2020 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 fish counting facility and conducted cooperative spawning ground surveys (carcass surveys) on the Scott River during the 2020 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 28, 2020 and ended on January 4, 2021.

The total number of Chinook Salmon that entered the Scott River during the 2020 season is estimated to be **855** 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 334 (39.0%) males and 521 (61.0%) females. Based on scale age analysis, adults comprised approximately 95.0% (812 fish) and grilse comprised 5.0% (43 fish) of the run. Males ranged in fork length (FL) from 32 cm to 93 cm and averaged 65.3 cm. Females ranged in FL from 39 cm to 88 cm and averaged 64.5 cm. 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 November 16, 2020, and the last Coho Salmon was observed on January 4, 2021. A net total of **1,766** Coho Salmon were estimated in the Scott River during the season. Based on the proportion of male and female Coho Salmon that were observed in the carcass survey, the run was comprised of approximately 916 (51.9%) males and 850 (48.1%) females. Based on live Coho Salmon images observed during video monitoring, adults comprised approximately 94.2% and grilse comprised 5.8% of the run. Males ranged in FL from 51 cm to 75 cm and averaged 67.0 cm. Females ranged in FL from 56 cm to 72 cm and averaged 64.8 cm. Based on observed hatchery marks during in the carcass survey, none of the Coho Salmon were estimated to be of hatchery origin.

The first steelhead >40.6 cm was observed on November 16, 2020, and the last steelhead was observed on January 4, 2021. During this time there were a total of 215 steelhead observations including both upstream (213) and downstream (2) movements. The net upstream movement of **213** fish represents a minimum number of steelhead for the season. A large fraction of the adult steelhead migration occurs outside the operational window of the Scott River Fish Counting Facility. Zero steelhead were recovered during the spawning ground survey effort.

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, (041º 38' 10.93" N; 123º 04' 3.08"W) 0.63 river miles downstream of the Jones Beach picnic area near the transition between canyon and valley reaches. 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.

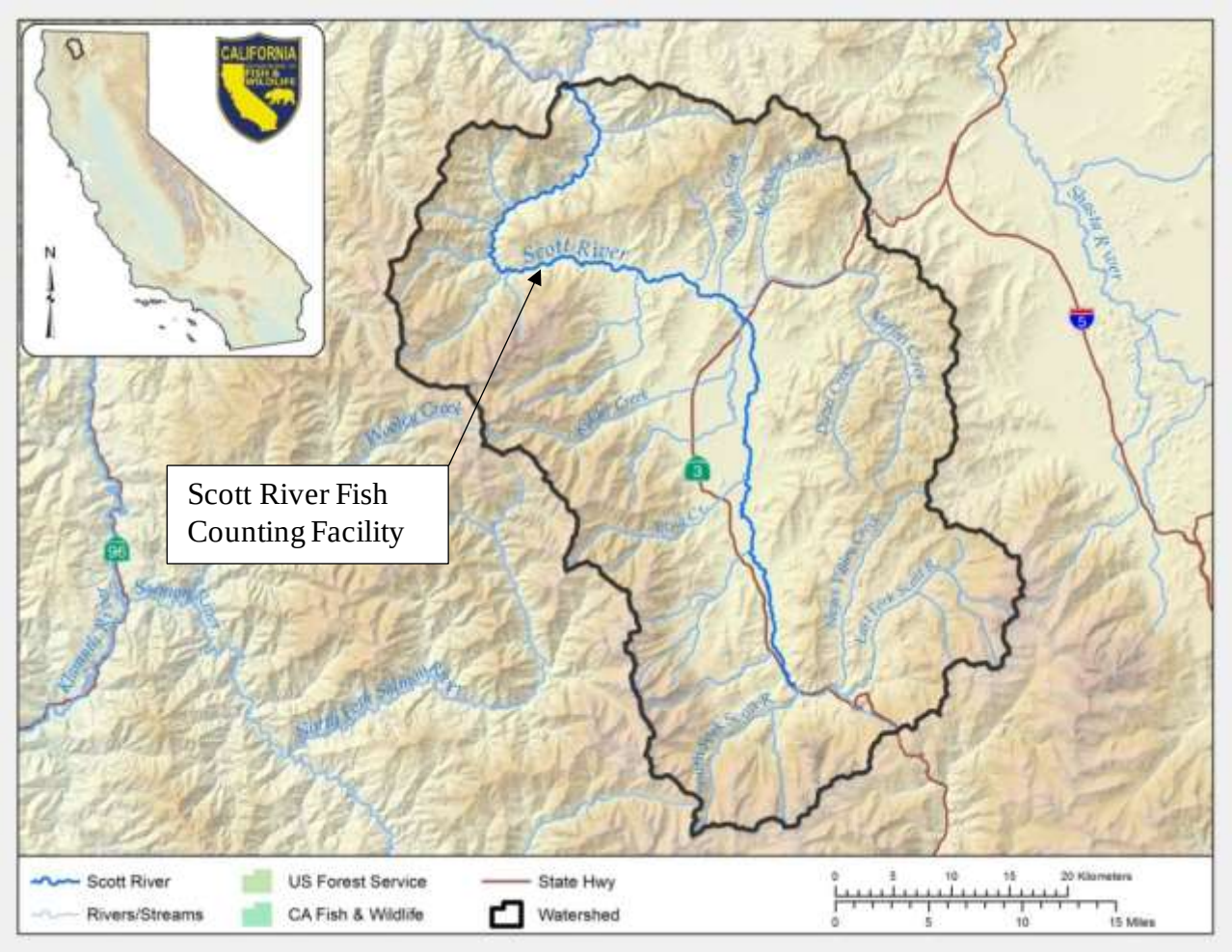


Figure 1. Location of the Scott River, tributary to the Klamath River, Siskiyou County, California.

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 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 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 marking weir was dropped in favor of conducting more intensive mark recapture spawning ground surveys in cooperation with United States Forest Service (USFS) fisheries staff. Currently the spawning ground survey is a cooperative effort between the USFS, Quartz Valley Tribe, Karuk Tribe, Northern California Resource Center, Siskiyou Resource Conservation District, Siskiyou County Schools and the Department.

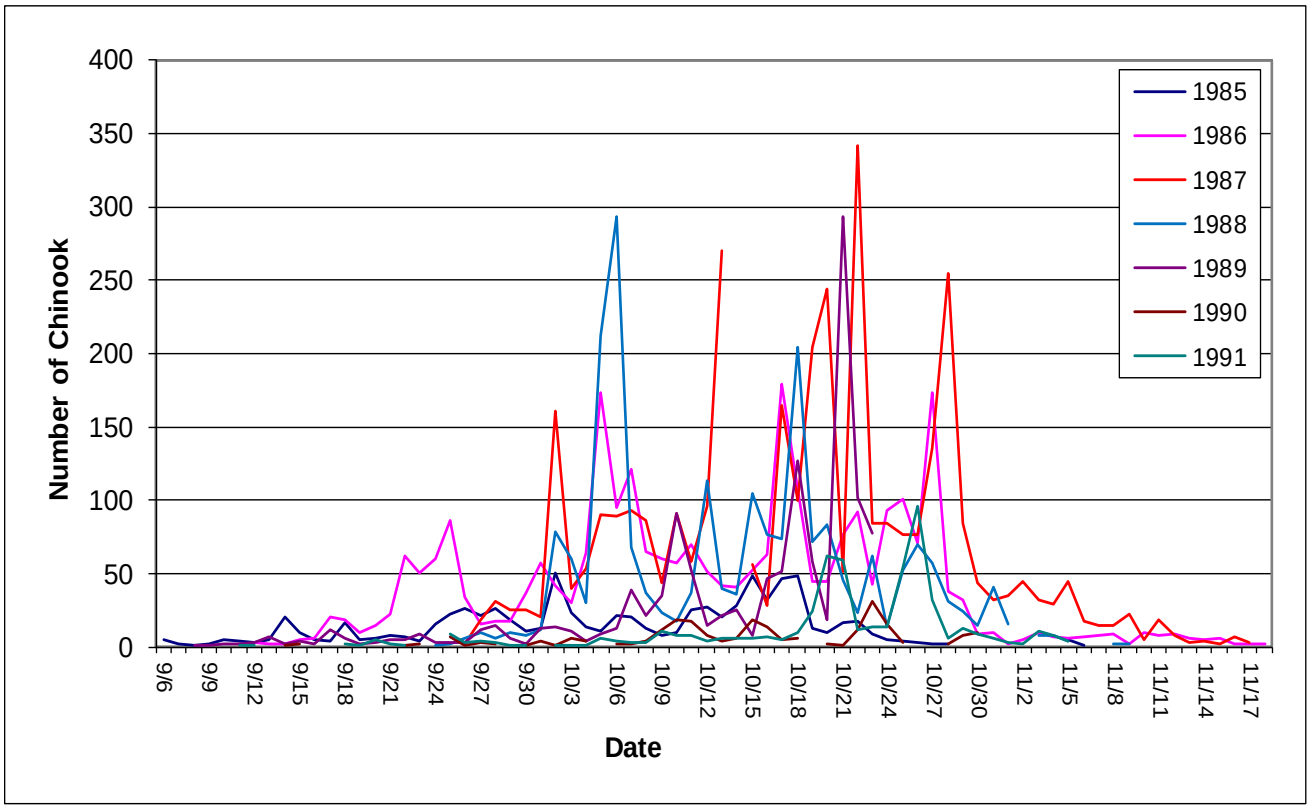


Figure 2. Chinook Salmon observed in the lower Scott River (river mile 1.6) during trapping efforts from 1985-1991.

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 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 Scott Valley. As a result of the limited landowner access to the valley reaches, since 2007 the Department has been operating the Scott River Fish Counting Facility (SRFCF) at the upper end of the canyon. The addition of the SRFCF has allowed for an accurate estimation of salmonid migration to areas of spawning habitat in the valley reaches without having to conduct spawning ground surveys in these reaches. Since 2014 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). 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.

SCOTT RIVER STUDY OBJECTIVES SUMMARIZED:

A. Determine the in-river run size (escapement) of Chinook Salmon and Coho Salmon returning to the Scott River.

B. Determine run timing, spawning distribution, length frequency (FL) distribution, and sex ratio for Chinook Salmon 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 Salmon and Coho Salmon spawning seasons.

METHODS

OPERATION OF THE SCOTT RIVER FISH COUNTING FACILITY

The video fish counting system was installed at the SRFCF on September 28, 2020 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 2020.

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. Additionally, salmon are classified as either adults or grilse based on observed length in the videography. During videography adult salmon are considered greater than and equal to 56 cm and salmon less than 56 cm are considers grilse. All rainbow trout (*onchorhynchus mykiss)* observed during videography greater than 40.6 cm (16 inches) in length are considered adult steelhead. 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. 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 two days prior and two days after the ARIS total count was observed. The ARIS camera was not used during the 2020 monitoring season.

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 22, 2020 and ending December 15, 2020. A total of 82 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 (SRCD) (Voight 2021). 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, and geo referenced using GPS coordinates. This information was provided to the Klamath National Forest for use in their annual reporting. 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 future recapture if the adipose fin clip determination could still be made with confidence. Therefore Path 3 carcasses could be recaptured multiple times. 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.

The final Chinook Salmon run-size estimate for reaches below the counting facility was calculated using the Cormack-Jolly-Seber (CJS) model as presented in Bergman et al. 2012.

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 4). 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).

Table 1. Description of cooperative spawning ground survey reach locations along the Scott River during the 2020 season.

Reach Number	Downstream Limit	RM	Upstream limit	RM	Length (miles)
1	Mouth	0.00	Mid Point	2.55	2.55
2	Mid Point	2.55	Pat Ford Ck	5.14	2.59
3	Pat Ford Ck	5.14	George Allen Gulch	8.51	3.37
4	George Allen Gulch	8.51	Gold Flat	11.38	2.87
5	Gold Flat	11.38	Bridge Flat	14.73	3.35
6	Bridge Flat	14.73	Counting Weir	18.20	3.47
7	Counting Weir	18.20	USGS Stream Gage	21.66	3.46
8	USGS Stream Gage	21.66	Meamber Bridge	25.36	3.70
9	Meamber Bridge	25.36	Dunlop	29.50	4.14
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

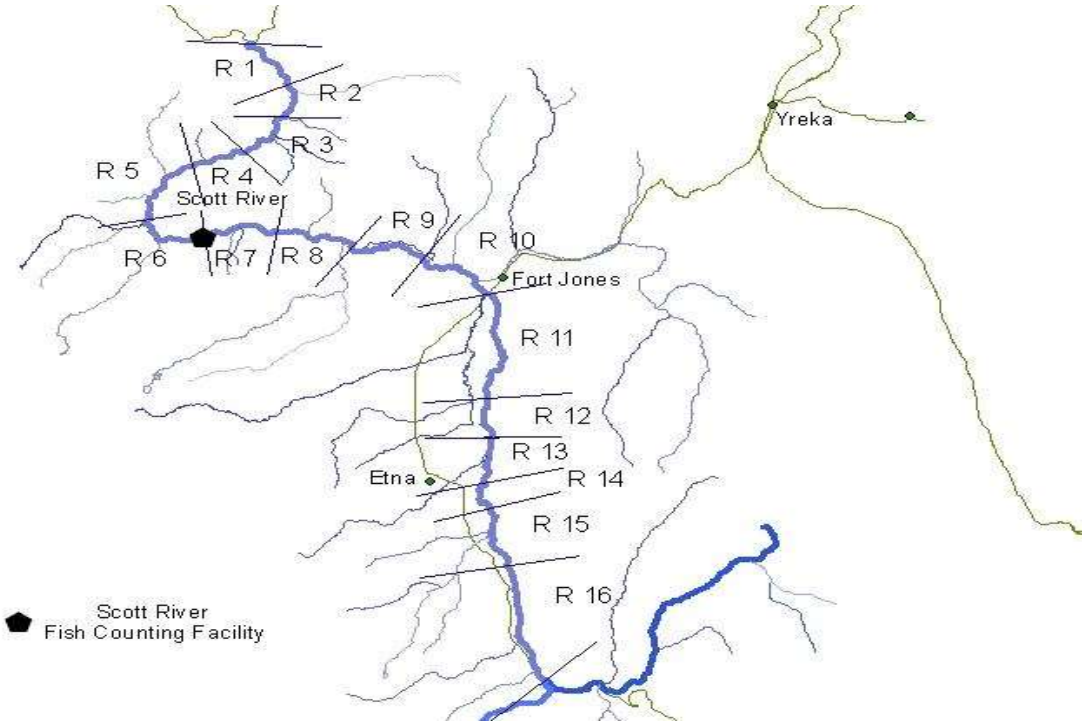


Figure 4. Location of the Scott River Fish Counting Facility and spawning ground survey reaches on the Scott River used during the 2020 field season.

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 82 Chinook Salmon and three Coho Salmon. Tissue was collected from the first Chinook Salmon 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 57 Chinook Salmon and three Coho. Otoliths were collected from the first Chinook Salmon 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). The Cormack-Jolly-Seber (CJS) model was used to estimate abundance in reaches 1 through 6. To estimate total escapement in the Scott River, the number of Chinook Salmon carcasses derived from the Cormack-Jolly-Seber (CJS) model were estimated (utilizing data from reach 1 through reach 6 only) and added to the count of all Chinook Salmon observed passing through the video counting facility.

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 January 20, 2021, in the main stem and tributaries (Tompkins Creek, Kelsey Creek, and Canyon Creek) below the counting facility. To estimate total adult Coho Salmon escapement in the Scott River, the number of observed Coho Salmon redds downstream of the counting station (zero in 2020) were multiplied by two in order to estimate the number of adult Coho Salmon (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). Zero Coho Salmon redds were identified downstream of the counting station during 2020. Therefore, no Coho Salmon were estimated downstream of the counting station.

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 live fish images observed at the fish counting facility. During the 2020 season hatchery contribution rates were based on observed clips on recovered carcasses for both Chinook Salmon and 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 Coho Salmon carcasses recovered during the spawning ground survey. The observed clip rate was then applied to the total estimated Coho Salmon run size.

RESULTS

OPERATION OF THE SCOTT RIVER FISH COUNTING FACILITY

The SRFCF began recording fish movement on September 28, 2020. The first Chinook Salmon was observed at the SRFCF on September 29, 2020, and the last Chinook Salmon was observed on December 16, 2020. The run peaked between November 16, 2020, and November 21, 2020, when 93.3% of the Chinook Salmon migration was observed (Figure 5). Unlike in previous years when over 90% of Chinook Salmon passed through the SRFCF during daylight hours, in 2019 and 2020 55% and 64% of the Chinook Salmon were observed during daylight (Figure 6).

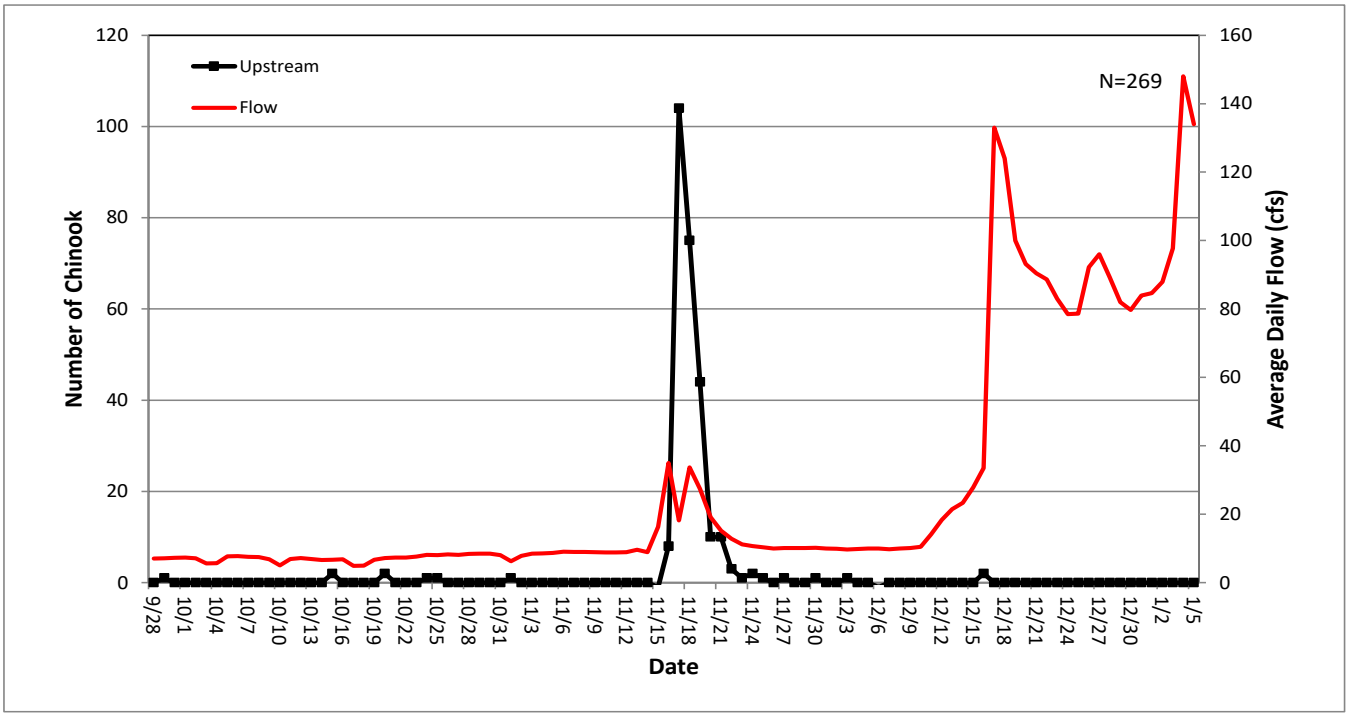


Figure 5. Run timing of Chinook Salmon through the Scott River Fish Counting Facility during the 2020 season (N=269), and average daily flows observed at USGS Gauge No. 11519500.

Table 2. Specific dates and times during the 2020 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 Salmon, Coho Salmon, 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	10/31/2020	0745	16:15	0	0	0
Filming Started	11/1/2020	1000	10:00	0	0	0
Totals				0	0	0

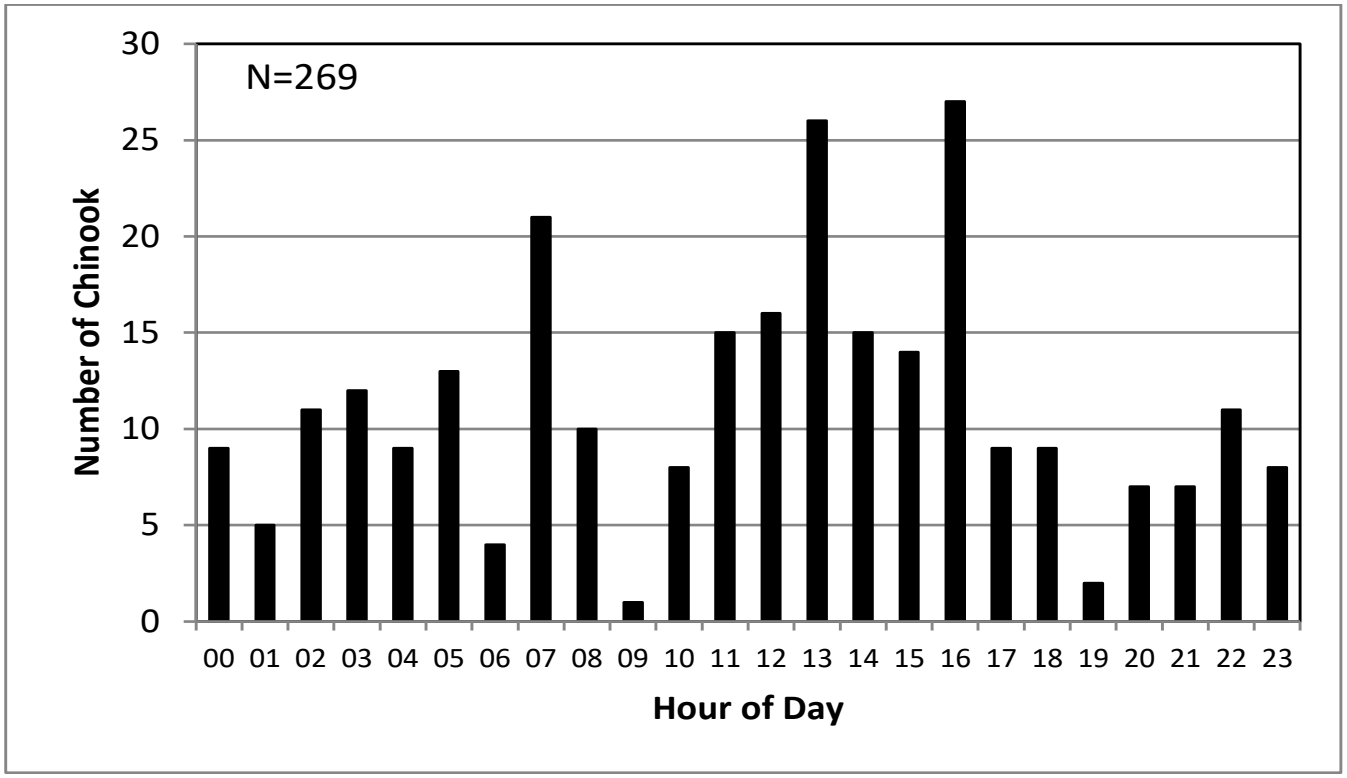


Figure 6. Summary of daily run timing of Chinook Salmon observed at the Scott River Fish Counting Facility during 2020 (N=269).

A net total of 269 Chinook Salmon were estimated to have passed through the SRFCF during the 2020 season (277 upstream and 8 downstream) when videography was employed. During the season the video monitoring station was inoperable on one occasion for a total of 26 hours and 15 minutes. To account for the time when the camera was not functioning specific times were averaged two days prior and two days after the outage. Zero Chinook Salmon were added to the seasonal count during the video loss on October 31, 2020 and November 1, 2020 (Table 2). Additionally, zero salmonids passed through the counting station that were not identified to species (unknown species). The ARIS (SONAR) camera was not used during the 2020 monitoring season. After accounting for upstream known and unknown observations and periods of time when the camera was not functioning a seasonal estimate of **269** Chinook Salmon upstream of the counting station was generated.

SPAWNING GROUND SURVEYS

A total of 246 Chinook Salmon carcasses were sampled during the spawning ground survey as Path 1 or Path 2 carcasses. Of these, 96 (39.0%) were male and 150 (61.0%) were female (there were two unmeasured female carcasses recovered). Males ranged in FL from 32 cm to 93 cm and averaged 65.3 cm (Figure 7). Females ranged in FL from 39 cm to 88 cm and averaged 64.5 cm (Figure 8). Zero adipose-clipped Chinook Salmon were observed during the spawning ground survey during the 2020 season. After examination of the length frequency distribution of Path 1 and Path 2 carcasses, a preliminary maximum grilse cut-off of 51 cm was established for Scott River Chinook Salmon. The preliminary grisle cut-off was supported by the final age determination which was derived from aged scales.

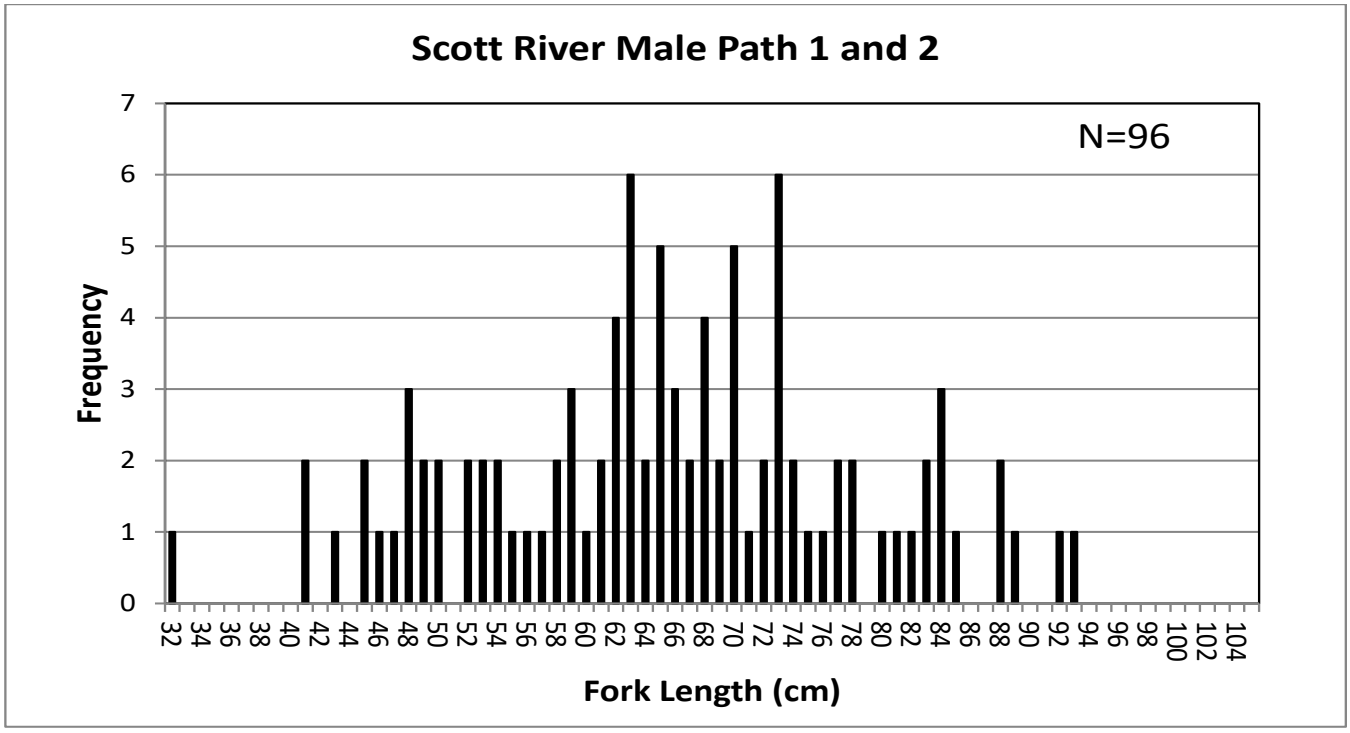


Figure 7. Length Frequency distribution of Path 1 and Path 2 male Chinook Salmon observed during spawning ground surveys in the Scott River, 2020 (N=96).

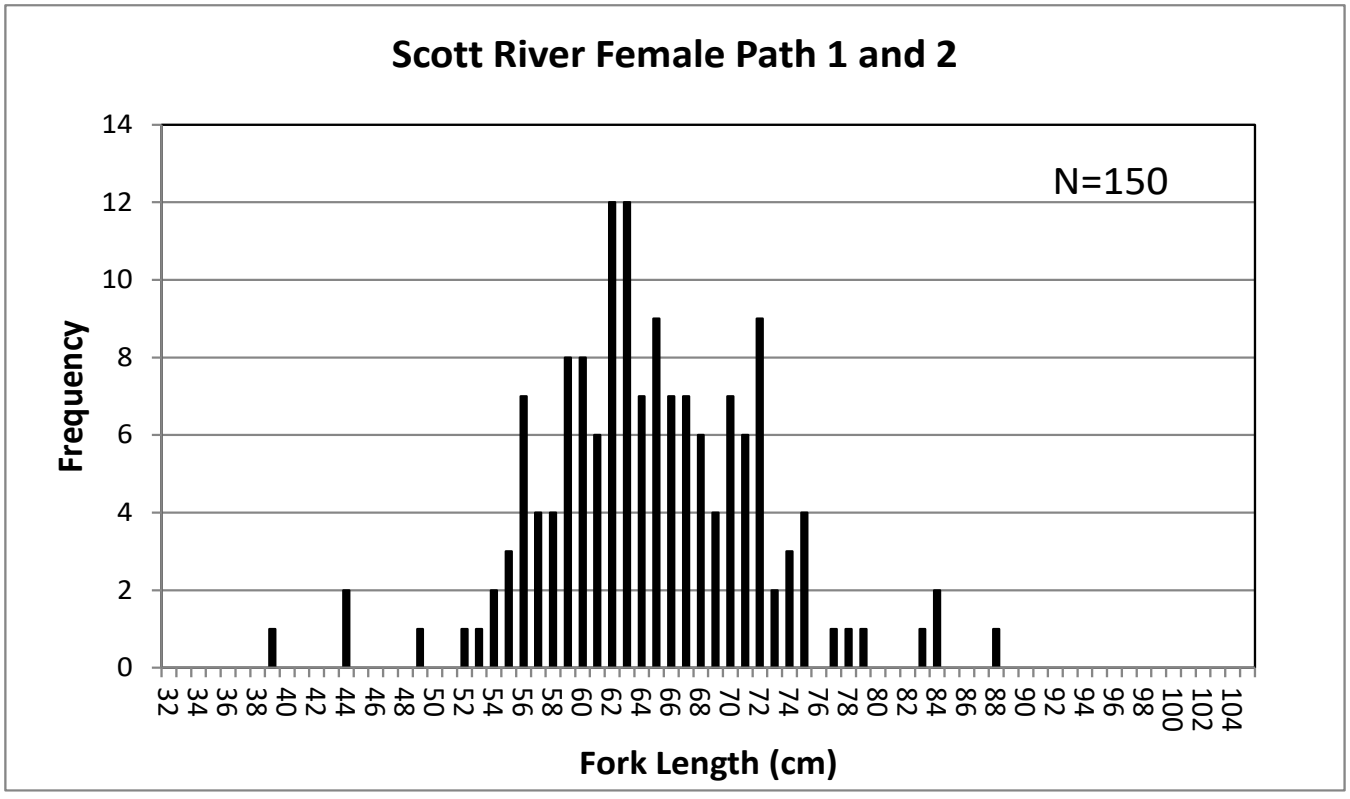


Figure 8. Length frequency distribution of Path 1 and Path 2 female Chinook Salmon observed during spawning ground surveys in the Scott River, 2020 (N=150)

A total of 152 Path 1 and Path 2 Chinook Salmon female carcasses were observed during the spawning ground survey (two unmeasured recoveries). 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 152 female Chinook Salmon carcasses examined, 139 females (91.4%) were found to have spawned, and 13 females (8.6%) were identified as un-spawned.

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 586 (+/- 106 95%CI) Chinook Salmon carcasses were estimated (Table 3) below the counting facility utilizing the CJS method (239 carcasses encountered; 178 carcasses marked and released; 85 recapture events from 69 carcasses).

Table 3. Chinook Salmon grilse, adult and total estimates for upstream and downstream of the counting station and total estimates for the Scott River 2020.

	Estimated Chinook Upstream of Counting station	Estimated Chinook Downstream of Counting Station		Total Chinook Estimates for Entire River	
	Video	CJS	Redds	CJS + Video	Redds + Video
Grilse	14	29	40	43	54
Adults	255	557	760	812	1015
Total	269	586	800	855	1069

Alternatively, Chinook Salmon abundance downstream of the counting station was estimated through expanding the seasonal total redd count of 380 redds. Multiplying the seasonal total redd count by 2 generates an adult estimate of 760. Forty grilse were added to the adult estimate utilizing the following equation: total run=adults/(1-%grilse estimated). A scale-based grilse estimate of 5.0% has been used to calculate the sub area total of 800.

There is a discrepancy between the CJS (586) and redd based (800) estimate downstream of the counting station of 214 Chinook Salmon (Table 3). The CJS estimate is the preferred method to estimate this sector and the redd estimate is only utilized when the CJS is interpreted to be problematic or in gross disagreement with the Redd estimate. Therefore, the carcass-based estimate for downstream of the counting station was used when generating the total estimated run size.

To estimate the total Chinook Salmon run for the entire river the CJS estimate from downstream of the counting station (586) was added to the video estimate (269) from upstream of the counting station to yield a total basin run size estimate of **855**. Based on scale age analysis, adults comprised approximately 95.0% (812) and grilse comprised 5.0% (43) of the run (KRTAT 2021).

COHO SALMON

The first adult Coho Salmon was observed at the counting facility on November 16, 2020, and the last Coho Salmon was observed on January 4, 2021 (Figure 9). A net total of 1,766 Coho Salmon (1,775 upstream and 9 downstream) were observed moving through the SRFCF when videography was employed. During the season the video monitoring station was inoperable on

one occasion for a total of 26 hours and 15 minutes. To account for the time when the camera was not functioning specific times and species observations were averaged two days prior and two days after the outage. Zero Coho Salmon were added to the seasonal count during the video loss on October 31, 2020 and November 1, 2020 (Table 2). Additionally, zero salmonids passed through the counting station that were not identified to species (unknown species). The ARIS (SONAR) camera was not used during the 2020 monitoring season. After accounting for upstream known and unknown observations and periods of time when the camera was not functioning a seasonal estimate of **1,766** Coho Salmon was generated.

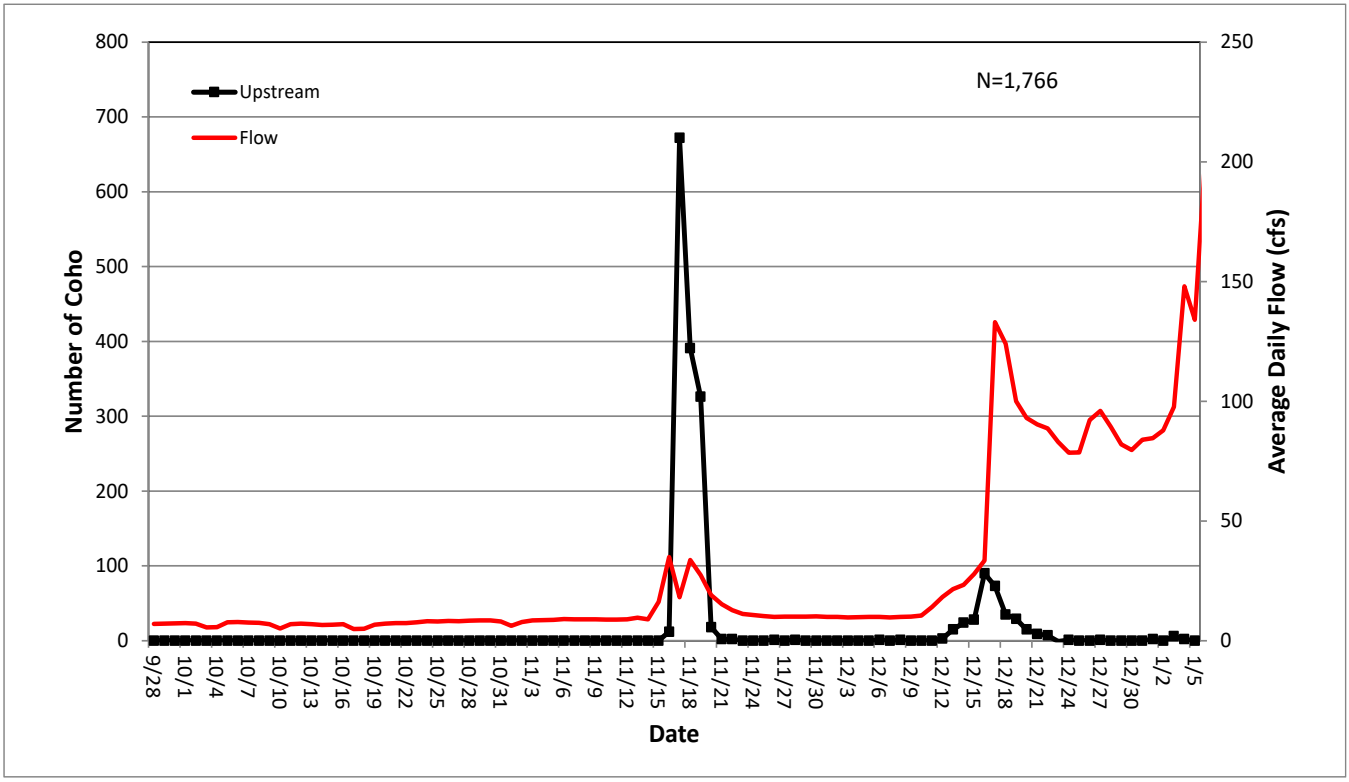


Figure 9. Run timing of Coho Salmon observed passing through the Scott River Fish Counting Facility during the 2020 season (N=1,766), and average daily flows observed at USGS Gauge No. 11519500.

Coho Salmon migration peaked following the first flow increase on November16, 2020. During a five-day period from November 16, 2020, through November 20, 2020, 80.3% of the Coho Salmon (1,419) were observed. During the 2020 season KRP staff estimated the number of grilse in the Scott River by enumerating the number of Coho Salmon observed in the video flume that were shorter or longer than 56 cm. Utilizing this method KRP staff identified 94.2% adults and 5.8% grilse (see below for further information on seasonal estimates of age proportions).

Diel movements of Coho Salmon through the SRFCF were consistent throughout the evening and night with peak observations in the afternoon (Figure 10). In recent years of Coho Salmon monitoring, migrations were generally low during the day and increased from the late afternoon through early morning. The hours between 0800 and 1100 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.

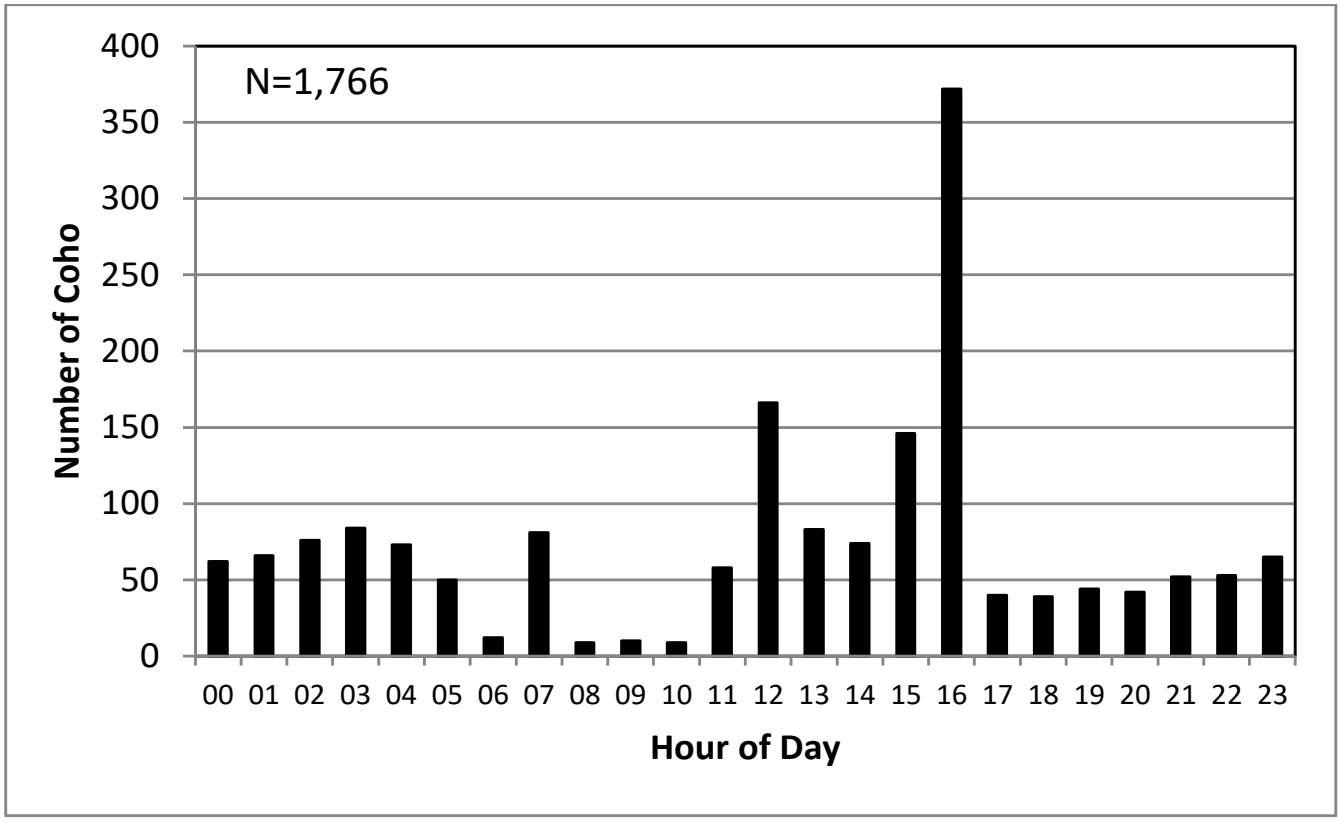


Figure 10. Diel migration patterns of Coho Salmon observed moving through the Scott River Fish Counting Facility in 2020 (N=1,766).

SPAWNING GROUND SURVEYS

Three Coho Salmon carcasses were observed during the cooperative spawning ground surveys on the lower main stem Scott River (Reaches 1-8) and 78 Coho Salmon carcasses were observed in upper Scott River (Reaches 9 through 16 and tributary reaches) during surveys coordinated by the Siskiyou Resource Conservation District (Voight, 2021). Females ranged in FL from 56 cm to 72 cm and averaged 64.8 cm. (Figure 11). Males ranged in FL from 51 cm to 75 cm and averaged 67.0 cm. (Figure 12). None of the recovered Coho Salmon carcasses were determined to have had clips or marks associated with hatchery production resulting in an estimated hatchery proportion of zero.

Applying the maximum grilse fork length of 55 cm to the total number of measured carcass recoveries (78) generated an age two proportion of 1.3% and an age three proportion of 98.7% (see below for further information on seasonal estimates of age proportions). Of the carcasses examined 79 were sampled for scales and 78 were sampled for tissue. Collected tissue samples were supplied to the NOAA Southwest Fisheries Science Center located in Santa Cruz, California for stock identification purposes. Additionally, 10 Coho Salmon otolith samples were collected and archived at the Department's Yreka office for future stock identification and life history examination. Zero Coho Salmon redds was observed during surveys in Kelsey Creek, Canyon Creek or Tompkins Creek.

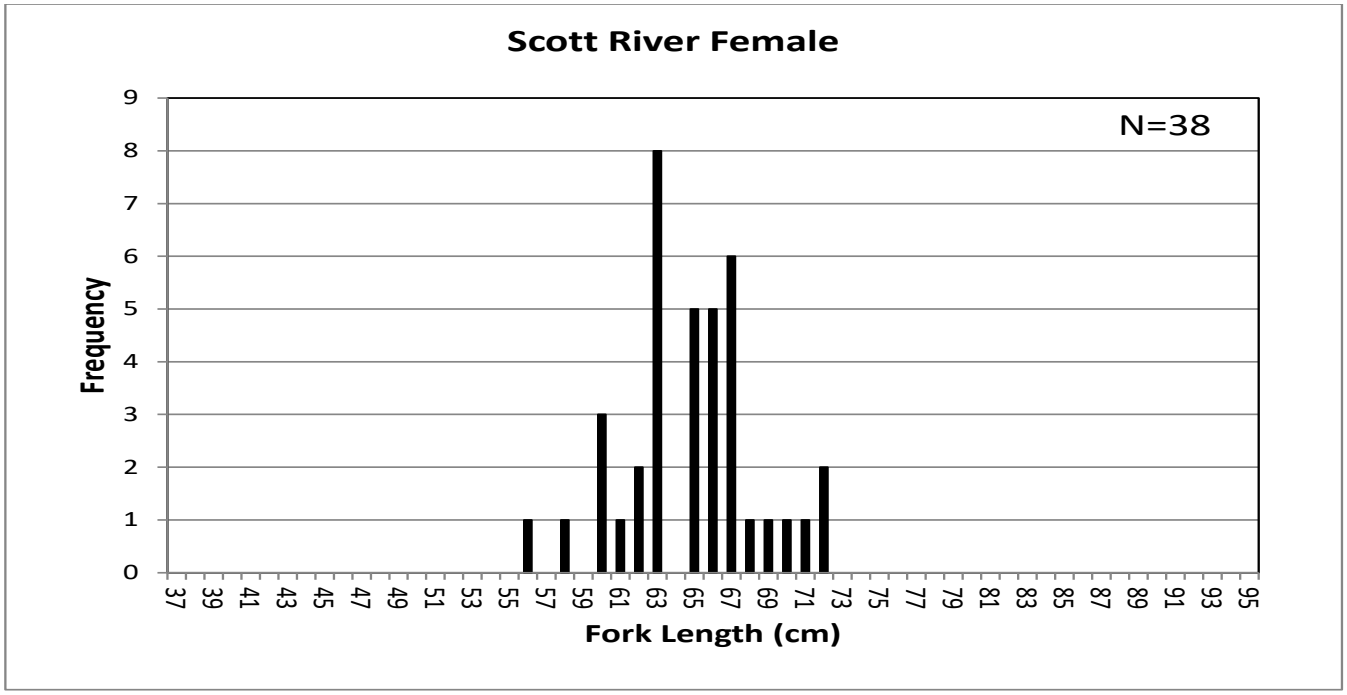


Figure 11. Length frequency distribution of Female Coho Salmon observed (N=38) during the cooperative spawning ground survey (1) and the SRCD (Voight 2021) spawning ground survey (37) in the Scott River 2020-2021.

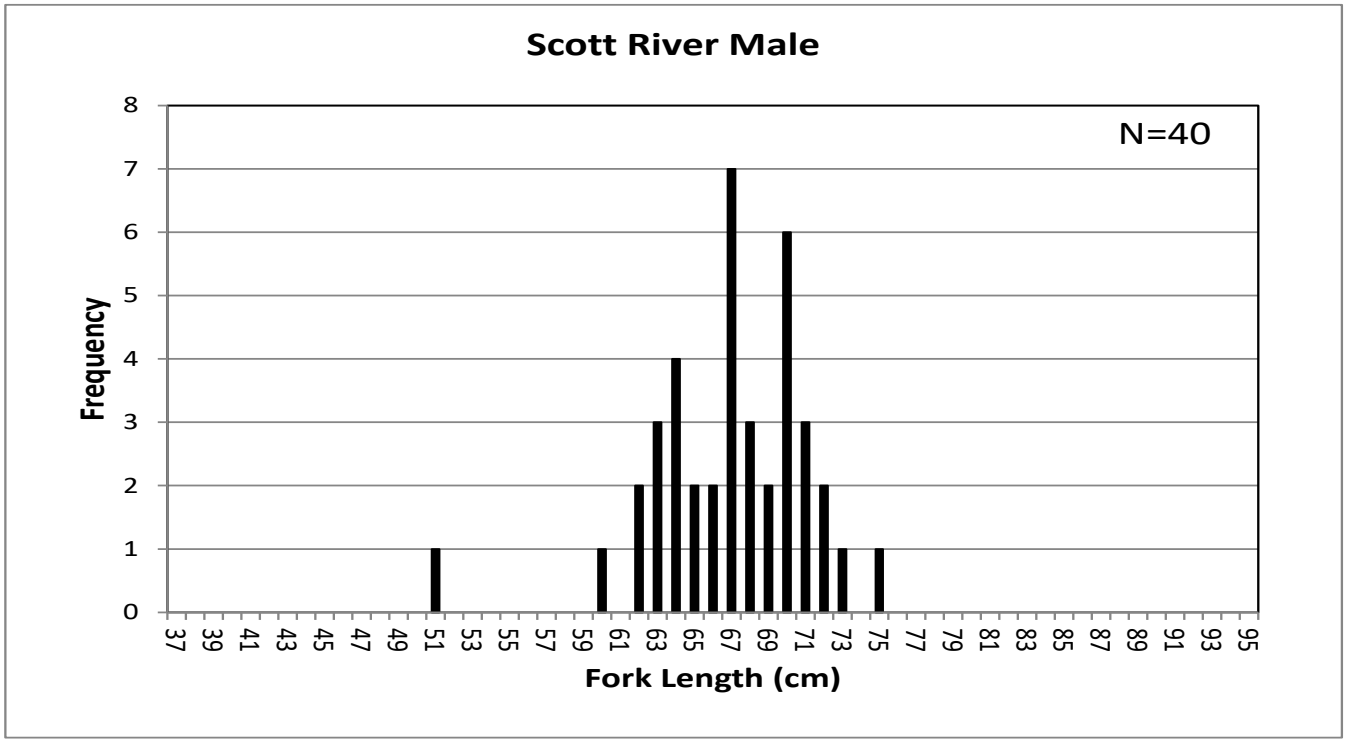


Figure 12. Length frequency distribution of Male Coho Salmon observed (N=40) during the cooperative spawning ground survey (2) and the SRCD (Voight 2021) spawning ground survey (38) in the Scott River 2020-2021.

A total of 1,766 Coho Salmon were estimated to have swam upstream through the SRFCF during the season. The age two proportions generated from videography and recovered carcasses were 5.8% and 1.3%, respectively. Due to the larger sample size available to estimate the age two proportion in the videography (1,766) verses measured carcass recoveries (81), the final age two proportion was determined using the videography data. Therefore, the resulting number of age two and three Coho Salmon are 102 (5.8%) and 1,664 (94.2%), respectively.

STEELHEAD

In 2020, a net total of 211 adult (>40.64 cm) steelhead (Figure 13) were estimated to have entered and remained in the Scott River during the video recording season from September 28, 2020 to January 4, 2021. Lines on the back of the video flume were set at 40.64 cm (16 inches) to delineate sub-adults versus adults. The 2020 season was the eleventh monitoring season that lines delineating adult steelhead and sub-adult steelhead were used.

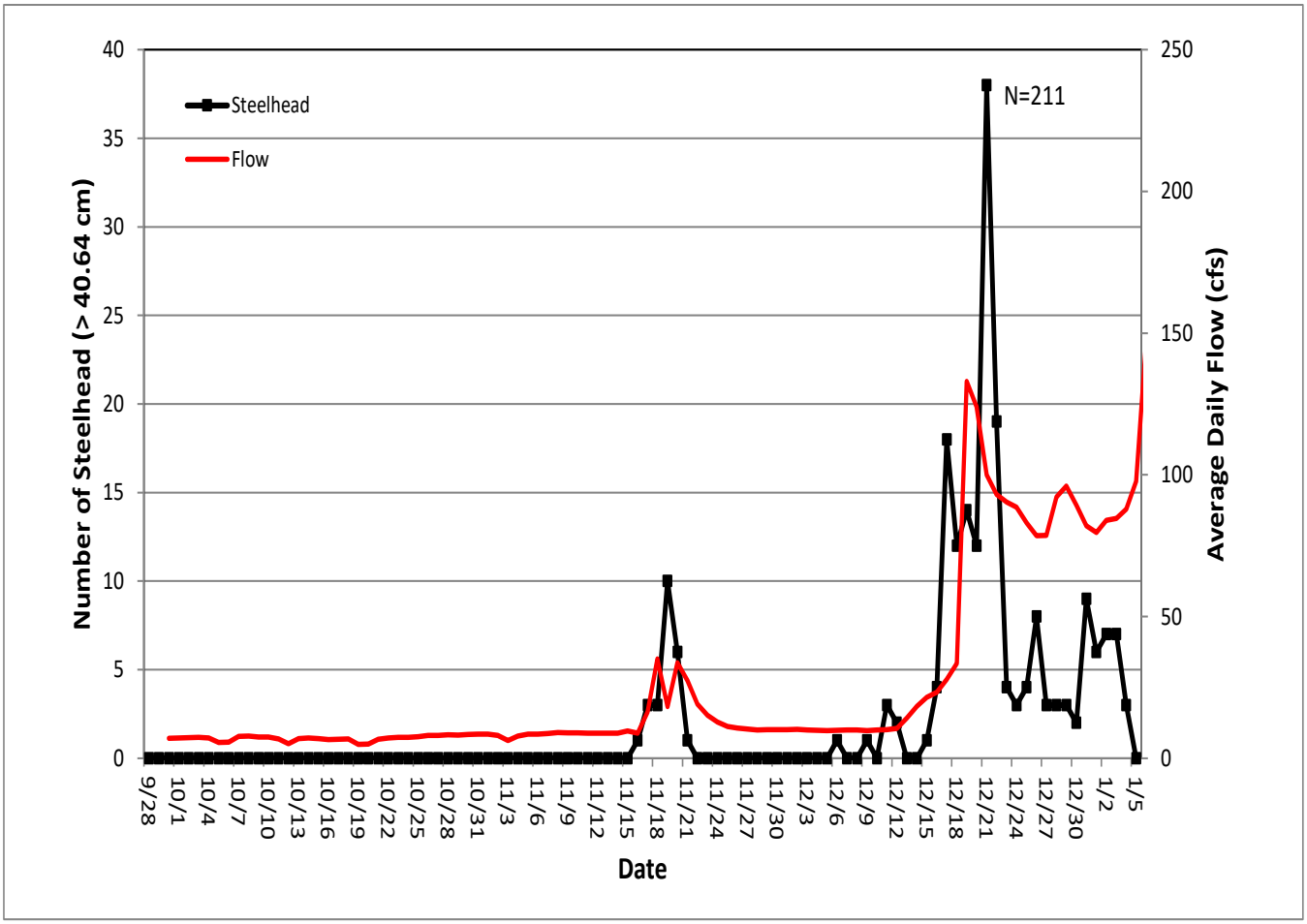


Figure 13. Run timing of steelhead trout (>40.64 cm) observed passing through the Scott River Fish Counting Facility during the 2020 season (N=211), and average daily flows observed at USGS Gauge No. 11519500.

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 4,977 fish (Figure 14). The 2020 Chinook Salmon run in the Scott River ranks 41 (855 fish) out of 43 years of monitoring. The 2020 run was 83% lower than the 43-year average of 4,977 Chinook Salmon. Chinook Salmon escapement to the Scott River from 2015 to 2020 averaged 1,738 fish, a 65% reduction from the historical average (4,977). Average escapement for the Klamath Basin from 2015-2020 is also down from the historical average, by 43% (CDFW 2021). It is concerning that the Scott River Chinook Salmon population is decreasing at a faster rate than the Klamath Basin as a whole.

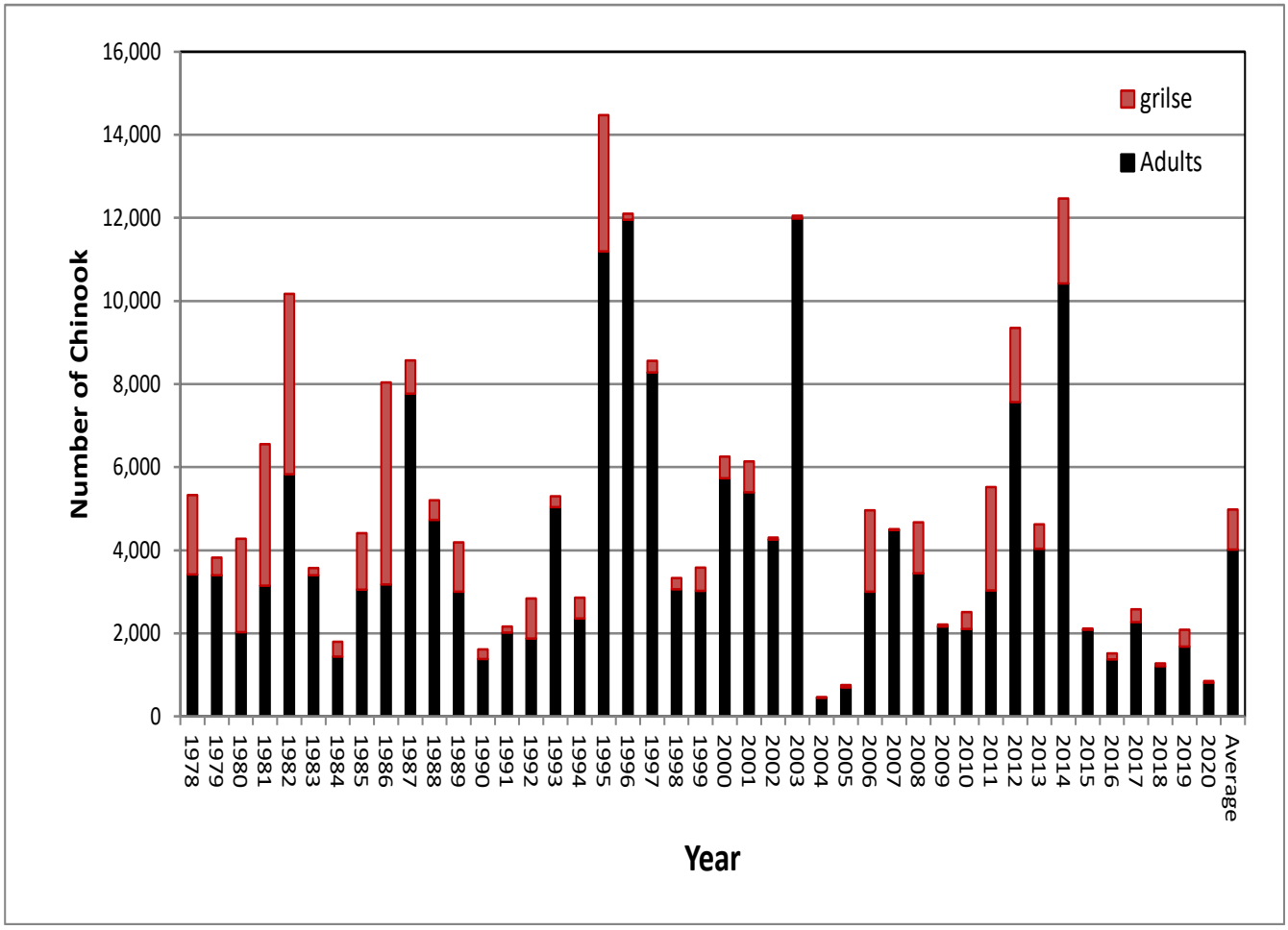


Figure 14. Estimated escapement of Chinook Salmon returning to the Scott River from 1978 to 2020.

The various proportions of the Chinook Salmon distribution for years 2008-2020 are detailed in Table 4 and identifies the importance of the entire Scott River watershed to Chinook Salmon. From 2008 through 2020 an average of 65% of the Chinook Salmon run spawned upstream of the counting station. Adult Chinook Salmon migration was impeded by low flows in 2020 and an estimated 31% of the Chinook Salmon run was observed passing through the counting station. It is important to track this metric as it helps describe the spatial distribution of annual

spawning. There is a lower risk of catastrophic loss due to potential redd scour when eggs are deposited throughout the watershed. More than 50% of the Chinook Salmon spawning occurred in canyon reaches during the 2015, 2018 and 2020 spawning seasons.

Table 4. Scott River Chinook Salmon abundance estimates by area and percentages of the total above and below the Counting Station during the 2008-2020 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
2019	537	1,553	26%	74%	2,090
2020	586	269	69%	31%	855
Average	1,044	2,940	35%	65%	3,984

The timing of Chinook Salmon passage through the SRFCF has consistently started in early October. With the exception of 2020, the Chinook Salmon run migrated through the SRFCF almost entirely during October, with 50% of the cumulative annual migration occurring in a narrow 17-day period between October 14 and October 30 (Figure 15), and without stage flow increases. The years 2015, 2018 and 2020 were the three driest falls during the period of monitoring at the counting facility. It is unclear why Chinook Salmon migration timing was delayed in 2020 compared to the previous 12 years. The run in 2020 was the lowest for the period of analysis, and the few fish that did migrate past the counting station were observed roughly two weeks after peak spawning occurred. The proportion of Chinook Salmon that spawned downstream of the counting station in 2015, 2018 and 2020 were 82%, 68% and 69% respectively which corresponded with the three lowest average October flow years (CDFW 2021). While the ability of Chinook Salmon to migrate does not appear to be limited by flow, the proportion of fish migrating upstream of SRFCF does appear to depend on flow.

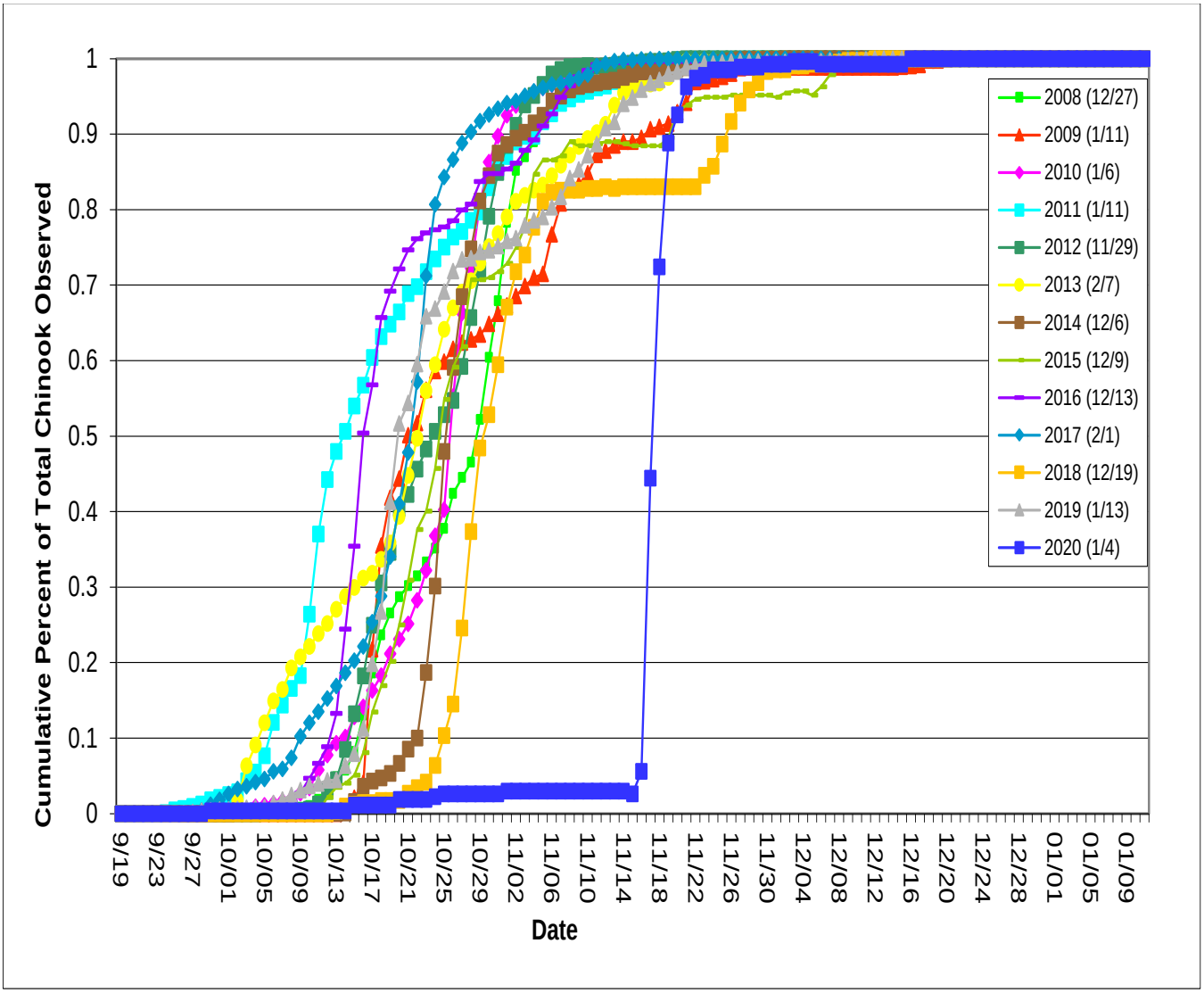


Figure 15. Cumulative percent of total Chinook Salmon observations by day at the Scott River Fish Counting Facility annually from 2008-2020. The date in parenthesis indicates the last date the fish counting facility was operated for each year.

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 2020 (Table 5). In most years the Scott River Chinook Salmon population tracks very similarly to the total Klamath Basin population ($r=0.7727$ 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 Salmon (Figure 16). While this relationship is significant over the period of record the relationship in the most recent 6 years is less consistent ($r=-.1816$ p-value$<.001$).

Table 5. Klamath Basin and Scott River Chinook Salmon natural spawner escapements (age 2-5), 1978-2020.

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%
2019	26,412	2,090	8%
2020	31,138	855	3%
Average	**59,383**	**4,977**	**9%**

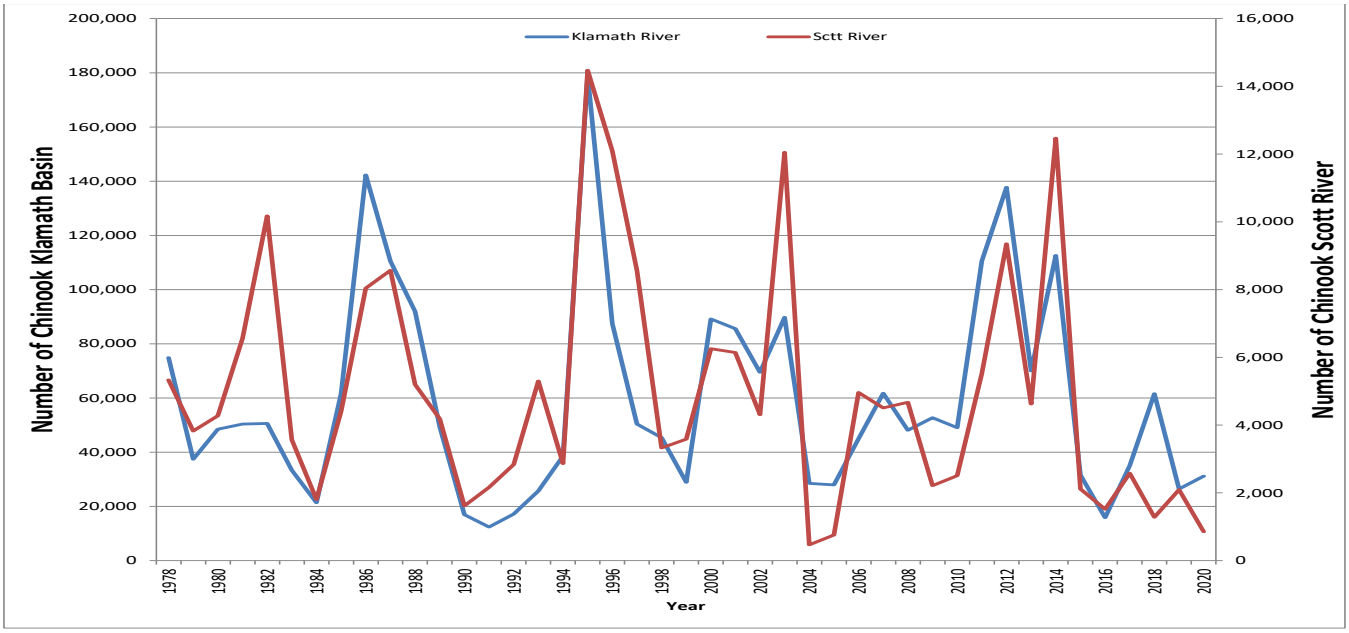


Figure 16. Chinook Salmon Klamath Basin natural spawner escapement (primary y-axis) and the Scott River natural spawner escapement (secondary y-axis) from 1978 through 2020.

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. 2021). The number of 0+ Chinook Salmon produced per adult has been calculated for Brood Years 1999-2015, 2017-2019 and has ranged from a low of 17.6 to a high of 453.6 and averaged 126 (Figure 17). Estimates of 0+ Chinook Salmon recruits per adult for Brood Year 2019 was 187.4. The observed 0+ Chinook Salmon produced per adult for Brood Year 2019 was 49% higher than the 20-year average of 125 fish.

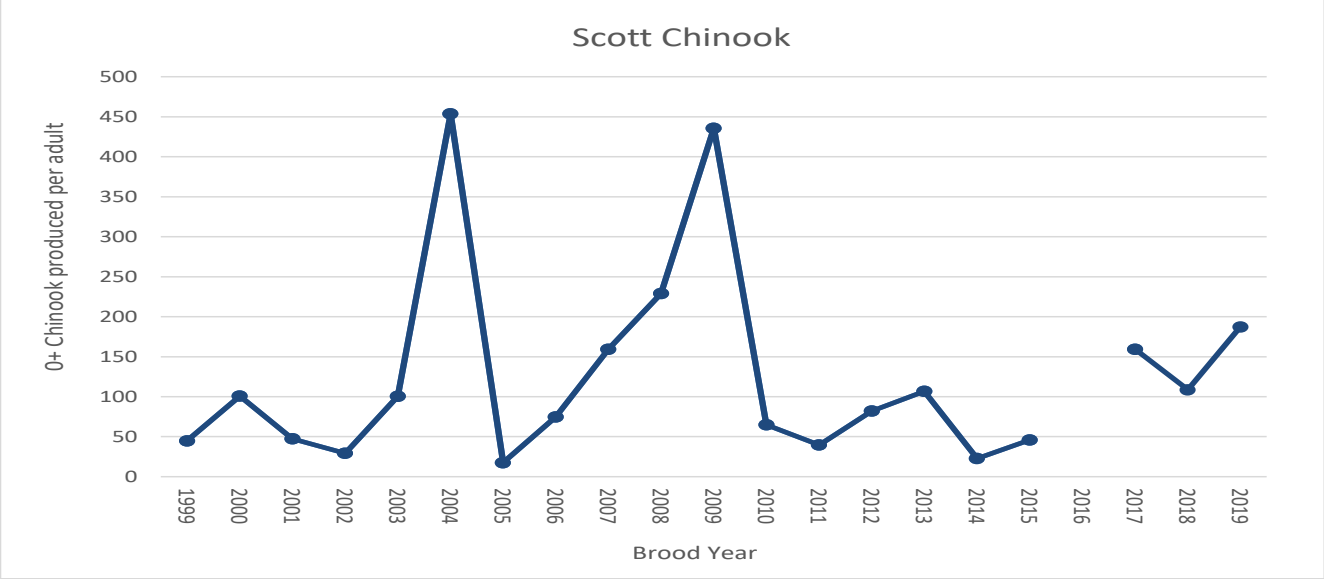


Figure 17. Number of 0+ Chinook Salmon produced per adult spawner in the Scott River by brood year, for Brood Years 1999-2015, 2017-2019.

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 Salmon produced per adult is a direct measure of in-river productivity, and as habitat conditions improve or diminish, this measure will reflect those conditions.

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 726 (Figure 18). 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 2020 indicates significant interannual variation (Massie et al. 2021). Results of the adult monitoring at the SRFCF support this observation. The brood year that returned in 2020 (age 3 in 2020 and age 2 in 2019) in one generation increased in total numbers by 1,303 fish to 1,671, an increase of 3.5 times, from returns in 2017 (Figure 19). In 4 generations this brood year has increased from an estimated 153 in 2008 to 1,671 in 2020.

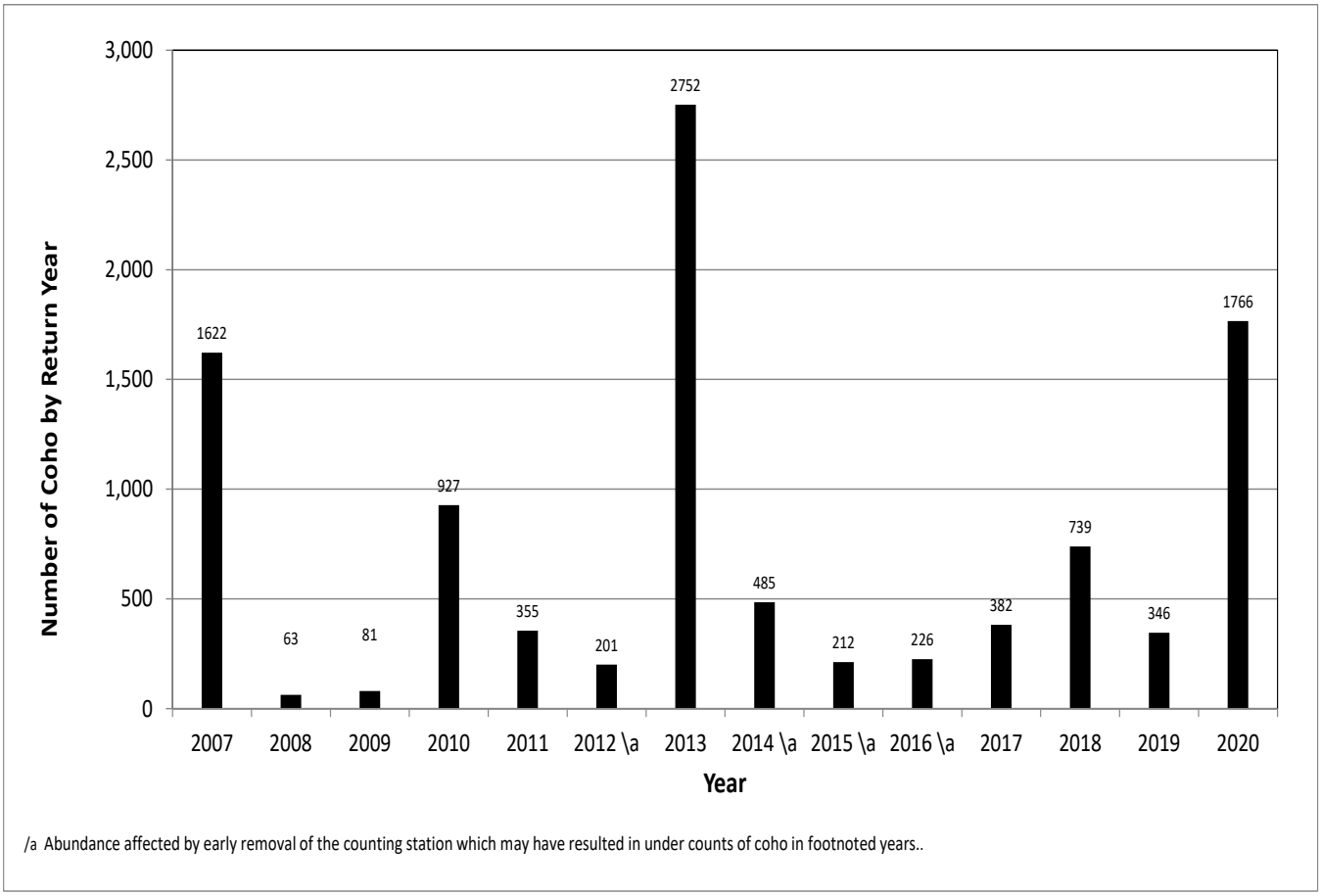


Figure 18. Estimated escapement by return year of adult and grilse Coho Salmon (age 2 and age 3) returning to the Scott River from 2007 to 2020.

The 2020 monitoring season extended to January 4 near what is considered the normal end of the Coho Salmon migration. To evaluate the accuracy of the 2020 estimate the proportion of the total annual run that has been observed by January 4th each season for the period of record (Figure 20) has been averaged. For the years 2007-2019 an average of 97.5% of the annual Coho Salmon run has been observed by January 4. If 97.5% of the Coho Salmon were observed during the 2020 season, then an estimated 45 additional Coho Salmon (total 1,811) 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 a small fraction.

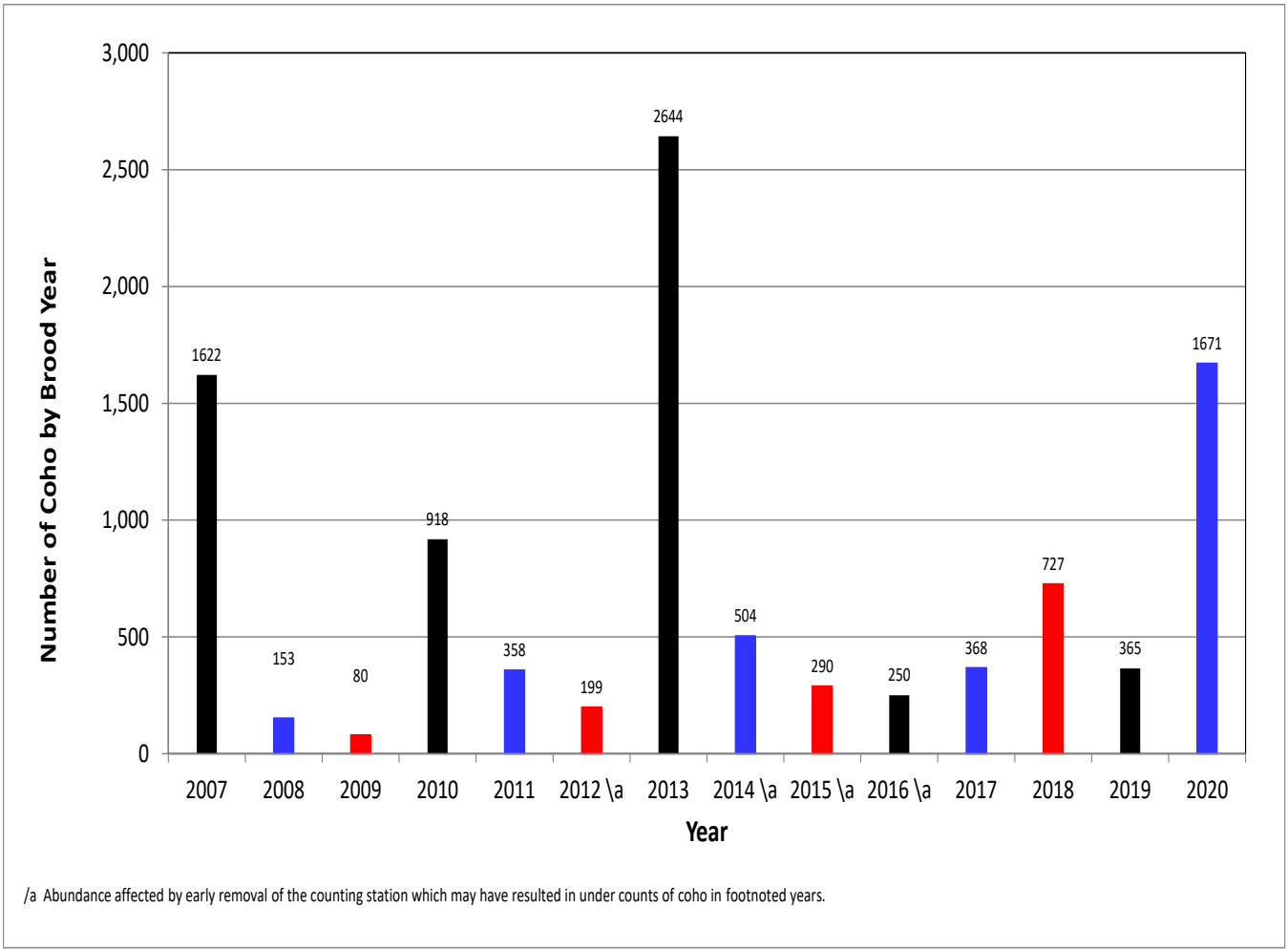


Figure 19. Estimated escapement by Brood Year of adult and grilse Coho Salmon (age 2 [year-1] and age 3 [year]) salmon returning to the Scott River from 2007 to 2020. Individual brood years are represented by different colors.

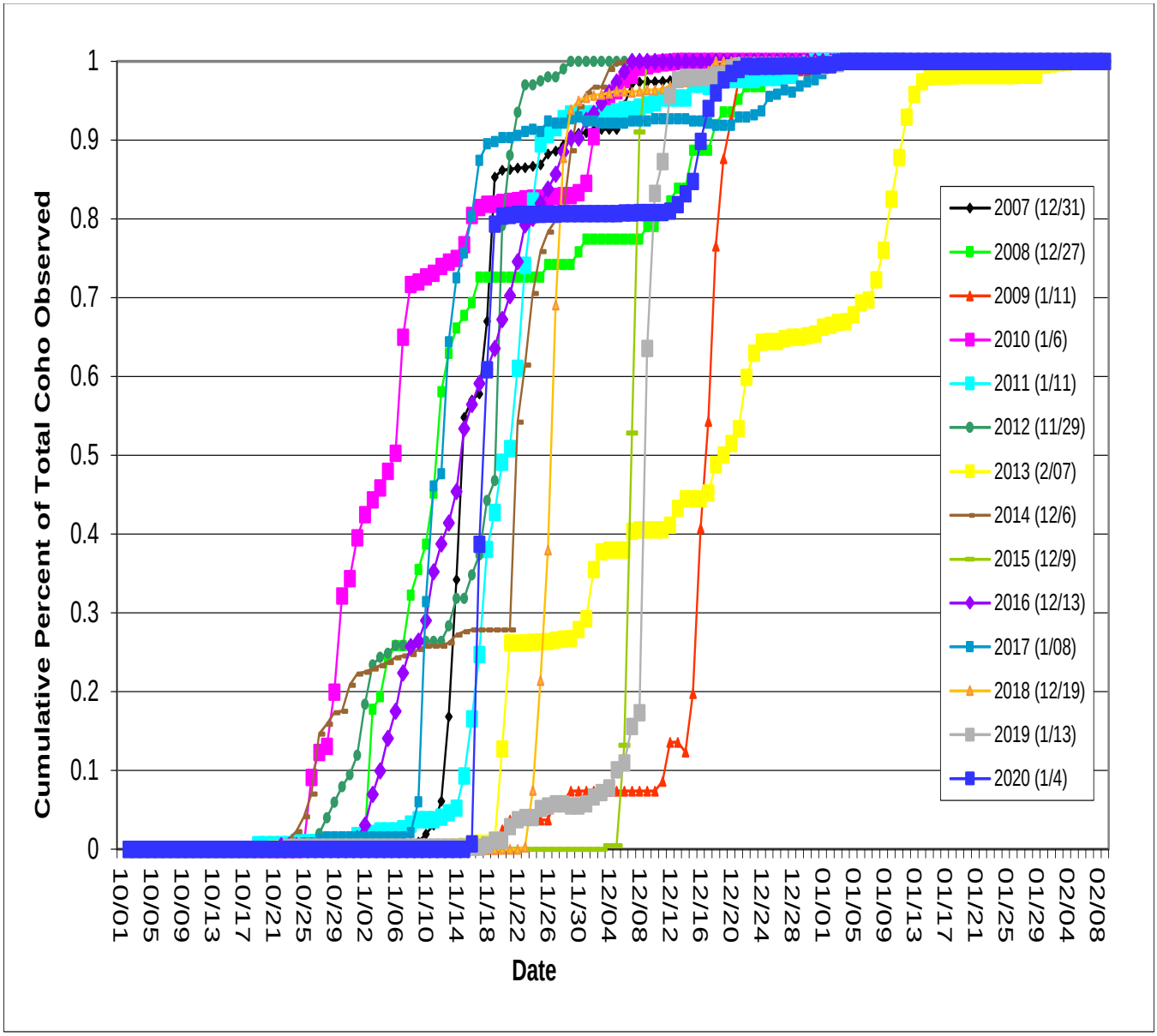


Figure 20. Cumulative percent of total Coho Salmon observations by day at the Scott River Fish Counting Facility annually from 2007-2020. The date in parenthesis indicates the last date the fish counting facility was operated for each year.

Utilizing the number of Coho Salmon smolts produced in the Scott River (Massie et al. 2021) 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 2004-2008, 2010-2014 and 2016-2017 the out of basin survival has averaged 5.26% and ranged from a low of 1.25% to a high of 10.99% (Table 6). 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 6. Coho Salmon smolt outmigrant abundance point estimates, age 2 and age 3 Coho Salmon abundance estimates, and proportion of outmigrant smolts that returned by brood year for the Scott River, Brood Years 2004-2017.

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
2016	2018	14628	2019	27	338	365	2.50
2017	2019	15707	2020	8	1664	1672	10.64

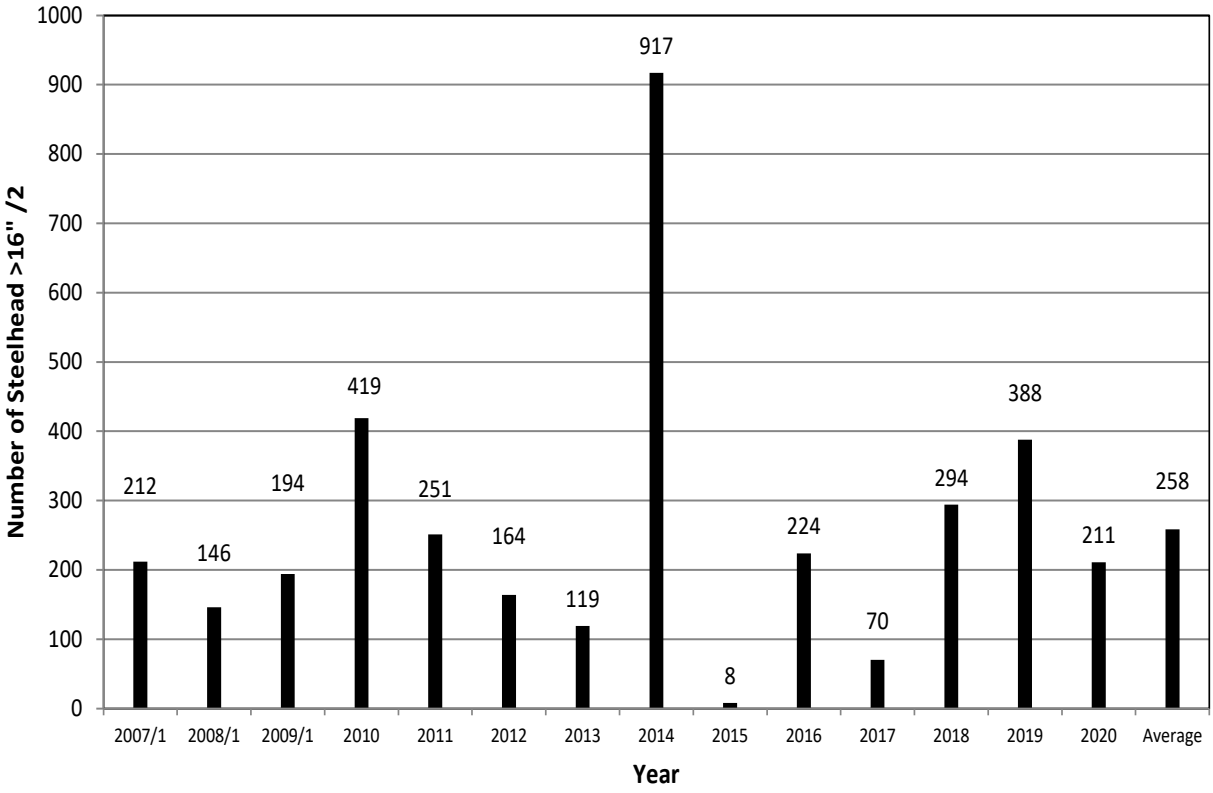
Analyzing comparisons of Coho Salmon smolt production estimates to estimated female adult Coho Salmon returns produces freshwater survival estimates in the form of Coho Salmon smolts produced per adult female return. For Brood Years 2007 through 2018, the number of Coho Salmon smolts produced per returning adult female has ranged from a low of 5.78 to a high of 101.78 and has averaged 60.02 (Table 7). 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.

Table 7. Adult Coho Salmon estimate, Coho Salmon smolt production point estimate and ratio of Coho Salmon smolts produced per adult female return for the Scott River, Brood Years 2007-2015, 2016-2018.

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
2017	382	174	2019	15707	90.27
2018	739	422	2020	14628	34.66
				Average	**60.02**

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 2020 the number of observed adult steelhead has ranged from a high of 917 to a low of 8 with an average of 258 (Figure 21). 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. A large fraction of the 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.



/1 Data may include an unknown number of sub-adult steelhead.
/2 Due to shifts in effort and timing of the run the number of steelhead observed represents an unknown proportion of the total annual return.

Figure 21. Number of observed steelhead >16" at the Scott River Fish Counting Facility from 2007 to 2020.

ACKNOWLEDGEMENTS

The California Department of Fish and Wildlife would like to thank Sport Fish Restoration Fund and the Pacific Coast Salmon Recovery Fund for their financial assistance in the operation of the SRFCF during 2020. 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.

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Appendix 1. Summary of surveys conducted in the Scott River watershed during the 2020 spawning season by date and reach.

	Reach																			
Survey lead	CDFW	CDFW	CDFW	CDFW	CDFW	CDFW	CDFW	CDFW	SRCD	SRCD	SRCD	SRCD	SRCD	SRCD	CDFW	CDFW	CDFW	USFS	USFS	USFS
Survey Date	1	2	3	4	5	6	7	8	9	12	13	14	15	16	Tompkins Creek	Canyon Creek	Kelsey Creek	Boulder Creek	Mill Creek (Scott Bar)	Fox Creek
10/15/2020	1	1	1	1	1															
10/19/2020		1	1	1																
10/22/2020	1		1	1	1	1														
10/26/2020	1	1	1		1															
10/29/2020	1	1	1	1	1															
11/2/2020	1	1	1	1	1															
11/5/2020	1	1	1	1	1	1														
11/9/2020	1	1	1	1																
11/12/2020		1	1		1															
11/16/2020	1		1	1																
11/17/2020																1	1			
11/19/2020	1	1	1	1	1															
11/23/2020	1	1	1	1																
11/30/2020	1	1	1	1	1															
12/3/2020	1	1		1	1	1	1													
12/11/2020		1																		
12/14/2020	1		1	1																
12/15/2020					1	1	1	1												
12/21/2020															1	1	1			
1/2/2021															1					
1/7/2021																1	1			
1/19/2021																1	1			
1/20/2021															1					