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**CHARLTON H. BONHAM Director**



June 16, 2016

**Subject: Shasta River Chinook and Coho Salmon Observations in 2015, Siskiyou County, California Final Report**

All,

Please find attached a copy of the subject report. This report describes our fall Chinook and coho sampling efforts on the Shasta River. Should you have any questions regarding this report please direct inquiries to either Senior Environmental Scientist Supervisor Wade Sinnen at (707) 822-5119, [Wade.Sinnen@Wildlife.ca.gov](mailto:Wade.Sinnen@Wildlife.ca.gov), or Environmental Scientist Diana Chesney at (530) 841-1176, [Diana.Chesney@Wildlife.ca.gov](mailto:Diana.Chesney@Wildlife.ca.gov).

Sincerely,

  
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# **Shasta River Chinook and Coho Salmon Observations in 2015 Siskiyou County, CA**



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**Shasta River Fish Counting Facility,  
Chinook and Coho Salmon Observations in 2015  
Siskiyou County, CA**

**ABSTRACT**

A total of 6,745 Fall-run Chinook salmon (*Oncorhynchus tshawytscha*) were estimated to have entered the Shasta River during the 2015 spawning season. An underwater video camera was operated in the flume of the Shasta River Fish Counting Facility (SRFCF) 24 hours a day, seven days a week, from September 1, 2015 until December 21, 2015. The first Chinook was observed on September 8, 2015 and the last Chinook on December 15, 2015. Klamath River Project staff also processed a total of 221 Chinook carcasses during spawning ground surveys, and 8 Chinook carcasses as wash backs against the SRFCF weir (a systematic 1:10 sample).

Chinook carcasses sampled in the spawning ground surveys were used to describe characteristics of the run. Carcasses ranged in fork length (FL) from 43 cm. to 91 cm. and grilse were determined to be < 58 cm. in FL. Males ranged in FL from 43 cm. to 91 cm. and averaged 73 cm. Females ranged in FL from 56 cm. to 82 cm. and averaged 66 cm. The run was comprised of 133 grilse (2%), and 6,612 adults (98%). The sex composition of the run, based on 221 fish sampled, was 59% (3,980) female and 41% (2,765) male. A total of 4 adipose-clipped (AD) Chinook were recovered in the spawning ground surveys and the weir wash back sample. Only one, a wash back carcass, contained a coded wire tag (CWT) which was identified as a 4 year old fish from Iron Gate Hatchery (IGH). A net total of 31 AD Chinook were observed in the video flume, and were presumed to be of hatchery origin. An estimate of total hatchery contribution was derived based on multiplying the recovered tag by an expansion factor of 22.22 (video count/ number of carcasses examined in spawning ground surveys and weir wash backs). Using this method, a total of 89 hatchery origin Chinook, or 1.3% of the total run, were estimated to have entered the Shasta River during the 2015 run.

A net total of 45 coho salmon (*Oncorhynchus kisutch*) were estimated to have entered the Shasta River prior to removal of the weir on December 21, 2015. The first coho of the season was observed swimming upstream through the SRFCF on November 19, 2015 and the last coho was observed swimming upstream through the SRFCF on December 19, 2015. Six of 28 coho which were passive integrated transponder- tagged and released from IGH were detected at antenna arrays located at the SRFCF and several points upstream. No coho carcasses were recovered in 2015 and as a result hatchery composition for Shasta River coho was not estimated in 2015.

A net total of 77 adult and 31 sub-adult steelhead trout (*Oncorhynchus mykiss*) were observed passing through the SRFCF during the 2015 season, prior to the removal of the SRFCF on December 21, 2015. An additional net total of four downstream swimming steelhead were detecting using an ARIS sonar unit between January 1, 2016 and February 29, 2016 for a net total of 104 steelhead known to have remained in the Shasta River prior to February 29, 2016. The ARIS unit was in place until May 3, 2016, and footage is currently under review. A technical report will be produced for the entire ARIS period after review and analysis are complete.

## INTRODUCTION

The Klamath River Project (KRP) of the California Department of Fish and Wildlife (Department) is responsible, in cooperation with other state, federal and tribal partners, for estimating the number of Chinook and coho salmon that return to the Klamath River Basin, excluding the Trinity River Basin, each year. To achieve this task the KRP employs several techniques which include a creel survey of sport fishing effort and harvest, recovery of fish returning to Iron Gate Hatchery (IGH), completion of cooperative spawning ground surveys in major tributary streams and rivers, and operation of video fish counting weirs on the Shasta River, Scott River and Bogus Creek. The Shasta River Fish Counting Facility (SRFCF) is located approximately 213 meters (700 feet) from the confluence of the Shasta and Klamath Rivers (Klamath RKM 283, Figure 1).

Video equipment was first installed at the SRFCF in 1998 and has been used to describe migration of salmonids into the Shasta River ever since. Although the primary responsibility of the KRP is to enumerate and describe Chinook and coho salmon populations, data are recorded for steelhead trout (*Oncorhynchus mykiss*) and other species observed at the SRFCF during its period of operation as well.

Since 2004, when the Southern Oregon/Northern California Coast ESU of coho salmon was listed as a Threatened Species by the California Fish and Game Commission, the KRP has operated its SRFCF video system through December, and into January when possible, in order to enumerate the coho run as well as the Chinook run into the Shasta River. This report describes the characteristics of the Chinook, coho and steelhead salmon runs that entered the Shasta River during the fall of 2015.

## METHODS

Monitoring of the salmon run within the Shasta River during the 2015 season was accomplished through three primary efforts: operation of a video weir, collection of data from salmon carcasses that become impinged on the weir panels as they float downstream (wash backs), and completion of spawning ground surveys upstream of the weir to obtain biological data from salmon carcasses.

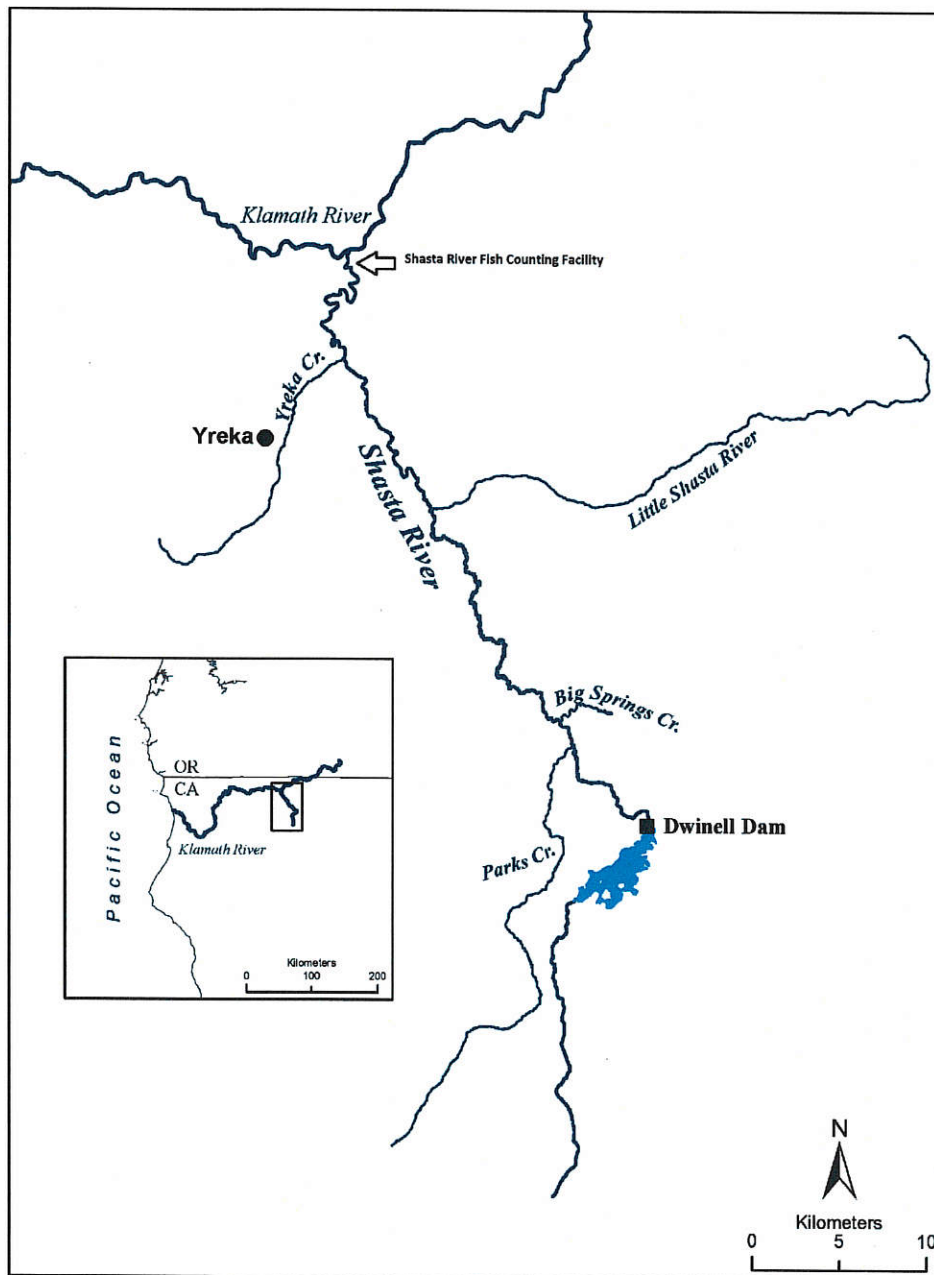


Figure 1. The Shasta River Watershed and location of Shasta River Fish Counting Facility (SRFCF).

## VIDEO WEIR

The SRFCF consists of a video camera, counting flume and an Alaska style weir strategically placed in a diagonal across the river channel (Figure 2). Fish immigrating upstream are directed through a narrow flume, which passes in front of an underwater video camera. A SplashCam Delta Vision black and white underwater camera with a 3.6 mm wide angle lens was used in 2015 for capturing images, and an ECOR 264 digital video recorder (DVR) with a swappable hard drive were used for recording<sup>1/</sup>.



Figure 2. Alaska-style panels of the Shasta River Fish Counting Facility (SRFCF)

The weir and video camera were installed and recording began on September 1, 2015. KRP staff performed routine daily maintenance of the SRFCF. This included inspecting the video system to ensure that everything was operating correctly, inspecting and cleaning weir panels and making any necessary repairs, and processing any wash-back carcasses present. Twice per week the hard drive was removed from the DVR and replaced with another drive. All recording equipment was secured in locked enclosures and access to the site was controlled through a locked gate located on private property.

Swappable drives with stored video data were immediately returned to the office where each was subsequently downloaded onto a shared network drive for storage and review by staff in the video lab. During each review, staff recorded the date, time (hour:min:sec), and species of each fish observed. In addition, staff noted the presence of adipose-clipped (AD) fish, and recorded the presence of lamprey or any other distinguishable marks that were visible on the footage. Fish were counted as downstream migrants if they entered the flume from the upstream end and exited at the downstream end. If fish entered the flume but backed down without exiting on the upstream end, they were not counted.

<sup>1/</sup>Use of product names in this report does not imply endorsement by the California Department of Fish and Wildlife.

Fish for which positive identification could not be made were recorded as “unknown” species. All data were then entered into files on a personal computer and each data file was edited and corrections made by a second individual prior to commencement of data analysis.

Operation of the SRFCF began on September 1, 2015 at 15:49 hours, Pacific Standard Time. The first Chinook of the season was observed on September 8, 2015 and the last Chinook was observed on December 15, 2015. The weir and recording equipment were removed on December 21, 2015 due to high flows. Video footage recorded during the first week of operation (September 1 to 8, 2015) did not successfully download, and as a result, 51 Chinook were added to the total count using the historic proportion of Chinook entering the Shasta River during the first week of migration.

### **WASHBACK CARCASSES**

All salmon carcasses that drifted downstream and became impinged on the weir panels were recovered, and a systematic sample of one in ten Chinook carcasses were processed. Data collected on these systematically sampled wash back carcasses included fork length (FL), gender, marks, tags and the presence of fin clips. Scales were removed from the left side of each carcass at a location posterior to the dorsal fin just above the lateral line whenever possible. Each female carcass was also examined to determine whether successful spawning had occurred. Spawning status was defined as un-spawned (many eggs remaining in the body) or spawned (few or no eggs remaining). In addition to the systematically sampled Chinook carcasses, all carcasses were examined for AD clips, and all AD carcasses and all coho and steelhead carcasses were processed. Heads were collected from each AD fish for later coded wire tag (CWT) recovery and analysis. All carcasses were cut in half to prevent sample duplication and returned to the river downstream of the weir. Coho carcasses with an operculum punch were scanned with a hand-held PIT tag detector, and PIT tag numbers recorded.

### **SPAWNING GROUND SURVEYS**

Spawning ground surveys were conducted between October 7, 2015 and December 23, 2015. Survey reaches included the lower seven miles of the Shasta River, (canyon reaches), as well as five reaches of the upper Shasta River main stem and Yreka Creek, Big Springs Creek, Little Springs Creek and Parks Creek, tributaries to the Shasta River. These surveys cover approximately 15% of the Shasta River basin, and their purpose is to gather biological data necessary to describe physical characteristics of the run, and to document spawning distribution in the reaches surveyed. Escapement numbers are derived from the video weir. Surveys were conducted once per week, usually on Wednesdays, and were limited to areas historically used, or believed to be used, by spawning salmon.

During each survey, crews walked along the river bank or in the channel searching for salmon carcasses. As carcasses were located, crews processed each as previously



described for weir wash backs. In addition to scale samples, a tissue and otolith sample was collected from the first carcass sampled from each reach on each survey day. All tissue samples were collected following protocols provided by the National Oceanic and Atmospheric Administration's (NOAA) Southwest Fisheries Science Center. Tissue samples were sent to the Salmonid Genetic Tissue Repository located at the NOAA Santa Cruz Laboratory for archiving and analysis. Otoliths were collected throughout the season and cataloged for future microchemistry analysis. Otolith samples were collected following standard protocols.

Table 1. Description of Shasta River Spawning Ground Survey Reaches, 2015

Reach Number	Downstream end	Upstream end
1	Confluence with Klamath River	Pioneer Bridge
2	Pioneer Bridge	Salmon Heaven
3	Highway 263	Shelley Bridge
19	Nelson Ranch	Confluence with Big Springs Creek
20	Confluence with Big Springs Creek	Confluence with Parks Creek
21	Mouth of Big Springs Creek	Upper bridge, Big Springs Creek
22	Mouth of Parks Creek	Hidden Valley Ranch
23	Mouth of Parks Creek	2nd Fence
24	Parks Creek, Dukes	Slough Rd. crossing

## RESULTS

### Chinook Salmon

A net total of 6,745 Chinook were counted passing through the SRFCF during the 2015 season. This number was derived by subtracting the number of downstream observations (68) from the number of upstream observations (6,813). The run peaked between September 25, 2015 and October 3, 2015, when 75.8% of the run was observed (Figure 3). Consistent with previous years' monitoring efforts, the majority of Chinook (90%) passed upstream through the SRFCF during daylight hours between 06:00 and 17:00 hours (Figure 4).

A total of 615 Chinook (9.1% of the run) were recorded as having at least one live lamprey attached to their bodies. Since the camera captures only the left side of each fish as it migrates upstream, attached lamprey, clips, scars or other abnormalities that may be present on the right side cannot be observed, so the incidence of lamprey attachment is probably higher.

A net total of 32 AD Chinook were observed passing through the SRFCF during the season, and these fish were assumed to be of hatchery origin. Because of turbulence,

the position of the fish in the flume or poor visibility due to water quality, the adipose fin is not always visible during video review, so the observed number is likely less than the number of AD Chinook that pass through the weir. For this reason, the hatchery contribution to the Shasta River is based on carcasses examined during spawning ground surveys and the weir wash back sample and not on video observations. The heads from four AD Chinook were recovered from carcasses, three from the wash back sample and one from the spawning ground survey. Only one, a washback sample, contained a CWT. It was identified as a 4 year-old fish from IGH which was released as a fingerling.

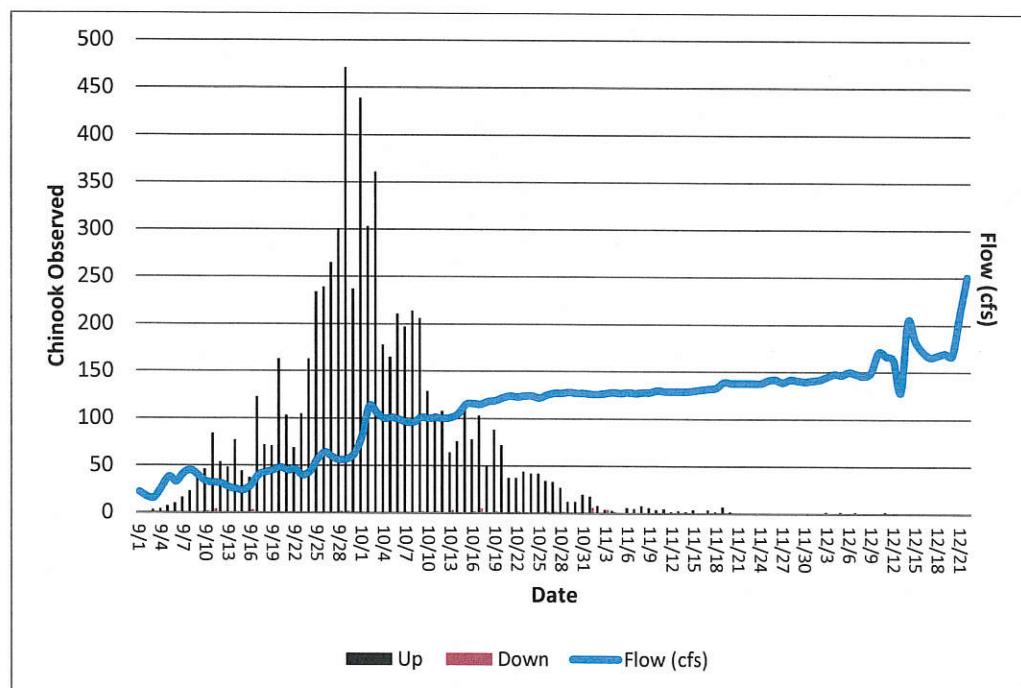


Figure 3. Chinook salmon observed migrating through the Shasta River Fish Counting Facility, 2015 by date, and flows at nearby USGS gauge 11517500.

An estimate of total hatchery contribution was derived based on multiplying the recovered tag by an expansion factor of 22.22 (video count/ number of carcasses examined in spawning ground surveys and weir wash backs). Using this method a total of 89 hatchery origin Chinook, or 1.3% of the total run, were estimated to have entered the Shasta River during the 2015 run (Table 2).

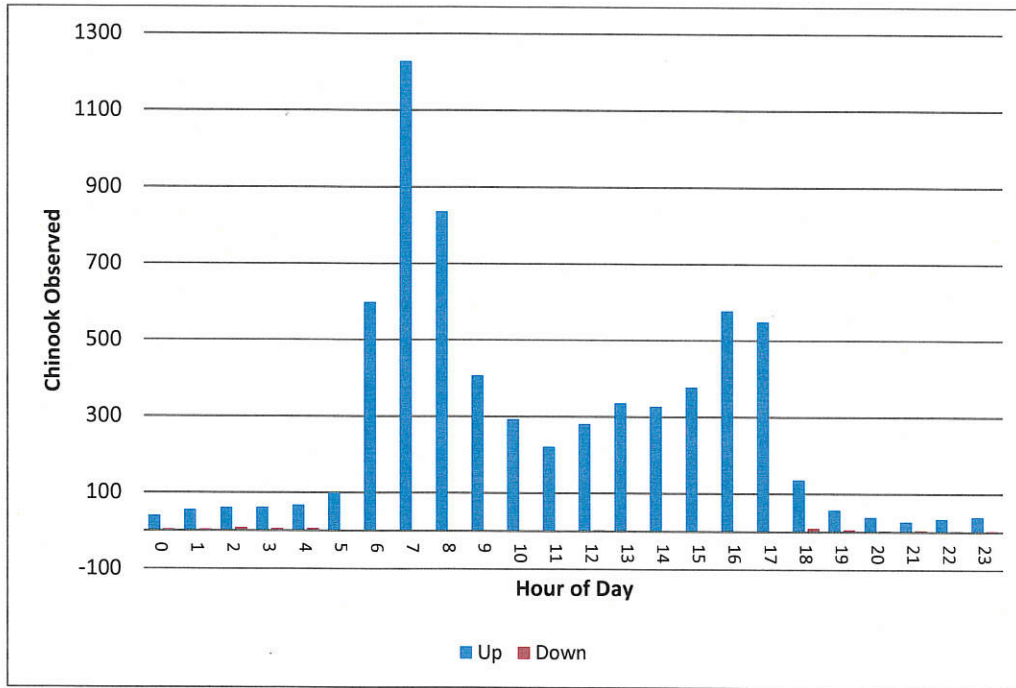


Figure 4. 2015 Shasta River Chinook observed by hour of day.

Table 2. Estimated contribution of 1 known coded wire tag (CWT) code recovered in the Shasta River during the 2015 season.

2015 Shasta River hatchery composition estimate using one weir wash back carcass with known CWT									
Coded Wire Tag	Location	Release Type a/	Brood Year	Age	Sample Number	Production Multiplier b/	Production Estimate	Sample Expansion c/	Total Estimate
060420	IGH	F	2011	4	1	4.01	4	22.22	89
Sub Total=					1	Sub Total=			89
Total Estimated Hatchery Contribution=									<b>89</b>

a/ Release type; F=Fall fingerling, Y=Fall Yearling  
 b/ Production Multiplier value is the inverse of the proportion of effectively tagged and total release from IGH  
 c/ Sample expansion is the inverse of the number samples sampled in spawning ground surveys and weir wash backs (N=303) divided by the video estimate (N=6,745)

## **Spawning Ground Surveys**

A total of 221 Chinook carcasses were observed and sampled during spawning ground surveys, of which 130 (59%) were female and 91 (41%) were male. Of the 130 female carcasses examined, 120 (92%) were determined to have spawned successfully (zero or few eggs observed) and 10 (8%) died without having spawned successfully (many eggs observed). Fork lengths of the recovered female and male carcasses are shown in Figures 5 and 6.

A total of 155 redds were observed during spawning ground surveys in 2015. These observations were not intended to represent a comprehensive description of spawning distribution in the Shasta River or to produce an escapement estimate, as spawning ground surveys only cover approximately 15% of the watershed. Redds observed in the canyon reaches were not flagged, and the season estimate was derived from the peak daily redd count. Redds encountered in the upper Shasta River were flagged and marked with a GPS unit, and after the initial survey, only new redds were identified. Species determinations of the redds were not always possible; however, two live coho were identified on redds in the main stem Shasta River between Parks Creek and the Hole in the Ground Ranch on December 23, 2015 and nine redds identified as coho redds were observed in the same reach on December 9 and 16, 2015. The remaining redds were believed to be Chinook redds.

## **Wash backs**

A total of 82 Chinook carcasses washed back on the SRFCF weir, of which 8 were sampled as part of a one in ten systematic sample. Seven (7) of the 8 had successful sex and FL determinations made. AD fish, if they were outside of the tenth sample, were sampled as non-random. Of the 7 carcasses that were successfully sampled, 5 (71%) were males and 2 (29%) were females. A length frequency distribution of these samples is presented in Figure 7. As in previous years, the wash back samples collected at the SRFCF show a heavy bias toward males (Table 3).

## **Grilse Cut-off**

The Shasta River spawning ground surveys in 2015 yielded 221 Chinook carcasses for which sex and length could be determined. From examination of length frequency distributions of these carcasses, a grilse cut-off of < 58 cm was established for the Shasta River. Scale age analysis of this sample by the Yurok Tribe determined that the 2015 Chinook run in the Shasta River consisted of 133 grilse (1.9%) and 6,612 adults (98.1%) for a total run size of 6,745 Chinook salmon (KRTAT, 2016).

Table 3. Sex composition of wash back carcasses sampled at Shasta River Fish Counting Facility, 2005-2015.

Year	Total Chinook Escapement Estimate	Total Wash Back Estimate	Number Sampled	% Males	% Females
2005	2,129	395	395	76	24
2006	2,185	457	457	94	6
2007	2,036	228	228	71	29
2008	6,362	767	767	96	4
2009	6,287	330	327	71	29
2010	1,348	118	118	83	17
2011	11,388	1,623	1,623	99.6	0.4
2012	29,544	1,040	104	81	19
2013	8,021	643	64	81	19
2014	18,357	1,450	145	73	27
2015	6,745	82	7	71	29
<b>AVERAGE</b>				<b>82</b>	<b>18</b>

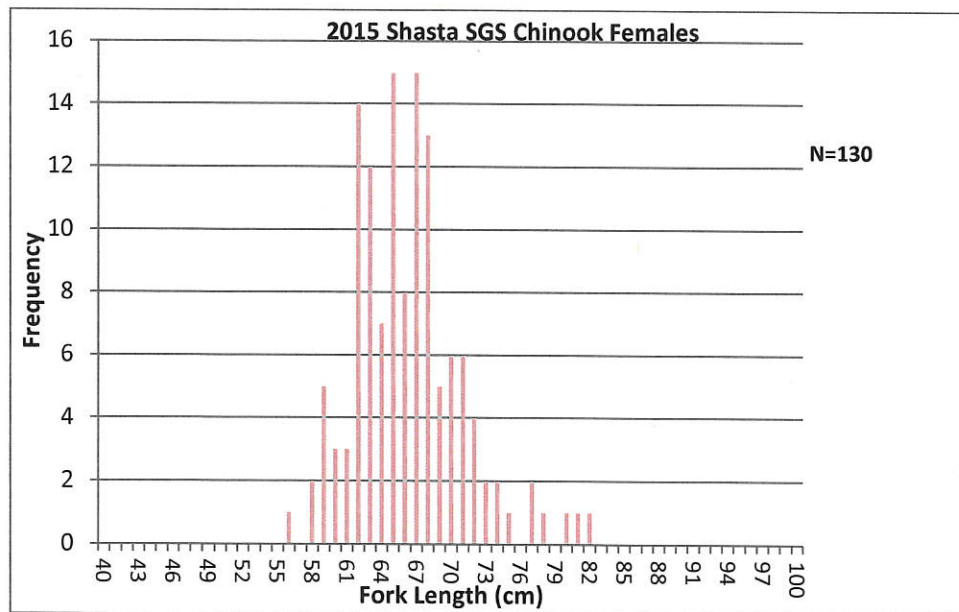


Figure 5. Length frequency distribution of Shasta River Chinook female salmon sampled in spawning ground surveys during the 2015 season.

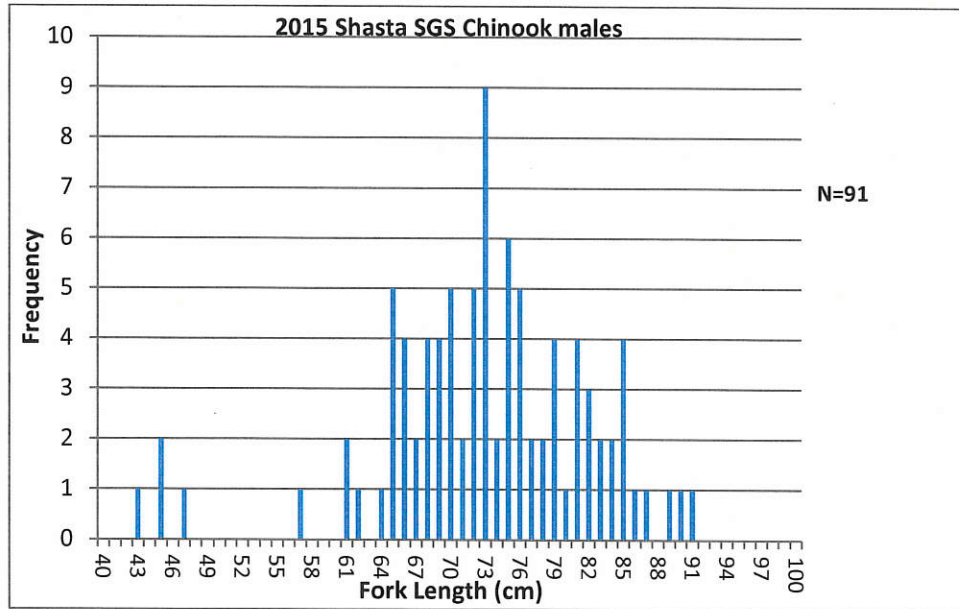


Figure 6. Length frequency distribution of Shasta River Chinook male salmon sampled in spawning ground surveys during the 2015 season.

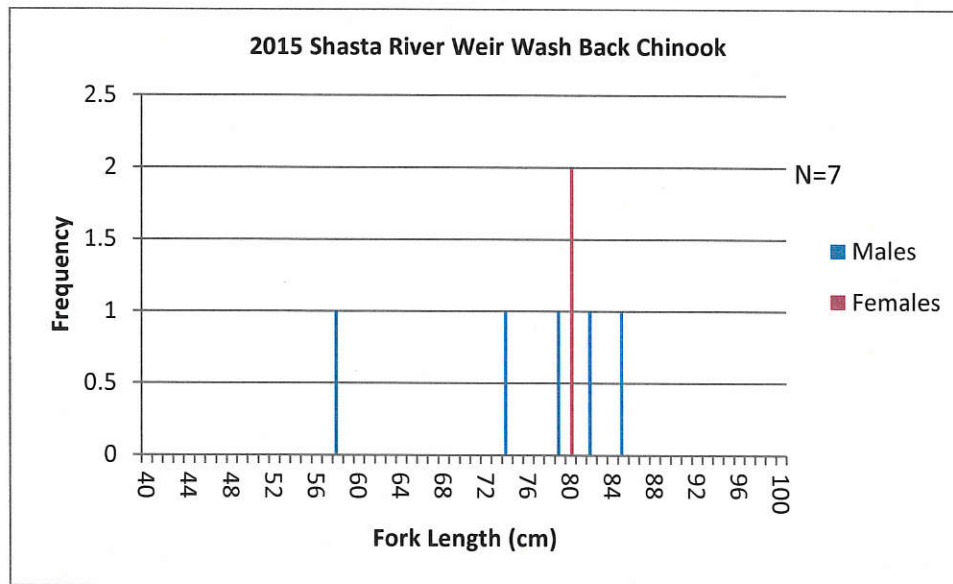


Figure 7. Length frequency distribution of Shasta River Chinook salmon sampled as weir wash backs during the 2015 season.

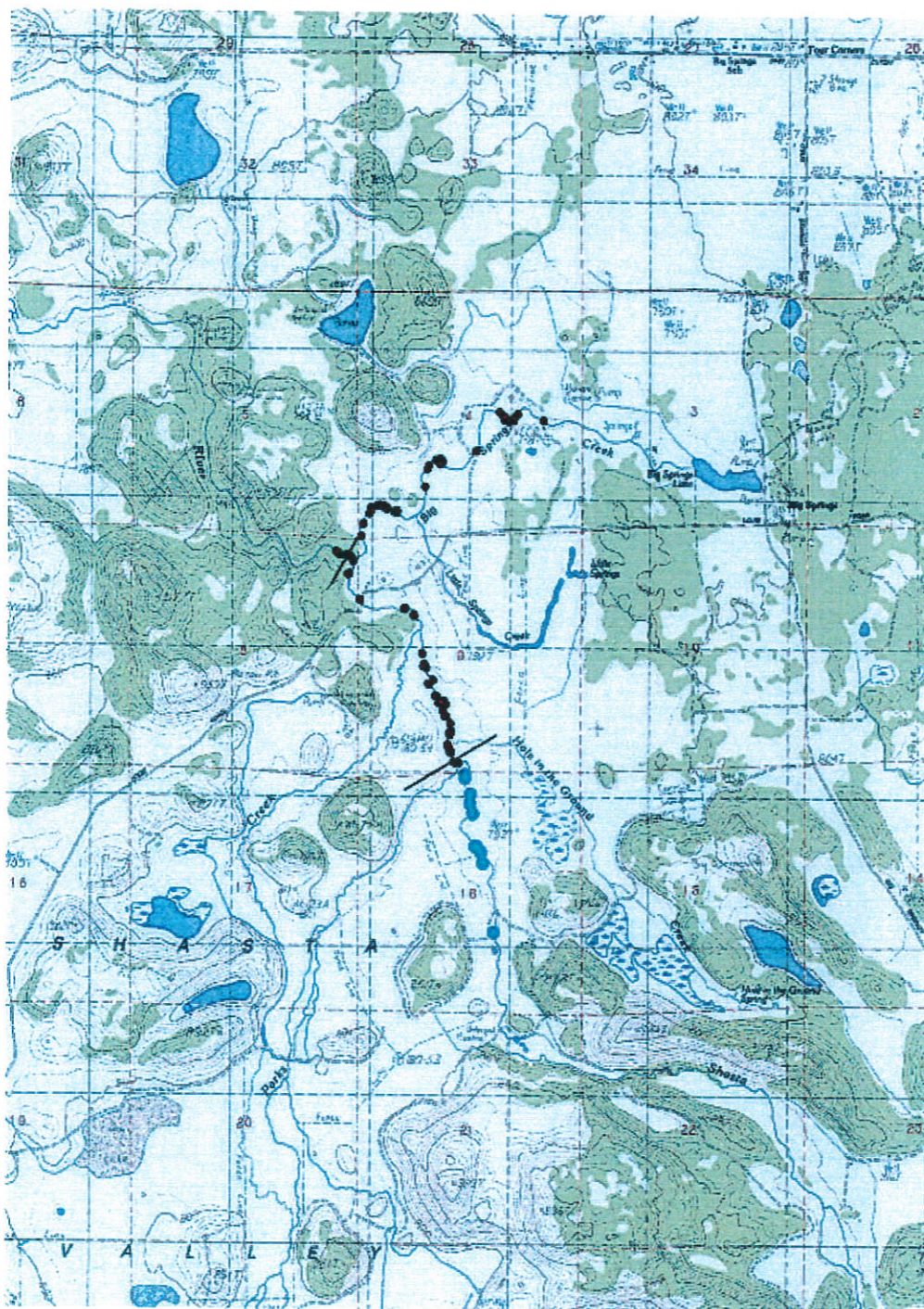
## Hatchery Straying

Since 2002, the KRP has estimated the number of hatchery origin Chinook that may have strayed into the Shasta River. These estimates have been based on sample expansions from known tag recoveries obtained from the Shasta River, or have been based on the proportional distribution of CWT recoveries observed at IGH and applied to the number of unrecovered ad-clipped Chinook that are observed passing through the SRFCF during the season, or both. Since 2001, the estimated contribution of hatchery strays to the Shasta River has ranged from a low of 0.4% in 2012 to a high of 38.7% in 2004 (Table 4).

**Table 4. Estimates of straying of hatchery origin Chinook salmon as a percentage of total escapement, 2002-2015.**

Year	Total Number of Chinook	Hatchery Stray Estimate	Percent Hatchery
2002	6,820	79	1.2%
2003	4,195	436	10.4%
2004	962	372	38.7%
2005	2,129	469	22.0%
2006	2,184	105	4.8%
2007	2,035	69	3.4%
2008	6,362	56	0.9%
2009	6,287	131	2.1%
2010	1,348	157	11.6%
2011	11,388	74	0.6%
2012	29,544	126	0.4%
2013	8,021	146	1.8%
2014	18,359	735	4.0%
2015	6,745	89	1.3%
<b>AVERAGE</b>			<b>7.4%</b>

Figure 8. Redds observed in the Big Springs area of the Shasta River, 2015. Red diamond symbols denote Chinook redds and turquoise circles denote coho redds.

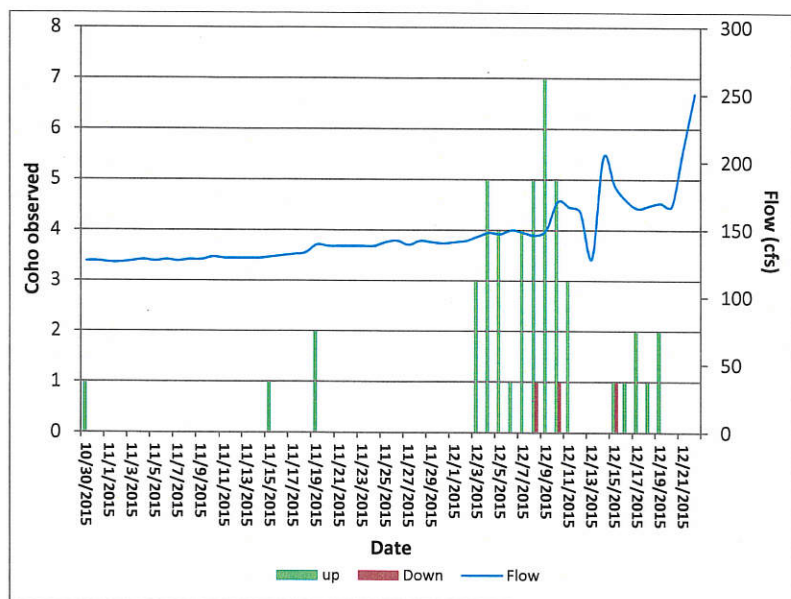


□



## Coho Salmon

A total of 48 coho salmon were observed passing upstream and 3 coho were observed passing downstream through the SRFCF from November 19, 2015 to December 19, 2015 (Figure 9). The net number of coho known to have entered and remained in the Shasta River prior to removal of the weir was 45. Because the weir was removed on December 21, 2015 due to a forecasted high flow event, it is possible that the video weir did not capture the entire coho migration period.



Coho salmon observed by date at the Shasta River Fish Counting Facility, 2015, and flow at nearby USGS gauge 11517500.

In 2015, 28 coho salmon which entered IGH and were either too early to be held as brood stock (due to infrastructure limitations) or did not have suitable mates on the spawning matrix were tagged with Passive Integrated Transponder (PIT) tags and released from the IGH spawning building between October 23, 2015 and December 3, 2015 (Chesney and Knechtle, 2016). Six of these coho were detected at PIT tag antenna arrays in the Shasta River located at the SRFCF. Two of the six were detected at river kilometer (RKM) 12, and one at RKM 56. No PIT detections occurred at the SRFCF after the December 21, 2015 removal of the weir, although the PIT antenna arrays continued to function. The number of days elapsed between release from IGH and first detection in the Shasta River ranged from 3 to 22 days, and the furthest upstream detection occurred at the mouth of Parks Creek (Shasta RKM 56). The fish detected at RKM 56 (Parks Creek), a 66 cm. male that was AD clipped and presumably from Cole Rivers Hatchery on the Rogue River in Oregon subsequently returned downstream to Shasta RKM 12 and was detected on 12/25/15, 32 days after its release from IGH.

Historically, the proportions of hatchery-origin and natural-origin coho entering the Shasta River have been estimated by applying the observed clip rates from spawning ground survey and weir wash back samples that were not PIT tagged to the unknown (video) portion of the run. However, in 2015 no coho carcasses were recovered, and the hatchery component was not estimated. All six of the PIT tagged fish detected in the Shasta River were of hatchery origin, five from IGH (left maxillary clipped) and one AD clipped coho, presumably from Cole Rivers Hatchery on the Rogue River in Oregon. It was not possible to determine with certainty whether coho passing through the video weir had maxillary clips.

No coho carcasses were recovered during the 2015 season. There were six coho grilse observations through the video flume, which uses lines on the backdrop 56 centimeters apart to delineate grilse vs. adult salmon, and 4-IGH released, PIT detected jacks (all hatchery origin and all having fork lengths less than or equal to 46 centimeters). Subtraction of the known IGH-released fish (N=6) from the 45 observed coho yields a net total of 37 adult and 2 grilse (5%) coho that entered the Shasta River without prior entry into IGH in 2015. Five observations (11%) were made of upstream migrating coho with lamprey attachments as they passed through the SRFCF during the 2015 season.

### **Steelhead Trout**

In 2015, a net total of 77 adult steelhead (82 upstream, 5 downstream) and 31 sub-adults or "half-pounders" (32 upstream, 1 downstream) were estimated to have entered and remained in the Shasta River during the video recording season from September 1, 2015 to December 21, 2015 (Figures 10 and 11). Lines on the back of the video flume were set at 16 inches (40.64 cm) to delineate sub-adults (half-pounders) versus adults. An additional minus four (-4) steelhead (44 up, 48 down) were detected by the ARIS sonar system between January 1, 2016 and February 29, 2016 for a net total of 104 steelhead (adult and sub-adult combined) estimated to have entered and remained in the Shasta River during the 2015-2016 season from September 1, 2015 to February 29, 2016. The Aris unit was in place until May 3, 2016. Footage collected between February 29, 2016 and removal of the unit is being reviewed and a technical report will follow completion of the review. Many of the steelhead detected moving downstream by the ARIS unit were likely to be spawned out "kelts" that were emigrating post spawning.

No observations were made of steelhead with AD clips, which would indicate hatchery origin. Because the Alaskan weir is not impermeable to juvenile fish smaller than half-pounders, juvenile steelhead were not counted as they passed through the video weir.

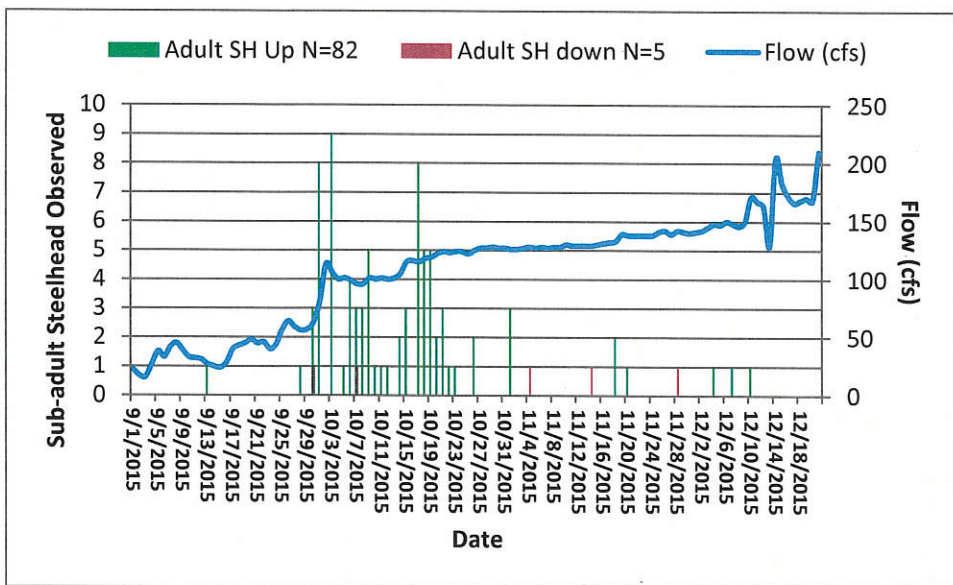


Figure 10. Adult ( $\geq 16''$ ) steelhead trout observations through the Shasta River Fish Counting Facility during the 2015 season from September 1, 2015 through December 21, 2015.

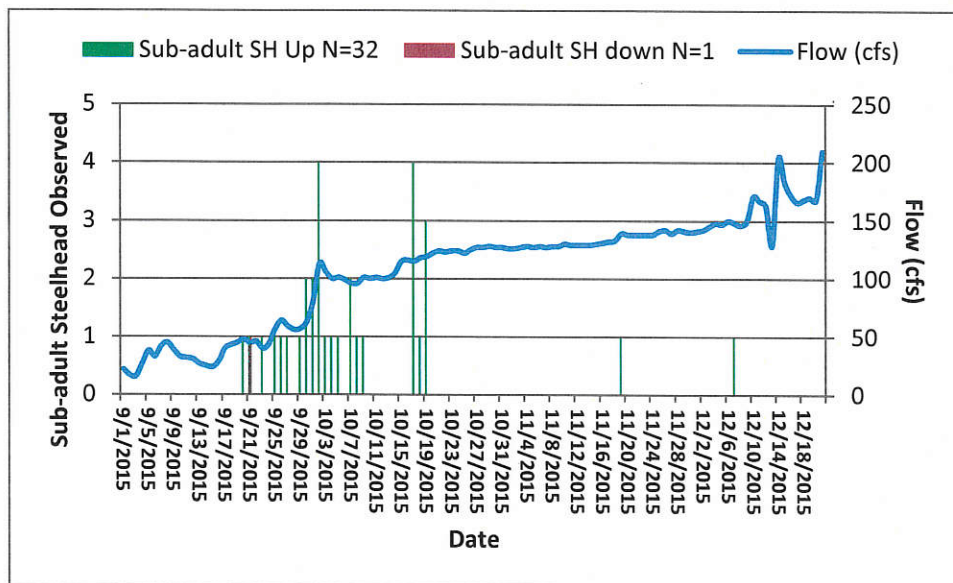


Figure 11. Sub-adult ( $< 16''$ ) steelhead trout observations through the Shasta River Fish Counting Facility during the 2015 season. season from September 1, 2015 through December 21, 2015.

## DISCUSSION

### Chinook Salmon

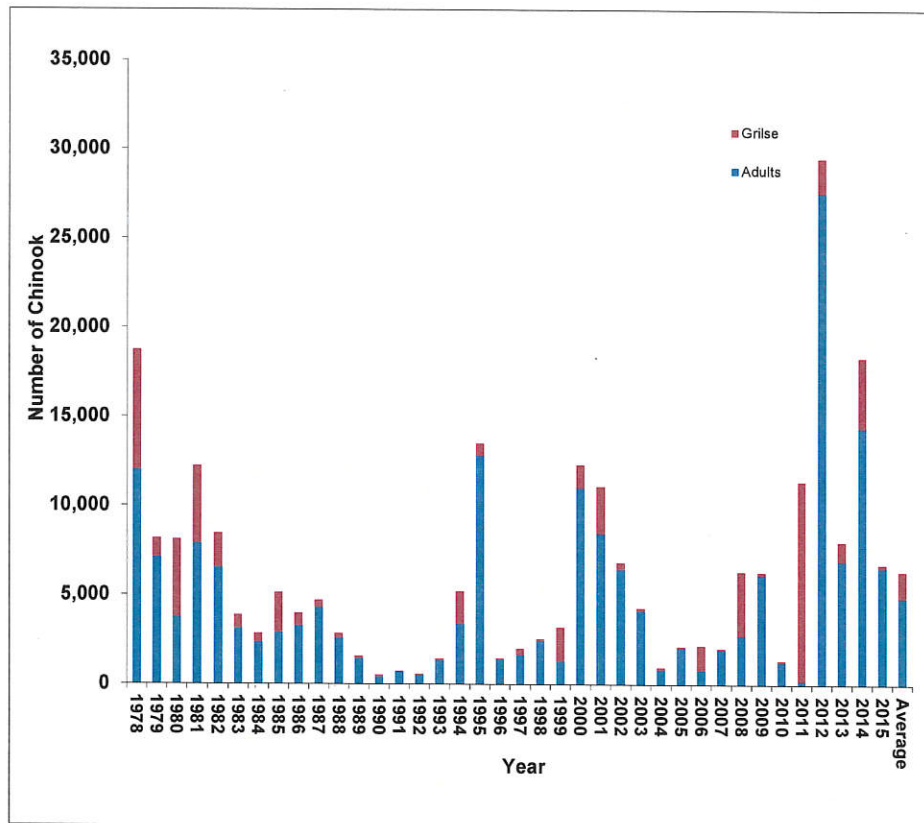
The 2015 run of Chinook salmon of 6,745 was 398 fish above the 38-year average of 6,347 (Figure 12). At the current monitoring site, run sizes have ranged from a low of 533 fish in 1990 to a high of 29,544 fish in 2012. At 398 fish above the 38 year average, the Shasta River exhibited a stronger return of Chinook in 2015 than other upper Klamath sectors such as Bogus Creek (27.8% of average), Scott River (39% of average) and Iron Gate Hatchery (49% of average) (Knechtle and Chesney, 2016; Chesney and Knechtle, 2016).

Rotary trapping studies in the Shasta and Scott River from 2000 to 2015 show that 0+ Chinook leave the Shasta River between February and May, a full three to four weeks earlier than Scott River 0+ Chinook (Stenhouse et al, 2016). This corresponds with the immigration of adult Chinook into the two systems, with the Shasta River adult Chinook entering the river in early September and Scott River Chinook approximately two to three weeks later. This may indicate that Shasta River 0+ Chinook enter the main stem Klamath River during periods of more favorable flow and temperature conditions have less exposure to *C. Shasta* and other disease organisms.

Data from Brood years 2000 through 2014 indicate the river's current habitat conditions continue to produce more 0+ Chinook as more adults return, indicating that the watershed continues to have an increasing ability to produce juvenile Chinook (Figure 13) although the rate at which juvenile Chinook were produced from Brood year 2012 was reduced when compared to previous seasons (Debrick et al., 2015). In addition, factors such as high flow events which result in streambed mobilization and sediment transport can cause significant damage to redds and emerging fry, and the age and sex composition of the Chinook run may also affect 0+ Chinook production.

**Table 5. Age composition of Shasta River Chinook runs as determined by Klamath River Technical Advisory Team, 2002-2015.**

	Age 2	Age 3	Age 4	Age 5	Total Adults	Total Run
2002	386	4,286	2,088	58	6,432	6,818
2003	155	2,798	1,325	11	4,134	4,289
2004	129	184	484	166	834	963
2005	38	1,409	600	82	2,091	2,129
2006	863	253	1,042	27	1,322	2,185
2007	27	1,855	146	8	2,009	2,036
2008	3,621	1,222	1,456	63	2,741	6,362
2009	126	5,595	314	252	6,161	6,287
2010	87	240	1,021	0	1,261	1,348
2011	11,175	23	190	0	213	11,388
2012	1,950	27,592	2	0	27,594	29,544
2013	1,096	3,896	3,029	0	6,925	8,021
2014	3,945	4,064	10,265	83	14,412	18,357
2015	133	5,752	658	202	6,612	6,745
<b>Average</b>	1,695	4,226	1,616	68	5,910	7,605



**Figure 12. Adult and grilse Chinook salmon returns to the Shasta River, 1978-2015.**

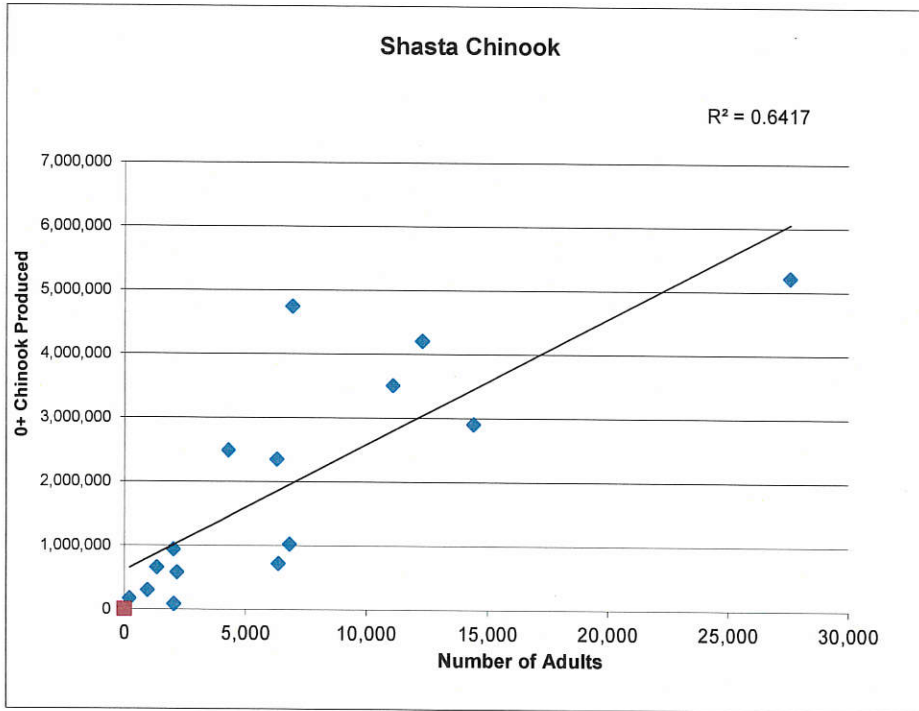


Figure 13. Number of 0+ Chinook produced per adult spawner in the Shasta River, Brood Years 2000-2014.

The Shasta River is an important component of the Klamath Basin (including Trinity River) Chinook run and has contributed an average of 10 percent of the basin-wide natural spawning escapement during the period from 1978 to 2015 (Table 6). A comparison of Shasta River escapement to Klamath Basin escapement is shown in Figure 14. Historically, the Shasta River was documented as a highly productive salmon stream, with a run of over 75,000 Chinook counted at the Shasta Racks (predecessor to the SRFCF) in 1935.

Efforts have been underway in recent years by the Department, the Shasta Resource Conservation District (RCD), and local landowners to coordinate the timing and magnitude of irrigation diversions during critical weeks in September to ensure adequate flows when adult Chinook begin to enter the river and before the irrigation season ends on October 1<sup>st</sup>.

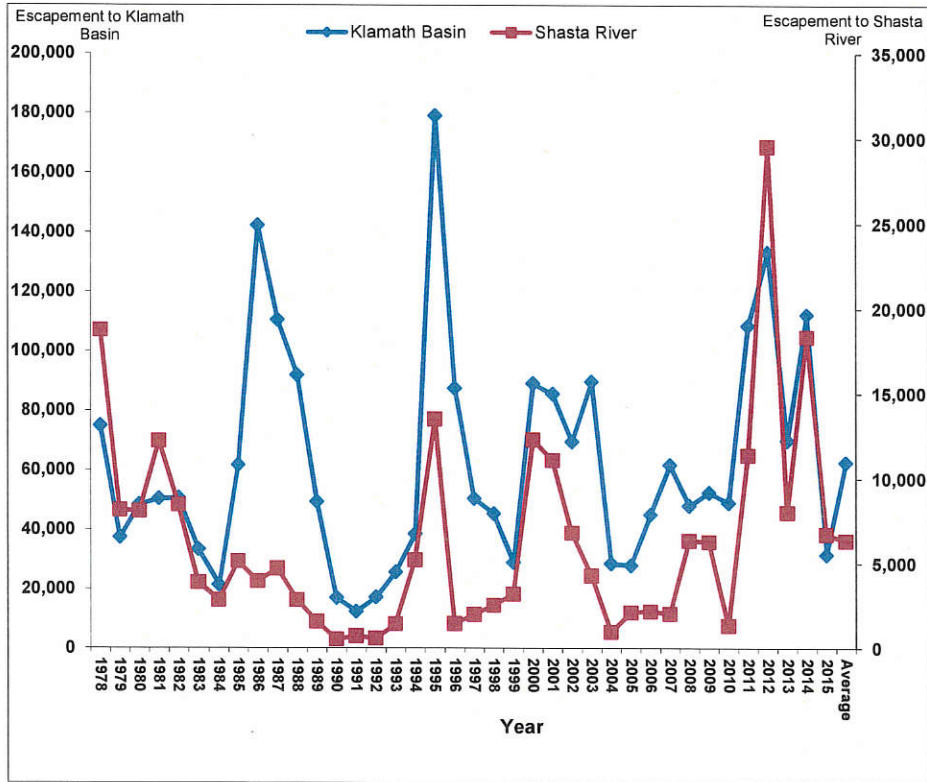


Figure 14. Chinook natural spawner escapement to the Klamath Basin (left axis) and Shasta River (right axis), 1978-2015.

**Table 6. Natural Chinook Spawner Escapement to Klamath Basin and Shasta River, 1978-2015.**

Year	Chinook Natural Spawner Escapement		% Shasta
	Klamath Basin	Shasta River	
1978	74,906	18,731	25%
1979	37,398	8,151	22%
1980	48,465	8,096	17%
1981	50,364	12,220	24%
1982	50,597	8,455	17%
1983	33,310	3,872	12%
1984	21,349	2,842	13%
1985	61,628	5,124	8%
1986	142,302	3,957	3%
1987	110,489	4,697	4%
1988	91,930	2,842	3%
1989	49,377	1,577	3%
1990	16,946	533	3%
1991	12,367	726	6%
1992	17,171	586	3%
1993	25,683	1,426	6%
1994	38,578	5,203	13%
1995	179,118	13,511	8%
1996	87,500	1,450	2%
1997	50,369	2,001	4%
1998	45,343	2,542	6%
1999	28,904	3,197	11%
2000	89,122	12,296	14%
2001	85,581	11,093	13%
2002	69,502	6,818	10%
2003	89,744	4,289	5%
2004	28,516	962	3%
2005	27,931	2,129	8%
2006	45,002	2,184	5%
2007	61,741	2,036	3%
2008	48,073	6,362	13%
2009	52,499	6,287	12%
2010	49,031	1,348	3%
2011	108,612	11,388	10%
2012	133,361	29,544	22%
2013	69,986	8,021	11%
2014	112,343	18,357	16%
2015	31,596	6,745	21%
<b>Average</b>	<b>62,546</b>	<b>6,358</b>	<b>10%</b>



## Coho Salmon

Coho returns to the Shasta River from 1978 to 2015 are shown in Figure 17. Sampling from 1983 to 2000 cannot be directly compared to other years, as the weir was removed on or before November 11th during those years and sampling does not represent the entire run of coho. Estimates of hatchery origin adult coho salmon entering the Shasta River from 2007-2015 are shown in Figures 18-20. In 2015, no coho carcasses were recovered in the spawning ground survey or as weir wash backs, and definitive presence or absence of a left maxillary clip could not be determined from video footage, so estimates of hatchery origin and natural origin coho were not made.

The decline of coho populations in the Klamath Basin, and the Shasta River in particular, has led to much discussion on the cost and benefits of different recovery strategies. The Hatchery Genetic Management Plan (HGMP) recently adopted for IGH identifies the IGH coho program as an integrated recovery program. This type of program is designed to aid in the recovery and conservation of a natural population, and the fish produced are intended to spawn in the wild or be genetically integrated with the targeted natural population (HGMP, 2013). The consensus among salmon geneticists involved in Shasta River coho management is that risk of extinction (due to inbreeding and difficulty finding mates) outweigh any negative effects of IGH fish straying and spawning in the Shasta River. Current research by Galbreath et al (2014) indicates that domestication effects carried by hatchery-origin coho that spawn in natural areas are moderated within as few as two generations by selection pressures encountered in the natural environment. Improved, genetically-based brood stock management practices at IGH are intended to increase the genetic diversity and fitness of IGH coho and their progeny, so that during periods of extreme low abundance of Shasta River coho the straying of IGH fish into the Shasta River will benefit the Shasta River coho population and its recovery.

Ongoing rotary trap operations at the mouth of the Shasta River (Debrick et al, 2015) have resulted in reports documenting annual smolt point estimates which, along with annual adult escapement estimates, can provide a means of estimating the survival of Shasta River coho from outmigration to adult escapement (Table 8).

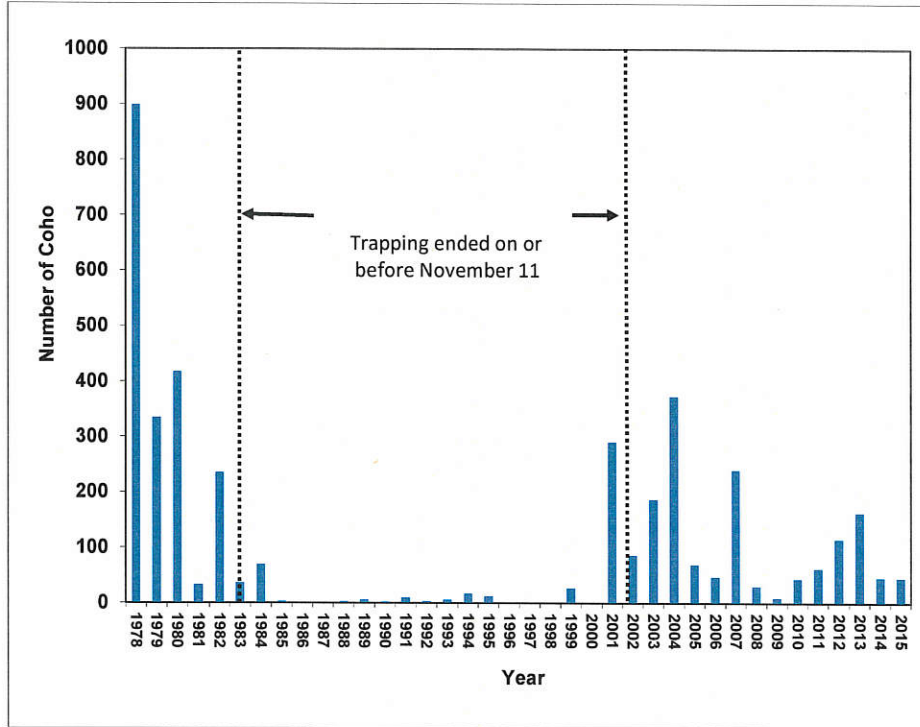


Figure 17. Returns of coho salmon to the Shasta River, 1978-2015.

Table 7. Estimates of hatchery strays as percentage of coho entering the Shasta River, 2007-2015.

Year	Total Number of Coho	Hatchery Stray Estimate	Percent Hatchery
2007	249	5	2%
2008	30	22	73%
2009	9	2	22%
2010*	44	11	25%
2011*	62	44	71%
2012*	115	81	70%
2013*	163	101	62%
2014*	46	37	80%
<b>AVERAGE</b>			<b>51%</b>

\* in 2010-2015, surplus adult coho were PIT tagged and released after entering Iron Gate Hatchery. Hatchery composition was not estimated in 2015 as no coho carcasses were recovered.

**Table 8. Coho smolt abundance point estimates, adult coho abundance estimates, ratio of smolts to adult returns and proportion of smolts that returned as adults by brood year for the Shasta River, Brood Years 2001-2012.**

Brood Year	Smolt Year	Smolt Point Estimate	Age 2 Return Year	Age 3 Return Year	Age 2 return	Age 3 return	Age 2&3 return	Percent smolt survival
2001	2003	11052	2003	2004	*	373	373	3.37%
2002	2004	1799	2004	2005	*	69	69	3.84%
2003	2005	2054	2005	2006	*	47	47	2.29%
2004	2006	10833	2006	2007	*	244	244	2.25%
2005	2007	1178	2007	2008	*	9	9	0.76%
2006	2008	208	2008	2009	*	7	7	3.37%
2007	2009	5396	2009	2010	*	33	33	0.61%
2008	2010	169	2010	2011	6	18	24	10.65%
2009	2011	19	2011	2012	32	34	66	178.95%
2010	2012	1930	2012	2013	1	61	62	3.16%
2011	2013	1618	2013	2014	6	9	15	0.56%
2012	2014	6279	2014	2015	2	37	39	0.59%

\* grilse information not available for Return Years 2001-2010.

These relationships are complicated by the difficulty of adequately estimating the contribution of hatchery-origin spawners, as well as the challenges of producing population estimates at extreme low abundance. The brood year 2009 group shows a percent smolt survival of 178.95%. It may be that the 2012 adult return of coho included fish that were not of Shasta River origin, yet were not identified as strays. The smolts observed in 2011 were the product of a very low adult return of 9 coho (7 after adjusted for hatchery contribution) in 2009, and although trapping effort and efficiency were normal in 2011 (Bill Chesney, pers. comm.), only 19 coho smolts were estimated to have left the Shasta River that year during the rotary trapping season.

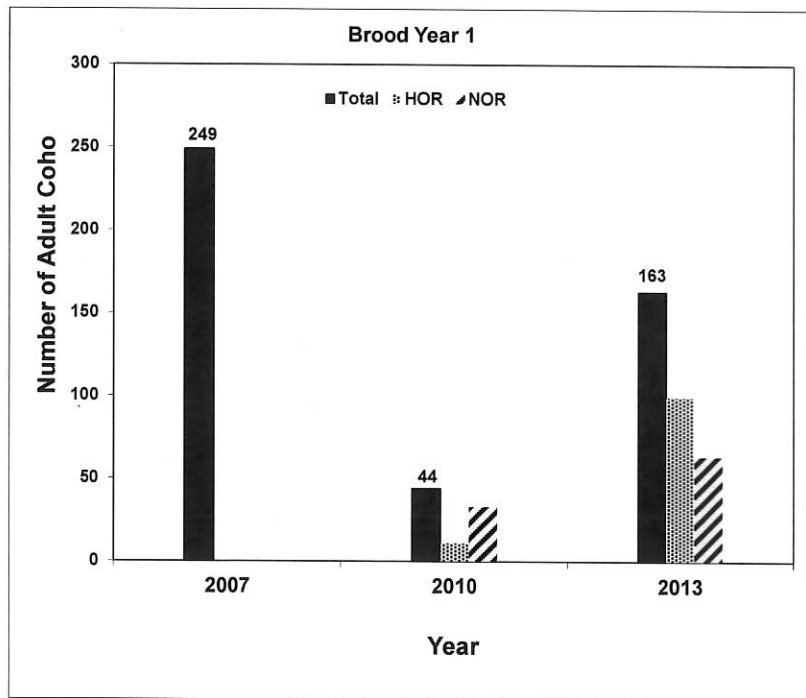


Figure 18. Three year brood cycle comparison of natural origin (NOR) and hatchery origin (HOR) coho salmon returning to the Shasta River from 2007 through 2013. Due to low carcass recovery in 2007 hatchery contribution rate was not estimated.

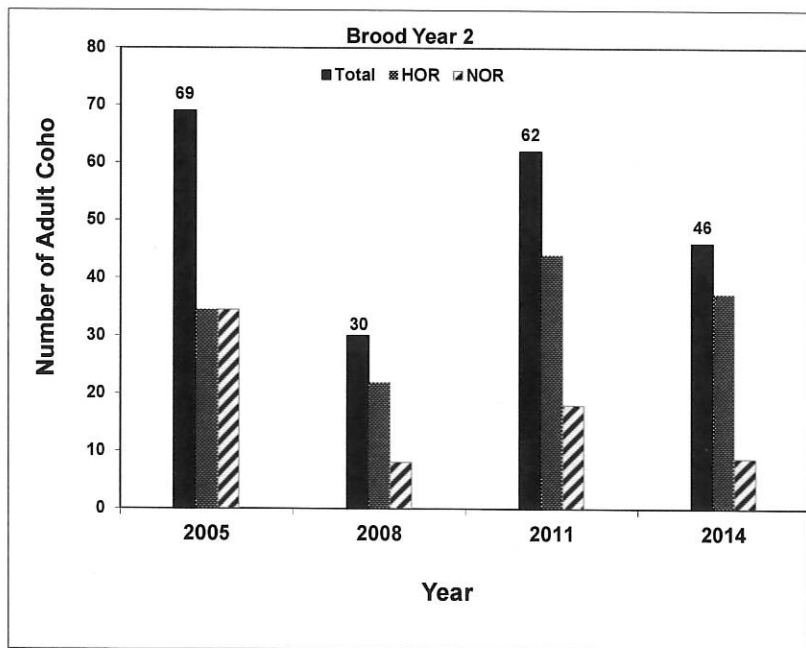


Figure 19. Three year brood cycle comparison of natural origin (NOR) and hatchery origin (HOR) coho salmon returning to the Shasta River from 2005 through 2014.

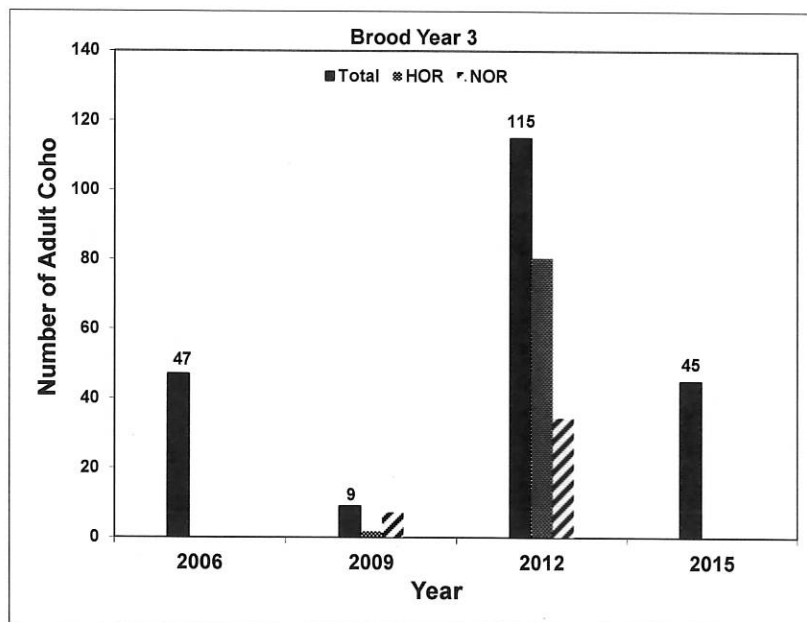


Figure 20. . Three year brood cycle comparison of natural origin (NOR) and hatchery origin (HOR) coho salmon returning to the Shasta River from 2006 through 2015. Due to low carcass recovery in 2006 and 2015, hatchery contribution rate was not estimated.

Analyzing the comparisons of estimated adult coho returns to yearling coho production estimates (Debrick et al, 2015) also produces freshwater survival estimates in the form of yearling coho produced per returning adult. The number of yearling coho produced per returning adult has averaged 19.2 and ranged from a low of 2.1 to a high of 46.6 for Brood years 2001-2013 (Table 9). As the number of yearlings produced per returning adult increases it can be inferred that in-river conditions for coho salmon are improving. Conversely as the number of yearlings produced per returning adult decreases it can be inferred that in river conditions for coho salmon are getting worse. Production is subject to variability in sex ratios of returning adults, as well as depensation effects that can occur at low population sizes. Refinements to these estimates will continue to be made in future years. As of the writing of this report, funding was not approved for operation of the rotary screw trap on the Shasta River in 2017. This will unfortunately interrupt a long-term (17-year) data set and remove a tool for evaluation of basin-wide restoration efforts, as well as a source of genetic material for current research on hatchery and wild coho interactions.

Increased straying of adult IGH coho due to releases from the IGH spawning building, as well as hatchery juveniles entering the Shasta River during their downstream migration (Bill Chesney, pers comm) and possibly imprinting on Shasta River water, have been observed in recent years. In 2013 through 2015, coho tissue samples were collected at the rotary screw trap located near the SRFCF and were provided to the NOAA salmon genetics repository in Santa Cruz, CA, where an analysis of natural versus hatchery origin composition of Shasta River coho salmon is currently underway.

**Table 9. Adult coho estimates, yearling coho production point estimates and ratio of yearling coho produced per adult return for the Shasta River, Brood Years 2001-2013.**

Adult Year Brood Year	Adult Estimate*	Yearling year	Yearling point estimate	Yearlings produced per adult
2001	291	2003	11,052	38.0
2002	86	2004	1,799	20.9
2003	187	2005	2,054	11.0
2004	373	2006	10,833	29.0
2005	69	2007	1,178	17.1
2006	47	2008	208	4.4
2007	255	2009	5,396	21.2
2008	30	2010	169	5.6
2009	9	2011	19	2.1
2010	44	2012	2,049	46.6
2011	62	2013	494	8.0
2012	115	2014	850	7.4
2013	163	2015	6,279	38.5
<b>Average</b>				<b>19.2</b>

## STEELHEAD TROUT

The objectives of the KRP have traditionally focused on monitoring the escapement of Chinook, and more recently coho salmon, however, the acquisition of an ARIS sonar detection system allowed the KRP to monitor the movements of salmonids entering the Shasta River beyond the removal of the weir on December 21, 2015. Estimating steelhead trout escapement has proven challenging due to run timing (steelhead migration is usually underway when flow conditions make weir removal necessary) and life history, as individual steelhead are often observed to move repeatedly through the video flume in upstream and downstream directions. A technical report describing the results of the 2015-16 ARIS recording season will be produced in 2016.

## ACKNOWLEDGMENTS

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## LITERATURE CITED

- California Department of Fish and Wildlife, 2013. Hatchery and Genetic Management Plan for Iron Gate Hatchery Coho Salmon V 10. Prepared for National Oceanic and Atmospheric Administration, National Marine Fisheries Service.
- Chesney, Diana and Morgan Knechtle, 2016. Recovery of Fall-run Chinook and Coho Salmon at Iron Gate Hatchery October 8, 2015 to December 3, 2015  
California Department of Fish and Wildlife, Klamath River Project, 1625 S. Main St. Yreka, CA. 96097
- Debrick, Amy J., Steven A. Stenhouse and William R. Chesney, 2015. Final Report, Shasta and Scott River Juvenile Salmonid Outmigrant Study. P0710307. Funded and prepared by the California Department of Fish and Wildlife, 1625 S. Main St., Yreka, CA. 96097 for the Shasta Valley Resource Conservation District.
- Deas, Michael, Alida Abbott and Andrew Bale, Watercourse Engineering, Inc. 2003. Shasta River Flow and Temperature Modeling Project.
- Galbreath, P. F., M. A. Bisbee, Jr., D. W. Dompier, C. M. Kamphaus, and T. H. Newsome. 2014. Extirpation and tribal reintroduction of Coho Salmon to the interior Columbia River Basin. *Fisheries* 39(2):77-87
- KRTAT (Klamath River Technical Advisory Team). 2016. Klamath River Fall Chinook Age-Specific Escapement, 2015 Run. Available from U.S. Fish and Wildlife Service, 1829 South Oregon Street, Yreka, CA, 96097.
- Stenhouse, Steven A., Amy J. Debrick and William R. Chesney, 2016  
Scott and Shasta River juvenile Chinook Salmon Out-migrant Study Multi-year Report, 2000-2015. California Department of Fish and Wildlife, Anadromous Fisheries Resource Assessment and Monitoring Program  
1625 South Main Street, Yreka, CA 96097