Emigration of Juvenile Chinook Salmon (*Oncorhynchus tschawytscha*) and Steelhead (*Oncorhynchus mykiss*) in the Lower Mokelumne River, December 2014 – June 2015

December 2015

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Key Words: Chinook salmon, emigration, juvenile monitoring, lower Mokelumne River, steelhead

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SUMMARY

The emigration of juvenile Chinook salmon (*Oncorhynchus tschawytscha*) and steelhead (*Oncorhynchus mykiss*) on the lower Mokelumne River was monitored using two rotary screw traps (RST) and a bypass trap during the 2014/15 season. The upstream rotary screw trap (VINO) was positioned just upstream of the Elliot Road bridge at river kilometer (rkm) 87.4 and was operated from 8 December 2014 to 8 June 2015. The downstream rotary screw trap (GOLF) was located just below the Lower Sacramento Road Bridge at rkm 61.8 and was operated from 6 January to 24 April 2015. The smolt bypass trap (BYPASS), located at Woodbridge Irrigation District Dam (rkm 62.2), was operated from 1 April to 19 June 2015.

The first juvenile Chinook salmon was captured at the VINO RST on 10 December 2014. Including weekend estimates, catch of naturally produced young-of-the-year (YOY) Chinook salmon was 42,154 during the monitoring period. Seven trap efficiency tests were conducted at VINO, four tests using naturally produced salmon and three tests using hatchery produced salmon. The annual estimated abundance of naturally produced YOY Chinook salmon at the VINO RST was 431,677 (95% CI: 338,021-769,057). Including weekend estimates, catch of wild YOY steelhead was 283 at the VINO RST during the 2014/15 season. The estimated passage of wild YOY steelhead (based on trap calibrations using Chinook salmon) was 5,070 (95% CI: 3,481-18,037).

The first juvenile Chinook salmon was captured at the downstream RST (GOLF) on 23 January 2015. Including weekend estimates, catch of naturally produced YOY Chinook salmon was 1,355 during the monitoring period. Four trap efficiency tests were conducted at GOLF, one test using naturally produced salmon and three tests using hatchery produced salmon. The annual estimated abundance of naturally produced YOY Chinook salmon at the GOLF RST was 17,761 (95% CI: 13,575-30,524). Zero wild YOY steelhead were captured at the GOLF RST during the 2014/15 season.

The first juvenile Chinook salmon was captured at the bypass smolt trap (BYPASS) on 2 April 2015. Including weekend estimates, catch of naturally produced YOY Chinook salmon was 43,545 at the BYPASS during the monitoring period. The total downstream

salmon emigration estimate, calculated from adding the BYPASS trap catch to the GOLF RST abundance estimate, was 61,305 (95% CI: 57,120-74,069).

Including weekend estimates, catch of wild YOY was nine at the BYPASS during the 2014/15 season. The total downstream passage estimate of wild YOY steelhead, calculated from adding the BYPASS trap catch to the GOLF RST estimate, was 9. No confidence interval was calculated because the estimate consisted of only fish caught at the BYPASS. Although age 1+ steelhead are captured during trapping, abundance estimates only calculate for YOY steelhead. Catch of other steelhead life stages are summarized below. At the downstream traps (GOLF and BYPASS), 37 wild steelhead were captured and classified as age 1+ silvery parr, smolts, and adults. Steelhead catch at the downstream traps also consisted of 58 hatchery origin (adipose fin-clipped) age 1+ silvery parr, smolts, and adults.

Nineteen fish species were caught at the VINO RST during the survey period, eight native and eleven non-native species. Native fish species were more frequently caught than non-native species and Chinook salmon was the most abundant species caught. At the downstream traps (GOLF and BYPASS) twenty-four fish species were caught, eight native and sixteen non-native species. Non-native fish species were more frequently caught than native species and unidentified black bass was the most abundant fish caught.

Average daily water releases from Camanche Reservoir ranged from 201 cfs (5.7 m^3/s) to 1,201 cfs (34.0 m^3/s) during the monitoring period. From 1 October 2014 through 31 March 2015 EBMUD operated under a “Dry” JSA water year type. From 1 April through 30 September 2015 EBMUD operated under a “Critically Dry” JSA water year type.

INTRODUCTION

East Bay Municipal Utility District (EBMUD) has been monitoring juvenile salmonid emigration on the lower Mokelumne River (LMR) since 1990 (Bianchi et al. 1992, Marine 2000, Workman et al. 2007). Nearly all salmonid spawning occurs in a 16-rkm reach of the LMR below Camanche Dam (Setka 2004). Fish traps are operated with the objectives of estimating the abundance and monitoring the emigration patterns of anadromous fish species in the LMR. This report presents the monitoring results for rotary screw trap and bypass trap operations from December 2014 through June 2015.

METHODS

Environmental Data

Water quality measurements were collected daily at each location when trap checks took place. Turbidity samples were collected by submerging a sample jar to a depth of 0.3 m and allowing it to fill with water. Turbidity samples were processed in the lab using a Hach ®P1000 turbidimeter. Water temperature and dissolved oxygen data were collected using a YSI 550A handheld dissolved oxygen meter. Flow and additional water temperature measurements were provided by EBMUD’s Camanche Dam (rkm 103), Elliot Road (rkm 86.1), Victor (rkm 80.7), Golf (rkm 61.3), and Frandy (rkm 46.4) gauging stations (Figure 1).

Rotary screw traps

Two 8-ft and one 5-ft (cone diameter) rotary screw traps (E.G. Solutions, Inc.) were operated at upstream and downstream locations on the lower Mokelumne River (Figure 1). One 8-ft rotary screw trap (RST) was operated at the upstream location near the Elliott Road Bridge, adjacent to property owned by Vino Farms, at rkm 87.4. At the downstream location, one 8-ft RST was intermittently operated, just below Woodbridge Irrigation District Dam (WIDD) and adjacent to the Lodi Golf and Country Club at rkm 61.8. During low flow periods (~75-120 cfs), the 8-ft RST was taken out of service and a 5-ft RST was operated at the downstream site. In this report, the upstream and downstream RST sites are referred to as VINO and GOLF, respectively.

During the 2014/15 monitoring season, RSTs were generally operated Monday through Friday, between December and late April. During Monday through Friday operations, traps were taken out of service after each check on Friday afternoon and reset each Monday morning. A'critically dry' water year type designation began on 1 April 2015, and the minimum flow requirement below Woodbridge Dam was 15 cfs beginning on 1 May 2015, which is insufficient to operate an RST. The GOLF trap was therefore removed from the river on 27 April 2015. The VINO and BYPASS traps were operated 7 days per week during the smolt emigration period from late April through June.

Efforts were made to position RSTs in the thalweg of the river where water velocities were 0.6 m/s or greater (USFWS 2008). Water velocity was measured at the center of the trap cone, just below the water surface, at the beginning of each trap check. Rotations were measured using a stopwatch to record the time for three full rotations. RPMs were taken at each trap check. Efforts were made to maintain a rotational speed of two rotations per minute (RPM) or greater at both RSTs. Trap cables were adjusted to optimize rotations. Cone rotations since the previous trap check were read off of a Redington® mechanical counter mounted on side rails near the mouth of the cone. Pontoons, cones, live boxes and decks were cleaned daily to maintain traps in good working order. Cables, pulleys, counters and cones were inspected daily to ensure proper function.

Bypass Trap

A smolt bypass trap was operated in the bypass pipe at WIDD (rkm 62.2) during the 2014/15 trapping season (Figure 1). The bypass trap (referred to as BYPASS) conveys fish that are screened off of the Woodbridge Irrigation Canal when Woodbridge Irrigation District is diverting water from the LMR. A fish crowder and a long-handled dip net were used to capture fish. Debris was cleared from the trap during each check.

Calibrations

Multiple trap efficiency tests were conducted at each RST throughout the emigration period to provide an estimate of the proportion of juvenile Chinook salmon each RST was capturing. Naturally produced Chinook salmon were used for the trap efficiency trials when salmon catch was high enough to produce a group of test fish. Additional test salmon were provided by California Department of Fish and Wildlife at the Mokelumne River Fish Installation (MRFI). Bismark® brown dye and/or upper caudal fin clips were used to mark groups of test fish for the VINO trap. A lower caudal fin clip and/or Bismark® brown dye were used to mark groups of test fish for the GOLF trap. The use of different marks provided the means to distinguish test fish between the two traps. The Bismark® brown dye was applied by holding test fish in an aerated tank of dye solution for approximately 60 minutes. Mark retention and mortality rates were determined before releasing test fish. Calibration fish for GOLF were released below the face of Woodbridge Dam, approximately 0.1 rkm upstream of the trap location. Test fish for VINO were released approximately 0.25 rkm upstream of the trap location. The test fish were distributed proportionally to the flow across the river at each location.

Rotary Screw Trap Abundance Estimates

Daily catch estimates were generated for non-trapping days by taking an average of daily catch for three days preceding and following these periods (Appendix A). Trap efficiencies were applied to daily catch estimates and daily catch numbers to produce daily abundance estimates. Daily RST abundance estimates were generated for juvenile Chinook salmon and steelhead using the Petersen equation (Volkhardt et al. 2007):

$$\hat{A}_i = n_i \times \hat{e}_i^{\,-1}$$

where,

$$\hat{e}_i = \frac{m_i}{M_i}$$

$\hat{A}_i$ = Estimated daily abundance during period *i*
M_i = Number of fish marked and released during period *i*
n_i = Number of fish captured during period *i*
m_i = Number of marked fish captured during period *i*
$\hat{e}_i$ = Estimated trap efficiency during period *i*

Confidence intervals (95%) for daily abundance estimates were calculated as follows:

$$95\%\ LCI_i = n_i /\ \hat{e}_i + 1.96 \times \sqrt{\hat{e}_i} \times \frac{(1-\hat{e}_i)}{m_i}$$

and

$$95\%\ UCI_i = n_i /\ \hat{e}_i - 1.96 \times \sqrt{\hat{e}_i} \times \frac{(1-\hat{e}_i)}{m_i}$$

95% LCI_i = 95% Lower confidence interval during period *i*
95% UCI_i = 95% Upper confidence interval during period *i*

Annual abundance estimates were calculated by summing the daily abundance estimates. Confidence intervals for annual abundance estimates were calculated by summing the daily 95% confidence intervals.

BYPASS Trap Abundance Estimates

Daily catch estimates at the BYPASS trap were generated for non-trapping days by taking an average of daily catch to the nearest fish, for three days preceding and following these periods. Daily catch at the BYPASS was added to the daily abundance estimate at the GOLF trap to produce a daily downstream abundance estimate.

Fish Handling and Condition Factors

Captured fish were processed in the field, adjacent to the trapping site, or in a tagging trailer near the trap. The trailer was equipped with a flow-through water supply and re-circulating anesthetic bath to allow for safe processing of larger numbers of fish. The trailer was used at VINO during the beginning of the season and later transferred to Woodbridge Dam when smolt-sized salmon were caught at the GOLF and BYPASS traps. A 20-45 mg/L solution of eugenol (AQUI-S®20E is 10% eugenol) was used to anesthetize salmonids and lampreys, when needed. All sedation records were submitted to the USFWS Aquatic Animal Drug Approval Partnership (AADAP) Program as part of an ongoing study to establish the effectiveness and safety of AQUI-S® 20E as an anesthetic/sedative for various fish species under a variety of environmental conditions. The AADAP suggested guidelines for preparing and using AQUI-S®20E as a sedative were followed. Pumps and mechanical aerators were used to maintain suitable dissolved oxygen concentrations in all fish holding receptacles during processing.

During each trap check, up to 50 Chinook salmon and up to 20 fish of other species from each trap were weighed and measured. Fish were weighed to the nearest 0.1 gram using an Ohaus® Scout portable scale. Fork lengths (FL) and total lengths (TL) of each fish were measured to the nearest millimeter (mm). Life stage and any observations of marks, injuries or anomalies were also recorded. Processed fish were allowed to recover before being transported to the release site by truck or boat. The fish were transported in 19 liter (5 gallon) buckets equipped with battery operated aerators and released approximately 0.4 rkm (0.25 miles) downstream of the capture sites. When the GOLF and BYPASS traps were both in service, all salmonids caught at the BYPASS trap were transported and released approximately 0.4 rkm downstream of the GOLF trap to avoid counting them twice.

Fulton’s Condition Factor (Bagenal and Tesh 1978) was calculated for up to 50 Chinook salmon caught each trapping day:

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

K = Fulton’s Condition Factor,
W = weight in grams,
FL = fork length in mm.

Trapping and Trucking

The Lower Mokelumne River Joint Settlement Agreement (1998) recommends that emigrating Chinook salmon smolts be trapped at Woodbridge Dam and transported to the Delta during dry and critically dry water years, when agreed upon by the California Department of Fish and Wildlife (CDFW), the United States Fish and Wildlife Service (USFWS), and EBMUD. The purpose of the trapping and trucking operation is to reduce mortalities of emigrating juvenile salmon due to elevated water temperatures in the lower Mokelumne River downstream of Woodbridge Dam. The CDFW, USFWS, and EBMUD agreed to the criteria listed below to initiate trapping and trucking during the 2015 season: water temperature at the Frandy gage (rkm 46) must exceed 24°C or a 7-day moving average of 20°C in April, May, June or July, trapping and trucking activities would be suspended if the 5-day average Chinook salmon count falls below 50 per day, and juvenile salmon would be trapped at Woodbridge Dam and transported to a release site with similar water temperatures.

Two transport tanks (567 and 1,135 liter) equipped with mechanical aerators were used to haul the salmon from the BYPASS trap to the MRFI or the release site at Wimpy's Marina (rkm 30). Tanks were filled with water from the BYPASS trap using a submersible pump. Water was treated with Novaqua®, ice, and salt to minimize stress to fish. A recommended concentration of salt (0.1 to 0.3% salt solution) was used for fish transport (Piper et al 1992). Water temperatures and dissolved oxygen levels were recorded before transport, immediately after arrival at the release or holding site, and just before the salmon were released. Mechanical aerators and oxygen were used to maintain dissolved oxygen levels at 7.00 mg/L or higher prior to and during transport. All salmon were acclimated to within 2°C of the release water in the transport tanks before their release.

Juvenile Chinook salmon transported to the MRFI were held in a 23 m^2 section of an isolated raceway for 1 to 7 days. The holding area was treated with six 23-kg bags of salt on a daily basis. Salmon mortality, condition, and water temperature were also recorded within the raceway holding area on a daily basis. No feed was directly provided to the salmon in the holding area. All live Chinook salmon in the raceway were coded-wire-tagged using the AutoFish System™, which can accommodate fish from 57 to 147 mm total length (Vander Haegen and Blankenship 2010). Any Chinook salmon that fell outside of the size range of the individual tagging lines set up for machine processing were sorted out and manually tagged. Coded-wire tagging took place once or twice per week, 1-2 days prior to the release of the tagged group. All salmon transported to the MRFI after the previous week's release group was tagged were held in a different isolated raceway. The length size range and total number of Chinook salmon successfully coded-wire-tagged for each tagging line was recorded. In addition, the total number of salmon hand processed and sacrificed for place checks was recorded. A 24-hour minimum holding period was be used to assess tagging mortality.

All live coded-wire-tagged Chinook salmon in each 7-day tagging group were transported and released in the San Joaquin River at Jersey Point (38° 2' 41.97" N, 121° 42' 48.72" W) during outgoing tide cycles. A DFW transport truck, containing two 2,721

L holding tanks, was filled with water from Camanche Reservoir, ice, and a recommended concentration of salt (0.1 to 0.3% salt solution). The truck was loaded with salmon using a submersible fish pump and hand nets. At Jersey Point, the fish were gravity-released through a planting tube and discharged into a net pen measuring 6.1 m long, 2.6 m wide, and 4.6 m deep. The net pen was allowed to drift horizontally down the deep channel along the right/north bank for a minimum of 1 hour. A jet craft equipped with tow ropes was used help steer the net pen down the channel. Time of release, temperature and dissolved oxygen of the receiving water, salmon mortality, and the condition of the fish during release were recorded. Additional flow measurements were acquired from the San Joaquin River at Jersey Point station maintained by the U.S. Geological Survey (California Department of Water Resources 2015).

Juvenile Chinook Salmon Survival

Chinook salmon egg to young-of-the-year survival indices were calculated at the upstream and downstream trapping locations based on the brood year (BY) 2014 redd count and BY 2014 average fecundity per female at the MRFI. The annual redd count was multiplied by the average fecundity per female to estimate the total production of young-of-the-year (YOY) salmon at 100% survival. Chinook salmon passage estimates at each trapping location were divided by the total production estimate (at 100% survival) to calculate the survival index. Survival indices for BY 2014 were compared with previous years. The minimum and maximum survival indices were expected to range between 0.0 and 1.0, respectively.

Migration response

Generalized linear models were constructed to examine the relationship between daily salmon abundance (expressed as percent of annual abundance) and daily average flow, change in daily average flow, water temperature, turbidity, photoperiod, and accumulated thermal units (ATU). A correlation matrix was built to determine if variables had a high level of collinearity with each other. Independent variables that correlated with one another at 0.70 or greater were not used together in the same models. The Minimum corrected Akaike Information Criterion (AICc) was used to select the best models. The top models at each trapping location were reported.

Spearman’s rho correlation was used to examine the relationships between weekly salmon abundance and weekly salmon redd emergence at the upstream and downstream trapping locations. A weekly redd emergence timeline was constructed based on weekly salmonid redd surveys and a water temperature egg model developed by Vogel (1993) from Piper et al. (1992). Seven extra days were added to the date of predicted emergence at the downstream traps to account for travel time from the spawning grounds to the downstream traps. No timing offset was used at the upstream trap because it is located just downstream of the majority of Chinook salmon spawning habitat (Setka 2004).

Data Analysis

Graphics were created and data were analyzed using ArcMAP™ 10.2 (ESRI Inc.), JMP® 9.0.0 (SAS Institute Inc.), Microsoft® Office Access 2007 and Excel 2007. Statistical tests were considered significant if the *P*-value was ≤ 0.05. Trap abundance estimates were reported with 95% confidence intervals (CI).

RESULTS

Mokelumne River Flow, Water Temperature, and Turbidity

Average daily flow at the Elliot Road gauging station (just downstream of the VINO trapping site) ranged from 169 cfs (4.8 m^3/s) to 1,067 cfs (30.2 m^3/s) during the time when the VINO trap was operated (8 December 2014 through 8 June 2015). The mean flow during that time was 238 cfs (6.7 m^3/s). Water temperatures recorded at VINO ranged from 9.1 to 17.4°C, with a mean of 13.0°C. Water turbidity at the VINO RST ranged from 1.7 to 12.6 Nephelometric Turbidity Units (NTU), with a mean of 3.2 NTU.

Average daily flow at the Golf gauging station ranged from 75 cfs (2.1 m^3/s) to 445 cfs (12.6 m^3/s) during the time when the GOLF RST was operated (6 January through 24 April 2015). The average daily flow during that time was 133 cfs (3.8 m^3/s). Water temperatures recorded at GOLF ranged from 8.3 to 19.3°C, with a mean of 13.5°C. Water turbidity at GOLF ranged from 1.8 to 10 NTU, with a mean of 3.7 NTU.

During the time that the BYPASS trap was operated (1 April through 19 June 2015) average daily flow at the Victor gauging station ranged from 165 cfs (4.7 m^3/s) to 1167 cfs (33.0 m^3/s), with a mean of 292 cfs (8.3 m^3/s). Flow at the Woodbridge Irrigation District Canal ranged from 49 cfs (1.4 m^3/s) to 119 cfs (3.4 m^3/s) and averaged 88 cfs (2.5 m^3/s). Water temperatures recorded at the BYPASS trap ranged from 13.9 to 21.9°C, with a mean of 19°C. Water turbidity at the BYPASS ranged from 1.8 to 5.5 NTU, with a mean of 3.1 NTU.

Figure 2 depicts average daily flow, water temperature and turbidity at locations between Camanche Dam and the GOLF gauging station in the lower Mokelumne River.

Trap Operations

The VINO RST was operated between 8 December 2014 and 8 June 2015. The cone was stopped by debris on 12 of 115 days when the trap was checked. Excluding days with trap stoppages, the minimum recorded cone rotation rate was 1.3 RPM and the maximum was 4.2 RPM. The mean rotation rate during the monitoring season was 2.7 RPM. The VINO trap met or exceeded a rotation speed of 2.0 RPMs on 96% of all operating days (excluding stoppage days). Water velocity entering the center of the trap cone ranged between 0.6 and 1.1 m/s, with a mean of 0.9 m/s.

The 8-ft RST at GOLF was operated from 6 January to 20 March 2015. Debris stopped the cone from rotating on 13 of 40 days when the trap was checked. Excluding trap stoppages, the minimum cone rotation rate was 1.1 RPM and the maximum rate was 3.8 RPM. Average rotational speed was 1.9 RPM. The 8-ft RST met or exceeded a rotation speed of 2.0 RPMs on 9% of all operating days (excluding stoppage days). Water velocity entering the center of the trap cone ranged between 0.1 and 1.0 m/s, with a mean of 0.64 m/s.

The 5-ft RST at GOLF was operated from 24 March to 24 April 2015. Debris stopped the cone from rotating on 5 of 18 days when the trap was checked. Excluding trap stoppages, the minimum cone rotation rate was 1.3 RPM and the maximum rate was 4.4 RPM. Average rotational speed was 2.2 RPM. The 5-ft RST met or exceeded a rotation speed of 2.0 RPMs on 54% of all operating days (excluding stoppage days). Water velocity entering the center of the trap cone ranged between 0.2 and 0.6 m/s, with a mean of 0.4 m/s.

The BYPASS trap at WIDD was operated between 1 April and 19 June 2015. During this time frame the trap was checked on 67 days. Water velocity at the top of the trap ranged between 0.4 and 1.1 m/s and averaged 0.8 m/s.

RST Calibrations

Seven calibration tests were conducted for the VINO RST during the 2014/15 juvenile monitoring season (Table 1). Naturally produced Chinook salmon were used as test fish for four tests and Chinook salmon from the MRFI were used for three tests. Trap efficiency tests 2 and 6 were not used to generate daily abundance estimates because the trap was stopped by debris shortly after the test fish were released. Excluding tests 2 and 6, trap efficiency ranged from 0.4% to 15.5% and averaged 8.2% (n = 5).

Four calibration tests were conducted for the GOLF RST during the 2014/15 juvenile monitoring season (Table 1). Naturally produced Chinook salmon were used as test fish for one test and Chinook salmon from the MRFI were used for three tests. Trap efficiency test 3 was not used to generate daily abundance estimates because the trap was stopped by debris shortly after the test fish were released. Excluding test 3, trap efficiency ranged from 1.2% to 10.6%, with a mean of 5.5% (n = 3).

Chinook Salmon

<u>Catch and Abundance Estimates</u>

At the VINO RST, 22,577 naturally produced young-of-the-year (YOY) Chinook salmon were captured between 9 December 2014 and 8 June 2015. Estimates for weekend catch were added to actual catch to produce an estimated count of 42,154 YOY Chinook salmon. Using trap efficiency data, the total estimated abundance of YOY salmon passing the upstream RST (VINO) was 431,677 (95% CI: 338,021-769,057). The highest monthly abundance estimate was recorded in February at the VINO RST (Table 2).

At the GOLF RST, 665 naturally produced YOY Chinook salmon were captured between 7 January and 27 April 2015. Estimates for weekend catch and trap stoppages were added to the actual catch to produce an estimated count of 1,355 YOY Chinook salmon. Using trap efficiency data, the estimated abundance of YOY Chinook salmon at the GOLF RST was 17,761 (95% CI: 13,575-30,524).

At the BYPASS trap, 39,129 naturally produced YOY Chinook salmon were captured between 2 April and 19 June 2015. Estimates for weekend catch were added to the actual catch to produce an estimated count of 43,545 YOY Chinook salmon.

The total downstream emigration estimate of 61,305 YOY Chinook salmon (95% CI: 57,120-74,069) was calculated by adding the BYPASS catch estimate to the GOLF RST abundance estimate. At the downstream traps (GOLF & BYPASS), the highest monthly abundance estimate was recorded during the month of May (Table 2).

Life stage, size and condition

At the VINO RST, 94.2% (n=14,453) of the naturally produced Chinook salmon catch was classified as fry. The remaining catch was classified as parr (0.6%, n=94), silvery parr (1.2%, n=181), and smolts (4.0%, n=612). The size distribution by life stage of naturally produced Chinook salmon caught and measured at the VINO RST during the 2014/15 season is provided by Figure 3.

At the downstream traps, naturally produced Chinook salmon catch was primarily composed of smolts (98.4%, n=39,155). The remaining catch was classified as fry (1.5%, n=615), parr (0.04%, n=15), and silvery parr (0.02%, n=9). The size distribution by life stage of naturally produced Chinook salmon caught and measured at the downstream traps during the 2014/15 season is provided by Figure 3.

The monthly average condition factors by life stage for naturally produced Chinook salmon caught and measured at the upstream and downstream traps are presented in Figure 4. Monthly average condition factors were only reported if the number of observations by life stage was three or greater (n>=3).

Migration Response

The relationships between three environmental variables (average daily flow, water temperature and turbidity) and estimated daily salmon abundance at the upstream and downstream traps during the 2014/15 monitoring season are presented graphically in Figures 5 and 6.

At the upstream trap, daily water turbidity, ATU, and average daily flow (Elliot, rkm 86.1) were the variables included in the generalized linear model (GLM) with the lowest AICc (Table 3). ATU and average daily flow had a significant negative relationship with daily salmon abundance (parameter estimates = -0.0003 and -0.0110, respectively). In addition, weekly redd emergence and weekly salmon abundance had a significant positive correlation at the upstream trap (r = 0.51, r =0.0114).

At the downstream traps, daily water turbidity, ATU, change in average daily flow at Victor (rkm 80.7), and change in average daily flow at Golf (rkm 61.3) were the variables included in the GLM with the lowest AICc (Table 3). Turbidity, ATU, and change in average daily flow at Golf were the variables included in the GLM that had a significant relationship with daily salmon abundance. Turbidity and ATU had a significant positive relationship with daily salmon abundance (parameter estimates = 0.2625 and 0.0004, respectively), while the change in average daily flow at Golf had a significant negative relationship with salmon abundance (parameter estimate = -0.0191). Weekly redd emergence and weekly salmon abundance did not have a significant correlation at the downstream traps (r = -0.26, r = 0.2044).

<u>Trapping and Trucking</u>

Trapping and trucking at the BYPASS trap was initiated on 28 April 2015. Juvenile Chinook salmon were transported for a total of forty trapping days, until 6 June 2015, when the 5-day Chinook salmon count average fell below 50 per day at the BYPASS trap.

Between 28 April and 1 June 2015, 33,999 salmon were trapped at the BYPASS and transported to the MRFI. During the loading, transport and release stages 430 salmon mortalities occurred, resulting in a 1.2% mortality rate. The mortalities were attributed to handling and/or transport stress. The majority of salmon mortalities (4,510, 13.3%) occurred during the 1-7 day holding period at the hatchery, which included mortalities that took place before, during, and after the coded-wire tagging process. Between 6 May and 3 June 2015, 28,759 salmon were released in net pens at Jersey Point. The salmon were released in five different groups at varying times of the day in conjunction with an outgoing tide (Figure 7). Three hundred salmon mortalities occurred during the transport and release stages at Jersey Point, resulting in a 0.9% mortality rate. A summary of salmon transported to the MRFI, coded-wire tagged, and released at Jersey Point on the San Joaquin River, is provided by Table 4.

Between 2 and 5 June 2015, 254 smolt-sized Chinook salmon were trapped at Woodbridge Dam (BYPASS, rkm 62) and transported to the South Fork of the lower Mokelumne River at Wimpy's Marina (rkm 30). During the loading, transport and release stages 4 salmon mortalities occurred, resulting in a 1.6% mortality rate. The mortalities were attributed to handling and/or transport stress.

<u>Egg-to-young-of-the-year survival indices</u>

During the BY 2014 spawning season, 911 Chinook salmon redds were identified in the LMR. The BY 2014 average salmon fecundity estimate (per female spawned at the MRFI) was 4,962 eggs. The resulting estimated salmon production at 100% survival was 4,520,382 juveniles. The BY 2014 egg-to-YOY survival index for naturally produced YOY Chinook salmon at the upstream trap (VINO) was 0.10 (95% CI: 0.07-0.17). At the downstream traps (GOLF and BYPASS), the BY 2014 survival index was 0.01 (95% CI: 0.01-0.02). The BY 2014 upstream survival index was low, similar to other brood years that experienced dry April through September water year types (Table 5). The BY 2014 downstream survival index was also low, similar to BY 2011-2013.

Steelhead

<u>Catch and Abundance Estimates</u>

At the VINO RST, 165 wild YOY steelhead were captured between 9 December 2014 and 8 June 2015. Estimates for weekend catch were added to actual catch to produce an estimated count of 283 naturally produced steelhead. The estimated abundance of wild YOY steelhead (based on trap calibrations using Chinook salmon) was 5,070 (95% CI: 3,481-18,037). The largest monthly catch of wild steelhead (113) occurred at VINO in March.

At the GOLF RST, zero wild YOY steelhead were captured during the season. At the BYPASS, eight YOY steelhead were captured between 2 April and 19 June 2015. Estimates for weekend catch were added to actual catch to produce an estimated count of nine naturally produced YOY steelhead. The estimated abundance of wild YOY steelhead at the downstream traps, calculated from adding the BYPASS trap catch to the GOLF RST estimate, was 9. No confidence interval was calculated because the estimate consisted of only fish caught at the BYPASS. The largest monthly catch of wild YOY steelhead (5) occurred at the downstream traps in June.

Life stage and size

At the VINO RST, 89.7% (n=148) of the naturally produced steelhead catch was classified as fry. The remaining wild steelhead catch was composed of parr (10.3%, n=17).

At the downstream traps (GOLF and BYPASS), 82.2% (n=37) of the wild steelhead catch was classified age 1+ silvery parr, smolts, and adults. The remaining wild steelhead catch was composed of parr (17.8%, n=8). Steelhead catch at the downstream traps also consisted of 58 hatchery origin (adipose fin-clipped) age 1+ silvery parr, smolts, and adults.

The size distribution by life stage of all wild steelhead measured at the upstream and downstream traps is presented in Figure 8.

Species Composition

Nineteen fish species were caught at the VINO RST during the survey period, eight native and eleven non-native species. Native fish species were more frequently caught than non-native species, comprising 99.1% of the total catch. Chinook salmon (no adipose fin-clip) was the most abundant species caught (90.3%), followed by Pacific lamprey (*Entosphenus tridentatus)* (7.0%) and unidentified juvenile black bass (*Micropterus* spp.) (0.7%).

At the downstream traps (GOLF and BYPASS) twenty-four fish species were caught, eight native and sixteen non-native species. Non-native fish species were more frequently caught than native species, comprising 63.7% of the total catch. Unidentified juvenile black bass were the most abundant fish caught (62.6%) at the downstream traps, followed by Chinook salmon (34.2%) and prickly sculpin (*Cottus asper*) (1.4%).

DISCUSSION

During the 2014/2015 juvenile outmigration monitoring season, the VINO RST was stopped by debris on twelve of 115 days when the trap was checked. Salmon catch was estimated at VINO on one of the twelve days with trap stoppages (4 February 2015), which occurred near the peak of juvenile salmon moving by the upstream trap. The GOLF RST was stopped by debris eighteen times throughout the monitoring season. Many of these stoppages occurred when Lodi Lake (located just above the GOLF RST) was being drained for maintenance or when it was refilled roughly one month later. Salmon catch was estimated at GOLF on four of the eighteen days with trap stoppages, when trap revolutions were low and moderate numbers of salmon were moving past the trap. During the other days when the GOLF or VINO traps were stopped, salmon catch was not estimated because the trap stops occurred outside of the peak of juvenile moving by the traps. These days may have led to a small, but not significant, underestimate of salmon abundance at the VINO and GOLF traps.

At the VINO RST, naturally produced salmon fry were used as test fish for trap efficiency trials that took place during the beginning of the monitoring season. Conversely, near the middle and the end of the season (late March through June), trap efficiency trials were conducted using parr and smolt-sized salmon from the MRFI. The results of the efficiency trials were consistent with previous seasons when the trap was operated at relatively stable low flows. Trap efficiencies steadily declined as salmon fork length increased. Two tests were not used due to a low number of recaptures and trap stoppages. Additional trap efficiency tests were performed shortly after the failed tests to provide suitable replacements.

At the GOLF RST, four trap efficiency trials were run using groups of naturally produced salmon and salmon from the MRFI. Three of the four tests were successful this season. Test 3 was not successful due to trap stoppages. Test 4, which used larger smolt-sized salmon from the MRFI, yielded just a few recaptures. This was likely due to the decreased capture efficiency of the 5-ft RST and the improved swimming ability of larger smolt-sized salmon.

The GOLF trap was removed from the river on 27 April 2015 because of a critically dry water year for the April through October period. During critically dry water years, the minimum flow requirement below Woodbridge Dam during the months of May and June is 15 cfs, which is insufficient flow to operate 8-ft or 5-ft RSTs at the downstream site. Therefore, between 28 April and 19 June 2015, only BYPASS salmon catch was used for daily downstream salmon abundance estimates. This may have accounted for an underestimate of salmon abundance at the downstream traps during the months of May and June. However, during the month of May the majority of the LMR flow was diverted to the WIDD canal (roughly 80%), which is screened to redirect salmon smolts and other fish to the BYPASS trap. It remains unclear what proportion of the juvenile salmon travel down the fish ladder at WIDD or spill over the concrete apron of the dam, which accounted for roughly 20% of the LMR flow during the month of May. To better understand this relationship, future studies may be warranted.

The upstream juvenile estimate at VINO, of 431,677 YOY Chinook salmon, ranked the 5th highest (of 9) on record since the trap site was initiated in the 2007/08 juvenile outmigration season. The downstream Chinook salmon juvenile outmigration estimate of

61,305 ranked the 19th highest (of 23) on record since the 1992/93 season. The annual juvenile estimates from upstream and downstream traps were relatively low, as were the BY 2014 survival indices at both traps. Dry conditions likely contributed to the low survival indices, as Calendar Years 2013-2015 were the driest on record in the Mokelumne River watershed. Other factors that may have contributed to the low survival rate of juvenile Chinook salmon in the upstream reaches of the LMR include predation by native and non-native fish species, egg losses that take place during egg deposition (Schroder et al. 2008), mortality associated with the physical and chemical habitat parameters associated at the spawning site (Merz et al. 2004), warm water temperatures, limited rearing habitat, and small unscreened surface water diversions in the LMR. Moyle and Israel (2005) indicated that small diversions may have a cumulative impact on fish populations, but the impacts of individual diversions may be highly variable depending on their size and location.

Trapping and trucking activities were initiated early this season due to the critically dry water year designation (April- October). In addition, trapping and hauling activities included coded-wire tagging 100% of the wild salmon that were transported to Jersey Point and released in net pens. The 15% overall mortality rate was largely attributed to holding and tagging stress, as the majority of the mortalities took place at the MRFI. It is also important to note that water temperatures were abnormally high in the LMR last spring and a pathology report by CADFW described a small proportion of the wild salmon as exhibiting signs of *Saprolegnia spp*. Further microscopic examinations revealed moderate to heavy amounts of *Flavobacterium columnare* (Columnaris).

At the upstream trap, ATU, daily average flow at Elliot (rkm 86.1), and turbidity were the variables included in the GLM with the lowest AICc. ATU and daily average flow at Elliot had a significant negative relationship with daily salmon abundance, establishing that most of the salmon passed the upstream trap when ATU and daily average flow were low. In addition, weekly redd emergence and weekly salmon abundance had a significant positive correlation at the upstream trap. In previous seasons, a significant positive relationship between weekly redd emergence and Chinook salmon abundance has also been established (Bilski et al. 2013), indicating that the majority of juvenile salmon rear below the upstream rotary screw trap.

At the downstream traps, turbidity, ATU, change in average daily flow at Victor, and change in average daily flow at GOLF were the variables included in the GLM with the lowest AICc. Turbidity and ATU had a significant positive relationship with daily salmon abundance indicating that many juvenile salmon emigrated past the downstream traps when turbidity and ATU were high. Interestingly, the change in average daily flow at GOLF had a significant negative relationship with salmon abundance, indicating the most of the juvenile salmon emigrated past the downstream traps when flows were stable at the GOLF gauge. However, it is important to note that there were only two daily average flow changes at GOLF that exceeded 100 cfs throughout the season.

ACKNOWLEDGEMENTS

We would like to thank Matt Saldate, Charles Hunter, Ed Rible, Henry Kei, Casey Del Real, Steve Boyd, and James Jones for field support and Terry Cummings for assistance with data entry and QA/QC. We also thank Michelle Workman for her assistance, review, and support. Thanks to Woodbridge Irrigation District for help with access at downstream trapping sites. We thank Bill Smith, Darrick Baker, and hatchery staff from the California Department of Fish and Wildlife who provided holding space for wild salmon at the MRFI, transported salmon to Jersey Point, and provided Mokelumne River hatchery origin Chinook salmon to use as test fish for trap efficiency tests.

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Table 1. Summary of trap efficiency tests conducted at trapping locations on the lower Mokelumne River during the 2014/2015 trapping season. Abbreviations are as follows: MRFI = Mokelumne River Fish Installation, LMR = lower Mokelumne River.

VINO FARMS (UPSTREAM RST)

Test #	Release date	Flow at release (cfs) - Elliot Rd.	Origin of test salmon	Ave. FL of test salmon (mm)	# Released	# Recaptured	% Recaptured	Used for abundance estimate?
1	21-Jan-15	231	WILD	35	261	34	**13.0%**	Yes
2	3-Feb-15	223	WILD	36	269	11	**4.1%**	No
3	10-Feb-15	222	WILD	36	998	95	**9.5%**	Yes
4	3-Mar-15	208	WILD	35	432	67	**15.5%**	Yes
5	30-Mar-15	208	MRFI	44	763	20	**2.6%**	Yes
6	29-May-15	173	MRFI	100	1012	1	**0.1%**	No
7	2-Jun-15	195	MRFI	92	1323	5	**0.4%**	Yes

GOLF (DOWNSTREAM RST)

Test #	Release date	Flow at release (cfs) - Golf	Origin of test salmon	Ave. FL of test salmon (mm)	# Released	# Recaptured	% Recaptured	Used for abundance estimate?
1	24-Feb-15	163	WILD	35	795	84	**10.6%**	Yes
2	16-Mar-15	112	MRFI	38	757	36	**4.8%**	Yes
3	14-Apr-15	81	MRFI	63	818	1	**0.1%**	No
4	20-Apr-15	79	MRFI	68	782	9	**1.2%**	Yes

Table 2. Expanded monthly catch, juvenile passage estimates with 95% confidence intervals (LCI and UCI), and percent passage for Chinook salmon captured at the upstream and downstream trapping locations on the lower Mokelumne River during the 2014/2015 trapping season.

Upstream (VINO FARMS)

Month	Catch Est.	Abundance Est.	95% LCI	95% UCI	Percent passage (%)
December	118	903	687	1,315	0.2%
January	7,704	59,140	45,026	86,146	13.7%
February	27,199	260,333	213,150	337,077	60.3%
March	6,059	46,778	38,647	59,376	10.8%
April	794	30,291	21,146	53,375	7.0%
May	274	32,645	18,518	219,080	7.6%
June	6	1,588	847	12,689	0.4%
Total	**42,154**	**431,677**	**338,021**	**769,057**	**100%**

Downstream (GOLF and BYPASS)

Month	Catch Est.	Abundance Est.	95% LCI	95% UCI	Percent passage (%)
January	66	625	520	783	1.0%
February	1,068	10,108	8,408	12,670	16.5%
March	163	1,972	1,582	2,641	3.2%
April	11,981	16,979	14,989	26,353	27.7%
May	31,245	31,245	31,245	31,245	51.0%
June	377	377	377	377	0.6%
Total	**44,900**	**61,305**	**57,120**	**74,069**	**100%**

Table 3. Generalized linear models for juvenile Chinook salmon abundance at the upstream and downstream trapping locations based on environmental variables on the lower Mokelumne River during the 2014/15 juvenile outmigration monitoring season. ∆ DA Flow = Change in daily average flow. ATU = Accumulated Thermal Units.

Upstream (VINO FARMS)

Model						
AICc	df	*P*	Independent Variable	df	X^2	*P*
222.15	3, 130	**0.0061**				
			ATU	1	7.136	**0.0076**
			DA flow (Elliott)	1	5.732	**0.0167**
			Turbidity	1	1.856	0.1731

Downstream (GOLF and BYPASS)

Model						
AICc	df	*P*	Independent Variable	df	X^2	*P*
231.60	4, 119	**<0.0001**				
			Turbidity	1	14.672	**0.0001**
			ATU	1	9.024	**0.0027**
			∆ DA Flow (Victor)	1	2.292	0.1301
			∆ DA Flow (GOLF)	1	19.048	**<.0001**

Table 4. Summary of wild Chinook salmon trapped at the BYPASS trap (Woodbridge Dam), transported to the MRFI, coded-wire tagged, transported to Jersey Point, and released in net pens at Jersey Point on the San Joaquin River.

BYPASS trap			MRFI					Jersey Point			
Sample week (Release group)	Date Range	Number of salmon loaded at BYPASS	Number of live salmon at MRFI (before tagging)	CWT codes used	Mean total length, mm (CV)	Batch total	Number of salmon transported to Jersey Point	Release date	Water temp. (°C)	Number of live salmon released	Total mort. %
1	4/28/15-5/4/15	10,978	10,609	069201-069205, 060370, 060371	96 (8.6)	10,205	9,561	5/6/15	18.4	9,361	14%
2	5/5/15-5/11/15	12,611	12,565	069201-069205, 060370, 060371	96 (8.6)	11,939	11,429	5/13/15	19	11,399	11%
3	5/12/15-5/18/15	6,585	6,572	069201-069205, 060370, 060371	99 (8.4)	5,663	5,283	5/20/15	18.4	5,233	23%
4	5/19/15-5/26/15	3,224	3,222	069201-069205, 060370, 060371	101 (8.6)	2,507	2,339	5/27/15	19.7	2,319	33%
5	5/27/15-6/1/15	601	601	069201-069205, 060370, 060371	102 (11.4)	489	447	6/3/15	19.5	447	37%
Total		**33,999**	**33,569**			**30,803**	**29,059**			**28,759**	**15%**

Table 5. A summary of annual upstream and downstream juvenile Chinook salmon survival indices (egg to young-of-the-year) on the lower Mokelumne River. Indices were calculated by dividing the annual upstream and downstream juvenile passage estimates by the estimated number of Chinook salmon naturally produced on the LMR for a given brood year (BY). The total estimated natural production for each BY was calculated by multiplying the annual Chinook salmon redd count by the average annual fecundity estimate for a female Chinook salmon spawned at the Mokelumne River Fish Installation (MRFI). JSA = 1998 Mokelumne River Joint Settle Agreement.

BY	Trap(s) used	Chinook salmon redd count	Estimated production (at 100% survival)	Abundance estimate	95% LCI	95% UCI	Survival index (LCI - UCI)	JSA water year type (Apr.-Sept.)
				Upstream (rkm 87.4)				
2008	Vino Farms	63	338,899	175,612	131,191	280,979	0.52 (0.39-0.83)	Below Normal
2009	Vino Farms	248	1,208,444	124,279	93,555	199,950	0.10 (0.08-0.17)	Below Normal
2010	Vino Farms	314	1,601,627	842,570	631,115	2,039,099	0.53 (0.39-1.27)	Normal & Above
2011	Vino Farms	564	2,983,439	202,772	152,937	312,856	0.07 (0.05-0.10)	Dry
2012	Vino Farms	1,287	6,509,206	1,203,754	958,664	1,724,580	0.18 (0.15-0.26)	Dry
2013	Vino Farms	1,823	10,098,958	595,070	437,148	955,327	0.06 (0.04-0.09)	Dry
2014	Vino Farms	911	4,520,382	431,677	338,021	769,057	0.10 (0.07-0.17)	Critically Dry
				Downstream (rkm 62)				
2008	Golf & Bypass	63	338,899	30,614	29,171	32,802	0.09 (0.09-0.10)	Below Normal
2009	Golf & Bypass	248	1,208,444	67,349	39,512	283,914	0.06 (0.03-0.23)	Below Normal
2010	Golf & Bypass	314	1,601,627	281,500	186,249	606,084	0.18 (0.12-0.38)	Normal & Above
2011	Golf & Bypass	564	2,983,439	51,799	42,063	70,631	0.02 (0.01-0.02)	Dry
2012	Golf & Bypass	1,287	6,509,206	147,590	130,342	176,579	0.02 (0.02-0.03)	Dry
2013	Golf & Bypass	1,823	10,098,958	169,864	134,673	287,964	0.02 (0.01-0.03)	Dry
2014	Golf & Bypass	911	4,520,382	61,305	57,120	74,069	0.01 (0.01-0.02)	Critically Dry

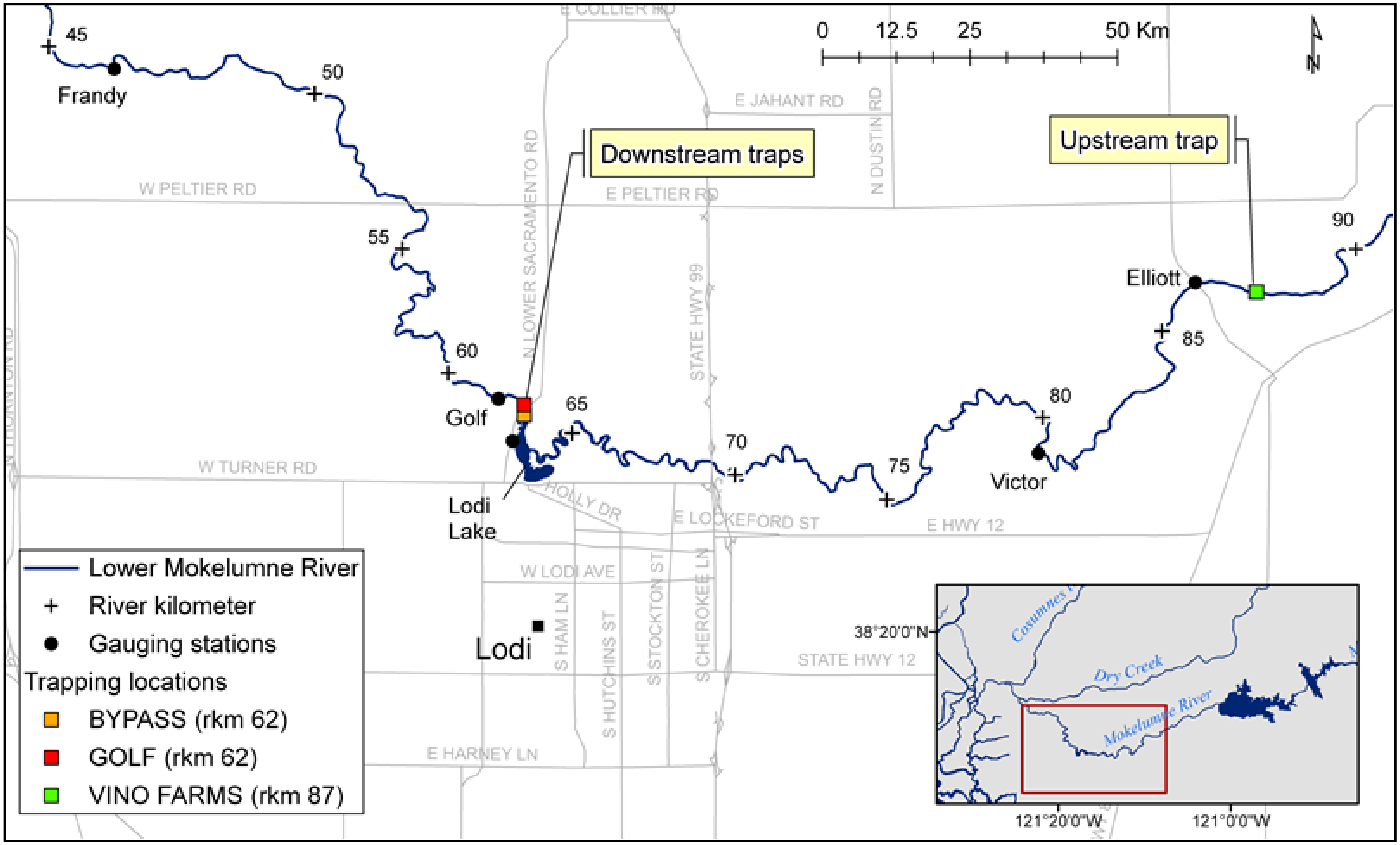

Figure 1. Trapping sites used for juvenile emigration monitoring on the lower Mokelumne River during the 2014/15 season.

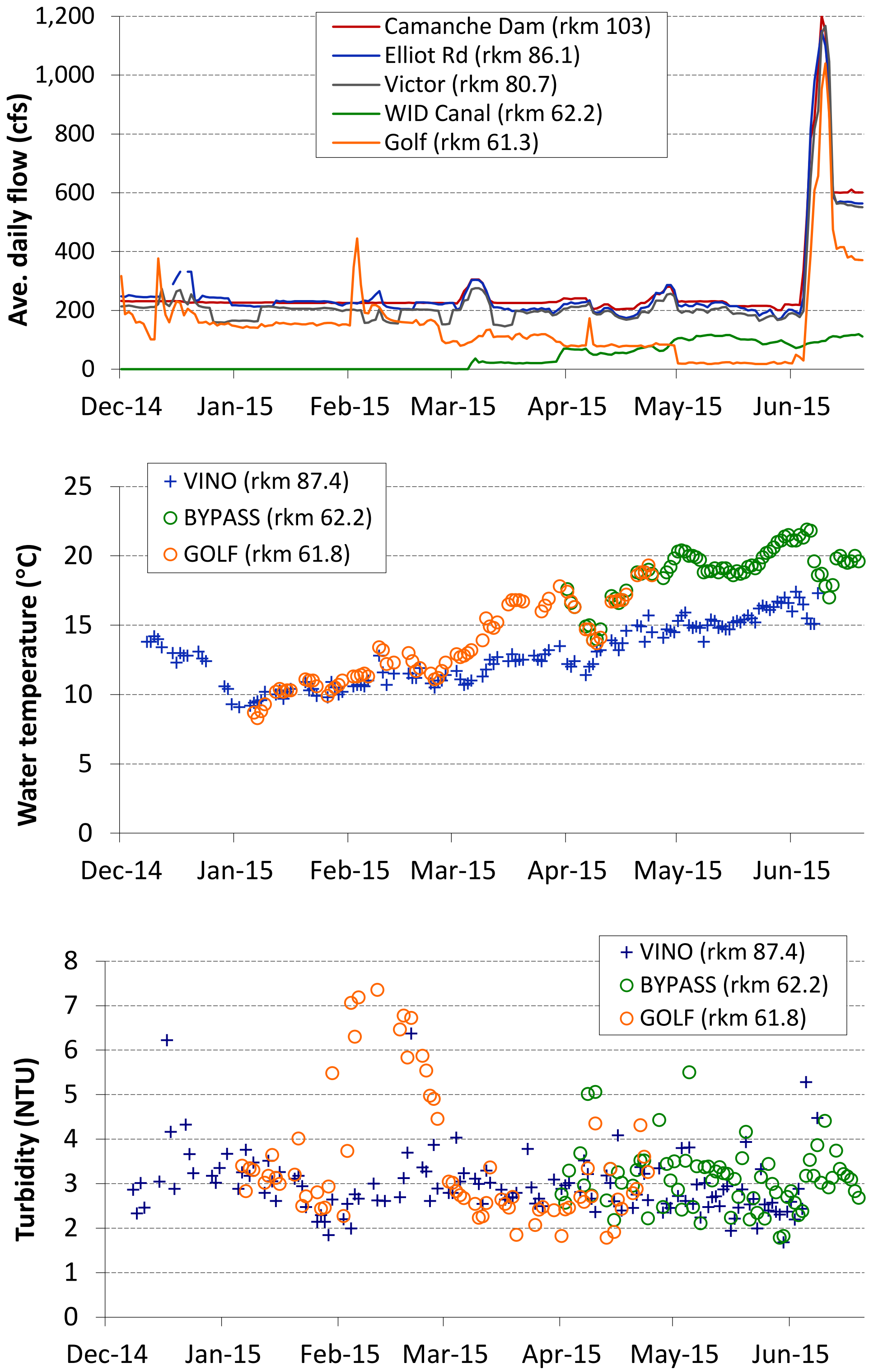

Figure 2. Average daily flow, turbidity and water temperature on the lower Mokelumne River between Camanche Dam (rkm 103) and Golf (rkm 61.3) during the 2014/15 juvenile emigration monitoring season.

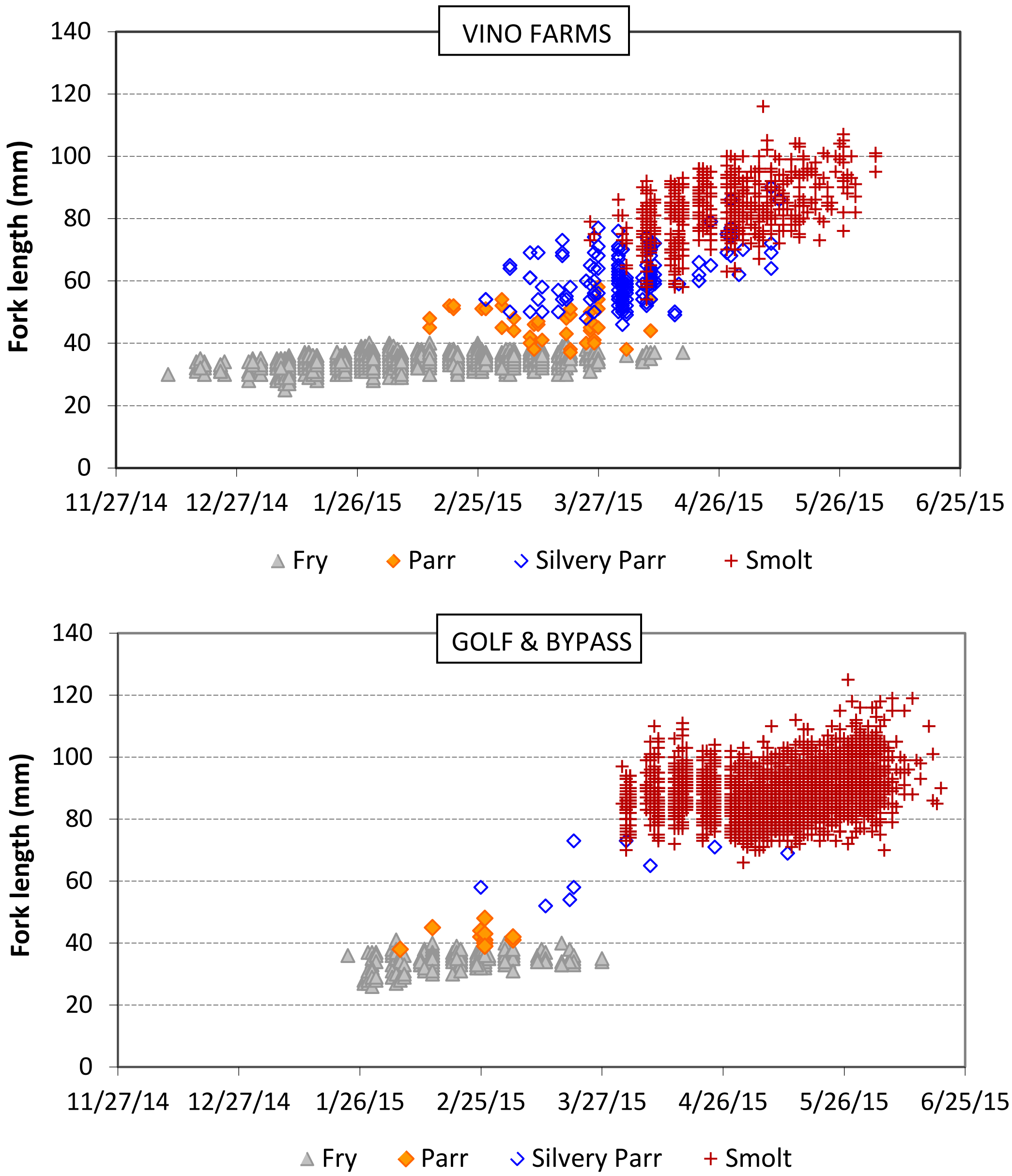

Figure 3. Size distribution by life stage of wild juvenile Chinook salmon caught and measured at the upstream (VINO FARMS) and downstream (GOLF and BYPASS) trapping locations during the 2014/15 juvenile emigration season on the lower Mokelumne River.

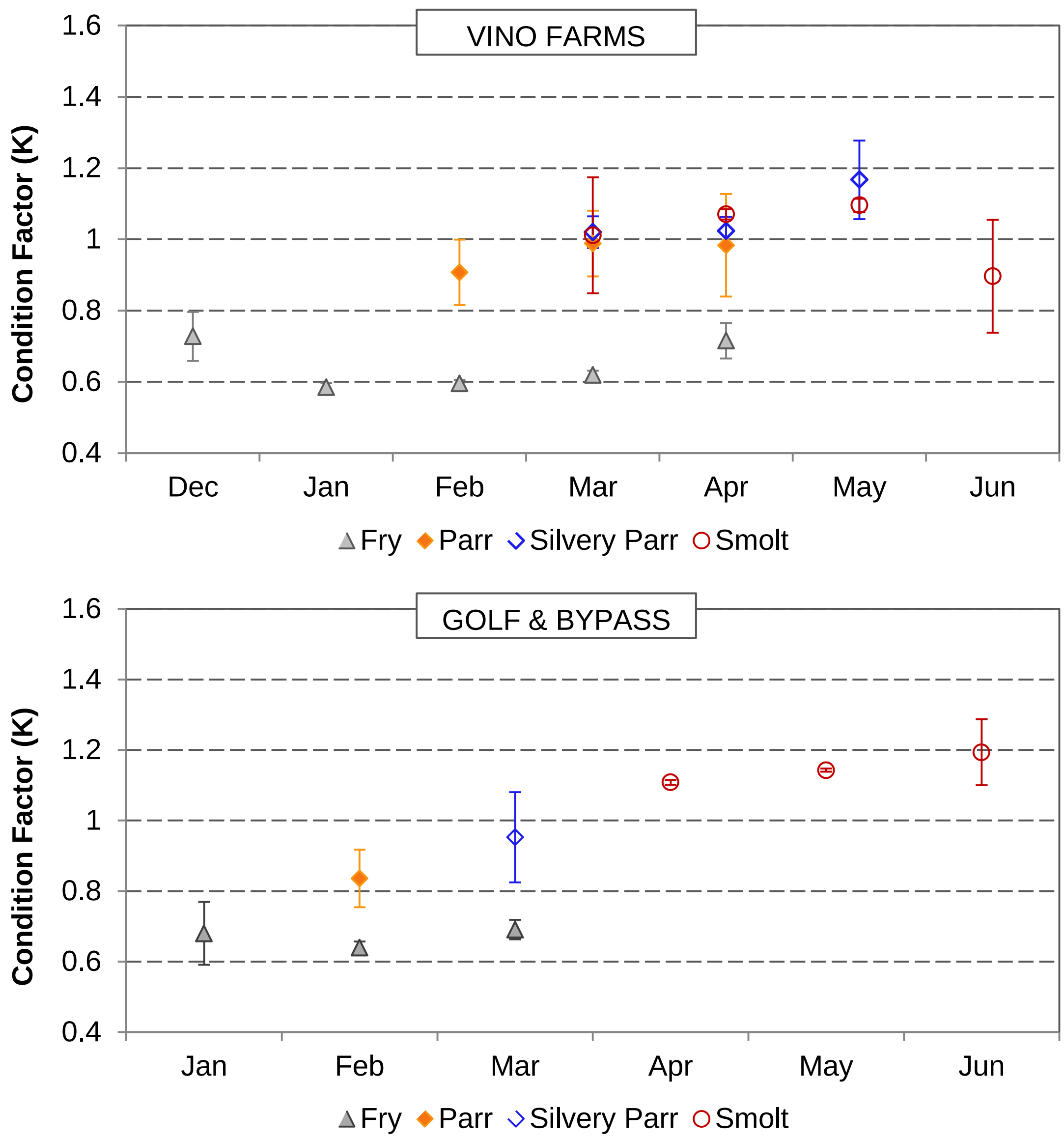

Figure 4. Monthly average condition factor ± 2 SE (vertical lines) of wild juvenile Chinook salmon caught and measured at the upstream (VINO FARMS) and downstream (GOLF & BYPASS) trapping locations during the 2014/15 juvenile emigration monitoring season on the lower Mokelumne River.

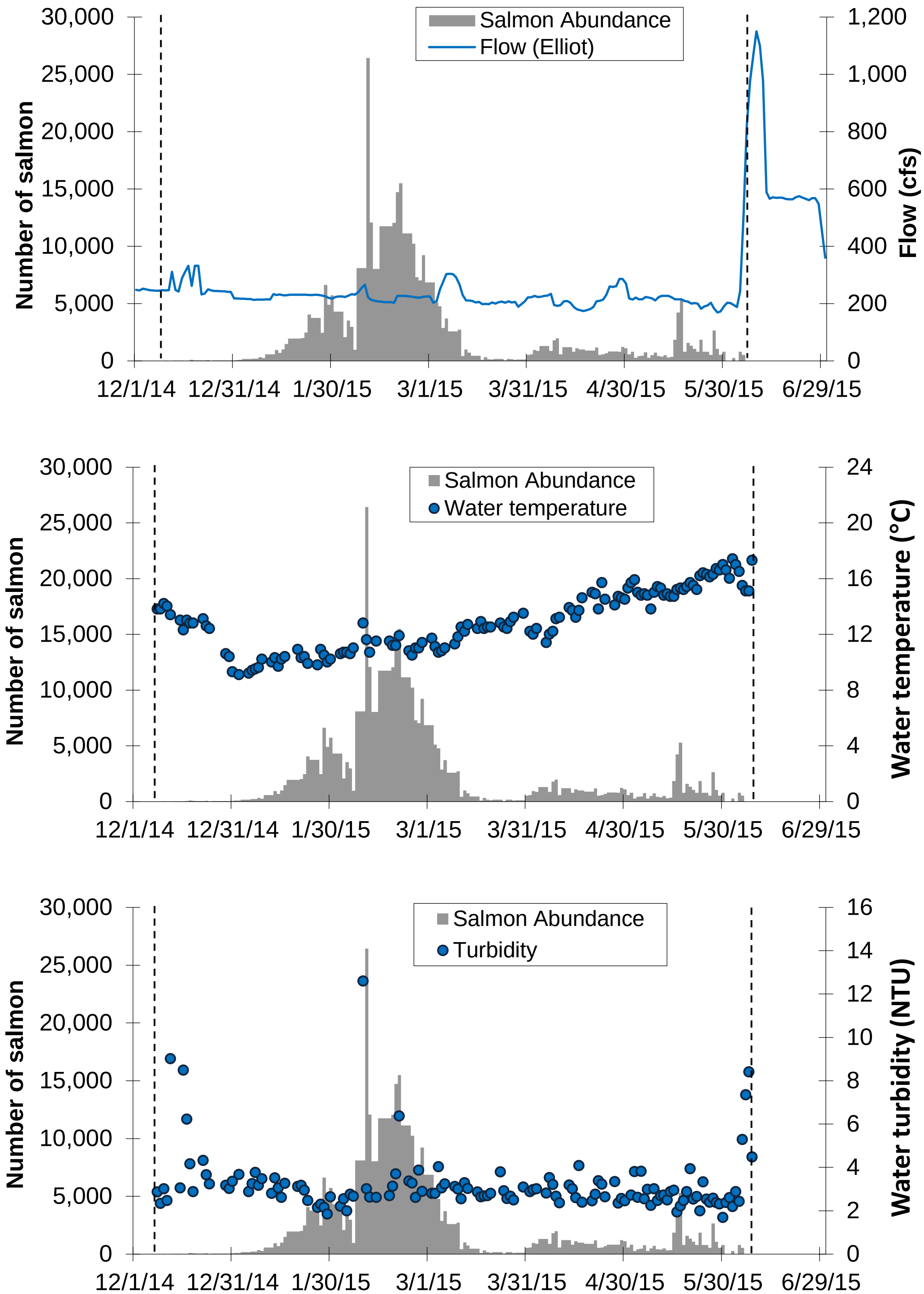

Figure 5. The relationship between estimated daily Chinook salmon abundance and flow (top), water temperature (middle), and turbidity (bottom) at the VINO RST (upstream trapping location) during the 2014/15 juvenile emigration monitoring season. The dashed vertical lines indicate the beginning and the end of the monitoring period.

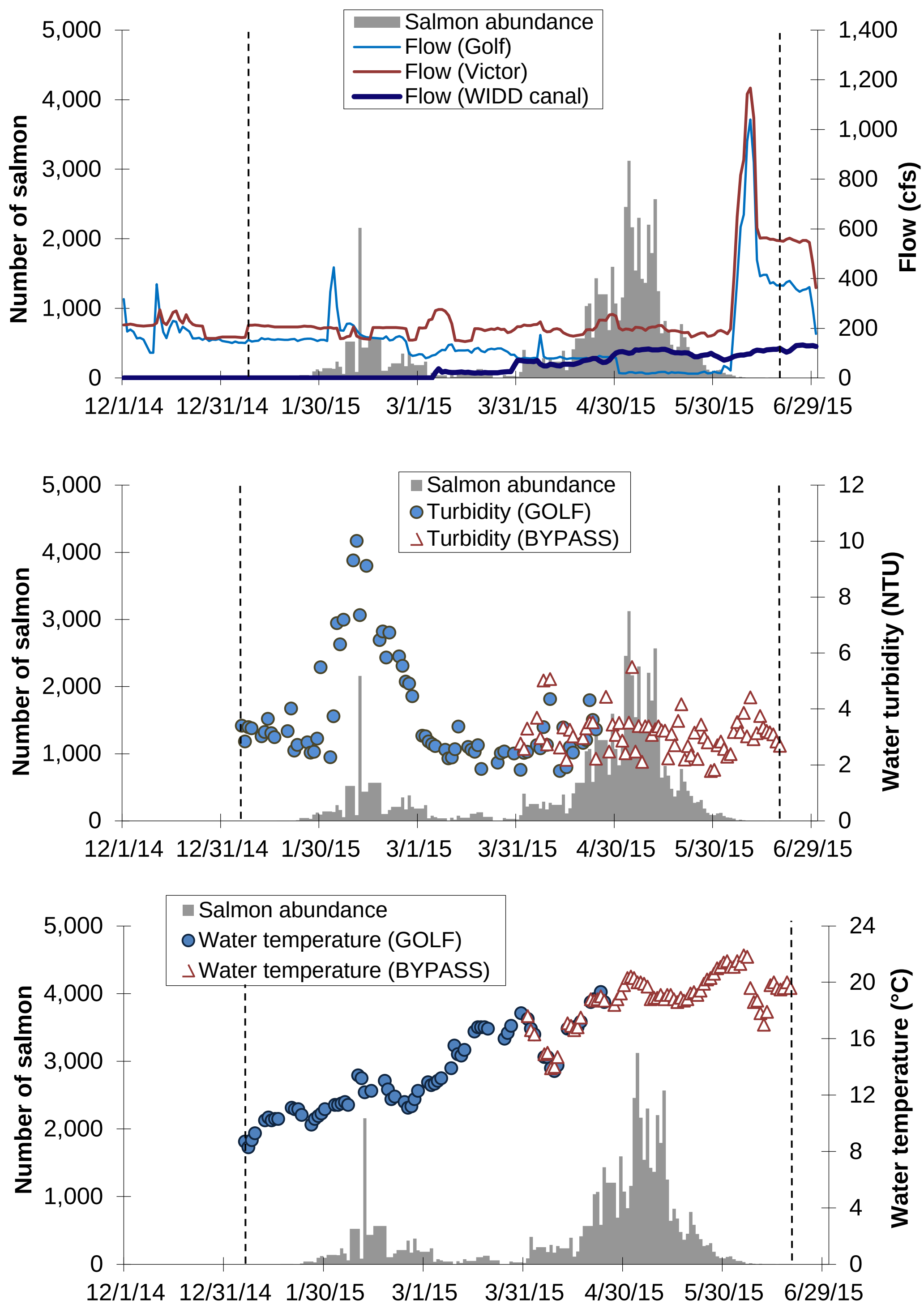

Figure 6. The relationship between estimated daily Chinook salmon abundance and flow (top), water temperature (middle), and turbidity (bottom) at the downstream trapping locations (GOLF & BYPASS) during the 2014/15 juvenile emigration monitoring season. The dashed vertical lines indicate the beginning and the end of the monitoring period.

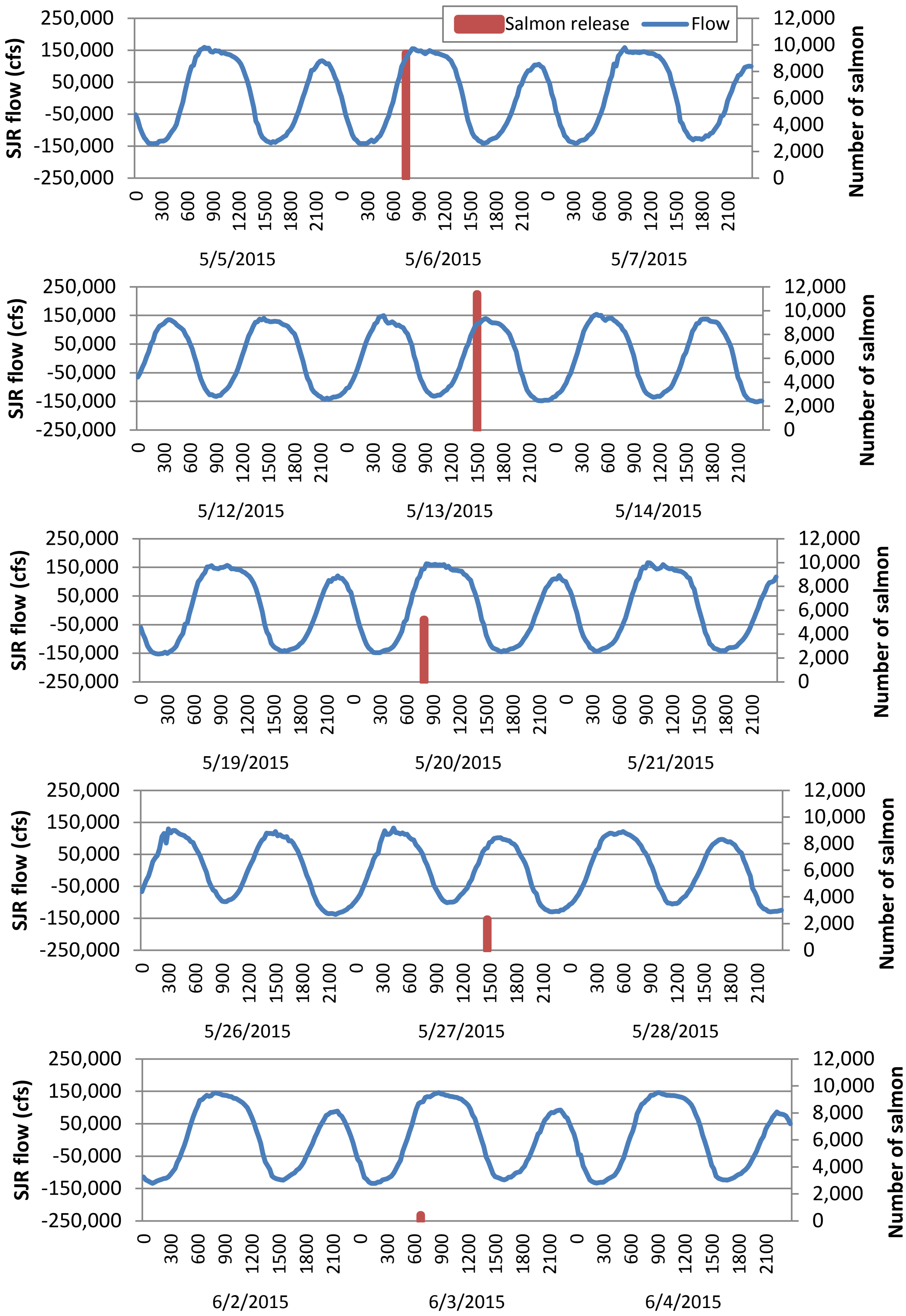

Figure 7. The timing, number of salmon released, and flow during the five net pen releases of smolt-sized wild Chinook salmon on the San Joaquin River near Jersey Point.

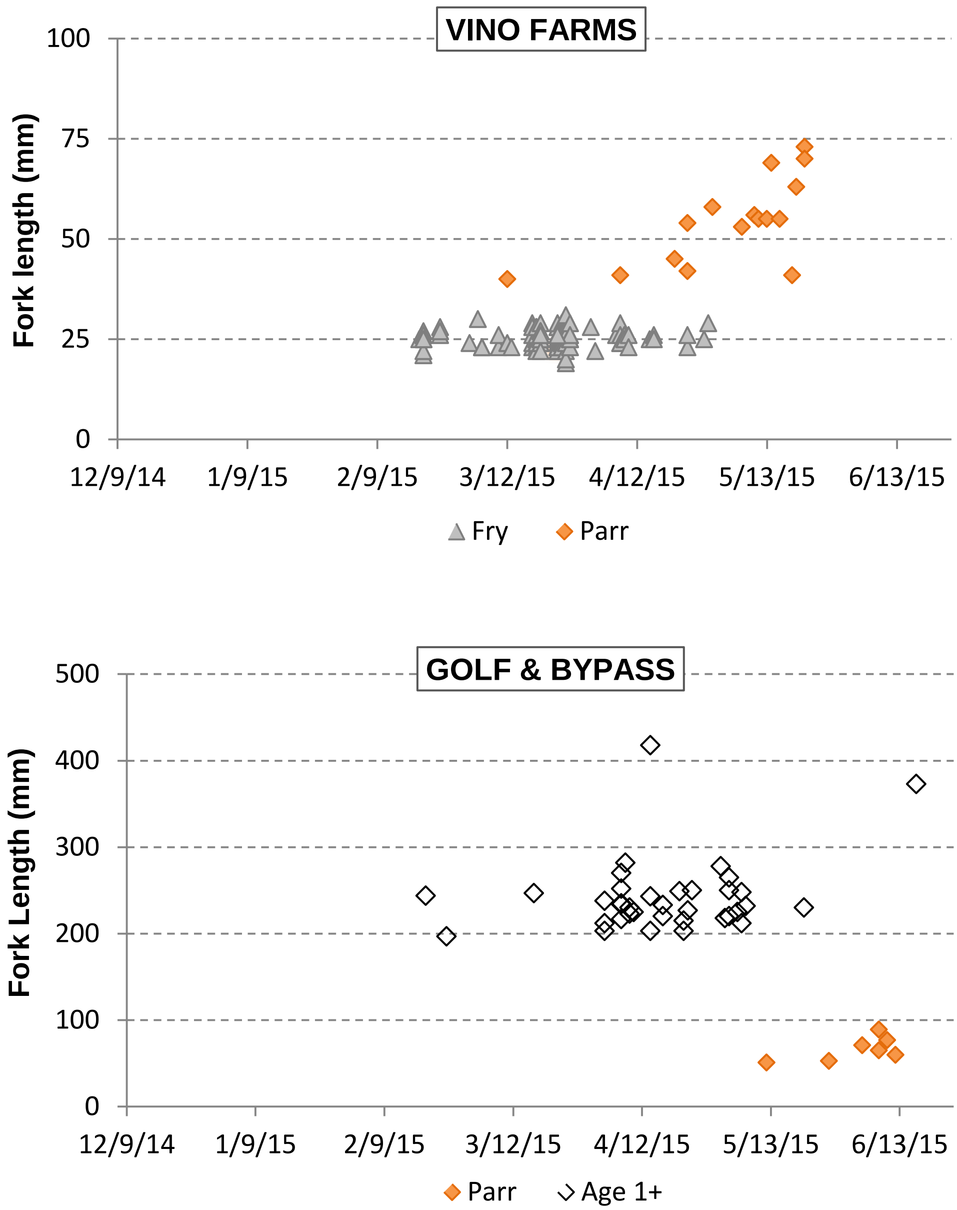

Figure 8. Size and life stage distribution of wild steelhead caught and measured at the upstream (VINO FARMS) and downstream (GOLF & BYPASS) trapping locations during the 2014/15 juvenile emigration monitoring season on the lower Mokelumne River.

Appendix A. Daily trap catch, trap efficiency, abundance estimates, and 95% confidence intervals (CI) of emigrating juvenile Chinook salmon at the upstream rotary screw trap (VINO) on the lower Mokelumne River during the 2014/15 monitoring period. Shaded areas represent non-trapping periods.

Date	Catch	Efficiency	Abundance estimate	95% Lower CI	95% Upper CI
12/9/2014	0	0.1303	**0**	0	0
12/10/2014	1	0.1303	**8**	6	11
12/11/2014	0	0.1303	**0**	0	0
12/12/2014	0	0.1303	**0**	0	0
12/13/2014	3	0.1303	**23**	18	34
12/14/2014	3	0.1303	**23**	18	34
12/15/2014	3	0.1303	**23**	18	34
12/16/2014	0	0.1303	**0**	0	0
12/17/2014	4	0.1303	**31**	23	45
12/18/2014	13	0.1303	**100**	76	145
12/19/2014	8	0.1303	**61**	47	89
12/20/2014	7	0.1303	**55**	42	81
12/21/2014	7	0.1303	**55**	42	81
12/22/2014	7	0.1303	**55**	42	81
12/23/2014	9	0.1303	**69**	53	101
12/24/2014	2	0.1303	**15**	12	22
12/25/2014	7	0.1303	**55**	42	81
12/26/2014	7	0.1303	**55**	42	81
12/27/2014	7	0.1303	**55**	42	81
12/28/2014	7	0.1303	**55**	42	81
12/29/2014	7	0.1303	**55**	42	81
12/30/2014	6	0.1303	**46**	35	67
12/31/2014	8	0.1303	**61**	47	89
1/1/2015	11	0.1303	**84**	64	123
1/2/2015	12	0.1303	**92**	70	134
1/3/2015	22	0.1303	**166**	127	242
1/4/2015	22	0.1303	**166**	127	242
1/5/2015	22	0.1303	**166**	127	242
1/6/2015	28	0.1303	**215**	164	313
1/7/2015	28	0.1303	**215**	164	313
1/8/2015	43	0.1303	**330**	251	481
1/9/2015	34	0.1303	**261**	199	380
1/10/2015	75	0.1303	**573**	436	835
1/11/2015	75	0.1303	**573**	436	835
1/12/2015	75	0.1303	**573**	436	835
1/13/2015	123	0.1303	**944**	719	1,375
1/14/2015	90	0.1303	**691**	526	1,006
1/15/2015	130	0.1303	**998**	760	1,454
1/16/2015	193	0.1303	**1,482**	1,128	2,158
1/17/2015	254	0.1303	**1,951**	1,485	2,842
1/18/2015	254	0.1303	**1,951**	1,485	2,842
1/19/2015	254	0.1303	**1,951**	1,485	2,842
1/20/2015	254	0.1303	**1,951**	1,485	2,842

Appendix A continued

Date	Catch	Efficiency	Abundance estimate	95% Lower CI	95% Upper CI
1/21/2015	262	0.1303	**2,011**	1,531	2,930
1/22/2015	322	0.1303	**2,472**	1,882	3,601
1/23/2015	528	0.1303	**4,053**	3,086	5,904
1/24/2015	489	0.1303	**3,752**	2,857	5,466
1/25/2015	489	0.1303	**3,752**	2,857	5,466
1/26/2015	489	0.1303	**3,752**	2,857	5,466
1/27/2015	321	0.1303	**2,464**	1,876	3,589
1/28/2015	862	0.1303	**6,617**	5,038	9,639
1/29/2015	638	0.1303	**4,898**	3,729	7,134
1/30/2015	746	0.1303	**5,727**	4,360	8,342
1/31/2015	561	0.1303	**4,306**	3,279	6,273
2/1/2015	561	0.1303	**4,306**	3,279	6,273
2/2/2015	561	0.1303	**4,306**	3,279	6,273
2/3/2015	271	0.1303	**2,080**	1,584	3,030
2/4/2015	461	0.1303	**3,539**	2,694	5,155
2/5/2015	388	0.1303	**2,978**	2,268	4,339
2/6/2015	126	0.1303	**967**	736	1,409
2/7/2015	1056	0.1303	**8,102**	6,169	11,802
2/8/2015	1056	0.1303	**8,102**	6,169	11,802
2/9/2015	1056	0.1303	**8,102**	6,169	11,802
2/10/2015	3443	0.1303	**26,430**	20,122	38,499
2/11/2015	1150	0.0952	**12,081**	10,141	14,939
2/12/2015	765	0.0952	**8,037**	6,746	9,937
2/13/2015	765	0.0952	**8,037**	6,746	9,937
2/14/2015	1117	0.0952	**11,738**	9,853	14,514
2/15/2015	1117	0.0952	**11,738**	9,853	14,514
2/16/2015	1117	0.0952	**11,738**	9,853	14,514
2/17/2015	1117	0.0952	**11,738**	9,853	14,514
2/18/2015	1147	0.0952	**12,050**	10,115	14,900
2/19/2015	1401	0.0952	**14,718**	12,355	18,199
2/20/2015	1476	0.0952	**15,506**	13,016	19,173
2/21/2015	1060	0.0952	**11,137**	9,349	13,772
2/22/2015	1060	0.0952	**11,137**	9,349	13,772
2/23/2015	1060	0.0952	**11,137**	9,349	13,772
2/24/2015	974	0.0952	**10,232**	8,589	12,652
2/25/2015	694	0.0952	**7,291**	6,120	9,015
2/26/2015	669	0.0952	**7,028**	5,900	8,690
2/27/2015	878	0.0952	**9,224**	7,743	11,405
2/28/2015	652	0.0952	**6,853**	5,753	8,474
3/1/2015	652	0.0952	**6,853**	5,753	8,474
3/2/2015	652	0.0952	**6,853**	5,753	8,474
3/3/2015	486	0.0952	**5,106**	4,286	6,313
3/4/2015	742	0.1551	**4,784**	3,921	6,134
3/5/2015	445	0.1551	**2,869**	2,352	3,679
3/6/2015	575	0.1551	**3,708**	3,039	4,754

Appendix A continued

Date	Catch	Efficiency	Abundance estimate	95% Lower CI	95% Upper CI
3/7/2015	401	0.1551	**2,587**	2,120	3,317
3/8/2015	401	0.1551	**2,587**	2,120	3,317
3/9/2015	401	0.1551	**2,587**	2,120	3,317
3/10/2015	423	0.1551	**2,727**	2,235	3,497
3/11/2015	66	0.1551	**426**	349	546
3/12/2015	156	0.1551	**1,006**	824	1,290
3/13/2015	113	0.1551	**729**	597	934
3/14/2015	71	0.1551	**457**	374	586
3/15/2015	71	0.1551	**457**	374	586
3/16/2015	71	0.1551	**457**	374	586
3/17/2015	14	0.1551	**90**	74	116
3/18/2015	51	0.1551	**329**	270	422
3/19/2015	25	0.1551	**161**	132	207
3/20/2015	20	0.1551	**129**	106	165
3/21/2015	26	0.1551	**165**	136	212
3/22/2015	26	0.1551	**165**	136	212
3/23/2015	26	0.1551	**165**	136	212
3/24/2015	7	0.1551	**45**	37	58
3/25/2015	26	0.1551	**168**	137	215
3/26/2015	25	0.1551	**161**	132	207
3/27/2015	14	0.1551	**90**	74	116
3/28/2015	20	0.1551	**128**	105	164
3/29/2015	20	0.1551	**128**	105	164
3/30/2015	20	0.1551	**128**	105	164
3/31/2015	14	0.0262	**534**	373	941
4/1/2015	15	0.0262	**572**	399	1,008
4/2/2015	25	0.0262	**954**	666	1,681
4/3/2015	23	0.0262	**877**	613	1,546
4/4/2015	34	0.0262	**1,297**	905	2,286
4/5/2015	34	0.0262	**1,297**	905	2,286
4/6/2015	34	0.0262	**1,297**	905	2,286
4/7/2015	23	0.0262	**877**	613	1,546
4/8/2015	47	0.0262	**1,793**	1,252	3,159
4/9/2015	52	0.0262	**1,984**	1,385	3,496
4/10/2015	15	0.0262	**572**	399	1,008
4/11/2015	32	0.0262	**1,208**	843	2,129
4/12/2015	32	0.0262	**1,208**	843	2,129
4/13/2015	32	0.0262	**1,208**	843	2,129
4/14/2015	21	0.0262	**801**	559	1,412
4/15/2015	29	0.0262	**1,106**	772	1,949
4/16/2015	26	0.0262	**992**	692	1,748
4/17/2015	26	0.0262	**992**	692	1,748
4/18/2015	24	0.0262	**897**	626	1,580
4/19/2015	24	0.0262	**897**	626	1,580
4/20/2015	24	0.0262	**897**	626	1,580
4/21/2015	31	0.0262	**1,183**	826	2,084
4/22/2015	14	0.0262	**534**	373	941

Appendix A continued

Date	Catch	Efficiency	Abundance estimate	95% Lower CI	95% Upper CI
4/23/2015	15	0.0262	**572**	399	1,008
4/24/2015	18	0.0262	**687**	479	1,210
4/25/2015	22	0.0262	**820**	573	1,445
4/26/2015	22	0.0262	**820**	573	1,445
4/27/2015	22	0.0262	**820**	573	1,445
4/28/2015	21	0.0262	**801**	559	1,412
4/29/2015	32	0.0262	**1,221**	852	2,151
4/30/2015	29	0.0262	**1,106**	772	1,949
5/1/2015	15	0.0262	**572**	399	1,008
5/2/2015	21	0.0262	**801**	559	1,412
5/3/2015	7	0.0262	**267**	186	471
5/4/2015	11	0.0262	**420**	293	739
5/5/2015	12	0.0262	**458**	320	807
5/6/2015	20	0.0262	**763**	533	1,344
5/7/2015	7	0.0262	**267**	186	471
5/8/2015	13	0.0262	**496**	346	874
5/9/2015	19	0.0262	**725**	506	1,277
5/10/2015	11	0.0262	**420**	293	739
5/11/2015	10	0.0262	**382**	266	672
5/12/2015	13	0.0262	**496**	346	874
5/13/2015	8	0.0262	**305**	213	538
5/14/2015	9	0.0262	**343**	240	605
5/15/2015	7	0.0038	**1,852**	988	14,803
5/16/2015	16	0.0038	**4,234**	2,258	33,837
5/17/2015	20	0.0038	**5,292**	2,823	42,296
5/18/2015	3	0.0038	**794**	423	6,344
5/19/2015	6	0.0038	**1,588**	847	12,689
5/20/2015	5	0.0038	**1,323**	706	10,574
5/21/2015	4	0.0038	**1,058**	565	8,459
5/22/2015	3	0.0038	**794**	423	6,344
5/23/2015	7	0.0038	**1,852**	988	14,803
5/24/2015	3	0.0038	**794**	423	6,344
5/25/2015	3	0.0038	**794**	423	6,344
5/26/2015	2	0.0038	**529**	282	4,230
5/27/2015	10	0.0038	**2,646**	1,411	21,148
5/28/2015	4	0.0038	**1,058**	565	8,459
5/29/2015	2	0.0038	**529**	282	4,230
5/30/2015	3	0.0038	**794**	423	6,344
5/31/2015	0	0.0038	**0**	0	0
6/1/2015	0	0.0038	**0**	0	
6/2/2015	1	0.0038	**265**	141	2,115
6/3/2015	0	0.0038	**0**	0	0
6/4/2015	3	0.0038	**794**	423	6,344
6/5/2015	2	0.0038	**529**	282	4,230
6/6/2015	0	0.0038	**0**	0	0
6/7/2015	0	0.0038	**0**	0	0
6/8/2015	0	0.0038	**0**	0	0

Appendix B. Daily trap catch, trap efficiency, abundance estimates, and 95% confidence intervals (CI) of emigrating juvenile Chinook salmon at the downstream traps (GOLF and BYPASS) on the lower Mokelumne River during the 2014/15 monitoring period. Shaded areas represent non-trapping periods.

Date	GOLF catch	GOLF efficiency	GOLF abundance	BYPASS catch	Downstream abundance estimate	95% Lower CI	95% Upper CI
1/7/2015	0	0.10566	**0**	–	0	0	0
1/8/2015	0	0.10566	**0**	–	0	0	0
1/9/2015	0	0.10566	**0**	–	0	0	0
1/10/2015	0	0.10566	**0**	–	0	0	0
1/11/2015	0	0.10566	**0**	–	0	0	0
1/12/2015	0	0.10566	**0**	–	0	0	0
1/13/2015	0	0.10566	**0**	–	0	0	0
1/14/2015	0	0.10566	**0**	–	0	0	0
1/15/2015	0	0.10566	**0**	–	0	0	0
1/16/2015	0	0.10566	**0**	–	0	0	0
1/17/2015	0	0.10566	**2**	–	2	1	2
1/18/2015	0	0.10566	**2**	–	2	1	2
1/19/2015	0	0.10566	**2**	–	2	1	2
1/20/2015	0	0.10566	**2**	–	2	1	2
1/21/2015	0	0.10566	**0**	–	0	0	0
1/22/2015	0	0.10566	**0**	–	0	0	0
1/23/2015	1	0.10566	**9**	–	9	8	12
1/24/2015	5	0.10566	**43**	–	43	35	53
1/25/2015	5	0.10566	**43**	–	43	35	53
1/26/2015	5	0.10566	**43**	–	43	35	53
1/27/2015	3	0.10566	**28**	–	28	24	36
1/28/2015	10	0.10566	**95**	–	95	79	119
1/29/2015	13	0.10566	**123**	–	123	102	154
1/30/2015	10	0.10566	**95**	–	95	79	119
1/31/2015	15	0.10566	**140**	–	140	117	176
2/1/2015	15	0.10566	**140**	–	140	117	176
2/2/2015	15	0.10566	**140**	–	140	117	176
2/3/2015	14	0.10566	**133**	–	133	110	166
2/4/2015	25	0.10566	**237**	–	237	197	297
2/5/2015	17	0.10566	**161**	–	161	134	202
2/6/2015	6	0.10566	**57**	–	57	47	71
2/7/2015	55	0.10566	**522**	–	522	434	654
2/8/2015	55	0.10566	**522**	–	522	434	654
2/9/2015	55	0.10566	**522**	–	522	434	654
2/10/2015	9	0.10566	**85**	–	85	71	107
2/11/2015	228	0.10566	**2,158**	–	2,158	1,795	2,705
2/12/2015	46	0.10566	**435**	–	435	362	546
2/13/2015	46	0.10566	**435**	–	435	362	546
2/14/2015	60	0.10566	**566**	–	566	471	710
2/15/2015	60	0.10566	**566**	–	566	471	710
2/16/2015	60	0.10566	**566**	–	566	471	710
2/17/2015	60	0.10566	**566**	–	566	471	710
2/18/2015	11	0.10566	**104**	–	104	87	130

Appendix B continued

Date	GOLF catch	GOLF efficiency	GOLF abundance	BYPASS catch	Downstream abundance estimate	95% Lower CI	95% Upper CI
2/19/2015	11	0.10566	**104**	–	104	87	130
2/20/2015	17	0.10566	**161**	–	161	134	202
2/21/2015	22	0.10566	**211**	–	211	176	265
2/22/2015	22	0.10566	**211**	–	211	176	265
2/23/2015	22	0.10566	**211**	–	211	176	265
2/24/2015	37	0.10566	**350**	–	350	291	439
2/25/2015	18	0.10566	**170**	–	170	142	214
2/26/2015	40	0.10566	**379**	–	379	315	475
2/27/2015	22	0.10566	**208**	–	208	173	261
2/28/2015	20	0.10566	**185**	–	185	154	231
3/1/2015	20	0.10566	**185**	–	185	154	231
3/2/2015	20	0.10566	**185**	–	185	154	231
3/3/2015	25	0.10566	**237**	–	237	197	297
3/4/2015	4	0.10566	**38**	–	38	31	47
3/5/2015	8	0.10566	**76**	–	76	63	95
3/6/2015	6	0.10566	**57**	–	57	47	71
3/7/2015	4	0.10566	**39**	–	39	33	49
3/8/2015	4	0.10566	**39**	–	39	33	49
3/9/2015	4	0.10566	**39**	–	39	33	49
3/10/2015	0	0.10566	**0**	–	0	0	0
3/11/2015	5	0.10566	**47**	–	47	39	59
3/12/2015	2	0.10566	**19**	–	19	16	24
3/13/2015	8	0.10566	**76**	–	76	63	95
3/14/2015	5	0.10566	**49**	–	49	41	61
3/15/2015	5	0.10566	**49**	–	49	41	61
3/16/2015	5	0.10566	**49**	–	49	41	61
3/17/2015	5	0.04756	**105**	–	105	80	154
3/18/2015	5	0.04756	**105**	–	105	80	154
3/19/2015	6	0.04756	**126**	–	126	96	185
3/20/2015	6	0.04756	**126**	–	126	96	185
3/21/2015	3	0.04756	**60**	–	60	45	87
3/22/2015	3	0.04756	**60**	–	60	45	87
3/23/2015	3	0.04756	**60**	–	60	45	87
3/24/2015	0	0.04756	**0**	–	0	0	0
3/25/2015	0	0.04756	**0**	–	0	0	0
3/26/2015	0	0.04756	**0**	–	0	0	0
3/27/2015	2	0.04756	**42**	–	42	32	62
3/28/2015	1	0.04756	**28**	–	28	21	41
3/29/2015	1	0.04756	**28**	–	28	21	41
3/30/2015	1	0.04756	**28**	–	28	21	41
3/31/2015	1	0.04756	**21**	–	21	16	31
4/1/2015	1	0.01151	**87**	–	87	53	248
4/2/2015	4	0.01151	**348**	57	405	268	1,049
4/3/2015	2	0.01151	**174**	39	213	144	535
4/4/2015	2	0.01151	**209**	43	251	169	638
4/5/2015	2	0.01151	**209**	43	251	169	638
4/6/2015	2	0.01151	**209**	43	251	169	638

Appendix B continued

Date	GOLF catch	GOLF efficiency	GOLF abundance	BYPASS catch	Downstream abundance estimate	95% Lower CI	95% Upper CI
4/7/2015	2	0.01151	**174**	9	183	114	505
4/8/2015	3	0.01151	**261**	24	285	182	768
4/9/2015	1	0.01151	**87**	85	172	138	333
4/10/2015	1	0.01151	**87**	184	271	237	432
4/11/2015	2	0.01151	**130**	107	237	186	479
4/12/2015	2	0.01151	**130**	107	237	186	479
4/13/2015	2	0.01151	**130**	107	237	186	479
4/14/2015	3	0.01151	**261**	133	394	291	877
4/15/2015	0	0.01151	**0**	112	112	112	112
4/16/2015	1	0.01151	**87**	103	190	156	351
4/17/2015	3	0.01151	**261**	151	412	309	895
4/18/2015	2	0.01151	**188**	379	567	493	916
4/19/2015	2	0.01151	**188**	379	567	493	916
4/20/2015	2	0.01151	**188**	379	567	493	916
4/21/2015	1	0.01151	**87**	949	1,036	1,002	1,197
4/22/2015	5	0.01151	**434**	636	1,070	899	1,876
4/23/2015	3	0.01151	**261**	322	583	480	1,066
4/24/2015	1	0.01151	**87**	1,347	1,434	1,400	1,595
4/25/2015	3	0.01151	**261**	944	1,204	1,102	1,687
4/26/2015	3	0.01151	**261**	944	1,204	1,102	1,687
4/27/2015	3	0.01151	**261**	944	1,204	1,102	1,687
4/28/2015	–	–	–	688	688	688	688
4/29/2015	–	–	–	1,596	1,596	1,596	1,596
4/30/2015	–	–	–	1,072	1,072	1,072	1,072
5/1/2015	–	–	–	828	828	828	828
5/2/2015	–	–	–	1,157	1,157	1,157	1,157
5/3/2015	–	–	–	2,458	2,458	2,458	2,458
5/4/2015	–	–	–	3,122	3,122	3,122	3,122
5/5/2015	–	–	–	2,168	2,168	2,168	2,168
5/6/2015	–	–	–	1,544	1,544	1,544	1,544
5/7/2015	–	–	–	2,301	2,301	2,301	2,301
5/8/2015	–	–	–	1,425	1,425	1,425	1,425
5/9/2015	–	–	–	1,366	1,366	1,366	1,366
5/10/2015	–	–	–	2,205	2,205	2,205	2,205
5/11/2015	–	–	–	1,794	1,794	1,794	1,794
5/12/2015	–	–	–	2,570	2,570	2,570	2,570
5/13/2015	–	–	–	1,250	1,250	1,250	1,250
5/14/2015	–	–	–	643	643	643	643
5/15/2015	–	–	–	821	821	821	821
5/16/2015	–	–	–	674	674	674	674
5/17/2015	–	–	–	478	478	478	478
5/18/2015	–	–	–	361	361	361	361
5/19/2015	–	–	–	451	451	451	451
5/20/2015	–	–	–	774	774	774	774
5/21/2015	–	–	–	584	584	584	584
5/22/2015	–	–	–	447	447	447	447

Appendix B continued

Date	GOLF catch	GOLF efficiency	GOLF abundance	BYPASS catch	Downstream abundance estimate	95% Lower CI	95% Upper CI
5/23/2015	–	–	–	373	373	373	373
5/24/2015	–	–	–	271	271	271	271
5/25/2015	–	–	–	281	281	281	281
5/26/2015	–	–	–	310	310	310	310
5/27/2015	–	–	–	184	184	184	184
5/28/2015	–	–	–	118	118	118	118
5/29/2015	–	–	–	90	90	90	90
5/30/2015	–	–	–	87	87	87	87
5/31/2015	–	–	–	110	110	110	110
6/1/2015	–	–	–	118	118	118	118
6/2/2015	–	–	–	73	73	73	73
6/3/2015	–	–	–	51	51	51	51
6/4/2015	–	–	–	49	49	49	49
6/5/2015	–	–	–	33	33	33	33
6/6/2015	–	–	–	8	8	8	8
6/7/2015	–	–	–	17	17	17	17
6/8/2015	–	–	–	7	7	7	7
6/9/2015	–	–	–	2	2	2	2
6/10/2015	–	–	–	6	6	6	6
6/11/2015	–	–	–	1	1	1	1
6/12/2015	–	–	–	2	2	2	2
6/13/2015	–	–	–	1	1	1	1
6/14/2015	–	–	–	2	2	2	2
6/15/2015	–	–	–	0	0	0	0
6/16/2015	–	–	–	3	3	3	3
6/17/2015	–	–	–	2	2	2	2
6/18/2015	–	–	–	1	1	1	1
6/19/2015	–	–	–	1	1	1	1

Appendix C. Monthly totals of species caught at the upstream RST (VINO) on the lower Mokelumne river during the 2014/15 juvenile outmigration monitoring season.

Common Name	**Genus**	**Species**	**Dec.**	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**June**	**Total**
Black Bass	*Micropterus*	*spp.*	0	0	0	0	0	177	1	**178**
Black Crappie	*Pomoxis*	*nigromaculatus*	0	1	0	0	0	0	0	**1**
Bluegill	*Lepomis*	*macrochirus*	0	0	0	0	1	0	0	**1**
Brown Bullhead	*Ameiurus*	*nebulosus*	1	0	0	0	0	1	0	**2**
Chinook Salmon	*Oncorhyhchus*	*tshawytscha*	51	4,371	14,211	3,188	477	274	6	**22,578**
Golden Shiner	*Notemigonus*	*crysoleucas*	4	1	3	3	2	0	0	**13**
Green Sunfish	*Lepomis*	*cyanellus*	0	0	0	1	0	0	0	**1**
Hitch	*Lavinia*	*exilicauda*	0	0	2	2	1	1	0	**6**
Largemouth Bass	*Micropterus*	*salmoides*	0	0	0	0	0	1	0	**1**
Pacific Lamprey	*Entosphenos*	*tridentatus*	169	31	337	130	448	311	310	**1,736**
Prickly Sculpin	*Cottus*	*asper*	2	7	10	14	27	50	4	**114**
Redear Sunfish	*Lepomis*	*microlophus*	1	0	0	0	0	1	0	**2**
Sacramento Pikeminnow	*Ptychocheilus*	*grandis*	0	0	2	1	7	38	2	**50**
Sacramento Sucker	*Catostomus*	*occidentalis*	0	0	2	0	8	15	12	**37**
Spotted Bass	*Micropterus*	*punctulatus*	2	0	0	0	0	0	0	**2**
Steelhead (No Ad-Clip)	*Oncorhynchus*	*mykiss*	0	0	16	113	25	11	0	**165**
Threadfin Shad	*Dorosoma*	*petenense*	1	1	0	0	0	0	0	**2**
Tule Perch	*Hysterocarpus*	*traski*	8	11	24	19	13	13	6	**94**
Western Mosquitofish	*Gambusia*	*affinis*	2	2	1	2	1	1	1	**10**
White Catfish	*Ameiurus*	*catus*	0	0	1	0	0	0	0	**1**

Appendix D. Monthly totals of fish species caught at the downstream traps (GOLF and BYPASS) on the lower Mokelumne river during the 2014/15 juvenile outmigration monitoring season.

Common Name	**Genus**	**Species**	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**June**	**Total**
Black Bass	*Micropterus*	*spp.*	0	14	0	9,103	31,308	32,343	**72,768**
Black Bullhead	*Ameiurus*	*melas*	0	0	0	1	0	0	**1**
Black Crappie	*Pomoxis*	*nigromaculatus*	8	14	0	0	0	14	**36**
Bluegill	*Lepomis*	*macrochirus*	0	1,028	7	7	3	7	**1,052**
Brown Bullhead	*Ameiurus*	*nebulosus*	0	0	0	0	2	0	**2**
Chinook Salmon	*Oncorhyhchus*	*tshawytscha*	37	527	71	7,537	31,245	377	**39,794**
Common Carp	*Cyprinus*	*carpio*	0	3	0	2	10	19	**34**
Golden Shiner	*Notemigonus*	*crysoleucas*	0	22	0	1	11	11	**45**
Goldfish	*Carassius*	*auratus*	0	0	0	0	2	1	**3**
Green Sunfish	*Lepomis*	*cyanellus*	0	20	0	1	2	0	**23**
Hitch	*Lavinia*	*exilicauda*	0	1	0	1	1	0	**3**
Largemouth Bass	*Micropterus*	*salmoides*	1	35	0	0	0	0	**36**
Pacific Lamprey	*Entosphenus*	*tridentatus*	2	9	15	163	46	120	**355**
Prickly Sculpin	*Cottus*	*asper*	4	19	12	214	1,174	238	**1,661**
Redear Sunfish	*Lepomis*	*microlophus*	1	3	0	0	1	0	**5**
Redeye bass	*Micropterus*	*coosae*	0	0	0	1	0	0	**1**
Sacramento Pikeminnow	*Ptychocheilus*	*grandis*	0	0	0	0	1	0	**1**
Sacramento Sucker	*Catostomus*	*occidentalis*	0	2	0	0	2	0	**4**
Smallmouth Bass	*Micropterus*	*dolomieu*	0	0	0	1	0	0	**1**
Spotted Bass	*Micropterus*	*punctulatus*	0	0	0	0	0	1	**1**
Steelhead (Ad-Clip)	*Oncorhynchus*	*mykiss*	0	48	0	3	4	6	**61**
Steelhead (No Ad-Clip)	*Oncorhynchus*	*mykiss*	0	2	1	24	12	6	**45**
Threadfin Shad	*Dorosoma*	*petenense*	1	0	0	0	0	0	**1**
Tule Perch	*Hysterocarpus*	*traski*	0	4	0	181	35	130	**350**
Warmouth	*Lepomis*	*gulosus*	0	1	0	0	0	0	**1**
Western Mosquitofish	*Gambusia*	*affinis*	0	4	3	0	0	1	**8**