

2018 SCOTT RIVER SALMON STUDIES FINAL REPORT



Prepared By:

Morgan Knechtle and Domenic Giudice

**California Department of Fish and Wildlife
Northern Region
Klamath River Project
1625 South Main Street
Yreka, CA 96097
(530) 842-3109**

2018 SCOTT RIVER SALMON STUDIES

California Department of Fish and Wildlife
Northern Region
Klamath River Project

ABSTRACT

The California Department of Fish and Wildlife's (Department), Klamath River Project (KRP) operated a video fish counting facility and conducted cooperative spawning ground surveys (carcass surveys) on the Scott River during the 2018 fall-run Chinook Salmon (*Oncorhynchus tshawytscha*) and Coho Salmon (*Oncorhynchus kisutch*) spawning season. The purpose of these surveys is to describe the run characteristics of adult Chinook and Coho into the Scott River. Fish counting operations began on October 3, 2018, and ended on December 20, 2018, due to high river flows.

The total number of Chinook Salmon that entered the Scott River during the 2018 season is estimated to be **1,279** fish. Based on the proportion of male and female Chinook that were sampled during the spawning ground surveys, the run was comprised of approximately 443 (34.6%) males and 836 (65.4%) females. Based on scale age analysis, adults comprised approximately 94.4% (1,208 fish) and grilse comprised 5.6% (71 fish) of the run. Males ranged in fork length (FL) from 43 cm to 99 cm and averaged 71.3 cm. Females ranged in FL from 47 cm to 78 cm and averaged 64.9 cm. KRP staff estimated that none of the Chinook that returned were of hatchery origin.

The first adult Coho Salmon was observed at the Scott River Fish Counting Facility (SRFCF) on November 23, 2018, and the last Coho was observed on December 18, 2018. A net total of 737 Coho were observed moving upstream through the SRFCF during the season. Two additional Coho were estimated in the main stem or tributaries downstream of the SRFCF yielding a season total of **739** Coho. Based on the proportion of male and female Coho that were sampled during the season, the run was comprised of approximately 317 (42.9%) males and 422 (57.1%) females. Based on live Coho images observed during video monitoring, adults comprised approximately 96.4% and grilse comprised 3.6% of the run. Males ranged in FL from 64 cm to 69 cm and averaged 66.3 cm. Females ranged in FL from 60 cm to 66 cm and averaged 63.3 cm. Based on observed hatchery marks during video monitoring, none of the Coho were estimated to be of hatchery origin.

INTRODUCTION

STUDY LOCATION AND RUN TIMING

The Scott River is a major tributary of the Klamath River located in Siskiyou County, and enters the Klamath River at river mile 143 (Figure 1). The Scott River Fish Counting Facility (SRFCF) is located at river mile 18.2 near the downstream edge of Scott Valley between the Indian Scotty Campground and Jones Beach picnic area (041° 38' 10.93" N; 123° 04' 3.08"W). Chinook Salmon typically return to the Scott River to spawn from mid-September to late December. The Coho Salmon spawning run typically occurs from mid-October to early January and steelhead run from November to April.

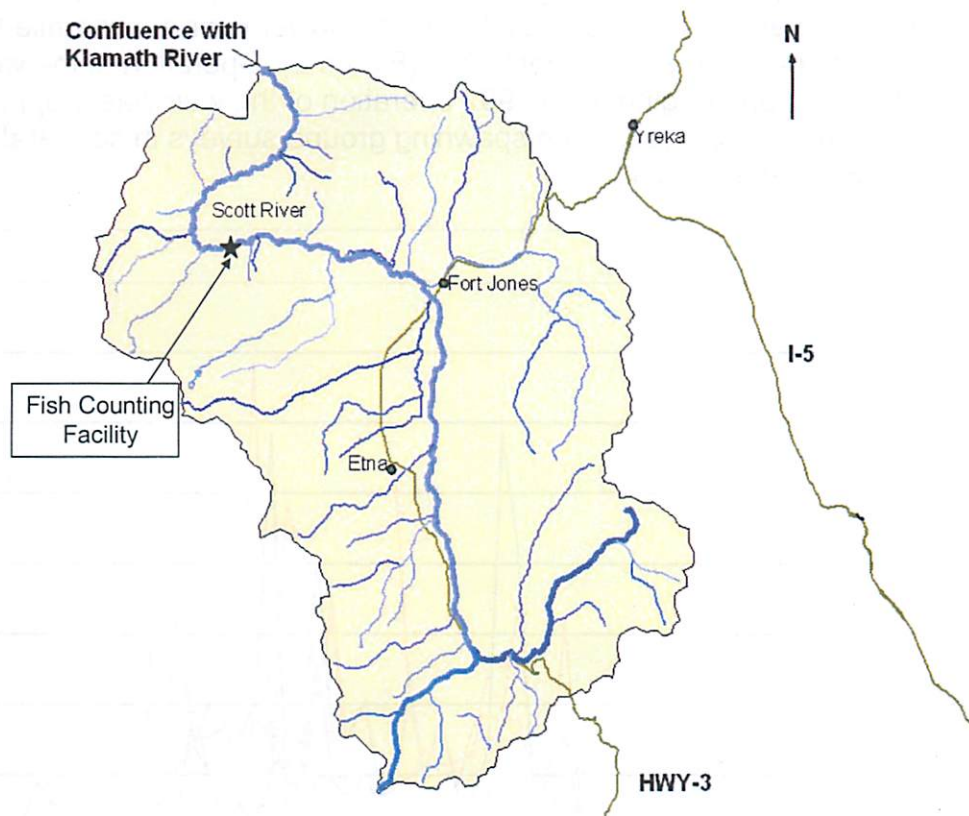


Figure 1. Location of the Scott River, tributary to the Klamath River, Siskiyou County, California.

KLAMATH RIVER PROJECT AND THE SCOTT RIVER STUDY

The Scott River study is one component of the Klamath River Project (KRP) (initiated in 1978). The goals of the KRP include obtaining information on species composition, hatchery composition, run timing, age structure, spawning distribution, fork length (FL) frequency and sex ratios in various tributaries to the Klamath River including the Salmon, Scott, and Shasta rivers, as well as Bogus Creek and 22 other smaller tributaries. The Scott River is particularly important because it is a major salmon spawning tributary. For example, during the 1996-98 spawning seasons, an average of 30.6% (8,914) of the total number of natural area Klamath

River adult Chinook Salmon spawners above the Trinity River confluence were estimated to have entered the Scott River to spawn. Therefore, a significant portion of natural escapement to the Klamath Basin would be unaccounted for if the Scott River studies were not conducted. In addition to providing valuable escapement estimates to the Pacific Fisheries Management Council for the effective management and allocation of fall Chinook originating from the Klamath River Basin, the Scott River studies provide an opportunity to monitor an independent population of Coho Salmon (Williams et al. 2008) within the State- and federally threatened Southern Oregon/Northern California Coast Coho (SONCC) range.

In the early years of the KRP, spawning ground surveys were conducted in the major spawning areas of the main stem Scott River which included an approximately 5.5 mile reach near Etna and a 4.75 mile reach downstream of the State Highway 3 Bridge crossing near Fort Jones. From 1989 through 1991 spawning ground surveys were limited to the lower river. In 1985 a temporary fish marking weir was installed on the lower river at river mile 1.6 and was operated during each spawning season until 1991 (Figure 2). Operation of the weir was often hampered by high flows, and beginning in 1992 operation of the weir was dropped in favor of conducting more intensive mark recapture spawning ground surveys in cooperation with USDA Forest Service (USFS) fisheries staff.

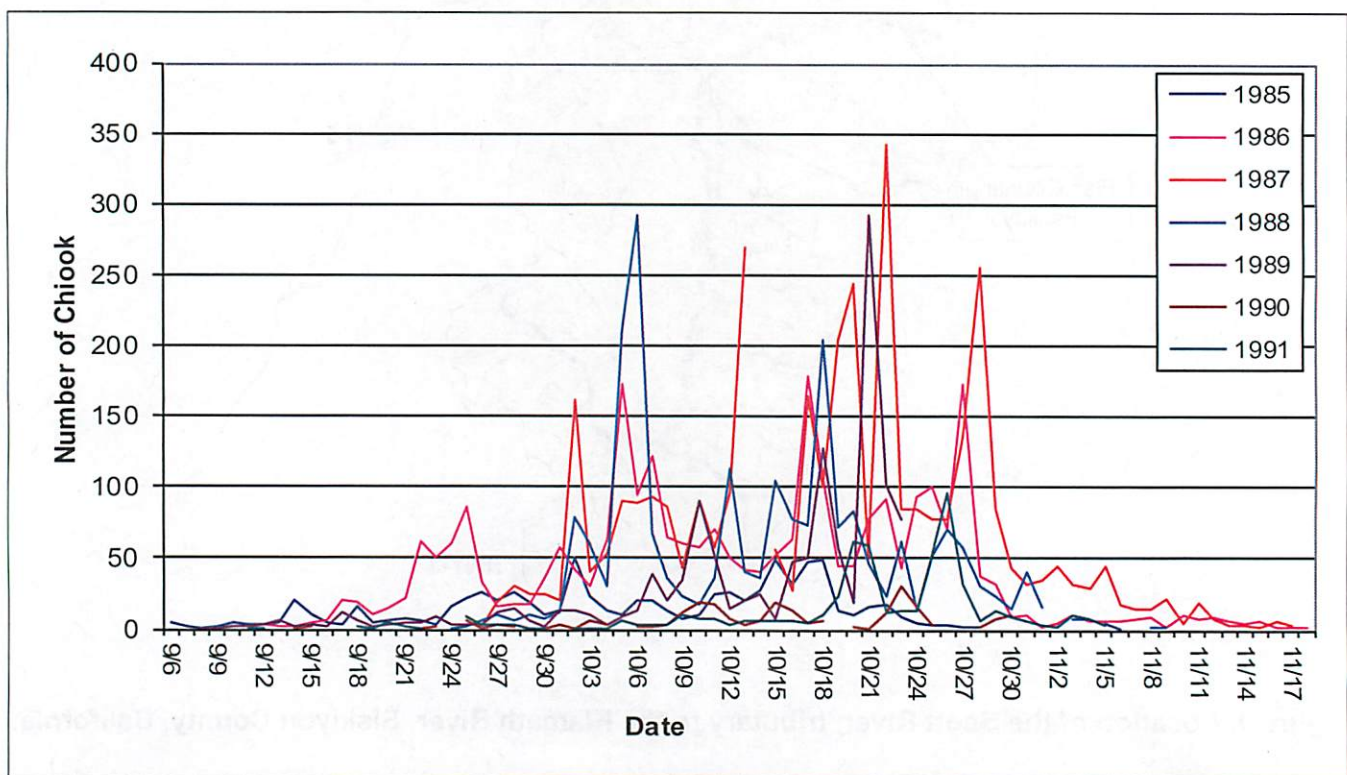


Figure 2. Chinook Salmon observed in the lower Scott River (river mile 1.6) during trapping efforts from 1985-1991.

In 1994 the California State Legislature passed the Leslie Amendment (SB 779). The passage of SB 779 required Departmental staff to obtain landowner permission prior to accessing private lands to conduct biological investigations. As a result, since 1994, spawning ground surveys have been limited to those areas of the river on private land where landowner permission has been granted. The entire length of the Scott River within the Scott Valley (above river mile 24) passes through private ownership. The level of cooperation from local

landowners has varied over the years. Controversies associated with the listing of SONCC Coho Salmon under the California Endangered Species Act (CESA) and other regulatory actions have reduced the amount of cooperation provided by local landowners to the extent that the Department has been denied permission to survey a large portion of the salmon spawning reaches present in the Scott Valley. As a result of the limited landowner access to the valley reaches, the Department proposed installation of a fish counting facility to be located at the upper end of the canyon reach. The addition of the fish counting facility has allowed for an accurate estimation of Chinook Salmon migration to areas of spawning habitat in the valley reaches without having to conduct spawning ground surveys in these reaches. The location of the fish counting station allows for monitoring fish abundance into the valley while Cormack-Jolly-Seber mark recapture carcass-based or redd based estimates are conducted in the areas downstream of the counting station. The counting facility is also located upstream of several tributaries that can produce significant fall and winter stream flows, thereby reducing the probability of having the counting facility inoperable due to high flow events. Beginning in the 2014 season the Department has exercised its authority under the navigability statute to access the Scott River adjacent to private lands in the lower 18.2 river miles (downstream of the counting facility).

SCOTT RIVER STUDY OBJECTIVES SUMMARIZED:

- A. Determine the in-river run size (escapement) of Chinook and Coho salmon returning to the Scott River.
- B. Determine run timing, spawning distribution, length frequency (FL) distribution, and sex ratio for Chinook and Coho salmon in the Scott River.
- C. Collect scale samples from carcasses and look for hatchery marks to determine age composition and hatchery contribution rates of the run.
- D. Collect biological data for all steelhead observed coincidentally during the Chinook and Coho salmon spawning seasons.

METHODS

OPERATION OF THE SCOTT RIVER FISH COUNTING FACILITY

The video fish counting system was installed at the Scott River Fish Counting Facility (SRFCF) on October 3, 2018 at 1200 hours Pacific Standard Time (PST). A temporary weir (Alaskan weir design) was installed to direct migrating fish into a flume where they pass in front of a video camera (Figure 3). The underwater video system consisted of a digital black and white video camera, water proof camera housing, viewing window, and counting flume which allowed for recording unimpeded fish passage through the facility. The facility was operated 24 hours a day, seven days a week during the Chinook Salmon and Coho Salmon migration. A Splash Cam digital black and white video camera equipped with a 3.6mm wide angle lens with an auto iris was used to collect the video image and an Ever Focus Digital Video Recorder (Model ECOR 264) was used to record the image to external hard drives. The time lapse DVR was set to record continuously and data storage drive changes were made at least twice a week.



Figure 3. Scott River Fish Counting Facility located in Siskiyou County, California 2018.

All hard drives were immediately returned to the office where each was subsequently downloaded and reviewed by project staff in the video lab. During each review staff recorded the date, time (hour:min:sec), and species of each fish observed on each video image. If the species could not be determined due to poor visibility or picture quality, staff recorded that observation as species unknown. Staff also noted any adipose fin clipped or maxillary clipped fish observed and recorded the presence of lamprey and any other distinguishable marks that were visible on the image. All data was then entered into computer files and each data file was subjected to one independent review prior to commencement of data analysis.

SPAWNING GROUND SURVEYS

Spawning ground surveys on the Scott River main stem were conducted twice a week on Mondays and Thursdays and opportunistically in main stem tributaries downstream of the counting facilities throughout the salmon spawning season starting October 15, 2018 and ending December 13, 2018. A total of 75 surveys were performed during the spawning season (Appendix 1). Additional surveys were conducted upstream of the counting facility in the main stem and select tributaries during the Coho Salmon period and are reported by the Siskiyou Resource Conservation District (Magranet 2019). On the morning of each survey, crews of at least two people each were given daily instructions, data sheets, field equipment, vehicle assignments, and were assigned a survey reach. Crews walked their assigned reach in a downstream direction looking for salmon carcasses and spawning redds. All new redd locations were flagged, mapped on USGS topographic maps, GPS coordinates collected and

the information was provided to the Klamath National Forest. All carcasses recovered were identified to species and gender, checked for marks or tags, and measured (FL); a scale sample was collected for age composition analysis, and females were examined for spawning success.

For purposes of the mark recapture estimate, each carcass was categorized into one of four pathways (Path). Fresh carcasses, those with clear eyes and/or firm flesh were designated as Path 1. Individually numbered jaw tags were attached to the lower right jaw of all Path 1 carcasses and returned to the river for potential recapture during later surveys. Older carcasses, those with two cloudy eyes and/or mushy flesh, were categorized as Path 2. All Path 2 carcasses were cut in half and returned to the river after all biological data was collected. Path 3 carcasses included all of the Path 1 carcasses (with jaw tag) that were recaptured during subsequent surveys. Path 3 carcasses were returned to the river for subsequent future recapture. Therefore Path 3 carcasses could be recaptured multiple times. Path 3 carcasses were returned to the river for future recapture as long as the adipose fin clip determination could still be made with confidence. Once an adipose fin had deteriorated to the point that adipose fin clip determination could not be made with confidence, the survey tag was removed and the carcass was chopped in half and removed from the mark recapture experiment. Any carcasses that could be observed by a survey crew but could not be retrieved for data collection, because they were located in inaccessible or unsafe locations, were designated as Path 4.

During 2018 the Cormack-Jolly-Seber (CJS) model (Bergman et al. 2012) was not utilized to estimate abundance in the area downstream of the counting station. As a result the adult Chinook Salmon abundance below the counting facility was estimated by multiplying the total number of redds observed during the Chinook period by two. The grilse component from the redd survey was then added back into the total (total run=adults/1-%grilse). The grilse proportion was estimated from aged scale samples collected during the spawning ground survey.

SURVEY REACHES

Survey reaches have remained fairly consistent since the beginning of the cooperative spawning ground survey in 1992. During the Chinook Salmon spawning season, decisions regarding which reaches should be surveyed were based on the known distribution of the Chinook run each week, the available labor force present during each survey, and reach specific stream conditions.

A total of 16 survey reaches, covering approximately 53.6 river miles, have been identified on the Scott River (Table 1, Figure 4). Access to private lands along the Scott River is critically important to the survey in those spawning areas that are present in Scott Valley. Historically, the highest observed densities of Chinook Salmon spawning areas within Scott Valley were located downstream of the State Highway 3 Bridge crossing (river mile 34.6) to the USGS gauging station located at river mile 21 (Reaches 8, 9, and 10), and in that part of the river located downstream of Young's Dam, (river mile 46 to about river mile 42) located upstream of the Eller Lane Bridge crossing (Reaches 12, 13, and 14).

To assist in developing stock identification baseline information, the KRP collected both genetic tissue and otolith samples during the season. Tissue samples were collected for future

DNA analysis from 57 Chinook Salmon and zero Coho Salmon. Tissue was collected from the first Chinook from each reach and each survey date and all Coho for which samples could be collected. All samples were collected following protocols provided by the National Oceanic Atmospheric Administration's (NOAA) Southwest Fisheries Science Center. Samples were sent to the Salmonid Genetic Tissue Repository located at the NOAA Santa Cruz Laboratory for archiving and analysis. Otoliths were collected from 41 Chinook and zero Coho. Otoliths were collected from the first Chinook from each reach and each survey date and all Coho for which samples could be collected. All otoliths collected were archived for future microchemistry analysis. All otolith samples were collected following standard protocols described by Stevenson (1992).

POPULATION ESTIMATES

The Chinook Salmon spawner escapement for the Scott River upstream of the counting facility was derived from a direct count of all Chinook observed at the counting facility (upstream minus downstream observations). To estimate adult escapement in the Scott River downstream of the counting station, the number of Chinook redds were multiplied by two (utilizing data from Reach 1 through Reach 6 only). The grilse component below the counting facility was estimated using the following equation: $\text{total run} = \text{adults} / (1 - \% \text{grilse})$. To estimate total Chinook escapement, the number of Chinook estimated downstream of the counting facility was summed with the estimate from upstream of the counting station.

The Coho Salmon spawner escapement for the area of the Scott River upstream of the counting facility was also derived from a direct count of all Coho observed at the counting facility. Spawning ground surveys were conducted through December 21, 2018, in the main stem and tributaries (Tompkins Creek, Kelsey Creek, and Canyon Creek) below the counting facility. To estimate total adult Coho escapement in the Scott River, the number of

Table 1. Description of cooperative spawning ground survey reach locations along the Scott River during the 2018 season.

Reach Number	Downstream Limit	RM	Upstream limit	RM	Length (miles)
1	Mouth	0.00	Mid Point	2.60	2.60
2	Mid Point	2.60	Pat Ford Ck	4.90	2.30
3	Pat Ford Ck	4.90	George Allen Gulch	7.80	2.90
4	George Allen Gulch	7.80	Townsend Gulch	10.50	2.70
5	Townsend Gulch	10.50	Bridge Flat	14.20	3.70
6	Bridge Flat	14.20	Counting Weir	18.20	4.00
7	Counting Weir	18.20	USGS Stream Gage	21.00	2.80
8	USGS Stream Gage	21.00	Meamber Bridge	24.40	3.40
9	Meamber Bridge	24.40	Dunlop	29.50	5.10
10	Dunlop	29.50	Highway 3 Bridge	35.60	6.10
11	Highway 3 Bridge	35.60	Eller Lane	41.10	5.50
12	Eller Lane	41.10	Sweezy Bridge	42.10	1.00
13	Sweezy Bridge	42.10	Horn Lane	43.90	1.80
14	Horn Lane	43.90	Young's Dam	46.00	2.10
15	Young's Dam	46.00	Fay Lane	49.60	3.60
16	Fay Lane	49.60	East Fork Confluence	53.60	4.00

observed Coho redds downstream of the counting station (1 in 2018) were multiplied by two in order to estimate the number of adult Coho (assuming two unique individuals participated in the construction of each redd) and were added to the count of all Coho salmon observed passing through the SRFCF. The grilse component below the counting facility was estimated using the following equation: $\text{total run} = \text{adults} / (1 - \% \text{grilse})$. One Coho redd was identified downstream of the counting station during 2018 so two additional Coho were added to the total observed at the counting station to estimate the total.

HATCHERY CONTRIBUTION RATES

The hatchery contribution rates for Chinook Salmon and Coho Salmon have been estimated both through the recovery of carcasses and through reviewing fish images observed at the fish counting facility. During the 2018 season hatchery contribution rates were based on observed clips on recovered carcasses for Chinook and on clips observed during video monitoring for Coho. The hatchery contribution rate of Chinook was calculated by multiplying the number of CWTs observed for each CWT group by its production multiplier value (the inverse of the proportion of each group of juveniles that were tagged). An additional sample expansion (the inverse of the number of fish handled during spawning ground surveys divided by the total estimated) was applied. The Coho hatchery contribution rate was estimated by direct observation from the Coho images observed during the video review process. Only Coho images that were clear enough to discern a left maxillary clip were used when generating the observed clip rate. The observed clip rate was then applied to the total estimated Coho run size.

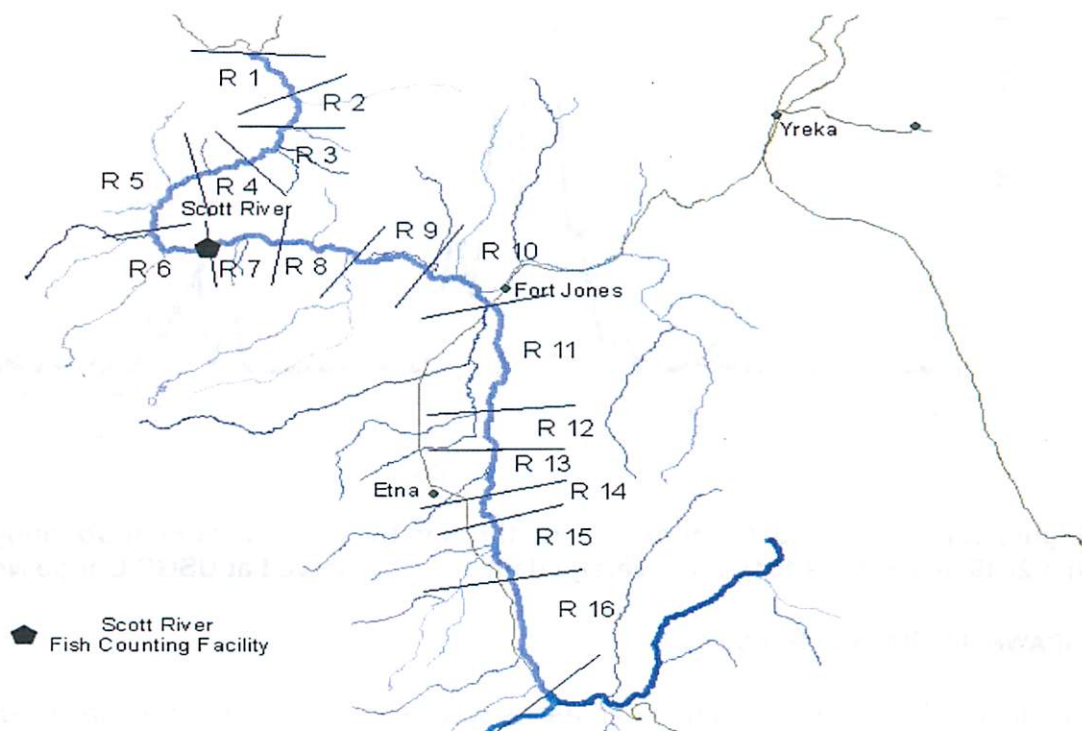


Figure 4. Location of the Scott River Fish Counting Facility and spawning ground survey reaches on the Scott River used during the 2018 field season.

RESULTS

OPERATION OF THE SCOTT RIVER FISH COUNTING FACILITY

The Scott River Fish Counting Facility (SRFCF) began recording fish movements on October 3, 2018. The first Chinook Salmon was observed at the SRFCF on October 13, 2018, and the last Chinook was observed on December 14, 2018. The run peaked between October 24, 2018, and November 5, 2018, when 77.3% of the Chinook migration was observed (Figure 5). Unlike in previous years when the majority of Chinook passed through the SRFCF during daylight hours during 2018 only 54% of the Chinook were observed during daylight (Figure 6).

A net total of 404 Chinook Salmon were estimated to have passed through the SRFCF during the 2018 season (408 upstream and 15 downstream) when videography was employed. A total of 8 Chinook were added to the seasonal count during periods of video loss (Table 2). Additionally, 105 adult salmonids passed through the counting station that were not identified to species. These 105 unknown salmonids were assigned species based on the know species composition from each day for which unknown species were observed. During the 2018 season three of the 105 unknown fish were re-classified as Chinook (Table 3).

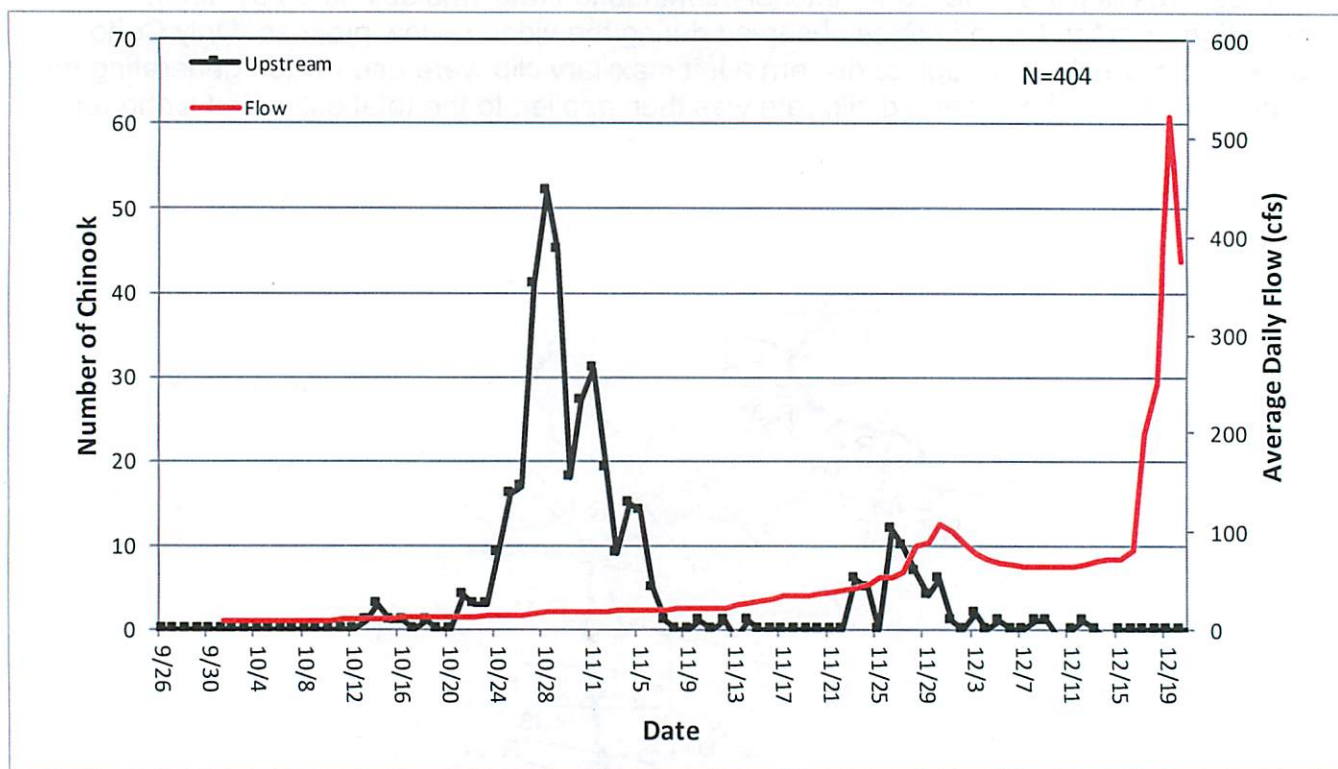


Figure 5. Run timing of Chinook Salmon through the Scott River Fish Counting Facility during the 2018 season (N=404), and average daily flows observed at USGS Gauge No. 11519500.

SPAWNING GROUND SURVEYS

A total of 156 Chinook Salmon carcasses were sampled during the spawning ground survey as Path 1 or Path 2 carcasses. Of these, 54 (34.6%) were male and 102 (65.4%) were female (103 collected but only 102 measured). Males ranged in FL from 43 cm to 99 cm and averaged 71.3 cm (Figure 7). Females ranged in FL from 47 cm to 78 cm and averaged 64.9 cm (Figure 8).

Zero ad-clipped Chinook were observed during the spawning ground survey effort during the 2018 season. After examination of the length frequency distribution and scale age analysis of Path 1 and Path 2 carcasses, a maximum grilse cut-off of 54 cm was established for Scott River Chinook. Due to low flows during the spawning season multiple surveys were canceled due to lack of river connectivity. Additionally, Reach 8 was not surveyed in 2018 due to lack of landowner access permission (Appendix 1).

Table 2. Specific dates and times during the 2018 season when videography was not functioning, the specific times filming started and stopped, the number of hours for each day, and the number of Chinook, Coho, and steelhead estimated during that time.

	Date	Time	Number of hours : minutes without data	Number of Chinook estimated	Number of Coho estimated	Number of Steelhead estimated
Filming Stopped	10/17/2018	730	16:30	0	0	0
Filming Started	10/18/2018	900	9:00	1	0	0
Filming Stopped	11/12/2018	1730	6:30	0	0	0
Filming Started	11/13/2018	0900	9:00	0	0	0
Filming Stopped	11/18/2018	2100	3:00	0	0	0
Filming Started	11/19/2018	0945	9:45	0	0	0
Filming Stopped	11/24/2018	1230	11:30	5	52	1
Filming Started	11/25/2018	0900	9:00	2	4	2
Filming Stopped	12/4/2018	1400	10:00	0	1	1
Filming Started	12/5/2018	1000	10:00	0	1	2
Totals			94:15	8	58	6

A total of 103 Path 1 and Path 2 Chinook Salmon female carcasses (one female carcass not measured) were observed during the spawning ground survey. Each female carcass was examined to determine if it had successfully spawned prior to death. Spawning status was defined as un-spawned (many eggs remaining in the body) or spawned (few or no eggs remaining). Of the 103 female Chinook carcasses examined, 98 females (95.1%) were found to have spawned, and 5 females (4.9%) were identified as un-spawned.

Table 3. The total number of unknown salmonids observed by day during the 2018 season, the number of Chinook, Coho, and steelhead assigned species for each day.

Date	Unknown Salmonids Observed	Estimated Unknown Salmonids assigned to species		
		Chinook	Coho	Steelhead
11/26/2018	2	0	2	0
11/27/2018	27	1	24	2
11/28/2018	31	1	26	4
11/29/2018	20	1	9	10
11/30/2018	3	0	1	2
12/17/2018	10	0	3	7
12/18/2018	11	0	1	10
12/19/2018	1	0	0	1
Total	105	3	66	36

The Cormack-Jolly-Seber (CJS) mark recapture method was used to estimate carcass abundance in the area downstream of the counting station. A total of 264 (+/- 34 90%CI) Chinook Salmon carcasses were estimated (Cormack Jolly Seber mark recapture method) below the counting facility utilizing the CJS method (Table 4).

Table 4. Chinook Salmon jack, adult and total estimates for upstream and downstream of the counting station and total estimates for the Scott River 2018.

	Upstream of Counting station	Downstream of Counting Station		Total Estimates for Entire River	
	Video Count	Redds	CJS	CJS + Video	Redds + Video
Jacks	22	49	17	39	71
Adults	382	826	247	629	1208
Total	404	875	264	668	1279

Alternatively Chinook Salmon abundance downstream of the counting station was estimated through expanding the seasonal total redd count of 413 redds. Multiplying the seasonal total redd count by two generates an adult estimate of 826. Forty-nine grilse were added to the adult estimate utilizing the following equation: total run=adults/(1-%jacks estimated). A scale based grilse estimate of 5.6% has been used to calculate the total run of 875.

There is a discrepancy between the CJS (264) and redd based (875) estimate downstream of the counting station of 611 Chinook Salmon (Table 4). As a result of the CJS estimate being lower than the unexpanded observed redds there was a concern that the CJS estimate was low. Therefore, the redd-based estimate for downstream of the counting station was used to generate total for the estimated run size.

To estimate the total Chinook Salmon run for the entire river the redd based estimate from downstream of the counting station (875) was added to the video estimate (404) from upstream of the counting station to yield a total basin run size estimate of 1,279. Based on scale age analysis, adults comprised approximately 94.4% (1,208) and grilse comprised 5.6% (71) of the run (KRTAT 2018).

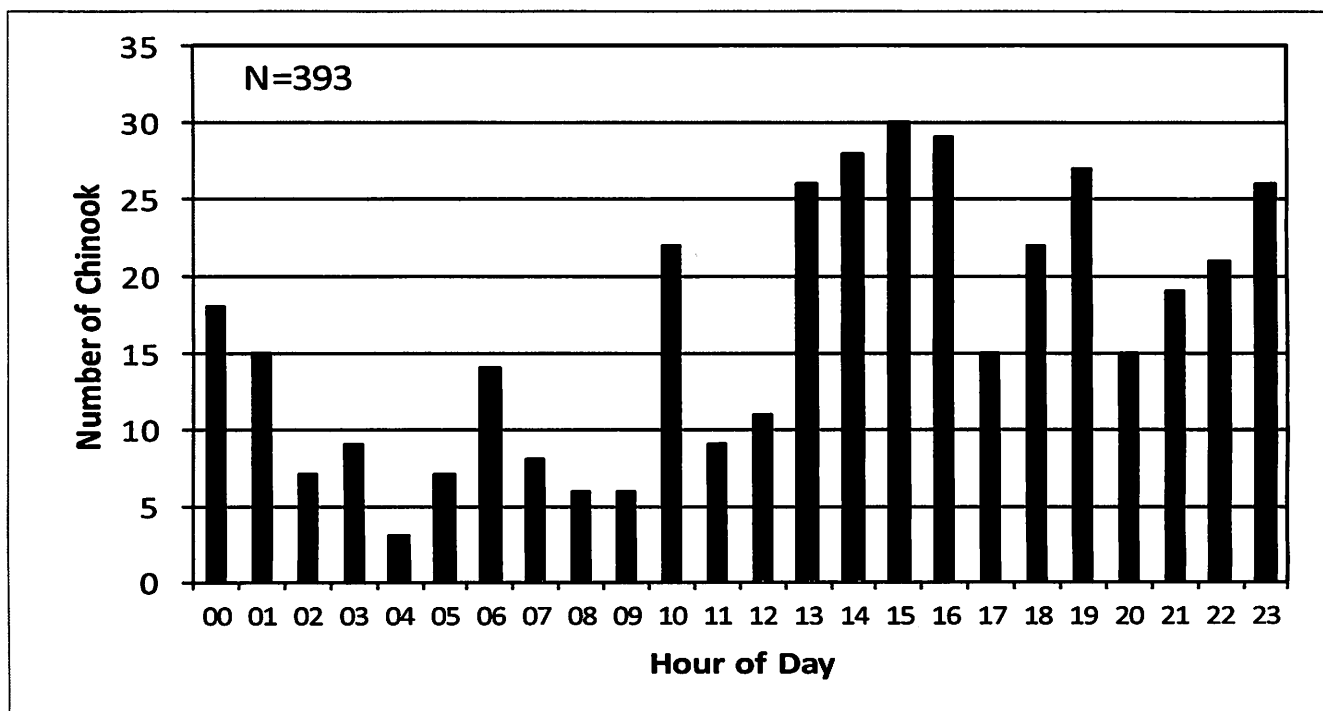


Figure 6. Summary of daily run timing of Chinook Salmon observed at the Scott River Fish Counting Facility during 2018 (N=393).

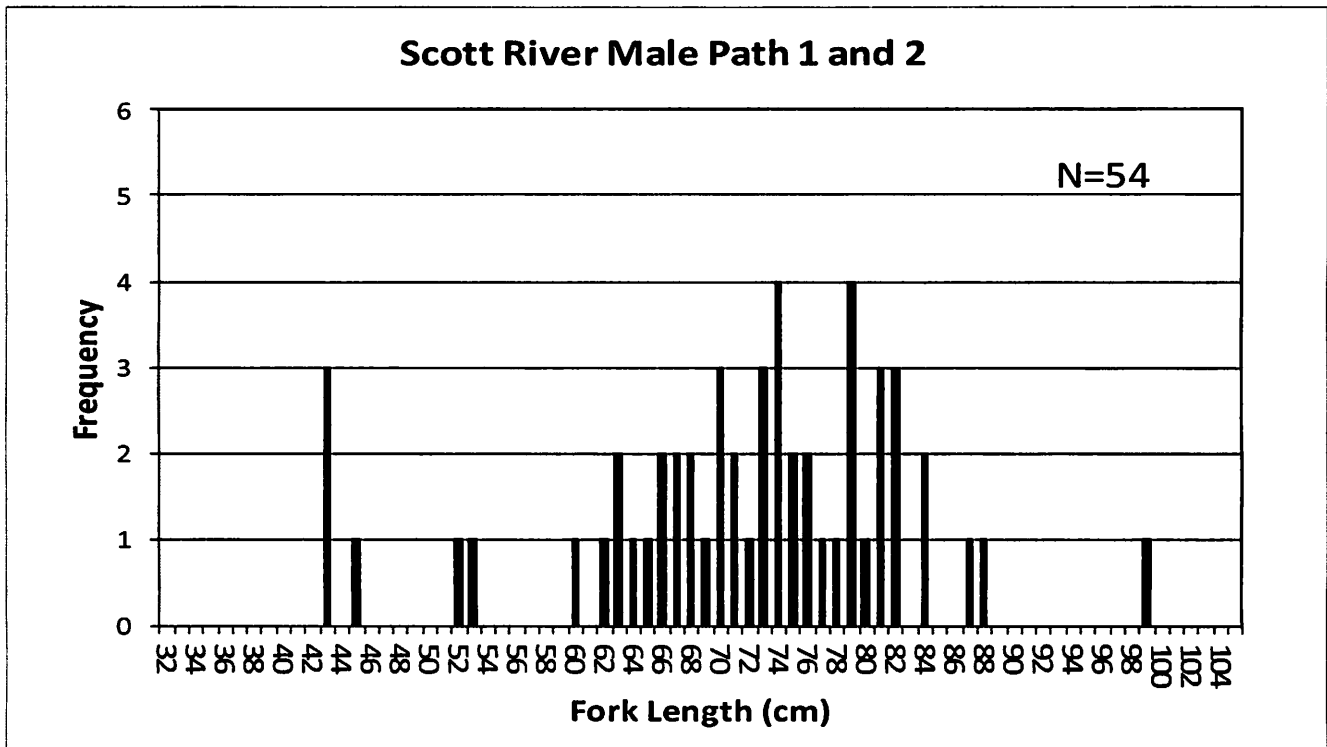


Figure 7. Length Frequency distribution of Path 1 and Path 2 male Chinook Salmon observed during spawning ground surveys in the Scott River, 2018 (N=54).

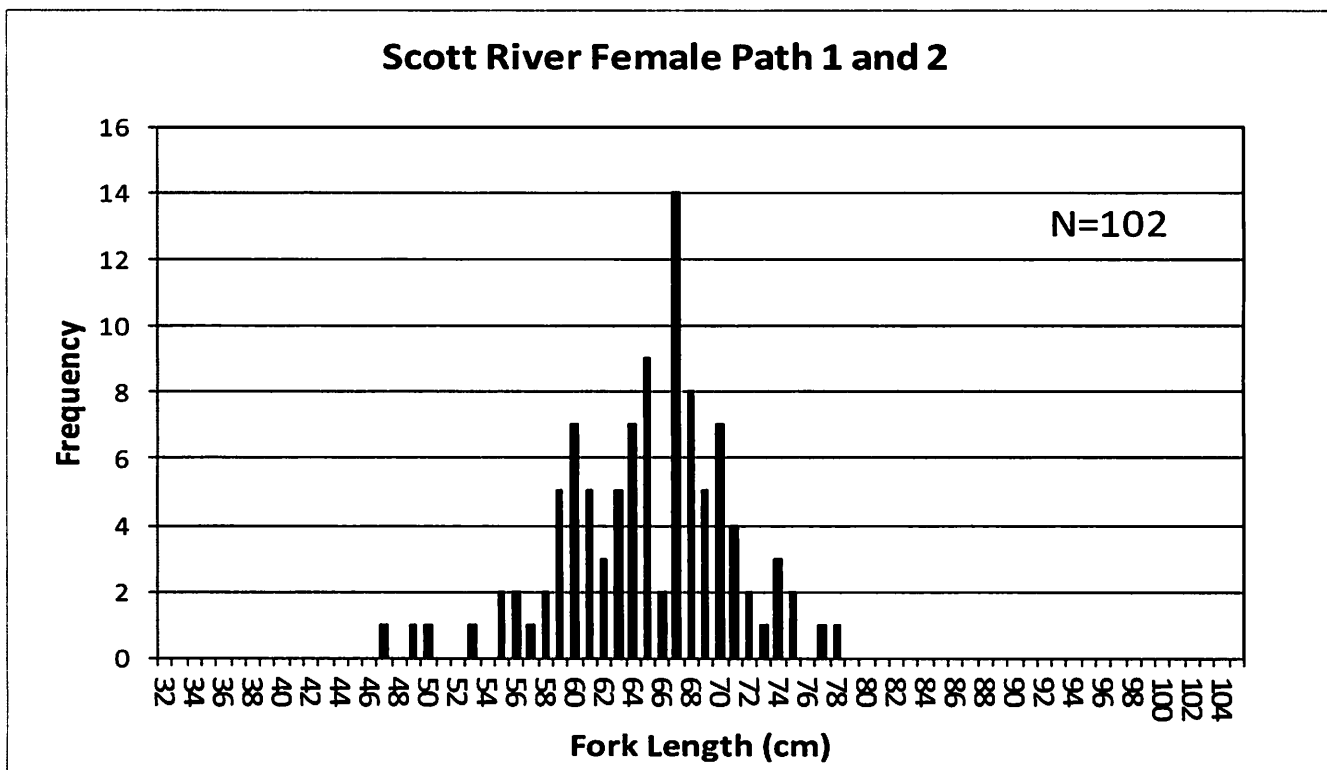


Figure 8. Length frequency distribution of Path 1 and Path 2 female Chinook Salmon observed during spawning ground surveys in the Scott River, 2018 (N=102).

COHO SALMON

The first adult Coho Salmon was observed at the counting facility on November 23, 2018, and the last Coho was observed on December 18, 2018 (Figure 9). A net total of 617 Coho (626 upstream and 9 downstream) were observed moving through the SRFCF when videography was employed. A total of 58 Coho were added to the seasonal count during periods of video loss (Table 2). Additionally, 105 adult salmonids passed through the counting station that were not identified to species. These 105 unknown salmonids were assigned species based on the known species composition from each day for which unknown species were observed. During the 2018 season 66 of the 105 unknown fish were re-classified as Coho (Table 3). A seasonal total of 737 Coho were estimated to have migrated above the counting station. Coho migration peaked following the first flow increase on November 24, 2018. During a six-day period from November 24, 2018, through November 29, 2018, 93.6% of the Coho (690) were observed. During the 2018 season KRP staff estimated the number of grilse in the Scott River by enumerating the number of Coho observed in the video flume that were shorter or longer than 56 cm. Utilizing this method KRP staff identified 96.4% adults and 3.6% grilse (see below for further information on seasonal estimates of age proportions).

Diel movements of Coho Salmon through the SRFCF were higher in the afternoon hours and peaked between 1400 hours and 2000 hours (Figure 10). Migrations were generally low during the day and increased from the late afternoon through early morning. The hours between 0900 and 1200 were generally the time during the day when the crew was at the weir conducting daily maintenance, and their presence may have affected fish movement.

Four hundred and seven of the 617 Coho Salmon images were clear enough to make a confident determination of the presence of a left maxillary clip. None of the 407 images were determined to have had a left maxillary clip, generating an estimated hatchery proportion of zero.

SPAWNING GROUND SURVEYS

Zero Coho Salmon carcasses were observed during the cooperative spawning ground surveys on the lower main stem Scott River (Reaches 1-7) and 7 Coho carcasses were observed in upper Scott River (Reaches 12 through 16 and tributary reaches) during surveys coordinated by the Siskiyou Resource Conservation District (SRCD) (Magranet, 2019). Zero Coho carcasses were collected as washbacks at the counting facility (Figure 11). Applying the sex ratios of recovered Coho carcasses observed during the SRCD's upper Scott River surveys to the total estimate yielded an estimated 42.9% (317) male and 57.1% (422) female Coho.

Applying the maximum grilse fork length cutoff of 56 cm to the total number of measured carcass recoveries (7) generated an age 2 proportion of 0% and an age 3 proportion of 100% (see below for further information on seasonal estimates of age proportions). All 7 of the carcasses examined were sampled for scales, tissue and otoliths. Collected tissue samples were supplied to the NOAA Southwest Fisheries Science Center located in Santa Cruz, California for stock identification purposes. Additionally, 7 Coho Salmon otolith samples were collected and archived at the Department's Yreka office for future stock identification and life history examination. One Coho redd was observed in Kelsey Creek and no Coho redds were observed in Canyon Creek or Tompkins Creek.

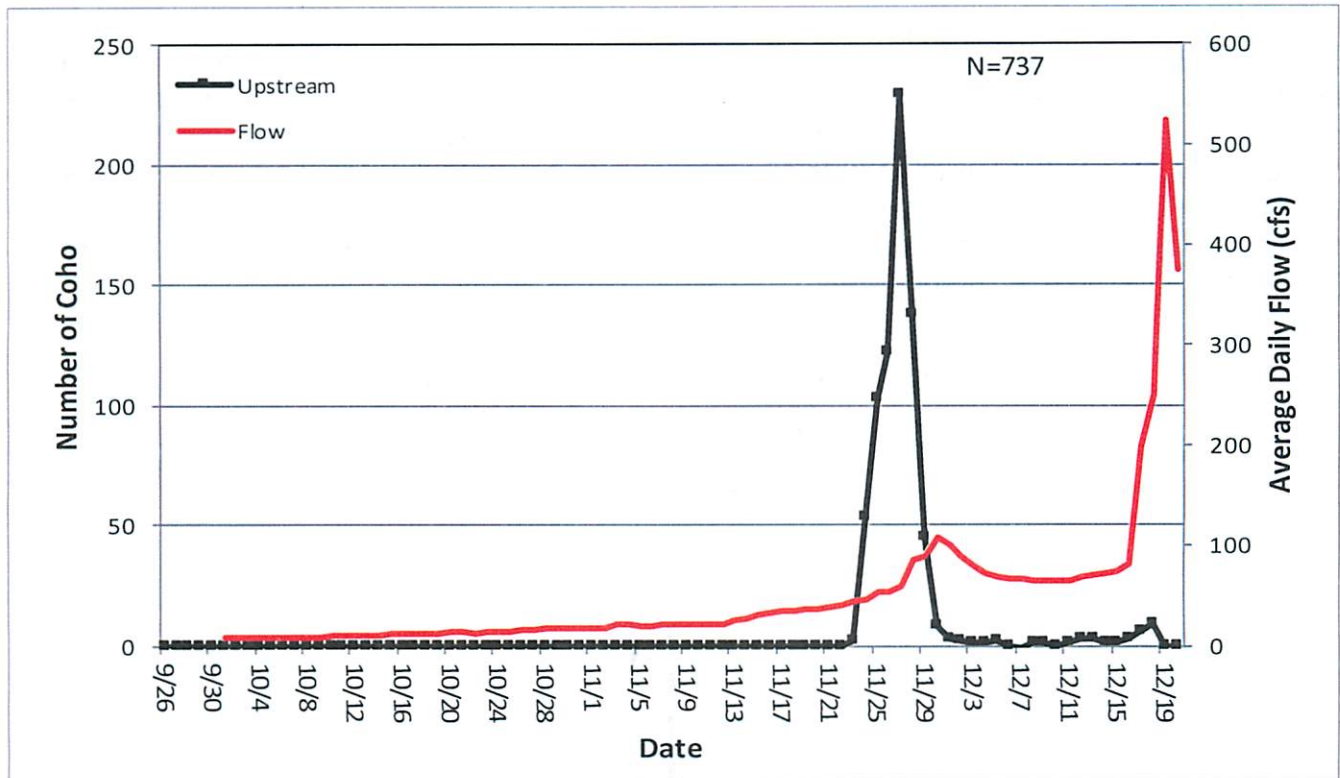


Figure 9. Run timing of Coho Salmon observed passing through the Scott River Fish Counting Facility during the 2018 season (N=737), and average daily flows observed at USGS Gauge No. 11519500.

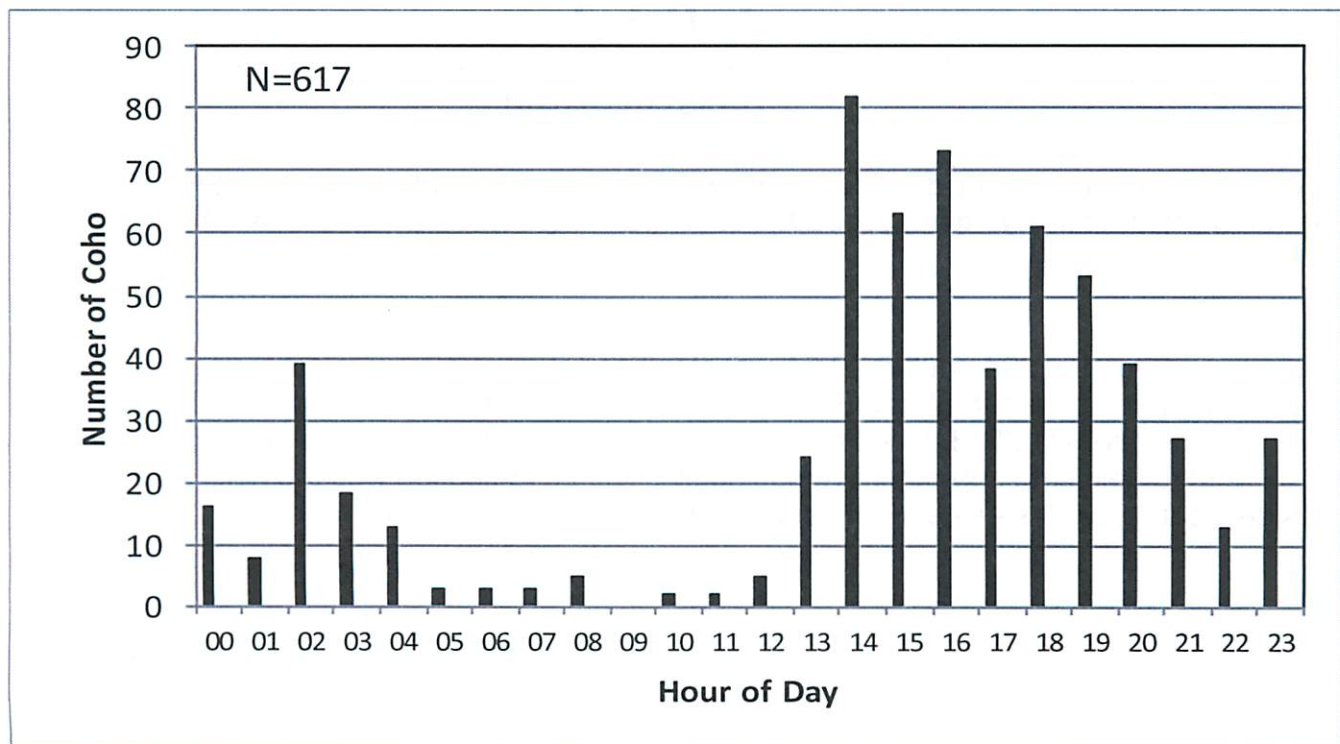


Figure 10. Diel migration patterns of Coho Salmon observed moving through the Scott River Fish Counting Facility in 2018 (N=617).

A total of 737 Coho Salmon were estimated to have swam upstream through the SRFCF during the season. One additional Coho redd was observed in areas downstream of the counting facility representing an additional two returning adults. Therefore, the total number of estimated Coho that entered the Scott River during the 2018-2019 season is 739. The age 2 proportions generated from videography and recovered carcasses were 3.6% and 0%, respectively. Due to the larger sample size available to estimate the age 2 proportion in the videography (617) verses carcass recoveries (7), the final age 2 proportion was determined using the videography data. Therefore, the resulting number of age 2 and three fish are 26 (3.6%) and 713 (96.4%), respectively.

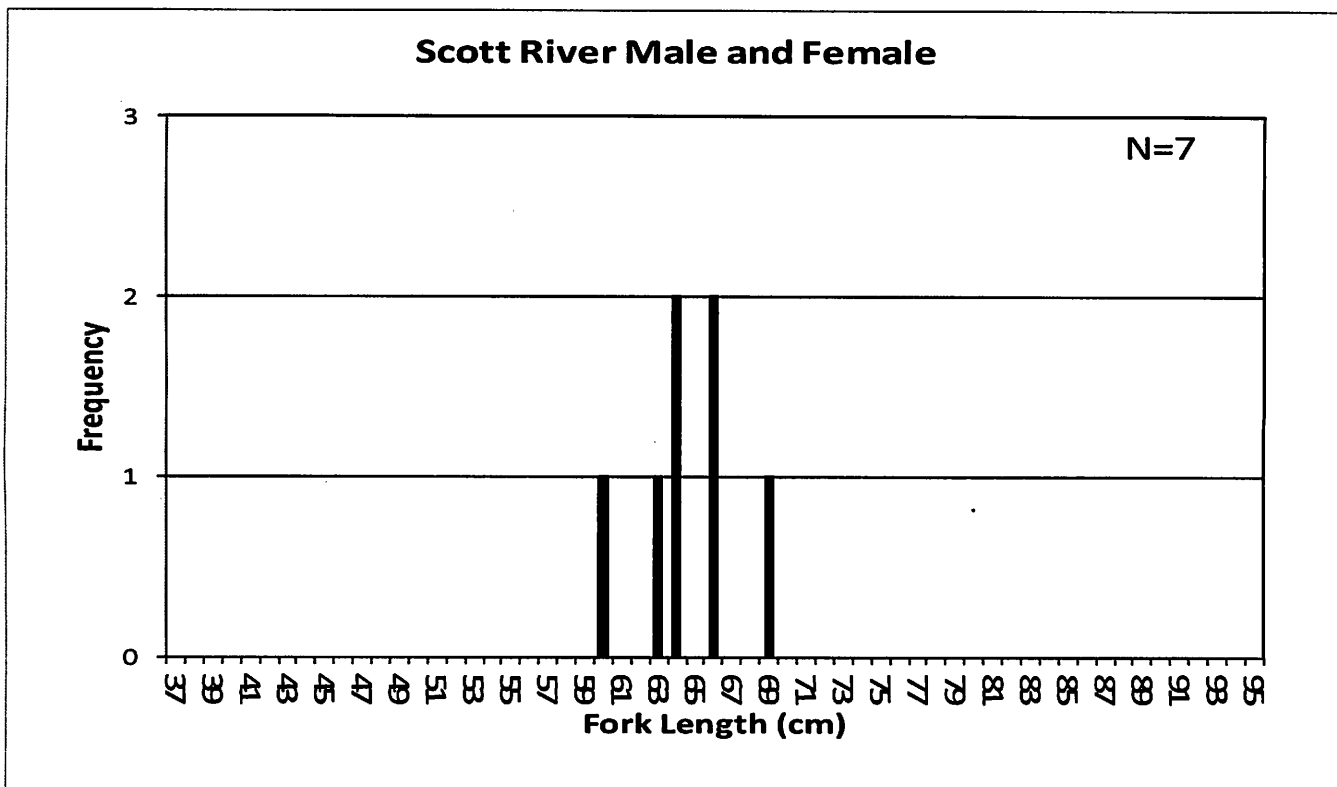


Figure 11. Length frequency distribution of Coho Salmon observed (N=7) during SRCD spawning ground surveys during the 2018-2019 spawning season (Magranet 2019).

STEELHEAD

In 2018, a net total of 294 adult (>40.64 cm) steelhead (Figure 12) were estimated to have entered and remained in the Scott River during the video recording season from October 3, 2018 to December 20, 2018. Lines on the back of the video flume were set at 40.64 cm (16 inches) to delineate sub-adults versus adults. The 2018 season was the ninth year that lines delineating adult steelhead and sub-adult steelhead were used.

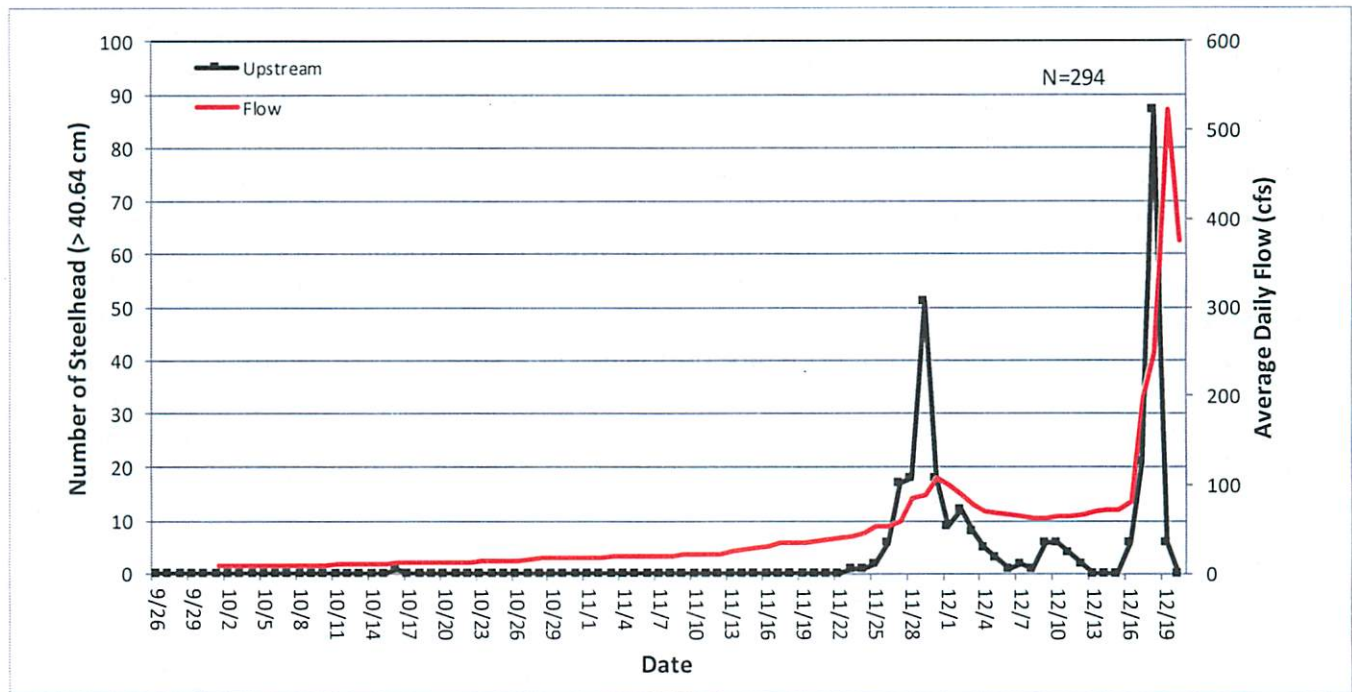


Figure 12. Run timing of steelhead trout (>40.64 cm) observed passing through the Scott River Fish Counting Facility during the 2018 season (N=294), and average daily flows observed at USGS Gauge No. 11519500.

DISCUSSION

CHINOOK SALMON RUNS

Since 1978, the Chinook Salmon run in the Scott River has ranged from 14,477 fish (1995) to 467 fish (2004) and has averaged 5,148 fish (Figure 13). The 2018 Chinook run in the Scott River ranks 39 (1,279 fish) out of 41 years of monitoring. The 2018 run was 75% lower than the 41 year average of 5,148 Chinook. A total of 404 Chinook were estimated to have passed through the SRFCF during the 2018 season. A total of 875 Chinook were estimated in Reach 1 through Reach 6 yielding a total run size estimate of **1,279** Chinook.

Table 5. Scott River Chinook Salmon abundance estimates by area and percentages of the total above and below the Counting Station during the 2008-2018 seasons.

Year	Downstream of Counting Station	Upstream of Counting Station	% Downstream of Counting Station	% Upstream of Counting Station	Total Basin Estimate
2008	1,439	3,234	31%	69%	4,673
2009	1,014	1,197	46%	54%	2,211
2010	280	2,228	11%	89%	2,508
2011	983	4,538	18%	82%	5,521
2012	1,208	8,144	13%	87%	9,352
2013	1,252	3,372	27%	73%	4,624
2014	2,995	9,476	24%	76%	12,471
2015	1,741	372	82%	18%	2,113
2016	363	1,152	24%	76%	1,515
2017	297	2,279	12%	88%	2,576
2018	875	404	68%	32%	1,279
Average	1,132	3,309	32%	68%	4,440

The various sub basin proportions of the Chinook Salmon distribution for years 2008-2018 are detailed in Table 5 and identifies the importance of the entire Scott River watershed to Chinook Salmon. From 2008 through 2018 an average of 68% of the Chinook run spawned upstream of the counting station. Adult Chinook migration was impeded by low flows in 2018 and an estimated 32% of the Chinook run was observed passing through the counting station. This is the second lowest proportion of Chinook that spawned in valley reaches for the period of record. For the period of record, the only other year when the proportion of Chinook spawners in the valley was less than 50% was during 2015 when 18% of the run spawned above the counting station. There is a higher risk of catastrophic loss due to potential redd scour when a disproportionately high proportion of eggs are deposited in a small portion of the watershed. Historically, Chinook spawning ground surveys have been conducted in valley Reaches 12-16, but due to low flows and the main stem Scott River not being connected above Member Bridge (River Mile 24.4), for the entire Chinook spawning season, surveys were not conducted in this portion of the watershed in 2018.

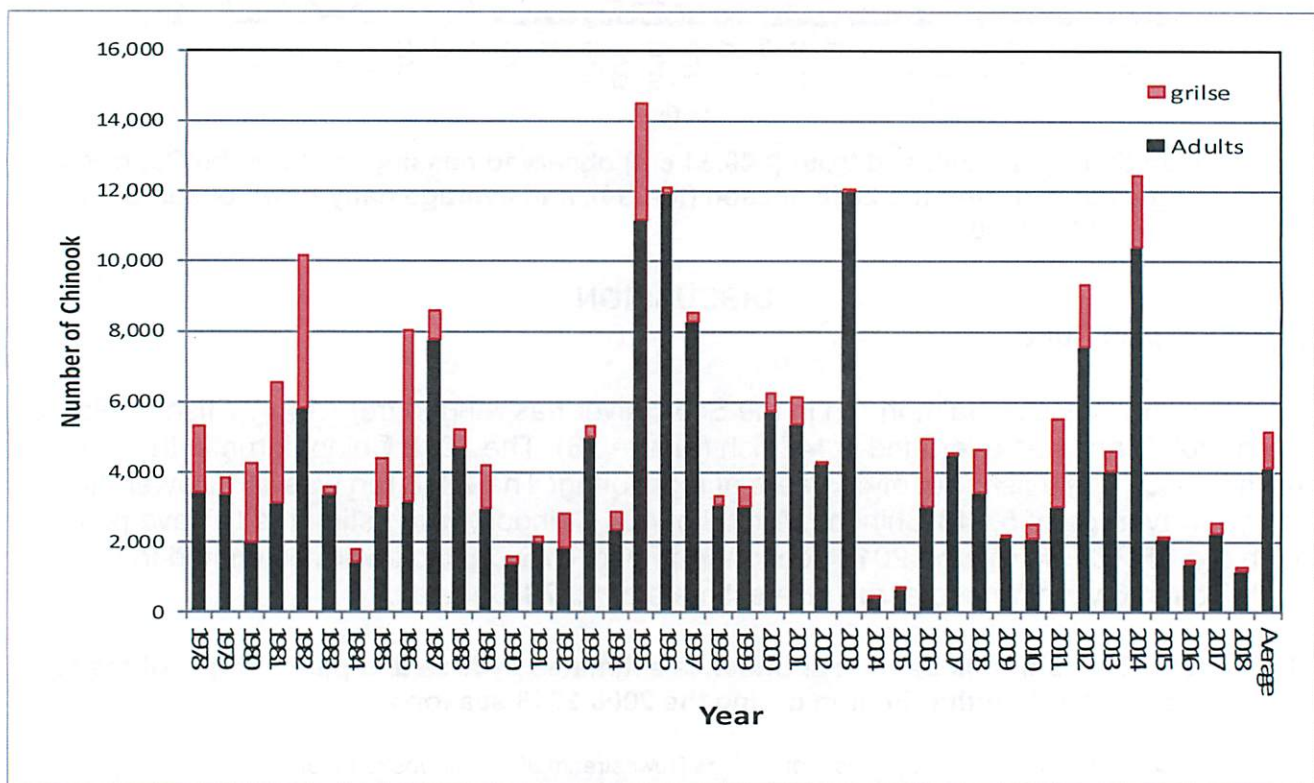


Figure 13. Estimated escapement of Chinook Salmon returning to the Scott River from 1978 to 2018.

The Scott River is an important component of the Klamath Basin Chinook Salmon runs. The Scott River has contributed an average of 9% of the basin-wide (including Trinity River) natural spawning escapement to the Klamath River basin during the period from 1978 to 2018 (Table 6). Although 2018 was an exception, in most years the Scott River Chinook population tracks very similarly to the total Klamath Basin population ($r=0.7651$ p -value <0.001) indicating that environmental factors outside the Scott River watershed play an important role in influencing abundance of this population of Chinook (Figure 14).

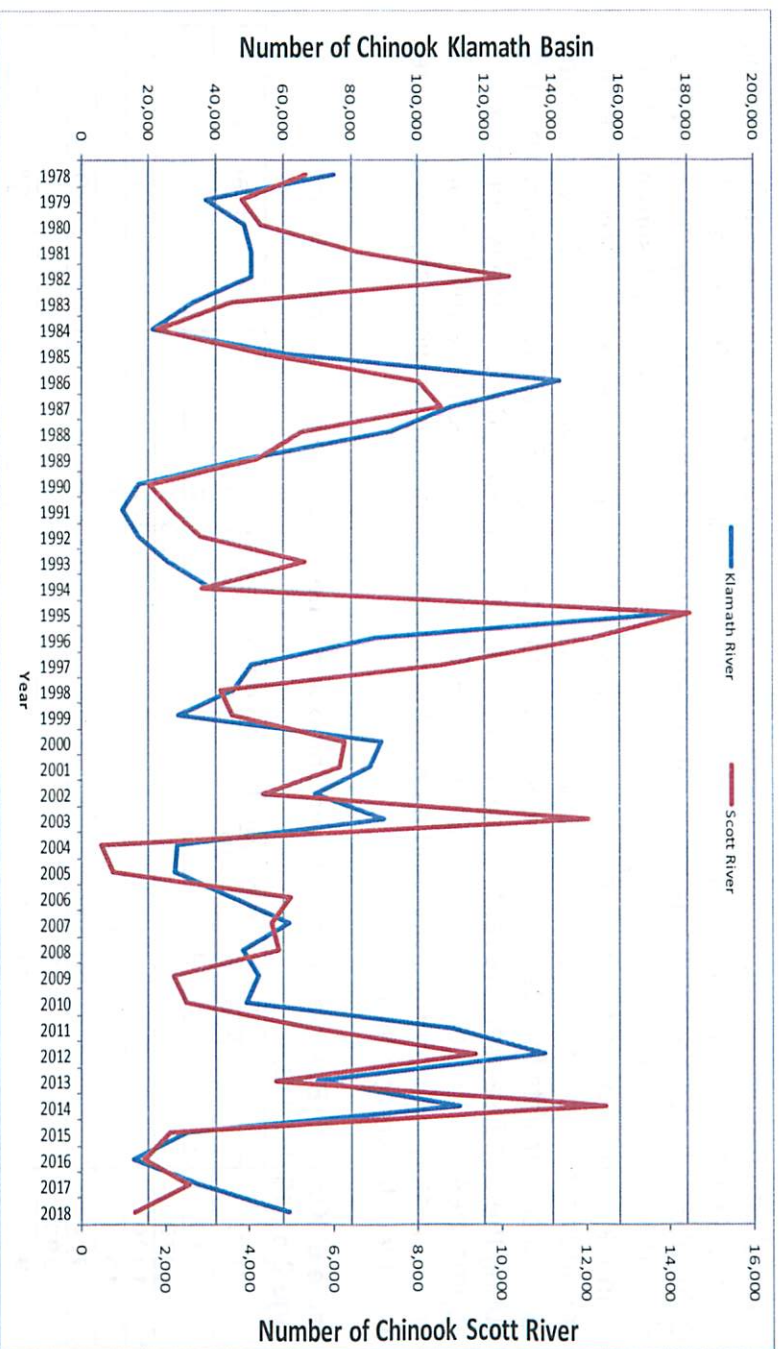


Figure 14. Chinook Salmon Klamath Basin natural spawner escapement (primary y-axis) and the Scott River natural spawner escapement (secondary y-axis) from 1978 through 2018.

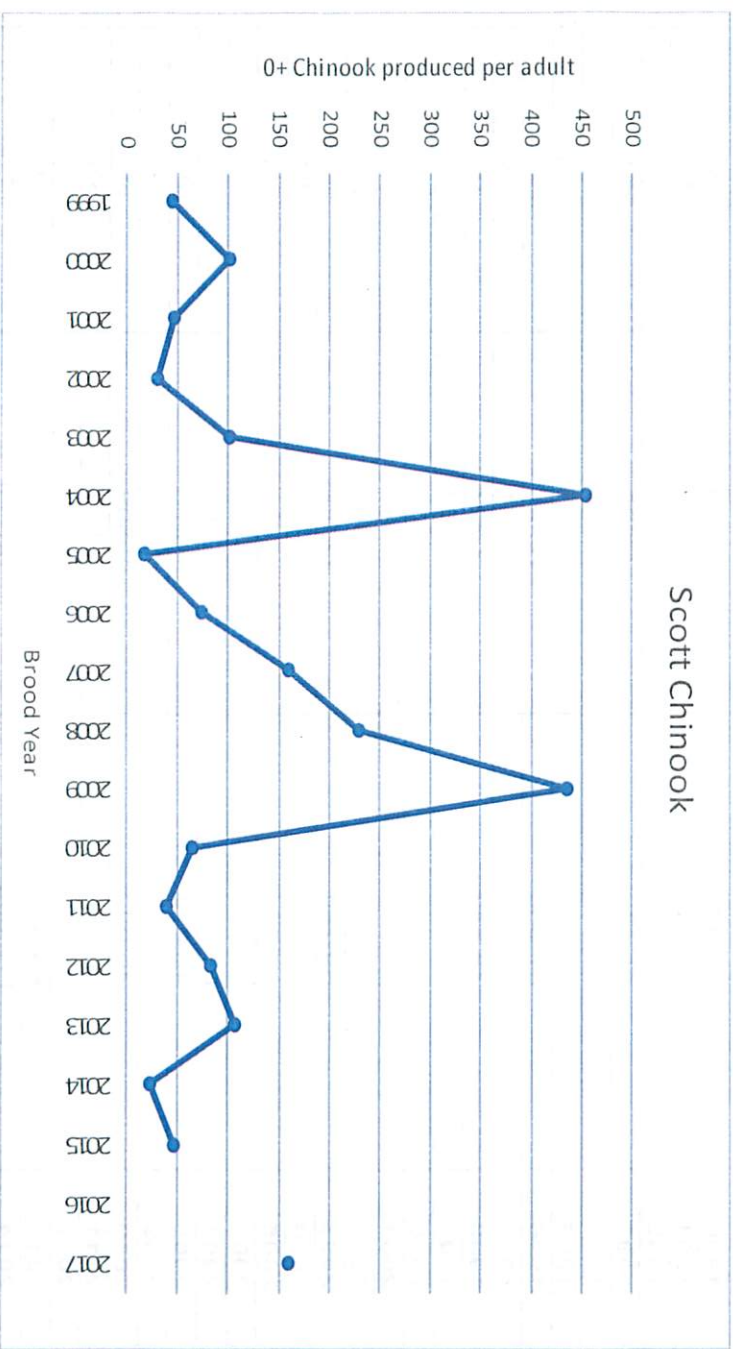


Figure 15. Number of 0+ Chinook Salmon produced per adult spawner in the Scott River by brood year, for Brood Years 1999-2015, 2017.

To evaluate freshwater productivity, the production of emigrating 0+ Chinook Salmon has been estimated in the Scott River since Brood Year 1999 (Massie et al. 2019). The number of 0+ Chinook produced per adult has been calculated for Brood Years 1999-2015, 2017 and has ranged from a low of 17.6 to a high of 453.6 and averaged 123 (Figure 15). Estimates of 0+ Chinook recruits per adult for Brood Year 2017 was 159.4. The observed 0+ Chinook produced per adult for Brood Year 2017 was 30% higher than the 18 year average of 123 fish. Due to funding constraints the Department was unable to operate the Scott River Rotary Screw Trap during the 2017 season preventing this analysis for Brood Year 2016. As the watershed approaches carrying capacity the number of 0+ Chinook produced per adult is a direct measure of in-river productivity, and as habitat conditions improve or diminish, this measure will reflect those conditions.

Table 6. Klamath Basin and Scott River Chinook Salmon natural spawner escapements (age 2-5), 1978-2018.

Year	Chinook Natural Spawner Escapement		% Scott
	Klamath Basin	Scott River	
1978	74,906	5,332	7%
1979	37,398	3,824	10%
1980	48,465	4,277	9%
1981	50,364	6,556	13%
1982	50,597	10,176	20%
1983	33,310	3,568	11%
1984	21,349	1,801	8%
1985	61,628	4,408	7%
1986	142,302	8,041	6%
1987	110,489	8,566	8%
1988	91,930	5,200	6%
1989	49,377	4,188	8%
1990	16,946	1,615	10%
1991	12,367	2,165	18%
1992	17,171	2,838	17%
1993	25,683	5,300	21%
1994	38,578	2,863	7%
1995	179,118	14,477	8%
1996	87,500	12,097	14%
1997	50,369	8,561	17%
1998	45,343	3,327	7%
1999	28,904	3,584	12%
2000	89,122	6,253	7%
2001	85,581	6,142	7%
2002	69,502	4,308	6%
2003	89,744	12,053	13%
2004	28,516	467	2%
2005	27,931	756	3%
2006	45,002	4,960	11%
2007	61,741	4,505	7%
2008	48,073	4,673	10%
2009	52,702	2,211	4%
2010	49,027	2,508	5%
2011	110,554	5,521	5%
2012	137,724	9,352	7%
2013	69,986	4,624	7%
2014	112,599	12,470	11%
2015	31,607	2,113	7%
2016	15,818	1,515	10%
2017	35,036	2,576	7%
2018	61,561	1,279	2%
Average	60,876	5,148	9%

COHO SALMON

Since video operations began in 2007 the estimated escapement of Coho Salmon in the Scott River has ranged from a low of 63 to a high of 2,752 and averaged 670 (Figure 16). The adult run size of Coho prior to 2007 is unknown, and with the addition of the counting facility, the ability to monitor this ESA listed run has greatly improved. Although recent adult run size data is sparse on the Scott River, monitoring of the yearling juvenile emigration has taken place since 2003. The emigration data generated from 2003 through 2018 indicates significant interannual variation (Massie et al. 2019). Results of the adult monitoring at the SRFCF support this observation. The brood year that returned in 2018 (age 3 in 2018 and age 2 in 2017) in one generation increased in total numbers by 437 fish, an increase of 151%, from returns in 2015 (Figure 17). An increase in brood year strength has been observed in this cohort for the last three generations. It should be noted that the 2018 monitoring season extended to December 20 near the end of the Coho migration, and the 2018 estimate may underestimate the true population estimate. In an effort to evaluate the accuracy of the 2018 Coho run, the observed average smolt survival of 5.0% (Brood Years 2004-2008 and 2010-2014) would normally be applied to the yearling point estimate from 2017 and generate a predicted adult return. This analysis is not possible this year due to lack of a yearling estimate for this brood year. An alternative way to evaluate the accuracy of the 2018 estimate is to evaluate the proportion of the total annual run that has been observed by December 20th each season for the period of record (Figure 18). For the years 2007-2017 an average of 93.4% of the annual Coho run has been observed by December 20. If 93.4% of the Coho were observed during the 2018 season then an estimated 52 additional Coho (total 791) would have been estimated if monitoring was conducted through the entire migration based on previous run timing observations. This analysis provides evidence that if adults were missed at the end of the migratory window due to removing the counting facility it was likely few.

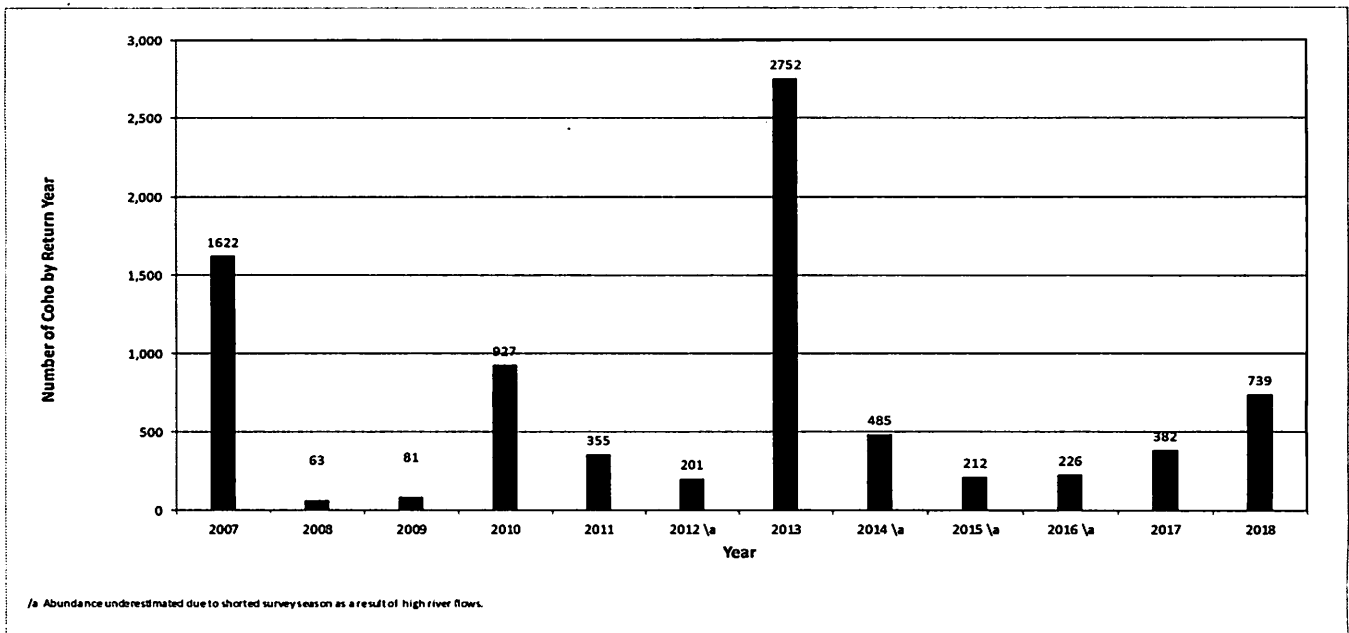


Figure 16. Estimated escapement by return year of adult and grilse Coho Salmon (age 2 and age 3) returning to the Scott River from 2007 to 2018.

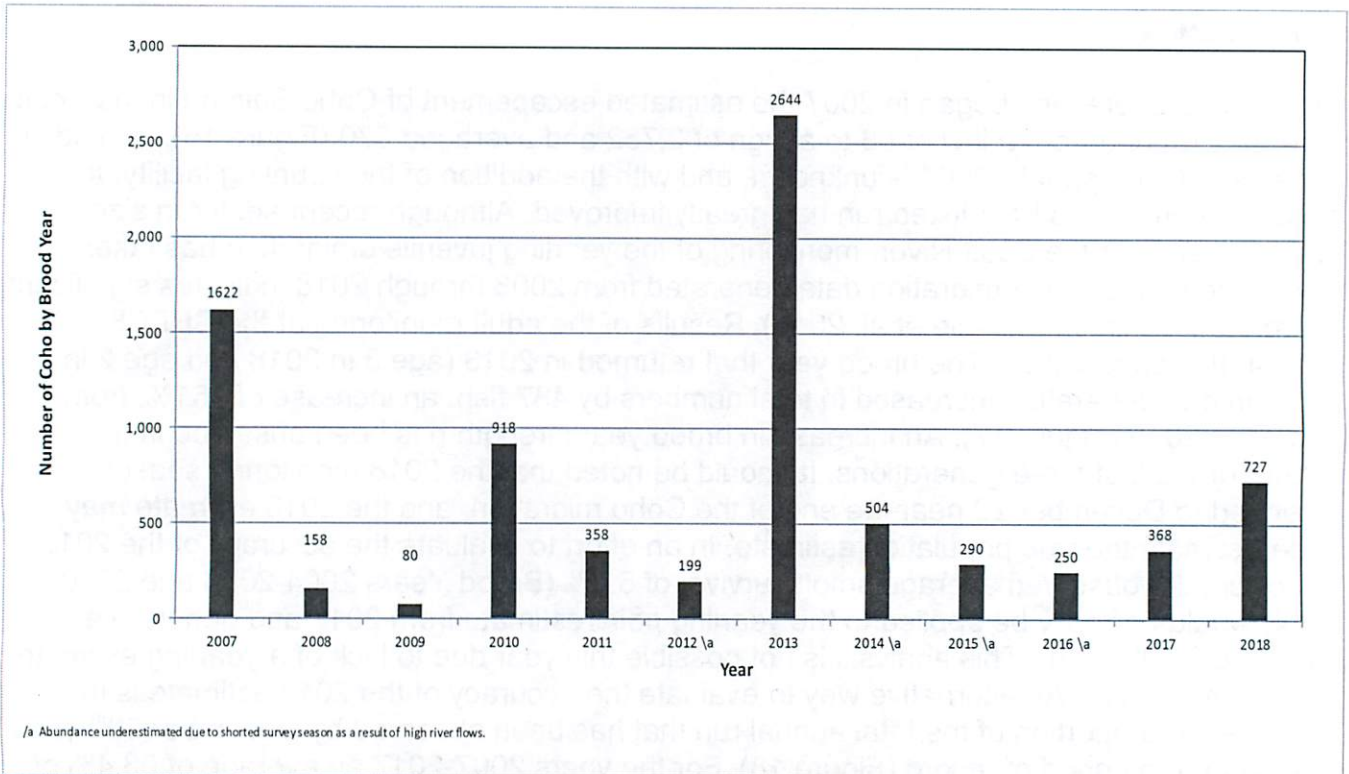


Figure 17. Estimated escapement by Brood Year of adult and grilse Coho Salmon (age 2 [year-1] and age 3 [year]) salmon returning to the Scott River from 2007 to 2018.

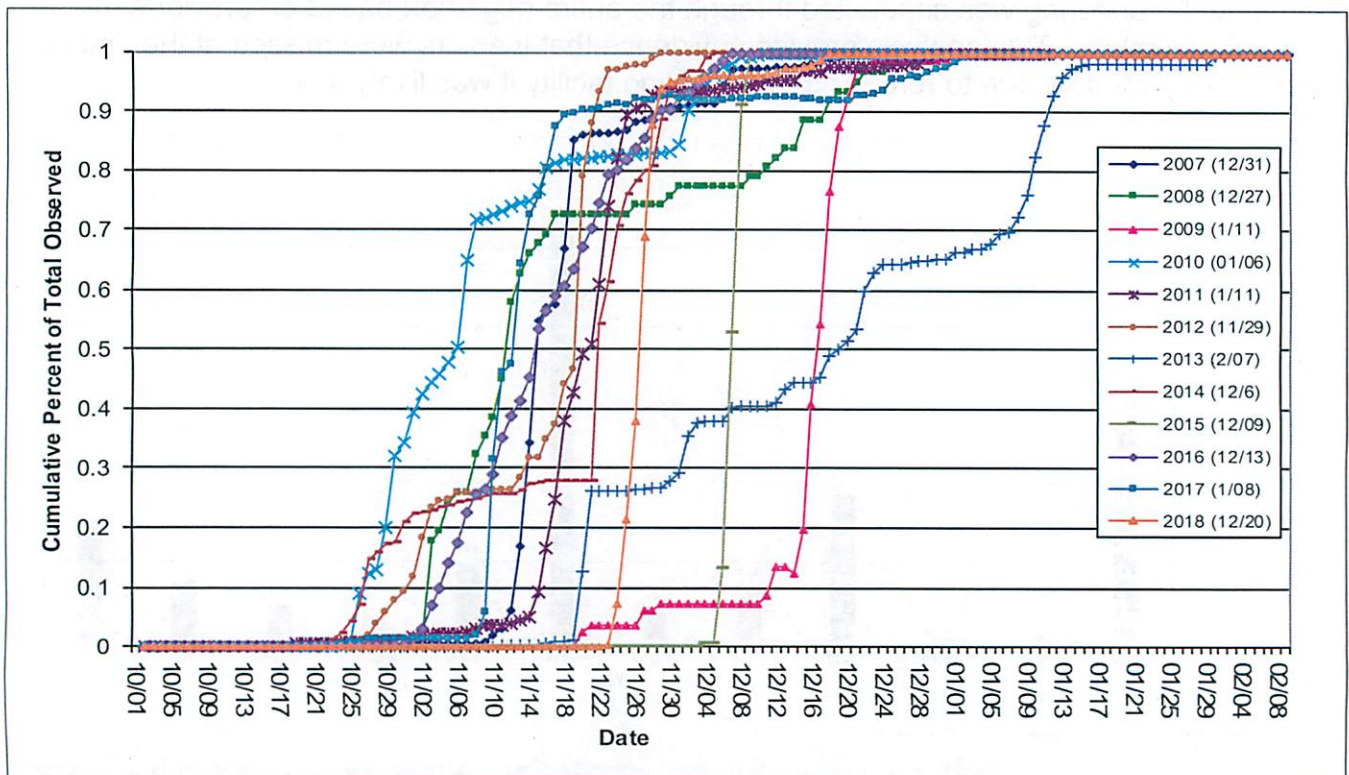


Figure 18. Cumulative percent of total observed Coho Salmon observations by day at the Scott River Fish Counting Facility annually from 2007-2018. The date in parenthesis indicates the last date the fish counting facility was operated for each year.

Utilizing the number of Coho Salmon smolts produced in the Scott River (Massie et al. 2019) and the results of the adult abundance estimates allows for analysis of Scott River freshwater production and out of basin survival by brood year. For Brood Years 2004 to 2008 and 2010 to 2014, the out of basin survival has averaged 5.0% and ranged from a low of 1.25% to a high of 10.99% (Table 7). Due to the extremely high observed percent smolt survival of 55.81 for Brood Year 2009, data from this brood year has been omitted from this analysis. It is possible that the smolt estimate generated for Brood Year 2009 underestimated the actual number of out migrants. It is also possible that out of basin adult strays positively biased the adult estimate in 2012. Although the proportion of smolts that survive outside the Scott River watershed is largely driven by uncontrollable factors, it is important to track this survival metric as it provides a deeper understanding of adult return trend information.

Table 7. Coho Salmon smolt outmigrant abundance point estimates, age 2 and age 3 Coho abundance estimates, and proportion of outmigrant smolts that returned by brood year for the Scott River, Brood Years 2004-2015.

Brood Year	Smolt Year	Smolt point Estimate	Age 3 Return Year	Age 2 Return	Age 3 Return	Age 2 and 3 Return	Percent smolt survival
2004	2006	95815	2007	0	1622	1622	1.69
2005	2007	3931	2008	0	58	58	1.48
2006	2008	1142	2009	5	75	80	7.01
2007	2009	73232	2010	6	913	919	1.25
2008	2010	3257	2011	14	344	358	10.99
2009	2011	353	2012	11	186	197	55.81
2010	2012	63135	2013	13	2631	2644	4.19
2011	2013	9283	2014	121	383	504	5.43
2012	2014	6734	2015	102	188	290	4.31
2013	2015	8758	2016	24	226	250	2.85
2014	2016	3372	2017	0	364	364	10.79
2015	2017	N/A	2018	14	712	726	N/A

Analyzing comparisons of Coho Salmon smolt production estimates to estimated female adult Coho returns produces freshwater survival estimates in the form of Coho smolts produced per adult female return. For Brood Years 2007 through 2016, the number of Coho smolts produced per returning adult female has ranged from a low of 5.78 to a high of 101.78 and has averaged 59.48 (Table 8). Unfortunately, due to funding constraints, the juvenile monitoring project was not conducted during 2017 preventing this analysis for Brood Year 2015. Due to the difficulty in estimating abundance of adults and out-migrants at low abundance levels it is unclear if the smolts produced per adult female ratio generated for Brood Year 2009 is a result of decreased freshwater productivity or a result of sampling difficulty. As additional years of data become available the freshwater production of Coho in the Scott River can be further evaluated. The number of smolts produced per returning adult female by brood year is a direct measure of freshwater survival. For levels below carrying capacity, it can be stated that as the number of smolts produced per returning adult female increases it can be inferred that in-river conditions for Coho are improving. Conversely as the number of smolts produced per returning adult female decreases, it can be inferred that in-river conditions for Coho are getting worse.

Table 8. Adult Coho Salmon estimate, Coho smolt production point estimate and ratio of Coho smolts produced per adult female return for the Scott River, Brood Years 2007-2015, 2016.

Adult Year Brood Year	Adult Estimate	Adult Female Estimate	Smolt Year	Smolt point Estimate	Smolts produced per Female
2007	1622	860	2009	73232	85.15
2008	63	32	2010	3257	101.78
2009	81	41	2011	353	8.61
2010	927	640	2012	63135	98.65
2011	355	170	2013	9283	54.61
2012	201	86	2014	6734	78.30
2013	2752	1514	2015	8758	5.78
2014	485	179	2016	3372	18.84
2015	212	170	2017	N/D	N/D
2016	226	175	2018	14628	83.59
				Average	59.48

STEELHEAD

The number of returning adult steelhead has been monitored at the SRFCF since 2007. During the 2007 through 2009 seasons an unknown number of sub-adult steelhead may have been counted as adults. Starting in 2010, lines on the back of the video flume were set 16 inches (40.64 cm) apart to delineate sub-adults versus adults. From 2007 to 2018 the number of observed adult steelhead has ranged from a high of 917 to a low of 8 with an average of 252 (Figure 19). The run size of adult steelhead prior to 2007 is unknown, and with the addition of the counting facility, the ability to monitor this run has greatly improved. Although recent adult run size data is sparse on the Scott River, monitoring of the juvenile emigration has taken place since 2003. It is believed the majority of adult steelhead migration occurs outside the operational window of the SRFCF. Therefore, the number of observed steelhead should be considered minimum number of returns and not basin estimates.

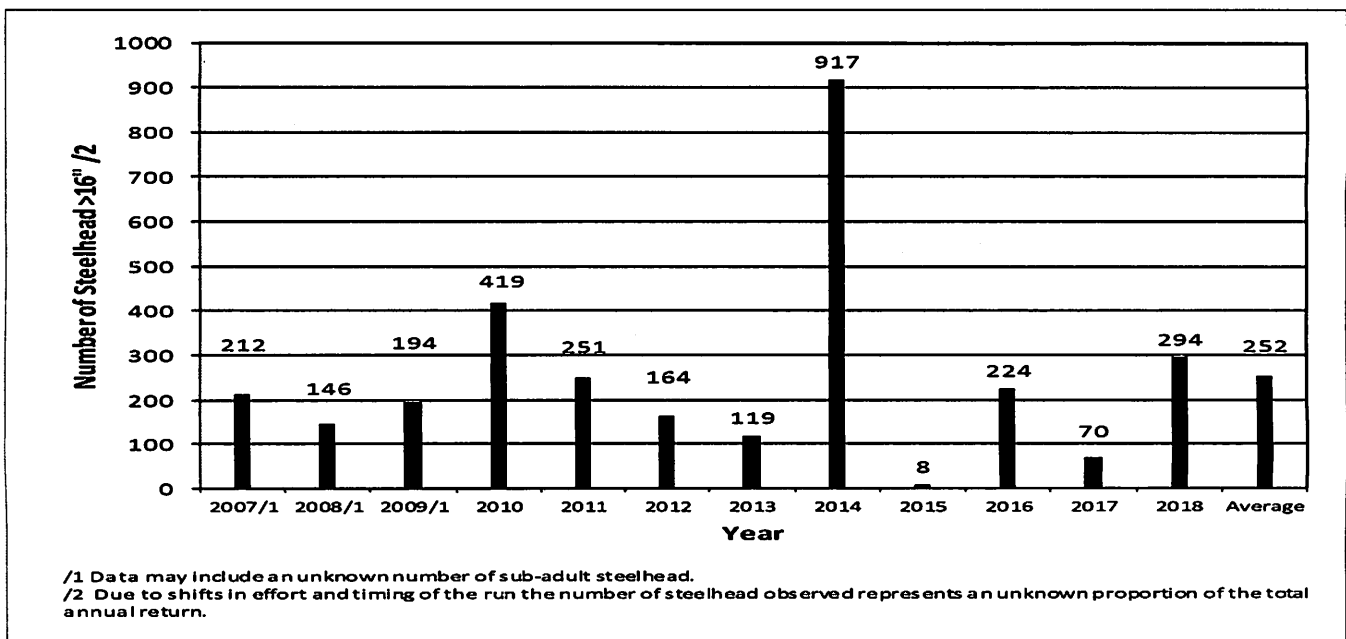


Figure 19. Number of observed steelhead >16" at the Scott River Fish Counting Facility from 2007 to 2018.

ACKNOWLEDGEMENTS

The California Department of Fish and Wildlife would like to thank Sport Fish Restoration Fund for their financial assistance in the operation of the SRFCF during 2018. The cooperative spawning ground surveys would not be possible without the assistance of the U.S. Fish and Wildlife Service Yreka office and the USFS. Additionally this work would not be possible without the cooperation and participation of the Siskiyou Resource Conservation District, Karuk Tribe, Quartz Valley Tribe, United States Forest Service, Northern California Resource Center, Americorps, and Etna High School who assisted in completing spawning ground surveys on the Scott River. We would also like to express our appreciation to the various landowners who have provided permission to access the Scott River through their property. Additionally, we thank the SRCD for making their data available for this report.

Literature Cited

- Bergman, J. M., R. M. Nielson, and A. Low. 2012. Central Valley in-river Chinook salmon escapement monitoring plan. Fisheries Branch Administrative Report Number: 2012-1. California Department of Fish and Game. Sacramento, CA.
- Giudice, D. and M. Knechtle. 2018. Shasta River Chinook and Coho observations in 2018-2019, Siskiyou County, CA. California Department of Fish and Wildlife. Available from 1625 South Main Street, Yreka, CA 96097
- Klamath River Technical Team (KRTAT). 2019. Klamath River Fall Chinook Salmon Age-Specific Escapement, River Harvest, and Run Size Estimates, 2018 Run.
- Magranet, Lindsay. 2019. Scott River Adult Coho Spawning Ground Surveys 2018-2019 Season. Data Tables. Siskiyou Resource Conservation District Etna, CA.
- Massie, M, and M. Anderson. 2019. Final Report Scott River Juvenile Salmonid Outmigrant Study, 2018. P1610529. California Department of Fish and Wildlife Available from California Department of Fish and Wildlife, 1625 South Main Street, Yreka, CA 96097
- Stevenson, David R., and Steven E. Campana. 1992. Otolith Microstructure Examination and Analysis. Department of Marine Resources, Marine Resources Laboratory, McKown Point, West Boothbay Harbor, ME 04575.
- Williams T. et al. 2008 Framework for assessing viability of threatened Coho salmon in the southern Oregon/northern California coast evolutionarily significant unit. NOAA-TM-NMFS-SWFSC-432.

