2012 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 2012 fall-run Chinook salmon (Chinook, *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 26, 2012 and ended on November 29, 2012 due to high river flows. The total number of Chinook salmon that entered the Scott River during the 2012 season is estimated to be **9,352** 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 5,443 (58.2%) males and 3,909 (41.8%) females. Based on scale age analysis, adults comprised approximately 80.9% (7,566 fish) and grilse comprised 19.1% (1,786 fish) of the run. Males ranged in fork length (FL) from 33cm to 101cm and averaged 66.6cm. Females ranged in FL from 42cm to 98cm and averaged 70.7cm. 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 on October 27, 2012 and the last coho salmon was observed on November 29, 2012. A total of 201 coho salmon were observed moving upstream through the Scott River Fish Counting Facility (SRFCF) during the season. Zero coho were estimated in the main stem or tributaries downstream of the SRFCF. Due to high flows the SRFCF was removed prior to the historical end of adult coho migration, therefore the 2012 estimate of 201 should be considered a minimum number. Based on the proportion of male and female coho salmon that were sampled during the season the run was comprised of approximately 115 (57.1%) males and 86 (42.9%) females. Based on video data, adults comprised approximately 93.7% (188 fish) and grilse comprised 6.3% (13 fish) of the run. Males ranged in fork length (FL) from 37cm to 65cm and averaged 48.0cm. Females ranged in FL from 64cm to 70cm and averaged 67.3cm. Based on observed video data 0.81% of the coho salmon (2) were estimated to be of hatchery origin.

INTRODUCTION

STUDY LOCATION AND RUN TIMING

The Scott River is a major tributary of the Klamath River located in Siskiyou County, and enters the Klamath River at river mile 143 (Figure 1). The Scott River fish counting facility is located at river mile 18.2 near the downstream edge of Scott Valley between the Indian Scotty Campground and Jones Beach picnic area (041º 38' 10.93" N; 123º 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 occurs from mid October to early January and steelhead run from November to April.

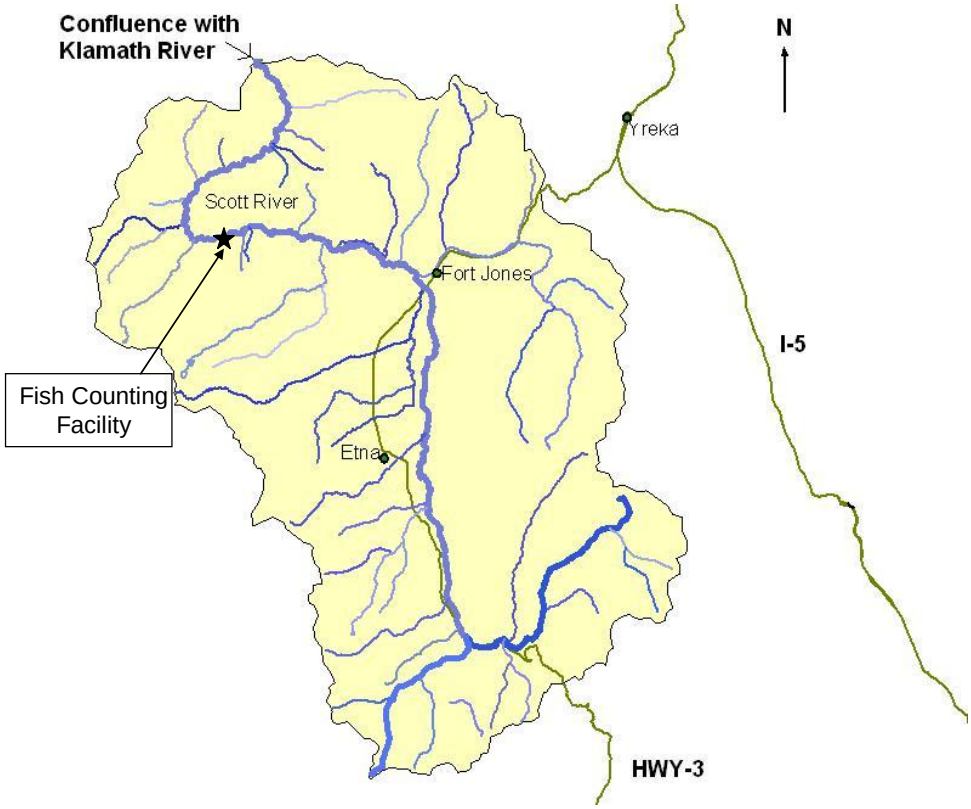

Figure 1. Location of the Scott River, tributary to the Klamath River, Siskiyou County, California.

KLAMATH RIVER PROJECT AND THE SCOTT RIVER STUDY

The Scott River study is one component of the KRP (initiated in 1978). The goals of the KRP include obtaining information on species composition, spawning distribution, 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 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 river which included about 5.5 miles of the Scott River near Etna and 4.75 miles of river downstream of the State Highway 3 Bridge crossing near Fort Jones. From 1989 through 1991 spawning ground surveys were limited to the lower river. In 1985 a temporary fish marking weir was installed on the lower river at river mile 1.6 and was operated during each spawning season until 1991. Operation of the weir was often hampered by high flows, and beginning in 1992 operation of the weir was dropped in

favor of conducting more intensive mark recapture spawning ground surveys in cooperation with USDA Forest Service (USFS) fisheries staff.

In 1994 the California State Legislature passed the Leslie Amendment (SB 779). The passage of SB 779 required Departmental staff to obtain landowner permission prior to accessing private lands to conduct biological investigations. 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 each year. 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 dramatically. 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 Chinook 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. 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, length frequency (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 Scott River Fish Counting Facility on September 26, 2012 at 1200 hours Pacific Standard Time (PST). A temporary weir (Alaskan/resistance board 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 EDSR100) 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 2012.

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 that were visible on the image. All data was then entered into computer files and each data file was subjected to one independent edit 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 Chinook salmon spawning season starting October 15, 2012 and ending December 13, 2012. A total of fifteen surveys were performed during the spawning season. On the morning of each survey, crews of at least two people 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 on private lands was limited to those areas where permission has been granted by private 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 34.6) 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. DNA samples were collected from 121 Chinook salmon and 2 coho salmon (Tissue collected from the first Chinook from each reach and each survey date and all coho salmon). 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 108 Chinook salmon and 2 coho salmon (Otoliths collected from the first Chinook from each reach and each survey date and all coho salmon). 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 2012 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 Cormack-Jolly-Seber 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. All carcass and redd data collected downstream of the counting facility (both in the mainstem and tributaries) is added to the counting facility data to generate a total estimate.

To estimate total escapement in the Scott River, the number of coho salmon redds multiplied by 2 (utilizing data from tributary reaches and mainstem reaches below the weir only) for adults were added to the count of all coho salmon observed passing through the video counting facility. The grilse component from below the counting facility was then added back into the total (total run= adults/(1-%jacks estimated).

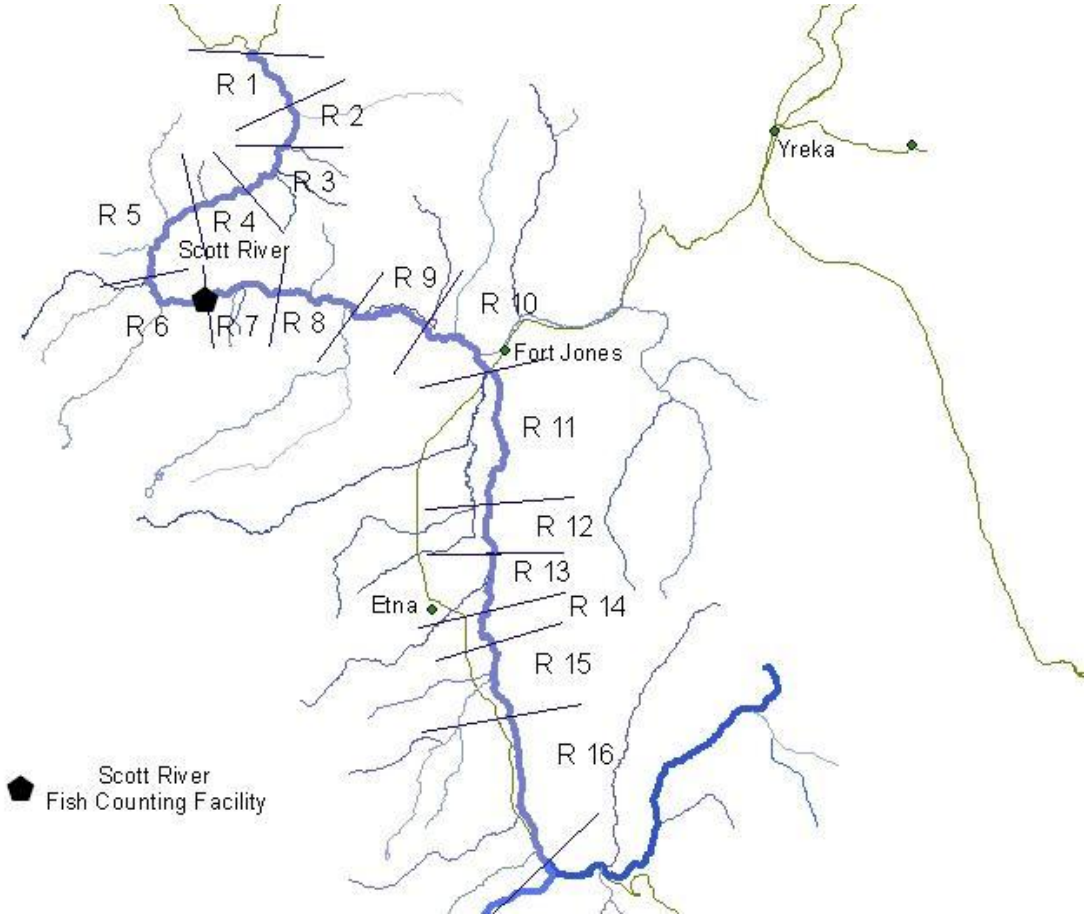

Figure 3. Location of the fish counting facility and spawning ground survey reaches on the Scott River used during the 2012 field season.

HATCHERY CONTRIBUTION RATES

The hatchery contribution rates for Chinook and coho have been estimated both through the recovery of carcasses and through reviewing fish images observed at the fish counting facility. Annually decisions are made on which method produces the most accurate estimate based on sample sizes generated from each method. During the 2012 season hatchery contribution rates have been based on collection of observed carcasses for Chinook and fish images observed at the fish counting facility for coho. The observed hatchery contribution rates are 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 26, 2012. The first Chinook salmon was observed at the SRFCF on October 5, 2012 and the last Chinook salmon was observed on November 26, 2012. The run peaked between October 12, 2012 and November 6, 2012 when 96.7% 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 1700 hours (Figure 5).

A total of 8,144 Chinook salmon were estimated to have passed through the Scott River Fish Counting Facility during the 2012 season. Seven Chinook were included in the total as an expansion for periods of time when the camera was not functioning. During the Chinook period the camera was not functioning on two separate occasions for a total of 31 hours (Table 2).

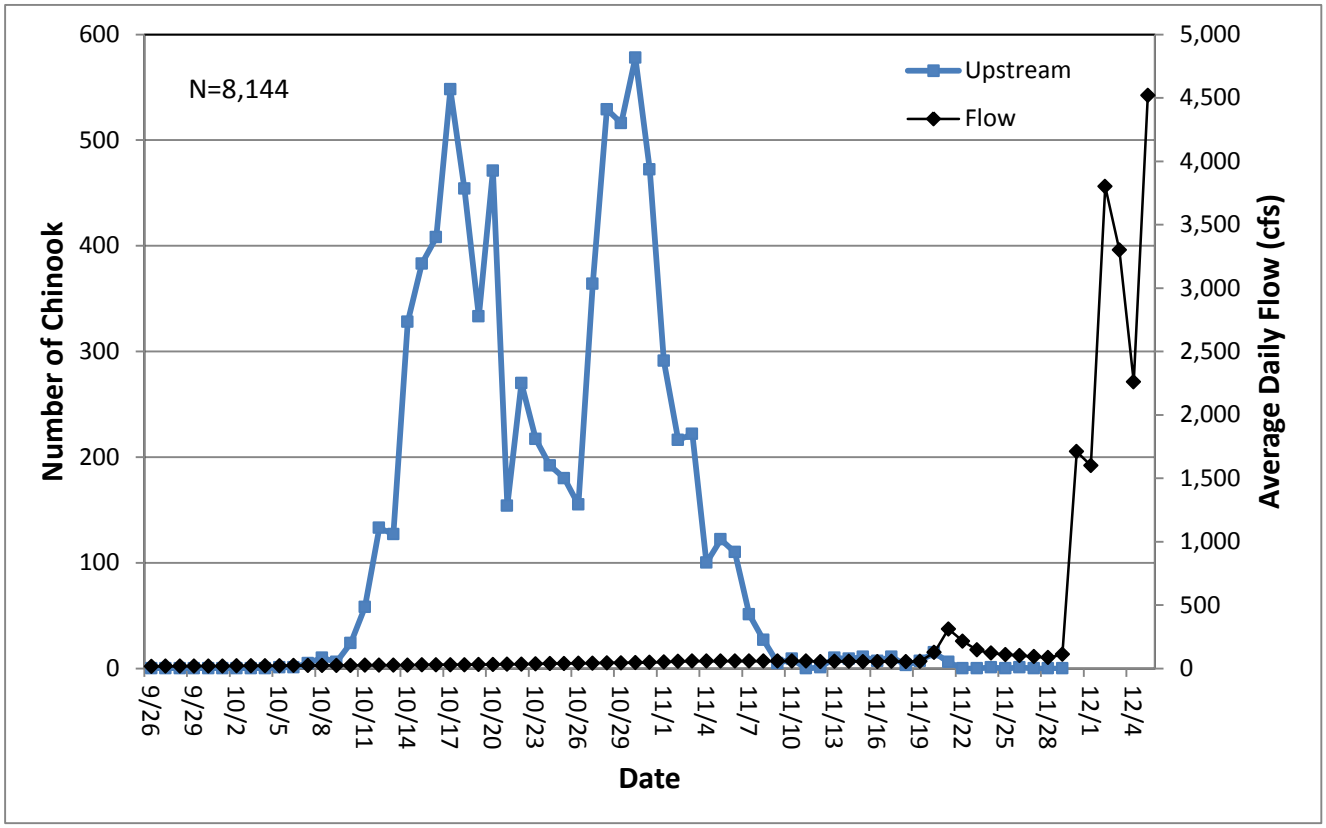

Figure 4. Run timing of Chinook salmon through the Scott River Fish Counting Facility during the 2012 season (N=8,144), and flows observed at USGS Gauge No. 11519500.

SPAWNING GROUND SURVEYS

A total of 3,838 Chinook carcasses were sampled during the spawning ground survey as Path 1 or Path 2 carcasses. Of these 2,225 (58.2%) were male and 1,595 (41.8%) were female (eighteen unknown sex). Males ranged in FL from 33cm to 101cm and averaged 66.6cm (Figure 6). Females ranged in FL from 42cm to 98cm and averaged 70.7cm (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 Scott River.

A total of 1,031 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 1,031 female Chinook salmon carcasses examined, 1,006 females (97.6%) were found to have spawned, and 25 females (2.4%) were identified as unspawned.

In 2012 the CJS mark recapture data generated from the spawning ground survey was segregated by reaches and analyzed independently for four areas: 1) reaches 1-6, 2) all reaches, 3) reaches 7-8 and 4) reach 8 alone. The basin estimate was derived by adding the CJS estimate generated from reaches 1-6 to

Table 2. Specific dates and times during the 2012 season when filming stopped and restarted, the number of hours without data and the number of Chinook, coho and steelhead estimated during that time.

	Date	Time	Number of hours without data	Number of Chinook estimated	Number of Coho estimated	Number of Steelhead estimated
Filming Stopped	11/21/2012	0000	24	6	18	13
Filming Started	11/22/2012	0700	7	1	4	1
Totals			31	7	22	14

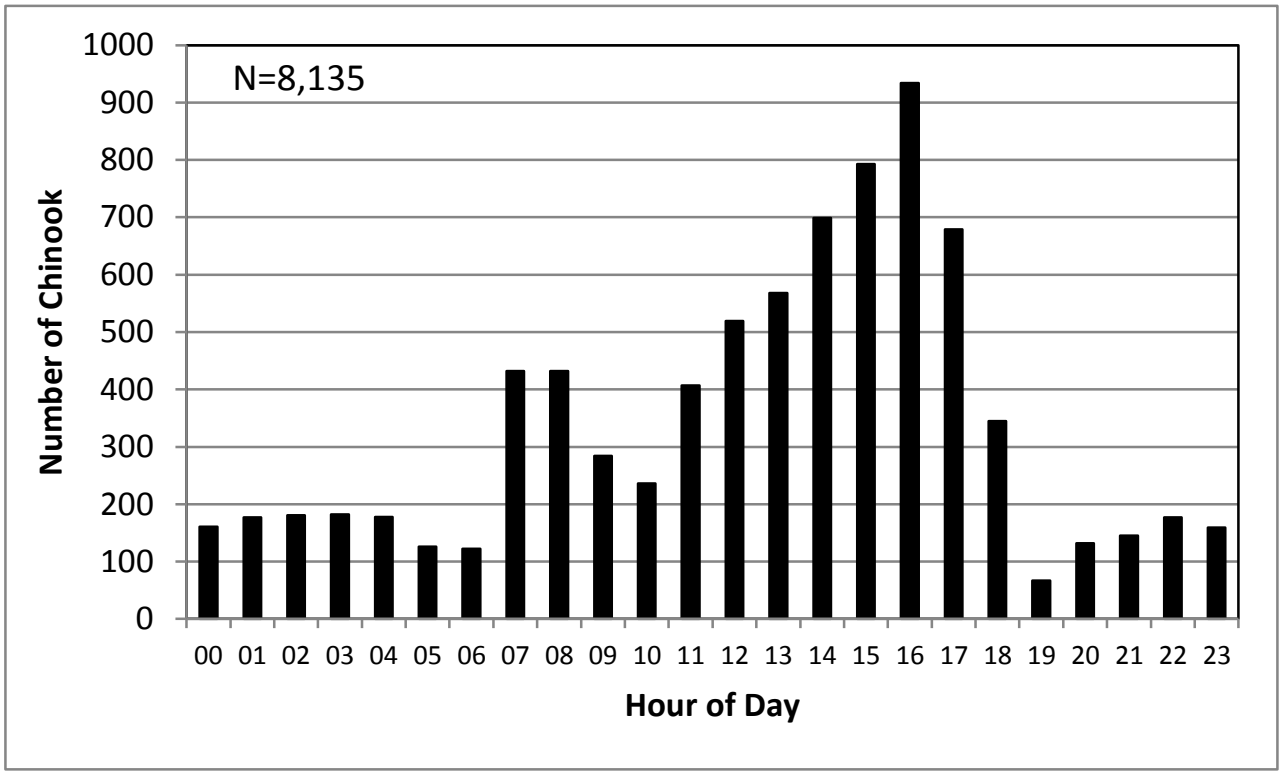

Figure 5. Summary of daily run timing of Chinook salmon observed at the Scott River Fish Counting Facility during 2012 (N=8,135).

the total number of Chinook observed passing through the counting facility. The CJS point estimates and 90% CI estimate for reaches 1-6, all reaches, reaches 7-8, and reach 8 were 1,208 +/- 139, 5,965 +/- 137, 3,305 +/- 76 and 2,941 +/- 73 respectively. The total Chinook salmon run size estimate (based on summing the video estimate and the CJS estimate from reaches 1-6 below the weir) was estimated to be 9,352 fish. Based on scale age analysis, adults comprised approximately 80.9% (7,569 fish) and grilse comprised 19.1% (1,783 fish) of the run (KRTAT 2013).

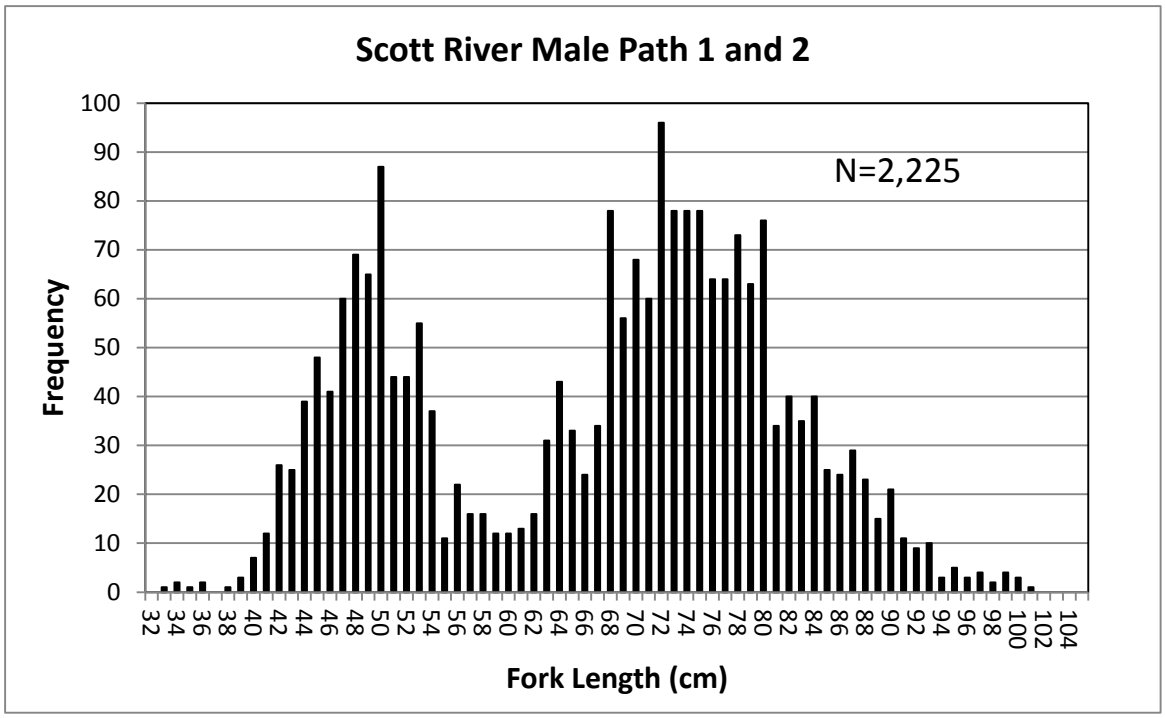

Figure 6. Length Frequency distribution of Path 1 and Path 2 male Chinook salmon observed during spawning ground surveys in the Scott River, 2012 (n = 2,225).

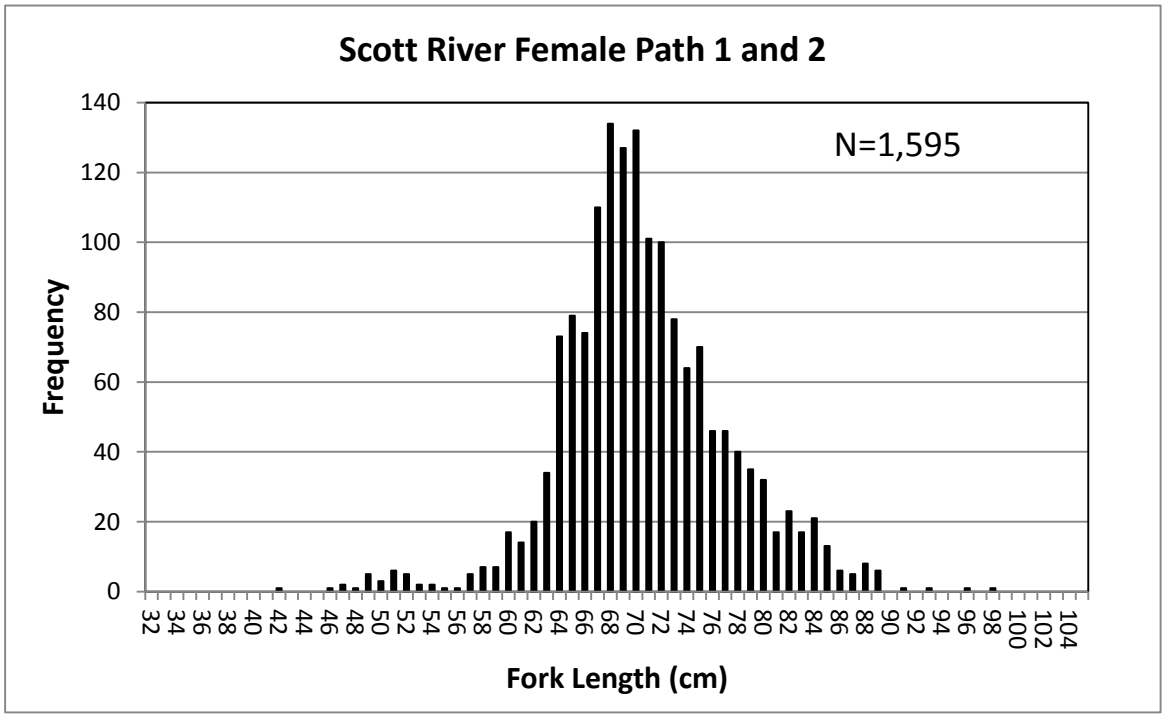

Figure 7. Length frequency distribution of Path 1 and Path 2 female Chinook salmon observed during spawning ground surveys in the Scott River, 2012 (n = 1,595).

COHO SALMON

The first adult coho salmon was observed at the counting facility on October 27, 2012 and the last coho salmon was observed on November 29, 2012. A total of 179 coho salmon were observed moving upstream through the SRFCF during the season (Figure 8). Coho salmon migration peaked during the 6 day period from November 18, 2012 through November 23, 2012 when 120 or 59.7% of the coho were observed. Three coho salmon were observed swimming downstream during the season. During the coho migration the weir was inoperable on one occasion for a total of 31 hours. Specific periods in which the counting facility was inoperable and the number of coho added are listed in Table 2. A total of 22 coho were added to the estimate during periods when the counting facility was not operational for a total of 201. Of the 179 observed coho, left maxillary clip identification was possible for 123 fish and not possible for 56 fish. One (0.81%) of the 123 coho was identified as having a left maxillary clip indicating Iron Gate Hatchery origin. During 2012 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 93.7% adults and 6.3% grilse.

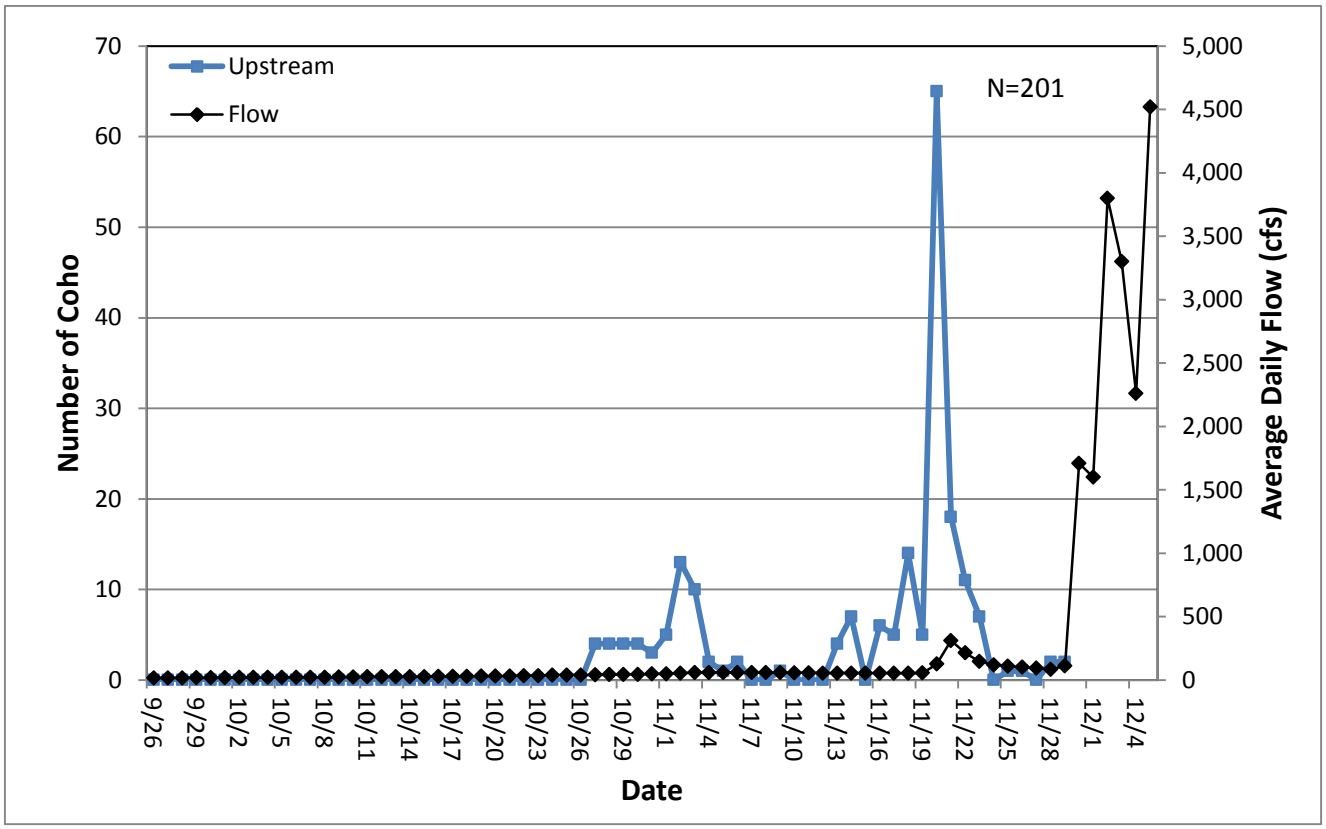

Figure 8. Run timing of coho salmon observed passing through the Scott River Fish Counting Facility during the 2012 season (N=201), and flows observed at USGS Gauge No. 11519500.

Diel movements of coho salmon through the SRFCF were higher in the evening hours and peaked between 1800 hours and 1900 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 was generally the time during the day when the crew was at the weir conducting daily maintenance.

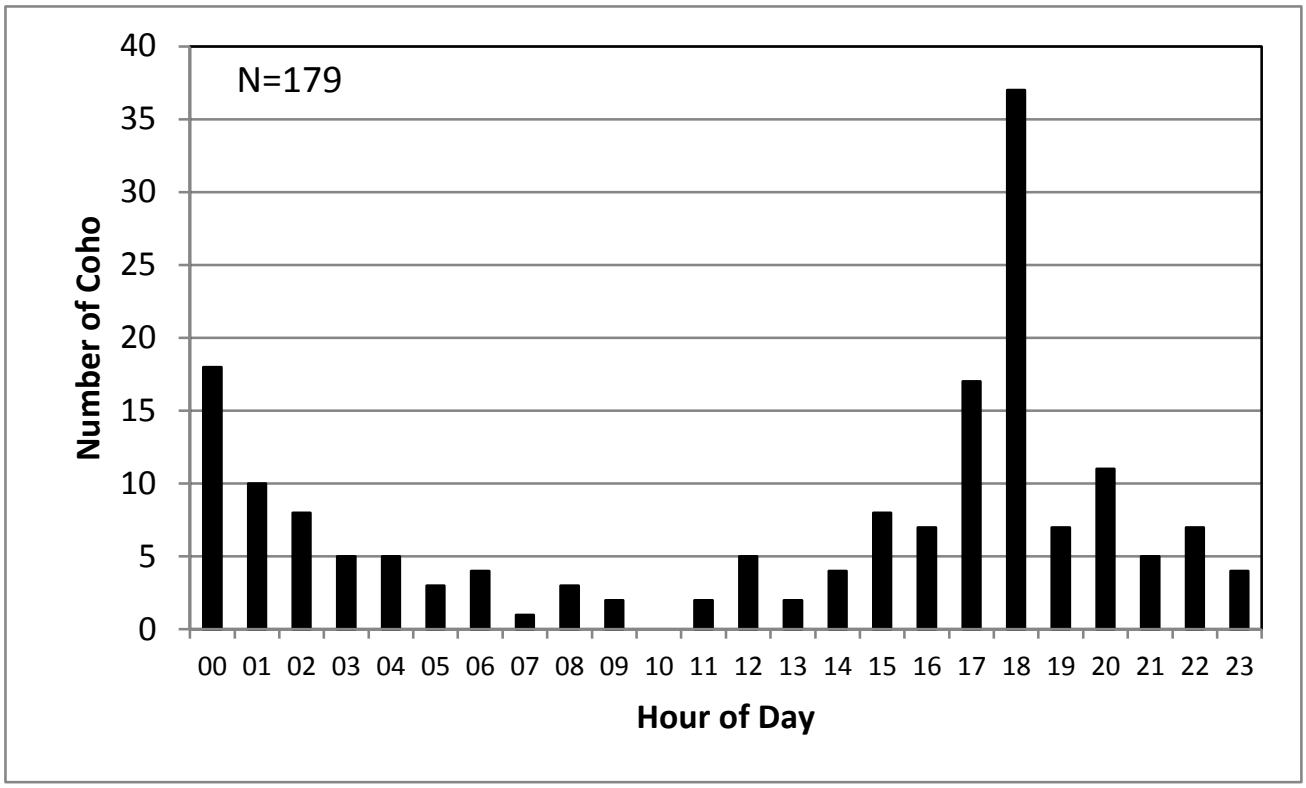

Figure 9. Diel migration patterns of coho salmon observed moving through the Scott River Fish Counting Facility in 2012 (N=179).

SPAWNING GROUND SURVEYS

One coho carcass was observed during the cooperative spawning ground survey on the mainstem Scott River (above the weir). Five coho carcasses were observed in Scott River tributaries during surveys coordinated by the Siskiyou Resource Conservation District (SRCD) above the counting facility (Yokel, 2013). One additional coho carcass was collected as a washback 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 2012 was 42.9% (3) female and 57.1% (4) male. One of the 7 carcasses examined had a maxillary clip resulting in an estimated hatchery composition from recovered carcasses of 14.3% (see discussion for final estimated hatchery proportion). Based on the fork length frequency distribution of the limited number of carcasses collected during the season, 4 of the 6 (one carcass not measured) fish would have been estimated to be age three. Due to the low number of recovered carcasses age structure has been estimated through data generated at the counting station. 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 201 coho salmon were estimated moving upstream through the SRFCF during the season. Additionally, no coho redds were estimated in areas below the counting facility. The total number of estimated coho salmon that entered the Scott River during the 2012 season is **201**. Utilizing the observed age proportions, derived from video data, the resulting number of age two and three fish are 13 (6.3%) and 188 (93.7%) respectively.

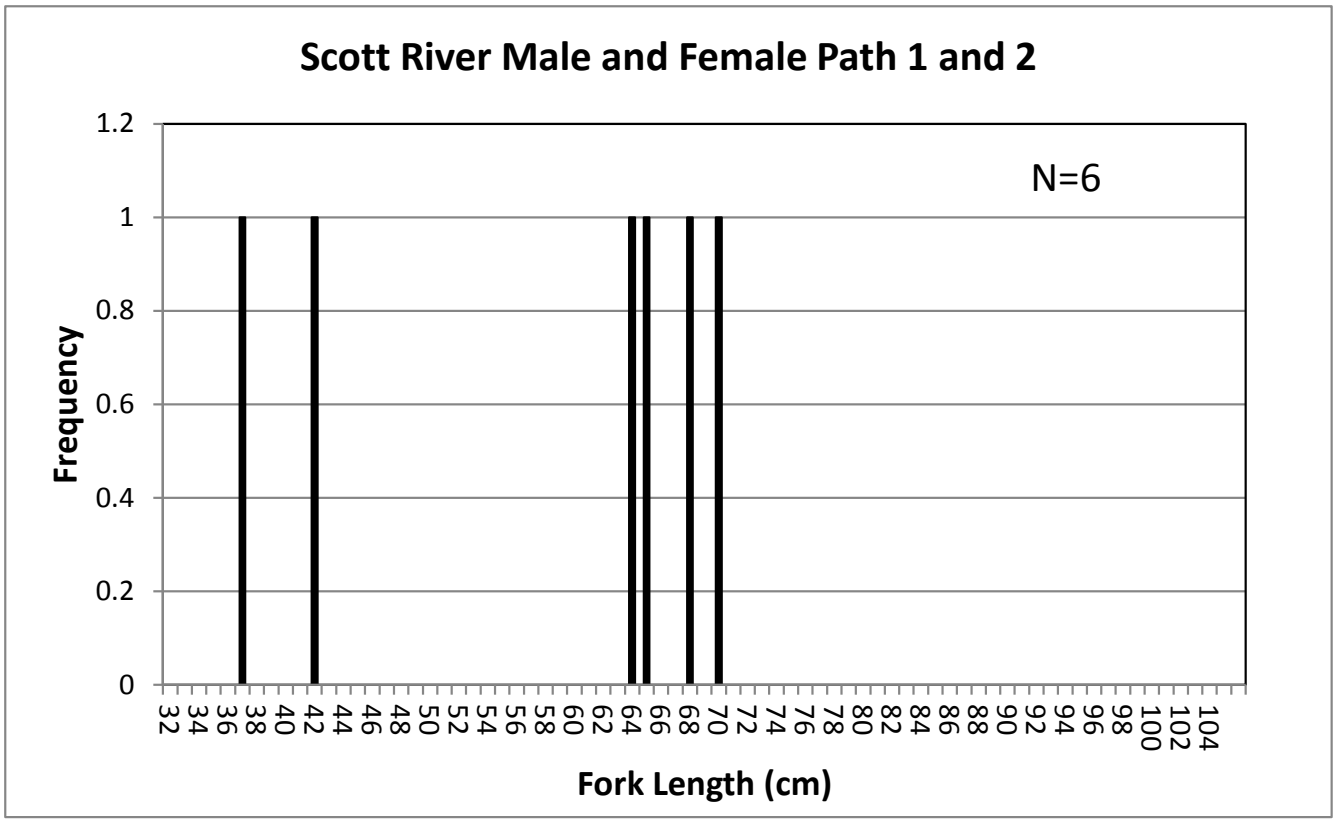

Figure 10. Length frequency distribution of male and female coho salmon observed during, cooperative spawning ground surveys (1), RCD spawning ground surveys (4) and as washbacks (1) on the Scott River Fish Counting Facility, during the 2012 spawning season (n = 6).

STEELHEAD

In 2012, a net total of 164 adult (>16") steelhead (Figure 11) and 47 sub-adult (<16") steelhead (Figure 12) were estimated to have entered and remained in the Scott River during the video recording season from September 26, 2012 to November 29, 2012. The peak of migration for adult steelhead was observed on November 20, 2012 in association with an increase in flow (Figure 11). Lines on the back of the video flume were set at 16 inches (40.64 cm) to delineate sub-adults versus adults. The 2012 season was the third year that lines delineating adult steelhead and sub-adult steelhead were used.

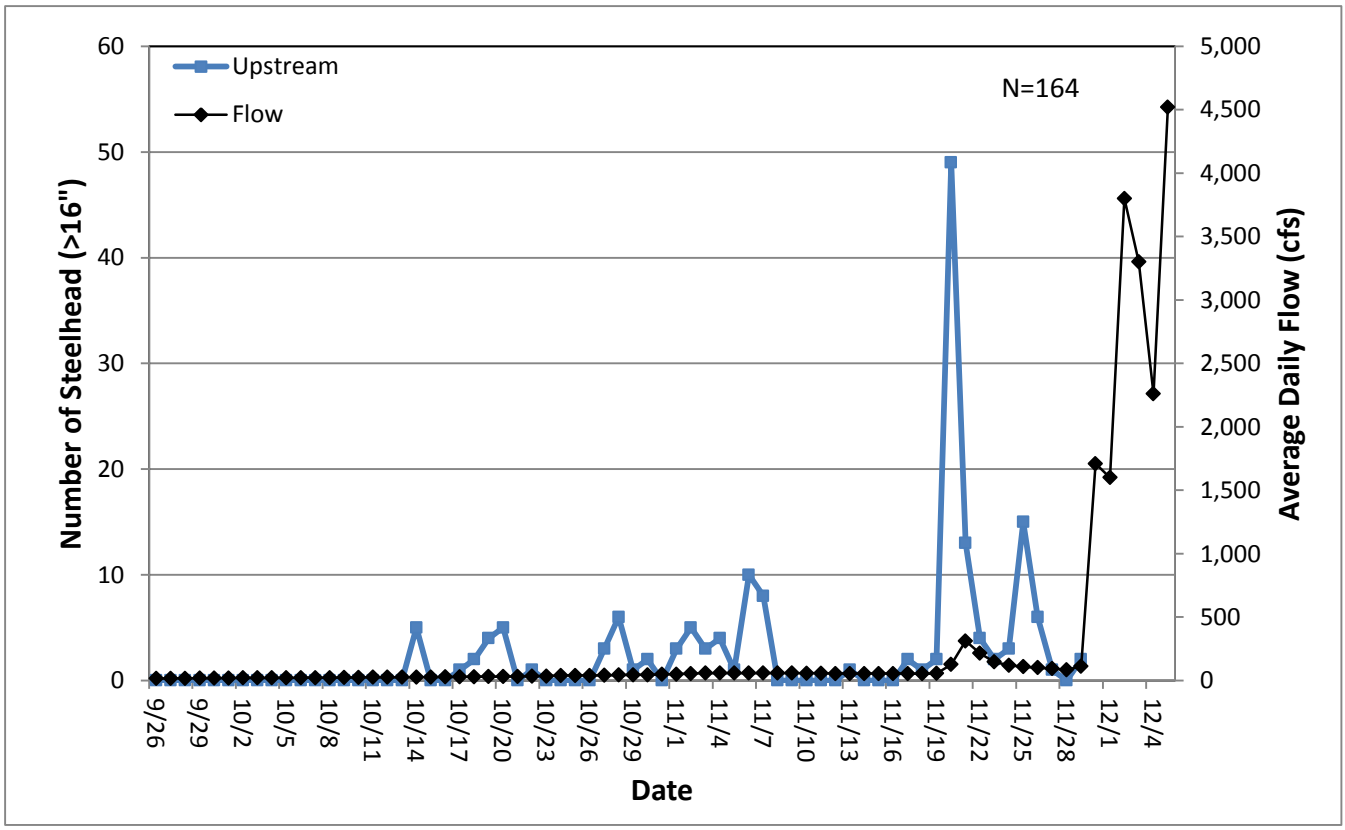

Figure 11. Run timing of steelhead trout (>16") observed passing through the Scott River Fish Counting Facility during the 2012 season (N=164), and flows observed at USGS Gauge No. 11519500.

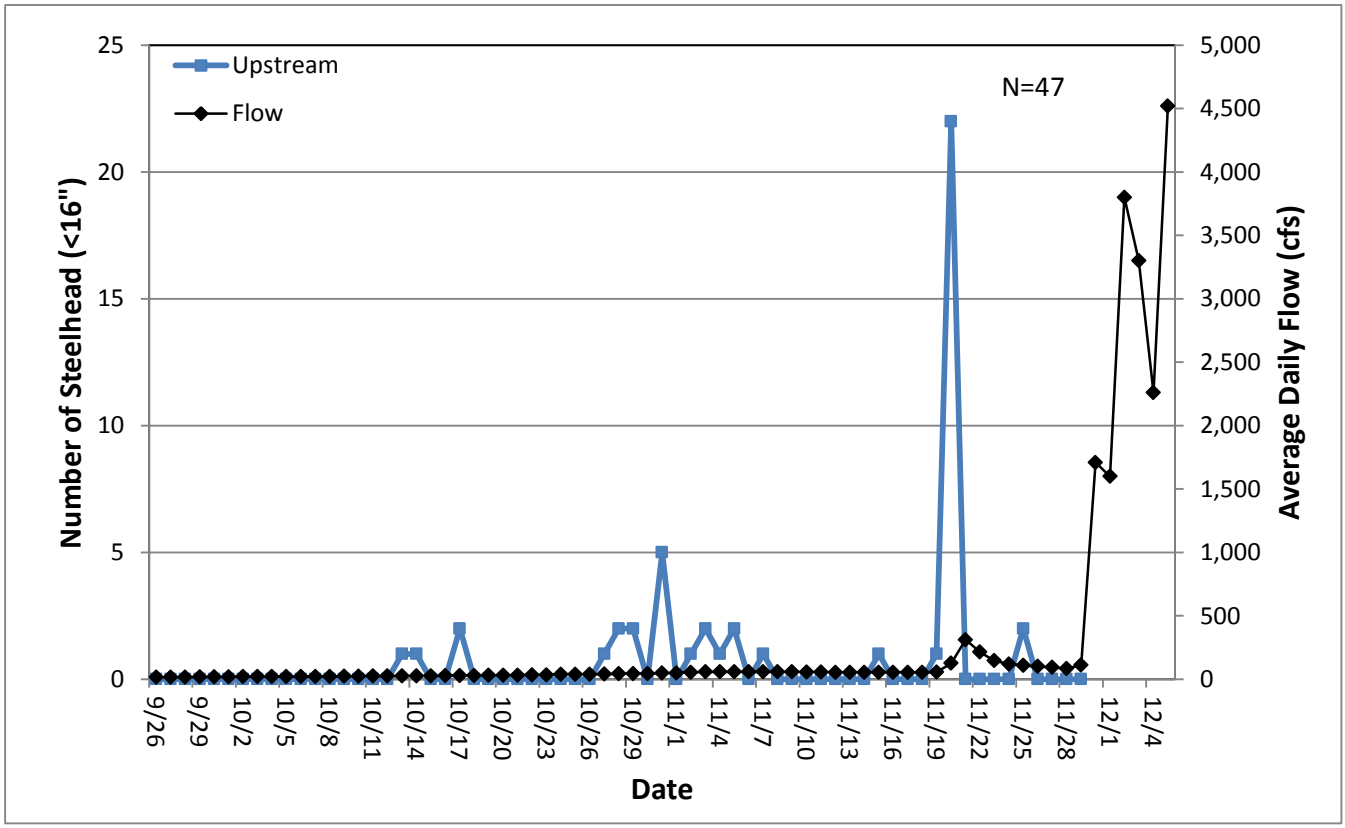

Figure 12. Run timing of steelhead trout (<16") observed passing through the Scott River Fish Counting Facility during the 2012 season (N=47), and flows observed at USGS Gauge No. 11519500.

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 5,328 fish (Figure 13). The 2012 Chinook salmon run in the Scott River ranks fifth (9,352 fish) out of 35 years of monitoring. The 2012 run was 75.5% higher than the 35 year average. A total of 8,144 Chinook salmon were estimated to have passed through the SRFCF during the 2012 season. A total of 1,208 +/-139 (90% CI) Chinook salmon carcasses were estimated in reach 1 through reach 6, yielding a total run size estimate of 9,352 Chinook salmon. A total of 3,305 +/- 76 (90% CI) Chinook salmon were estimated in reaches 7 and 8. If the total number of Chinook estimated in reach 7 and 8 are subtracted from the weir estimate the proportion of the run that utilized areas upstream of Reach 8 can be estimated. During 2012, 51.7% (4,839) of the Chinook run utilized areas of the watershed above Meamber Bridge (upper end of reach 8) (Table 3). A total of 1,139 +/- 45 (90% CI) Chinook were estimated to have spawned in reaches 12-15. If the total number of estimated Chinook spawners estimated in reaches 12-15 (1,139) are subtracted from the estimate above Reach 8 (4,839) the number of Chinook that utilized areas upstream of Meamber Bridge in areas that were not surveyed can be estimated at 3,700 fish. Reach 8, a 3.4 mile section of the river, between Meamber Bridge and the USGS gauging station accounted for 2,941 +/- 73 (90% CI) Chinook salmon. These 2,941 fish that utilized reach 8 accounted for 36.1% and 31.4% of the total spawning above the weir and total spawning throughout the entire watershed respectively. The CJS mark recapture carcass estimate for the entire watershed that was surveyed (reaches 9-11 not surveyed) was 5,965 +/- 137 (90% CI) fish. This estimate of 5,965 fish underestimates the total estimate by 36.2%. The addition of the fish counting facility has yielded a more accurate estimate of the total number of Chinook in the Scott River and has allowed for accurate estimation of Chinook utilization in the valley reaches without having to survey 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. Table 4 shows that the Scott River has contributed an average of 9 percent of the basin-wide (including Trinity River) natural spawning escapement to the Klamath River during the period from 1978 to 2012. 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 2011 and has ranged from a low of 14.4 to a high of 383.0 and averaged 112.1 (Figure 14). As the watershed approaches carrying capacity the number of 0+ Chinook produced per adults is a direct measure of in-river productivity and as habitat conditions improve or diminish this measure will reflect those conditions.

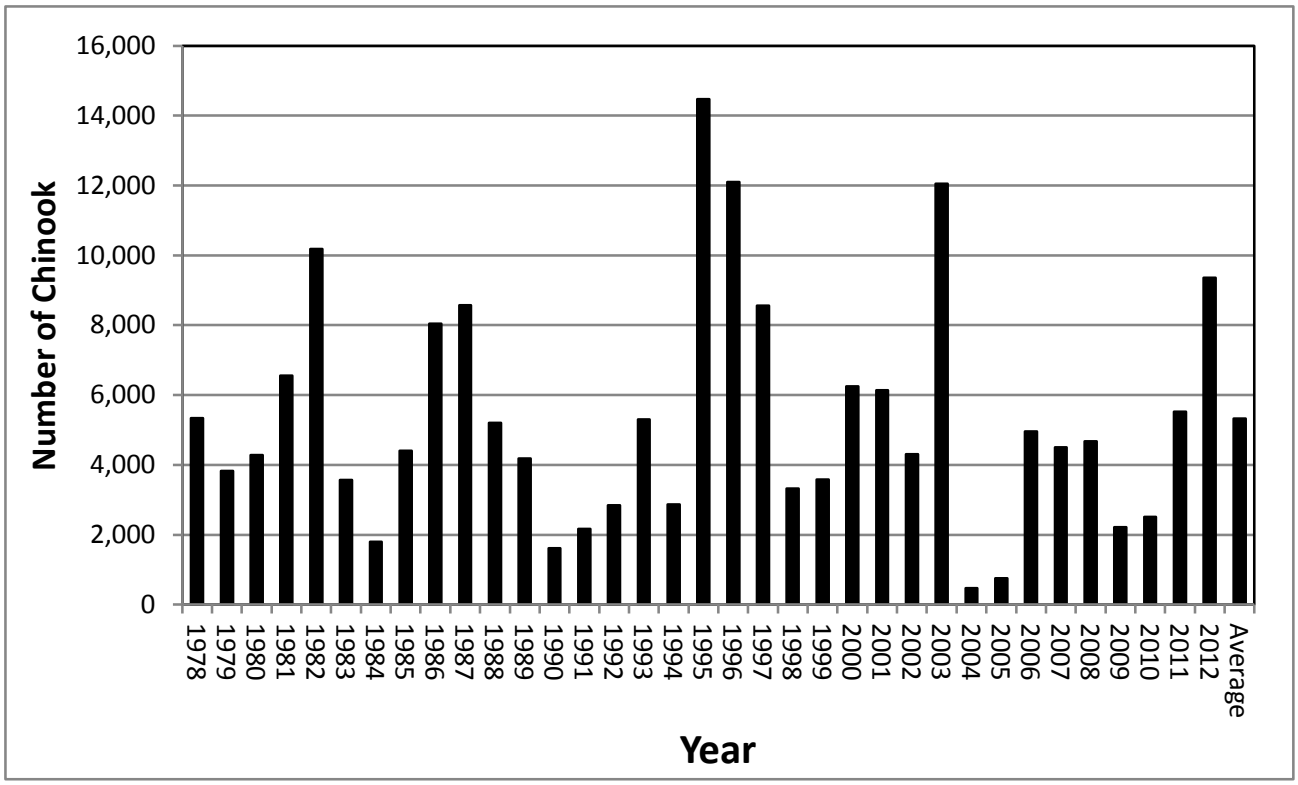

Figure 13. Estimated escapement of Chinook salmon returning to the Scott River from 1978 to 2012.

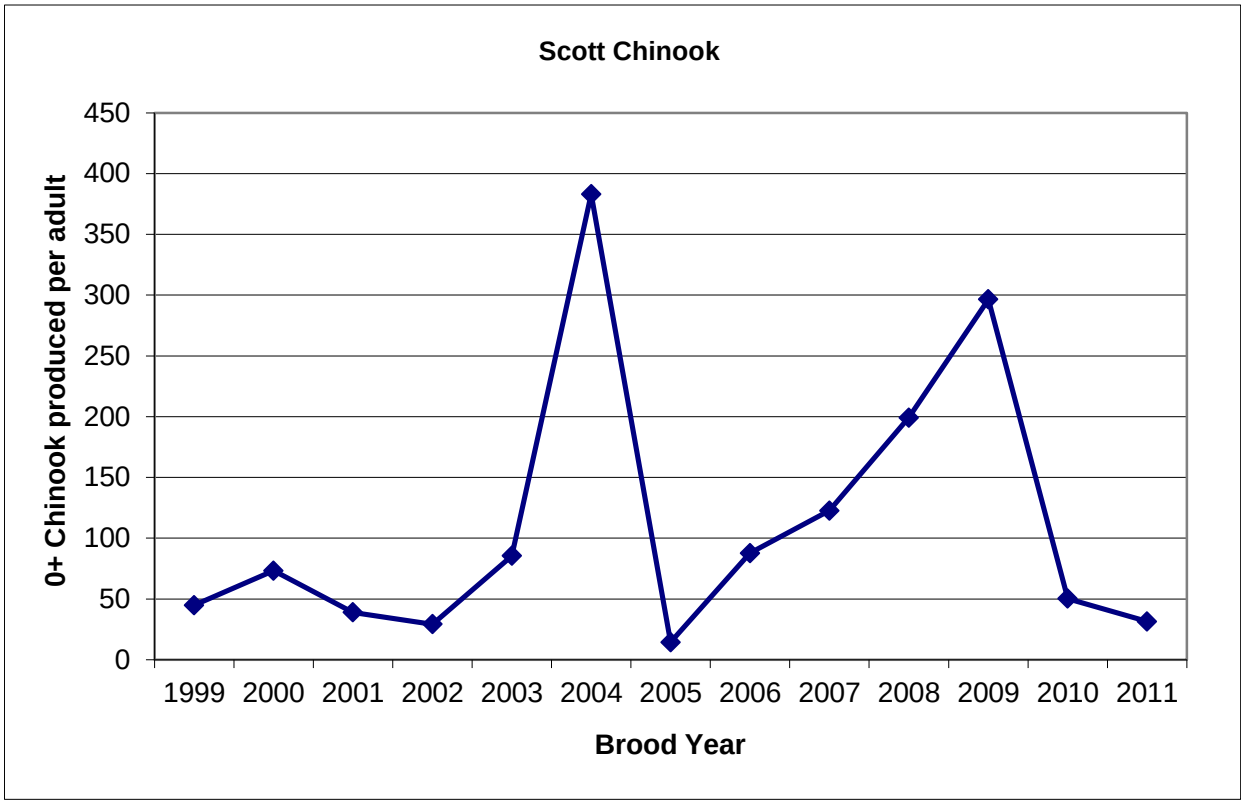

Figure 14. Number of 0+ Chinook produced per adult spawner in the Scott River by brood year, for Brood Years 1999-2011.

Table 4. Klamath Basin and Scott River Chinook natural spawner escapements (age 2-5), 1978-2012.

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%
Average	**61,980**	**5,328**	**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 1,622 and averaged 542 (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 2012 indicates significant variation in brood year strength (Daniels et al. 2012). Results of the first six years of adult monitoring at the SRFCF support this observation. The cohort that returned in 2012 is not the strongest year class but one of the two weaker year classes in the Scott River. In one generation the 2012 coho salmon returns of 201 were 1.48 times greater than the 2009 returns of 81, an increase in brood year strength of 120 fish. It is very encouraging that over the

past two seasons a positive growth rate for Scott River coho salmon has been observed. It should be noted that the 2012 monitoring season ended prior to the end of the coho migration and the 2012 estimate is believed to underestimate the actual run size. Even though the 2012 estimated run size is likely low, 201 adult coho were observed indicating that the abundance of this brood year is increasing.

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. The spawning ground survey data and video data produced hatchery proportions of 14.3% and 0.81% respectively. The sample sizes that the spawning ground survey and video data relied on were 7 and 123 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 2012 season has been estimated using the video data and is estimated to be 0.81% or 2 fish.

The cumulative percent observed coho by date at the SRFCF has varied from 2007-2011 but migrations have been shown to be strongly correlated to flow increases. The daily cumulative percent observed for 2007, 2008, 2010 and 2011 are very similar with an average of 85.3% of the coho observed on or before November 29, the date the counting station was removed as a result of high water in 2012 (Figure 16). The 2009 data was not included in this average as the flow conditions were different that season and coho largely did not migrate past the SRFCF until December 15th after the first substantial increase in flow occurred. Although the Department supports the minimum estimate of 201 coho, if 85.3% of the coho run had passed the SRFCF by November 29th an alternative estimate for 2012 accounting for the remainder of the season would be 236. One assumption of this exercise is that the base years that the comparisons are being made upon captured 100% of the migration period.

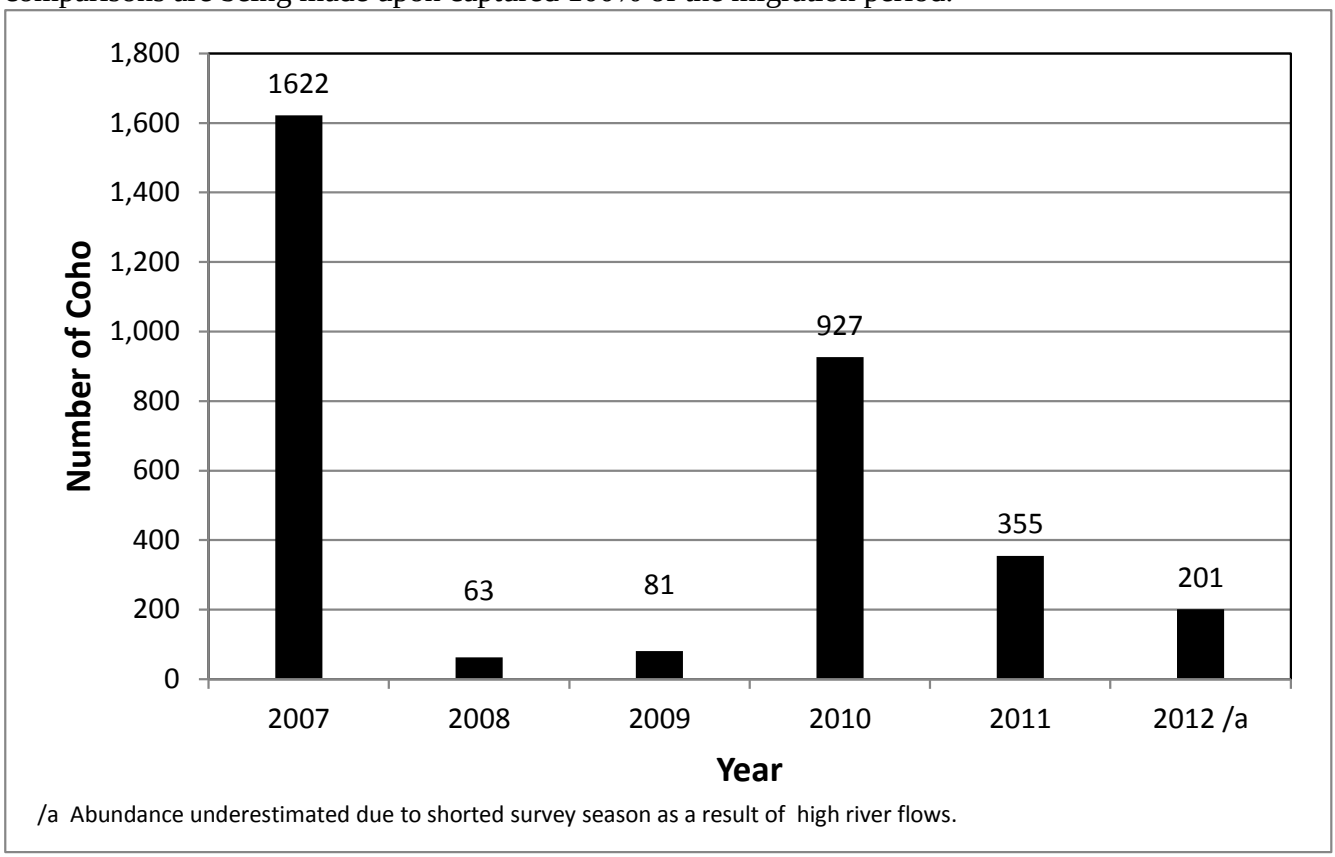

Figure 15. Estimated escapement of adult coho (age 2 and age 3) salmon returning to the Scott River from 2007 to 2012.

Utilizing the number of coho smolts produced in the Scott River (Daniels et al. 2012) 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 the number of coho smolts that were required to produce a single adult coho averaged 38.8 and ranged from a low of 5.37 to a high of 67.11. The corresponding out of basin survival has averaged 6.35 percent and ranged from a low of 1.49

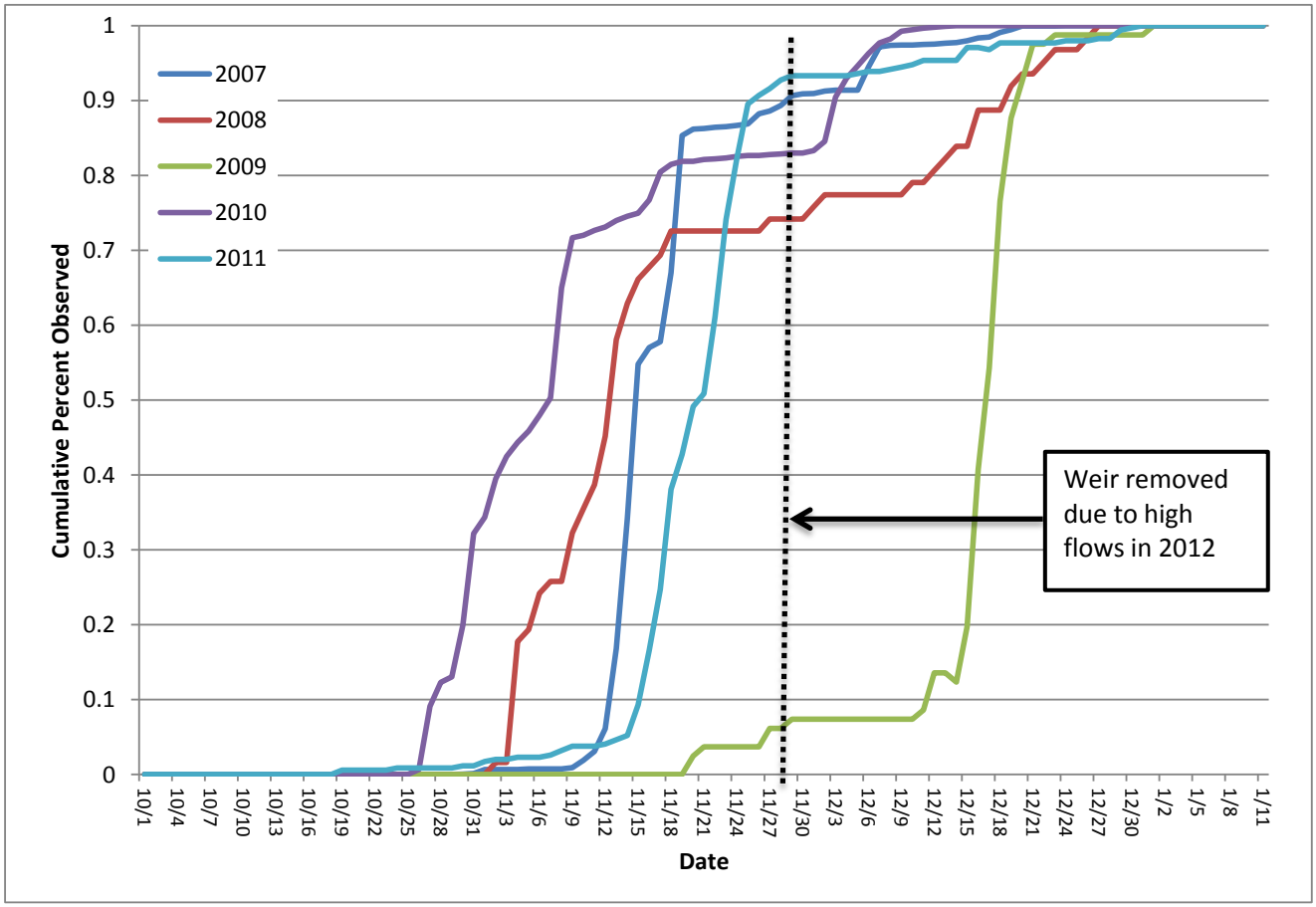

Figure 16. Cumulative percent of total observed coho salmon at the SRCFC by date from 2007-2011.

percent to a high of 17.94 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 2004-2009.

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	1979	2011	355	5.57	17.94
2009	2011	275	2012	201	1.37	73.09

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 2010 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 31.86 (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 2010.

Adult Year Brood Year	Adult Estimate	Smolt Year	Smolt point Estimate	Smolts produced per adult
2007	1622	2009	62207	38.35
2008	63	2010	1979	31.41
2009	81	2011	275	3.40
2010	927	2012	50315	54.28

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 and 164 for 2010, 2011 and 2012 respectively (Figure 17). From 2007 to present the number of observed adult steelhead has ranged from a high of 419 to a low of 146 with an average of 231. 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.

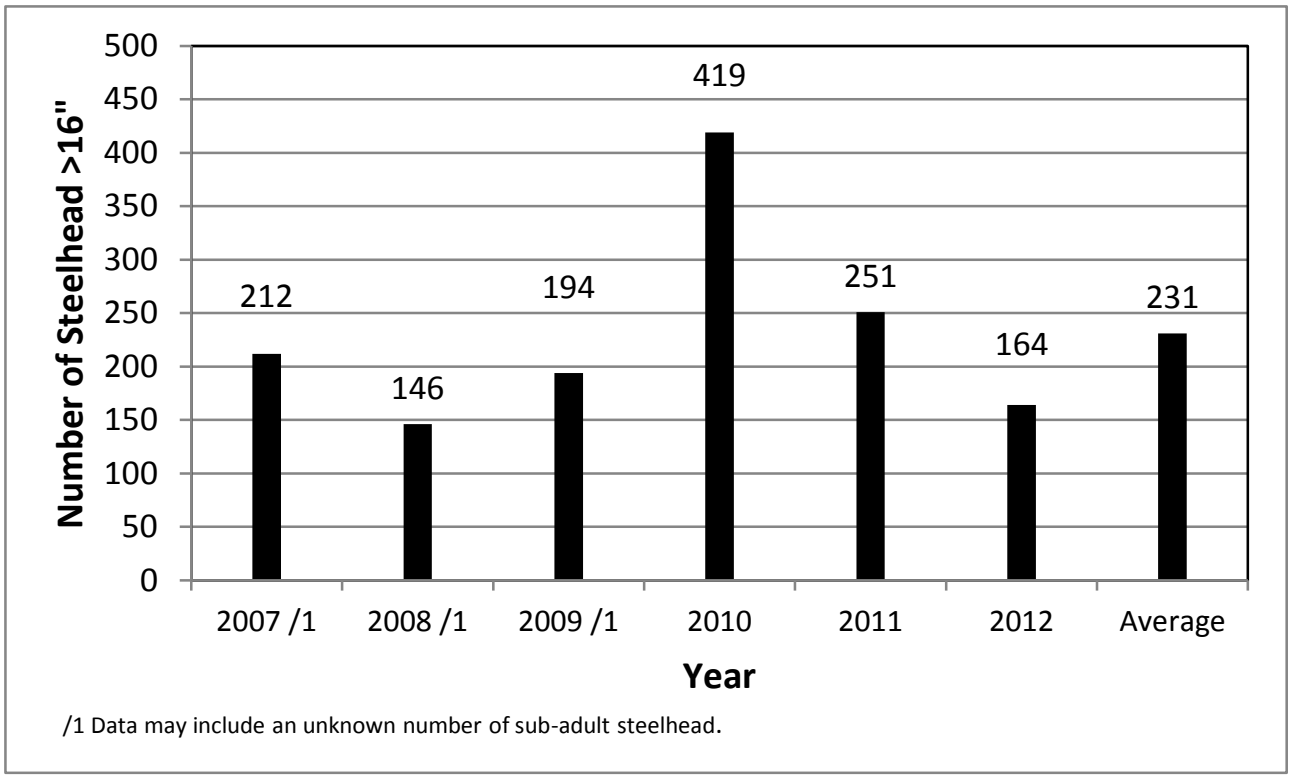

Figure 17. Number of observed Steelhead >16" at the Scott River Fish Counting Facility from 2007 to 2012.

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