State of California – Natural Resources Agency
DEPARTMENT OF FISH AND WILDLIFE
Region 1 – Northern
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EDMUND G. BROWN JR., Governor
CHARLTON H. BONHAM, Director

September 3, 2014

Subject: Scott River Salmon Studies, Final Report (July 24, 2014)

All,

Please find attached a copy of the subject report. This report describes our fall Chinook and coho sampling efforts on the Scott River. Should you have any questions regarding this report, please direct inquiries to either Senior Environmental Scientist Wade Sinnen at (707) 822-5119, wade.sinnen@wildlife.ca.gov, or Environmental Scientist Morgan Knechtle at (530) 842-3109, morgan.knechtle@wildlife.ca.gov.

Sincerely,

Wade Sinnen for

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2013 SCOTT RIVER SALMON STUDIES

FINAL REPORT

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SCOTT RIVER SALMON STUDIES, 2013

California Department of Fish and Wildlife
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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 2013 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. Video fish counting operations began on September 30, 2013, and ended on February 8, 2014, due to high river flows.

The total number of Chinook salmon that entered the Scott River during the 2013 season is estimated to be **4,624** fish. Based on the proportion of male and female Chinook salmon sampled during the spawning ground surveys, the run was comprised of approximately 2,201 (47.6%) males and 2,423 (52.4%) females. Based on scale age analysis, adults comprised approximately 87.3% (4,036 fish) and grilse comprised 12.7% (588 fish) of the run. Males ranged in fork length (FL) from 39 cm to 103 cm and averaged 70.6 cm. Females ranged in FL from 42 cm to 93 cm and averaged 75.0 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 October 21, 2013, and the last coho salmon was observed on February 6, 2014. A net total of 2,731 coho salmon were observed moving upstream through the SRFCF during the season (2,757 upstream and 26 downstream). An additional 21 coho were estimated in the main stem or tributaries downstream of the SRFCF, yielding a total basin estimate of **2,752** fish. Based on the proportion of male and female coho salmon sampled during the season, the run was comprised of approximately 1,250 (45.4%) males and 1,502 (54.6%) females. Based on observed carcasses, adults comprised approximately 95.6% (2,631 fish) and grilse comprised 4.4% (121 fish) of the run. Males ranged in FL from 44 cm to 91 cm and averaged 70.3 cm. Females ranged in FL from 55 cm to 77 cm and averaged 68.6 cm. Based on observed carcasses, none 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 (SRFCF) is located at river mile 18.2 near the downstream edge of Scott Valley between the Indian Scotty Campground and Jones Beach picnic area (041° 38' 10.93" N; 123° 04' 3.08"W). Chinook salmon typically return to the Scott River to spawn from mid-September to late December. The coho salmon spawning run typically occurs from mid-October to early January, and steelhead run from November to April.

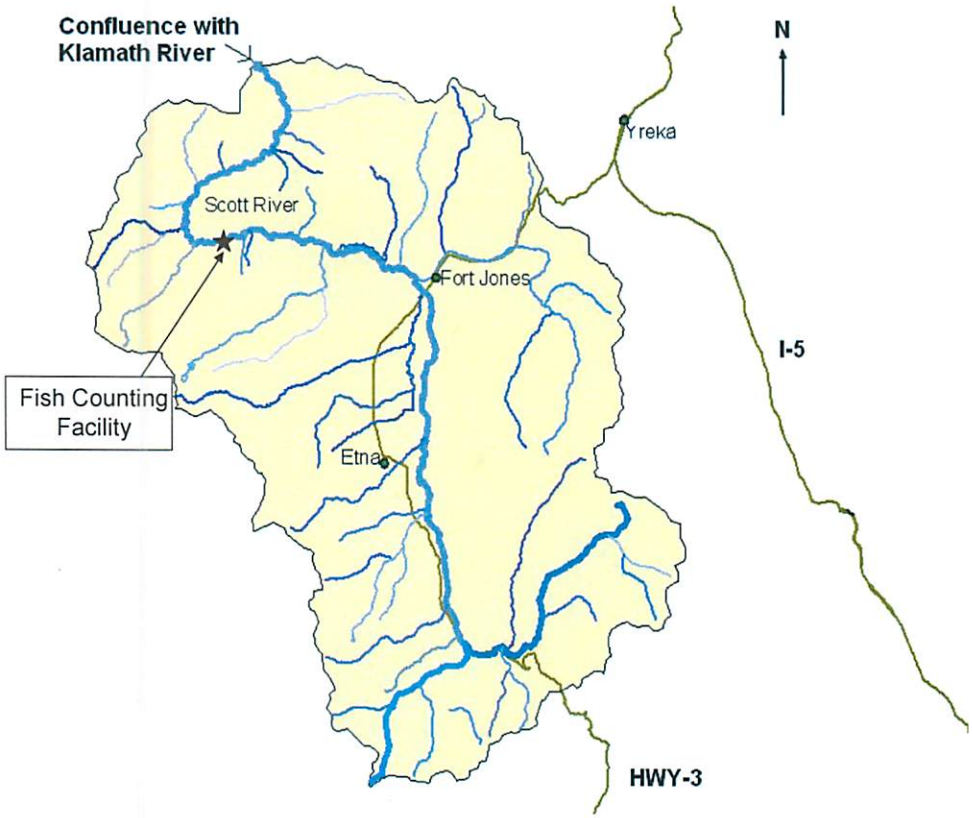

Figure 1. Location of the Scott River, tributary to the Klamath River, Siskiyou County, California.

KLAMATH RIVER PROJECT AND THE SCOTT RIVER STUDY

The Scott River study is one component of the Klamath River Project (KRP) (initiated in 1978). The goals of the KRP include obtaining information on species composition, spawning distribution, fork length (FL) frequency, and sex ratios for salmonids, primarily Chinook salmon, in various tributaries to the Klamath River including the Salmon, Scott, and Shasta rivers, as well as Bogus Creek and a dozen 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 (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 mainstem 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 Scott 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 California Department of Fish and Wildlife (Department) staff to obtain landowner permission prior to accessing private lands to conduct biological investigations. The entire length of the Scott River within the Scott Valley (above river mile 24) passes through privately owned agricultural lands. 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 level of cooperation from local landowners has varied over the years. However, since the 2001 and 2002 spawning seasons, the number of landowners that have denied permission for access has increased. Controversies associated with the listing of SONCC coho salmon under the California Endangered Species Act (CESA) and other regulatory actions have substantially 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 Jolly-Seber mark recapture carcass-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 and coho salmon returning to the Scott River.

B) Determine run timing, spawning distribution, FL distribution, and sex ratio for Chinook and coho salmon in the Scott River.

C) Collect scale samples from carcasses and recover heads (containing coded wire tags) from ad-clipped Chinook in order to determine age composition and hatchery contribution rates of the run.

D) Collect biological data for all steelhead observed 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 SRFCF on September 30, 2013, 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 color 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, throughout the Chinook and coho salmon migration period. A Splash Cam digital color video camera equipped with a 3.6mm wide angle lens with an auto iris was used to collect the photo 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 drive changes were made at least twice a week.

Figure 2. Scott River Fish Counting Facility located in Siskiyou County, California, 2013.

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-clipped fish observed and recorded the presence of lamprey scars and any other distinguishable marks 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. When the counting facility was inoperable, fish passage was estimated for that period by averaging the number of observed fish migrations for the specific time periods for which the counting facility was inoperable two days prior and two days after the malfunction.

SPAWNING GROUND SURVEYS

Spawning ground surveys were conducted twice a week on Mondays and Thursdays throughout the salmon spawning season starting October 17, 2013, and ending December 16, 2013. Additional surveys were conducted during the coho salmon period through February 3, 2014. A total of 196 surveys were performed during the spawning season (see Appendix 1). 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 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 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. Path 4 designations were rarely encountered during the survey.

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 private lands where permission had been granted by the landowners.

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 are located downstream of the State Highway 3 Bridge crossing (rm 35.60) to the USGS gauging station located at river mile 21 (Reaches 8, 9, and 10), and in that reach 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 112 Chinook salmon and 204 coho salmon. Tissue was collected from the first Chinook from each reach and each survey date, and all coho for which samples could be collected. All samples were collected following protocols provided by the National Oceanic Atmospheric Administration's (NOAA) Southwest Fisheries Science Center. Samples were sent to the Salmonid Genetic Tissue Repository located at the NOAA Santa Cruz Laboratory for archiving and analysis. Otoliths were collected from 113 Chinook salmon and 206 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).

Table 1. Description of cooperative spawning ground survey reach locations along the Scott River during the 2013 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

POPULATION ESTIMATE

The Chinook salmon spawner escapement for the area of Scott River upstream of the counting facility was derived from a direct count of all Chinook salmon observed at the video counting facility. To estimate total escapement in the Scott River, the number of Chinook salmon carcasses derived from the 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 video counting facility. Spawning ground surveys were conducted through mid-December in the main stem and the beginning of January in 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 observed coho salmon redds downstream of the counting station 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 from below the counting facility was then added back into the total (total run= adults/(1-%jacks estimated).

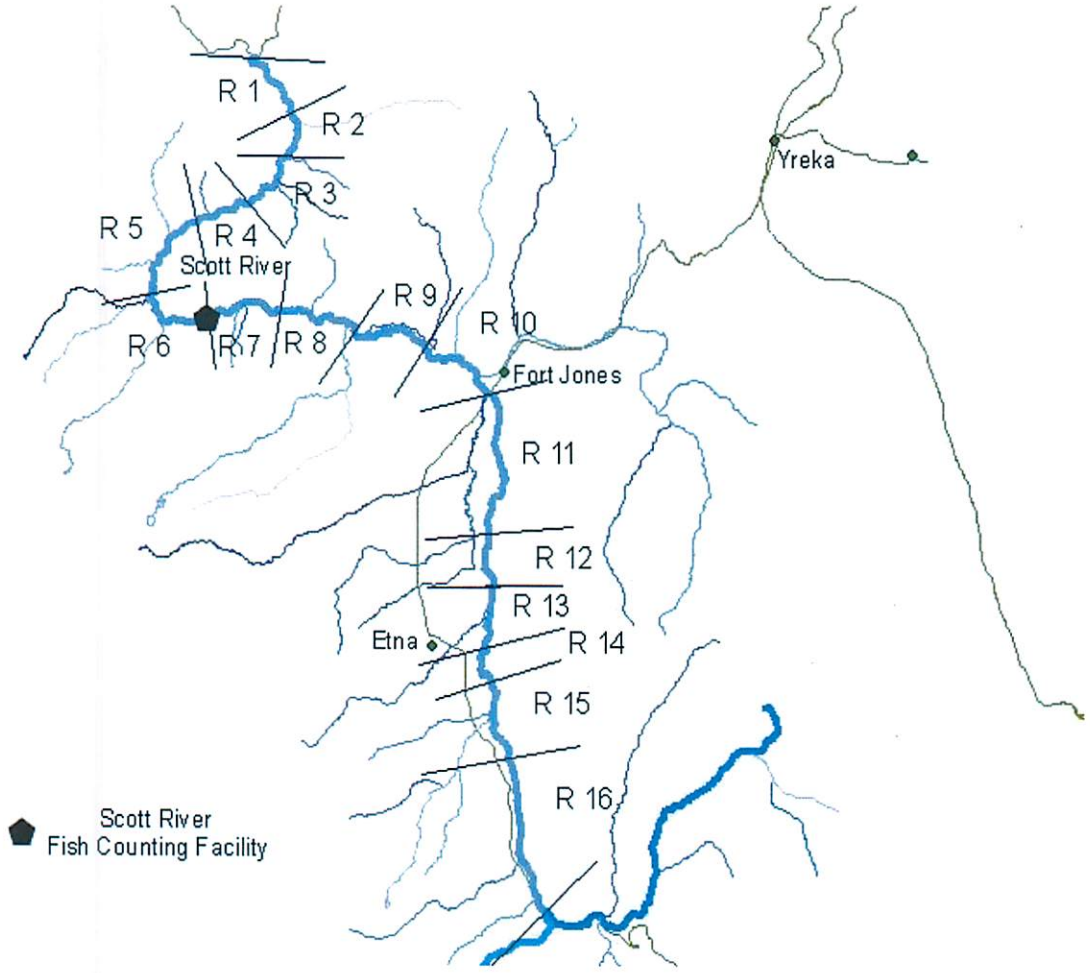

Figure 3. Location of the fish counting facility and spawning ground survey reaches on the Scott River used during the 2013 field season.

HATCHERY CONTRIBUTION RATES

The hatchery contribution rates for Chinook salmon and coho salmon have been estimated both through the recovery of carcasses and through reviewing fish images observed at the fish counting facility. Annually, decisions are made on which method produces the most accurate estimate based on sample sizes generated from each method. During the 2013 season, hatchery contribution rates were based on collection of data from observed carcasses for Chinook and coho salmon. The observed hatchery contribution rates were then applied to the total estimate by species to generate an estimated final number of hatchery origin fish.

RESULTS

Operation of the Scott River Fish Counting Facility

The SRFCF began recording fish movements on September 30, 2013. The first Chinook salmon was observed at the SRFCF on October 1, 2013, and the last Chinook salmon was observed on December 3, 2013. The run peaked between October 1, 2013 and November 2, 2013, when 81.2% of the Chinook migration was observed (Figure 4). The majority of Chinook salmon passed through the SRFCF during daylight hours and peaked in the afternoon between 1200 and 1800 hours (Figure 5).

A net total of 3,372 Chinook salmon were estimated to have passed through the SRFCF during the 2013 season (3,546 upstream and 174 downstream). Three hundred and fifteen (315) Chinook were included in the total as an expansion for periods of time when the camera was not functioning. During the Chinook spawning period, the camera was not functioning on three separate occasions for a total of 66 hours and 36 minutes (Table 2).

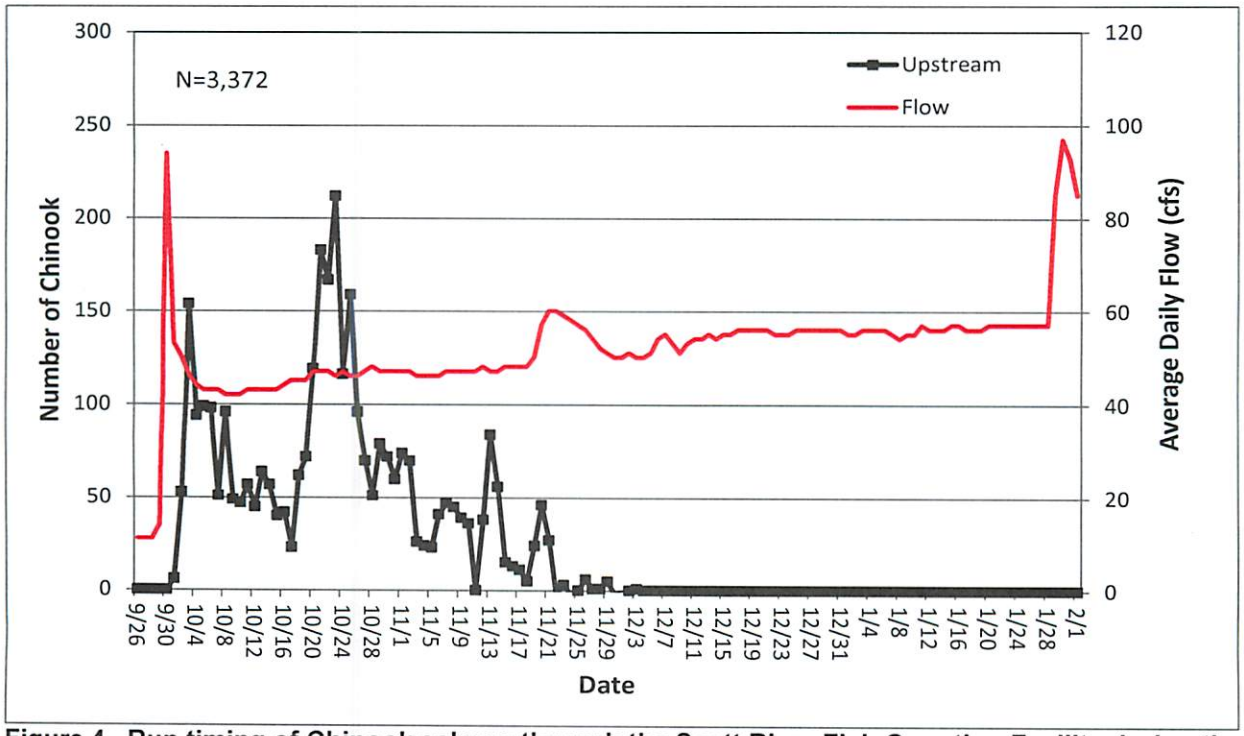

Figure 4. Run timing of Chinook salmon through the Scott River Fish Counting Facility during the 2013 season (N=3,372), and flows observed at USGS Gauge No. 11519500.

SPAWNING GROUND SURVEYS

A total of 1,103 Chinook salmon carcasses were sampled during the spawning ground survey as Path 1 or Path 2 carcasses. Of these, 525 (47.6%) were male and 577 (52.4%) were female (one unknown sex). Males ranged in FL from 39 cm to 103 cm and averaged 70.6 cm (Figure 6). Females ranged in FL from 42 cm to 93cm and averaged 75.0 cm (Figure 7). No ad-clipped Chinook were observed during the spawning ground survey effort. After examination of the length frequency distribution and scale age analysis of Path 1 and Path 2 carcasses, a maximum grilse cut-off of < 60 cm was established for the Scott River.

A total of 213 Path 1 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 213 female Chinook salmon carcasses examined, 211 females (99.1%) were found to have spawned, and 2 females (0.9%) were identified as un-spawned.

In 2013 the CJS mark recapture data collected during the spawning ground survey was analyzed for reaches 1-6 only. The basin estimate was derived by adding the CJS estimate generated from reaches 1-6 to the total number of Chinook observed passing through the counting facility. The CJS point estimates and 90% CI estimate for reaches 1-6 was 1,252 +/- 229. The total Chinook salmon run-size estimate (based on summing the video estimate of 3,372 and the CJS point estimate from reaches 1-6 below the weir) was estimated to be 4,624 fish. Based on scale age analysis, adults comprised approximately 87.3% (4,036 fish) and grilse comprised 12.7% (588 fish) of the run (KRTAT 2014).

Table 2. Specific dates and times during the 2013 season when filming stopped and re-started, the number of hours without data, and the number of Chinook, coho, and steelhead estimated during that time.

	Date	Time	Number of hours : minutes without data	Number of Chinook estimated	Number of Coho estimated	Number of Steelhead estimated
Filming Stopped	10/5/2013	1630	7:30	64	0	1
	10/6/2013		24 :00	98	0	2
Filming Started	10/7/2013	0615	6 : 15	4	0	1
Filming Stopped	10/17/2013	2230	1 : 30	2	0	0
Filming Started	10/18/2013	0810	8 : 10	13	0	0
Filming Stopped	10/23/2013	1330	10 :30	107	0	1
Filming Started	10/24/2013	0841	8 : 41	27	0	0
Totals				315	0	5

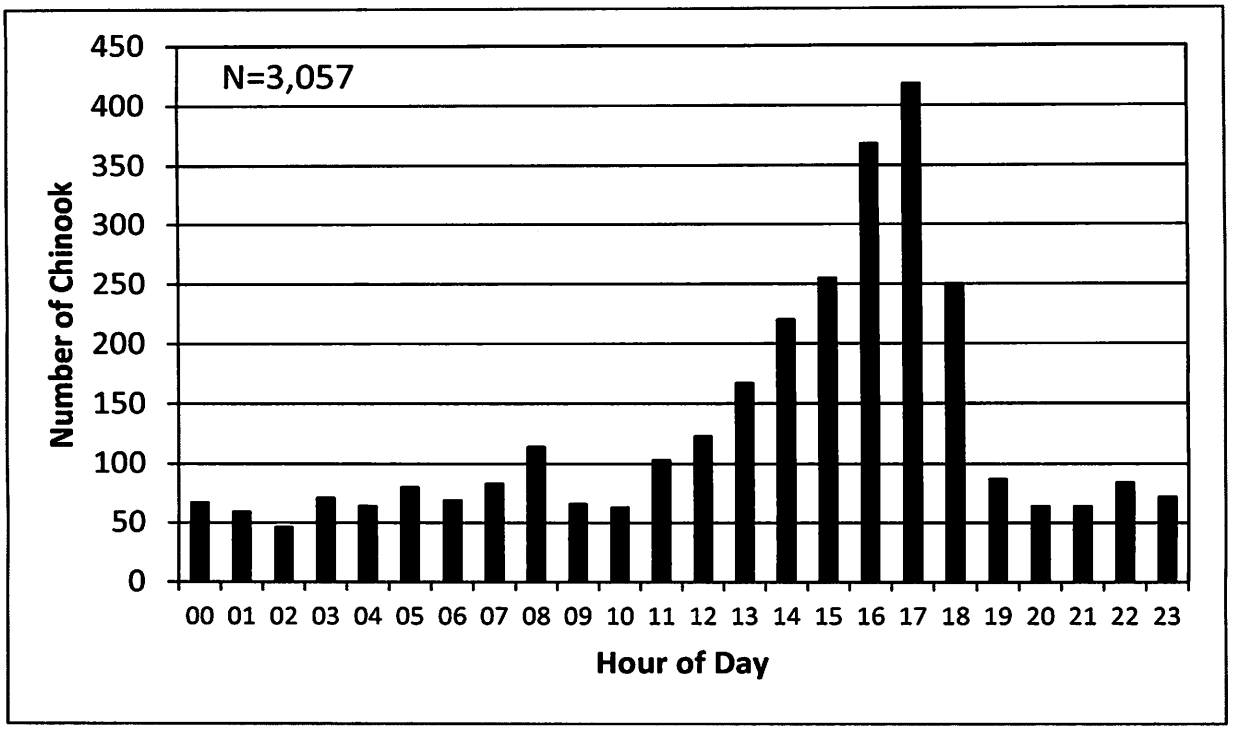

Figure 5. Summary of daily run timing of Chinook salmon observed at the SRFCF during 2013 (N=3,057).

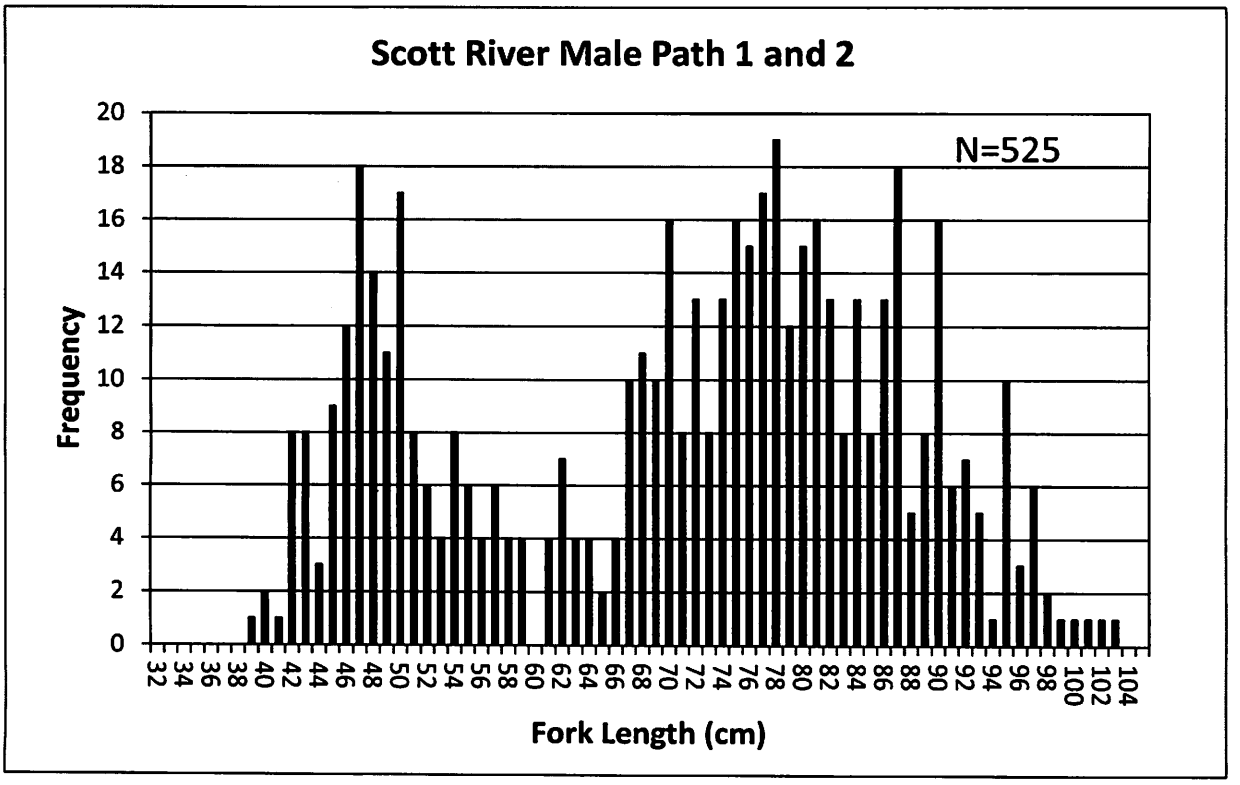

Figure 6. Length Frequency distribution of Path 1 and Path 2 male Chinook salmon observed during spawning ground surveys in the Scott River, 2013 (N=525).

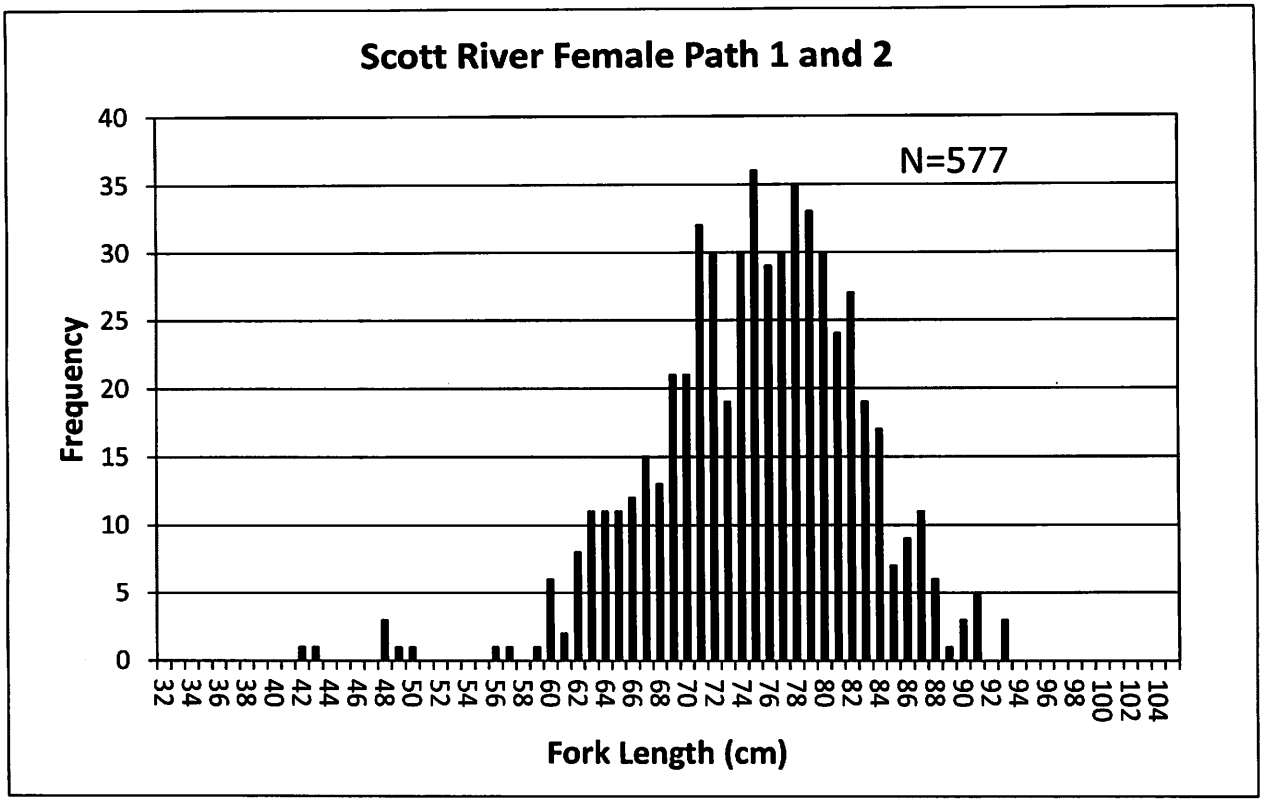

Figure 7. Length frequency distribution of Path 1 and Path 2 female Chinook salmon observed during spawning ground surveys in the Scott River, 2013 (N=577).

COHO SALMON

The first adult coho salmon was observed at the counting facility on October 21, 2013 and the last coho salmon was observed on February 6, 2014. A net total of 2,731 coho salmon (2,757 upstream and 26 downstream) were observed moving upstream through the SRFCF during the season (Figure 8). Coho salmon migration peaked during the two day period from November 20, 2013 through November 21, 2013, when 682 or 25.0% of the coho were observed. Three additional pulses of coho movements were documented from November 30, 2013 through December 3, 2013; December 17, 2013 through December 24, 2013; and January 5, 2014 through January 15, 2014. During these four pulses of migration spanning 25 days, 87% of the entire season's adult coho were observed. A total of 26 coho salmon were observed swimming downstream during the season. During the coho migration, the weir successfully operated the entire time, and as a result, zero coho were added to the estimate to account for periods of time in which the counting station was not functioning. During 2013-2014 season, KRP staff attempted to estimate 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 98.3% adults and 1.7% grilse. (See the discussion 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 2000 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 0800 and 1100 were generally the time during the day when the crew was at the weir conducting daily maintenance.

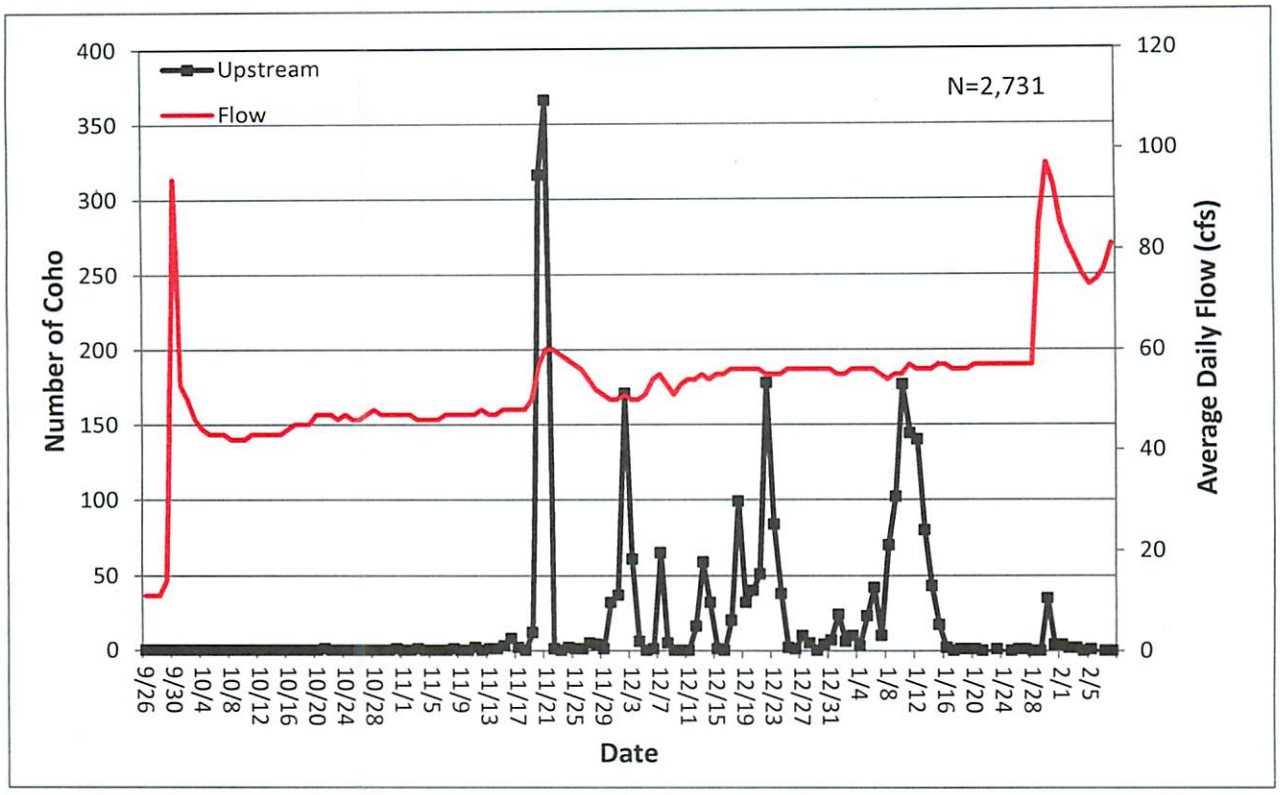

Figure 8. Run timing of coho salmon observed passing through the SRFCF during the 2013 season (N=2,731), and flows observed at USGS Gauge No. 11519500.

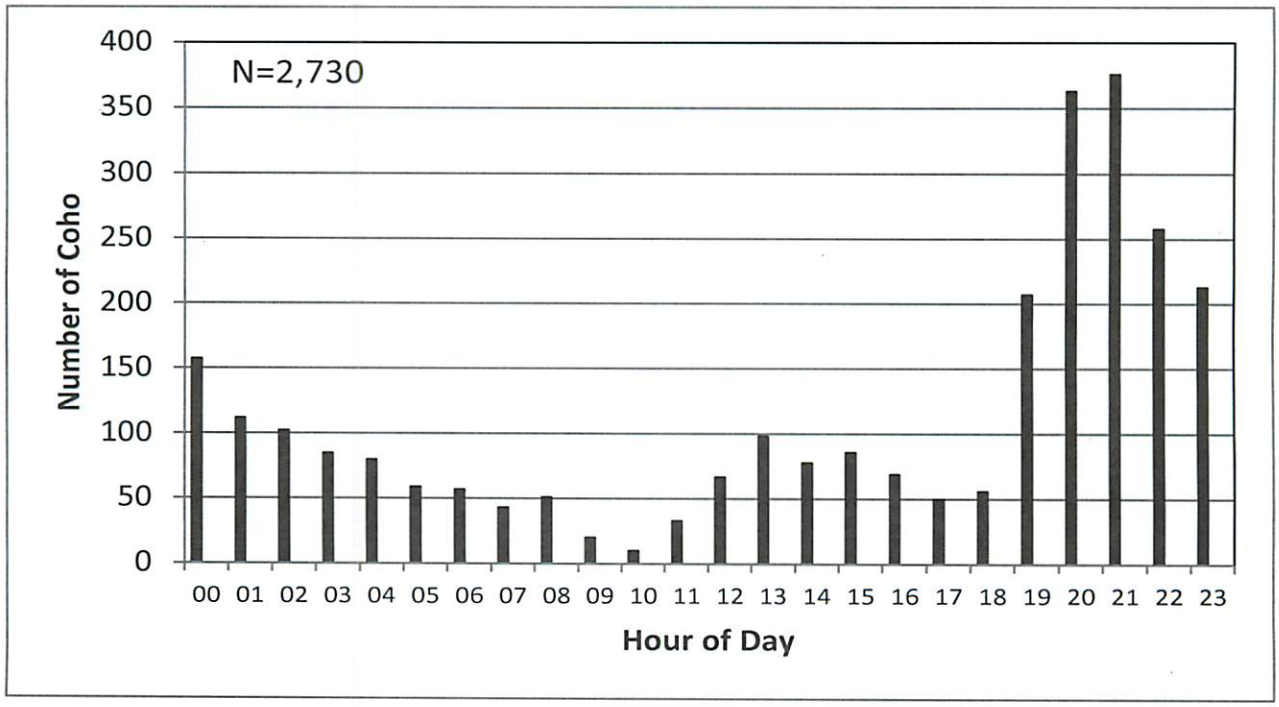

Figure 9. Diel migration patterns of coho salmon observed moving through the SRFCF in 2013 (N=2,730).

SPAWNING GROUND SURVEYS

Forty-nine (49) coho carcasses were observed during the cooperative spawning ground survey on the main stem Scott River in reaches 1 through 8. One hundred seventy-nine (179) coho carcasses were observed in Scott River main stem (reaches 12 through 16) and tributaries during surveys coordinated by the Siskiyou Resource Conservation District (SRCD) (Yokel, 2014). Nine (9) additional coho carcasses were collected as wash backs at the counting facility (Figure 10). Utilizing all of the recoveries throughout all areas, the sex ratio of observed coho salmon carcasses in the Scott River during 2013 was 54.6% (1,502) female and 45.4% (1,250) male. None of the 237 coho carcasses examined had a maxillary clip, resulting in an estimated hatchery composition of zero. Based on the FL frequency distribution of the carcasses measured during the season (nine carcasses were not measured), a maximum grilse FL was established at <58 cm. Applying the maximum grilse FL cutoff to the total number of measured carcass recoveries generated an age 2 proportion of 4.4% and an age 3 proportion of 95.6%. All of the 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. Coho redds were not observed in Canyon Creek, Kelsey Creek, or Tompkins Creek.

A total of 2,731 coho salmon were estimated moving upstream through the SRFCF during the season. Additionally, 10 coho redds were observed in areas below the counting facility resulting in an estimated 21 additional coho downstream of the counting station (N=(redds*2)/(1-proportion grilse)). Therefore, the total number of estimated coho salmon that entered the Scott River during the 2013-2014 season is **2,752**. Utilizing the observed age proportions derived from the sampled carcasses, the resulting numbers of age 2 and age 3 fish are 121 (4.4%) and 2,631 (95.6%), respectively.

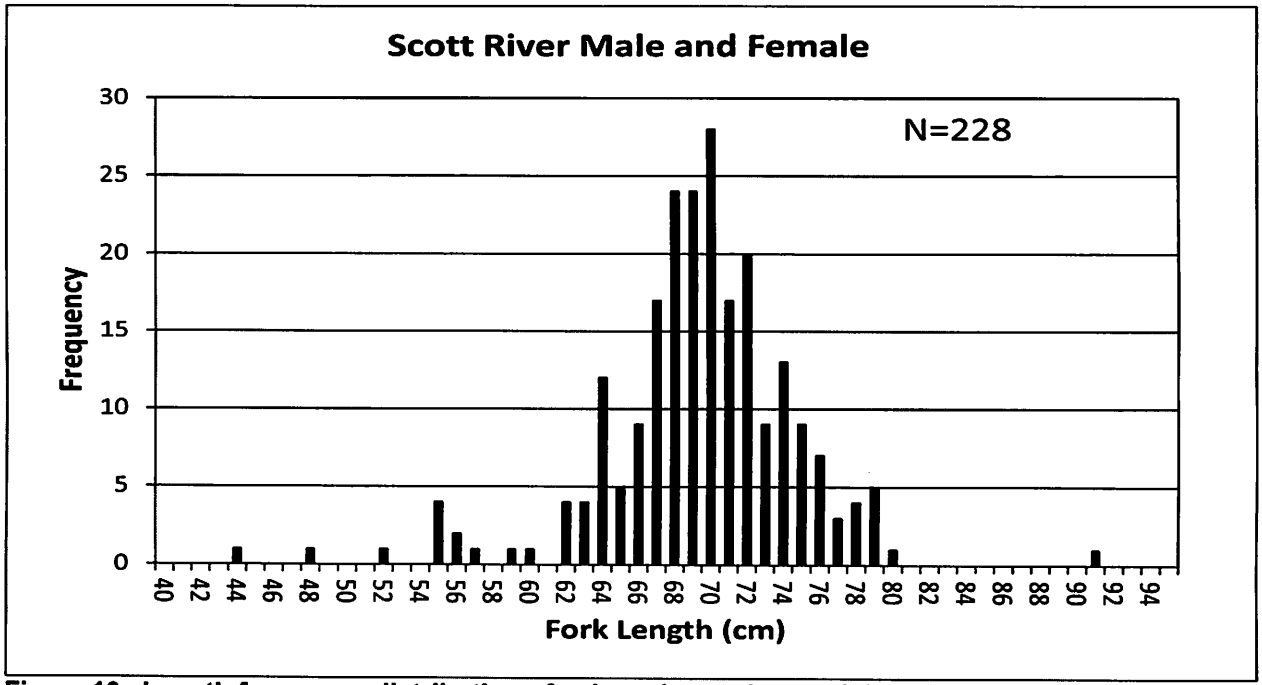

Figure 10. Length frequency distribution of coho salmon observed during cooperative spawning ground surveys (49), RCD spawning ground surveys (179), and as wash backs (9) on the SRFCF, during the 2013-2014 spawning season (N=228).

STEELHEAD

In 2013, a net total of 119 adult (>16") steelhead (Figure 11) and 2 sub-adult (<16") steelhead were estimated to have entered and remained in the Scott River during the video recording season from September 30, 2013 to February 8, 2014. The peak of migration for adult steelhead was observed on January 30, 2014 and January 31, 2014 in association with an increase in flow (Figure 11) when 33.6% (40 fish) of the season's steelhead were observed. Lines on the back of the video flume were set at 16 inches (40.64 cm) to delineate sub-adults versus adults. The 2013 season was the fourth year that lines delineating adult steelhead and sub-adult steelhead were used.

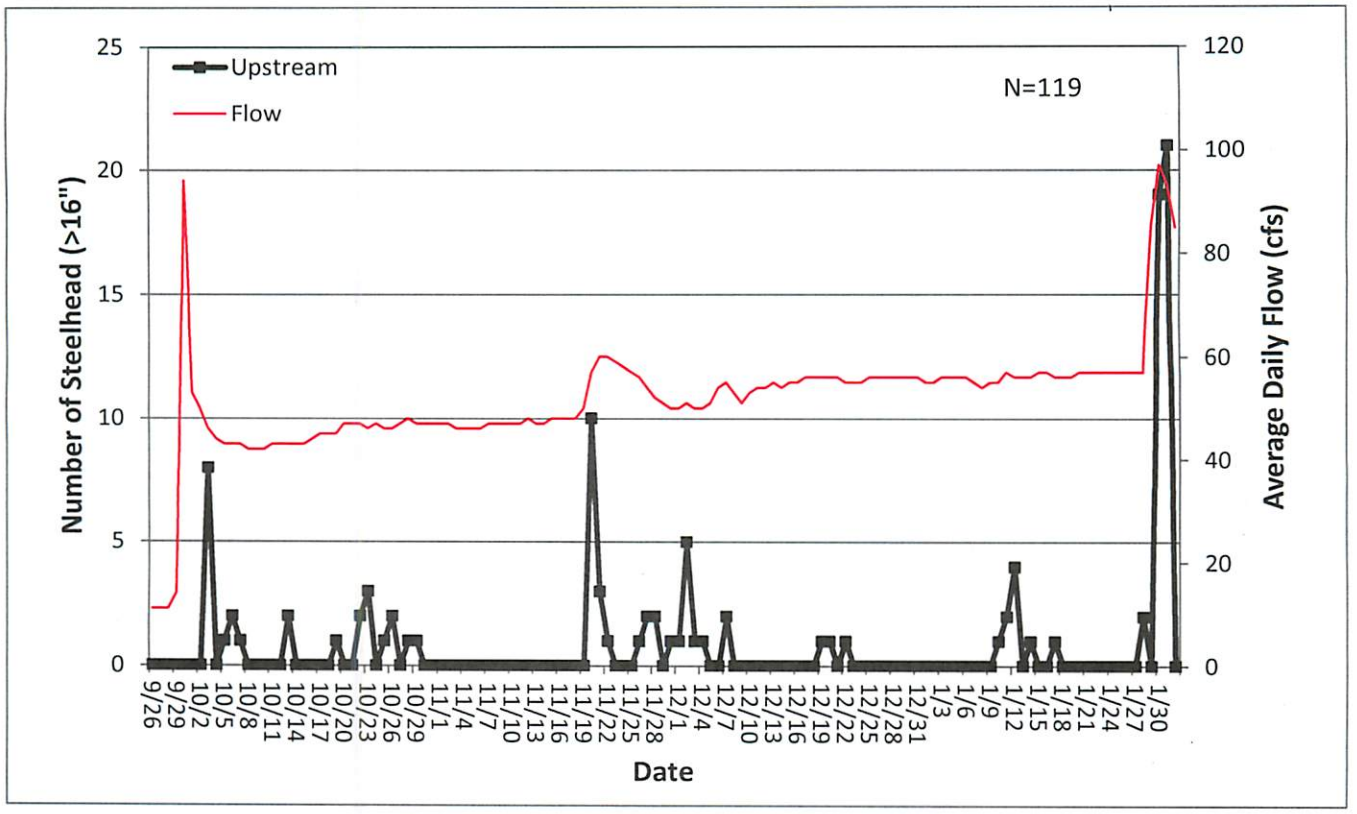

Figure 11. Run timing of steelhead trout (>16") observed passing through the SRFCF during the 2013 season (N=119), and flows observed at USGS Gauge No. 11519500.

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 5,308 fish (Figure 12). The 2013 Chinook salmon run in the Scott River ranks 18th (4,624 fish) out of 36 years of monitoring. The 2013 run was 12.5% lower than the 36-year average. A total of 3,372 Chinook salmon were estimated to have passed through the SRFCF during the 2013 season. A total of 1,252 +/-229 (90% CI) Chinook salmon carcasses were estimated in Reach 1 through Reach 6, yielding a total run size estimate of 4,624 Chinook salmon. During the 2013 season, the CJS mark-recapture estimator was utilized for areas downstream of the SRFCF, and as a result, only the total estimate and not sub area estimates are available upstream of the counting station. Table 3

presents the various sub basin proportions of the Chinook distribution for years 2008-2012 and identifies the importance of the entire watershed to Chinook salmon. From 2008 through 2012, an average of 44% of the Chinook run spawned upstream of Meamber Bridge (reaches 9 through 16). The addition of the fish counting facility has allowed for an accurate estimation of Chinook utilization of spawning habitat in the valley reaches without having to conduct spawning ground surveys in these reaches.

Table 3. Scott River Chinook salmon abundance estimates by area and percentages of the total above and below Reach 8 during the 2008-2012 seasons.

Year	Reaches 1-6	Above Weir	Reaches 7-8	Reaches 1-8	Above Reach 8	% below Reach 8	% above Reach 8	Total Basin Estimate
2008	1439	3234	2034	3473	1200	74%	26%	4673
2009	1014	1197	402	1416	795	64%	36%	2211
2010	280	2228	549	829	1679	33%	67%	2508
2011	983	4538	2255	3238	2283	59%	41%	5521
2012	1208	8144	3305	4513	4839	48%	52%	9352

The Scott River is an important component of the Klamath Basin Chinook runs. The Scott River has contributed an average of nine percent of the basin-wide (including Trinity River) natural spawning escapement to the Klamath River during the period from 1978 to 2013 (Table 4). The Scott River Chinook population tracks very similarly to the total Klamath Basin population ($r=0.751$ 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). The production of emigrating 0+ Chinook has been estimated in the Scott River since Brood Year 1999 (Daniels et al., 2012). The number of 0+ Chinook produced per adult has been calculated for Brood Years 1999 through 2012 and has ranged from a low of 14.4 to a high of 383.0 and averaged 108.9 (Figure 14). 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.

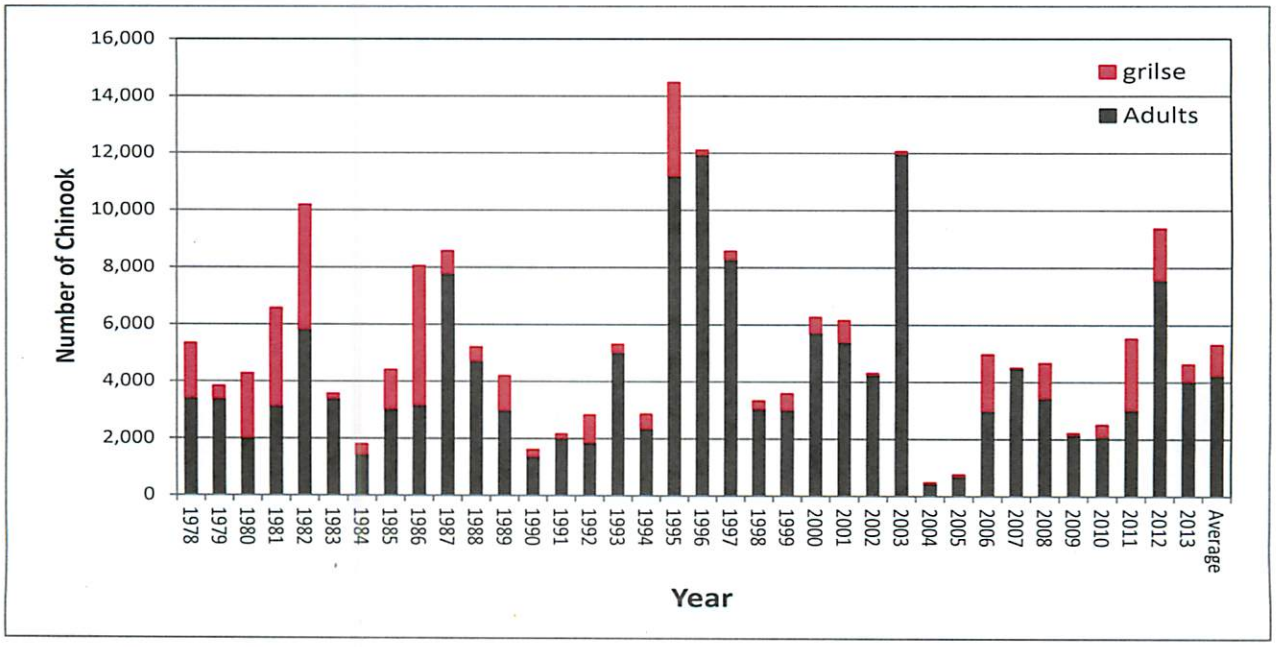

Figure 12. Estimated escapement of Chinook salmon returning to the Scott River from 1978 to 2013.

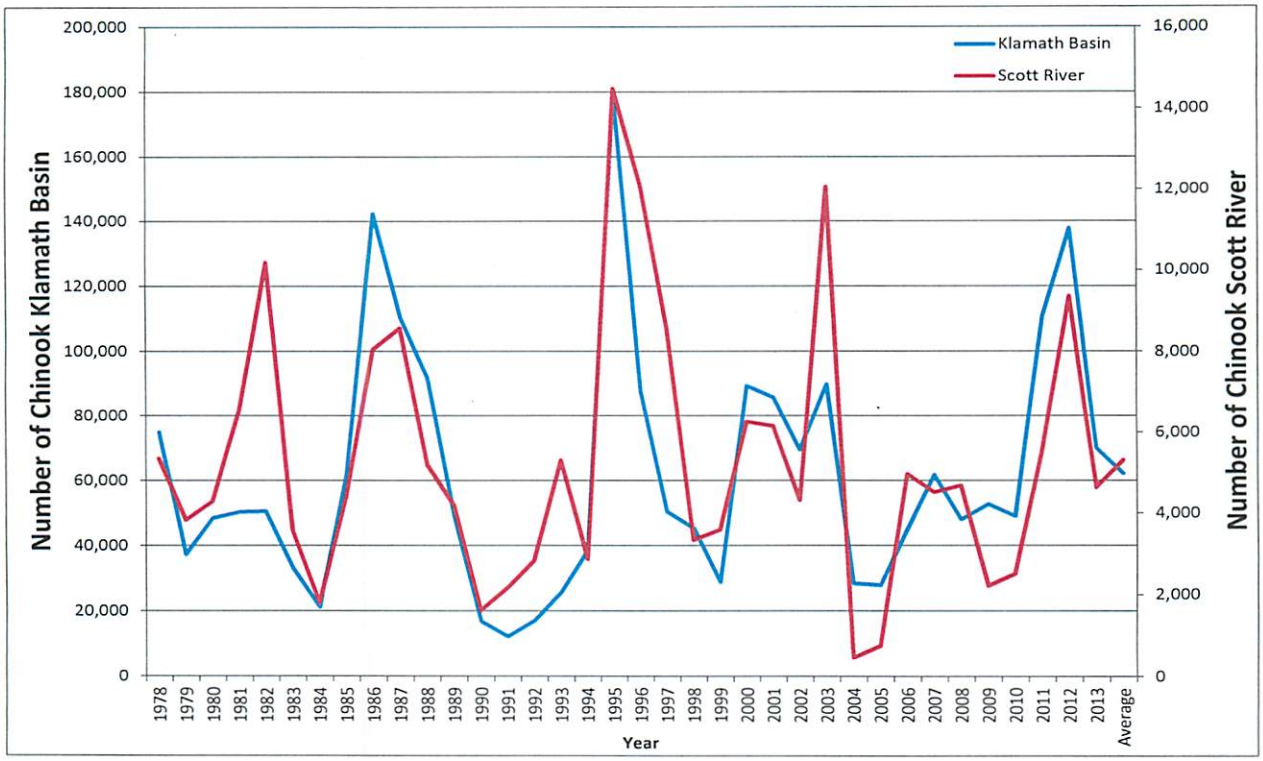

Figure 13. Chinook salmon Klamath Basin natural spawner escapement (primary y-axis) and the Scott River natural spawner escapement (secondary y-axis) from 1978 through 2013.

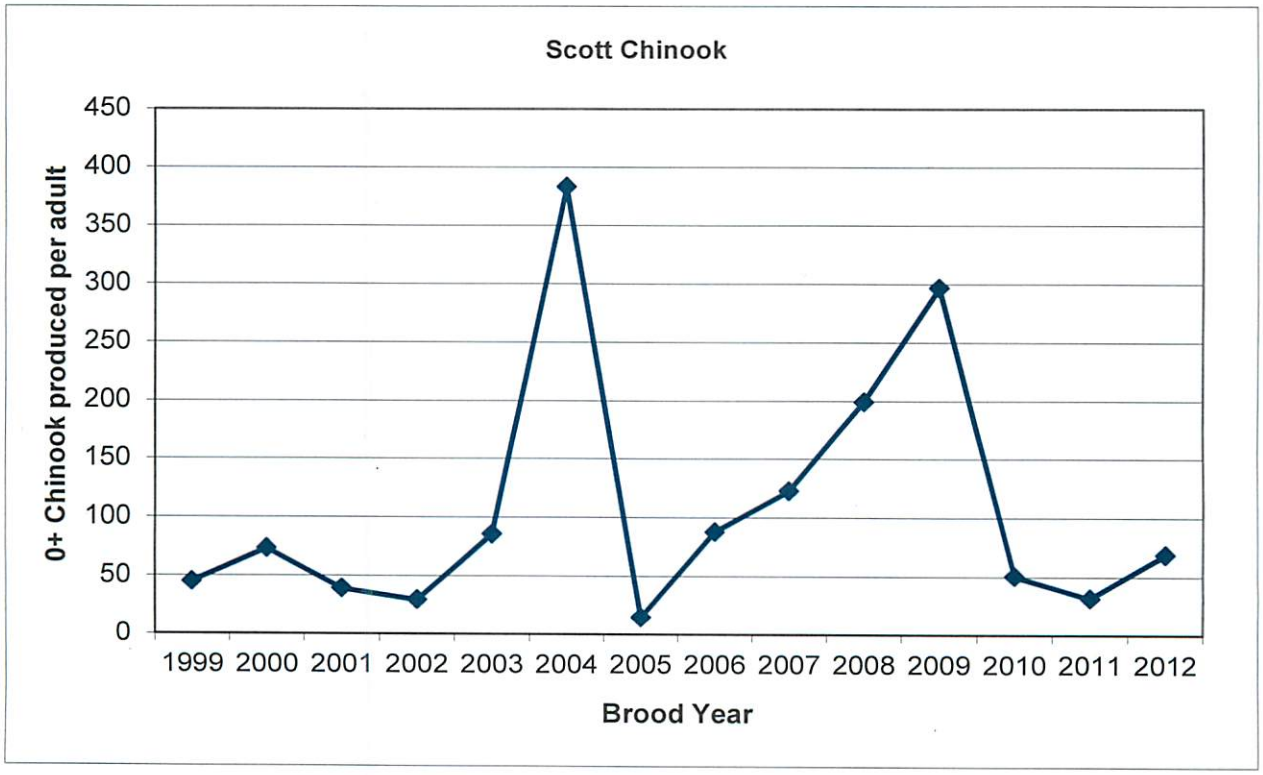

Figure 14. Number of 0+ Chinook produced per adult spawner in the Scott River by brood year, for Brood Years 1999-2012.

Table 4. Klamath Basin and Scott River Chinook natural spawner escapements (age 2-5), 1978-2013.

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%
Average	**62,203**	**5,308**	**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 857 (Figure 15). The adult run size of coho salmon prior to 2007 is unknown, and with the addition of the counting facility, the Department's 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 2013 indicates significant variation in brood year strength (Daniels et al., 2013). Results of the first seven years of adult monitoring at the SRFCF support this observation. The cohort that returned in 2013 is the strongest cohort in the Scott River. In one generation, the 2013 coho salmon

returns of 2,752 were 2.97 times greater than the 2010 returns of 927, an increase in brood year strength of 1,825 fish. It is very encouraging that over the past three seasons, a positive growth rate for Scott River coho salmon has been observed.

As a result of low flows during the adult coho salmon migration, the majority of documented spawning occurred in the main stem between reaches 8 and 15, with the heaviest concentrations in reaches 13 through 15 (Yokel 2014). Under normal flow conditions, coho salmon have access to multiple tributaries within the Scott River basin to spawn and rear within a diversity of habitats that were mostly inaccessible during the spawning season of 2013-2014. It is hoped that as juvenile coho emerge, they will have the ability to redistribute to rearing habitats within Scott River tributaries as it is likely that the habitats in which spawning took place will deteriorate throughout the rearing season if the drought persists.

During the first six seasons of monitoring coho at the SRFCF, movements through the station have been associated with increases in flow. During the 2013 season the largest pulse of migrating coho occurred in association with an increase in flow between November 20 and 21, 2013, when the flow (daily average cubic feet per second [cfs]) recorded at the USGS gauge increased from 47 cfs to 60 cfs. The remaining three smaller pulses of migration were not associated with increases in flow as observed in the past. It is unclear why this occurred, but possible explanations could be linked to migration shifts associated with the formation of the sand bar at the mouth of the Klamath River or the Scott River freezing over in multiple locations in the canyon reaches throughout December. Another possible explanation of coho being observed later in the season than in previous seasons is the effect of extreme low flows of mid Klamath tributaries during the coho migration. Some of the mid Klamath tributaries that under normal flow conditions receive coho in January and early February were at critically low flow levels with creek mouths inaccessible to adult coho. It is possible that some or most of the coho observed at the counting station late in the season were fish that strayed into the Scott River as a result of the drought looking for a suitable place to spawn.

The estimated proportion of hatchery origin coho in the Scott River during 2012 has been estimated two independent ways: first, through the recovery of carcasses during spawning ground survey efforts, and second, through clip identification of images collected at the video weir. Both the spawning ground survey data and video data produced hatchery proportions of zero. The sample sizes that the spawning ground survey and video data relied on were 237 and 2,731, respectively. Due to the significantly larger sample size available from video data, the estimated proportion of hatchery origin coho in the Scott River during the 2013 season has been estimated using the video data and is estimated to be 0.0%.

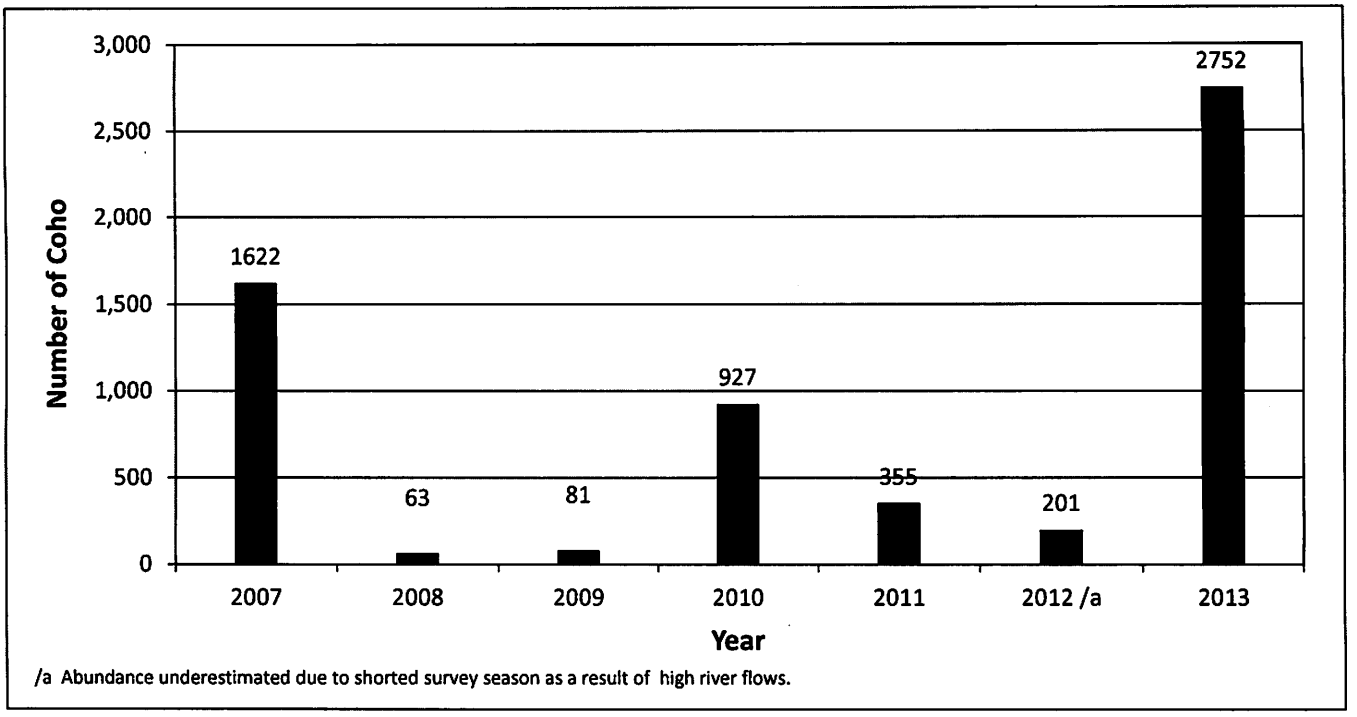

Figure 15. Estimated escapement of adult coho salmon (age 2 and age 3) returning to the Scott River from 2007 to 2013.

Utilizing the number of coho smolts produced in the Scott River (Daniels et al., 2013) 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, the number of coho smolts that were required to produce a single adult coho averaged 35.5 and ranged from a low of 6.12 to a high of 67.11. The corresponding out-of-basin survival has averaged 5.94 percent and ranged from a low of 1.49 percent to a high of 16.33 percent (Table 5). Due to the extremely high observed percent smolt survival of 73.09 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. 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 5. Coho smolt outmigrant abundance point estimates, adult coho abundance estimates, ratio of outmigrant smolts to adult returns, and proportion of outmigrant smolts that returned as adults by brood year for the Scott River, Brood Years 2004-2010.

Brood Year	Smolt Year	Smolt point Estimate	Adult Year	Adult Estimate	Smolts to adult	Percent smolt survival
2004	2006	75097	2007	1622	46.30	2.16
2005	2007	3931	2008	62	63.40	1.58
2006	2008	941	2009	81	11.62	8.61
2007	2009	62207	2010	927	67.11	1.49
2008	2010	2174	2011	355	6.12	16.33
2009	2011	275	2012	201	1.37	73.09
2010	2012	50315	2013	2752	18.28	5.47

Analyzing the comparisons of coho smolt production estimates to estimated adult coho returns produces freshwater survival estimates in the form of coho smolts produced per adult return. For Brood Years 2007 through 2011, the number of coho smolts produced per returning adult has ranged from a low of 3.40 to a high of 54.28 and has averaged 30.57 (Table 6). Due to the difficulty in estimating abundance of outmigrants at low abundance levels, it is unclear if the smolts produced per adult 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. To give some context to the smolts produced per adult in the Scott River, this value in the Shasta River has averaged 19.6 and ranged from a low of 2.1 to a high of 46.6 for Brood Years 2001-2010 (Chesney, D. 2013). The number of smolts produced per returning adult 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 increases it can be inferred that in-river conditions for coho salmon are improving. Conversely, as the number of smolts produced per returning adult decreases, it can be inferred that in-river conditions for coho salmon are getting worse. The number of smolts produced per returning adult can be influenced by inter-annual variation in sex ratios, and in future years, attempts will be made to further refine this analysis.

Table 6. Adult coho estimate, coho smolt production point estimate, and ratio of coho smolts produced per adult return for the Scott River, Brood Years 2007 through 2011.

Adult Year Brood Year	Adult Estimate	Smolt Year	Smolt point Estimate	Smolts produced per adult
2007	1622	2009	62207	38.35
2008	63	2010	2174	34.51
2009	81	2011	275	3.40
2010	927	2012	50315	54.28
2011	355	2013	7927	22.33

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 at 16 inches (40.64 cm) to delineate sub-adults versus adults. Since this time, the number of steelhead >16" observed in the Scott River has been 419, 251, 16, and 119 for 2010, 2011, 2012, and 2013, respectively (Figure 16). From 2007 to present, the number of observed adult steelhead has ranged from a high of 419 to a low of 119 with an average of 215. The run-size of adult steelhead prior to 2007 is unknown, and with the addition of the counting facility, the Department's 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 DIDSON camera in the Scott River after the end of the coho migration may add in the Department's ability to monitor the steelhead migration.

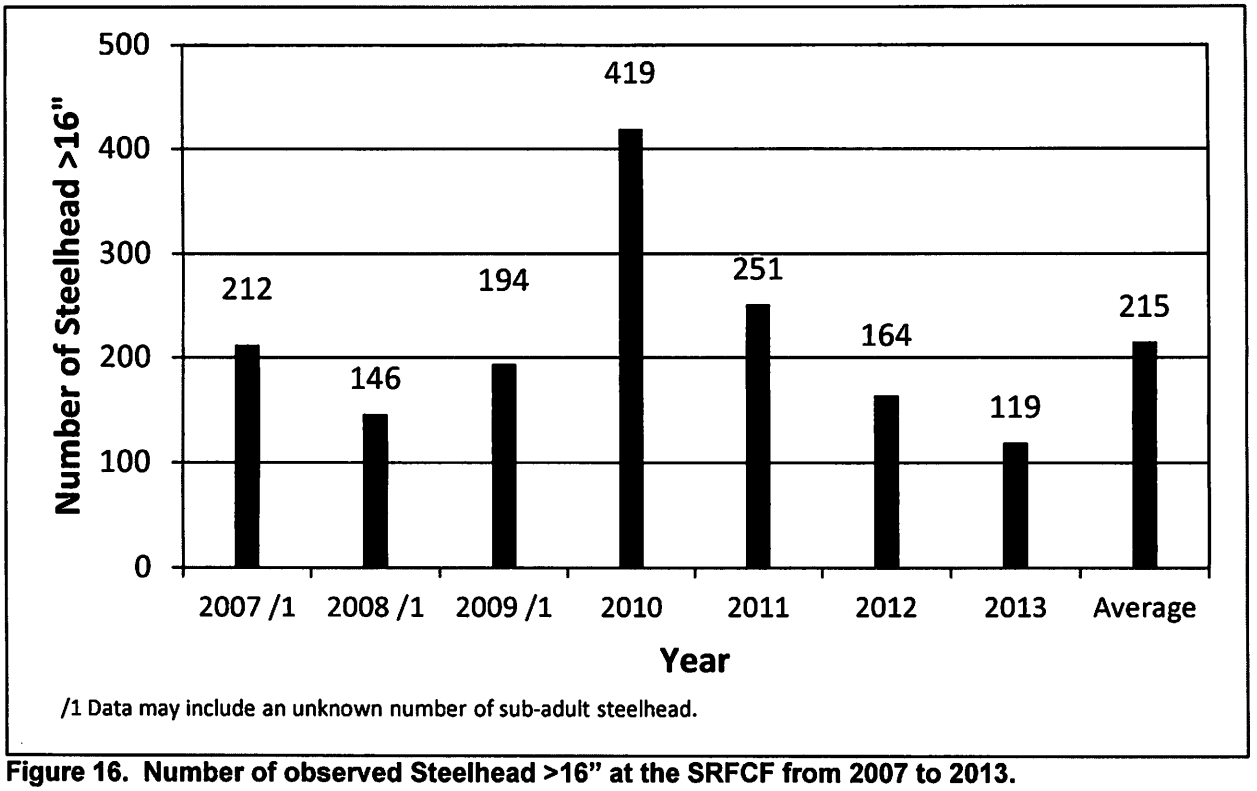

Figure 16. Number of observed Steelhead >16" at the SRFCF from 2007 to 2013.

ACKNOWLEDGEMENTS

The California Department of Fish and Wildlife would like to thank Sport Fish Restoration Fund for their financial assistance in the operation of the SRFCF during 2014. 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, USFS, 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 on their lands. Additionally, we thank NOAA for providing funding to the Siskiyou Resource Conservation District to conduct coho surveys on Scott River tributaries and send thanks to the RCD 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 2013-2014 spawning season by date and by reach.

	Reach																			
Survey lead	CDFW	CDFW	CDFW	CDFW	CDFW	CDFW	CDFW	CDFW	SRCD	SRCD	SRCD	SRCD	SRCD	CDFW	CDFW	CDFW	SRCD	SRCD	SRCD	SRCD
Survey Date	1	2	3	4	5	6	7	8	12	13	14	15	16 (lower)	Canyon Creek	Kelsey Creek	Tompkins Creek	French (upper)	French (lower)	Shackelford (lower)	Mill
10/17/2013	1	1	1	1	1	1			1	1	1	1								
10/21/2013	1	1	1	1	1	1		1	1	1	1	1								
10/24/2013	1	1	1	1	1	1	1	1	1	1	1	1								
10/28/2013	1	1	1	1	1	1		1	1	1	1	1								
10/31/2013	1	1	1	1	1	1	1	1	1	1	1	1								
11/4/2013	1	1	1	1	1	1		1			1	1								
11/7/2013	1	1	1	1	1	1		1	1	1	1	1								
11/11/2013	1	1																		
11/14/2013	1	1	1	1	1	1		1	1	1	1	1		1	1					
11/18/2013	1	1	1	1	1	1		1	1	1	1	1								
11/20/2013																		1		
11/21/2013	1	1	1	1	1	1		1	1		1	1		1	1					
11/25/2013	1	1	1	1	1	1		1	1	1	1	1								
11/26/2013																			1	1
11/27/2013						1								1	1			1		
12/2/2013	1		1	1		1	1	1	1	1				1	1					
12/3/2013																1				
12/4/2013																		1		
12/5/2013	1	1	1	1	1			1	1	1										
12/6/2013																		1		
12/9/2013											1	1								
12/12/2013									1	1										
12/16/2013			1	1	1	1		1			1	1	1							
12/17/2013																		1		
12/19/2013						1			1					1	1					
12/20/2013																	1			
12/23/2013								1			1	1	1							
12/26/2013									1									1		
12/30/2013						1						1		1	1					
12/31/2013											1									
1/2/2014									1	1								1		
1/6/2014												1								
1/7/2014											1									
1/8/2014																		1		
1/9/2014							1	1	1	1										
1/15/2014																		1		
1/16/2014								1												
1/24/2014								1												
2/3/2014								1												
Totals	14	13	14	14	13	16	4	18	17	14	16	16	2	6	6	1	1	9	1	1