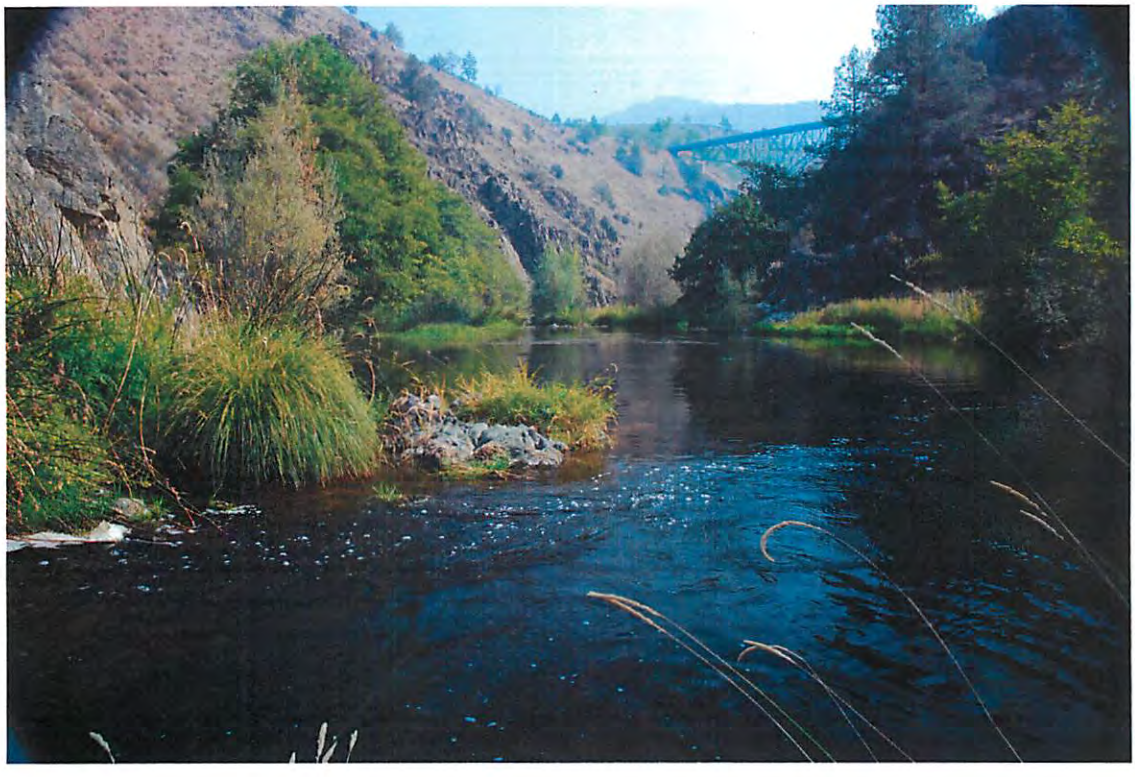
# Shasta River
# Chinook and Coho Salmon Observations in 2011-2012
# Siskiyou County, CA



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# Shasta River Fish Counting Facility, Chinook and Coho Salmon Observations in 2011-2012 Siskiyou County, CA

## ABSTRACT

A total of **11,388** Chinook salmon (Chinook, *Oncorhynchus tshawytscha*) were estimated to have entered the Shasta River during the 2011-12 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 August 31, 2011, until January 9, 2012. The first Chinook was observed on September 1, 2011, and the last Chinook on January 6, 2012. Klamath River Project staff also processed a total of 312 Chinook carcasses during spawning ground surveys, and a total of 1,631Chinook carcasses were collected as wash backs against the SRFCF weir during the season.

Sampled Chinook carcasses ranged in fork length (FL) from 37 cm to 98 cm and grilse were determined to be < 64 cm in FL. The run was comprised of 11,175 grilse (98%), and 213 adults (2%). A net total of 17 adipose-clipped (AD) Chinook were observed passing through the SRFCF during the season, and these fish were assumed to be of hatchery origin. The heads of four AD Chinook were recovered in the weir wash back sample. Tag codes indicated one 3-year-old fish and three 2-year-old fish, all tagged at Iron Gate Hatchery (IGH). Expansion of the four known tag codes and the 13 unknown tag codes based on proportions of coded-wire tags (CWTs) recovered at IGH resulted in an estimated hatchery contribution of 74 Chinook, or 0.65% of the total run observed in 2011.

A net total of **62** coho salmon (coho, *Oncorhynchus kisutch*) were estimated to have entered the Shasta River during the 2011-12 season. The first coho of the season was observed passing through the SRFCF on October 18, 2011, and the last coho was observed swimming downstream through the SRFCF on January 1, 2012. A total of 66 coho were observed passing upstream through the SRFCF and five coho were observed passing downstream, for a net number of 61 coho known to have remained in the Shasta River. In addition, one coho was added for a period of time during which the video camera was not functioning, using an average of coho observed two days prior to and two days following the camera downtime. The net number of coho to have entered and remained in the Shasta River in 2011 was **62.**

A net total of 180 adult and 505 sub-adult steelhead trout (*Oncorhynchus mykiss)* were observed passing through the SRFCF during the 2011-12 season, although the video weir operation period does not cover the entire migration period for steelhead trout.

## INTRODUCTION

The Klamath River Project (KRP) of the California Department of Fish and Game (Department) is responsible for estimating the number of fall-run Chinook salmon (Chinook, *Oncorhynchus tshawytscha*) 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.

Video equipment was first installed at the Shasta River Fish Counting Facility (SRFCF) in 1998 and is still being used to describe migration of fall-run Chinook into the Shasta River. Although the primary responsibility of the KRP is to enumerate and describe fall-run Chinook and coho salmon (coho, *Oncorhynchus kisutch*) populations, data are recorded for other salmonid species observed at the SRFCF during its period of operation as well.

In 2004, the California Fish and Game Commission proposed to add coho populations between San Francisco and Punta Gorda (Central California Coast ESU) to the State's list of Endangered Species and those between Punta Gorda and the northern border of California, including the Klamath River (Southern Oregon/Northern California Coast ESU), to the list of Threatened Species (Walsh and Hampton, 2007). Since that time, 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 and coho runs that entered the Shasta River during the fall of 2011.

## METHODS

Monitoring of the salmon run within the Shasta River is 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 to obtain biological data from salmon carcasses.

## 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 1). Fish immigrating upstream are directed through a narrow flume, which passes in front of an underwater video camera (Figure 2). A SplashCam Delta Vision black and white underwater camera was used in 2011 for capturing images, and an Everfocus EDSR 100H digital video recorder (DVR) with a Seagate 250 hard drive in a swappable Everfocus DTLA 250F tray used for recording.*

**Figure 1. Alaska-style panels of the SRFCF.**

***Use of product names in this report does not imply endorsement of the product by the California Department of Fish and Game.**

**Figure 2. Camera housing and flume, SRFCF.**

The weir and video camera were installed during the last week of August and began recording on August 31, 2011. KRP staff performed routine daily maintenance of the SRFCF. Staff inspected the video system to insure everything was operating correctly, inspected and cleaned the weir panels and made any necessary repairs, and processed any wash back carcasses present. Twice per week, on Mondays and Thursdays, the hard drive was removed from the DVR and replaced with a blank drive. All recording equipment was secured in locked enclosures (Figure 3) and access to the site was controlled through a locked gate located on private property.

**Figure 3. Digital DVR and monitor at the SRFCF.**

Hard drives with stored video data were immediately returned to the office where each was subsequently downloaded onto 1-TB external hard drives 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 lampreys or any other distinguishable marks that were visible on the footage. Fish recorded as "unknown" as to species were reviewed by project biologists. All data were then entered into files on a personal computer and each data file was edited by a second individual prior to commencement of data analysis.

## WASH BACK CARCASSES

All salmon carcasses that drifted downstream and became impinged on the weir panels were recovered and processed. Data collected on these wash back carcasses included species, gender, fork length (FL), 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. Heads were collected from each AD fish for later coded-wire tag (CWT) recovery and analysis. 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). Carcasses were then cut in half to prevent sample duplication and returned to the river downstream of the weir.

## SPAWNING GROUND SURVEYS

Spawning ground surveys were conducted on the lower seven miles of the Shasta River on publicly owned lands, on private lands where permission to access was obtained, and in the Big Springs area including the mainstem upper Shasta River, Big Springs Creek, and Parks Creek. The purpose of the spawning ground surveys was to gather biological data necessary to describe physical characteristics of the run, and to document spawning distribution. Surveys were conducted once per week and were limited to areas historically used, or believed to be used, by spawning salmon.

During each survey, crews walked along the river bank searching for salmon carcasses. As carcasses were located, crews processed each as previously described for weir wash backs. In addition to scale and tissue samples, otolith samples were collected when possible, following standard protocols, and these were archived for future life history and stock identification purposes.

### RESULTS

Operation of the SRFCF began the morning of September 1, 2011, at approximately 11:44 hours, Pacific Standard Time. The first Chinook of the season was observed on September 9, 2011, at 07:09 hours and the last Chinook was observed on January 6, 2012, at 15:33 hours. The weir and recording equipment were removed on January 9, 2012, due to anticipated high in-stream flows.

Recording was disrupted on three occasions: from 23:03 hours on November 4, 2011, until 10:15 hours on November 7, 2011 (59 hours and 47 minutes), from 16:49 hours until 17:07 hours on November 12, 2011 (28 minutes), and from 00:00 hours on November 13, 2011, until 09:29 hours on November 14, 2011 (33 hours and 18 minutes), for a season total of 93 hours and 33 minutes. These interruptions were caused by power outages or equipment failure which caused incomplete recording or download of footage.

### Chinook Salmon

A net total of 11,384 Chinook were counted passing upstream through the SRFCF during the 2011 season (Figure 4). This number was derived by subtracting the number of downstream observations (509) from the number of upstream observations (11,893). The number of Chinook which may have passed through the SRFCF during periods of video malfunctions was estimated by averaging Chinook movements during the same time period two days prior to and two days after each video malfunction. Four additional Chinook were estimated to have entered the Shasta River during the periods of equipment malfunction, yielding a total estimate of **11,388** Chinook.

Consistent with previous years' monitoring efforts, the majority of Chinook (93%) passed through the SRFCF during daylight hours between 06:00 and 17:00 hours (Figure 5). The majority of downstream movements occurred during night time hours.

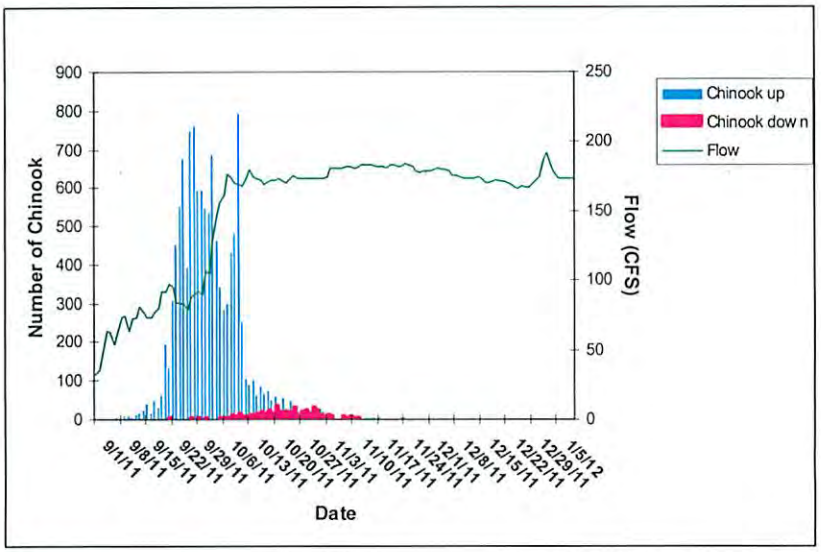



**Figure 4. Run timing and up/down movements of fall Chinook salmon at the SRFCF in 2011, and flows observed at USGS Gauge No. 11517500.**

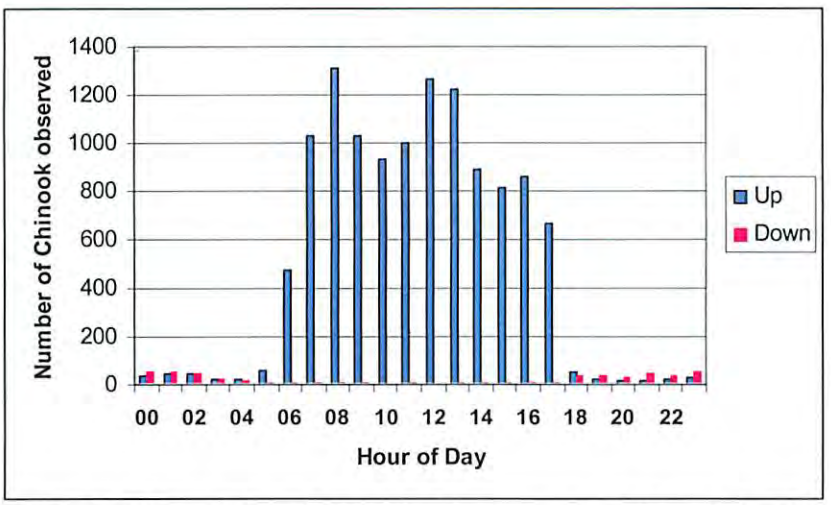



**Figure 5. Diel run timing of Chinook salmon movement through the SRFCF during the 2011 season.**

The video camera is positioned on the right side of the flume, facing downstream, and therefore, only the left side of each fish is visible to the camera as salmon migrate upstream. As staff reviewed each video tape, information was recorded on the presence of lamprey, fin clips, scars, or other abnormalities present on each fish. A total of 697 Chinook (6% of the run) were recorded as having at least one live lamprey attached to their bodies. Of these, 35 Chinook had more than one

lamprey attached, one had as many as five visible. Since the right side of each fish cannot be seen during review of video tapes, any of these abnormalities present on the right side cannot be observed. In many cases, lamprey attached to the right side of fish can be seen dangling below, above, or behind these fish as they pass through the flume. As a result, the estimated number of fish observed with lamprey attached likely underestimates the actual occurrence of lamprey attachments.

A net total of 17 AD Chinook were observed passing through the SRFCF during the season, and these fish were assumed to be of hatchery origin (Table 1). The heads from four AD Chinook were recovered from carcasses examined in the wash back sample. The tag codes recovered from these four fish indicated they were all of Iron Gate Hatchery (IGH) origin. One was a three-year-old fish and the other three were two-year-old grilse. Three of the recovered codes were from fish released as fingerlings, and the other (a two-year-old) was released as a yearling. Expansion of these CWTs by their production multipliers (the inverse of the proportion of each group of juveniles that were tagged) yielded an estimate of 16 hatchery-origin Chinook. The remaining 13 AD Chinook were observed in the video flume but not recovered. An estimate of hatchery contribution was derived based on applying the proportion of CWT recoveries observed at IGH to these 13 AD fish. Using this method, a total of 58 additional hatchery-origin Chinook were estimated to have entered the Shasta River during the 2011 run. This yields a total estimate of 74 hatchery Chinook, or 0.6% of the total run observed in 2011.

**Table 1. Estimated contribution of 17 AD Chinook salmon observed at the SRFCF in 2011 based on the number of CWT fish observed at IGH and expanded based on the production multiplier for each CWT release code.**

| CWT | BY | # CWTs Recovered | Proportion of CWTs recovered | Estimated Number | Production Multiplier | Expanded Estimate |
|---|---|---|---|---|---|---|
| 601020704 | 2006 | 1 | 0.000292826 | 0.00381 | 9.58 | 0 |
| 608020000 | 2007 | 8 | 0.002342606 | 0.03045 | 19.84 | 1 |
| 608020001 | 2007 | 4 | 0.001171303 | 0.01523 | 18.10 | 0 |
| 608020002 | 2007 | 6 | 0.001756955 | 0.02284 | 15.93 | 0 |
| 608020003 | 2007 | 7 | 0.002049780 | 0.02665 | 16.26 | 0 |
| 608020004 | 2007 | 5 | 0.001464129 | 0.01903 | 16.66 | 0 |
| 608020005 | 2007 | 10 | 0.002928258 | 0.03807 | 17.59 | 1 |
| 608020006 | 2007 | 122 | 0.035724744 | 0.46442 | 10.64 | 5 |
| 65357 | 2008 | 1 | 0.000292826 | 0.00381 | 3.99 | 0 |
| 68820 | 2008 | 2 | 0.000585652 | 0.00761 | 4.05 | 0 |
| 68642 | 2008 | 46 | 0.013469985 | 0.17511 | 4.02 | 1 |
| 68643 | 2008 | 93 | 0.027232796 | 0.35403 | 4.02 | 1 |
| 68644 | 2008 | 154 | 0.045095168 | 0.58624 | 4.03 | 2 |
| 68645 | 2008 | 257 | 0.075256223 | 0.97833 | 4.02 | 4 |
| 68646 | 2008 | 335 | 0.098096633 | 1.27526 | 4.03 | 5 |
| 68647 | 2008 | 314 | 0.091947291 | 1.19531 | 4.06 | 5 |
| 68648 | 2008 | 156 | 0.045680820 | 0.59385 | 4.02 | 2 |
| 68661 | 2008 | 16 | 0.004685212 | 0.06091 | 4.02 | 0 |
| 68662 | 2008 | 23 | 0.006734993 | 0.08755 | 4.03 | 0 |
| 68710 | 2009 | 603 | 0.176573939 | 2.29546 | 4.02 | 9 |
| 68711 | 2009 | 491 | 0.143777452 | 1.86911 | 4.01 | 7 |
| 68712 | 2009 | 335 | 0.098096633 | 1.27526 | 4.01 | 5 |
| 68713 | 2009 | 184 | 0.053879941 | 0.70044 | 4.17 | 3 |
| 68714 | 2009 | 125 | 0.036603221 | 0.47584 | 4.01 | 2 |
| 68715 | 2009 | 92 | 0.026939971 | 0.35022 | 4.04 | 1 |
| 68716 | 2009 | 25 | 0.007320644 | 0.09517 | 4.01 | 0 |
| **Totals** | | **3,415** | **1.0000** | **13** | | **58** |
| **Hatchery contribution of 13* unknown tag codes** | | | | | | **58** |
| **Expansion of 4 known tag codes** | | | | | | **16** |
| **Total estimated contribution of hatchery origin Chinook** | | | | | | **74** |
| *Unknown tag codes observed X proportion of IGH ads with wire | | | | | (13) (0 .99) | 12.87 |
| Unreadable CWTs: 100000=no CWT, 200000=CWT lost, 400000=CWT unreadable | | | | | | |

## Spawning Ground Surveys

A total of 110 redds were observed during spawning ground surveys in 2011 (Table 2). Of these, 42 were seen in the canyon reaches and 68 in the Big Springs complex (Figures 7 and 8). Species determinations of the redds were not always possible, but one redd was observed with live coho on it, and three were believed to be steelhead redds based on their dimensions.

**Table 2. Number of live Chinook and coho salmon and redds observed by date during Shasta River spawning ground surveys, 2011.**

| Reach | Description of Reach | Date | # Live Chinook | # Live Coho | # New Redds | Comments |
|---|---|---|---|---|---|---|
| 1 | Mouth to Pioneer Bridge | 10/12/2011 | 32 | | 12 | |
| 1 | | 11/9/2011 | 39 | | NR | |
| 2 | Pioneer Bridge to Salmon Heaven | 10/19/2011 | 60 | | 8 | |
| 2 | | 10/26/2011 | 183 | | 22 | |
| 2 | | 11/2/2011 | 120 | | NR | |
| 2 | | 11/9/2011 | 0 | | 0 | |
| 2 | | 11/16/2011 | 3 | | NR | |
| 20 | Main stem Shasta River, Parks Creek to Big Springs Creek | 10/19/2011 | 40 | | 6 | |
| 20 | | 10/26/2011 | 85 | | 6 | |
| 20 | | 11/9/2011 | 39 | | 1 | |
| 20 | | 11/16/2011 | 11 | | 5 | |
| 20 | | 11/23/2011 | NR | | 2 | |
| 20 | | 11/30/2011 | 0 | | 4 | |
| 20 | | 12/7/2011 | 0 | | 0 | |
| 20 | | 12/21/2011 | 0 | 0 | 0 | |
| 20 | | 12/28/2011 | 0 | 0 | 0 | |
| 21 | Big Springs Creek (upper bridge to mouth) | 10/19/2011 | 45 | | 2 | |
| 21 | | 10/16/2011 | 136 | | 1 | |
| 21 | | 11/2/2011 | 52 | | NR | |
| 21 | | 11/9/2011 | 13 | | 2 | |
| 21 | | 11/16/2011 | 1 | | 12 | |
| 21 | | 11/23/2011 | 0 | | 2 | |
| 21 | | 12/7/2011 | 1 | | 0 | |
| 21 | | 12/14/2011 | 1 | 0 | 0 | |
| 21 | | 12/21/2011 | 0 | 0 | 1 | |
| 22 | Main stem Shasta River, Parks Creek to Hidden Valley Ranch | 11/17/2011 | 0 | | 3 | |
| 22 | | 11/23/2011 | 0 | | 1 | |
| 22 | | 11/30/2011 | 0 | 2 | 4 | male and female coho on redd |
| 22 | | 12/7/2011 | 0 | | 4 | coho head on bank above redd |
| 22 | | 12/14/2011 | 0 | 0 | NR | |
| 23 | Lower Parks Creek to 2nd Fence | 11/23/2011 | 0 | | 3 | |
| 23 | | 11/30/2012 | 0 | 0 | 2 | probable Chinook redds 2mx1m |
| 23 | | 12/7/2011 | 0 | | 0 | |
| 24 | Upper Parks Creek | 11/23/2011 | 0 | | 1 | |
| 24 | | 11/30/2011 | 0 | | 3 | small redds possibly steelhead |
| 24 | | 12/7/2011 | 0 | 0 | 3 | small redds possibly steelhead |
| 24 | | 12/14/2011 | 0 | 0 | 0 | |

A total of 312 Chinook carcasses were sampled during spawning ground surveys. Of the 305 for which sex determinations were made, 16 (5%) were female and 289 (95%) were male. Fork lengths of the 305 carcasses recovered are shown in Figure 6.

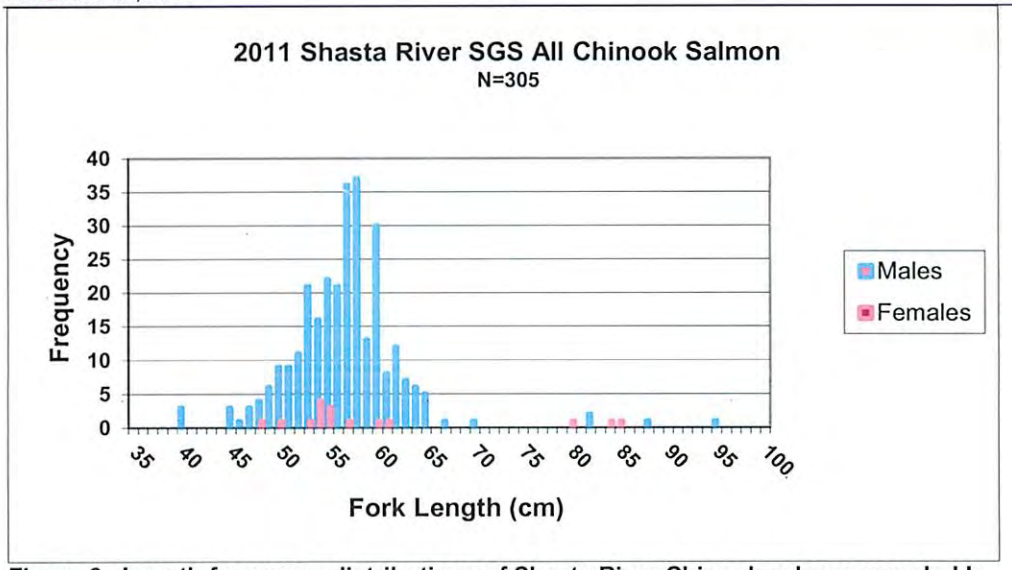



**Figure 6. Length frequency distributions of Shasta River Chinook salmon sampled In spawning ground surveys conducted during the 2011 season.**

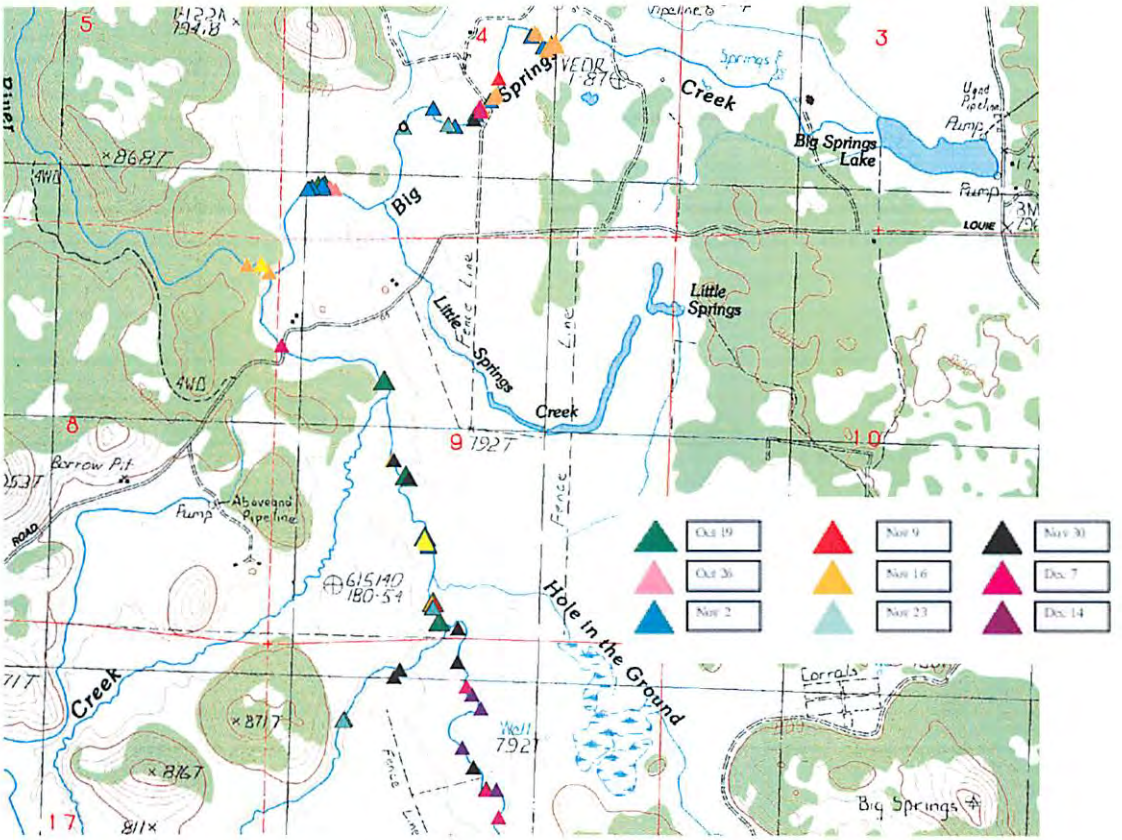



**Figure 7. Redds observed in the Big Springs area, 2011.**

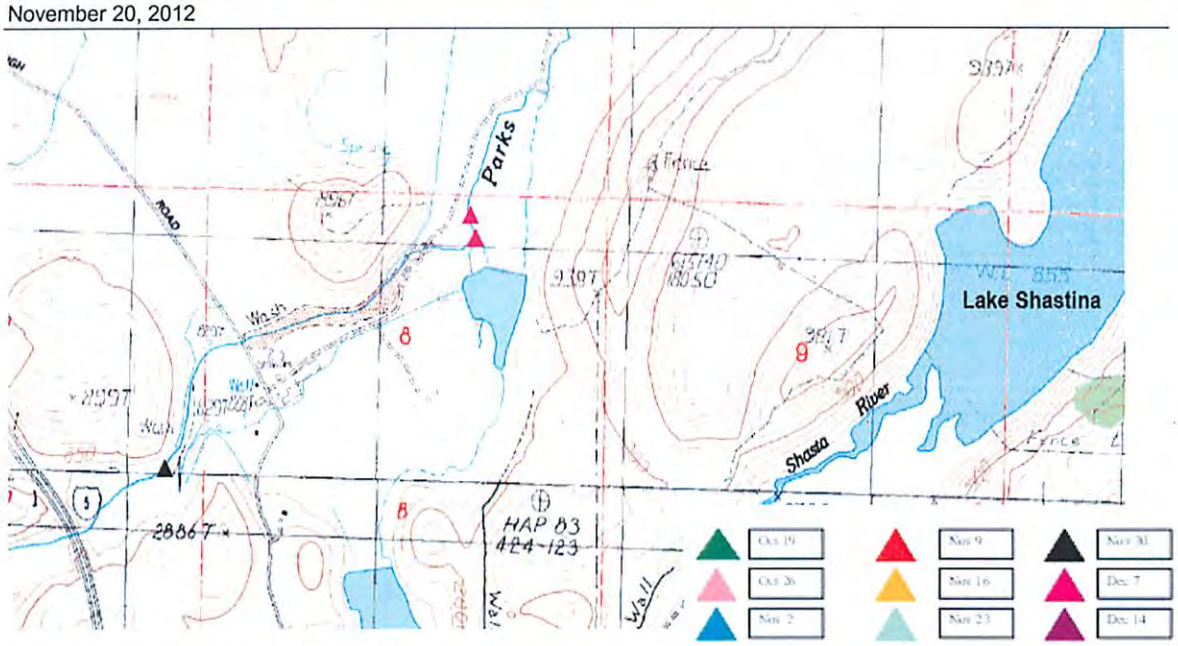



**Figure 8. Redds observed in upper Parks Creek, 2011.**

## Wash Backs

A total of 1,631 Chinook carcasses were recovered and sampled as wash backs on the weir. Of the 1,623 that were identified as to sex, seven (0.4%) were female and 1,616 (99.6%) were male. Figures 9 and 10 show the length frequency distribution of these samples. Since 2004, the wash back samples at the SRFCF have shown a heavy bias toward males (Table 3).

**Table 3. Sex composition of wash back carcasses sampled at SRFCF, 2005-2011.**

| Year | Sample Number | % Males | % Females |
|---|---|---|---|
| 2005 | 395 | 76 | 24 |
| 2006 | 457 | 94 | 6 |
| 2007 | 228 | 71 | 29 |
| 2008 | 767 | 96 | 4 |
| 2009 | 327 | 71 | 29 |
| 2010 | 118 | 83 | 17 |
| 2011 | 1,623 | 99.6 | 0.4 |
| AVERAGE | | 84 | 16 |

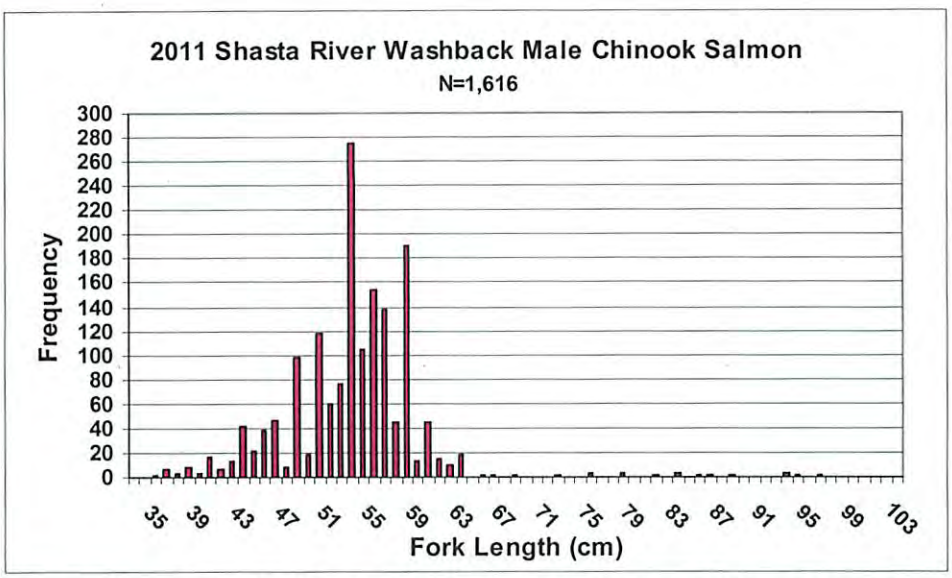



**Figure 9. Length frequency distributions of Shasta River male Chinook salmon sampled as weir wash backs during the 2011 season.**

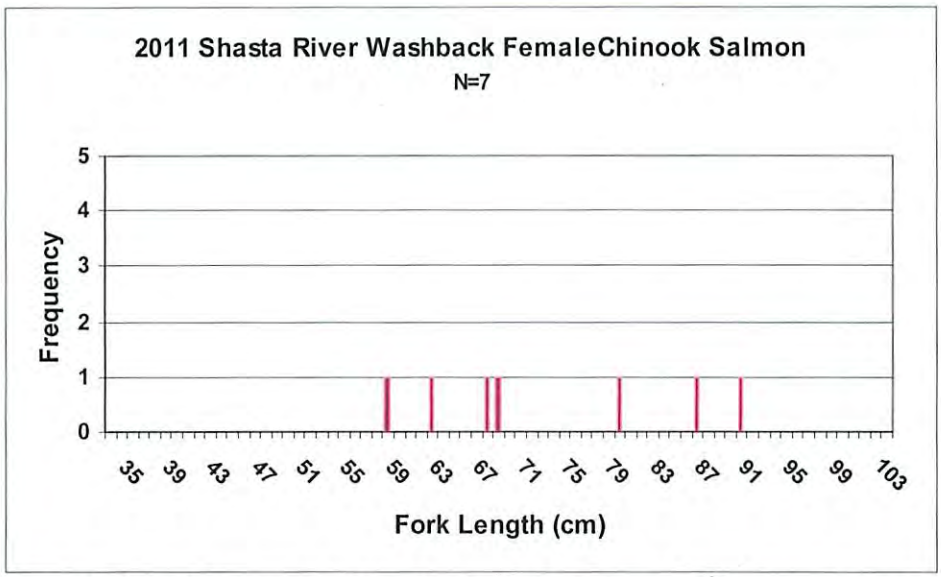



**Figure 10. Length frequency distributions of Shasta River female Chinook salmon sampled as weir wash backs during the 2011 season.**

## Grilse Cut-off

In 2011, the grilse cutoff and subsequent grilse/adult proportions of the Shasta River run were determined by scale age analysis. The KRP collected and sent a total of 1,802 scale samples from Shasta River spawning ground survey and weir wash back carcasses to the Yurok Tribe for ageing.

KRP staff examined length frequencies from spawning ground survey and wash back carcasses (N=1,928) and determined that grilse were < 64 cm in FL.

The Department estimates that the Chinook run in the Shasta River during 2011-12 was comprised of 11,160 (98%) grilse and 228 (2%) adults, for a total run-size of **11,388** Chinook salmon.

## Coho Salmon

A total of 66 coho were observed passing upstream and five coho were observed passing downstream through the SRFCF from October 18, 2011, to January 1, 2012 (Figure 11). After subtracting the five coho observed moving downstream through the SRFCF, and adding one fish estimated to have entered the river during the period of video equipment malfunction, the total number of coho that are known to have remained in the Shasta River is **62**.

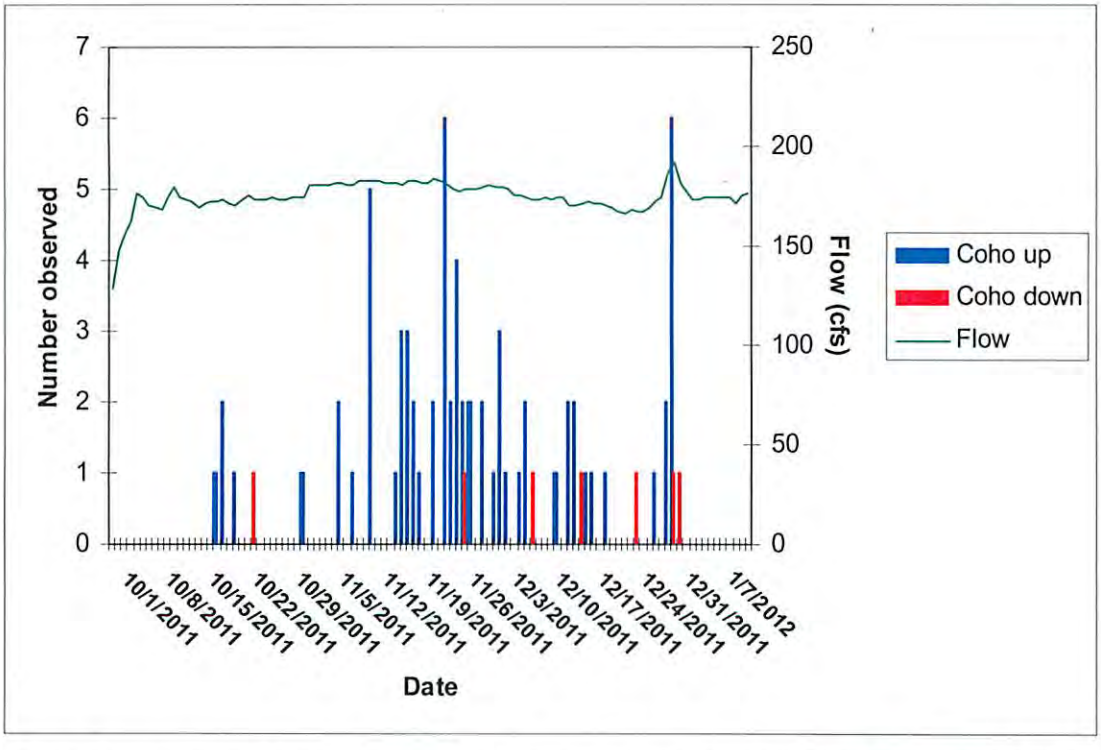



**Figure 11. Run timing of coho salmon and flow measured in average daily flows (cfs) at the mouth (USGS Gauge No. 11517500) at the SRFCF in 2011-12.**

In 2011, 259 adult coho that had entered IGH, and were in excess of the hatchery's brood stock needs, were tagged with Passive Integrated Transponder (PIT) tags and released from the IGH spawning building between October 31, 2011, and December 12, 2011. Seventeen of these PIT-tagged coho were detected by antenna arrays in the Shasta River. Sixteen were detected once at the upstream end of the SRFCF, 700 feet from the mouth of the Shasta River, and one was detected in the mainstem Shasta River near the mouth of Big Springs Creek, RM 31, and later above Parks Creek, RM 32. It is not known how far the other sixteen fish detected at the SRFCF swam up the Shasta River as they were only detected once at the arrays located at the counting station. They were not detected at the next upstream PIT-tag antenna array, located at the Nelson Ranch, RM 28.6.

Beginning in 1996, all coho released from IGH (75,000 yearlings) receive a left maxillary clip and all coho released from Trinity River Hatchery (500,000 yearlings) receive a right maxillary clip. Some video images of coho migrating through the SRFCF allow for the identification of a left maxillary clip. During the 2011 video season, 17 observations of left maxillary clips were made on coho salmon passing through the SRFCF.

Five observations were made of upstream migrating coho with lamprey attachments as they passed through the SRFCF, and of these, three were observed with at least two lamprey attachments. There was one observation of a downstream-swimming coho with a lamprey attached.

**Steelhead Trout**

In 2011, a net total of 180 adult steelhead (201 upstream, 21 downstream) and 505 sub-adults (540 upstream, 35 downstream) were estimated to have entered and remained in the Shasta River during the video recording season from August 31, 2011, to January 9, 2012 (Figure 12). Lines on the back of the video flume were set at 16 inches (40.64 cm) to delineate sub-adults versus adults.

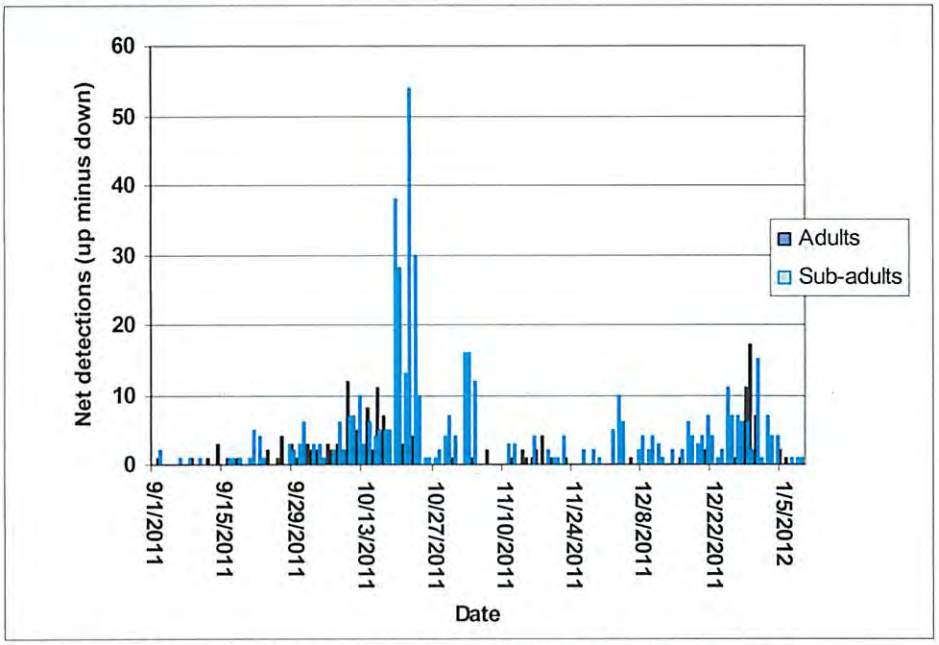



**Figure 12. Steelhead trout observations through the SRFCF in 2011.**

## Flow

In-stream flow data for the Shasta River was downloaded from the U.S. Geological Survey (USGS) Gauge No. 11517500 located near the mouth of the Shasta River north of Yreka. Flow data for the SRFCF 2011 season are shown in Figure 13.


**Figure 13. Average daily flows (cfs) in the Shasta River at USGS Gauge No. 11517500 from August 31, 2011, to January 9, 2012.**

## DISCUSSION

### Chinook Salmon

Since 1978, the run-size of fall Chinook in the Shasta River has averaged 5,263 fish, and ranged from a low of 533 fish in 1990 to a high of 18,731 fish in 1978. The 2011 fall Chinook run totaled 11,388 fish, and ranks as the 5th highest run recorded since 1978 (Figure 14). The 2011 return of two–year-old Chinook (grilse) was the highest on record for the Klamath Basin. Returns of grilse to the Shasta River were also the highest on record at 98%of the total run (Figure 15). Despite the large return of Chinook salmon to the Shasta River in 2011, only 110 redds were observed during the spawning ground surveys, compared to 291 in 2010 (D. Chesney and M. Knechtle, 2011). This is possibly explained by the low return of adult females in 2011 (estimated to be 114, or one half of the adult return) and the unusually high return of two-year-old grilse, which are predominantly male.

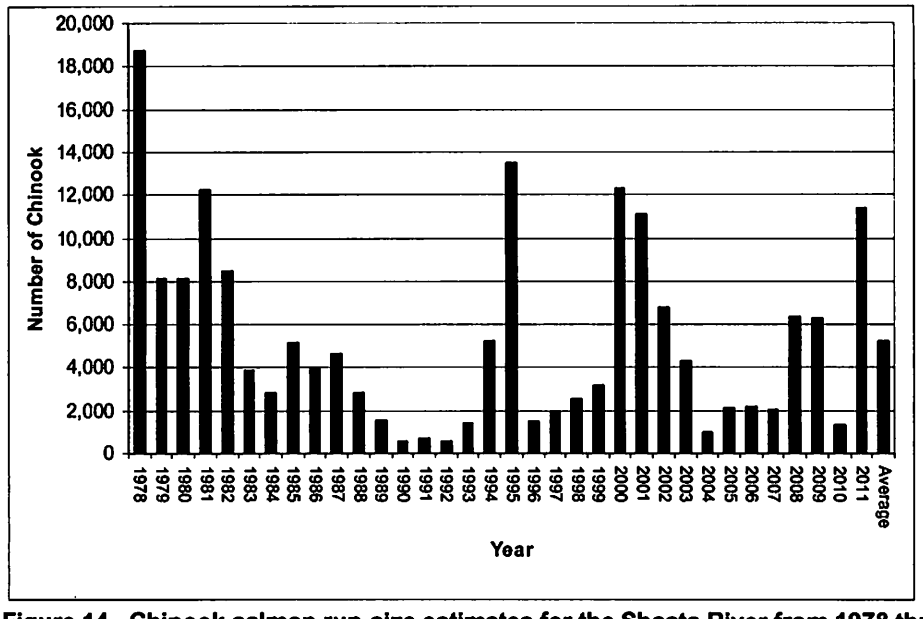



**Figure 14. Chinook salmon run-size estimates for the Shasta River from 1978 through 2011.**

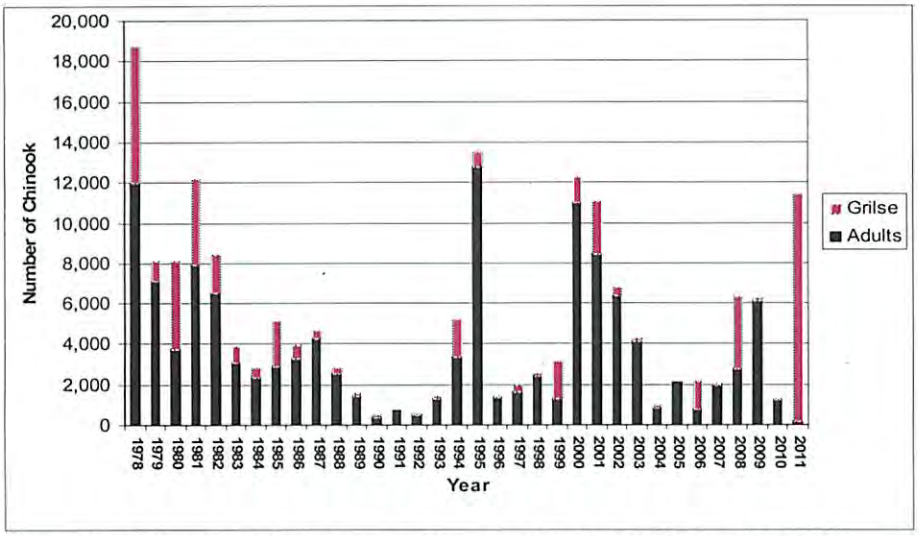



**Figure 15. Chinook adult and grilse returns to the Shasta River, 1978-2011.**

## Hatchery Straying

Since 2002, the KRP has estimated the number of hatchery-origin fall Chinook that may have strayed into the Shasta River. These estimates have been based on sample expansions from 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 AD Chinook 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 0.6% in 2011 to a high of 38.7% in 2004 (Table 4).

**Table 4. Estimates of hatchery strays as percentage of Chinook entering the Shasta River, 2002-2011.**

| 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% |
| **AVERAGE** | | | **9.6%** |

Each year, the Klamath River Technical Advisory Team (KRTAT) determines the age composition for fall Chinook populations that return to the Klamath River and its tributary streams. These analyses are based on both length frequency distributions and results of scale-age analysis conducted for each sub-basin within the Klamath River watershed. The data are used in a Klamath River Ocean Harvest Model to estimate age-specific ocean abundance and to develop harvest management recommendations for the following season. A summary of the age composition determinations for Shasta River fall Chinook are provided in Table 5.

**Table 5. Age composition of Shasta River fall Chinook salmon from 2002 through 2011 as determined by the KRTAT.**

| Year | 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 | 833 | 962 |
| 2005 | 38 | 1,409 | 600 | 82 | 2,091 | 2,129 |
| 2006 | 863 | 253 | 1,042 | 27 | 1,321 | 2,184 |
| 2007 | 27 | 1,855 | 146 | 8 | 2,008 | 2,035 |
| 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 |

The Shasta River is an important component of the Klamath Basin Chinook runs. The Shasta River has contributed an average of 9% of the basin-wide natural spawning escapement during the period from 1978 to 2011 (Table 6). As habitat conditions improve in the Shasta River watershed, the ability of the watershed to produce fish will hopefully improve. The river's current habitat conditions continue to produce more 0+ Chinook as more adults return, indicating that the watershed has not reached a "saturated level" or "carrying capacity" for Chinook (Figure 16). The Shasta River has been known for its extremely productive conditions, and at the current levels of fish abundance, the Shasta River is considered spawner-limited.

**Table 6. Klamath Basin (including Trinity River basin) and Shasta River Chinook natural spawner escapements (age 2-5), 1978-2011.**

| 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 | 110,554 | 11,388 | 10% |
| **Average** | **59,747** | **5,263** | **9%** |

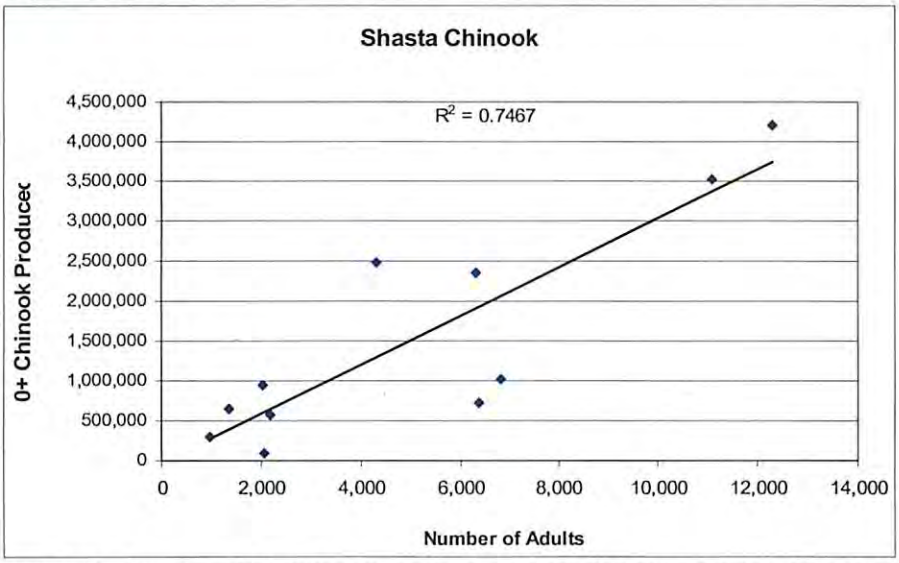



**Figure 16. Number of 0+ Chinook produced per adult spawner in the Shasta River, Brood Years 2000-2010.**

## Coho Salmon

Since 2001, the KRP has operated the SRFCF beyond the Chinook migration period in an effort to better document coho returns in the Shasta River. Returns of coho to the Shasta River from 1978 to 2011 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 11 during those years and sampling does not represent the entire run of coho. Estimates of hatchery-origin adult coho entering the Shasta River from 2007-2011 are shown in Table 7. In 2011, these estimates were derived from PIT tag detections of coho released from IGH as well as some positive identification of left-maxillary clipped coho swimming through the SRFCF video flume. In prior years when a trap was operated at the SRFCF, hatchery components were estimated from coho handled at the trap. An improved video image in 2011 allows for an increase in positive left maxillary clip identification.

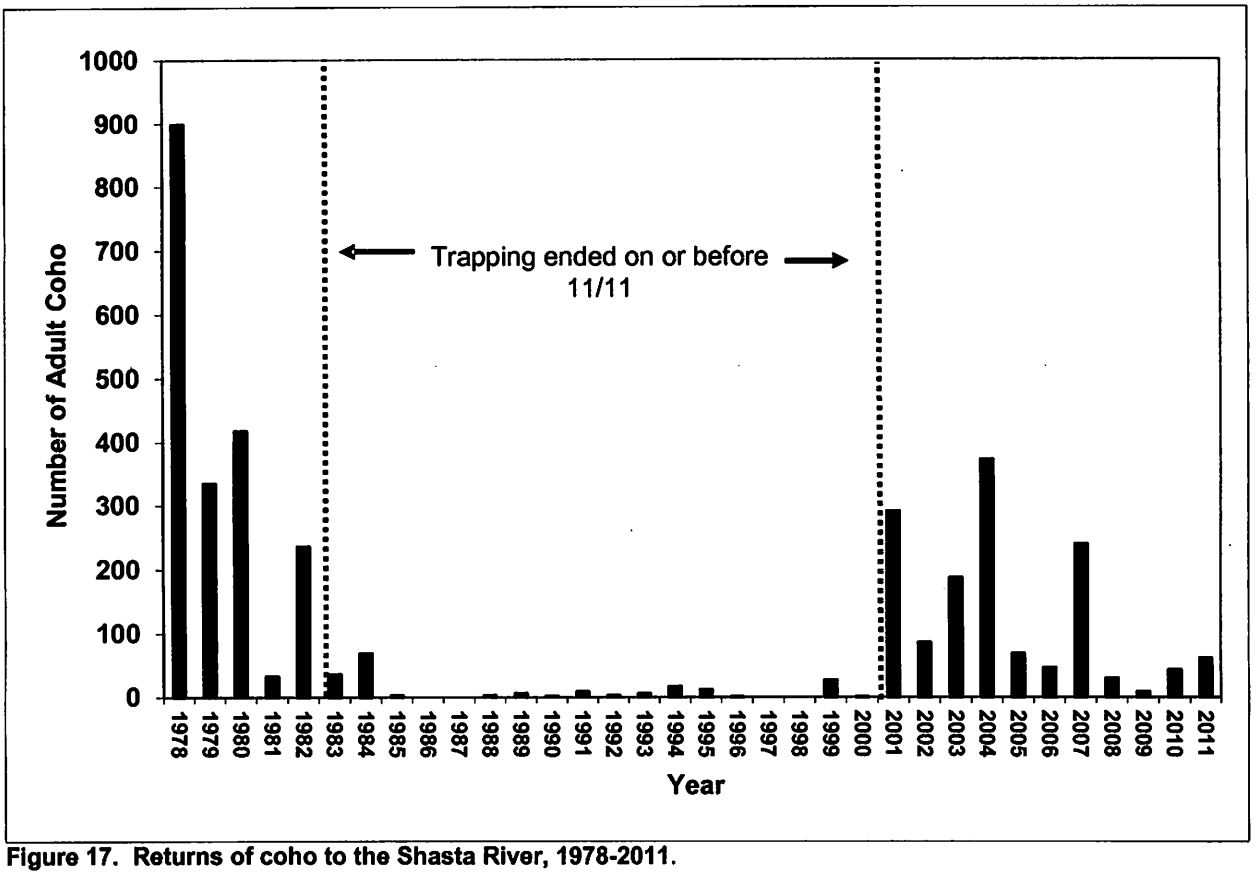



**Figure 17. Returns of coho to the Shasta River, 1978-2011.**

**Table 7. Estimates of hatchery strays as percentage of coho entering the Shasta River, 2007-2011.**

| Year | Total Number of Coho | Hatchery Stray Estimate | Percent Hatchery |
|---|---|---|---|
| 2007 | 249 | 5 | 2% |
| 2008 | 30 | 22 | 73% |
| 2009 | 9 | 2 | 20% |
| 2010 | 44 | 11 | 25% |
| 2011* | 62 | 44 | 71% |
| * In 2011, 259 adult coho were PIT tagged and released after entering IGH | | | |

Radio-tagging studies conducted in 2004 through 2009 identified two main coho spawning areas in the Shasta River: the lower six miles of canyon and the upstream area known as the Big Spring Complex (Littleton and Pisano, 2006; Olswang, 2007, 2008, and 2009). In 2010, the Department was granted limited access to Parks Creek for the purpose of conducting salmon migration studies. Both of the coho salmon radio-tagged at the SRFCF in 2010 swam up to and entered Parks Creek, although they both eventually re-entered the mainstem Shasta River and swam downstream. In 2011, no radio-tagging of coho took place; however, two live coho were observed on a redd in the mainstem Shasta River between Parks Creek (RM 32) and Hidden Valley Ranch (RM 34), confirming that coho utilize these upper reaches of the Shasta River for spawning.

Rotary screw trapping studies at the mouth of the Shasta River from 2003 to 2009 have documented the emigration of coho fry or parr in response to low flows and high water temperatures which typically occur after the start of the agricultural irrigation season on April 1 (Chesney et al, 2010). These studies concluded that high summer temperatures, low flows, and barriers to juvenile migration out of the canyon make it unlikely that the progeny of canyon-spawning coho are able to find over-summer rearing habitat in the Shasta River. Non natal rearing of juvenile coho has been documented in the Klamath River, and it is unclear how these juvenile fish contribute to the Shasta River population in future years (Hillemeier et al, 2009).

Ongoing efforts by the Department and other partners (Shasta Valley Resource Conservation District, the Nature Conservancy) to secure adequate flows in critical springs providing coho rearing habitat as well as basin-wide improvements including fencing, tailwater management, and strategically timed releases from Dwinnell Dam may be increasing the survival of juvenile coho in the Shasta River. Preliminary results from PIT tagging studies indicate that survival rates in some study reaches improved in 2012 over those observed in 2009 (Adams, 2012).

Figures 18, 19, and 20 show adult returns of three Shasta River coho cohorts. In 2011, cohort 2 showed a reversal of the downward trend seen in Shasta River coho returns in recent years. However, this may be in part due to the release of adult coho from IGH. When the 17 PIT-tagged IGH coho are subtracted from the 2011 escapement, 44 coho remain.

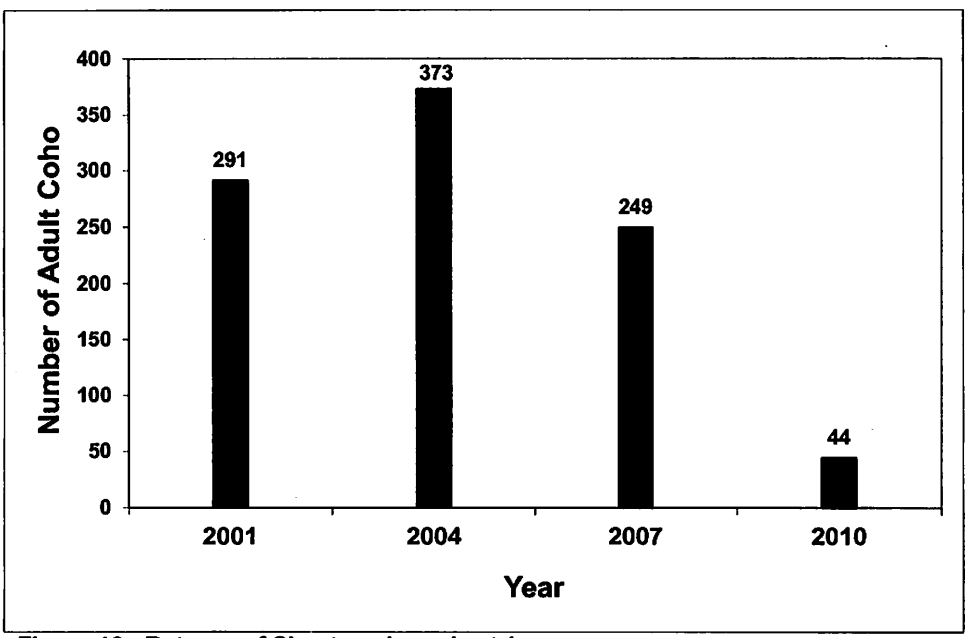



**Figure 18. Returns of Shasta coho cohort 1.**

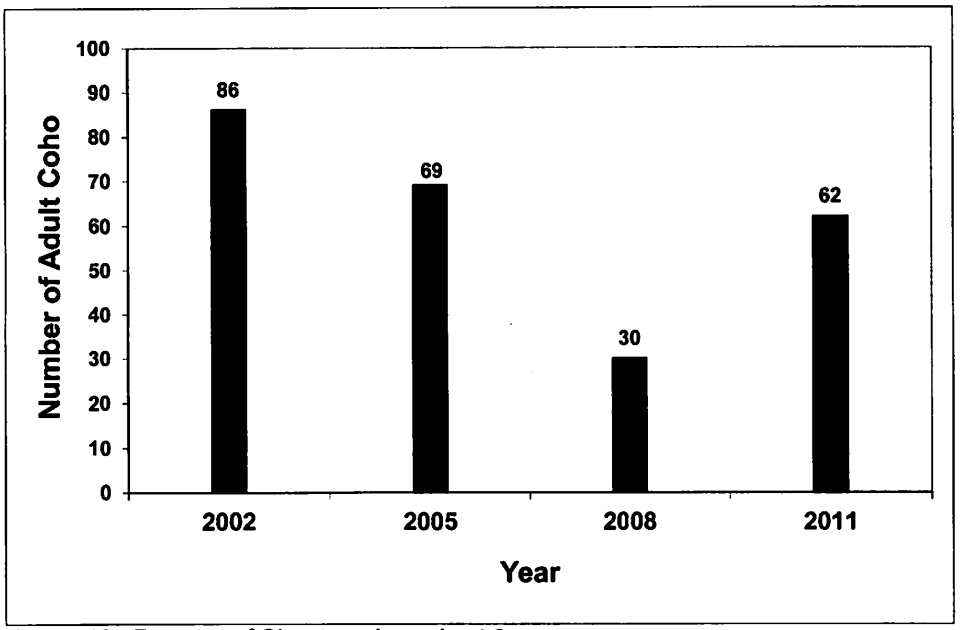
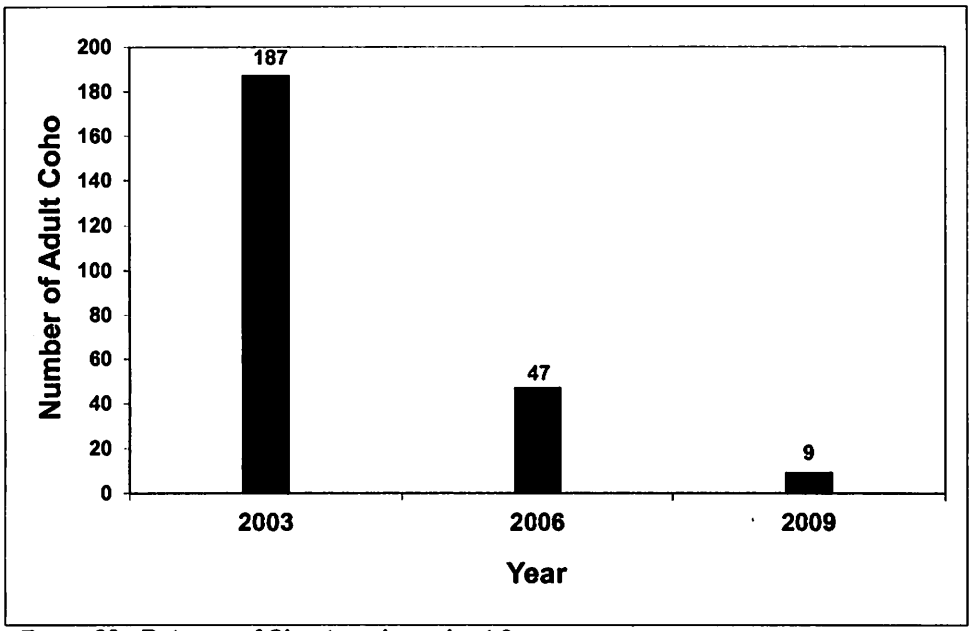



**Figure 19. Returns of Shasta coho cohort 2.**




**Fgure 20. Returns of Shasta coho cohort 3.**

Freshwater production and out-of-basin survival by brood year are shown in Table 8. Coho smolt survival ranges from a low of 0.61 to a high of 10.65. Although the proportion of smolts that survive outside of the Shasta River watershed are driven by variable factors, it is important to track this survival metric to accurately evaluate ongoing restoration efforts taking place within the watershed.

**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 2001-2008.**

| Brood Year | Smolt Year | Smolt point estimate | Adult Year | Adult Estimate | Smolts to Adults | Percent smolt survival |
|---|---|---|---|---|---|---|
| 2001 | 2003 | 11052 | 2004 | 373 | 29.63 | 3.37% |
| 2002 | 2004 | 1799 | 2005 | 69 | 26.07 | 3.84% |
| 2003 | 2005 | 2054 | 2006 | 47 | 43.70 | 2.29% |
| 2004 | 2006 | 10833 | 2007 | 244 | 44.40 | 2.25% |
| 2005 | 2007 | 1178 | 2008 | 9 | 130.89 | 0.76% |
| 2006 | 2008 | 208 | 2009 | 7 | 29.71 | 3.37% |
| 2007 | 2009 | 5396 | 2010 | 33 | 163.52 | 0.61% |
| 2008 | 2010 | 169 | 2011 | 18 | 9.39 | 10.65% |
| **Average** | | | | | | **3.39%** |

Analyzing the comparisons of estimated adult coho returns to coho smolt production estimates (Chesney et al, 2010) also produces freshwater survival estimates in the form of coho smolts produced per adult return. The number of smolts produced per returning adult has averaged 19.5 and ranged from a low of 0.9 to a high of 46.6 for brood years 2001-2010 (Table 9). As the number of smolts produced per returning adult increases, it can be inferred that in-river conditions for coho are improving. Conversely, as the number of smolts produced per returning adult decreases, it can be inferred that in-river conditions for coho 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.

**Table 9. Adult coho estimates, smolt coho production point estimates, and ratio of smolt coho produced per adult return for the Shasta River, Brood Years 2001-2010.**

| Adult Year Brood Year | Adult Estimate | Smolt Year | Smolt point Estimate | Smolts produced per adult |
|---|---|---|---|---|
| 2001 | 291 | 2003 | 11052 | 38.0 |
| 2002 | 86 | 2004 | 1799 | 20.9 |
| 2003 | 187 | 2005 | 2054 | 11.0 |
| 2004 | 373 | 2006 | 10833 | 29.0 |
| 2005 | 69 | 2007 | 1178 | 17.1 |
| 2006 | 47 | 2008 | 208 | 4.4 |
| 2007 | 249 | 2009 | 5396 | 21.7 |
| 2008 | 30 | 2010 | 169 | 5.6 |
| 2009 | 9 | 2011 | 8 | 0.9 |
| 2010 | 44 | 2012 | 2049 | 46.6 |
| | | | Average | **19.5** |

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## LITERATURE CITED

Adams, C. California Department of Fish and Game and Humboldt State University, 2012. Personal communication; BY2010 Shasta River Coho Habitat and Migration Study.

Chesney, D., and M. Knechtle. 2011. Shasta River Chinook and Coho Observations in 2010-2011, Siskiyou County, CA. Available from the California Department of Fish and Game, 1625 S. Main Street, Yreka, CA. 96097.

Chesney, W., Christopher A. Adams, Whitney B. Crombie, Heather D. Langendorf, Steven A. Stenhouse, and Kristen M. Kirkby. 2010. Shasta River Juvenile Coho Habitat and Migration Study. California Department of Fish and Game, Prepared for U.S. Bureau of Reclamation, Klamath Area Office.

Hillemeier, D. Soto, T. Silloway, S. Corum, A. Kleeman, L. Lestelle. 2009. The Role Of The Klamath River Mainstem Corridor In The Life History And Performance Of Juvenile Coho Salmon (Oncorhynchus kisutch), Yurok Tribal Fisheries Department. http://www.yuroktribe.org/departments/fisheries/documents/YTFPKlamathCohoEcologyReport2009FINAL.pdf

KRTAT (Klamath River Technical Advisory Team). 2012. Klamath River Fall Chinook Age-Specific Escapement, 2011 Run. Available from U.S. Fish and Wildlife Service, 1829 South Oregon Street, Yreka, CA, 96097.

Olswang, Mary. 2011. Shasta River Coho Salmon Radio Telemetry Investigation, 2010. Brief Preliminary Summary. California Department of Fish and Game.

Walsh, Brannon, and Mark Hampton. 2007. Shasta River Fish Counting Facility, Chinook and Coho Salmon Observations, Siskiyou County, CA. Available from California Department of Fish and Game, 1625 S. Main Street, Yreka, CA. 96097