

2017 SCOTT RIVER SALMON STUDIES FINAL REPORT



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ABSTRACT

The California Department of Fish and Wildlife's (Department), Klamath River Project (KRP) operated a video/SONAR fish counting facility and conducted cooperative spawning ground surveys (carcass surveys) on the Scott River during the 2017 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 Salmon and Coho Salmon into the Scott River. Fish counting operations began on September 22, 2017 and ended on January 8, 2018 due to high river flows.

The total number of Chinook Salmon that entered the Scott River during the 2017 season is estimated to be **2,576** fish. Based on the proportion of male and female Chinook Salmon that were sampled during the spawning ground surveys the run was comprised of approximately 1,194 (46.4%) males and 1,382 (53.4%) females. Based on scale age analysis, adults comprised approximately 88.1% (2,269 fish) and grilse comprised 11.9% (307 fish) of the run. Males ranged in fork length (FL) from 38cm to 100cm and averaged 69.3cm. Females ranged in FL from 47cm to 88cm and averaged 68.5cm. KRP staff estimated that none of the Chinook Salmon that returned were of hatchery origin.

The first adult Coho Salmon was observed at the Scott River Fish Counting Facility (SRFCF) on October 24, 2017 and the last Coho Salmon was observed on January 4, 2018. A net total of **382** Coho Salmon were observed moving upstream through the SRFCF during the season. No additional coho were estimated in the main stem or tributaries downstream of the SRFCF. Based on the proportion of male and female Coho Salmon that were sampled during the season the run was comprised of approximately 208 (54.5%) males and 174 (45.5%) females. Based on live coho images observed during video monitoring, adults comprised approximately 96.3% (368 fish) and grilse comprised 3.7% (14 fish) of the run. Males ranged in fork length (FL) from 55cm to 69cm and averaged 62.8cm. Females ranged in FL from 57cm to 65cm and averaged 60.0cm. Based on observed hatchery marks during video monitoring, 1.08% of the Coho Salmon 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 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.

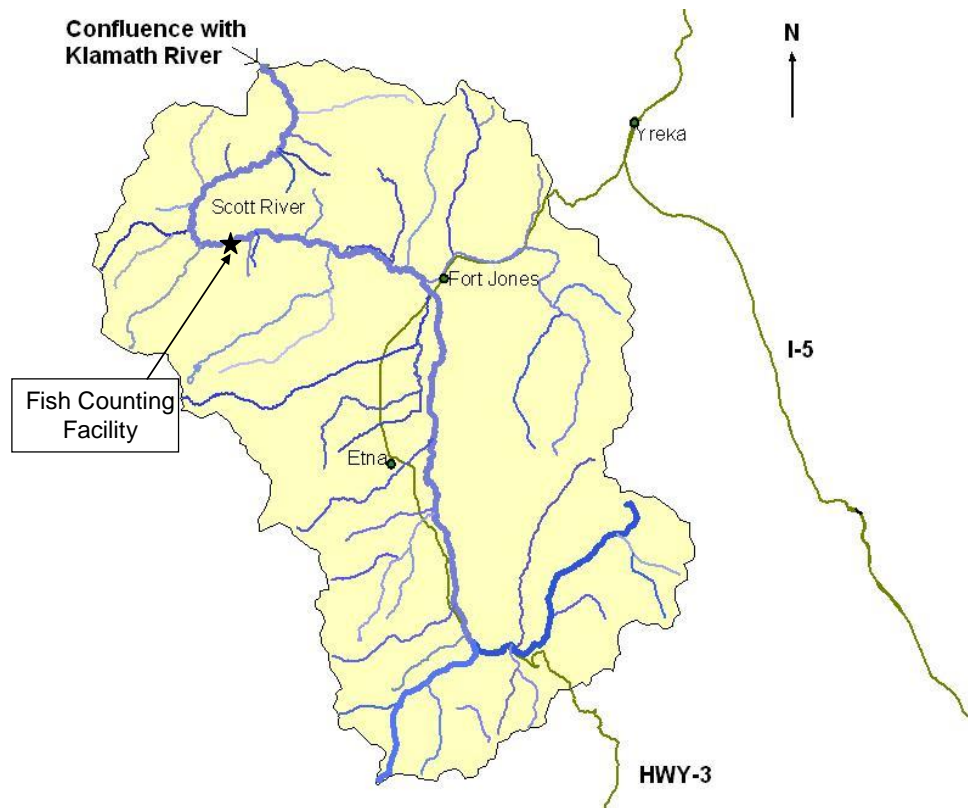


Figure 1. Location of the Scott River, tributary to the Klamath River, Siskiyou County, California.

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 twenty-two 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 Salmon 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 listed Southern Oregon/Northern California Coast Coho Salmon (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. 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.

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 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 on September 22, 2017 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 2). 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 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 2. Scott River Fish Counting Facility located in Siskiyou County, California 2017.

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 ad- 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. During periods of high flow when the video camera was inoperable an ARIS SONAR camera was installed to estimate the total number of adult salmonids. The ARIS camera is unable to determine species composition and as a result species apportionment was estimated by averaging the known species composition observed from videography three days prior and three days after the ARIS total count was observed.

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 12, 2017 and ending November 30, 2017. A total of 118 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 period and are reported by the Siskiyou Resource Conservation District (Magranet 2018). 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 redds were flagged and mapped on USGS topographic maps, and the information was provided to the Klamath National Forest. All carcasses recovered were identified to species and gender, checked for marks or tags, 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 (Paths). 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 couldn't 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.

Unfortunately during 2017 extreme low numbers of carcasses were recaptured in the spawning ground survey below the counting facility which prevented the use of the Cormack-Jolly-Seber (CJS) model (Bergman et al. 2012) to estimate total in this area. As a result the adult Chinook 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 Salmon 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 3). 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 63 Chinook Salmon and 3 Coho Salmon. Tissue was collected from the first Chinook from each reach and each survey date and all Coho Salmon 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 64 Chinook Salmon and 2 Coho Salmon (otoliths were collected from the first Chinook from each reach and each survey date and all Coho Salmon 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 Salmon 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 Salmon redds were multiplied by 2 (utilizing data from reach 1 through reach 6 only). The grilse component below the counting facility was estimated using the following equation: total run= adults/(1-%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 Salmon observed at the counting facility. Spawning ground surveys were conducted through December 15, 2017 in the main stem and tributaries (Tompkins, Kelsey Creek and Canyon Creek) below the counting facility. To estimate total adult Coho Salmon escapement in the Scott River, the number of

Table 1. Description of cooperative spawning ground survey reach locations along the Scott River during the 2017 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 salmon redds downstream of the counting station (zero in 2017) 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: total run = adults / (1 - %grilse). No coho redds were identified downstream of the counting station during 2017 so the number of coho observed at the counting station represented the total.

HATCHERY CONTRIBUTION RATES

The hatchery contribution rates for Chinook and coho have been estimated both through the recovery of carcasses and through reviewing fish images observed at the fish counting facility. During the 2017 season hatchery contribution rates were based on observed clips on recovered carcasses for Chinook and on clips observed during video monitoring for Coho Salmon. The hatchery contribution rate of Chinook Salmon 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 Salmon 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 this observed clip rate. The observed clip rate was then applied to the estimated coho run size.

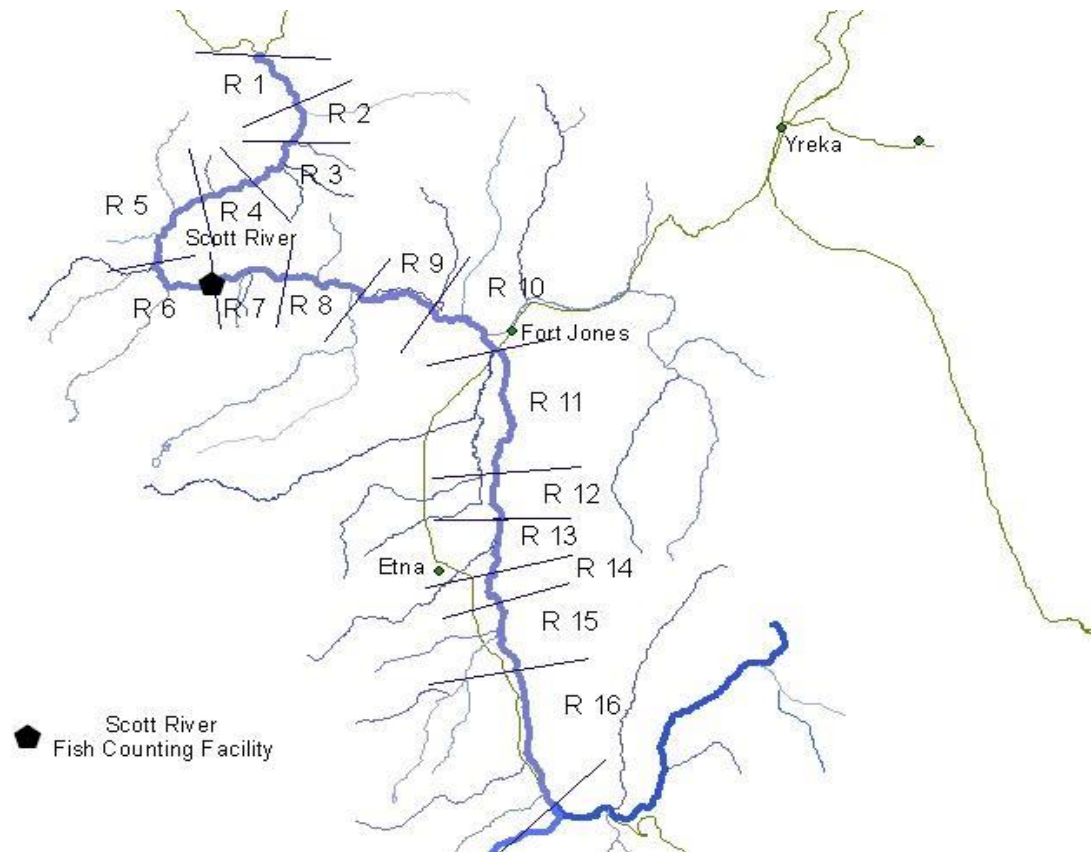


Figure 3. Location of the fish counting facility and spawning ground survey reaches on the Scott River used during the 2017 field season.

RESULTS

OPERATION OF THE SCOTT RIVER FISH COUNTING FACILITY

The Scott River Fish Counting Facility (SRFCF) began recording fish movements on September 22, 2017. The first Chinook Salmon was observed at the SRFCF on September 26, 2017 and the last Chinook Salmon was observed on December 10, 2017. The run peaked between October 17, 2017 and October 27, 2017 when 66.8% of the Chinook migration was observed (Figure 4). Sixty-nine percent of Chinook Salmon passed through the SRFCF during daylight hours and peaked in the afternoon between 1300 and 1600 hours (Figure 5).

A net total of 2,278 Chinook Salmon were estimated to have passed through the SRFCF during the 2017 season (2,348 upstream and 70 downstream) when videography was employed. During periods of high flows KRP operated an ARIS (SONAR) camera on one

occasion (14 days) and estimated an additional 1 Chinook (Table 2) for a seasonal estimate of 2,279 Chinook upstream of the counting facility.

SPAWNING GROUND SURVEYS

A total of 454 Chinook carcasses were sampled during the spawning ground survey as Path 1 or Path 2 carcasses (one carcass did not have a sex determination). Of these 210 (46.4%) were male and 243 (53.6%) were female. Males ranged in FL from 38cm to 100cm and averaged 69.3cm (Figure 6). Females ranged in FL from 47cm to 88cm and averaged 68.5cm (Figure 7). Zero ad-clipped Chinook were observed during the spawning ground survey effort during the 2017 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 54cm was established for Scott River Chinook. Due to high flows during the spawning season multiple surveys were canceled due to unsafe survey conditions (Appendix 1).

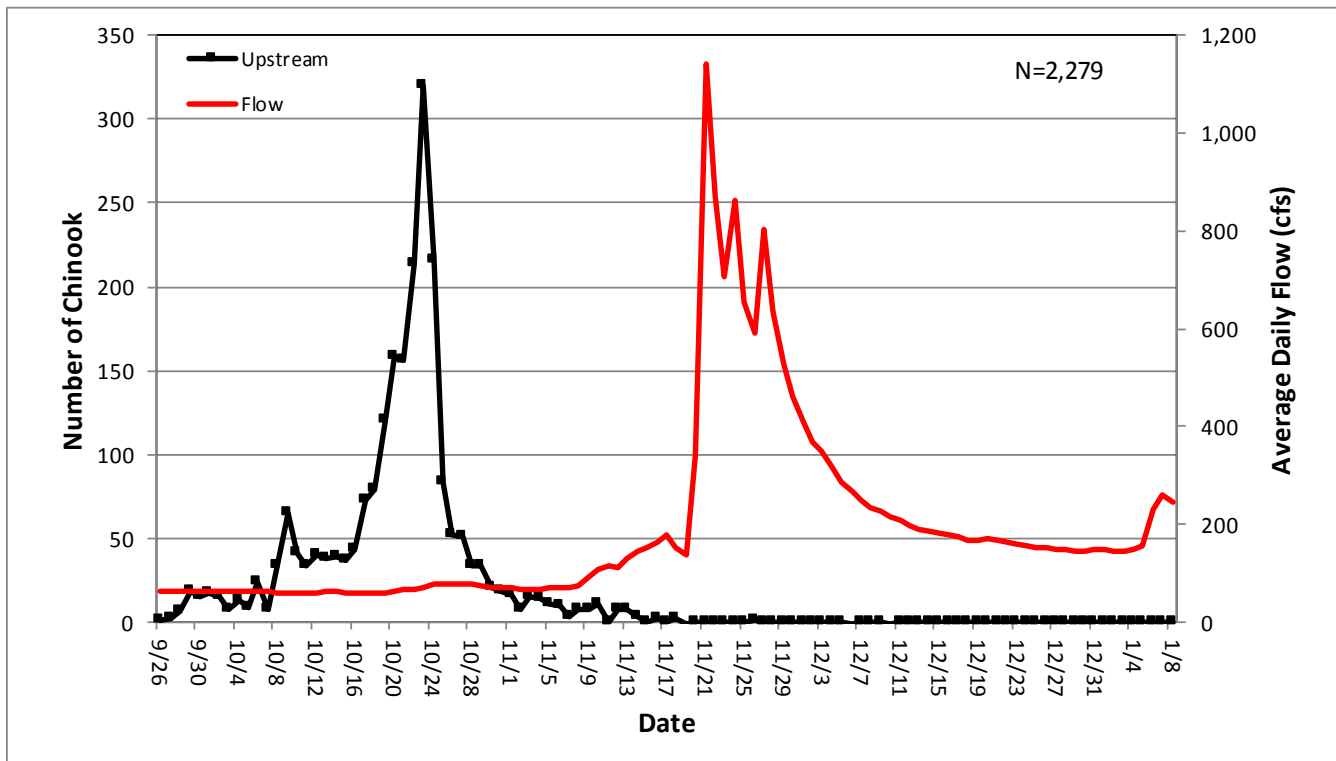


Figure 4. Run timing of Chinook Salmon through the Scott River Fish Counting Facility during the 2017 season (N=2,279), and average daily flows observed at USGS Gauge No. 11519500.

A total of 243 Path 1 and Path 2 Chinook Salmon female carcasses 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 243 female Chinook Salmon carcasses examined, 233 females (99.6%) were found to have spawned, and 10 females (0.4%) were identified as un-spawned.

In 2017 the CJS mark recapture data collected during the spawning ground survey was analyzed for reaches 1-6 only. Due to inconsistent results, a lack of marks and recaptures in

the mark recapture study (M=8; C=3; R=0) the use of the CJS mark recapture method to estimate carcass abundance (downstream of the weir) was not possible. Therefore the lower river abundance estimate was derived utilizing data generated from the redd survey. A total of 131 Chinook Salmon redds were observed in Reaches 1 through 6 below the counting facility. Multiplying the season total redd count by 2 generates an estimate of 262 adults. Utilizing the formula total run= adults/(1-%grilse) generates a sub area total of 297 Chinook, 262 adults and 35 grilse. The total Chinook Salmon run size estimate of **2,576** Chinook was generated by summing the video estimate (2,279) and the Redd survey estimate (297). Based on scale age analysis, adults comprised approximately 88.1% (2,269 fish) and grilse comprised 11.9% (307 fish) of the run (KRTAT 2018).

Table 2. Specific dates and times during the 2017 season when ARIS filming started and stopped, the number of hours the ARIS was used each day and the number of Chinook, coho and steelhead estimated during that time.

	Date	Time	Number of hours : minutes	Number of Chinook estimated	Number of Coho estimated	Number of Steelhead estimated
ARIS Started	11/20/2017	1000	14 : 00	0	1	0
	11/21/2017		24 : 00	0	0	0
	11/22/2017		24 : 00	0	1	0
	11/23/2017		24 : 00	0	2	0
	11/24/2017		24 : 00	0	1	0
	11/25/2017		24 : 00	0	-1	0
	11/26/2017		24 : 00	1	5	1
	11/27/2017		24 : 00	0	-1	0
	11/28/2017		24 : 00	0	0	0
	11/29/2017		24 : 00	0	2	0
	11/30/2017		24 : 00	0	1	0
	12/1/2017		24 : 00	0	-2	0
	12/2/2017		24 : 00	0	0	0
ARIS Stopped	12/3/2017	1400	10 : 00	0	-1	0
Total				1	8	1

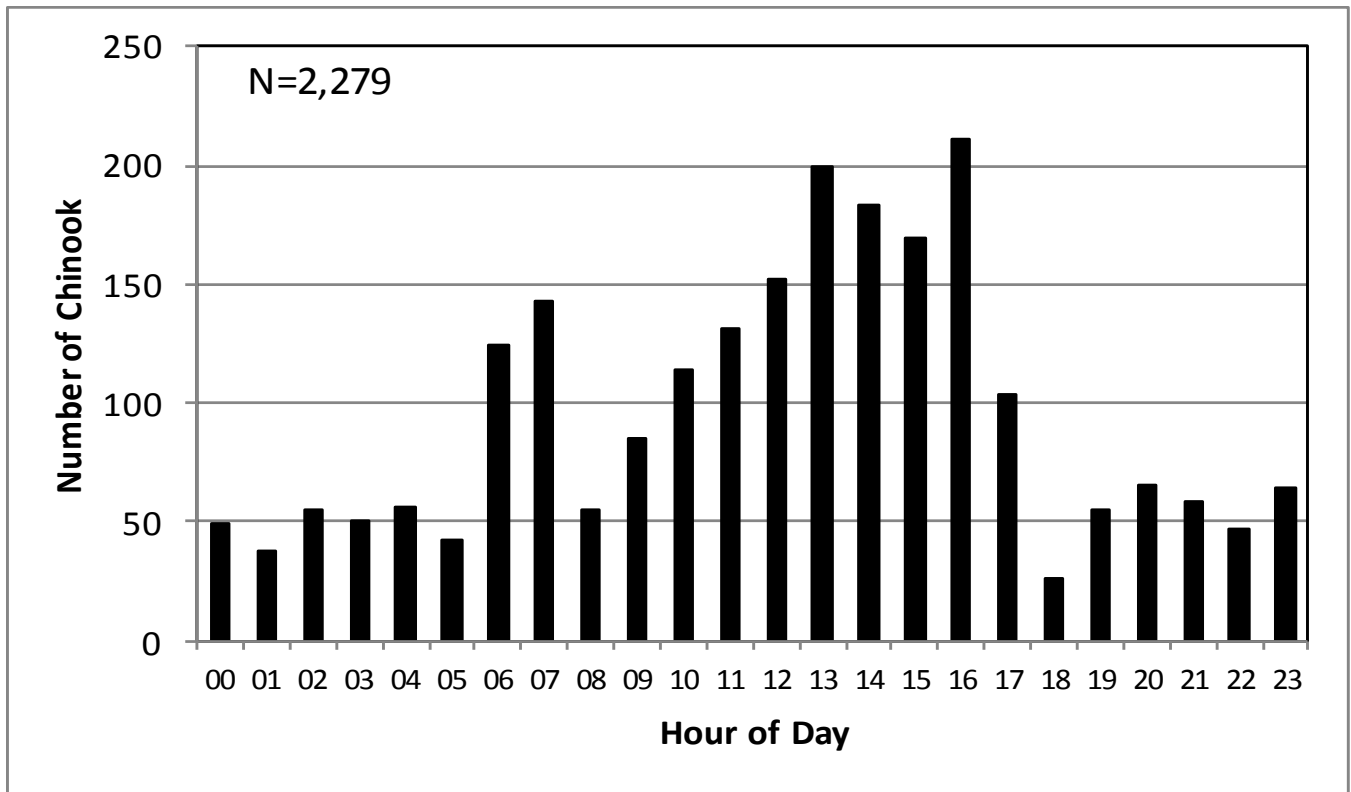


Figure 5. Summary of daily run timing of Chinook Salmon observed at the Scott River Fish Counting Facility during 2017 (N=2,279).

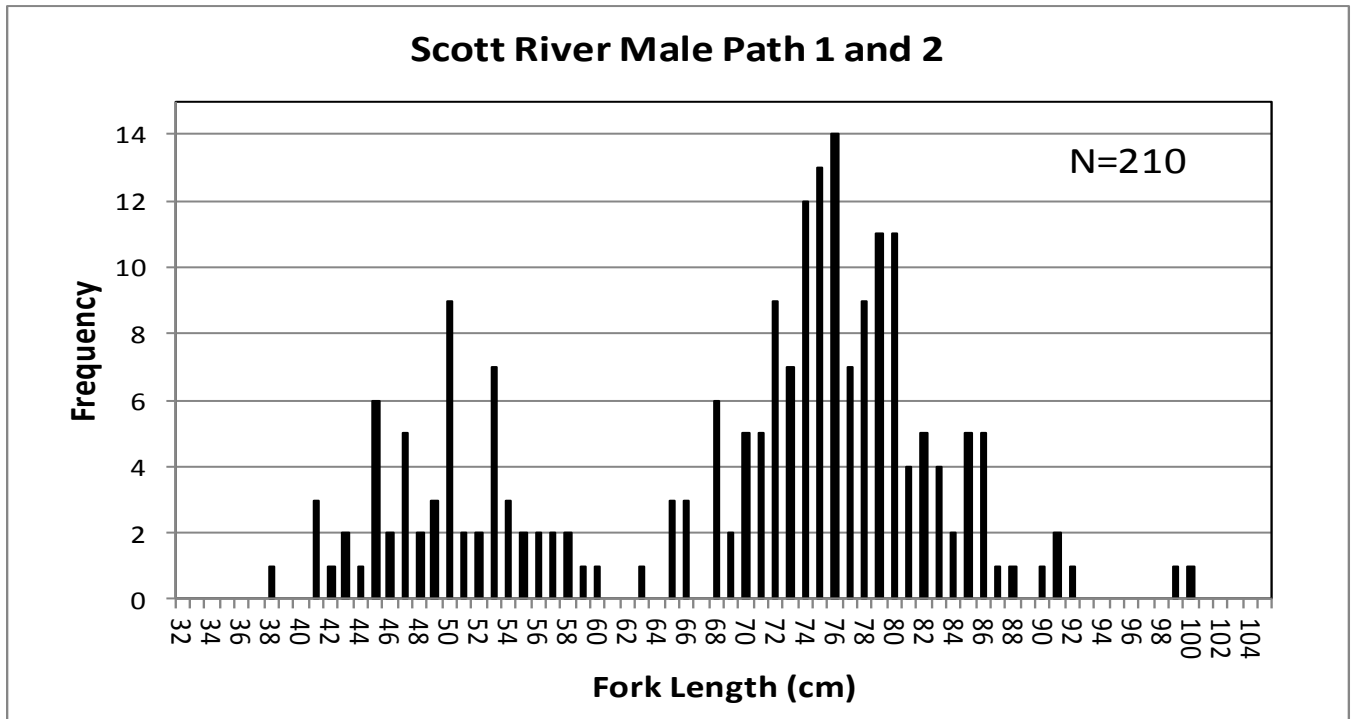


Figure 6. Length Frequency distribution of Path 1 and Path 2 male Chinook Salmon observed during spawning ground surveys in the Scott River, 2017 (n = 210).

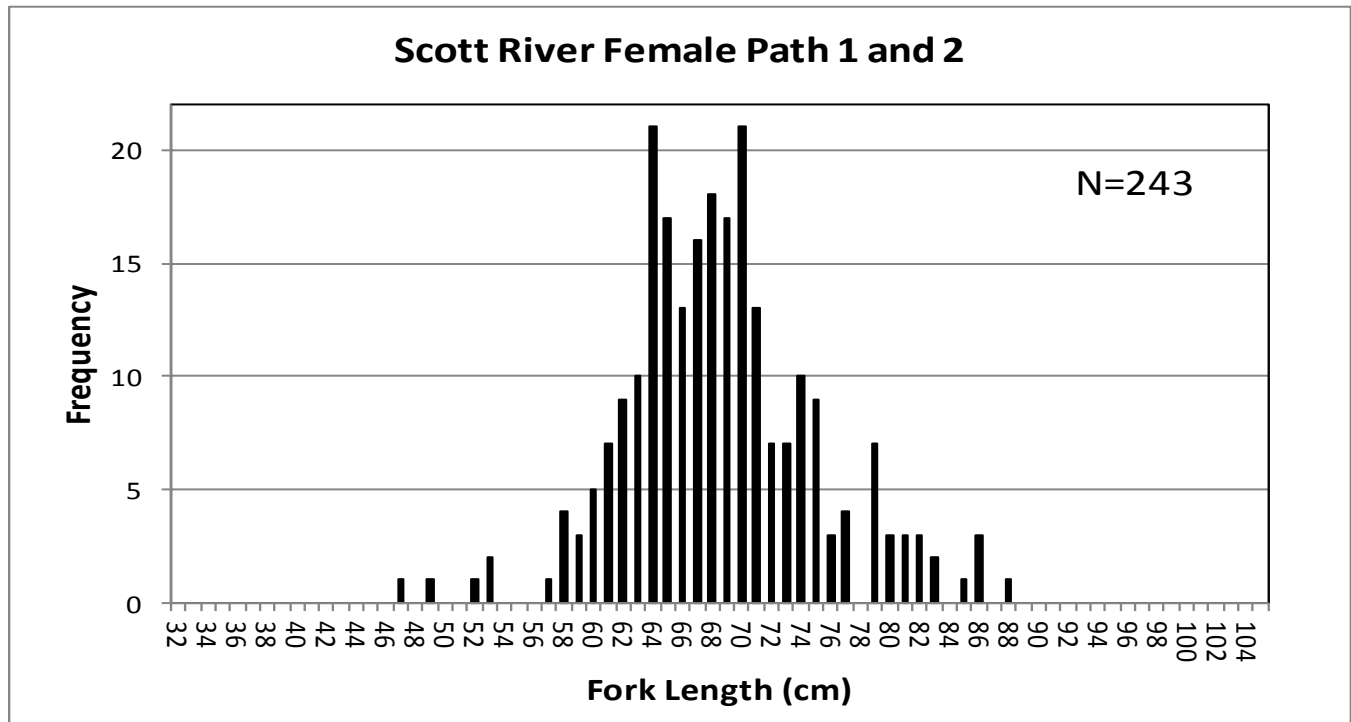


Figure 7. Length frequency distribution of Path 1 and Path 2 female Chinook Salmon observed during spawning ground surveys in the Scott River, 2017 (n = 243).

COHO SALMON

The first adult Coho Salmon was observed at the counting facility on October 24, 2017 and the last Coho Salmon was observed on January 4, 2018 (Figure 8). A net total of 374 Coho Salmon (379 upstream and 5 downstream) were observed moving through the SRFCF when videography was employed. During periods of high flows KRP operated an ARIS (SONAR) camera on one occasion for 14 days and estimated an additional 8 coho (Table 2) for a seasonal videography/SONAR estimate of **382** Coho Salmon. Coho Salmon migration peaked following the first flow increase on November 9, 2017. During an 11 day period from November 8, 2017 through November 18, 2017 88.0% of the coho (336) were observed. During the 2017 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 96.3% adults and 3.7% grilse (see below for further information on seasonal estimates of age proportions).

Diel movements of Coho Salmon through the SRFCF were higher in the evening hours and peaked between 1800 hours and 2100 hours (Figure 9). 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.

Ninety-two of the 382 Coho Salmon images were clear enough to make a confident determination of the presence of a left maxillary clip. Of the 92 images one was determined to

have had a left maxillary clip generating an estimated hatchery proportion of 1.08%. Applying this hatchery proportion to the total estimated run size generates an estimate 378 natural origin and 4 hatchery origin fish.

SPAWNING GROUND SURVEYS

Zero coho carcasses were observed during the cooperative spawning ground survey on the lower mainstem Scott River (reaches 1-8) and 7 coho carcasses (6 measured) were observed in upper Scott River main stem (reaches 12 through 16 and tributary reaches) during surveys coordinated by the Siskiyou Resource Conservation District (SRCD) (Magranet, 2018). Four coho carcasses were collected as wash backs at the counting facility (Figure 10). Applying the sex ratios of recovered coho carcasses observed as wash backs and from the SRCD’s upper Scott River surveys to the total estimate yielded an estimated 54.5% (208) male and 45.5% (174) female Coho Salmon. One of the 10 coho carcasses examined for clips had a left maxillary clip.

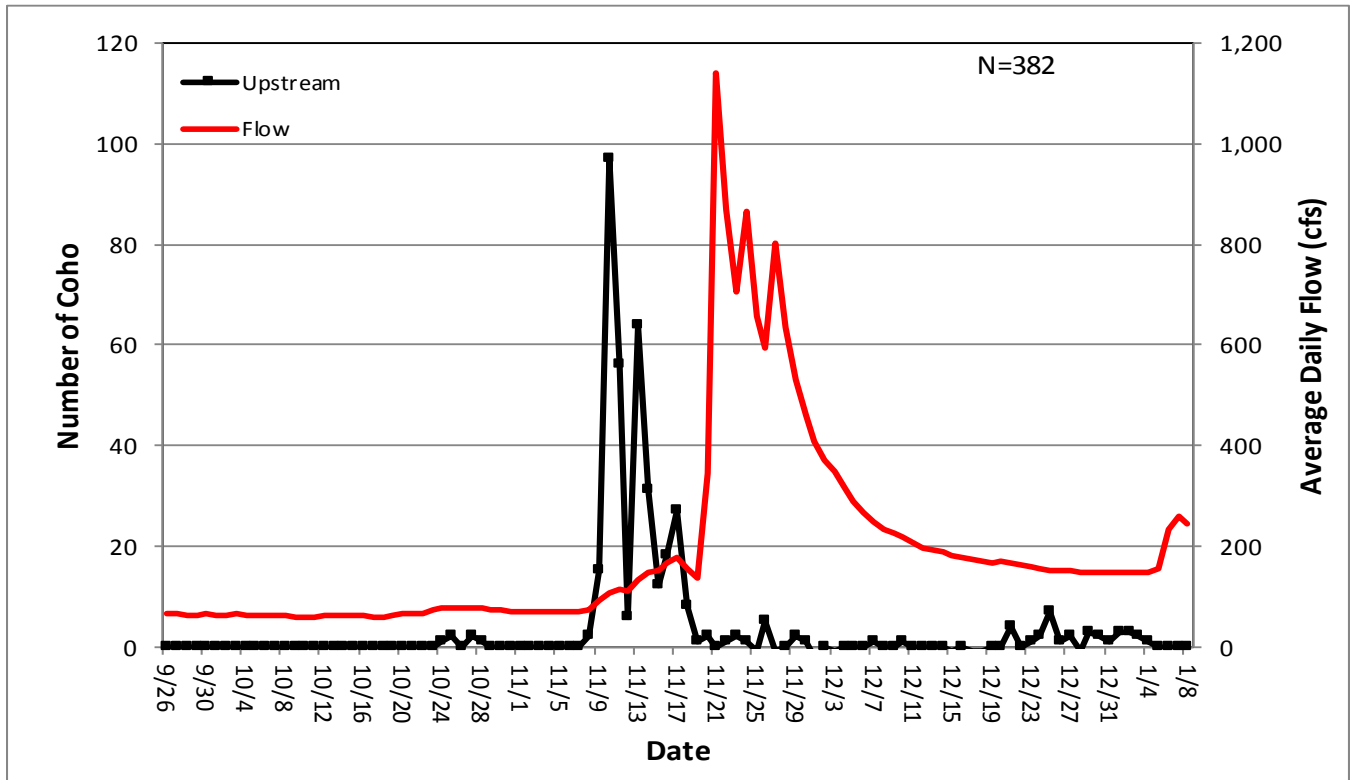


Figure 8. Run timing of Coho Salmon observed passing through the Scott River Fish Counting Facility during the 2017 season (N=382), and average daily flows observed at USGS Gauge No. 11519500.

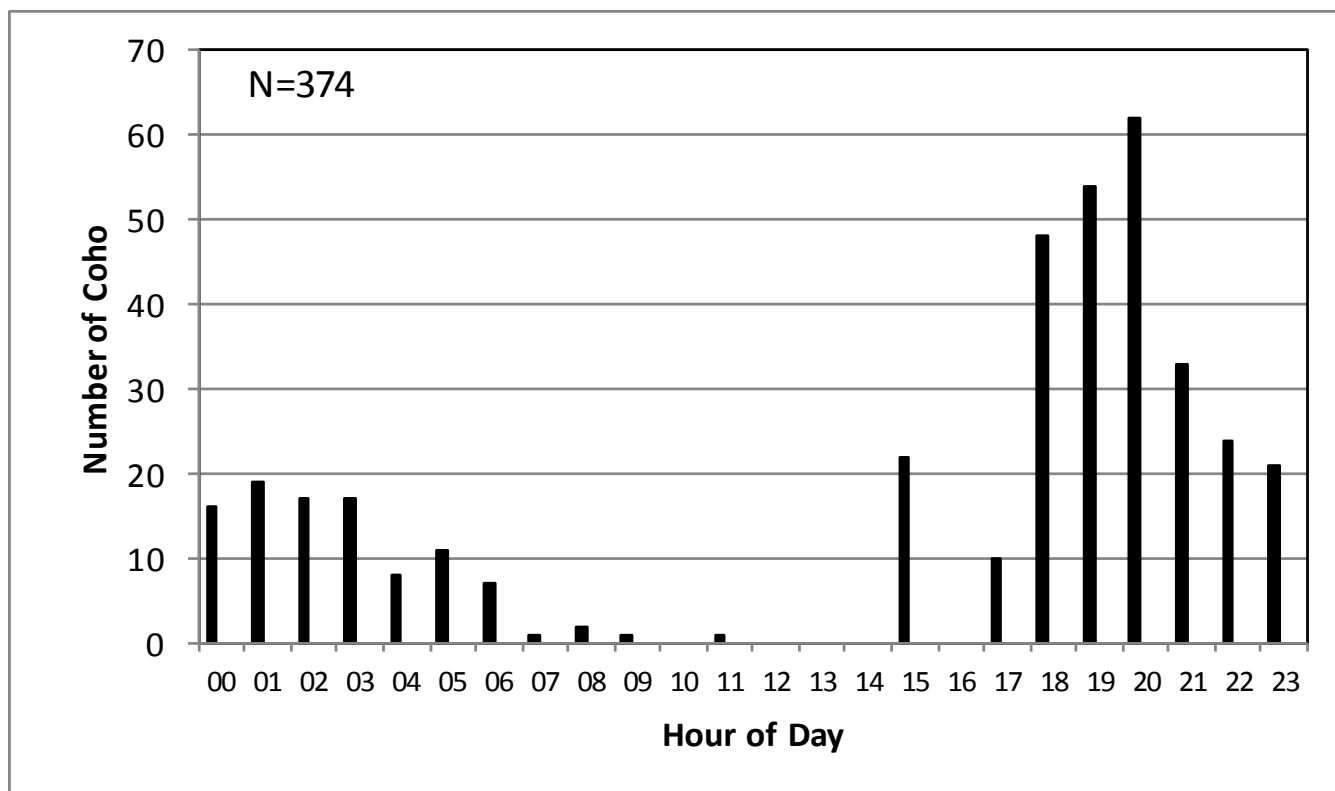


Figure 9. Diel migration patterns of Coho Salmon observed moving through the Scott River Fish Counting Facility in 2017 (N=374).

Applying the maximum grilse fork length cutoff of 56cm to the total number of measured carcass recoveries (10) generated an age two proportion of 10% and an age three proportion of 90% (see below for further information on seasonal estimates of age proportions). Nine of the 11 carcasses examined were sampled for tissue and collected samples were supplied to the NOAA Southwest Fisheries Science Center located in Santa Cruz, California for stock identification purposes. Additionally, 9 Coho Salmon otolith samples were collected and archived at the CDFW Yreka California office for future stock identification and life history examination. Coho redds were not observed in Canyon Creek, Kelsey Creek or Tompkins Creek.

A total of 382 Coho Salmon were estimated to have swam upstream through the SRFCF during the season. Zero additional coho redds were observed in areas below the counting facility. Therefore, the total number of estimated Coho Salmon that entered the Scott River during the 2017-2018 season is **382**. The age 2 proportions generated from videography and recovered carcasses were 3.7% and 10% respectively. Due to the larger sample size available to estimate the age 2 proportion in the videography (374) verses carcass recoveries (10) the final age two proportion was determined using the videography data. Therefore, the resulting number of age two and three fish are 14 (3.7%) and 368 (96.3%) respectively.

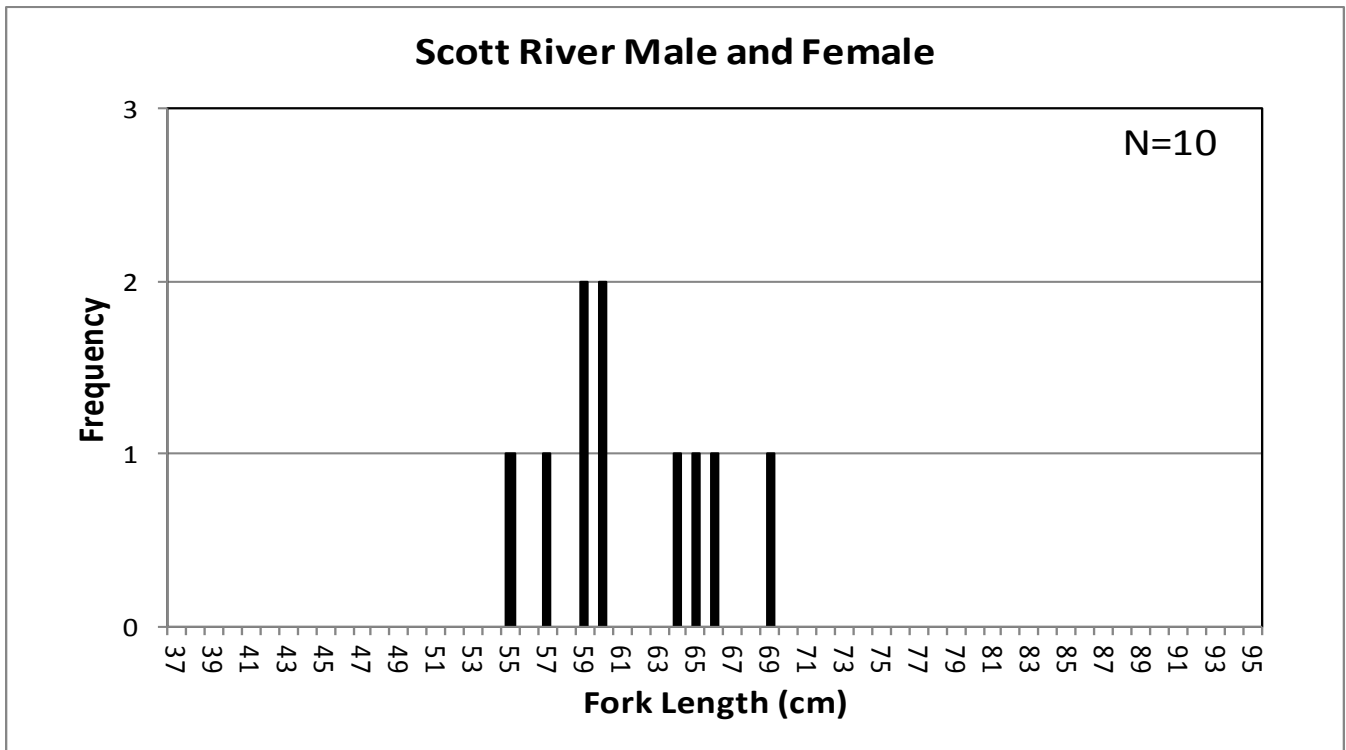


Figure 10. Length frequency distribution of Coho Salmon observed during cooperative spawning ground surveys (0), SRCD spawning ground surveys (6) and as wash backs (4) on the Scott River Fish Counting Facility, during the 2017-2018 spawning season (n = 10).

STEELHEAD

In 2017, a net total of 70 adult (>40.64 cm) steelhead (Figure 11) were estimated to have entered and remained in the Scott River during the video recording season from September 22, 2017 to January 8, 2018. Lines on the back of the video flume were set at 40.64 cm (16 inches) to delineate sub-adults versus adults. The 2017 season was the eighth year that lines delineating adult steelhead and sub-adult steelhead were used.

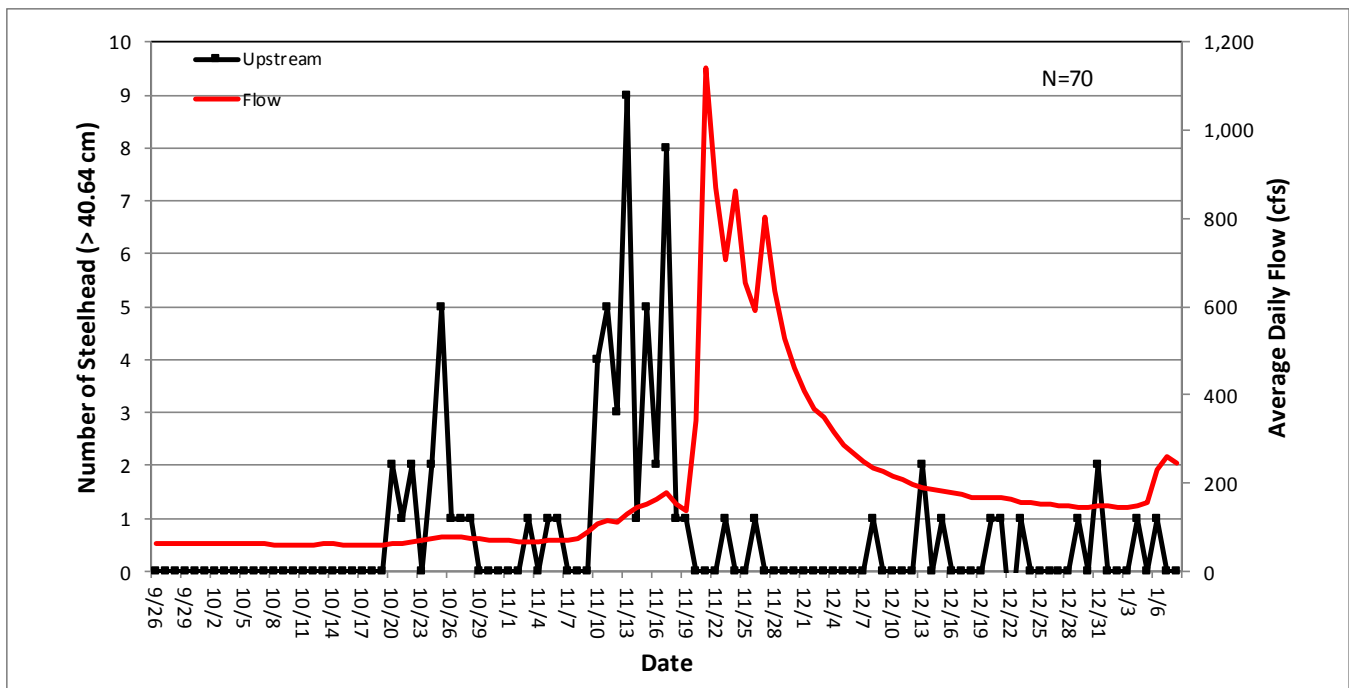


Figure 11. Run timing of Steelhead Trout (>40.64 cm) observed passing through the Scott River Fish Counting Facility during the 2017 season (N=70), and average daily flows observed at USGS Gauge No. 11519500.

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 5,244 fish (Figure 12). The 2017 Chinook Salmon run in the Scott River ranks thirty-first (2,576 fish) out of 40 years of monitoring. The 2017 run was 51% lower than the 40 year average. A total of 2,279 Chinook Salmon were estimated to have passed through the SRF CF during the 2017 season. A total of 297 Chinook Salmon were estimated in reach 1 through reach 6 yielding a total run size estimate of **2,576** Chinook Salmon. The various sub basin proportions of the Chinook distribution for years 2008-2017 are detailed in Table 5 and identifies the importance of the entire Scott River watershed to Chinook Salmon. From 2008 through 2017 an average of 71% of the Chinook run spawned upstream of the counting station (reaches 7 through 16). As a result of the higher flow conditions during the Chinook migration adult fish passage in the lower canyon reaches was not a concern in 2017 and an estimated 88% of the Chinook run was observed passing through the counting station. The addition of the fish counting facility has allowed for an accurate estimation of Chinook migration to areas of spawning habitat in the valley reaches without having to conduct spawning ground surveys in these reaches.

The Scott River is an important component of the Klamath Basin Chinook runs. The Scott River has contributed an average of 9 percent of the basin-wide (including Trinity River) natural spawning escapement to the Klamath River basin during the period from 1978 to 2017 (Table 6). The Scott River Chinook population tracks very similarly to the total Klamath Basin population ($r=0.7783$ p -value <0.001) indicating that forces outside the Scott River watershed play an important role in influencing abundance of this population of Chinook (Figure 13).

Table 5. Scott River Chinook Salmon abundance estimates by area and percentages of the total above and below the Counting Station during the 2008-2017 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
Average	1,157	3,599	29%	71%	4,756

To evaluate freshwater productivity the production of emigrating 0+ Chinook has been estimated in the Scott River since Brood Year 1999 (Jetter et al. 2016). The number of 0+ Chinook produced per adult has been calculated for Brood Years 1999 through 2015 and has ranged from a low of 14.4 to a high of 383.0 and averaged 97.9 (Figure 14). Brood year 2015 recorded an observed 26.8 0+ Chinook produced per adult. The observed 0+ Chinook produced per adult for brood year 2015 was 73% less than the 17 year average of 97.9 fish. Due to funding constraints the Department was unable to operate the Scott River Rotary Screw Trap during 2017 season preventing this analysis for brood year 2016. The Department is conducting Scott River Rotary Screw Trapping in the winter and spring of 2018 and will be continuing to provide data for this important analysis. 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.

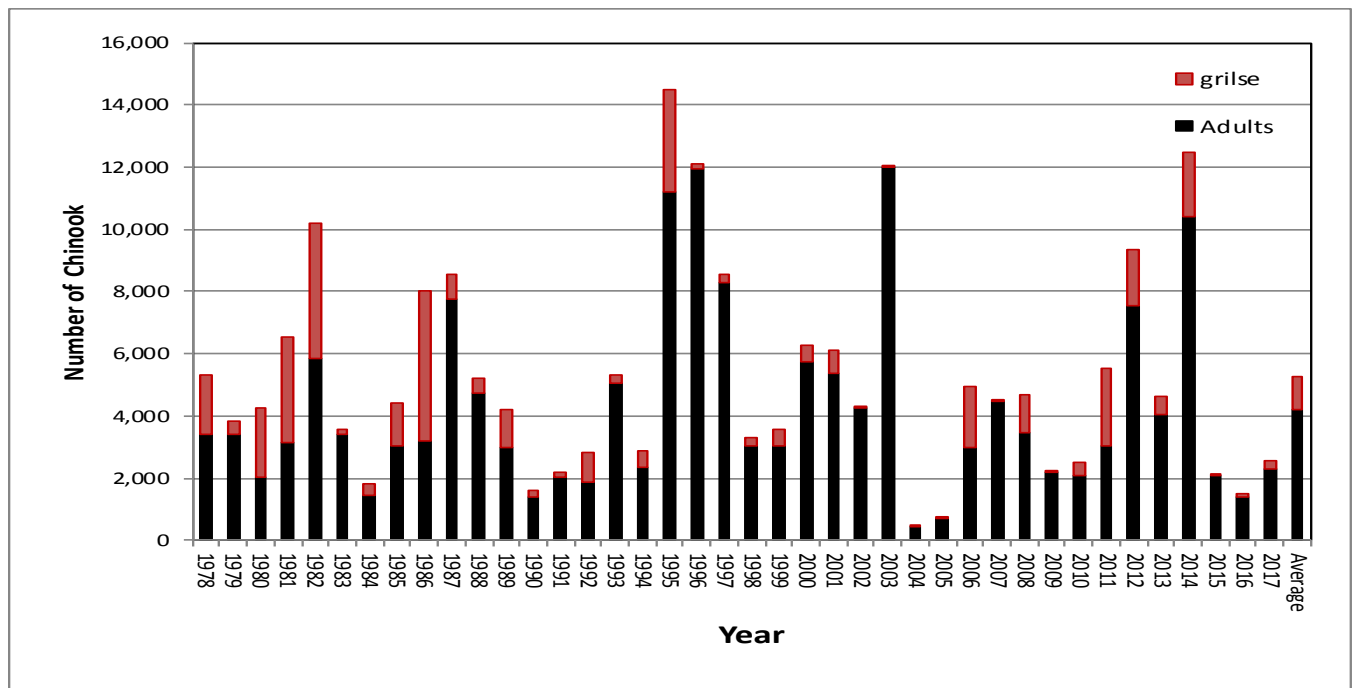


Figure 12. Estimated escapement of Chinook Salmon returning to the Scott River from 1978 to 2017.

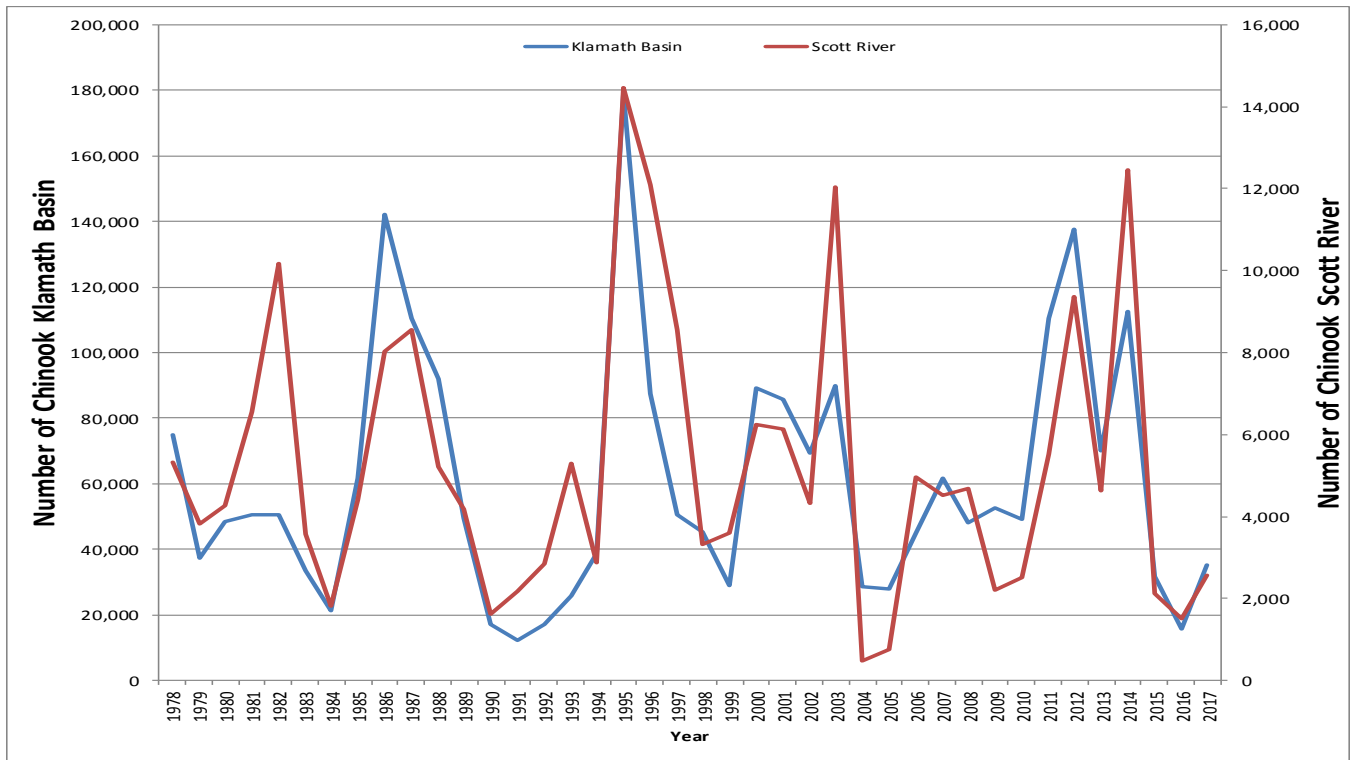


Figure 13. Chinook Salmon Klamath Basin natural spawner escapement (primary y-axis) and the Scott River natural spawner escapement (secondary y-axis) from 1978 through 2017. Table 6. Klamath Basin and Scott River Chinook natural spawner escapements (age 2-5), 1978-2017.

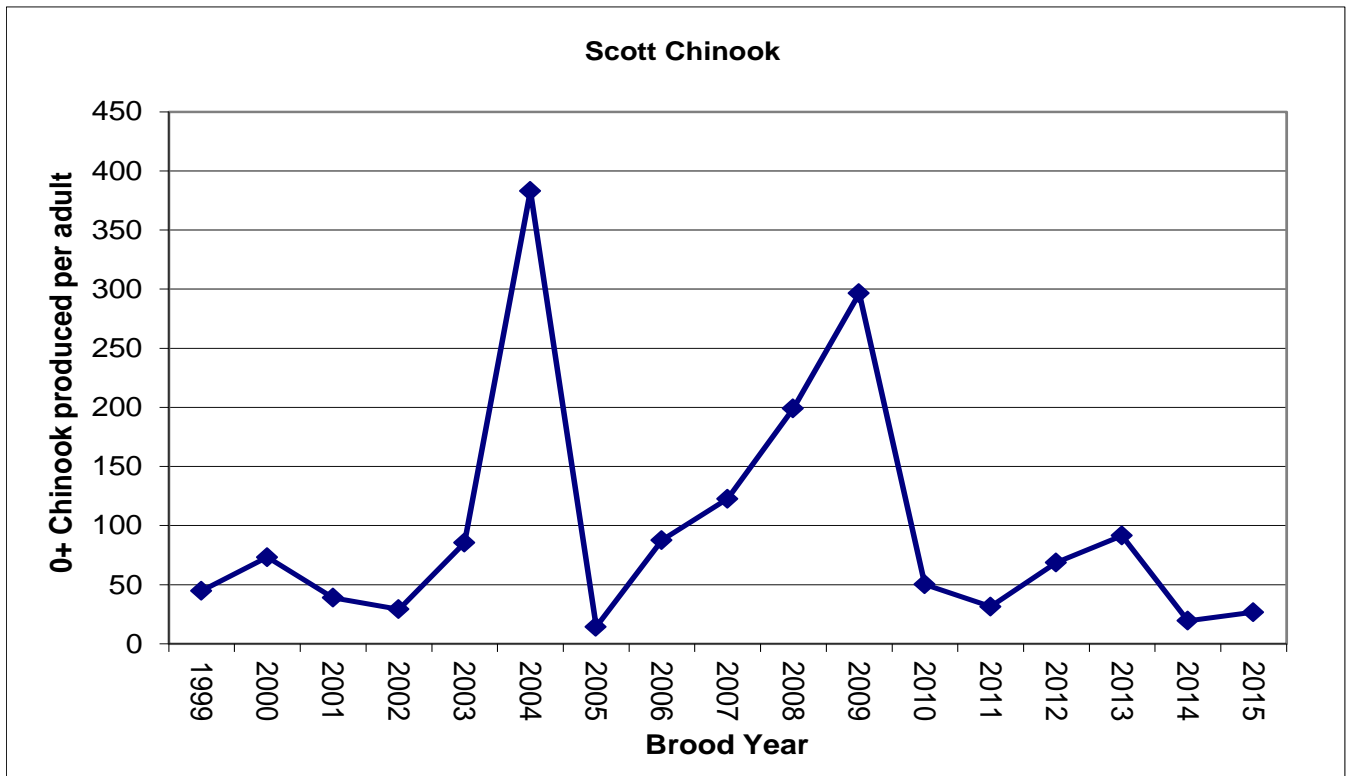


Figure 14. Number of 0+ Chinook produced per adult spawner in the Scott River by brood year, for Brood Years 1999-2015.

Table 6. Klamath Basin and Scott River Chinook natural spawner escapements (age 2-5), 1978-2017.

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%
Average	60,859	5,244	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 664 (Figure 15). The adult run size of Coho Salmon 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 2016 indicates significant variation in brood year strength (Jetter et al. 2016). Results of the adult monitoring at the SRFCF support this observation. The brood year that returned in 2017 (age 3 in 2017 and age 2 in 2016) in one generation decreased in total numbers by 136 fish, a reduction of 27.0%, from returns in 2014 (Figure 17). This decline in brood year strength is the first decline observed in this brood year in 3 generations. It should be noted that the 2017 monitoring season extended to January 8th near the end of the coho migration and the 2017 estimate is believed to accurately estimate run size. In an effort to evaluate the accuracy of the 2017 coho run we used the observed average smolt survival of 6.53% (Brood Years 2004-2008 and 2010-2014) and applied it to the yearling point estimate from 2016 of 2,411 which yields a predicted 2017 return of 157. The 364 observed natural origin coho (0 age 2 from 2016 and 364 age 3 from 2017) is more than the predicted returns of 157 using this method. An additional way to evaluate the accuracy of the 2017 estimate is to look at the proportion of the total annual run that has been observed by January 8th for the period of record (Figure 16). For the years 2007-2016 an average of 97.2% of the annual coho run has been observed by January 8th. If 97.2% of the age three coho were observed during the 2017 season then an estimated 10 additional Coho Salmon 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 17).

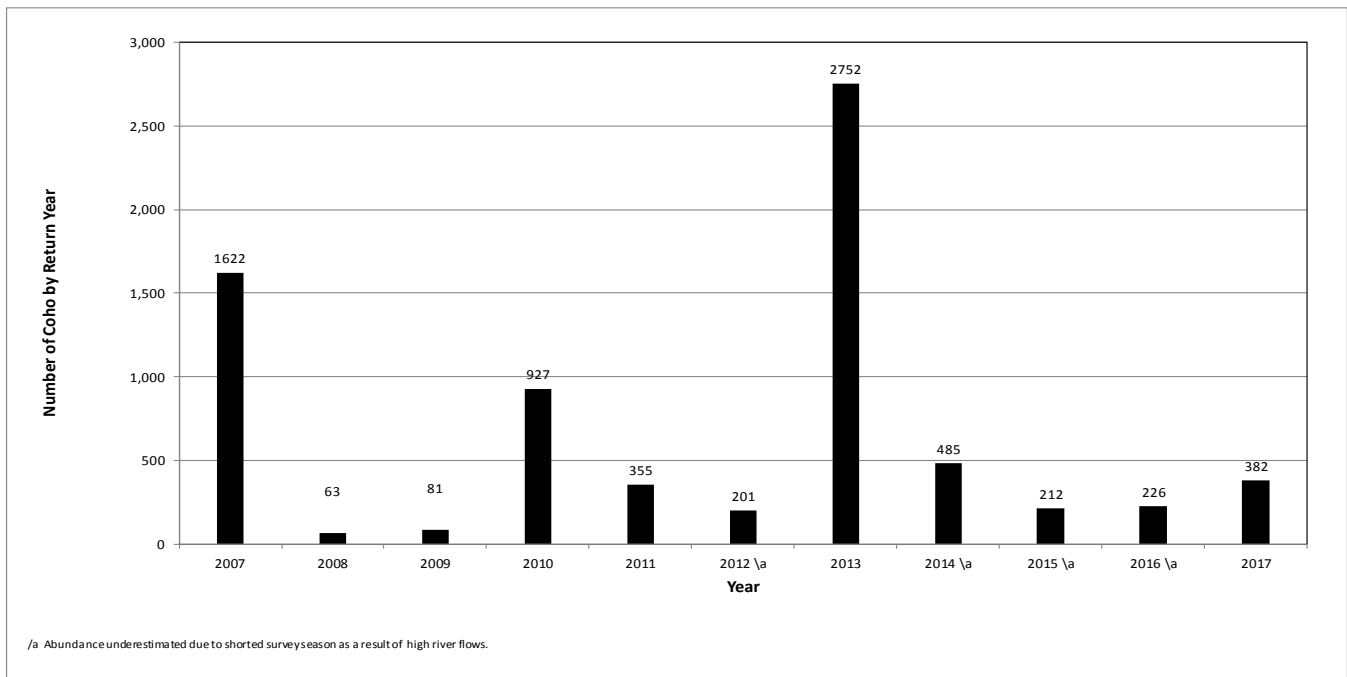


Figure 15. Estimated escapement by return year of adult and grilse coho (age 2 and age 3) salmon returning to the Scott River from 2007 to 2017.

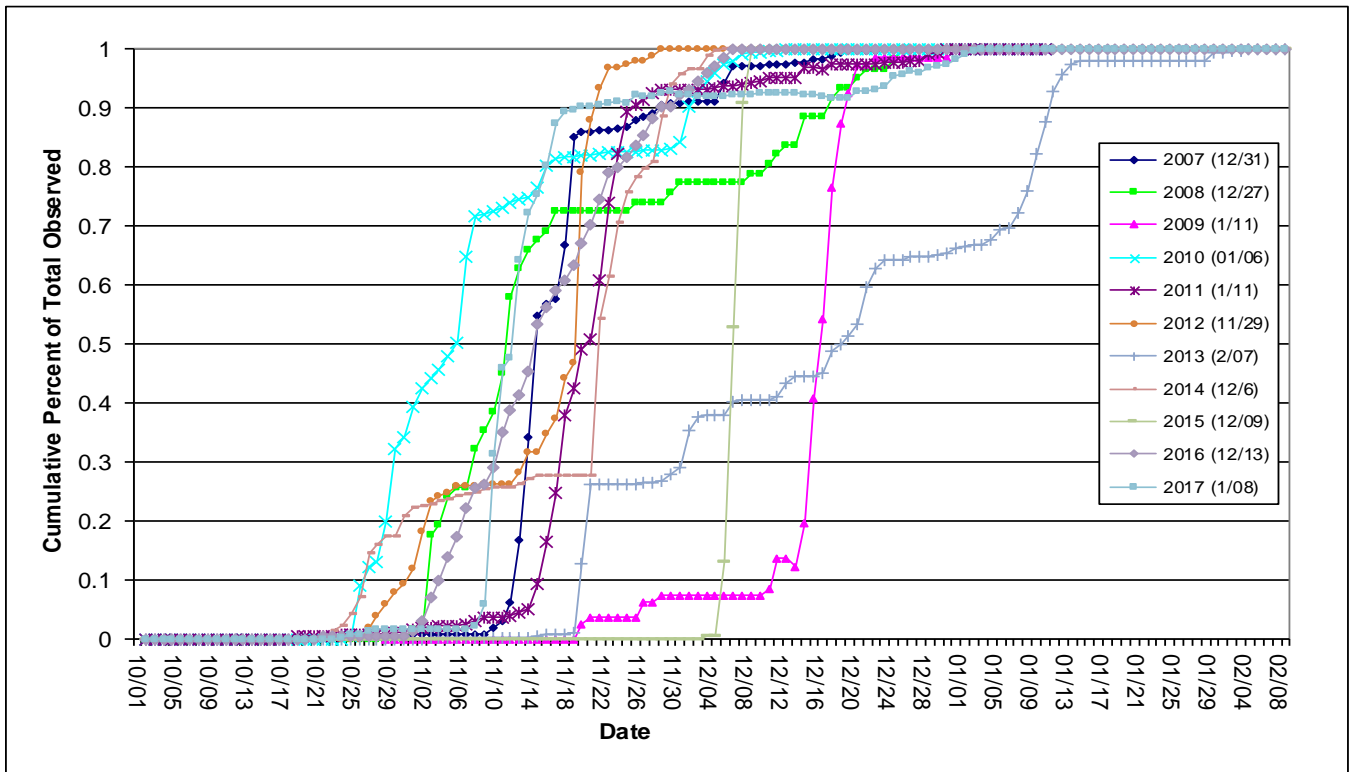


Figure 16. Cumulative percent of total observed Coho Salmon observations by day at the Scott River Fish Counting Facility annually from 2007-2017. The date in parenthesis indicates the last date the fish counting facility was operated for each year.

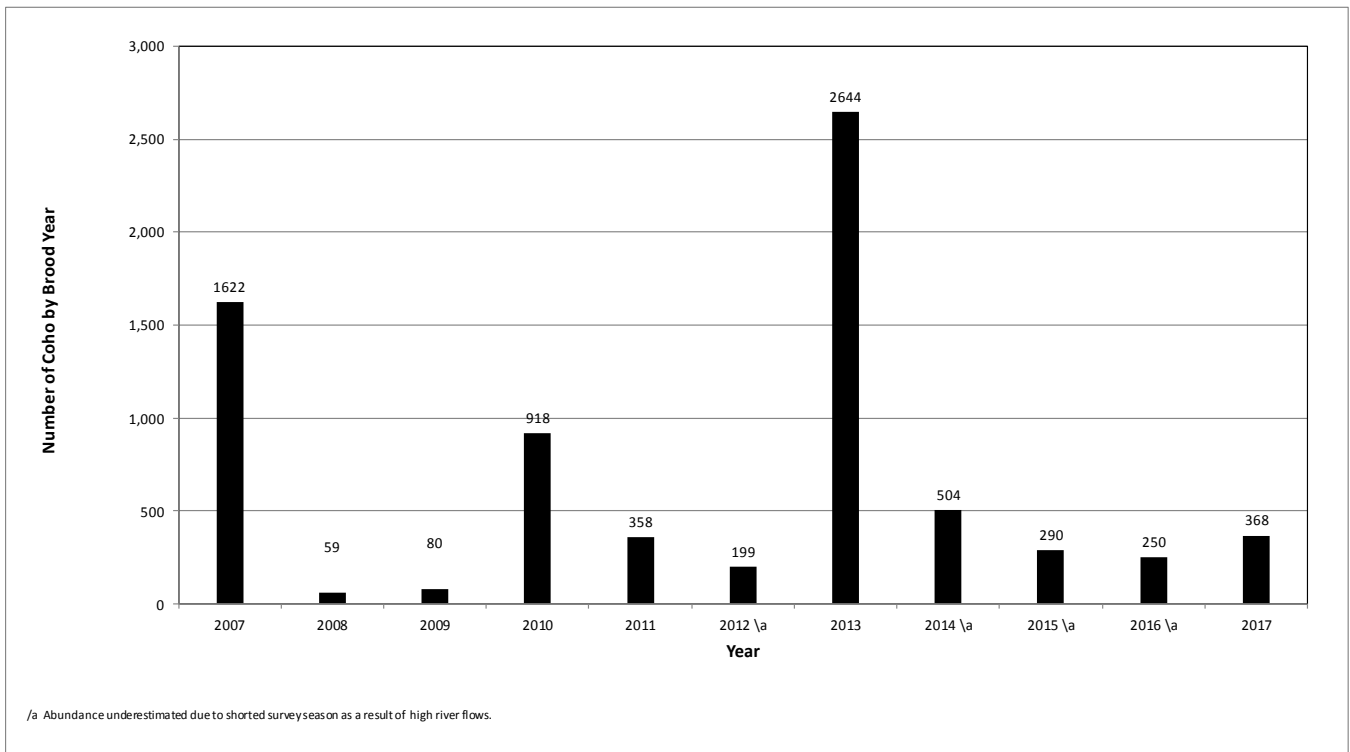


Figure 17. Estimated escapement by Brood Year of adult and grilse coho (age 2 and age 3) salmon returning to the Scott River from 2007 to 2017.

Utilizing the number of coho smolts produced in the Scott River (Jetter et al. 2016) 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 6.53% and ranged from a low of 1.48% to a high of 16.47% (Table 7). Due to the extremely high observed percent smolt survival of 71.64 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 to accurately evaluate ongoing restoration efforts taking place within the watershed.

Table 7. Coho 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 2004-2014.

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	75097	2007	0	1622	1622	2.16
2005	2007	3931	2008	0	58	58	1.48
2006	2008	941	2009	5	75	80	8.50
2007	2009	62207	2010	6	913	919	1.48
2008	2010	2174	2011	14	344	358	16.47
2009	2011	275	2012	11	186	197	71.64
2010	2012	50315	2013	13	2631	2644	5.25
2011	2013	7927	2014	121	383	504	6.36
2012	2014	5708	2015	102	188	290	5.08
2013	2015	7253	2016	24	226	250	3.45
2014	2016	2411	2017	0	364	364	15.10

Analyzing the comparisons of coho 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 2014 the number of coho smolts produced per returning adult female has ranged from a low of 4.79 to a high of 78.62 and has averaged 44.61 (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 Salmon 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 Salmon are improving. Conversely as the number of smolts produced per returning adult female decreases it can be inferred that in-river conditions for Coho Salmon are getting worse. The number of smolts produced per returning adult is influenced by inter-annual variation in sex ratios and age structure, and these variables have been estimated during in this analysis.

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

Adult Year Brood Year	Adult Estimate	Adult Female Estimate	Smolt Year	Smolt point Estimate	Smolts produced per Female
2007	1622	860	2009	62207	72.33
2008	63	32	2010	2174	67.94
2009	81	41	2011	275	6.71
2010	927	640	2012	50315	78.62
2011	355	170	2013	7927	46.63
2012	201	86	2014	5708	66.37
2013	2752	1514	2015	7253	4.79
2014	485	179	2016	2411	13.47
2015	212	170	2017	N/D	N/D
				Average	44.61

STEELHEAD

The number of returning adult steelhead has been monitored at the SRFCF beginning in 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 2017 the number of observed adult steelhead has ranged from a high of 917 to a low of 8 with an average of 248 (Figure 18). 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 that 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. The use of a SONAR camera in the Scott River after the end of the coho migration may add in the Department's ability to monitor the steelhead migration.

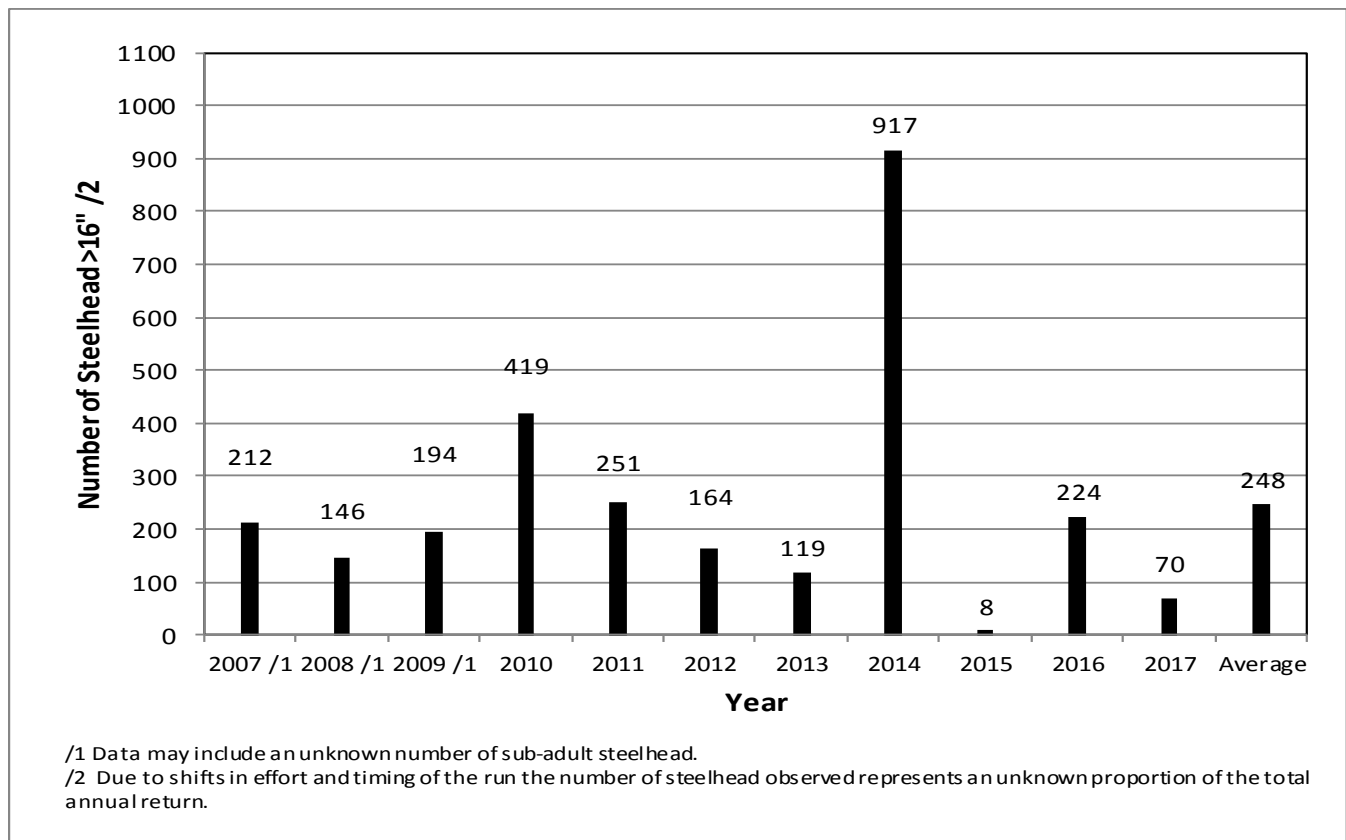


Figure 18. Number of observed Steelhead >16” at the Scott River Fish Counting Facility from 2007 to 2017.

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