supply, recreation. | Tri-Dam Project | 55 (88.5) |
| Goodwin Dam | Constructed 1913; Flood control, water supply. | U.S. Bureau of Reclamation | 58.4 (94) |
| Lover's Leap | Habitat improvement; Gravel augmentation | | 53.4-51.8 (85.9-83.4) |
| Lancaster Road | Habitat improvement; side channel restoration project | | ~41 (65.9) |
| Oakdale | RST site for monitoring juvenile salmonid abundance and outmigration | FishBio Consulting | 40.1(64.5) |
| Stanislaus River at Ripon (Hwy 99 Bridge) | River discharge and temperature monitoring station | U.S. Geological Survey | 15.8 (25.4) |
| Upper Irrigation Pump at Caswell | Release site for trap efficiency mark-recapture trials | | 8.9 (14.3) |
| Caswell Memorial State Park | RST site for monitoring juvenile salmonid abundance and outmigration | | 8.6 (13.8) |
| Mouth of Stanislaus River | Stanislaus-San Joaquin Confluence | | 0 |

**Appendix 2:** Weekly environmental conditions during the 2017 Stanislaus River rotary screw trap survey season.

| Julian | Water Temperature °C | | | Discharge (CFS) | | | Turbidity (NTU) | | | DO (mg/L) | | | Velocity (m/s) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Week | Average | Min | Max | Average | Min | Max | Average | Min | Max | Average | Min | Max | Average | Min | Max |
| 1/29 - 2/4 | 11.6 | 9.7 | 13.4 | 293 | 274 | 347 | 5.2 | 4.5 | 5.7 | 7.2 | 7.2 | 7.2 | | | |
| 2/5 - 2/11 | 12.4 | 11.7 | 13.1 | 1,381 | 263 | 2,870 | 12.7 | 4.2 | 19.8 | 8.4 | 7.8 | 9.5 | | | |
| 2/12 - 2/18 | 12.4 | 11.0 | 14.1 | 852 | 388 | 2,540 | 6.8 | 3.9 | 12.0 | 8.6 | 8.1 | 9.7 | 0.2 | 0.1 | 0.4 |
| 2/19 - 2/25 | 11.8 | 10.6 | 13.0 | 1,434 | 860 | 2,280 | 20.3 | 8.7 | 44.9 | 9.1 | 8.0 | 9.8 | 0.4 | 0.2 | 0.8 |
| 2/26 - 3/4 | 12.4 | 11.0 | 14.1 | 649 | 532 | 1,010 | 11.5 | 5.9 | 16.7 | 8.9 | 8.4 | 9.3 | 0.3 | 0.2 | 0.4 |
| 3/5 - 3/11 | 13.7 | 11.6 | 16.0 | 517 | 466 | 551 | 12.8 | 10.0 | 15.1 | 8.8 | 8.4 | 9.5 | 0.3 | 0.2 | 0.3 |
| 3/12 - 3/18 | 14.7 | 13.6 | 15.7 | 1,163 | 512 | 1,250 | 8.7 | 4.8 | 12.8 | 8.9 | 7.1 | 9.6 | 0.5 | 0.3 | 0.7 |
| 3/19 - 3/25 | 12.8 | 11.3 | 14.1 | 1,339 | 1,130 | 1,530 | 7.9 | 5.4 | 11.5 | 9.2 | 8.5 | 9.9 | 0.6 | 0.5 | 0.8 |
| 3/26 - 4/1 | 12.3 | 11.4 | 13.3 | 1,433 | 1,380 | 1,450 | 6.7 | 5.1 | 8.3 | 9.9 | 9.6 | 10.1 | 0.6 | 0.4 | 0.7 |
| 4/2 - 4/8 | 12.2 | 10.7 | 13.6 | 1,595 | 1,340 | 1,970 | 5.8 | 4.4 | 6.9 | 9.8 | 9.4 | 10.0 | 0.7 | 0.5 | 0.9 |
| 4/9 - 4/15 | 11.1 | 10.4 | 11.8 | 2,091 | 1,940 | 2,360 | 6.6 | 5.8 | 7.5 | 10.4 | 10.0 | 10.6 | 0.5 | 0.3 | 0.7 |
| 4/16 - 4/22 | 11.0 | 10.0 | 12.0 | 2,513 | 2,320 | 2,790 | 6.0 | 5.4 | 6.5 | 9.9 | 8.6 | 10.4 | 0.6 | 0.2 | 0.9 |
| 4/23 - 4/29 | 11.6 | 10.8 | 12.5 | 3,262 | 2,790 | 4,020 | 5.1 | 4.4 | 5.9 | 9.9 | 9.4 | 10.2 | 0.6 | 0.3 | 0.8 |
| 4/30 - 5/6 | 12.0 | 11.1 | 12.9 | 4,141 | 4,020 | 4,420 | 4.4 | 3.4 | 5.2 | 8.9 | 8.2 | 9.9 | 0.8 | 0.4 | 1.2 |
| 5/7 - 5/13 | 11.3 | 10.6 | 12.2 | 4,760 | 4,420 | 5,260 | 4.7 | 3.1 | 6.4 | 9.2 | 8.2 | 9.9 | 0.9 | 0.6 | 1.2 |
| 5/14 - 5/20 | 10.9 | 10.0 | 12.0 | 5,347 | 5,250 | 5,410 | 4.6 | 3.4 | 5.2 | 9.7 | 8.3 | 10.3 | 0.8 | 0.5 | 1.0 |
| 5/21 - 5/27 | 11.6 | 10.5 | 12.5 | 5,337 | 5,230 | 5,440 | 4.1 | 2.6 | 5.5 | 9.7 | 9.6 | 10.0 | 0.8 | 0.6 | 0.9 |
| 5/28 - 6/3 | 11.7 | 10.8 | 12.6 | 4,933 | 4,600 | 5,250 | 3.1 | 2.5 | 3.8 | 9.7 | 8.8 | 10.0 | 0.8 | 0.6 | 1.0 |
| 6/4 - 6/10 | 11.7 | 10.8 | 12.7 | 4,296 | 3,670 | 4,620 | 3.3 | 2.3 | 4.0 | 9.9 | 9.8 | 10.1 | 0.7 | 0.5 | 0.9 |
| 6/11 - 6/17 | 12.0 | 10.6 | 13.6 | 3,377 | 2,810 | 3,670 | 3.6 | 2.8 | 4.4 | 10.0 | 8.5 | 10.9 | 0.8 | 0.6 | 0.9 |
| 6/18 - 6/24 | 13.3 | 12.7 | 14.0 | 2,633 | 2,380 | 2,820 | 3.9 | 3.5 | 4.6 | 9.7 | 9.1 | 10.0 | 0.7 | 0.5 | 0.8 |

Note: The USGS website provides the discharge and temperature data by day in 15 minute intervals. To calculate the averages by week, the 15 minute intervals were first averaged by day, and then the days were averaged by the seven day Julian week indicated by the “Week” column in the table above. The min and max values for the discharge and temperature data are the highest and lowest values recorded for the week. Dissolved oxygen was calculated by weekly averages from daily values gathered by crew members in the field. Dissolved oxygen min and max values are reflective of the minimum and maximum daily value gathered during the Julian week defined by the “Julian Week” column in the table above. Turbidity and velocity reflect a weekly average of values, gathered per trap by crew members in the field and averaged into a single daily value. Turbidity and velocity min and max values are reflective of the minimum and maximum daily value gathered for each trap during the Julian week defined by the “Julian Week” column in the table above.

**Appendix 3:** List of fish species caught during the 2017 Stanislaus River rotary screw trap survey season.

| Common Name | Family Name | Species Name | Total Number Caught |
|---|---|---|---|
| Chinook salmon | Salmonidae | *Oncorhynchus tshawytscha* | 8,246 |
| Black Crappie | Centrarchidae | *Pomoxis nigromaculatus* | 5 |
| Bluegill | Centrarchidae | *Lepomis macrochirus* | 15 |
| Brown Bullhead | Ictaluridae | *Ameiurus nebulosus* | 9 |
| Channel catfish | Ictaluridae | *Ictalurus punctatus* | 11 |
| Golden shiner | Cyprinidae | *Notemigonus crysoleucas* | 7 |
| Goldfish | Cyprinidae | *Carassius auratus* | 82 |
| Green sunfish | Centrarchidae | *Lepomis cyanellus* | 3 |
| Hardhead | Cyprinidae | *Mylopharodon conocephalus* | 40 |
| Inland silverside | Atherinopsidae | *Menidia beryllina* | 2 |
| Largemouth bass | Centrarchidae | *Micropterus salmoides* | 3 |
| Pacific lamprey | Petromyzontidae | *Entosphenus tridentatus* | 5 |
| Redear sunfish | Centrarchidae | *Lepomis microlophus* | 3 |
| Sacramento pikeminnow | Cyprinidae | *Ptychocheilus granelis* | 58 |
| Sacramento sucker | Catostomidae | *Catostomus occidentalis* | 18 |
| Smallmouth bass | Centrarchidae | *Micropterus dolomieu* | 5 |
| Spotted bass | Centrarchidae | *Micropterus punctulatus* | 16 |
| Threadfin shad | Clupidae | *Dorosoma petenense* | 2 |
| Tule perch | Embiotocidae | *Hysterocarpus traskii* | 1 |
| Western mosquitofish | Poeciliidae | *Gambusia affinis* | 168 |
| White catfish | Ictaluridae | *Ameiurus catus* | 3 |
| Unidentified catfish or bullhead | Ictaluridae | | 9 |
| Unidentified Minnows | Cyprinidae | | 3 |
| Unidentified Sculpins | Cottidae | | 4 |
| Unidentified Sunfish | Centrarchidae | | 1 |
| Unidentified | | | 1 |
| | | **Total Cumulative** | **8,720** |

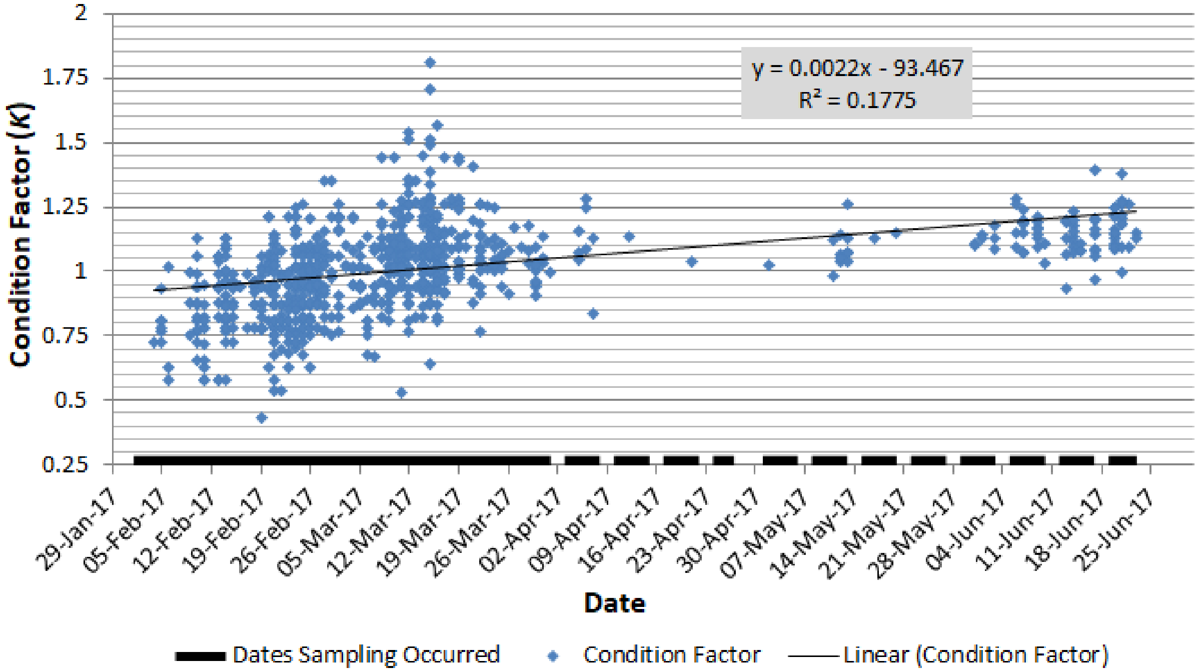
**Appendix 4:** Genetic results for fin-clip samples from Chinook salmon caught during the 2017 Stanislaus River rotary screw trap survey season.

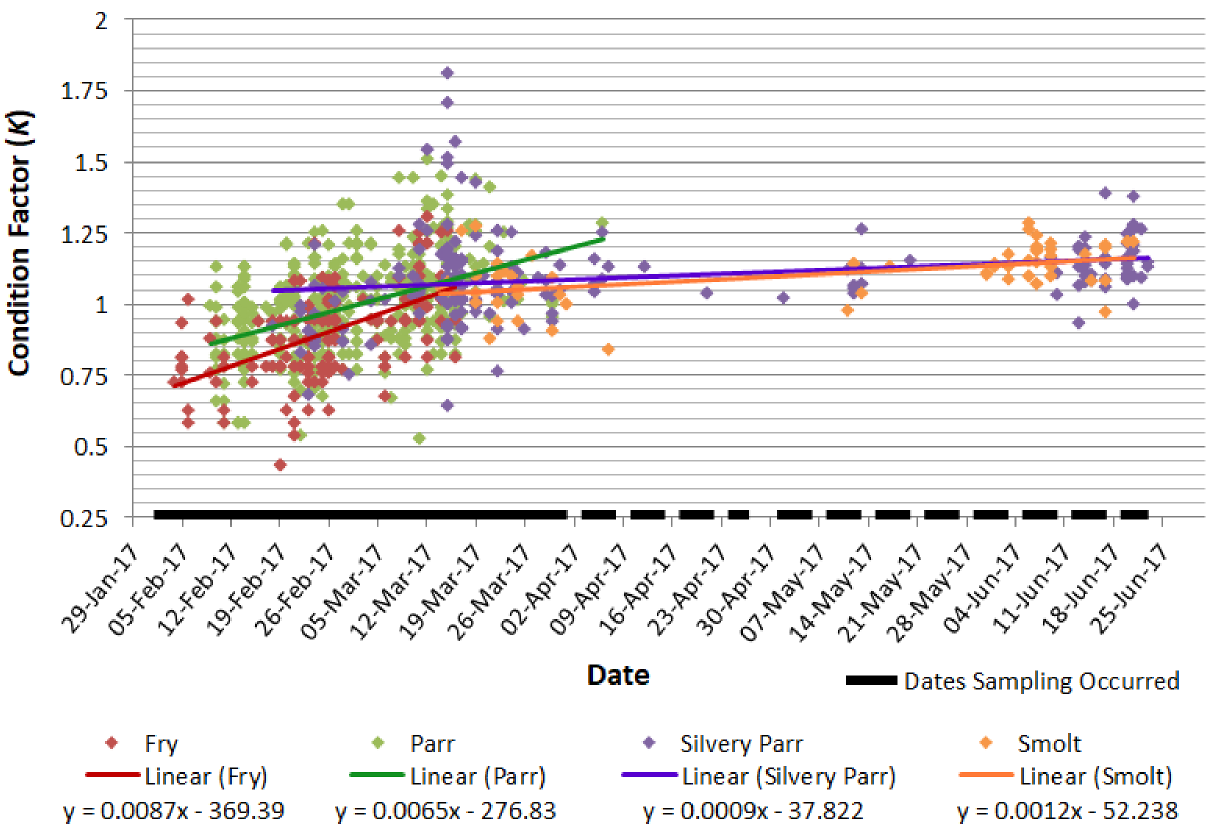
Sample #: refer to a unique number assigned by field staff, and that allowed the tracking of individual fish samples.
At Capture run assignment: Chinook salmon run assignment based on the historically held assumption that the Stanislaus River only supports fall-run Chinook salmon.
SNP Run Assignment: Chinook salmon run assignment using "Genetic Call to three lineages" single-nucleotide polymorphism (SNP) markers.
SNP Probability: Probability of the correct SNP Chinook salmon run assignment.
Final run assignment: run assignment using a 50 percent threshold based on the SNP probability.
FL: fork length in millimeters.
W: weight in grams.

| Date | Sample # | At Capture Run Assignment | SNP Run Assignment | SNP Probability | Final Run Assignment | FL (mm) | W (g) |
|---|---|---|---|---|---|---|---|
| 24-Feb | 3282-001 | Fall | Fall | 100.00% | Fall | 62 | 2.4 |
| 25-Feb | 3282-002 | Fall | Fall | 99.98% | Fall | 61 | 2 |
| 27-Feb | 3282-003 | Fall | Fall | 100.00% | Fall | 65 | 2.9 |
| 28-Feb | 3282-004 | Fall | Fall | 100.00% | Fall | 69 | 3.7 |
| 28-Feb | 3282-005 | Fall | Fall | 100.00% | Fall | 72 | 4.1 |
| 4-Mar | 3282-006 | Fall | Fall | 100.00% | Fall | 64 | 2.6 |
| 6-Mar | 3282-007 | Fall | Fall | 100.00% | Fall | 62 | 2.4 |
| 8-Mar | 3282-010 | Fall | Fall | 100.00% | Fall | 63 | 2.6 |
| 8-Mar | 3282-011 | Fall | Fall | 100.00% | Fall | 67 | 2.6 |
| 9-Mar | 3282-012 | Fall | Fall | 100.00% | Fall | 41 | 0.7 |
| 9-Mar | 3282-017 | Fall | Fall | 100.00% | Fall | 55 | 1.7 |
| 9-Mar | 3282-019 | Fall | Fall | 99.98% | Fall | 67 | 3.3 |
| 10-Mar | 3282-020 | Fall | Fall | 100.00% | Fall | 76 | 4.6 |
| 11-Mar | 3282-022 | Fall | Fall | 100.00% | Fall | 71 | - |
| 12-Mar | 3282-021 | Fall | Fall | 100.00% | Fall | 78 | 5 |
| 12-Mar | 3282-024 | Fall | Fall | 100.00% | Fall | 71 | 3.8 |
| 14-Mar | 3282-031 | Fall | Fall | 100.00% | Fall | 79 | 5.3 |
| 14-Mar | 3282-033 | Fall | Fall | 99.93% | Fall | 72 | 4.1 |
| 15-Mar | 3282-025 | Fall | Fall | 100.00% | Fall | 75 | 4.3 |
| 15-Mar | 3282-029 | Fall | Fall | 100.00% | Fall | 73 | 4.5 |
| 16-Mar | 3282-032 | Fall | Fall | 100.00% | Fall | 77 | 5 |
| 16-Mar | 3282-047 | Fall | Fall | 100.00% | Fall | 78 | 5.5 |
| 16-Mar | 3282-049 | Fall | Fall | 99.96% | Fall | 77 | 5.8 |
| 16-Mar | 3282-051 | Fall | Fall | 100.00% | Fall | 74 | 4.2 |
| 17-Mar | 3282-061 | Fall | Fall | 100.00% | Fall | 69 | 3.6 |
| 19-Mar | 3282-057 | Fall | Fall | 100.00% | Fall | 80 | 4.5 |
| 19-Mar | 3282-060 | Fall | Fall | 100.00% | Fall | 82 | 5.8 |

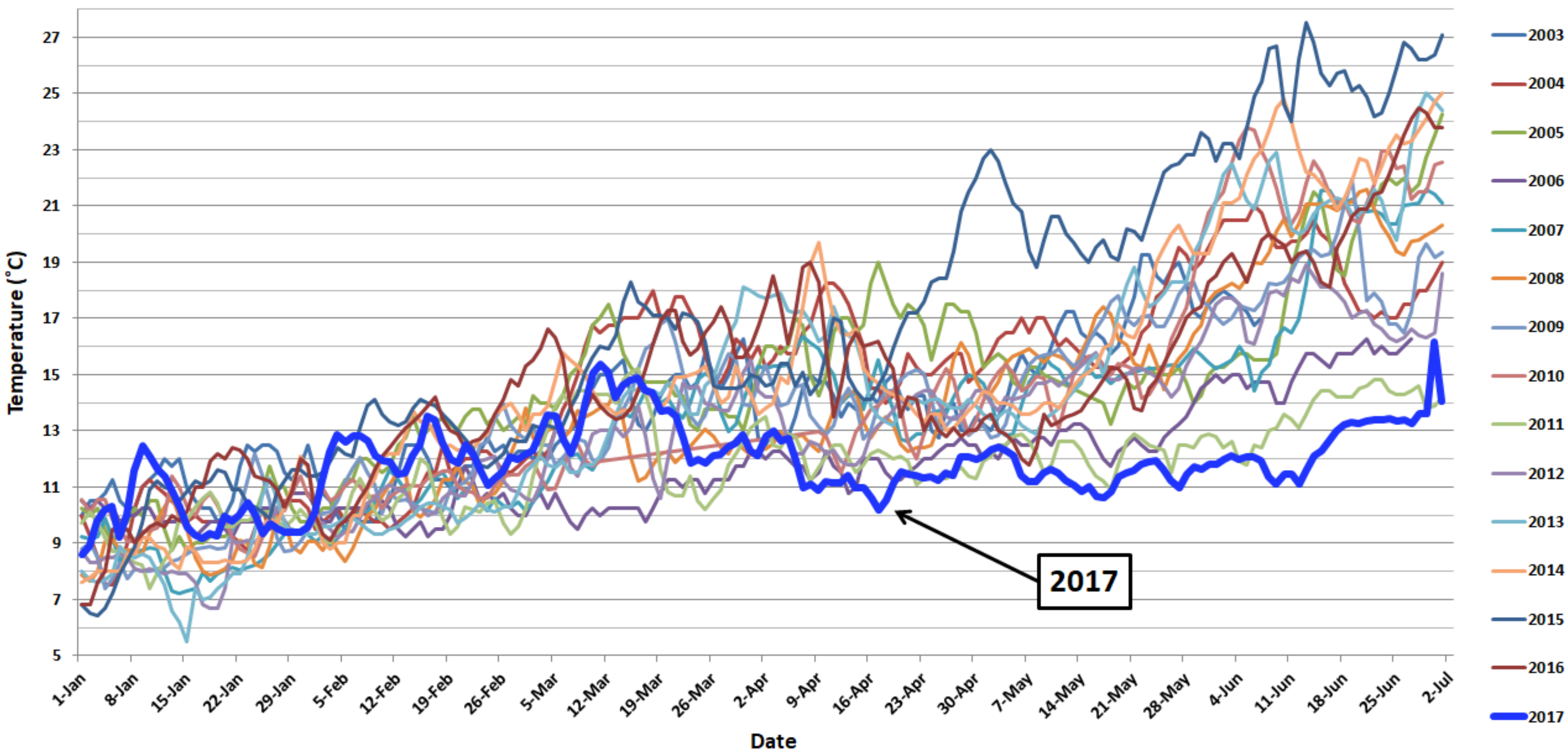
| Date | Sample # | At Capture Run Assignment | SNP Run Assignment | SNP Probability | Final Run Assignment | FL (mm) | W (g) |
|---|---|---|---|---|---|---|---|
| 20-Mar | 3282-062 | Fall | Fall | 100.00% | Fall | 76 | 5 |
| 21-Mar | 3282-064 | Fall | Fall | 100.00% | Fall | 61 | 2.3 |
| 22-Mar | 3283-007 | Fall | Fall | 99.99% | Fall | 71 | 4.5 |
| 22-Mar | 3283-009 | Fall | Fall | 100.00% | Fall | 74 | 5.1 |
| 25-Mar | 3283-012 | Fall | Fall | 99.99% | Fall | 75 | 4.6 |
| 27-Mar | 3283-015 | Fall | Fall | 100.00% | Fall | 82 | 5.7 |
| 29-Mar | 3283-021 | Fall | Fall | 100.00% | Fall | 76 | 4.7 |
| 30-Mar | 3283-020 | Fall | Fall | 100.00% | Fall | 85 | 6.5 |
| 31-Mar | 3283-013 | Fall | Fall | 99.99% | Fall | 87 | 7.7 |
| 4-Apr | 3283-014 | Fall | Fall | 99.98% | Fall | 72 | 4.4 |
| 5-Apr | 3283-022 | Fall | Fall | 100.00% | Fall | 80 | - |
| 5-Apr | 3283-023 | Fall | Fall | 100.00% | Fall | 75 | 4.4 |
| 11-May | 3283-048 | Fall | Fall | 100.00% | Fall | 99 | 9.5 |
| 13-May | 3283-049 | Fall | Fall | 100.00% | Fall | 101 | 10.7 |

**Appendix 5:** Fulton's condition factor (*K*), overall, and by life-stage, of fall-run Chinook salmon during the 2017 survey season.



**Appendix 6:** Daily average water temperature (°C) in the Stanislaus River at Ripon during the typical survey season months for the 15-year period between 2003 – 2017. Data from USGS station number 11303000.



**Appendix 7:** Daily average discharge (CFS) on the Stanislaus River at Ripon during the typical survey season months for the 15-year period between 2003 – 2017. Data from USGS station number 11303000.