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The Resources Agency
DEPARTMENT OF FISH AND GAME

THREE YEAR REPORT 2013-2015
SHASTA AND SCOTT RIVER
JUVENILE SALMONID OUTMIGRANT STUDY
P1110316

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1.0 Abstract:
Since 2000, the Anadromous Fisheries Resource Assessment and Monitoring Program (AFRAMP) conducted by the Yreka office of the California Department of Fish and Wildlife has operated rotary screw traps in the Scott and Shasta Rivers of the greater mid-Klamath River basin for the purpose of generating population estimates for out-migrating juvenile salmon. Described here are the results obtained during the 2013-2015 sampling seasons. Using rotary screw traps, all age classes of out-migrating Chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*O. kisutch*), and steelhead trout (*O. mykiss*), as well as a variety of native and non-native fish species were sampled over these three years. Only Chinook and coho salmon data will be presented in this report. Using the Carlson method for mark and recapture of salmonids, trap efficiencies and population estimates were produced on a weekly basis. Established age-length cutoffs for each species were used to determine fish age. In-stream conditions such as flow and water temperature were also monitored. Weekly estimates for the smolt class of all species were compared to show multi-year population trends. Using multi-year seasonal production estimates and coho salmon returns to the Shasta River, adult survival and smolt production estimates were calculated for Shasta River coho. In 2013, it was estimated a total of 5,218,270 0+ Chinook, 1,930 0+ coho, and 494 1+ coho emigrated from the Shasta River during the sampling period. It was also estimated for the same sample period that 656,031 0+ Chinook, 1,290 0+ coho, and 7,927 1+ coho emigrated from the Scott River. In 2014, a total of 4,744,838 0+ Chinook, 10,752 0+ coho, and 850 1+ coho emigrated from the Shasta River. Additionally, 423,085 0+ Chinook, 760 1+ Chinook, 16,962 0+ coho, and 5,708 1+ coho, emigrated from the Scott River. It was estimated that for the period sampled in 2015, a total of 2,901,966 0+ Chinook, 851 0+ coho, and 6,279 1+ coho emigrated from the Shasta River. It was estimated for this same sample period that 243,431 0+ Chinook, 23 (actual number caught) 0+ coho, and 7,253 1+ coho emigrated from the Scott River.

2.0 Introduction:
The Scott and Shasta Rivers have historically supported substantial runs of Chinook and coho salmon. However, a long history of habitat modifications, including dam construction, dredging and channel homogenization, coupled with the increased development of agricultural and livestock resources and their attendant surface water diversions for irrigation needs, have reduced both the quantity and quality of historic salmonid spawning and rearing habitat. Despite these changes that have occurred over many decades within the watershed, Chinook remain relatively abundant in the Scott and Shasta Rivers. However, within the greater Klamath watershed, it was spring-run Chinook which once predominated (Snyder, 1931). Similar to the Klamath, the Shasta River historically supported large numbers of spring-run Chinook (Wales, 1951). At present, only fall-run fish persist while there remain numerous and significant threats to their continued survival within the Klamath River and its tributaries. In light of such threats, there exists a clear need to retain salmon population monitoring programs such as is described in this report.

For the past fifteen years the Anadromous Fisheries Research Assessment and Monitoring Program has conducted rotary screw trapping of out migrating juvenile salmonids on the Shasta and Scott Rivers in Siskiyou County, California. This report summarizes the past three years of trapping on these two river systems. Monitoring of salmonids on the Shasta River dates back to 1930 when returning adult Chinook salmon were first counted. Monitoring of juvenile salmonids on the Shasta River dates back to 1981 (KRIS, 2010). This monitoring initially began with the use of fyke nets and did not occur every year. However, in 2000, annual monitoring began on the Shasta River using rotary screw traps. The use of screw traps allows the calculation of trap efficiencies and corresponding juvenile production estimates. Monitoring of juvenile salmonid migration in the Scott River also began in 2000 and has continued since. In 2002, coho salmon of the Southern Oregon/Northern California Coast Evolutionary Significant Unit (SONCC ESU) were listed as a threatened species from the Oregon border to Punta Gorda, California under the California Endangered Species Act (CESA). In 2010 monitoring became even more important with the release of a California Department of Fish and Game report stating that two of the three coho cohorts on the Shasta River were “functionally extinct” with populations and production rates in decline (Chesney 2010). Juvenile salmonid out migration monitoring is necessary in order to continue to assess the status of populations of Chinook salmon, coho salmon, and steelhead trout in the Shasta and Scott Rivers.

2.1 Study Goals and Objectives:

The specific study goals of the 2013-2015 out-migration monitoring program on the Scott and Shasta rivers were as follows:

- To determine emigration abundance and timing of all age classes of juvenile salmonids in the Shasta and Scott Rivers between late January and into early July of each year, flows permitting.
- To investigate the relationships between in-stream conditions and emigration patterns of juvenile salmonids

To accomplish this, the specific objectives were as follows:

- To measure fork lengths and ages of salmonids in the catch from a measured sub-sample and to record changes throughout the sampling seasons.
- To estimate weekly rotary trap efficiencies for all age classes of Chinook and coho salmon in the catch and produce weekly production estimates for each age class according to river and year.
- To monitor stream flow and temperature at the traps.

3.0 Shasta River Rotary Screw Trap Methods

3.1.0 Methods

The Shasta River was sampled with a modified five-foot rotary screw trap manufactured by EG Solutions (Corvallis, Oregon). The trap was fitted with a specially modified, extended live car. The extended live car dimensions are 15' x 3'4" x 1'10". The trap operated six days per week, Sunday afternoon through Saturday morning. It was located at 041º 49' 46.38" N, 122º 35' 35.38" W (WGS 84), directly downstream of the Shasta River Fish Counting Facility, and approximately 750 yards from the mouth of the river. In 2013 during Julian Weeks 8 through 13 a five foot rotary screw trap with a stock live car was operated downstream of the original trap in order to optimize fry catches. During this fishing period a special smaller and ventilated live car was fitted to the upstream trap allowing fry to escape and facilitating higher smolt catches and recaptures. For all years the trap was processed daily at approximately 0800 hours. The trap was also checked at approximately 1600 hours to monitor operation and remove debris as necessary.

All vertebrates collected in the trap were identified and counted. Salmonids collected in the trap were classified by species, age, and life stage. Data collected during each set included: length of time fished, water velocity in front of cone using a flow meter manufactured by General Oceanics (model 2030R), number of cone rotations, debris amount, water temperatures, and weather. The velocity of the water entering the cone was measured at the beginning and end of each set and the total volume of water sampled by the trap was calculated for each set in million cubic feet (MCF).

3.1.1 Bio-Sampling

A sub-sample of fish was processed daily for bio-data which consisted of fork length, life stage, and age. Scales were also collected from some selected fish. Up to 25 individuals of each age class of steelhead and coho, as well as 50 0+ Chinook, and 15 1+ Chinook were sampled daily. This task involved anesthetizing the sub-sample of fish in a CO_2 water bath. The fish would be anesthetized within 45 seconds to 1 minute. Thereafter fish were measured, aged, attributed a life stage, and scales were collected. After each fish was sampled it was placed into a well aerated recovery bucket containing Stress Coat® Water Conditioner by Mars Fishcare North America, Inc. (Chalont, Pennsylvania), to aid quick recovery. Every week up to 10 scale samples of each age class were taken. At least 12 scales per fish were collected. Attempts were made to collect scales from fish representing a range of fork lengths within each age class. Scales were taken from the left side of the fish in a region known as the "scale pocket" (located between the dorsal fin and the adipose fin above the lateral line). Once the scales were collected, they were then added to a multi-year scale collection library from which the age-length cutoffs were derived. Otoliths were removed from deceased salmon and added to a multi-year otolith library for future micro-chemistry analyses.

3.1.2 Age Determination

Age–length cutoffs developed in 2007 were used to estimate ages of salmonids in the catches (Appendix 1). These cutoffs were determined by calculating the ages of scales in the 2001-2007 collection. Individual scale samples were visually examined and categorized into brood years using scale age-estimation methods (Van Oosten 1957, Chilton and Beamish 1982, Casselman 1983). Fork length intervals for each age class were determined for appropriate time periods and updated throughout the season to create the age-length cutoffs used. These intervals are not absolutes and as a result of variable growth, some individuals may be older or younger than the cutoff fork lengths suggest.

3.1.3 Trap Efficiency Determinations and Production Estimates

Trap efficiency trials ran Monday through Saturday when sufficient fish were in the catch. Multiple trap efficiency trials were conducted to determine the mean weekly trap efficiency for 0+ Chinook, and 0+, 1+, 2+, and 3+ steelhead. For each trial, a known number of marked fish from each age class were taken three quarters of a mile upstream from the trap, and placed in an automatic time release box set to release upon nightfall and the number of marked fish in the following day's catch was recorded. The goal of the study was to maintain a minimum 10% recapture rate.

Up to 500 0+ salmonids were dyed in a solution of 0.6 – 1.2 grams of Bismarck Brown Y (Alfa Aesar, Ward Hill, Massachusetts). The number of fish marked in this manner depended on fish size, water temperature, and other stress factors, with increases in all these factors trending to decrease the number of fish selected for marking. 1+, 2+, and 3+ aged fish were marked with a caudal fin margin clip. Age 1+ coho caudal clippings were retained as tissue samples and dried on blotter paper to be kept for future genetic analyses. Three different caudal fin margin clips were used in a weekly rotation in order to only count recaptured fish from the week they were marked. The three caudal clips used were upper caudal, lower caudal, and upper/lower caudal.

For each species and age class, the number of fish recaptured during the week divided by the total number marked equaled the weekly estimated trap efficiency. An estimate of the total number of outmigrants per week was determined using a stratified mark and recapture technique (Carlson 1998). Zero was used for the lower confidence limit if the calculated lower confidence limit for the estimate was negative. In weeks when marked fish were released but none were recaptured, the average trap efficiency for the season (the seasonal trap efficiency) was used.

During 2013, due to low numbers of 0+ and 1+ coho, fish handling was minimized and coho were not marked. To calculate trap efficiency, data from years past was used to correlate coho and steelhead and trap efficiencies for similar life stages. 0+ coho were correlated to 0+ steelhead, and 1+ coho were correlated to 2+ steelhead.

The correlation between 0+ steelhead and 0+ coho in 2005,2006 and 2008 was expressed by the equation y=0.8224x+0.0039 (Figure 1), where "x" represented the weekly efficiencies for 0+ steelhead from 2013, while "y" represented and 1+ coho observed in 2004,2005 and 2009 was used to estimate the number of coho smolts produced in 2013. The equation was expressed by y=0.7532x+0.1485 (Figure

2), where "x" represented the weekly efficiencies for 2+ steelhead from 2013, while "y" represented the trap efficiency for 1+ coho.

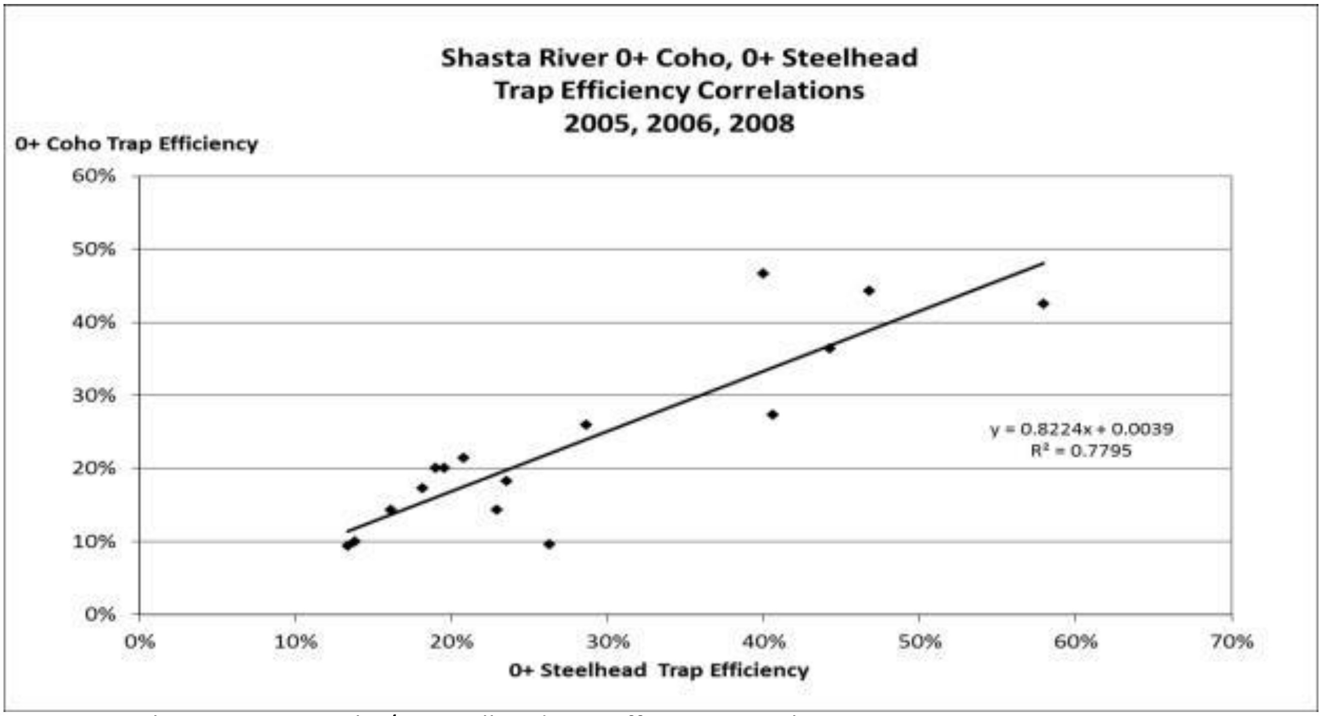


Figure 1: *Shasta River 0+ coho/0+ steelhead trap efficiency correlations 2013*

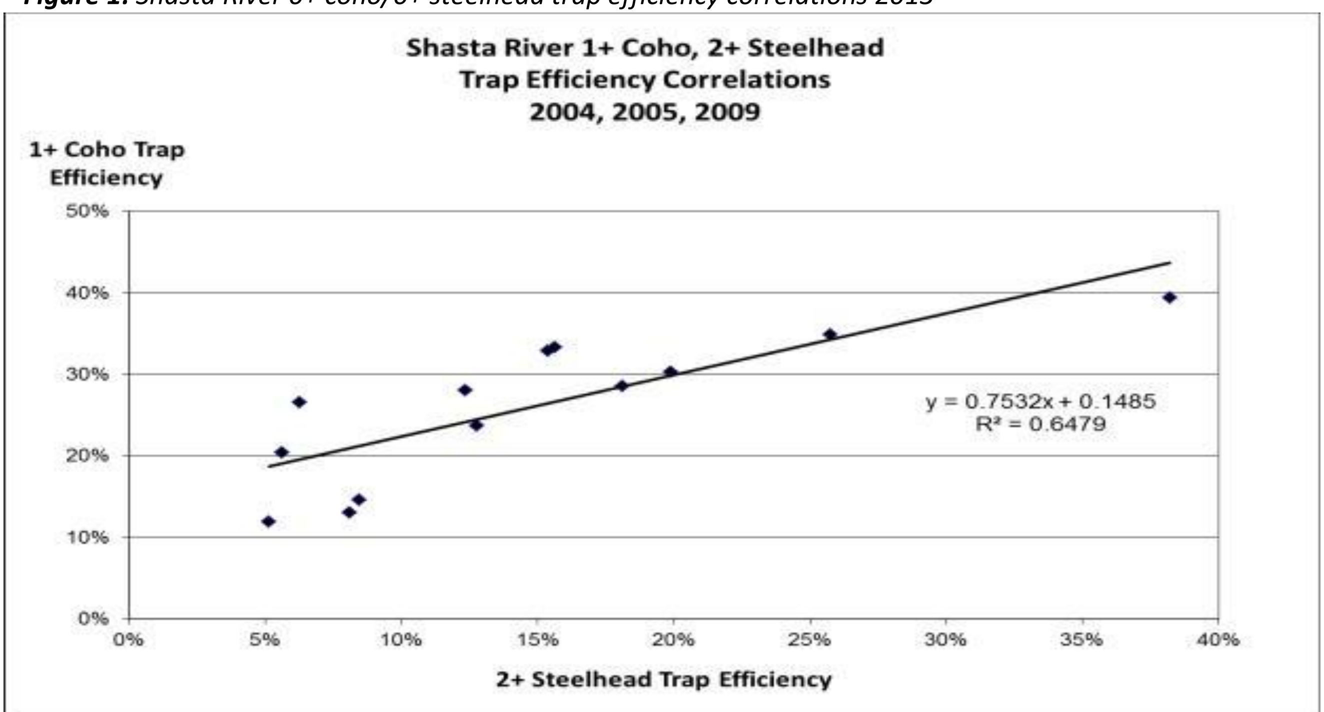


Figure 2: *Shasta River 1+coho/2+ steelhead trap efficiency correlations2013*

3.1.4 Water Temperature and Flow Monitoring

Hourly water temperatures were recorded using a waterproof temperature loggers (Model U22-001, Onset Computer Corporation, Bourne, Massachusetts) attached on river right near the trap location. The logger was deployed in January, before salmonid out migration monitoring began, and continued to collect data through Julian week 26, when the season ended.

Stream flow measurements were obtained from a United States Geological Survey (USGS) stream gauge, number 11517500, Shasta River, Yreka (SRY). This gauge is located approximately 0.75 miles upstream of the confluence with the Klamath River and records stream flow and gauge height every 15 minutes. Stream flow data presented in this report has been finalized by the USGS however it appears the last three months in 2015 are still subject to revision.

3.1.5 Data Entry and Analysis

All data from field forms were entered into Microsoft Access database software. Summary tables were created in Access and exported to Microsoft Excel, where data were broken down by species and age class.

Temperature data were downloaded in the field and then uploaded into HOBOware Pro version 2.7.3 (Onset Corp.). These data were then exported to Excel for analysis.

4.0 Scott River Rotary Screw Trap Methods

4.1.0 Methods

The Scott River was sampled with a five foot and an eight foot rotary screw trap manufactured by EG Solutions, Corvallis, Oregon. The traps were operated six days per week, Sunday afternoon through Saturday morning, at approximately 4.75 miles upstream of the confluence with the Klamath River at 041º 43' 34.87" N, 123º 00' 30.11" W. The catch in the trap was processed daily at approximately 0900 hrs.

Salmonids collected in the trap were classified by species, age, and life stage. All other vertebrates collected in the trap were identified and counted and measured only on Saturday.

Data collected during each set for the two traps included: length of time fished, water velocity in front of cone using a flow meter manufactured by General Oceanics (model 2030R), number of cone rotations, debris amount, water temperature, and weather. The velocity of the water entering the cone was measured at the beginning and end of each set and the total volume of water sampled by the trap was calculated for each set in million cubic feet (MCF).

4.1.1 Bio-Sampling

The same bio-sampling methods as described in the Shasta River section on page 7 of this report were also used on the Scott River.

4.1.2 Age Determination

The same age–length cutoffs for salmonids that were developed for use in 2007 were used again this year (Appendix 2). These cutoffs were determined from fork length frequency distributions and by estimating the age of scales in the 2001-2007 collection. Individual scale samples were visually examined and categorized into brood years using scale age-estimation methods (Van Oosten 1957, Chilton and Beamish 1982, Casselman 1983). Fork length intervals for each age class were determined for appropriate time periods and updated throughout the season. The intervals are not absolutes and as a result of variable growth, some individuals may be larger or smaller than the cutoff fork length.

4.1.3 Trap Efficiency Determinations and Production Estimates

Trap efficiencies for Chinook, coho and steelhead were calculated weekly using the same methods described in the Shasta River section on page 4 of this report. Weekly efficiency trials for all age classes of Chinook, coho and steelhead were conducted for all three years on the Scott River. In 2013 handling of 0+ coho was minimized. In order to obtain a population estimate the correlation between 0+ steelhead efficiencies and 0+ coho efficiencies in 2005 and 2006 was used. This correlation is expressed by the equation $y = 1.2666x + 0.0847$ (Figure 3). The weekly efficiencies for 0+ steelhead from 2013 were equal to x and with y equaling 0+ coho.

During 2014 and 2015 0+ coho were abundant enough to run a mark recapture methods similar to other 0+ Chinook and steelhead as described in the Shasta River methods on page 8.

Age 1+ Coho were abundant enough all three years to perform mark recapture methods in order to obtain population estimate. The same procedure of caudal clipping was used on Chinook and steelhead also described on page 4.

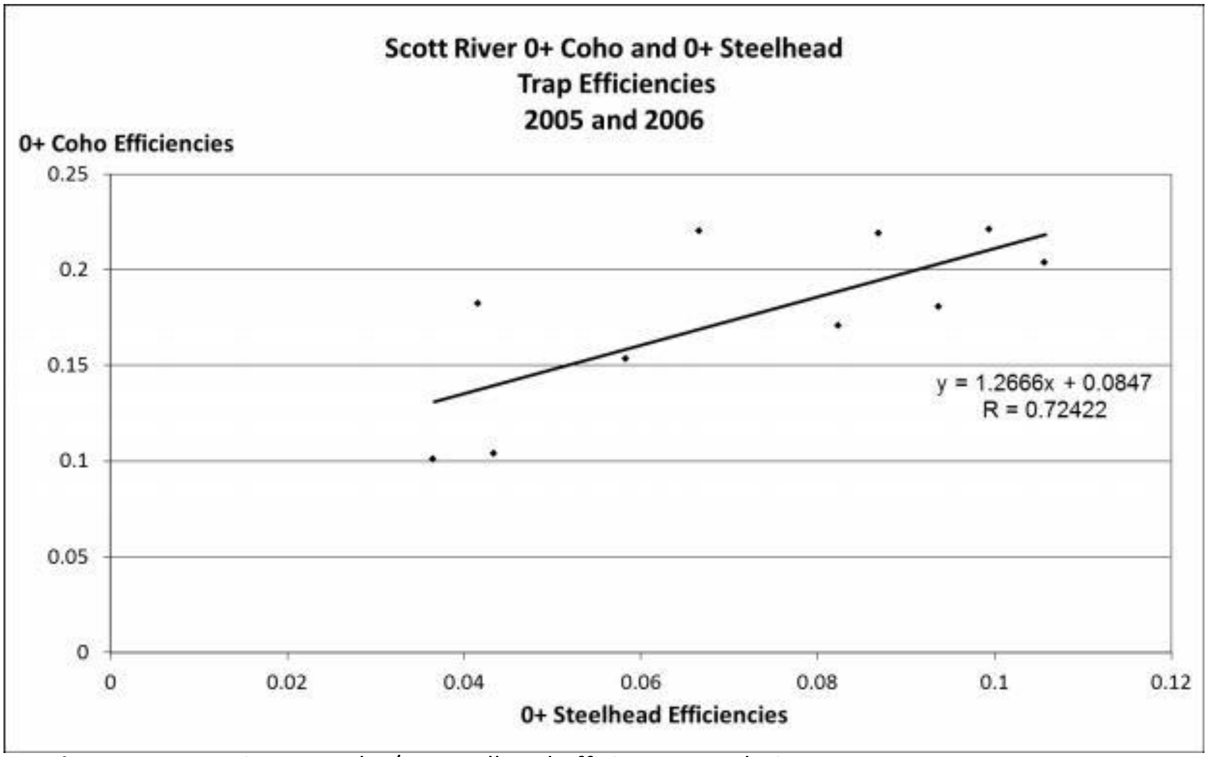


Figure 3: Scott River 0+ coho/0+ steelhead efficiency correlation, 2013

4.1.4 Water Temperature and Flow Monitoring

Stream flow measurements presented in this report were made using preliminary data from a USGS stream gauge, number 11519500, located approximately 19.5 miles upstream of the trap. Several tributaries without stream gauges enter the Scott River between the gauge and the trap and are not included in the flow measurements.

Hourly water temperature was recorded using similar methods as described in the Shasta River section of this report on page 10. A waterproof temperature loggers (Model U22-001, Onset Computer Corporation, Bourne, Massachusetts) was attached on river right near the trap location. The logger was deployed in January, before salmonid out migration monitoring began, and continued to collect data through Julian week 26, when the season ended.

4.1.5 Data Entry and Analysis

The same data entry and analysis methods as described in the Shasta River section of this report were also used to analyze the data obtained from the traps on the Scott River.

5.0 Results

5.1 Results for 2013

5.1.1 Shasta River

An estimated 5,218,270 0+ Chinook (95% CI, 4,916,768 - 5,519,771) emigrated from the Shasta River during the 2013 trapping season (Table 6). A total of 580,142 0+ Chinook were trapped during sampling. An estimated 1,931 0+ coho emigrated from the Shasta River during the same period (Table 12). A total of 374 0+ coho were trapped during sampling. No fork lengths for 0+ coho were taken until Julian week 21 (Figure 19). The outmigration population estimate was derived from a correlation of observed trap efficiencies between 0+ steelhead and 0+ coho from the 2005, 2006 and 2008 trapping seasons. An estimated 495 1+ coho emigrated from the Shasta River. A total of 152 1+ coho were trapped during the sampling period (Table 18). The population estimate was derived from the correlation of observed trap efficiencies between 2+ steelhead and 1+ coho from the 2004, 2005 and 2009 trapping seasons.

5.1.2 Scott River

An estimated 656,031 0+ Chinook (95% CI, 606,468 – 705,594) emigrated from the Scott River during the period sampled (Table 7). A total of 72,759 0+ Chinook were trapped during sampling. An estimated 1,290 0+ coho emigrated from the Scott River during the same period. A total of 372 0+ coho were trapped during sampling (Table 16). An estimated 7,925 1+ coho (95% CI 4,809 – 11,045) emigrated from the Scott River during the 2013 season. A total of 663 1+ coho were trapped during sampling (Table 19).

5.2 Results for 2014

5.2.1 Shasta River

In 2014, an estimated 4,744,838 0+ Chinook (95% CI, 4,591,469 – 4,898,206) emigrated from the Shasta River during the sampling season. A total of 1,008,580 Chinook 0+ were sampled (Table 5). An estimated 10,753 0+ coho (95% CI, 7,916 – 13,588) emigrated from the Shasta River during the season. A total of 1,618 0+ coho were trapped during sampling (Table 11). An estimated 849 (95% CI, 623 – 1,076) 1+ coho emigrated from the Shasta River. A total of 299 1+ coho were trapped during sampling (Table 17).

5.2.2 Scott River

In the Scott River, an estimated 423,087 0+ Chinook (95% CI, 364,462 – 481,709) emigrated during the sampling period. A total of 23,610 0+ Chinook were trapped during sampling (Table 9). An estimated 16,962 (95% CI, 12,457 – 21,647) 0+ coho emigrated from the Scott River. A total of 1,565 0+ coho were trapped during sampling (Table 15). An estimated 5,710 1+ coho (95% CI, 3,734 – 7,682) emigrated during the season. A total of 591 1+ coho were trapped during sampling (Table 21). In the sub-sample, 706 0+ coho and 573 1+ coho were measured (Figure22-23) and aged; 20 otolith samples were taken from 0+ coho; 69 scale, 5 otolith and 212 tissue samples were taken from 1+ coho.

5.3 Results for 2015

5.3.1 Shasta River

In 2015 an estimated 2,901,968 0+ Chinook (95% CI, 2,772,054 – 3,031,878) emigrated from the Shasta River during the sampling period. A total of 550,637 Chinook 0+ were sampled during the trapping season (Table 13) An estimated 852 0+ coho (95% CI, 514 – 1,189) emigrated from the Shasta River in 2015. A total of 189 0+ coho were trapped during sampling (Table 16). An estimated 6,281 (95% CI, 5,510 – 7,048) 1+ coho emigrated from the Shasta River in the same period. A total of 1,920 1+ coho were trapped during sampling (Table 22).

5.3.2 Scott River

An estimated 243,431 0+ Chinook (95% CI, 210,816 – 276,047) emigrated from the Scott River during the period sampled. A total of 9,555 0+ Chinook were trapped during sampling (Table 11). A total of 23 0+ coho were captured during sampling (Table 17). No mark/recapture trials were successful. An estimated 7,253 1+ coho (95% CI, 4,689 – 9,816) emigrated from the Scott River in 2015. A total of 529 1+ coho were trapped during sampling on the Scott River (Table 23). In the sub-sample, 16 0+ coho and 527 1+ coho were measured (Figure 25-26) and aged; 3 scale, 1 otolith and 3 tissue samples were taken from 0+ coho; 108 scale, 7 otolith and 118 tissue samples were taken from 1+ coho.

6.0 Discussion

6.1.1 Shasta River Chinook

Rotary trap operation on the Shasta River during 2013, 2014 and 2015 estimated the three largest years of production for 0+ Chinook salmon during the period of record (2002-2014 Table 1, Figure 4). The number of juveniles produced from returning adults in Brood Years (BY) 2012 through 2014 ranged from 189 per adult for BY 2012, to 685 for BY 2013.

Table 1: Production of 0+ Chinook salmon 2002-2014

Brood Year	number of adults	RST catch year	juvenile estimate	juveniles produced / adult
2002	6,432	2003	2,486,076	386.5
2003	4,134	2004	297,298	71.9
2004	833	2005	297,208	356.8
2005	2,018	2006	83,387	41.3
2006	789	2007	579,735	734.8
2007	2,009	2008	938,503	467.1
2008	2,714	2009	718,949	264.9
2009	6,145	2010	2,347,783	382.1
2010	1,261	2011	654,625	519.1
2011	213	2012	166,500	781.7
2012	27,600	2013	5,218,270	189.1
2013	6,925	2014	4,744,838	685.2
2014	14,412	2015	2,901,966	201.4

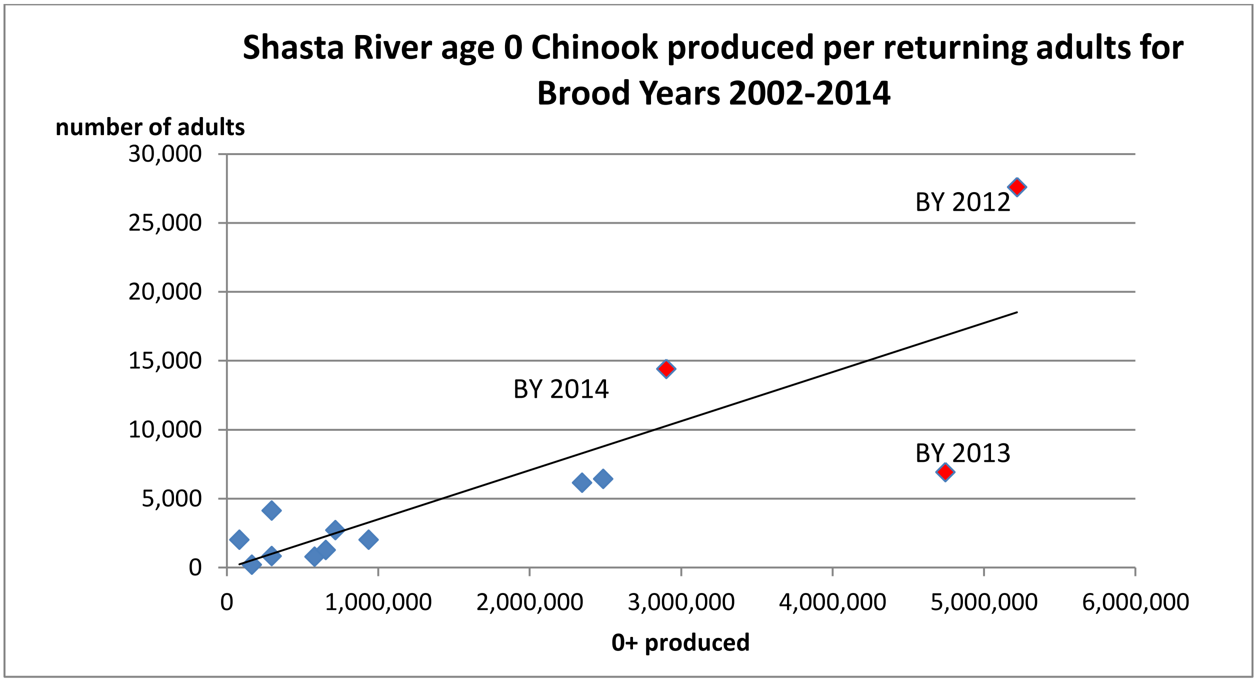


Figure 4: *Shasta River 0+ Chinook produced per returning adults for brood years 2002-2014*

The survival and return of salmonids from any cohort depends on a complex relationship between the number of fish produced and environmental factors. An example of this is shown in Table 2 using the return percentage of 2 year old Shasta River Chinook salmon. 2 year old salmon known as grilse or jacks are not targeted in the fishery to the same extent as older age Chinook, so the impacts from harvest to this age class are reduced. The return of age 2 Chinook is considered to be a good indication of cohort survival and is one of the key elements of the harvest model used by the Pacific Fisheries Management Council.

Table 2 includes some of the variables known to affect the survival of anadromous salmonids native to the Klamath watershed, including ocean conditions as described by the Pacific Decadal Oscillation (PDO). A negative value for this index indicates conditions favorable of salmon survival (Mantura et al 1997). Another variable affecting survival is exposure and mortality due to *Ceratonova shasta* (*C. shasta).* The potential for loss to *C.shasta is* measured monthly by the observed mortality of sentinel fish held at specific locations in the Klamath River, (Bartholomew 2015).

Brood Years 2012 and 2013 have similar production estimates of age 0 Chinook (5,218,270 and 4,744,838) emigrating from the Shasta River at approximately the same size and time yet the survival and return of age 2 fish is 27 times greater for Brood Year 2012 than 2013 (0.0756% or 3945 grilse compared with .0028% or 133 grilse). The PDO index for June along with the observed *C. shasta* caused mortality in the sentinel juvenile Chinook health studies downstream of the Shasta River near Beaver Creek are different for these two Brood Years. Ocean conditions were better for BY 2012 than BY 2013 during the month of July as indicated by the PDO index of -1.25 and 0.72 respectively. The observed mortality of sentinel fish in the Klamath River near Beaver Creek due to *C.Shasta* during May of 2013 was 0% compared to 40% during the same period in 2014 when the majority of Shasta origin Chinook are in the Klamath River and are potentially exposed to *C. Shasta.* The different PDO and disease conditions observed for these two years may have played a role in the rate of return of grilse from these two brood years

As stated previously the relationship between environmental conditions and the survival is complex. Outmigrant trapping and juvenile production estimates provide managers with a starting point to evaluate the effects of these variables.

Table 2: Survival Variables for Chinook salmon, 2004-2015

Brood Year	RST catch year	RST age 0 est	juv/adult	Age 2 return	% return at age 2	PDO index for July	% C. shasta mortality
2004	2005	297,208	357	395	0.1329%	.66	
2005	2006	83,387	41	27	0.0324%	.35	
2006	2007	579,735	735	3621	0.6246%	.78	28.00%
2007	2008	938,503	467	151	0.0161%	-1.67	74.00%
2008	2009	718,949	265	87	0.0121%	-0.53	78.00%
2009	2010	2,347,783	382	11187	0.4765%	-1.05	0.00%
2010	2011	654,625	519	1944	0.2970%	-1.86	0.00%
2011	2012	166,500	782	1096	0.6583%	-1.52	0.00%
2012	2013	5,218,270	189	3945	0.0756%	-1.25	0.00%
2013	2014	4,744,838	685	133	0.0028%	0.7	40.00%
2014	2015	2,901,966	201			1.84	

6.1.2 Shasta River Coho

Yearly and weekly estimates of 1+ coho from Shasta River were compared with data from the previous twelve years of sampling. The estimates from 2013 and 2014 were the fourth and fifth lowest, respectively (494, 850) and estimates from 2015 were the third highest (6,279) for the period of 2003-2015. (Table 3, Figure 5). Estimates for 0+ coho for the last three years have been variable yet are intrinsically tied to cohort strength. For example, 1+ coho smolts in 2015 were the progeny of the strongest adult coho cohort (Cohort B)(Figure 6). However, 1+ coho smolts in 2013 are the progeny of the second strongest cohort the population estimate was slightly lower than 1+ coho smolts in 2014. In 2013 the estimates for coho were based on steelhead 2+ trap efficiencies. We still believe this to be a good correlation (Figures 1,2) due to the fact that 1+ coho and 2+ steelhead are at the same life stage and responding to similar environmental conditions but it can be argued that it is not perfect. If we look back to 2003 at our yearly estimate data and compare our estimates to returning cohort we do see relationship in between size of cohort and smolts produced at least for years 2004-2009. Again other variables will need to be weighed and these estimates provided a start for future evaluation.

The smolt to adult survival by year is shown for Shasta River coho 1+ in Table 3. We estimated 38.52 smolts were produced per adult from brood year 2013, 7.39 smolts from brood 2012, and 7.97 smolts from brood year 2011. (Figure 7, Table 3) The average survival of 4.10% does not include the adult percent return reflected in 2011 and 2012. Adult coho numbers returning in the fall have reflected more IGH strays. The estimate of IGH strays into the Shasta River for 2011 was 71%, and in 2012, 70%. Table 4 displays adult coho numbers returning to the Shasta, with percent of IGH strays for brood years 2011 –

2014. Due to this, percent return in Table 3 from brood years 2011 to 2014 is an overestimation and does not accurately represent wild coho populations. This is not abnormal, however due to continuing declining numbers of wild coho the effect of IGH strays exaggerates the actual percent return to a greater degree.

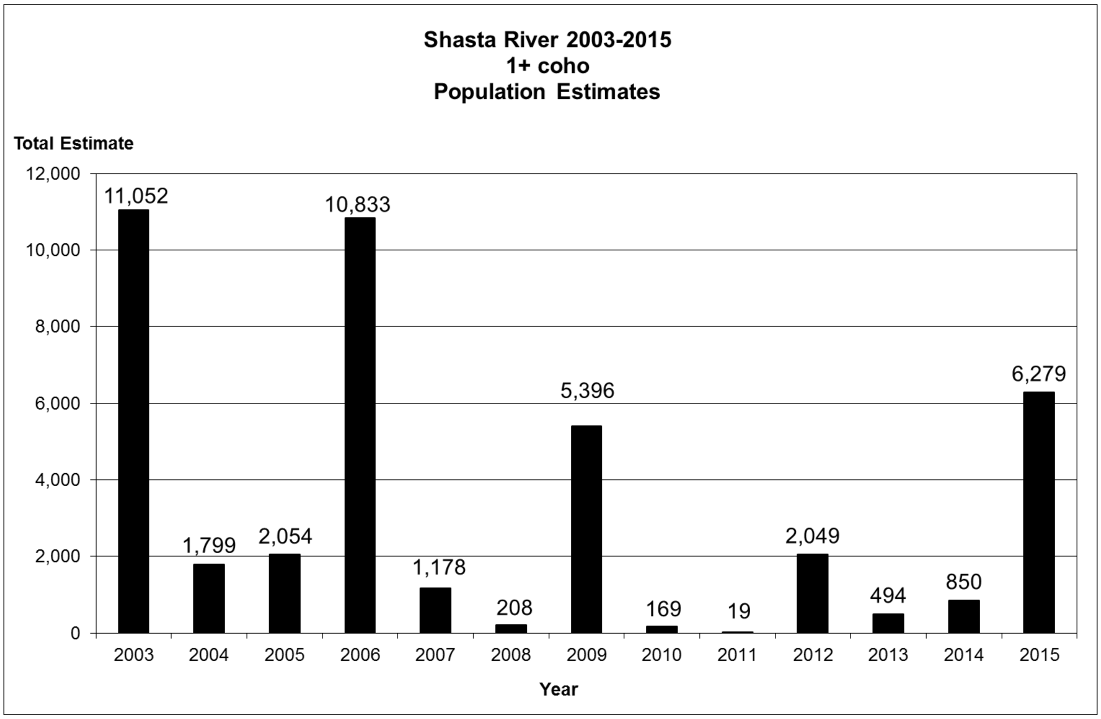


Figure 5: *Shasta River 2003 – 2015 1+ coho population estimates*

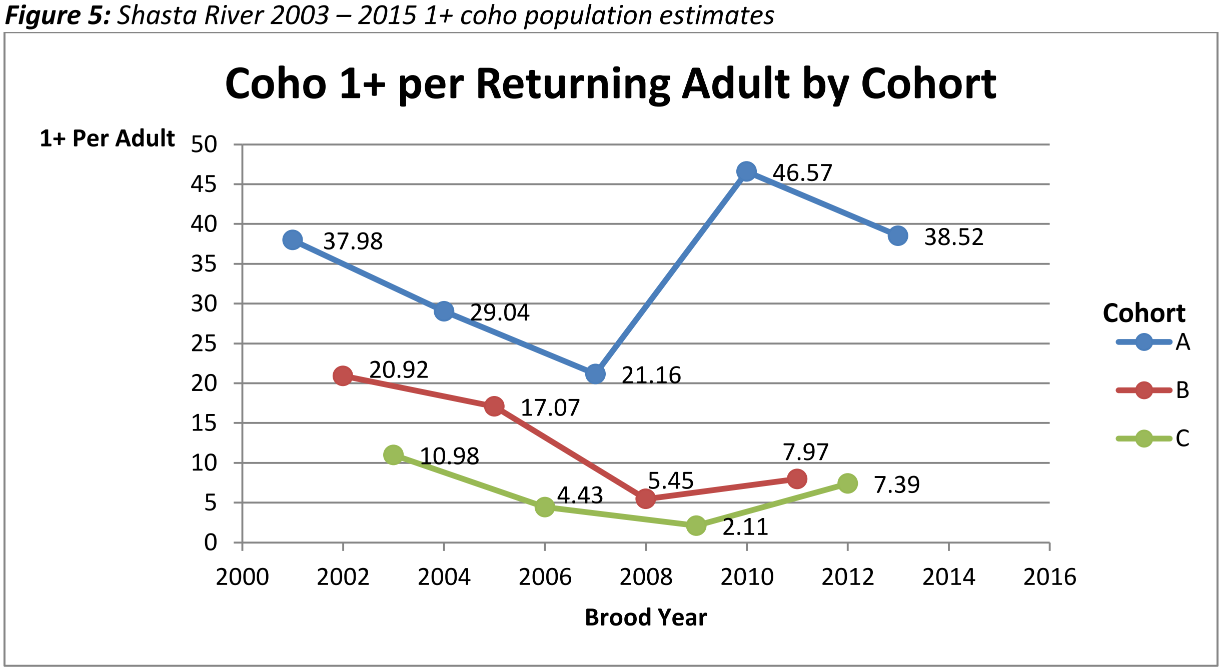


Figure6: Coho 1+ produced per returning adult by cohort

Table 3: Shasta River coho 1+ produced per returning adult and percent return of total adults

Brood year	Adults	year of emigration	1+ produced	smolts per adult	% Return	Adults Returning in	Brood Year
2001	291	2003	11,052	37.98	3.37%	373	2004
2002	86	2004	1,799	20.92	3.84%	69	2005
2003	187	2005	2,054	10.98	2.29%	47	2006
2004	373	2006	10,833	29.04	2.35%	255	2007
2005	69	2007	1,178	17.07	2.63%	31	2008
2006	47	2008	208	4.43	4.33%	9	2009
2007	255	2009	5,396	21.16	0.82%	44	2010
2008	31	2010	169	5.45	36.69%	62	2011
2009	9	2011	19	2.11	605.26%	115	2012
2010	44	2012	2,049	46.57	7.96%	163	2013
2011	62	2013	494	7.97	9.31%	46	2014
2012	115	2014	850	7.39	***4.10%***	***35***	***2015***
2013	163	2015	6,279	38.52	***4.10%***	***257***	***2016***
			Average	**19.20**			

Table 4: Shasta River 2011-2014 Iron Gate Hatchery and wild adult coho returns

Total Adults Returning in	Brood Year	% IGH Strays	IGH Adults	Wild Adults
62	2011	71%	44	18
115	2012	70%	81	35
163	2013	62%	101	62
46	2014	83%	38	8

(Data from the above table composed from Chesney & Knechtle 2012, Chesney & Knechtle 2013, Chesney & Knechtle 2014, and Chesney & Knechtle 2015)

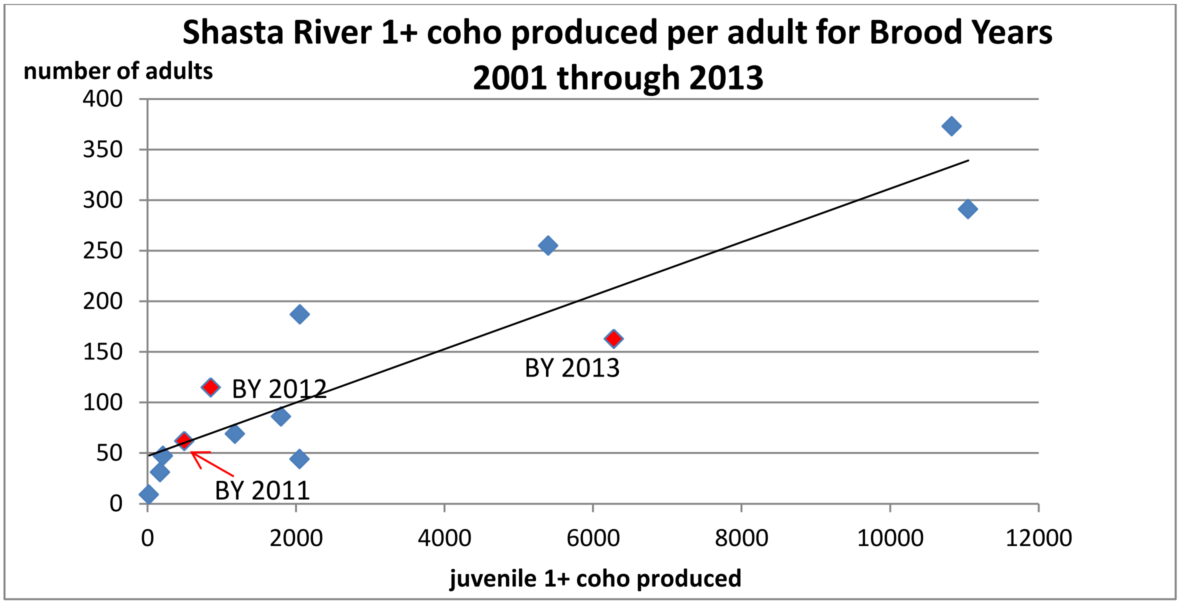


Figure 7: *Shasta River 1+ coho produced per Adult for Brood years 2001-2013*

6.1.3 Scott River Chinook

Both weekly and yearly population estimates were compared with the previous fourteen years of sampling. The past three years for 0+ Chinook on the Scott River have been variable from year to year. In 2013 the population estimate was above average with the third largest estimate in the past fourteen years of sampling (656,031, Figure XX). In sampling year 2014 an average estimate was observed (423,085) and in 2015 the estimate was well below average (*243,431)* (Figure 8).See appendix 4 for production per brood year for the past three brood years.

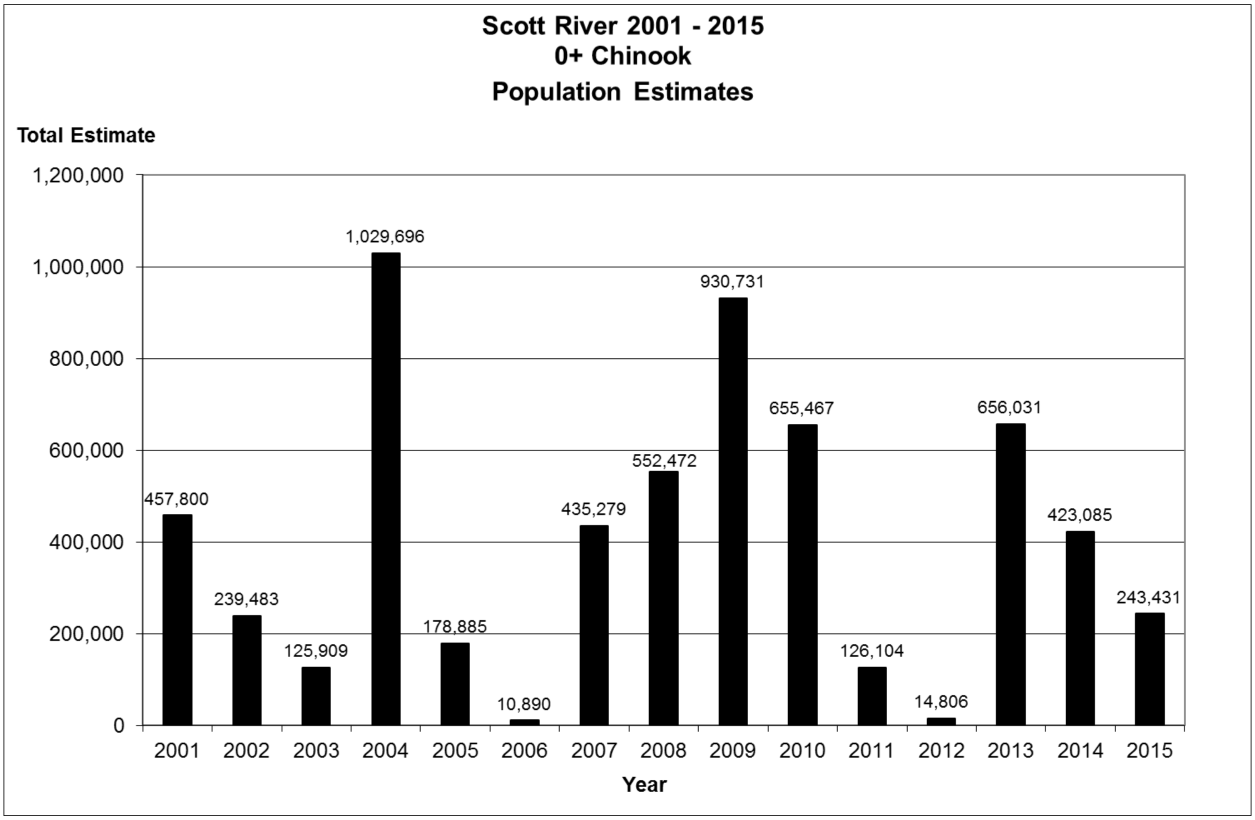


Figure 8: *Scott River 2001-2015 0+ Chinook population estimates*

6.1.4 Scott River Coho

Both yearly and weekly estimates of the number of 1+ coho salmon produced from the Scott River were compared with the data from the previous twelve years of sampling (Figure 9). The estimate of 7,253 for 2015 was found to be the sixth largest in the thirteen years of 1+ coho population estimates, the 2014 estimate of 5,708 was the sixth lowest, and the 2013 estimate of 7,927 was the fifth largest.

Figure 10 below shows the number of 1+ coho smolts per returning adult for brood years 2007-2012. This a strong correlation between the number of adults returning to the Scott River and the estimated of the number of age 1 smolts produced by those adults (r=0.96868). In the fall of 2013, 2,731 adult coho returned to the Scott River, the largest number of adult coho for the period of record (2001-2013). Figure 10 shows the number of coho smolts produced per returning adult for Brood Years 2007-2013. Based on the previous 6 years of tracking the relationship between adults and juveniles produced, we did not see the expected number of smolts produced. Rotary trap estimates indicate that the return of 201 adults in 2012 produced 62 more smolts per adult than the return of 2,731 adults in 2013 (Table 5)

Hatchery influence on the Scott is negligible. The estimated proportion of hatchery origin coho in the Scott River during 2012 was estimated to be 0.81% of the population or 2 fish (Chesney and Knechtle2012)

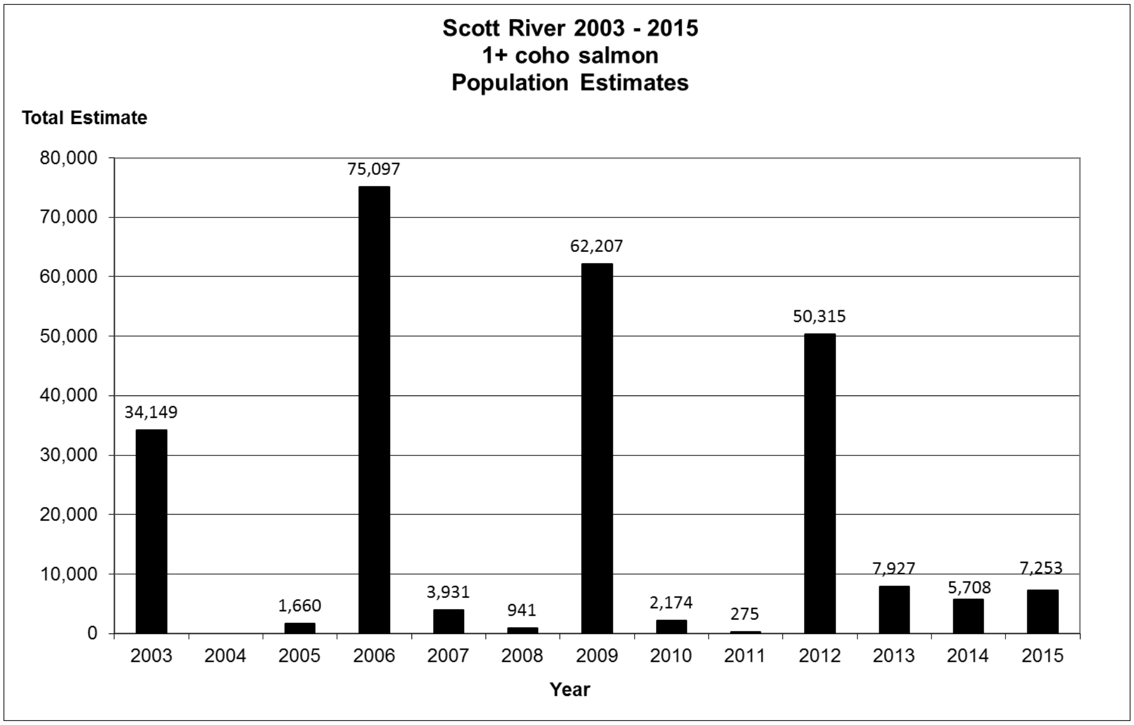


Figure 9: *Scott River 2003-2015 1+ coho population estimates*

Table 5: Scott River coho 1+ produced per returning adult

Scott River Coho					
		1+			
Brood Year	Adults	Emigration	Caught	Estimate	Smolts/Adult
2001		2003	1414	34149	
2002		2004	91	91	
2003		2005	248	1660	
2004		2006	3828	75097	
2005		2007	352	3931	
2006		2008	160	941	
2007	162	2009	5340	62207	38
2008	62	2010	185	2174	35
2009	81	2011	78	261	3
2010	911	2012	2926	50315	55
2011	344	2013	633	7927	23
2012	201	2014	591	5708	28
2013	2731	2015	529	7253	3

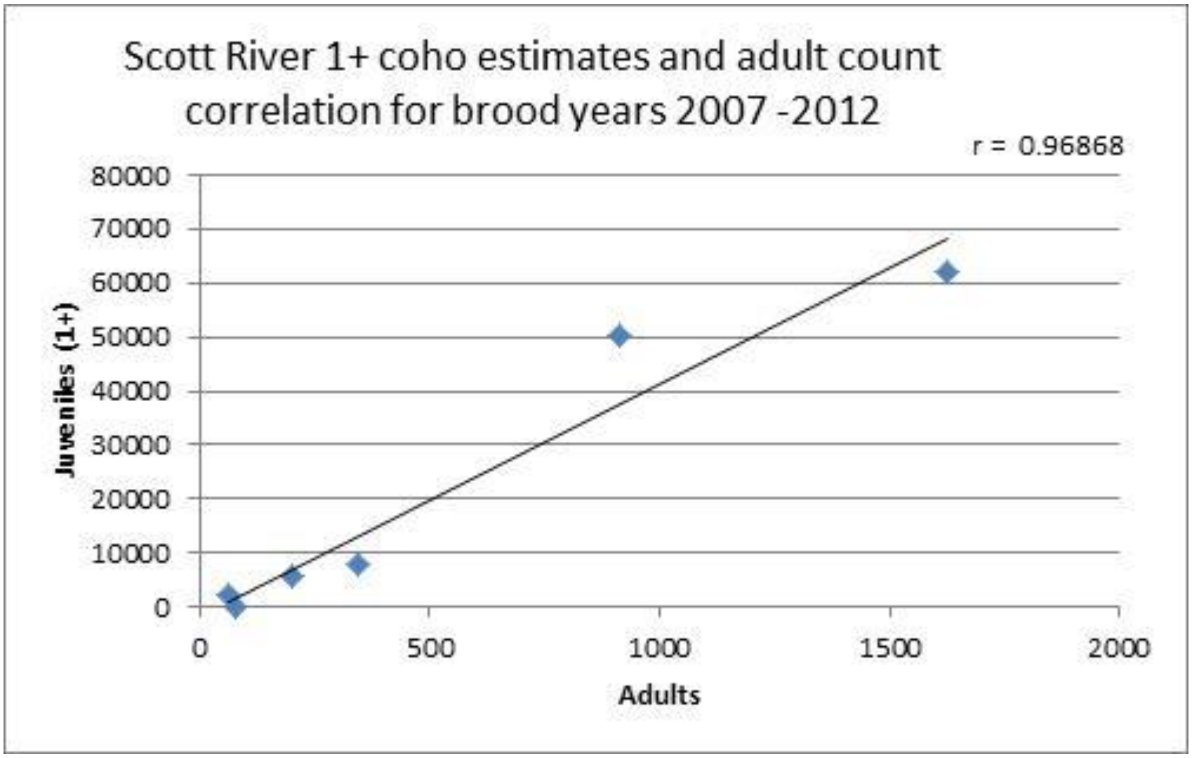


Figure 10: *Scott River 1+ coho estimated and adult count correlation for brood years 2007-2012*

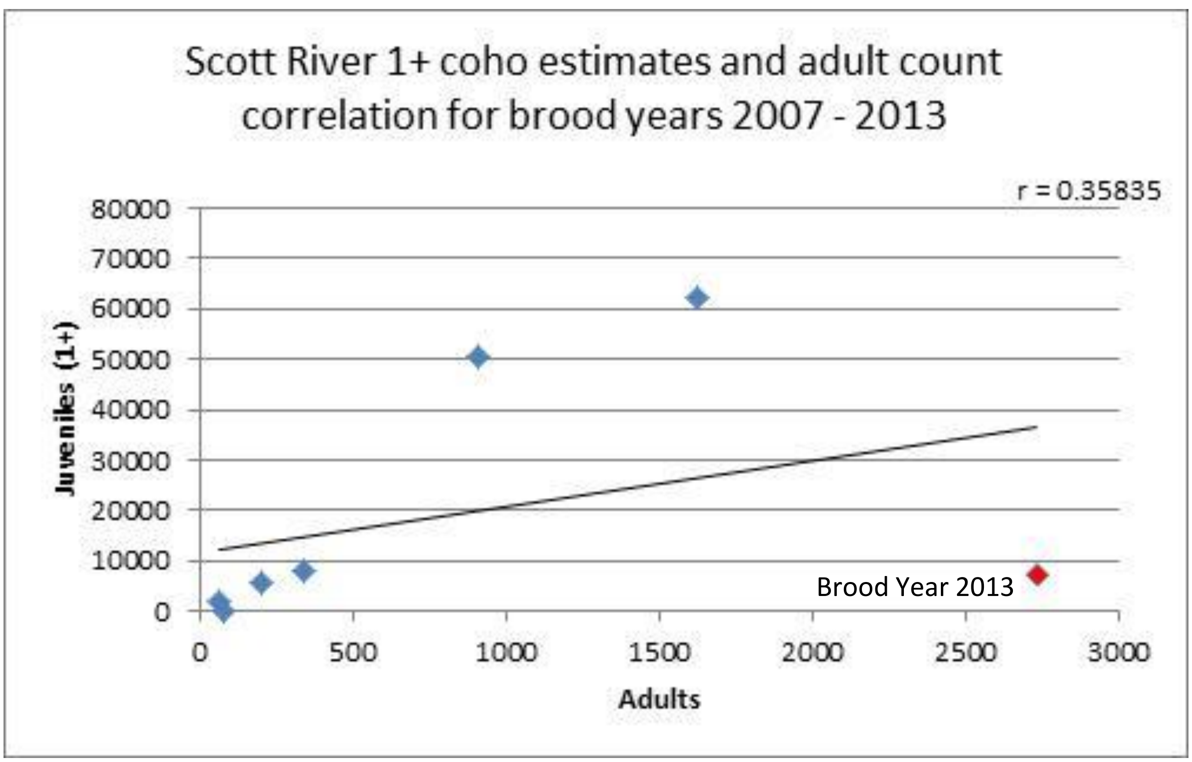


Figure 11: Scott River 1+ coho estimated and adult count correlations for brood years 2007-2013

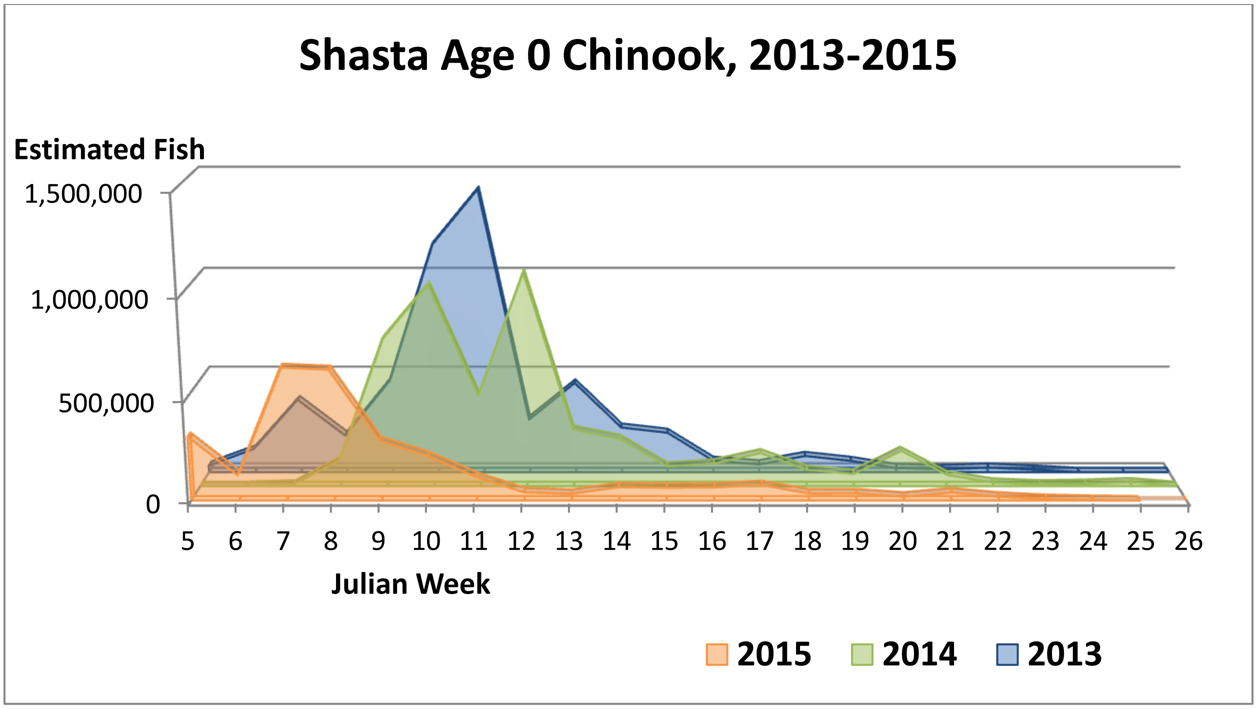


Figure 12: *Shasta River Age 0 Chinook weekly estimates for years 2013-2015*

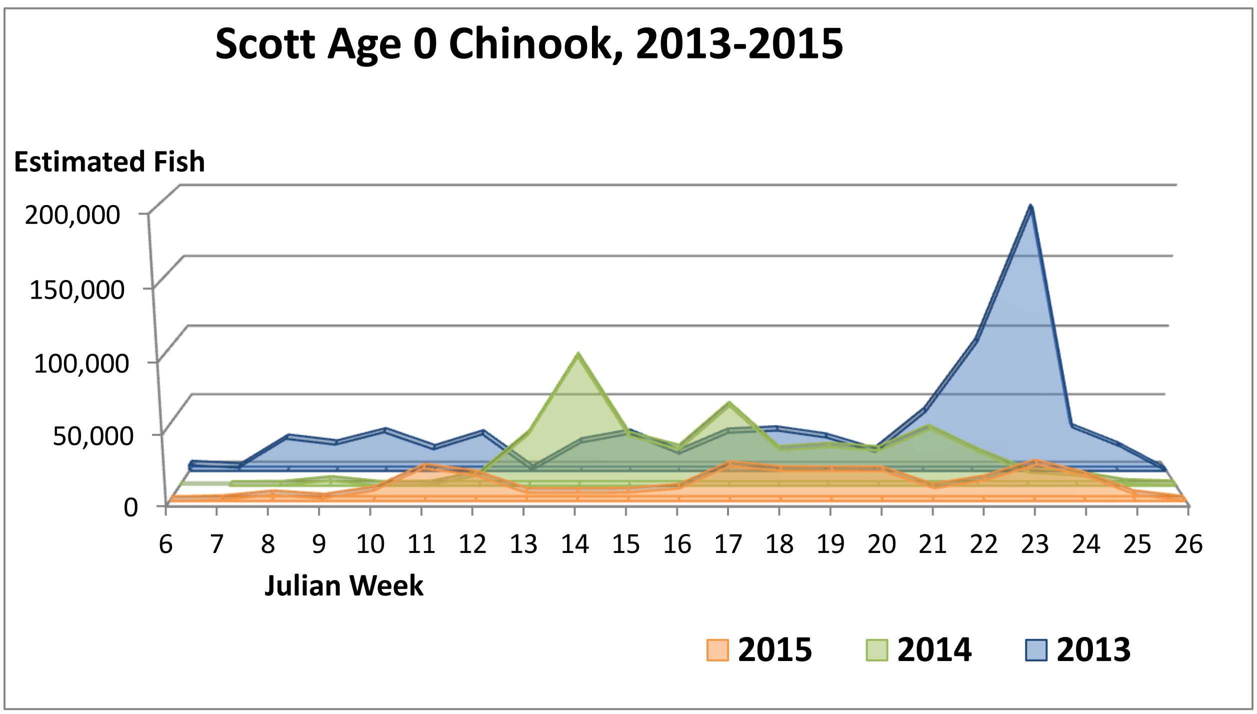


Figure 13: *Scott River Age 0 Chinook weekly estimates for years 2013-2015*

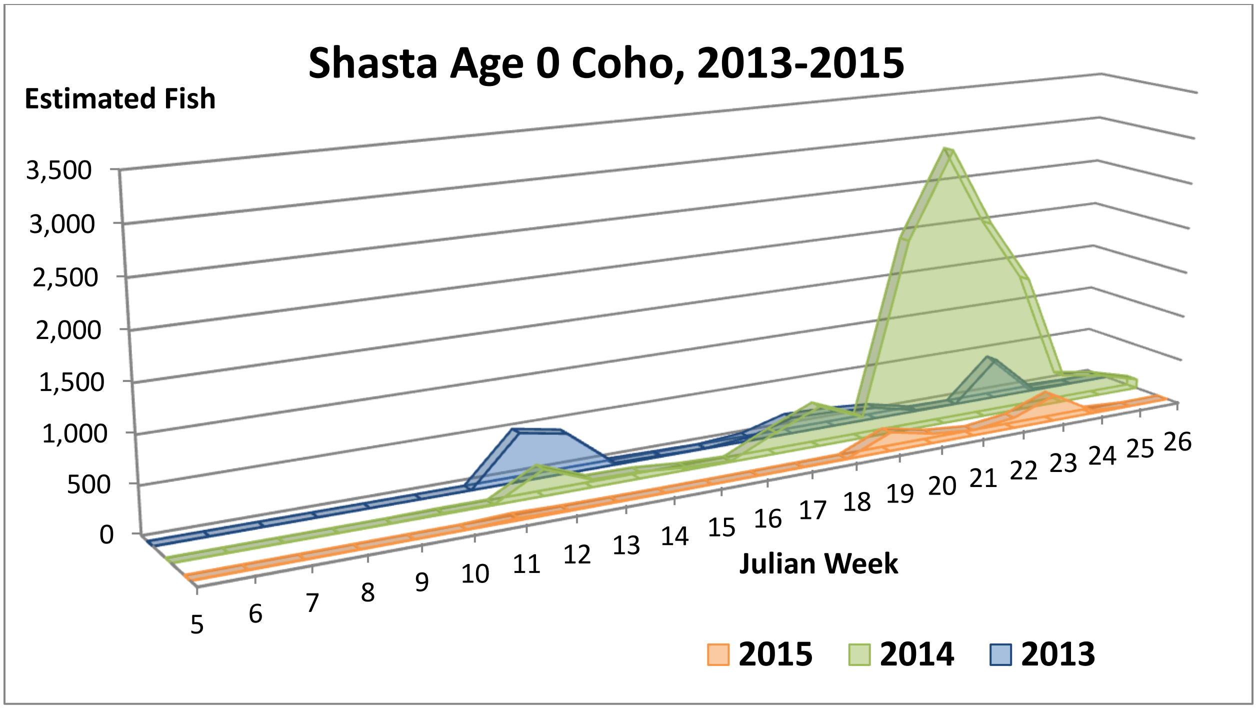


Figure 14: *Shasta River Age 0 coho weekly estimates for years 2013-2015*

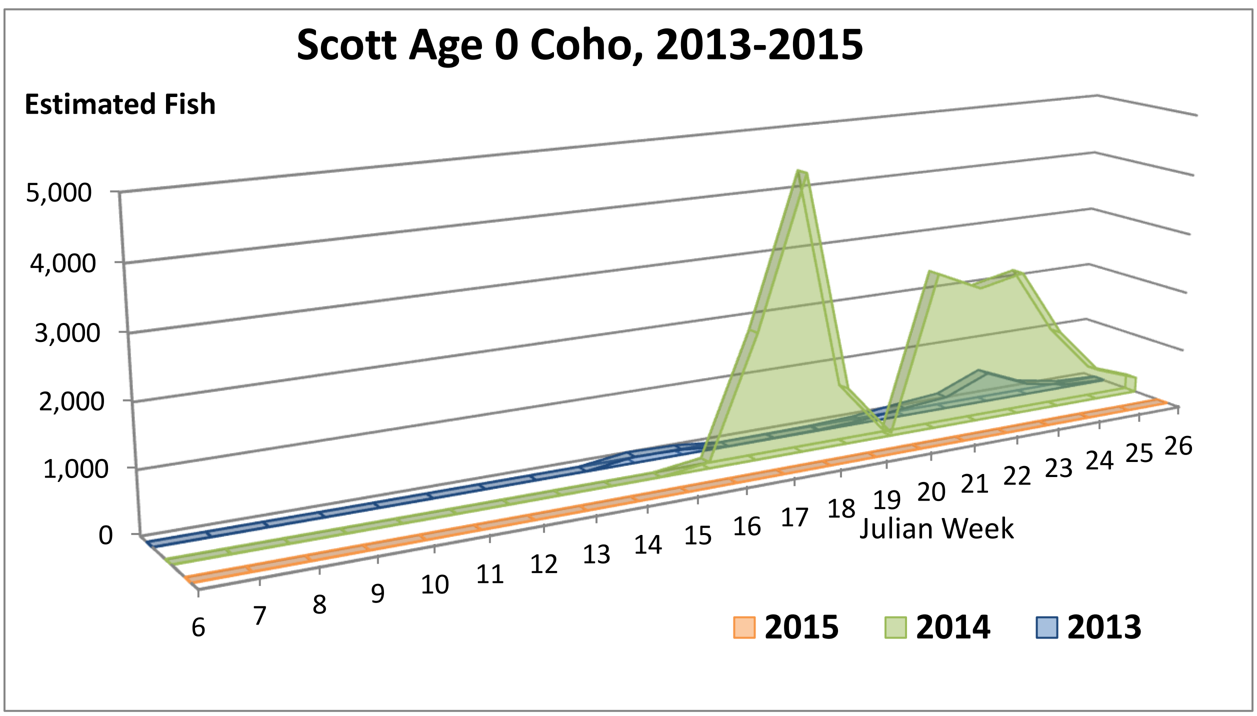


Figure 15: *Scott River Age 0 coho weekly estimates for years 2013-2015*

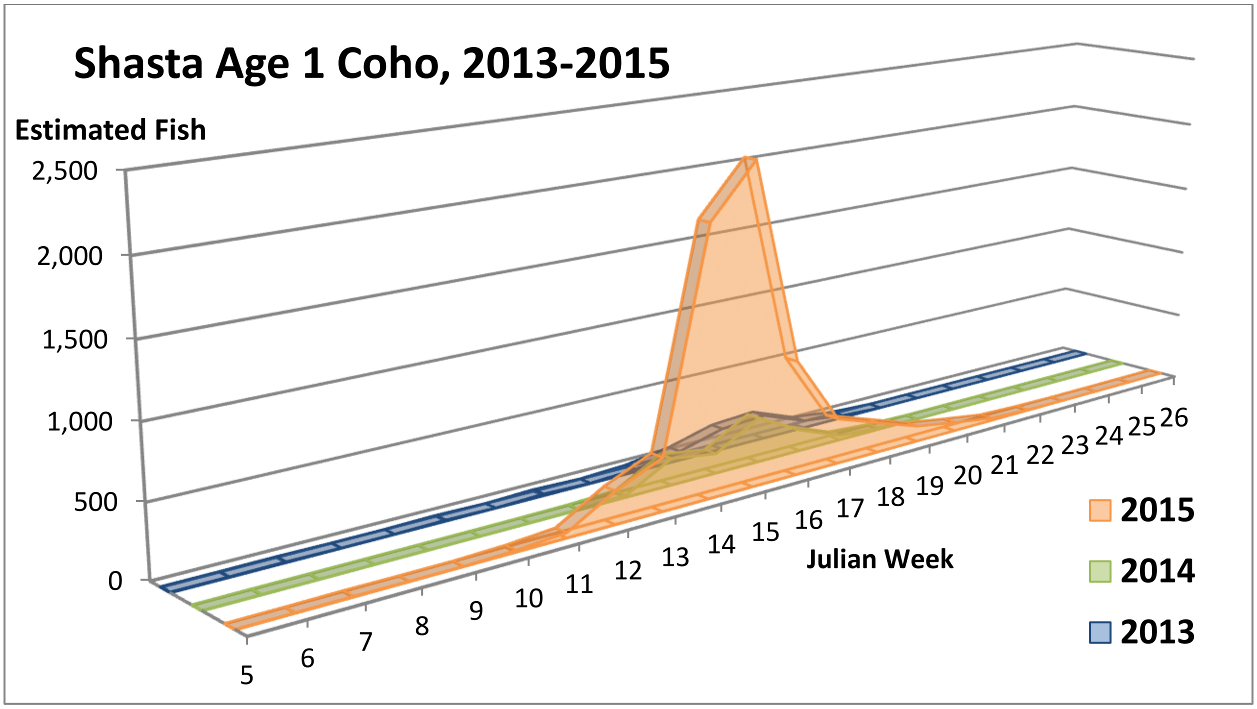


Figure 16: *Shasta River Age 1 coho weekly estimates for 2013-2015*

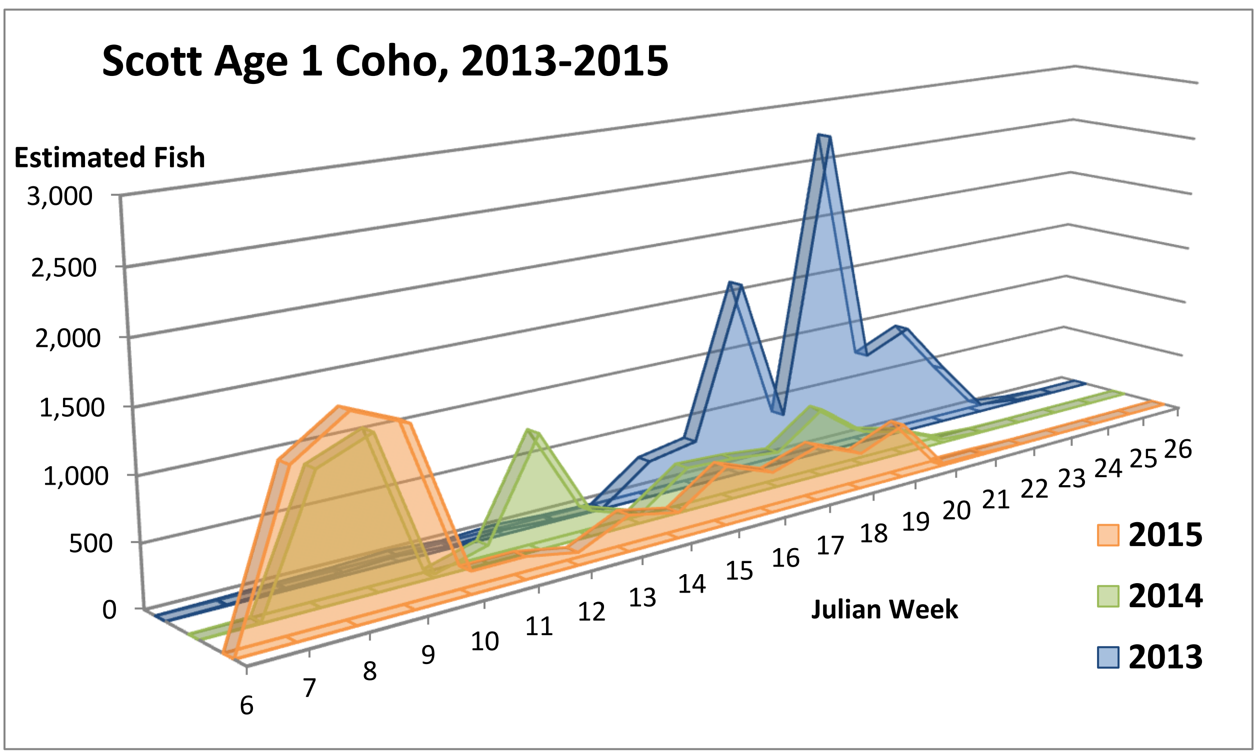


Figure 17: *Scott River Age 1 coho weekly estimates for years 2013-2015*

Chinook Catch Tables

Table 6: Shasta 2013 age 0+ Chinook salmon catch table

Week	Start	Live	Dead	Total	Marked	Recaps	Efficiency	Weekly estimate and 95% CI
5	1/29	5,552	95	5,647	198	32	0.162	34,053 [23,568–44,538]
6	2/5	26,596	267	26,863	497	111	0.223	119,444 [100,015–138,874]
7	2/12	73,221	412	73,633	1,696	335	0.198	371,890 [336,251–407,530]
8	2/19	19,783	269	20,052	2,495	264	0.106	188,867 [167,267–210,467]
9	2/26	32,849	271	33,120	2,493	176	0.071	466,674 [400,417–532,931]
10	3/5	61,517	507	62,024	2,492	134	0.054	1,145,377 [957,956–1,332,797]
11	3/12	97,358	1,964	99,322	2,498	174	0.070	1,418,318 [1,216,067–1,620,569]
12	3/19	22,225	458	22,683	2,487	208	0.084	270,025 [234,911–305,140]
13	3/26	23,926	2,353	26,279	2,467	141	0.057	456,736 [383,865–529,608]
14	4/2	17,015	2,606	19,621	1,687	143	0.085	230,002 [194,066–265,938]
15	4/9	55,534	1,596	57,130	1,482	416	0.281	203,175 [186,601–219,748]
16	4/16	18,470	402	18,872	1,473	473	0.321	58,686 [54,285–63,088]
17	4/23	20,447	364	20,811	1,399	726	0.519	40,076 [38,023–42,130]
18	4/30	46,125	950	47,075	730	411	0.563	83,524 [78,179–88,869]
19	5/7	16,970	818	17,788	418	127	0.304	58,228 [49,824–66,632]
20	5/14	13,398	107	13,505	497	317	0.638	21,149 [19,738–22,561]
21	5/21	6,514	66	6,580	493	216	0.438	14,979 [13,466–16,493]
22	5/28	4,908	158	5,066	429	93	0.217	23,174 [19,017–27,332]
23	6/4	3,793	65	3,858	500	147	0.294	13,060 [11,266–14,854]
24	6/11	112	6	118	143	28	0.196	586 [377–795]
25	6/18	93	2	95	66	25	0.379	245 [163–326]
Total catch		566,406	13,736	580,142	26,640	4,697	0.176	5,218,270 [4,916,768–5,519,771]

Table 7: Scott 2013 age 0+ Chinook salmon catch table

Week	Start	Live	Dead	Total	Marked	Recaps	Efficiency	Weekly estimate and 95% CI
7	2/12	306	10	316	123	8	0.065	4,354 [1,718–6,989]
8	2/19	158	6	164	58	3	0.052	2,419 [347–4,491]
9	2/26	807	18	825	229	7	0.031	23,719 [8,421–39,017]
10	3/5	1,613	86	1,699	902	78	0.086	19,420 [15,262–23,579]
11	3/12	1,720	38	1,758	858	52	0.061	28,493 [21,021–35,965]
12	3/19	480	18	498	448	13	0.029	15,972 [7,905–24,038]
13	3/26	460	4	464	348	5	0.014	26,989 [7,040–46,938]
14	4/2	36	16	52	14	0	0.000	780 [0–1,834]
15	4/9	854	20	874	478	19	0.040	20,932 [12,069–29,796]
16	4/16	1,820	13	1,833	1,632	108	0.066	27,461 [22,358–32,564]
17	4/23	1,525	28	1,553	1,101	132	0.120	12,868 [10,739–14,996]
18	4/30	3,654	34	3,688	1,610	210	0.130	28,158 [24,525–31,791]
19	5/7	1,968	170	2,138	1,028	73	0.071	29,730 [23,137–36,323]
20	5/14	1,683	11	1,694	710	48	0.068	24,580 [17,912–31,249]
21	5/21	1,996	10	2,006	1,524	218	0.143	13,969 [12,170–15,768]
22	5/28	4,670	16	4,686	1,335	143	0.107	43,476 [36,689–50,262]
23	6/4	17,930	113	18,043	447	85	0.190	93,991 [76,195–111,788]
24	6/11	24,071	91	24,162	896	114	0.127	188,464 [156,365–220,563]
25	6/18	4,843	25	4,868	749	113	0.151	32,026 [26,573–37,479]
26	6/25	1,431	7	1,438	392	30	0.077	18,230 [12,103–24,357]
Total catch		72,025	734	72,759	14,882	1,459	0.098	656,031 [606,468–705,594]

Table 8: Shasta 2014 age 0+ Chinook salmon catch table

Week	Start	Live	Dead	Total	Marked	Recaps	Efficiency	Weekly estimate and 95% CI	
5	1/29	104	6	110	11	1	0.091	660	[0–1,348]
6	2/5	192	2	194	92	14	0.152	1,203	[643–1,763]
7	2/12	1,168	17	1,185	427	58	0.136	8,596	[6,527–10,666]
8	2/19	25,211	89	25,300	2,443	470	0.192	131,281	[120,541–142,021]
9	2/26	162,681	951	163,632	2,498	556	0.223	734,141	[680,351–787,930]
10	3/5	155,060	4,454	159,514	2,494	396	0.159	1,002,487	[912,060–1,092,915]
11	3/12	79,615	889	80,504	2,488	439	0.176	455,396	[416,727–494,066]
12	3/19	192,864	3,525	196,389	2,451	452	0.184	1,063,015	[974,623–1,151,407]
13	3/26	47,894	661	48,555	2,481	419	0.169	286,937	[261,846–312,028]
14	4/2	55,061	842	55,903	1,683	392	0.233	239,544	[218,761–260,327]
15	4/9	29,320	2,031	31,351	1,298	404	0.311	100,555	[92,389–108,722]
16	4/16	53,040	281	53,321	899	416	0.463	115,081	[106,968–123,195]
17	4/23	81,579	1,903	83,482	498	248	0.498	167,299	[152,598–182,000]
18	4/30	26,778	423	27,201	499	163	0.327	82,930	[72,526–93,334]
19	5/7	29,105	73	29,178	499	234	0.469	62,081	[56,291–67,870]
20	5/14	30,398	1,103	31,501	489	85	0.174	179,482	[145,190–213,775]
21	5/21	10,365	1,369	11,734	344	72	0.209	55,455	[44,201–66,709]
22	5/28	5,507	188	5,695	250	78	0.312	18,094	[14,789–21,399]
23	6/4	1,965	17	1,982	247	57	0.231	8,475	[6,554–10,395]
24	6/11	649	4	653	250	13	0.052	11,707	[5,889–17,526]
25	6/18	1,069	13	1,082	200	10	0.050	19,771	[8,840–30,702]
26	6/25	112	2	114	135	23	0.170	646	[393–899]
Total catch		989,737	18,843	1,008,580	22,676	5,000	0.220	4,744,838	[4,591,469–4,898,206]

Table 9: Scott 2014 age 0+ Chinook salmon catch table

Week	Start	Live	Dead	Total	Marked	Recaps	Efficiency	Weekly estimate and 95% CI	
6	2/5	0	0	0	0	0	----	0	[0–0]
7	2/12	1	0	1	0	0	----	1	[1–1]
8	2/19	21	1	22	7	0	0.000	120	[0–353]
9	2/26	153	25	178	61	2	0.033	3,679	[132–7,225]
10	3/5	23	6	29	3	0	0.000	97	[0–239]
11	3/12	53	6	59	7	0	0.000	321	[0–938]
12	3/19	319	13	332	69	2	0.029	7,747	[286–15,207]
13	3/26	1,024	51	1,075	720	20	0.028	36,908	[21,564–52,253]
14	4/2	1,454	34	1,488	929	14	0.015	92,256	[47,191–137,321]
15	4/9	1,006	18	1,024	629	17	0.027	35,840	[19,817–51,863]
16	4/16	2,817	32	2,849	1,501	161	0.107	26,415	[22,477–30,352]
17	4/23	5,545	53	5,598	1,249	121	0.097	57,357	[47,623–67,090]
18	4/30	3,989	33	4,022	1,073	168	0.157	25,560	[21,960–29,160]
19	5/7	2,148	14	2,162	851	65	0.076	27,909	[21,393–34,426]
20	5/14	1,097	40	1,137	624	27	0.043	25,379	[16,241–34,518]
21	5/21	1,737	18	1,755	1,001	42	0.042	40,896	[28,930–52,861]
22	5/28	1,013	12	1,025	880	37	0.042	23,764	[16,334–31,194]
23	6/4	397	14	411	365	15	0.041	9,402	[4,947–13,856]
24	6/11	279	6	285	260	9	0.035	7,439	[3,053–11,824]
25	6/18	114	3	117	115	0	0.000	1,551	[0–20,359]
26	6/25	37	4	41	37	0	0.000	446	[0–2,603]
Total catch		23,227	383	23,610	10,381	700	0.067	423,087	[364,462–481,709]

Table 10: Shasta 2015 age 0+ Chinook salmon catch table

Week	Start	Live	Dead	Total	Marked	Recaps	Efficiency	Weekly estimate and 95% CI	
5	1/29	51,506	176	51,682	1,999	324	0.162	318,043	[286,348–349,738]
6	2/5	10,886	38	10,924	500	42	0.084	127,277	[91,249–163,306]
7	2/12	42,919	103	43,022	1,998	130	0.065	656,496	[548,068–764,925]
8	2/19	90,407	205	90,612	2,489	348	0.140	646,487	[583,561–709,412]
9	2/26	54,646	133	54,779	2,494	458	0.184	297,764	[273,080–322,448]
10	3/5	37,923	54	37,977	2,499	426	0.170	222,348	[203,058–241,637]
11	3/12	25,233	48	25,281	2,498	530	0.212	118,978	[109,912–128,044]
12	3/19	9,813	33	9,846	2,298	540	0.235	41,841	[38,677–45,005]
13	3/26	10,526	13	10,539	1,999	615	0.308	34,218	[31,907–36,528]
14	4/2	32,457	51	32,508	1,998	961	0.481	67,550	[64,432–70,668]
15	4/9	30,652	106	30,758	1,997	956	0.479	64,216	[61,235–67,196]
16	4/16	28,758	176	28,934	1,499	655	0.437	66,160	[62,322–69,998]
17	4/23	34,753	94	34,847	1,498	671	0.448	77,732	[73,328–82,136]
18	4/30	18,962	17	18,979	1,498	798	0.533	35,606	[33,885–37,328]
19	5/7	24,737	31	24,768	1,200	819	0.683	36,276	[34,855–37,697]
20	5/14	13,533	29	13,562	999	696	0.697	19,458	[18,643–20,272]
21	5/21	16,170	52	16,222	500	197	0.394	41,047	[36,584–45,509]
22	5/28	10,638	33	10,671	500	270	0.540	19,728	[18,119–21,336]
23	6/4	3,795	111	3,906	442	220	0.498	7,830	[7,080–8,579]
24	6/11	777	21	798	249	68	0.273	2,891	[2,291–3,492]
25	6/18	9	4	13	0	0	----	13	[13–13]
26	6/25	3	6	9	0	0	----	9	[9–9]
Total catch		549,103	1,534	550,637	31,154	9,724	0.312	2,901,968	[2,772,054–3,031,878]

Table 11: Scott 2015 age 0+ Chinook salmon catch table

Week	Start	Live	Dead	Total	Marked	Recaps	Efficiency	Weekly estimate and 95% CI	
6	2/5	23	1	24	0	0	----	24	[24–24]
7	2/12	92	24	116	8	0	0.000	789	[0–1,730]
8	2/19	141	3	144	58	1	0.017	4,248	[0–9,006]
9	2/26	70	0	70	52	1	0.019	1,855	[0–3,943]
10	3/5	249	5	254	113	3	0.027	7,239	[957–13,521]
11	3/12	593	4	597	309	7	0.023	23,134	[8,116–38,151]
12	3/19	602	5	607	486	15	0.031	18,476	[9,725–27,226]
13	3/26	196	1	197	211	6	0.028	5,966	[1,829–10,103]
14	4/2	253	4	257	134	5	0.037	5,783	[1,546–10,019]
15	4/9	359	1	360	283	16	0.057	6,014	[3,257–8,771]
16	4/16	505	2	507	422	23	0.055	8,936	[5,454–12,418]
17	4/23	1,194	3	1,197	855	40	0.047	24,991	[17,491–32,491]
18	4/30	583	1	584	439	11	0.025	21,413	[9,815–33,011]
19	5/7	1,293	15	1,308	844	51	0.060	21,255	[15,602–26,908]
20	5/14	744	10	754	617	21	0.034	21,181	[12,557–29,804]
21	5/21	273	2	275	198	5	0.025	9,121	[2,394–15,847]
22	5/28	542	8	550	350	12	0.034	14,850	[7,127–22,573]
23	6/4	883	6	889	439	14	0.032	26,077	[13,414–38,741]
24	6/11	569	8	577	453	14	0.031	17,464	[8,940–25,987]
25	6/18	243	3	246	264	14	0.053	4,346	[2,215–6,477]
26	6/25	42	0	42	57	8	0.140	271	[101–441]
Total catch		9,449	106	9,555	6,592	267	0.041	243,433	[210,816–276,047]

Table 12: Shasta 2013 0+ coho salmon catch table

Week	Start	Live	Dead	Total	Marked	Recaps	Efficiency	Weekly estimate and 95% CI
5	1/29	0	0	0	0	0	----	0 [[0–0]–0]
6	2/5	0	0	0	0	0	----	0 [[0–0]–0]
7	2/12	0	0	0	0	0	----	0 [[0–0]–0]
8	2/19	0	0	0	0	0	----	0 [[0–0]–0]
9	2/26	0	0	0	0	0	----	0 [[0–0]–0]
10	3/5	0	0	0	0	0	----	0 [[0–0]–0]
11	3/12	0	0	0	0	0	----	0 [[0–0]–0]
12	3/19	93	0	93	0	0	----	511 [[0–0]–0]
13	3/26	76	1	77	0	0	----	419 [[0–0]–0]
14	4/2	3	3	6	0	0	----	21 [[0–0]–0]
15	4/9	3	1	4	0	0	----	12 [[0–0]–0]
16	4/16	2	0	2	0	0	----	4 [[0–0]–0]
17	4/23	10	0	10	0	0	----	40 [[0–0]–0]
18	4/30	29	0	29	0	0	----	171 [[0–0]–0]
19	5/7	42	4	46	0	0	----	157 [[0–0]–0]
20	5/14	20	0	20	0	0	----	118 [[0–0]–0]
21	5/21	6	0	6	0	0	----	11 [[0–0]–0]
22	5/28	1	0	1	0	0	----	2 [[0–0]–0]
23	6/4	65	6	71	0	0	----	437 [[0–0]–0]
24	6/11	6	0	6	0	0	----	22 [[0–0]–0]
25	6/18	3	0	3	0	0	----	6 [[0–0]–0]
26	6/25	0	0	0	0	0	----	0 [[0–0]–0]
Total catch		359	15	374	0	0	----	1,931 [[0–0]–0]

Table 13: Scott 2013 0+ coho salmon catch table

Week	Start	Live	Dead	Total	Marked	Recaps	Efficiency	Weekly estimate and 95% CI
6	2/5	0	0	0	0	0	----	0 [0–0]
7	2/12	0	0	0	0	0	----	0 [0–0]
8	2/19	0	0	0	0	0	----	0 [0–0]
9	2/26	0	0	0	0	0	----	0 [0–0]
10	3/5	0	0	0	0	0	----	0 [0–0]
11	3/12	0	0	0	0	0	----	0 [0–0]
12	3/19	0	0	0	0	0	----	0 [0–0]
13	3/26	0	0	0	0	0	----	0 [0–0]
14	4/2	1	0	1	0	0	----	2 [0–0]
15	4/9	28	0	28	0	0	----	101 [0–0]
16	4/16	23	0	23	0	0	----	81 [0–0]
17	4/23	1	0	1	0	0	----	2 [0–0]
18	4/30	3	0	3	0	0	----	7 [0–0]
19	5/7	5	0	5	0	0	----	13 [0–0]
20	5/14	14	0	14	0	0	----	46 [0–0]
21	5/21	21	0	21	0	0	----	126 [0–0]
22	5/28	49	2	51	0	0	----	191 [0–0]
23	6/4	121	2	123	0	0	----	488 [0–0]
24	6/11	86	1	87	0	0	----	179 [0–0]
25	6/18	12	0	12	0	0	----	46 [0–0]
26	6/25	3	0	3	0	0	----	8 [0–0]
Total catch		367	5	372	0	0	----	1,290 [0–0]

Table 14: Shasta 2014 0+ coho salmon catch table

Week	Start	Live	Dead	Total	Marked	Recaps	Efficiency	Weekly estimate and 95% CI
5	1/29	0	0	0	0	0	----	0 [0–0]
6	2/5	0	0	0	0	0	----	0 [0–0]
7	2/12	0	0	0	0	0	----	0 [0–0]
8	2/19	0	0	0	0	0	----	0 [0–0]
9	2/26	0	0	0	0	0	----	0 [0–0]
10	3/5	4	5	9	0	0	----	9 [9–9]
11	3/12	8	0	8	0	0	----	8 [8–8]
12	3/19	244	35	279	0	0	----	279 [279–279]
13	3/26	79	1	80	0	0	----	80 [80–80]
14	4/2	64	8	72	0	0	----	72 [72–72]
15	4/9	14	4	18	4	2	0.500	30 [10–50]
16	4/16	6	1	7	1	0	0.000	12 [0–27]
17	4/23	32	3	35	19	2	0.105	233 [14–453]
18	4/30	100	2	102	67	15	0.224	434 [240–627]
19	5/7	51	0	51	36	7	0.194	236 [89–383]
20	5/14	109	4	113	73	3	0.041	2,091 [277–3,904]
21	5/21	190	12	202	133	8	0.060	3,008 [1,167–4,848]
22	5/28	314	8	322	153	22	0.144	2,156 [1,333–2,979]
23	6/4	151	2	153	134	13	0.097	1,475 [737–2,214]
24	6/11	56	2	58	67	12	0.179	303 [145–462]
25	6/18	71	1	72	46	14	----	226 [125–326]
26	6/25	37	0	37	48	17	----	101 [57–145]
Total catch		1,530	88	1,618	781	115	0.147	10,753 [7,916–13,588]

Table 15: Scott 2014 0+ coho salmon catch table

Week	Start	Live	Dead	Total	Marked	Recaps	Efficiency	Weekly estimate and 95% CI
6	2/5	0	0	0	0	0	----	0 [0–0]
7	2/12	0	0	0	0	0	----	0 [0–0]
8	2/19	0	0	0	0	0	----	0 [0–0]
9	2/26	0	0	0	0	0	----	0 [0–0]
10	3/5	0	0	0	0	0	----	0 [0–0]
11	3/12	0	0	0	0	0	----	0 [0–0]
12	3/19	0	0	0	0	0	----	0 [0–0]
13	3/26	1	0	1	0	0	----	1 [1–1]
14	4/2	1	0	1	0	0	----	1 [1–1]
15	4/9	0	0	0	0	0	----	0 [0–0]
16	4/16	53	1	54	1	0	0.000	100 [1–215]
17	4/23	193	5	198	93	8	0.086	2,068 [822–3,314]
18	4/30	335	5	340	304	22	0.072	4,509 [2,716–6,301]
19	5/7	49	5	54	33	1	0.030	918 [0–1,944]
20	5/14	14	0	14	13	3	0.231	49 [8–90]
21	5/21	137	0	137	75	3	0.040	2,603 [350–4,856]
22	5/28	224	2	226	119	11	0.092	2,260 [1,064–3,456]
23	6/4	295	7	302	191	23	0.120	2,416 [1,496–3,336]
24	6/11	146	4	150	153	17	0.111	1,283 [709–1,857]
25	6/18	57	2	59	28	0	0.000	507 [0–4,061]
26	6/25	28	1	29	27	0	0.000	247 [0–1,936]
Total catch		1,533	32	1,565	1,037	88	0.085	16,962 [12,457–21,467]

Table 16: Shasta 2015 0+ coho salmon catch table

Week	Start	Live	Dead	Total	Marked	Recaps	Efficiency	Weekly estimate and 95% CI
5	1/29	0	0	0	0	0	----	0 [0–0]
6	2/5	0	0	0	0	0	----	0 [0–0]
7	2/12	0	0	0	0	0	----	0 [0–0]
8	2/19	0	0	0	0	0	----	0 [0–0]
9	2/26	1	0	1	0	0	----	1 [1–1]
10	3/5	1	0	1	0	0	----	1 [1–1]
11	3/12	13	0	13	1	0	0.000	22 [3–41]
12	3/19	3	0	3	4	0	0.000	9 [0–19]
13	3/26	3	0	3	1	0	0.000	5 [0–10]
14	4/2	0	0	0	0	0	----	0 [0–0]
15	4/9	0	1	1	0	0	----	1 [1–1]
16	4/16	2	0	2	0	0	----	2 [2–2]
17	4/23	3	0	3	0	0	----	3 [3–3]
18	4/30	3	0	3	1	0	0.000	5 [0–10]
19	5/7	24	0	24	16	1	0.063	204 [0–430]
20	5/14	16	0	16	12	1	0.083	104 [0–219]
21	5/21	15	0	15	11	2	0.182	60 [4–116]
22	5/28	37	0	37	24	7	0.292	116 [47–184]
23	6/4	49	3	52	32	5	0.156	286 [84–488]
24	6/11	13	1	14	15	6	0.400	32 [12–52]
25	6/18	0	0	0	0	0	----	0 [0–0]
26	6/25	1	0	1	0	0	----	1 [1–1]
Total catch		184	5	189	117	22	0.188	852 [514–1,189]

Table 17: Scott 2015 0+ coho salmon catch table

Week	Start	Live	Dead	Total	Marked	Recaps	Efficiency	Weekly estimate and 95% CI
6	2/5	0	0	0	0	0	----	0 [0–0]
7	2/12	0	0	0	0	0	----	0 [0–0]
8	2/19	0	0	0	0	0	----	0 [0–0]
9	2/26	0	0	0	0	0	----	0 [0–0]
10	3/5	0	0	0	0	0	----	0 [0–0]
11	3/12	0	0	0	0	0	----	0 [0–0]
12	3/19	1	0	1	0	0	----	1 [1–1]
13	3/26	1	0	1	2	0	0.000	1 [1–1]
14	4/2	0	0	0	0	0	----	0 [0–0]
15	4/9	0	0	0	0	0	----	0 [0–0]
16	4/16	0	0	0	0	0	----	0 [0–0]
17	4/23	0	0	0	0	0	----	0 [0–0]
18	4/30	1	0	1	1	0	0.000	1 [1–1]
19	5/7	2	0	2	0	0	----	2 [2–2]
20	5/14	4	0	4	4	0	0.000	4 [4–4]
21	5/21	3	0	3	3	0	0.000	3 [3–3]
22	5/28	2	0	2	2	0	0.000	2 [2–2]
23	6/4	4	0	4	1	0	0.000	4 [4–4]
24	6/11	3	1	4	1	0	0.000	4 [4–4]
25	6/18	1	0	1	0	0	----	1 [1–1]
26	6/25	0	0	0	0	0	----	0 [0–0]
Total catch		22	1	23	14	0	0.000	23 [23–23]

Table 18: 2013 Shasta 1+ coho salmon catch table

Week	Start	Live	Dead	Total	Marked	Recaps	Efficiency	Weekly estimate and 95% CI
5	1/29	1	0	1	0	0	----	2 [0–3]
6	2/5	1	0	1	0	0	----	2 [0–3]
7	2/12	2	0	2	0	0	----	4 [0–8]
8	2/19	0	0	0	0	0	----	0 [0–0]
9	2/26	0	0	0	0	0	----	0 [0–0]
10	3/5	4	0	4	0	0	----	6 [0–12]
11	3/12	0	0	0	0	0	----	0 [0–0]
12	3/19	4	0	4	0	0	----	11 [0–23]
13	3/26	1	0	1	0	0	----	2 [0–4]
14	4/2	6	0	6	0	0	----	16 [0–33]
15	4/9	19	0	19	0	0	----	64 [18–109]
16	4/16	44	0	44	0	0	----	149 [75–224]
17	4/23	46	0	46	0	0	----	170 [83–257]
18	4/30	19	0	19	0	0	----	53 [19–87]
19	5/7	5	0	5	0	0	----	16 [0–33]
20	5/14	0	0	0	0	0	----	0 [0–0]
21	5/21	0	0	0	0	0	----	0 [0–0]
22	5/28	0	0	0	0	0	----	0 [0–0]
23	6/4	0	0	0	0	0	----	0 [0–0]
24	6/11	0	0	0	0	0	----	0 [0–0]
25	6/18	0	0	0	0	0	----	0 [0–0]
26	6/25	0	0	0	0	0	----	0 [0–0]
Total catch		152	0	152	0	0	----	495 [364–625]

Table 19: 2013 Scott 1+ coho salmon catch table

Week	Start	Live	Dead	Total	Marked	Recaps	Efficiency	Weekly estimate and 95% CI
6	2/5	0	0	0	0	0	----	0 [0–0]
7	2/12	4	0	4	1	0	0.000	7 [0–0]
8	2/19	6	0	6	5	1	0.200	18 [0–37]
9	2/26	7	0	7	4	0	0.000	26 [0–0]
10	3/5	9	0	9	7	0	0.000	46 [0–0]
11	3/12	7	0	7	4	1	0.250	18 [0–35]
12	3/19	9	0	9	5	0	0.000	38 [0–0]
13	3/26	4	0	4	7	1	0.143	16 [0–35]
14	4/2	2	0	2	0	0	----	5 [0–0]
15	4/9	30	0	30	19	1	0.053	300 [0–633]
16	4/16	52	0	52	35	4	0.114	374 [83–665]
17	4/23	58	0	58	55	1	0.018	1,624 [0–3,459]
18	4/30	66	1	67	43	6	0.140	421 [140–702]
19	5/7	124	1	125	109	4	0.037	2,750 [558–4,942]
20	5/14	62	0	62	24	1	0.042	775 [0–1,630]
21	5/21	89	3	92	60	5	0.083	935 [256–1,614]
22	5/28	80	1	81	71	11	0.155	486 [228–744]
23	6/4	13	0	13	14	2	0.143	65 [0–0]
24	6/11	5	0	5	5	0	0.000	21 [0–48]
25	6/18	0	0	0	0	0	----	0 [0–0]
26	6/25	0	0	0	0	0	----	0 [0–0]
Total catch		627	6	633	468	38	0.081	7,925 [4,809–11,045]

Table 20: 2014 Shasta 1+ coho salmon catch table

Week	Start	Live	Dead	Total	Marked	Recaps	Efficiency	Weekly estimate and 95% CI
5	1/29	0	0	0	0	0	----	0 [0–0]
6	2/5	0	0	0	0	0	----	0 [0–0]
7	2/12	0	0	0	0	0	----	0 [0–0]
8	2/19	0	0	0	0	0	----	0 [0–0]
9	2/26	0	0	0	0	0	----	0 [0–0]
10	3/5	0	0	0	0	0	----	0 [0–0]
11	3/12	1	0	1	0	0	----	1 [1–1]
12	3/19	3	0	3	1	0	0.000	4 [0–11]
13	3/26	14	0	14	0	0	----	14 [14–14]
14	4/2	59	0	59	18	5	0.278	187 [67–307]
15	4/9	44	0	44	37	11	0.297	139 [69–210]
16	4/16	73	2	75	41	9	0.220	315 [142–488]
17	4/23	80	0	80	55	29	0.527	149 [107–191]
18	4/30	18	0	18	18	10	0.556	31 [17–46]
19	5/7	4	0	4	3	1	0.333	8 [0–16]
20	5/14	1	0	1	0	0	----	1 [1–1]
21	5/21	0	0	0	0	0	----	0 [0–0]
22	5/28	0	0	0	0	0	----	0 [0–0]
23	6/4	0	0	0	0	0	----	0 [0–0]
24	6/11	0	0	0	0	0	----	0 [0–0]
25	6/18	0	0	0	0	0	----	0 [0–0]
26	6/25	0	0	0	0	0	----	0 [0–0]
Total catch		297	2	299	173	65	0.376	849 [623–1,076]

Table 21: 2014 Scott 1+ coho salmon catch table

Week	Start	Live	Dead	Total	Marked	Recaps	Efficiency	Weekly estimate and 95% CI
6	2/5	0	0	0	0	0	----	0 [0–0]
7	2/12	7	0	7	0	0	----	7 [7–7]
8	2/19	113	0	113	45	4	0.089	1,040 [237–1,842]
9	2/26	111	1	112	75	6	0.080	1,216 [388–2,044]
10	3/5	6	0	6	5	0	0.000	27 [0–76]
11	3/12	23	0	23	9	0	0.000	144 [0–453]
12	3/19	50	0	50	36	1	0.028	925 [0–1,963]
13	3/26	22	0	22	23	0	0.000	210 [0–942]
14	4/2	13	0	13	10	1	0.100	72 [0–150]
15	4/9	31	0	31	22	1	0.045	357 [0–754]
16	4/16	43	2	45	14	1	0.071	338 [0–701]
17	4/23	49	0	49	35	5	0.143	294 [83–505]
18	4/30	52	1	53	42	3	0.071	570 [77–1,063]
19	5/7	33	0	33	25	2	0.080	286 [11–561]
20	5/14	25	2	27	11	0	0.000	188 [0–626]
21	5/21	5	0	5	9	0	0.000	31 [0–103]
22	5/28	2	0	2	2	0	0.000	5 [0–13]
23	6/4	0	0	0	0	0	----	0 [0–0]
24	6/11	0	0	0	0	0	----	0 [0–0]
25	6/18	0	0	0	0	0	----	0 [0–0]
26	6/25	0	0	0	0	0	----	0 [0–0]
Total catch		585	6	591	363	24	0.066	5,710 [3,734–7,682]

Table 22: Shasta 2015 1+ coho salmon catch table

Week	Start	Live	Dead	Total	Marked	Recaps	Efficiency	Weekly estimate and 95% CI
5	1/29	0	0	0	0	0	----	0 [0–0]
6	2/5	0	0	0	0	0	----	0 [0–0]
7	2/12	3	0	3	0	0	----	3 [3–3]
8	2/19	1	0	1	0	0	----	1 [1–1]
9	2/26	0	1	1	0	0	----	1 [1–1]
10	3/5	6	0	6	2	0	0.000	11 [1–20]
11	3/12	15	0	15	10	0	0.000	36 [10–62]
12	3/19	61	0	61	44	11	0.250	229 [112–345]
13	3/26	94	1	95	73	18	0.247	370 [217–523]
14	4/2	306	0	306	170	27	0.159	1,869 [1,219–2,519]
15	4/9	687	0	687	473	145	0.307	2,230 [1,900–2,561]
16	4/16	392	1	393	332	162	0.488	803 [698–907]
17	4/23	156	0	156	114	55	0.482	320 [251–390]
18	4/30	92	0	92	69	29	0.420	215 [149–280]
19	5/7	66	1	67	47	28	0.596	111 [81–141]
20	5/14	27	0	27	17	7	0.412	61 [27–94]
21	5/21	7	0	7	8	3	0.375	16 [3–29]
22	5/28	3	0	3	2	1	0.500	5 [1–8]
23	6/4	0	0	0	0	0	----	0 [0–0]
24	6/11	0	0	0	0	0	----	0 [0–0]
25	6/18	0	0	0	0	0	----	0 [0–0]
26	6/25	0	0	0	0	0	----	0 [0–0]
Total catch		1,916	4	1,920	1,361	486	0.357	6,281 [5,510–7,048]

Table 23: Scott 2015 1+ coho salmon catch table

Week	Start	Live	Dead	Total	Marked	Recaps	Efficiency	Weekly estimate and 95% CI
6	2/5	2	0	2	0	0	----	2 [2–2]
7	2/12	80	0	80	47	2	0.043	1,280 [43–2,517]
8	2/19	86	0	86	72	3	0.042	1,570 [201–2,938]
9	2/26	66	0	66	62	2	0.032	1,386 [31–2,741]
10	3/5	26	1	27	19	2	0.105	180 [9–351]
11	3/12	18	0	18	14	0	0.000	181 [0–404]
12	3/19	16	0	16	7	0	0.000	103 [0–231]
13	3/26	29	0	29	14	0	0.000	292 [0–646]
14	4/2	25	1	26	15	1	0.067	208 [0–436]
15	4/9	36	1	37	25	1	0.040	481 [0–1,018]
16	4/16	37	0	37	26	2	0.077	333 [13–653]
17	4/23	34	1	35	22	0	0.000	455 [0–984]
18	4/30	24	0	24	20	0	0.000	297 [0–648]
19	5/7	31	2	33	24	0	0.000	449 [0–966]
20	5/14	6	1	7	2	0	0.000	20 [0–43]
21	5/21	4	1	5	2	0	0.000	14 [0–31]
22	5/28	1	0	1	1	0	0.000	2 [0–5]
23	6/4	0	0	0	0	0	----	0 [0–0]
24	6/11	0	0	0	0	0	----	0 [0–0]
25	6/18	0	0	0	0	0	----	0 [0–0]
26	6/25	0	0	0	0	0	----	0 [0–0]
Total catch		521	8	529	372	13	0.035	7,253 [4,689–9,816]

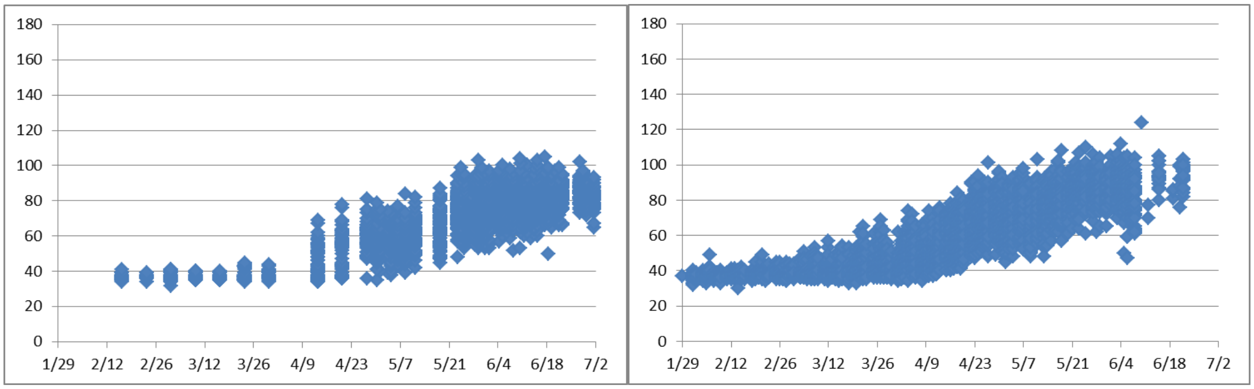


Figure 18: Scott (Left) and Shasta (Right) age 0+ Chinook fork lengths (mm), 2013.

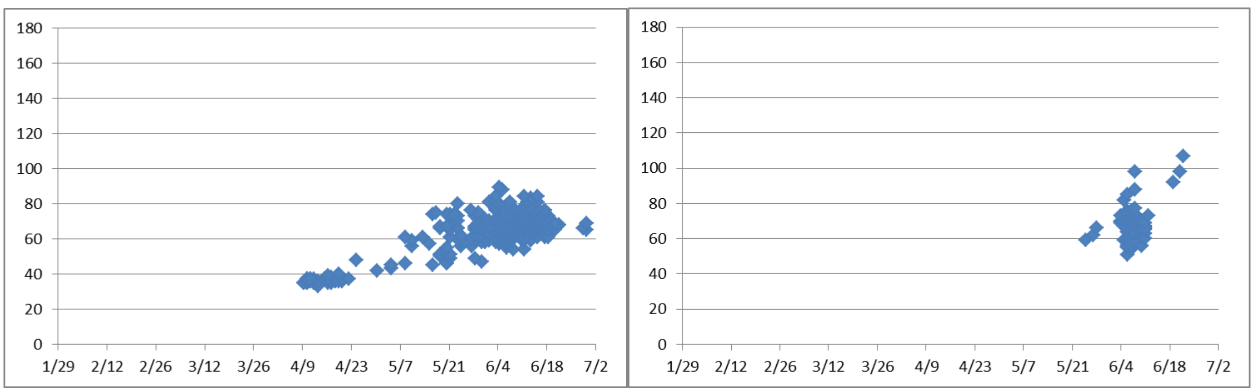


Figure 19: Scott (Left) and Shasta (Right) age 0+ Coho fork lengths (mm), 2013.

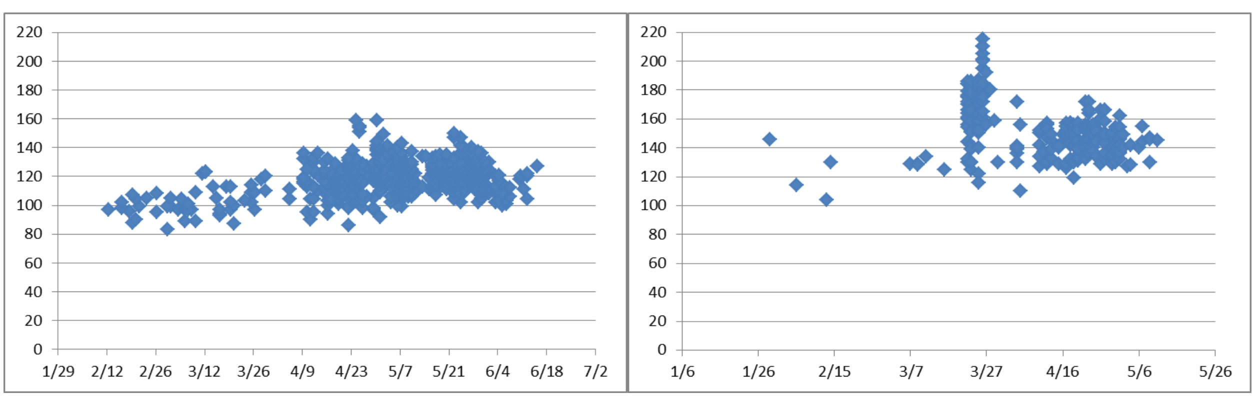


Figure 20: Scott (Left) and Shasta (Right) age 1+ Coho fork lengths (mm), 2013.

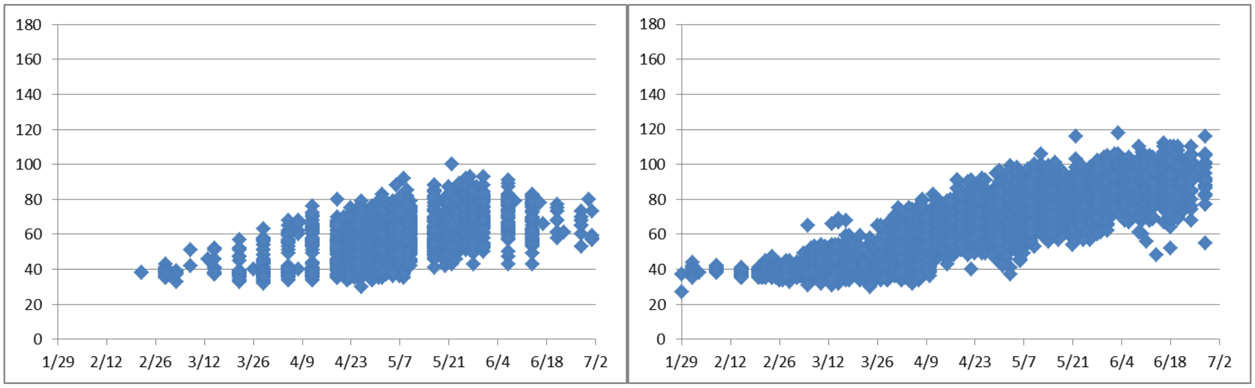


Figure 21: Scott (Left) and Shasta (Right) age 0+ Chinook fork lengths (mm), 2014.

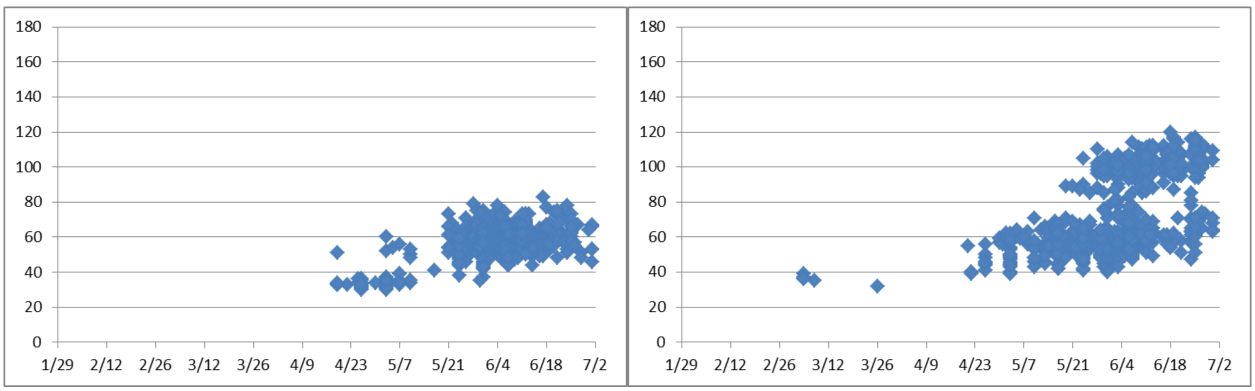


Figure 22: Scott (Left) and Shasta (Right) age 0+ Coho fork lengths (mm), 2014.

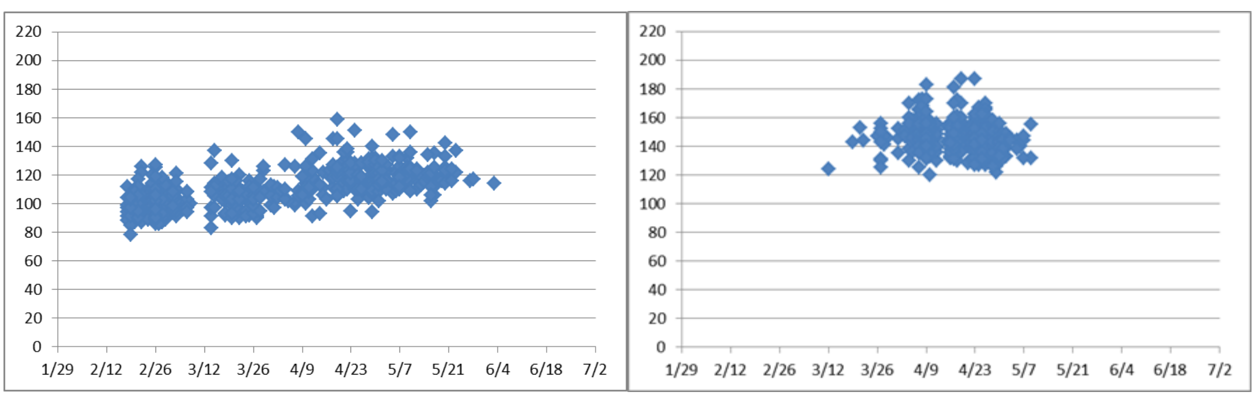


Figure 23: Scott (Left) and Shasta (Right) age 1+ Coho fork lengths (mm), 2014.

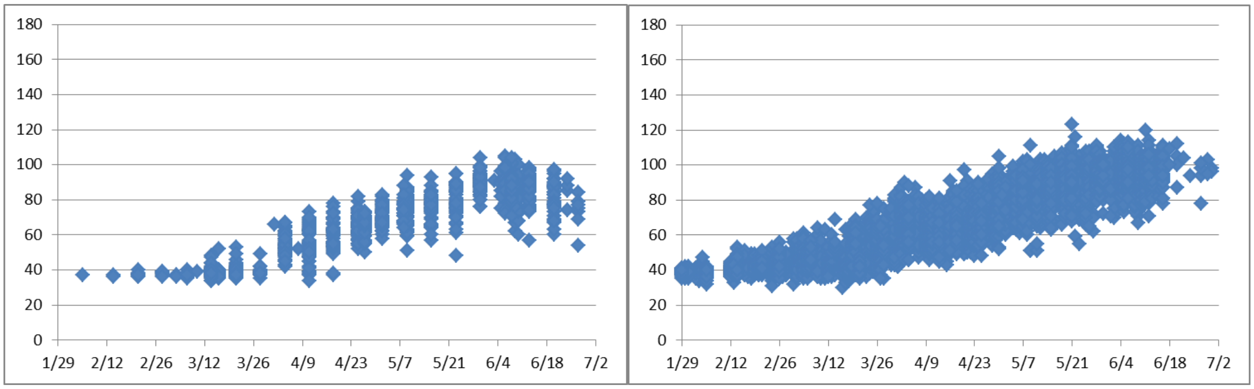


Figure 24: Scott (Left) and Shasta (Right) age 0+ Chinook fork lengths (mm), 2015.

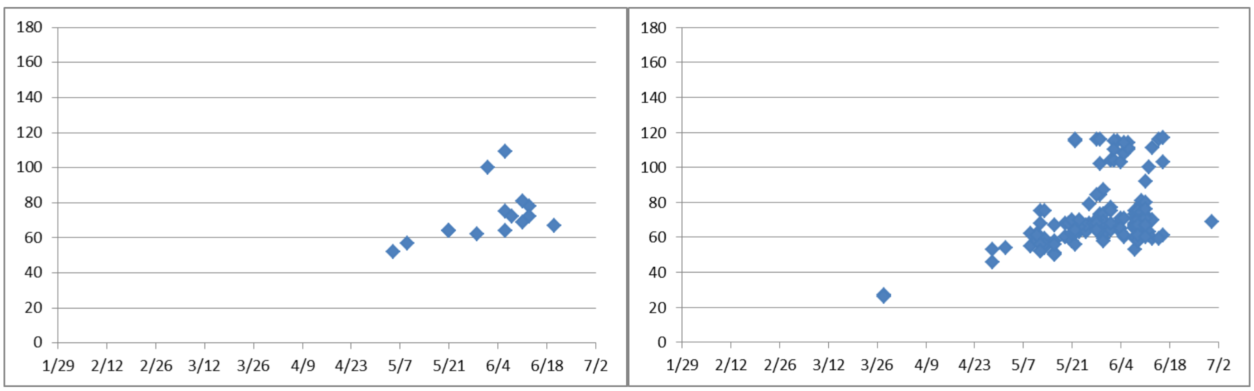


Figure 25: Scott (Left) and Shasta (Right) age 0+ Coho fork lengths (mm), 2015.

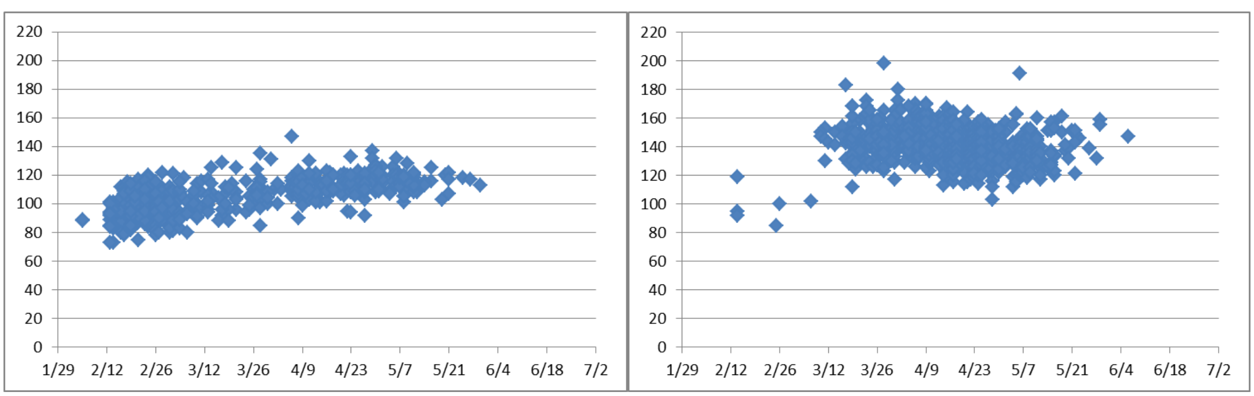


Figure 26: Scott (Left) and Shasta (Right) age 1+ Coho fork lengths (mm), 2015.

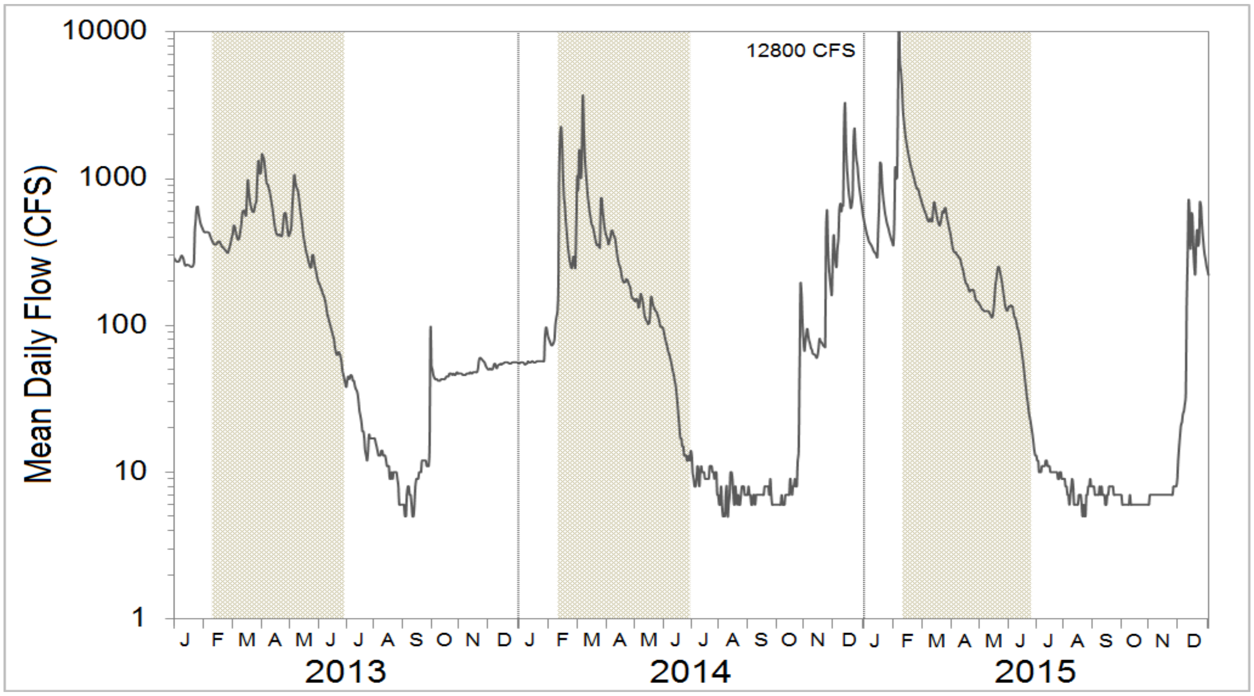
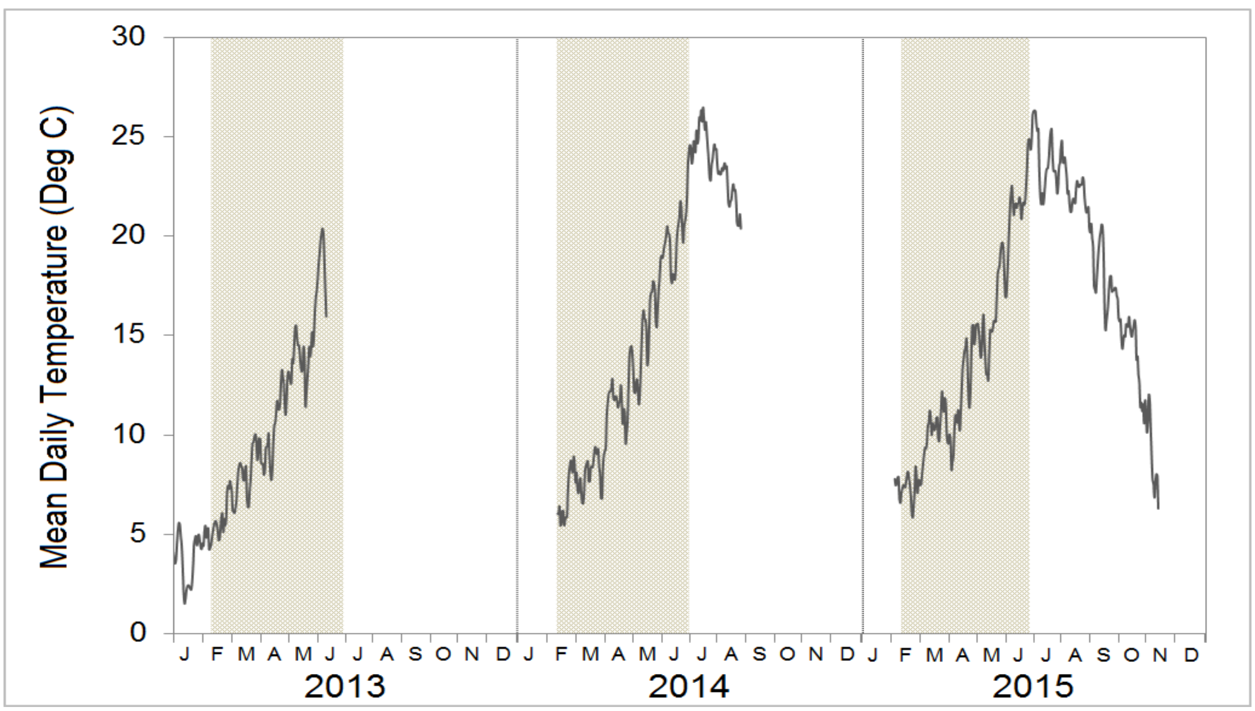


Figure 27: Mean daily flow (CFS) at the Scott River (USGS gauge 11519500), 2012-2015. Shaded regions delineate annual rotary trapping seasons. The labeled flow indicates a single large peak outside the chart space.



· **Figure 28:** Mean daily water temperatures (Deg C) at the Scott River trap site, 2012-2015. Shaded regions delineate annual rotary trapping seasons. Temperature loggers are now retained at the Scott River trap site throughout the year

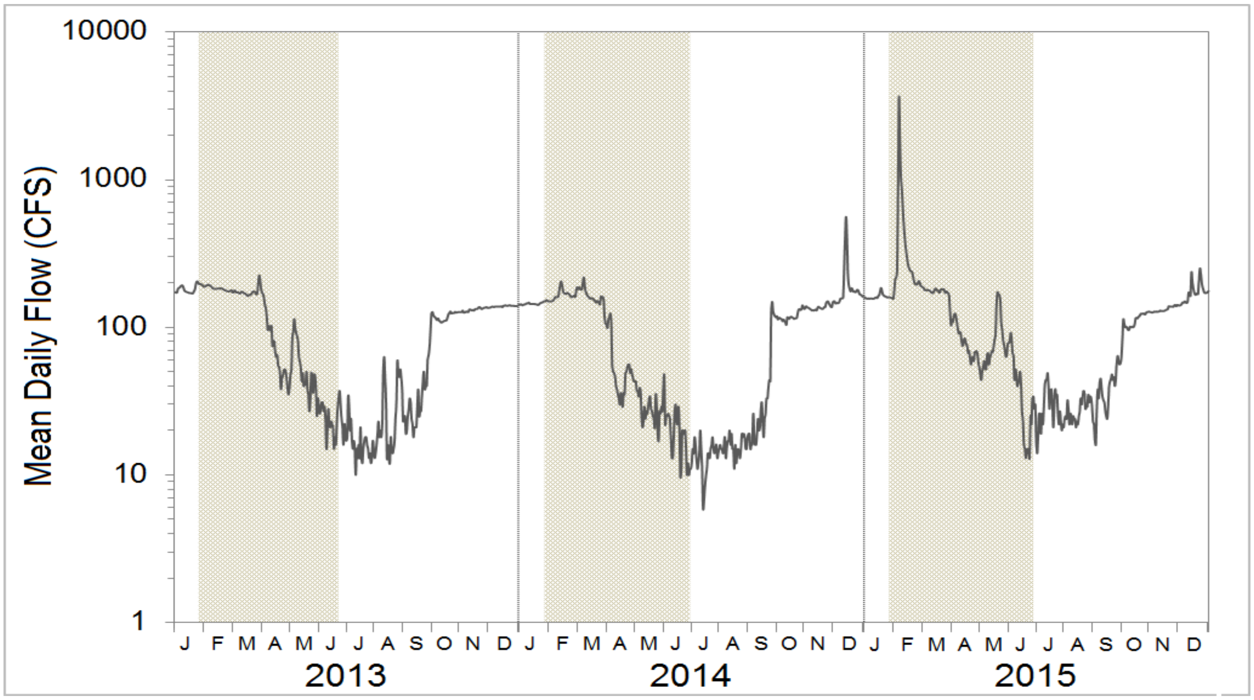


Figure 29: Mean daily flow (CFS) at the Shasta River (USGS gauge 11517500), 2012-2015. Shaded regions delineate annual rotary trapping seasons.

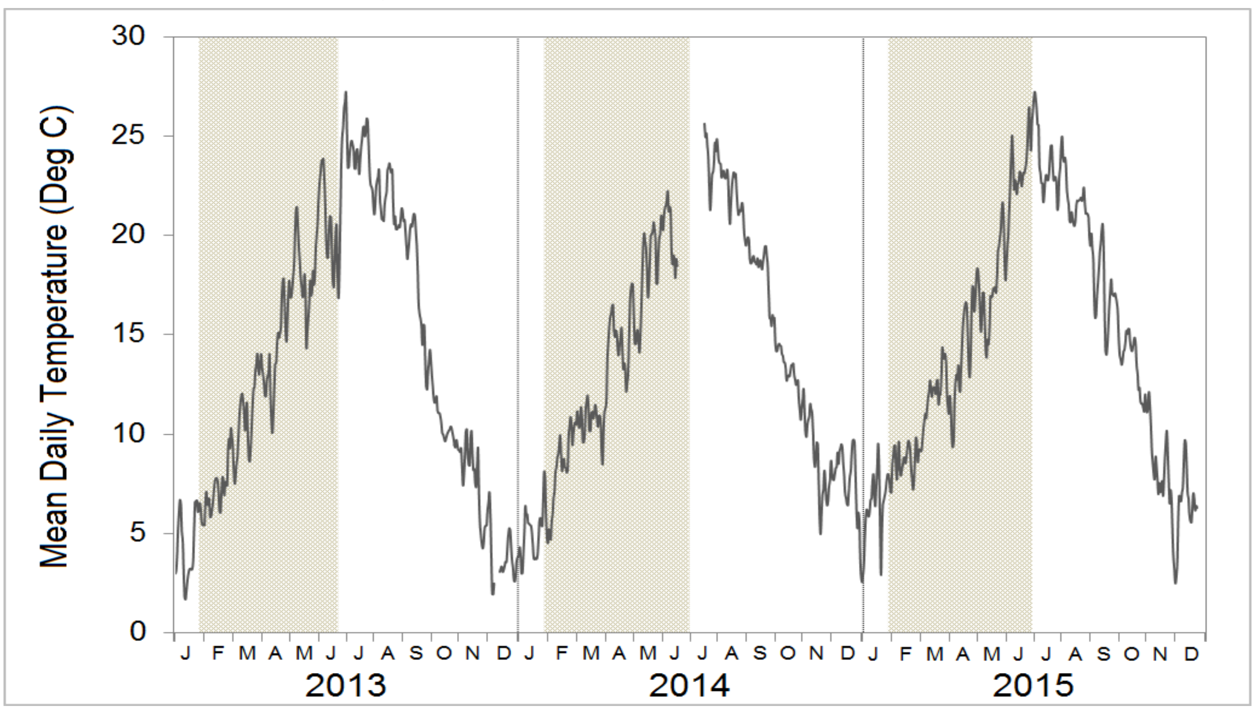


Figure 30: Mean daily water temperatures (Deg C) at the Shasta River trap site, 2012-2015. Shaded regions delineate annual rotary trapping seasons.

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Appendices

Appendix 1 Shasta Age Length cut-offs for Shasta River juvenile salmonids
Appendix 2 Scott Age Length cut-offs for Shasta River juvenile salmonids
Appendix 3 List of Julian Weeks and Calendar Equivalents
Appendix 4 Cumulative percentage of returning adult Chinook salmon and estimated juvenile production on Scott and Shasta Rivers in relation to for brood years 2012-2014

Appendix 1

Age Length cut-offs for Shasta River juvenile salmonids
Shasta River age-length cut-offs for Julian weeks 7-28 based on 2000 - 2006 scale ageing data

Chinook

	Age-length cut-offs	
Julian Week	Age 0+	Age 1+
1-8	≤ 49	≥ 50
9-12	≤ 79	≥ 80
13-14	≤ 79	≥ 80
15-16	≤ 89	≥ 90
17-20	≤ 119	≥ 120
21-28	≤ 159	≥ 160

Coho

	Age-length cut-offs		
Julian Week	Age 0+	Age 1+	Age 2+
1-8	≤ 39	40-149	≥ 150
9-12	≤ 49	50-189	≥ 190
13-14	≤ 59	60-219	≥ 220
15-16	≤ 99	100-159	≥ 160
17-20	≤ 99	100-169	≥ 170
21-28	≤ 119	120-149	≥ 150

Steelhead

	Age-length cut-offs			
Julian Week	Age 0+	Age 1+	Age 2+	Age 3+
1-8	≤ 39	40-139	140-229	≥ 230
9-12	≤ 39	40-139	140-209	≥ 210
13-14	≤ 89	90-139	140-229	≥ 230
15-16	≤ 79	80-139	140-219	≥ 220
17-20	≤ 79	80-159	160-229	≥ 230
21-28	≤ 109	110-179	180-269	≥ 270

Appendix 2

Age Length Cut-Offs for Scott River Juvenile Salmonids
Scott River age-length cut-offs for Julian weeks 7-28 based on 2000 - 2006 scale ageing data

Chinook

	Age-length cut-offs	
Julian Week	Age 0+	Age 1+
1-8	≤ 49	≥ 50
9-12	≤ 69	≥ 70
13-14	≤ 79	≥ 80
15-16	≤ 99	≥ 100
17-20	≤ 119	≥ 120
21-28	≤ 129	≥ 130

Coho

	Age-length cut-offs		
Julian Week	Age 0+	Age 1+	Age 2+
1-8	≤ 49	50-119	≥ 120
9-12	≤ 49	50-149	≥ 150
13-14	≤ 59	60-149	≥ 150
15-16	≤ 69	70-149	≥ 150
17-20	≤ 69	70-159	≥ 160
21-28	≤ 109	110-159	≥ 160

Steelhead

	Age-length cut-offs			
Julian Week	Age 0+	Age 1+	Age 2+	Age 3+
1-8	≤ 59	60-119	120-189	≥ 190
9-12	≤ 49	50-119	120-229	≥ 230
13-14	≤ 49	50-119	120-259	≥ 260
15-16	≤ 59	60-109	110-219	≥ 220
17-20	≤ 59	60-149	150-229	≥ 230
21-28	≤ 79	80-179	180-229	≥ 230

Appendix 3

List of Julian Weeks and Calendar Equivalents

Julian Week #	Inclusive Dates
1	1/1 - 1/7
2	1/8 - 1/14
3	1/15 - 1/21
4	1/22 - 1/28
5	1/29 - 2/4
6	2/5 - 2/11
7	2/12 - 2/18
8	2/19 - 2/25
9	2/26 - 3/4*
10	3/5 - 3/11
11	3/12 - 3/18
12	3/19 - 3/25
13	3/26 - 4/1
14	4/2 - 4/8
15	4/9 - 4/15
16	4/16 - 4/22
17	4/23 - 4/29
18	4/30 - 5/6
19	5/7 - 5/13
20	5/14 - 5/20
21	5/21 - 5/27
22	5/28 - 6/3
23	6/4 - 6/10
24	6/11 - 6/17
25	6/18 - 6/24
26	6/25 - 7/1

* = eight days only during leap years
** = eight day Julian week

Julian Week #	Inclusive Dates
27	7/2 - 7/8
28	7/9 - 7/15
29	7/16 - 7/22
30	7/23 - 7/29
31	7/30 - 8/5
32	8/6 - 8/12
33	8/13 - 8/19
34	8/20 - 8/26
35	8/27 - 9/2
36	9/3 - 9/9
37	9/10 - 9/16
38	9/17 - 9/23
39	9/24 - 9/30
40	10/1 - 10/7
41	10/8 - 10/14
42	10/15 - 10/21
43	10/22 - 10/28
44	10/29 - 11/4
45	11/5 - 11/11
46	11/12 - 11/18
47	11/19 - 11/25
48	11/26 - 12/02
49	12/03 - 12/09
50	12/10 - 12/16
51	12/17 - 12/23
52	12/24 - 12/31**

Appendix 4

Cumulative percentage of returning adult Chinook salmon and estimated juvenile production on Scott and Shasta Rivers in relation to for brood years 2012-2014

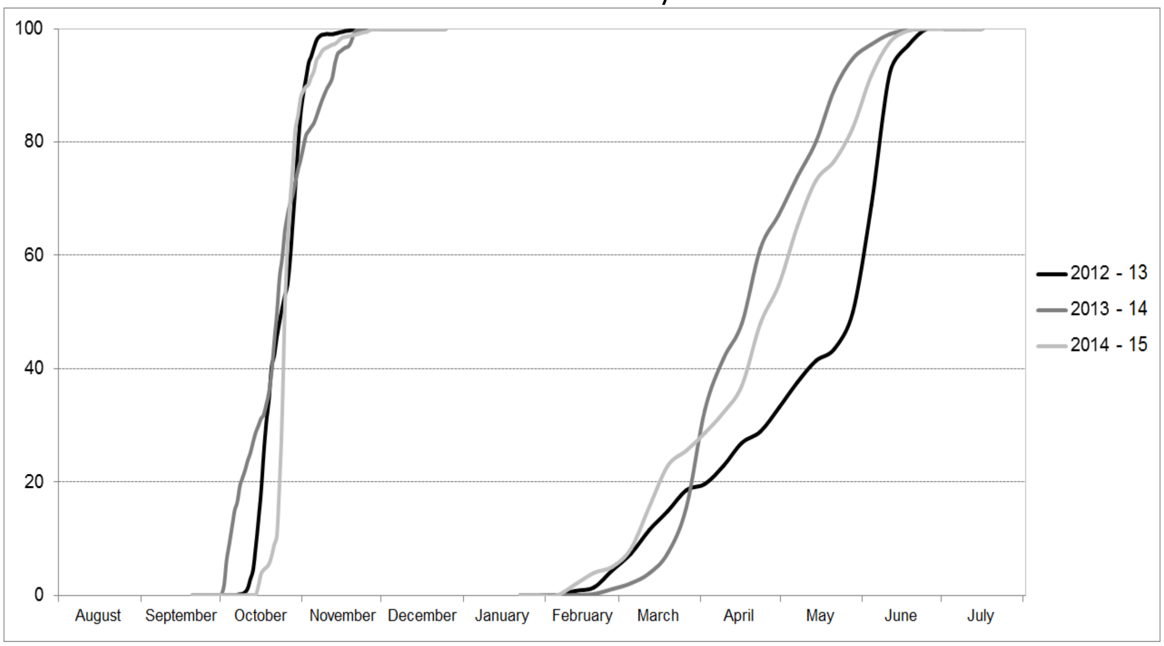

Figure 31: Cumulative percentages of spawning adult (left) and estimated juvenile (right) Chinook salmon production within the Scott River for brood years 2012 - 2014 and emergence years 2013 – 2015. Adult weir count data courtesy of CDFW, Klamath River Project.

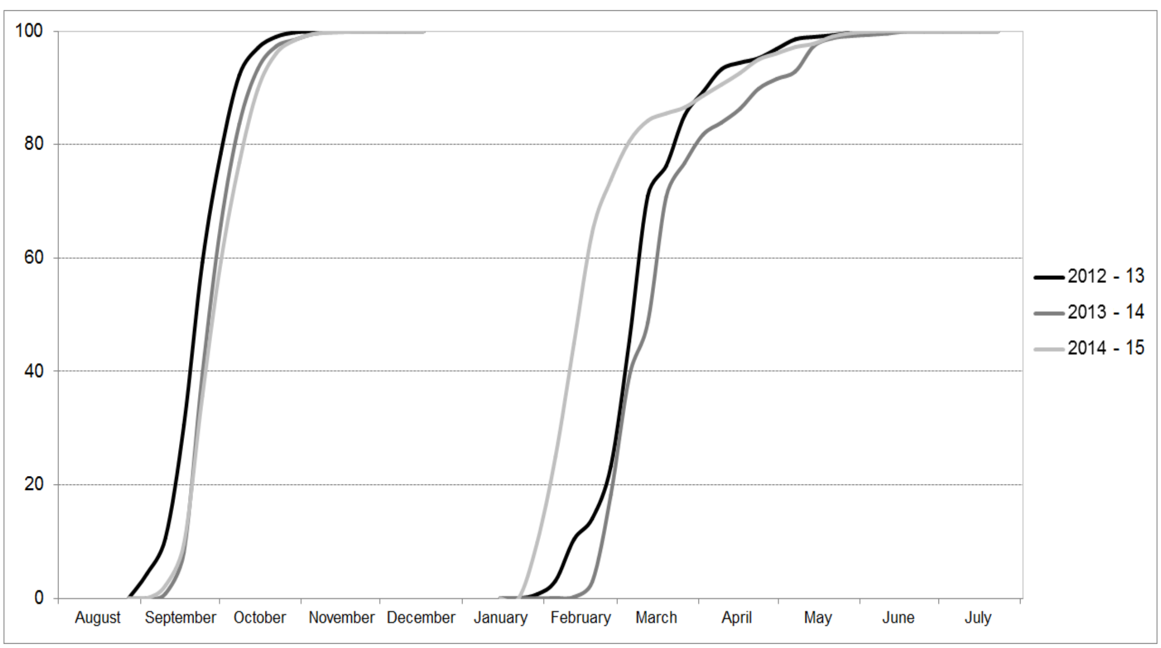

Figure 32: Cumulative percentages of spawning adult (left) and estimated juvenile (right) Chinook salmon production within the Shasta River for brood years 2012 - 2014 and emergence years 2013 – 2015. Adult weir count data courtesy of CDFW, Klamath River Project.