Shasta River Fish Counting Facility, Chinook and Coho Salmon Observations in 2004, Siskiyou County, CA

By:

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ABSTRACT

An underwater video camera was operated in the flume of the Shasta River Fish Counting Facility twenty four hours a day, seven days a week, from 7 September until 8 December when high flows forced the removal of the video camera and weir. A total of 962 Chinook salmon were observed at the SRFCF during the 2004 spawning season. KRP staff processed a total of 33 carcasses during spawning ground surveys, of which, staff was able collect fork lengths for 27 fish. A total of 265 Chinook salmon carcasses were collected as wash backs against the weir during the season. Chinook salmon ranged in fork length from 39 cm to 99 cm (Figure 4) and grilse were determined to be $\leq$ 57 cm in fork length. The run was comprised of 614 (63.8%) males and 348 (36.2%) females. Based on analysis of length frequencies staff estimated that the male population of the run was comprised of 129 (13.4%) grilse and 485 (50.4%) adults. A total of 23 ad-clipped Chinook salmon were observed passing through the SRFCF indicating that these fish maybe of hatchery origin. No ad-clipped Chinook salmon were recovered during the spawning ground survey or as wash backs against the weir. Assuming that each of these ad-clip fish did in fact carry a CWT an estimate of the potential hatchery contribution to the Shasta River was derived based on the proportion of CWTs that were observed at IGH during 2004. Based on this assumption, a maximum of 372 hatchery origin Chinook, 38.7% of the run, may have strayed into the Shasta River during the 2004 season. A total of 248 Chinook salmon (25.8% of the run) had one or more lamprey attached to them as they passed through the flume.

A total of 373 coho salmon were observed passing through the SRFCF from 13 October through the early morning hours of 8 December. During the 2004 coho spawning season the Department applied a caudal clip and floy tag was applied to 337 unmarked coho salmon that entered Iron Gate Hatchery and were subsequently released providing these fish the opportunity to spawn naturally. A total of 20 coho salmon with a caudal clip and/or Floy tag were observed at the SRFCF. No coho salmon carcasses were recovered during the spawning ground surveys which ended on November 3rd. However, a total of 24 coho salmon were observed as wash backs against the weir between November 11th and December 6th. Of these, 14 were males and 10 were females. Two of the 10 females were pre spawn mortalities and 1 of the 2 pre spawn mortalities was a caudal clipped and Floy tagged coho that was previously released from IGH on November 23, 2004. Ninety (90) coho salmon were observed with lamprey attachments as they passed through the SRFCF.

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 (*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 efforts, recovery of fish returning to Iron Gate Hatchery (IGH), completion of cooperative spawning ground surveys in major tributary streams and rivers, and operation of a video fish counting weir on the Shasta River and Bogus Creek.

Video equipment was first installed at the Shasta River Fish Counting Facility (SRFCF) in 1998 and has been used to describe migration of fall-run Chinook salmon into the Shasta River ever since. Although the primary responsibility of the KRP is to enumerate and describe fall-run Chinook salmon populations with in the basin to assist harvest managers, data is recorded for

other fish species observed at the SRFCF during its normal period of operation from September through the first week of November.

The Southern Oregon Northern California Coastal coho salmon were listed as threatened by the National Marine Fisheries Service under the Federal Endangered Species Act in 1997. A petition to list coho salmon (*Oncorhynchus kisutch*) under the California Endangered Species Act was received by the California Fish and Game Commission on 28th of July, 2000. Prior to and following receipt of this petition, the Department intensified efforts to document coho salmon presence with in the Klamath River Basin and elsewhere. Consistent with this effort, the KRP has elected to continue operating the SRFCF beyond its normal period of operation in an effort to document migration of coho salmon into the Shasta River. Operation of the SRFCF has been extended through December, or until high flows force removal of equipment, since the 2001 season.

This report describes the characteristics of the Chinook and coho salmon runs that entered the Shasta River during the fall of 2004.

METHODS

Monitoring of the salmon run with in 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 needed biological data from salmon carcasses.

The SRFCF consists of a video camera, counting flume and an Alaska style weir strategically placed in a diagonal direction across the river channel. Fish immigrating upstream are directed through a narrow flume, which passes in front of an underwater video camera. The camera was connected to a time lapse video recorder and monitor. A Panasonic Color CCTV Camera Model No.WV-CP150 equipped with a 3.5 – 8mm 1:1.4 Computar lens[1] was used throughout the season. A Panasonic time lapse video cassette recorder, model AG-6740, was used to record flume observations and SVHS 120 minute video tapes were used as the recording medium. The weir and video camera was installed during the first week of September and began recording on September 7th. Recording speeds were set at 12 hour mode during the entire period of operation from September 7th to December 8th when high flows forced removal of the weir and counting system. The video recorder was set to include both a date and time stamp on every recording to accurately document run timing.

KRP staff visited the SRFCF twice daily, once in the morning and once in the evening of each day. During each visit staff inspected the video system to insure that everything was operating as anticipated, changed the video tape, inspected and cleaned the weir panels and conducted

[1] Use of trade names in this report does not imply endorsement by the Department of Fish and Game.

routine maintenance of the facility. All equipment was secured under lock and key and access to the site was also controlled through a locked gate located on private property.

All tapes were immediately returned to the office where each was subsequently reviewed by seasonal and scientific aides in the video lab. During each review staff recorded the date, time (hour:min:sec), and species of each fish observed on each video tape. In addition, staff noted any adipose fin clips (ad-clips) observed, and recorded the presence of lampreys or any other distinguishable marks that were visible on the tape. All data was then entered into computer files and each data file was subjected to two independent edits prior to commencement of any data analysis.

Any 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 identification, gender, and fork length. 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. Scale samples were then provided to the Yurok Tribal Fisheries Department for analysis. Every carcass was also examined for the presence of any fin clips, marks or tags. Heads were collected from each ad-clipped fish for later coded wire tag recovery and analysis. Each carcass was also examined to determine whether successful spawning had likely occurred. Female salmon with more than 50% of their egg mass still present in their body cavity were identified as pre-spawn mortalities. Carcasses were then cut in half to prevent sample duplication and returned to the river downstream of the weir.

Spawning ground carcass surveys were limited to the lower section of the Shasta River downstream of the Interstate 5 Bridge crossing just north of the city of Yreka. The purpose of the spawning ground surveys was to gather biological data necessary to describe the physical characteristics of the run. Surveys were limited to areas typically used by spawning salmon. During each survey crews walked along the river bank searching for salmon carcasses. As carcasses were located crews identified each to species and gender, collected a fork length measurement (cm), and a scale sample collected from the left side of each carcass above the lateral line just posterior to the dorsal fin. All of the scale samples that were collected from Chinook salmon were provided to the Yurok Tribal Fisheries Department for age determination. This information is then used to assist the Klamath Fishery Management Council in determining the age composition of fall Chinook salmon in the Klamath basin for use in harvest management determinations. Each carcass was also examined for the presence of any clips, marks or tags. Heads were collected from any ad-clipped fish for later coded wire tag recovery and analysis. All female carcasses were examined internally to determine spawning success. Females with greater than 50% of their eggs remaining in their body cavity were identified as a pre-spawn mortality. Once examined all carcasses were cut in two to prevent potential recounting during later surveys.

Spawning ground carcass surveys were scheduled to occur once a week throughout the fall Chinook salmon spawning season. The first survey occurred on October 20th and the last survey occurred on November 3rd. Spawning ground surveys were ended after November 3rd because of

the lack of carcasses that were being recovered during this effort. With limited funds, KRP staff elected to dedicate additional effort towards other spawning ground surveys on the Scott and Salmon River where video counting facilities are not present.

Flow information was obtained from the USGS gauge (# 11517500) located near the mouth of the river a short distance upstream of the SRFCF.

RESULTS

The SRFCF was operated from September 7th through December 8th of 2004. Shasta River flows began to increase dramatically the night of December 7th and by the early morning hours of December 8th flows were already approaching 500 cfs and exceeded 1,000 cfs before midnight (Figure 1). Staff began pulling the weir on the morning of December 8th and operation of the SRFCF ended at that time.

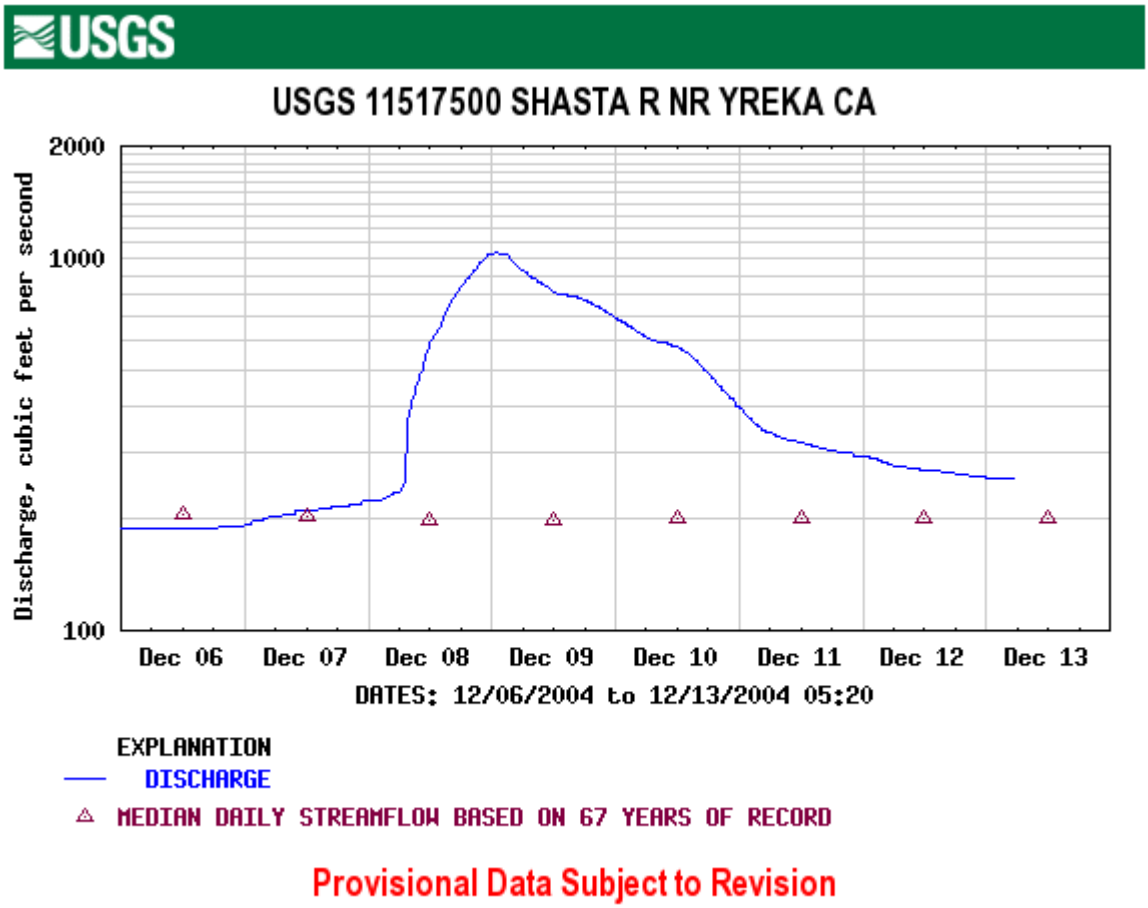

Figure 1. Shasta River flows (cfs) recorded at the USGS Gauge #11517500 from December 6 through December 13, 2004.

Chinook Salmon

A total of 962 Chinook salmon were observed at the SRFCF in 2004. The first Chinook salmon was observed passing through the video weir on September 9th and the last Chinook salmon was observed on November 10th. The run peaked on October 2nd when 60 Chinook salmon were observed passing through the SRFCF (Figure 2). KRP staff estimate that the Chinook salmon was comprised of 614 (63.8%) males and 348 (36.2%) females. Based on analysis of length frequencies staff estimate that the male population of the run was comprised of 129 (13.4%) grilse and 485 (50.4%) adults.

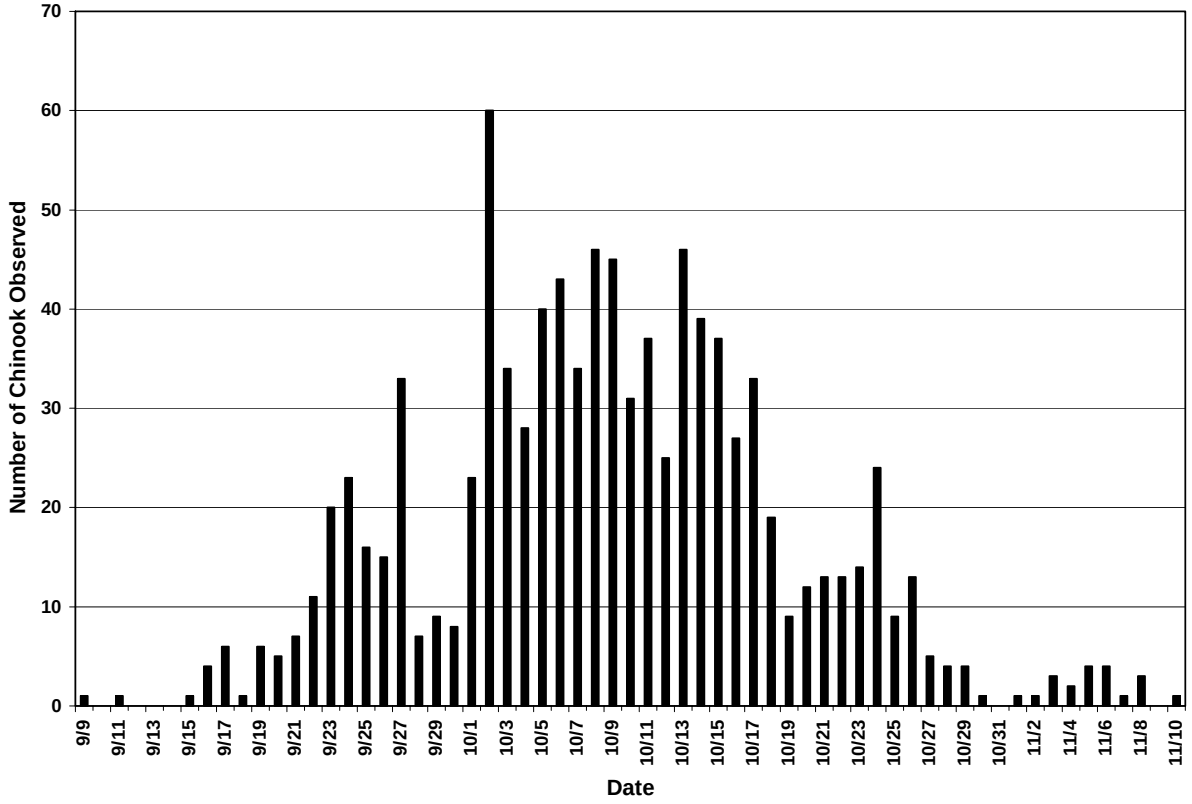

Figure 2. Run timing of fall Chinook salmon (n = 962 fish) observed at the Shasta River Fish Counting Facility in 2004.

The vast majority of Chinook salmon, 81% (784 fish) of the run passed through the SRFCF during daylight hours between 0700 hours and 1800 hours (Figure 3). During the day, movement of Chinook salmon through the flume was deliberate in nature. Peak migration times occurred in the morning and late afternoon hours. Although the number of Chinook salmon moving into the flume was much less at night, those few fish that did enter the flume appeared to be more hesitant to pass through the flume. It was not uncommon to observe individual fish entering the flume several times over a short period. Some of these fish eventually passed through the flume, while others appeared to have dropped back downstream and probably passed through the flume the following morning. There was never any indication that the weir caused

migration delays upstream as large numbers of fish were not observed holding the pool downstream of the weir for prolonged periods of time, several days, during the season.

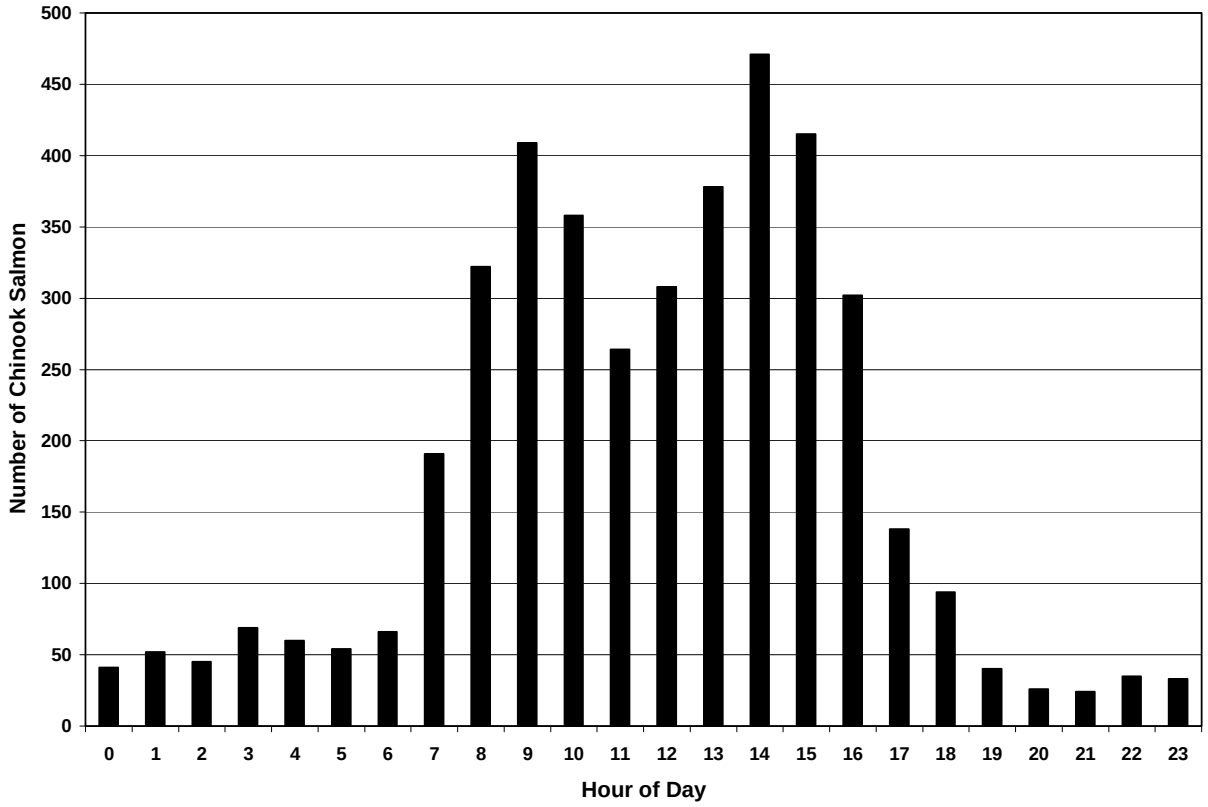

Figure 3. Diel run timing of Chinook salmon movement through the Shasta River Fish Counting Facility during the 2004 season (n= 962 fish).

The video camera is positioned on the right side of the flume, facing downstream, and therefore, 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 any lamprey, scars, ad-clips, or other abnormalities that are may be present on each fish. Since the right side of each fish cannot be seen during review of video tapes, any scars or abnormalities that may be present on the right side cannot be observed. However, in many cases, lamprey that are attached to the right side of fish can be seen dangling below, above, or behind, these fish as they pass through the flume. Regardless, an unknown number of lamprey may be attached to the right side of migrating salmon, and therefore, may not be observed by staff as these fish pass through the flume. A total of 248 Chinook salmon (25.8% of the total run) had one or more lamprey attached to them as they passed through the flume.

A total of 23 Chinook salmon that were observed passing through the video flume appeared to have an adipose fin clip (ad-clip) indicating that these fish maybe of hatchery origin. No ad-clipped Chinook salmon were recovered during the spawning ground survey or as wash backs against the weir. Since the heads of these 25 fish could not be recovered for tag extraction or

verification a direct estimate of the total hatchery contribution could not be derived. However, if we assume that each of these ad-clip fish did in fact carry a CWT an estimate of the potential hatchery contribution to the Shasta River could be derived based on the proportion of CWTs that were observed at IGH during 2004 (Table 1). This assumes that the proportion of hatchery strays into the Shasta River is equivalent to the proportion of CWT recoveries observed at IGH. Based on these assumptions, a maximum of 372 hatchery origin Chinook salmon may have strayed into the Shasta River during the 2004 season.

Table 1. Estimated contribution of 23 ad-clipped Chinook salmon observed at the SRFCF derived based on the proportion of CWT fish actually observed at IGH and expanded based on the production multiplier for each CWT release code.

Coded Wire Tag (CWT)	Brood Year	# of CWTs Observed at IGH	Proportion of CWTS Observed at IGH	Predicted # of CWTs from SRFCF ad-clips observed	CWT Production Multiplier	Hatchery Contribution Estimate for SRFCF
0601020309	1999	2	0.0027739	0.09	27.493310	3
0601020310	1999	1	0.001387	0.05	27.493467	1
601020311	1999	1	0.001387	0.05	27.493844	1
066351	1999	9	0.0124827	0.42	11.459130	5
066352	1999	4	0.0055479	0.19	11.459217	2
0601020305	2000	8	0.0110957	0.38	17.686251	7
0601020306	2000	5	0.0069348	0.24	17.756772	4
0601020307	2000	10	0.0138696	0.47	39.298861	19
0601020308	2000	14	0.0194175	0.66	32.435287	21
066353	2000	99	0.1373093	4.67	9.643396	45
066354	2000	207	0.2871012	9.76	8.509615	83
0601020400	2001	1	0.001387	0.05	17.497881	1
0601020401	2001	2	0.0027739	0.09	17.974168	2
0601020402	2001	2	0.0027739	0.09	33.094991	3
0601020403	2001	2	0.0027739	0.09	30.663112	3
066355	2001	161	0.223301	7.59	9.324618	71
066356	2001	74	0.1026352	3.49	10.550473	37
066357	2001	70	0.0970874	3.30	9.806446	32
0601020404	2002	13	0.0180305	0.61	16.317343	10
0601020405	2002	10	0.0138696	0.47	15.744139	7
0601020406	2002	6	0.0083218	0.28	32.965040	9
0601020407	2002	1	0.001387	0.05	28.465702	1
066358	2002	4	0.0055479	0.19	10.522401	2
066359	2002	5	0.0069348	0.24	9.998251	2
066360	2002	1	0.001387	0.05	7.988021	0
Total =		**712**		**23**		**372**

KRP staff processed a total of 33 carcasses during spawning ground surveys, of which, staff was able collect fork lengths for 27 fish. The remaining 6 carcasses were partially eaten preventing accurate fork length measurements for these fish. Gender could be determined for 30 carcasses and of these 26 were males and 4 were females. A total of 265 Chinook salmon carcasses were collected as wash backs against the weir during the season. Of the 265 fish processed, 239 were males and 26 were females. Chinook salmon ranged in fork length from 39 cm to 99 cm (Figure 4) and grilse were determined to be $\leq$ 57 cm in fork length.

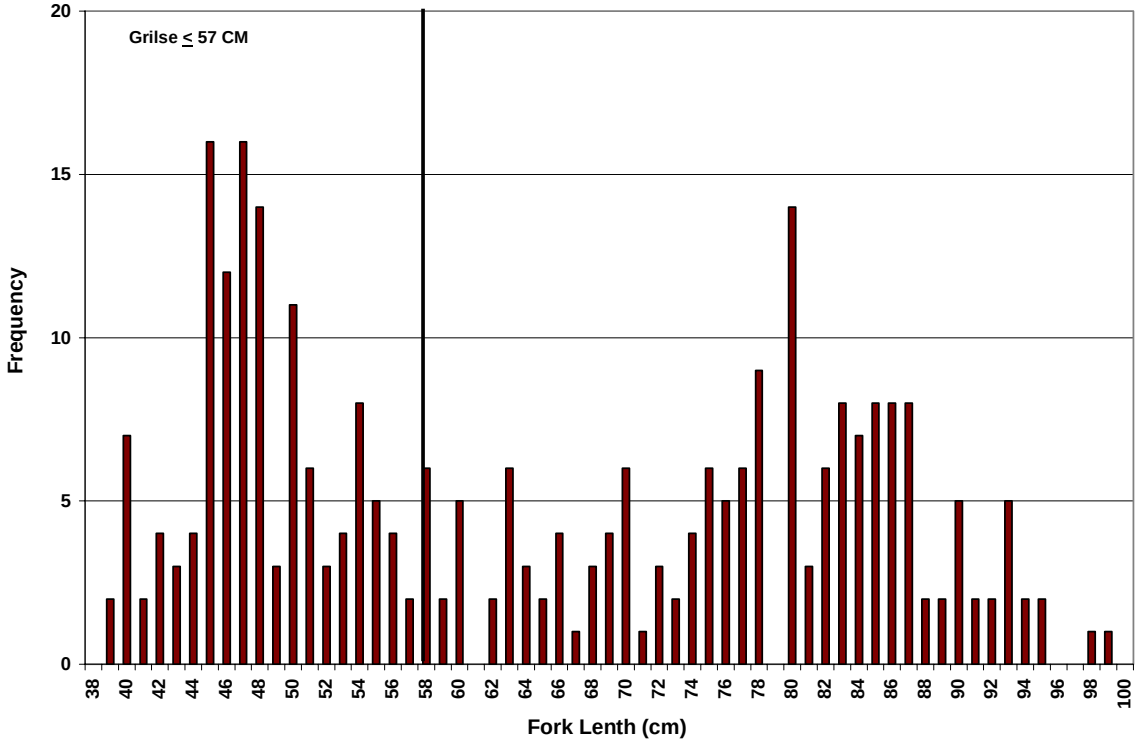

Figure 4. Fork length frequency distribution of Chinook salmon examined (n = 292) during spawning ground carcass surveys and as wash backs against the SRFCF during the 2004 season.

Coho Salmon

A total of 373 coho salmon were observed passing through the SRFCF from October 13th through the early morning hours of December 8th, when operations of the weir were forced to end due to high flows (Figure 5). The numbers of coho salmon that may have entered the Shasta River after December 8th is unknown therefore, the estimated 373 coho salmon that were observed certainly under estimate the actual number that coho salmon that entered the Shasta River during the 2004–2005 season. No coho salmon carcasses were recovered during the spawning ground surveys which ended on November 3rd. However, a total of 24 coho salmon were observed as wash backs against the weir between November 11th and December 6th. Of

these, 14 were males and 10 were females. Two of the 10 females were pre spawn mortalities and 1 of the 2 pre spawn mortalities was a caudal clipped and Floy tagged coho that was previously released from IGH on November 23, 2004.

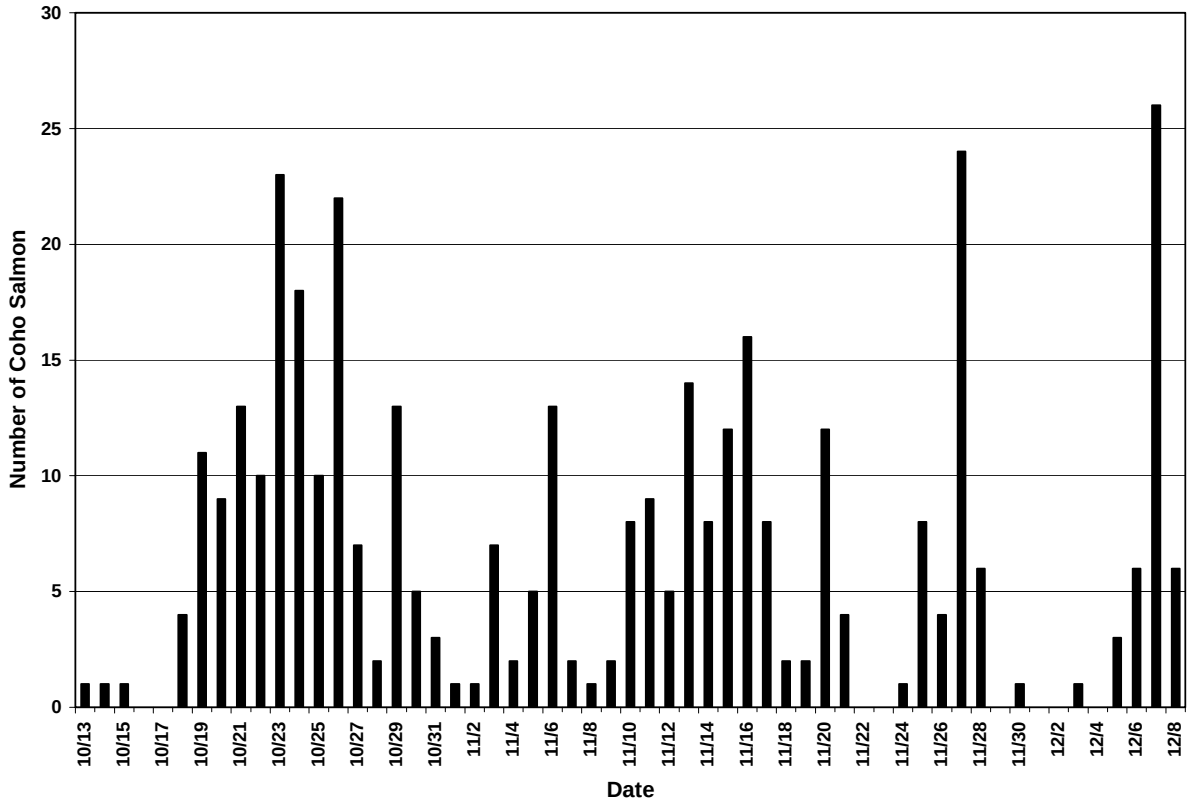

Figure 5. Run timing of coho salmon observed at the Shasta River Fish Counting Facility in 2004 (n = 373).

Two of the 373 coho salmon that were observed on the video tapes from the SRFCF appear to have been ad-clipped indicating that these fish were likely of hatchery origin. California does not apply an ad-clip to hatchery coho salmon released from state operated facilities. However, the Oregon Department of Fish and Wildlife (ODFW), in collaboration with NOAA fisheries, does mark coho salmon hatchery releases with a combination of external clips and/or CWTs for fishery management research purposes. The closest of these hatcheries is Cole Rivers Hatchery located at the base of Lost Creek Dam on the Rogue River about 153 river miles upstream from the Pacific Ocean on the Southern Oregon Coast. Cole Rivers Hatchery releases 200,000 coho salmon smolts annually, which include, 150,000 fish with an ad-clip only, 25,000 fish with an ad-clip and CWT, and 25,000 fish that are tagged with a CWT and are not ad-clipped. Since Oregon has an extensive coho salmon marking and tagging program, incorporating various hatcheries along the Southern Oregon Coast, it is impossible to determine the precise origin of the ad-clipped coho salmon observed at the SRFCF without specific CWT recovery information.

However, it appears likely that the ad-clipped coho salmon observed at the SRFCF originated from Oregon hatchery stocks that strayed into the Shasta River during the 2004 season. Beginning in 1996, all coho salmon released from IGH (75,000 yearlings) receive a left maxillary clip and all coho salmon released from TRH (500,000 yearlings) receive a right maxillary clip. Unfortunately, the picture quality of the video tapes does not allow for accurate determination of the presence of a maxillary clip. Therefore, the potential contribution of IGH coho salmon cannot be determined from video tape review. In addition, the video only records the left side of each fish as they pass through the flume on their upstream migration. Therefore, any coho salmon with a right maxillary clip (TRH) would not be visible even if the picture quality were good enough to detect the presence of this clip. IGH is not the only hatchery along the Pacific Coast that uses a left maxillary clip. No maxillary clips were observed on coho salmon carcasses that washed back against the weir panels during the 2004 season.

In the fall of 2004, the Department, in collaboration with NOAA Fisheries, initiated a new program intended to reduce potential take of unmarked coho salmon that enter Iron Gate Hatchery. Under this program all unmarked coho, with the exception of a small number of fish (10) that were incorporated into the spawn with marked coho, were released back to the river providing them the opportunity to spawn naturally. Prior to release, each unmarked coho was given an upper caudal clip and an individually numbered Floy tag. These marks were applied to allow the Department and others to track the movements of these fish after release from the hatchery. The caudal clip provided a means to easily identify these fish should they pass through one of the video fish counting facilities which are operated by the Department on Bogus Creek and the Shasta River. In addition, the U.S. Fish and Wildlife Service inserted radio tags to 40 adult unmarked coho salmon at the hatchery which were then released back to the river. A total of 337 unmarked coho salmon were Floy tagged and 40 coho were radio tagged by USFWS and released from IGH during the 2004 season.

A total of 20 coho salmon with caudal clips and/or Floy tags attached (unmarked coho released from IGH) were seen passing through the SRFCF. Three (3) coho salmon with caudal clips and a Floy tag were recovered at the SRFCF as wash backs and additional information about these fish is presented in Table 2.

Table 2. Information for 3 unmarked coho salmon that were tagged and released from IGH and subsequently recovered at the SRFCF as wash backs.

Floy Tag #	Fork Length	Sex	IGH Release Date	SRFCF Recovery Date
BT1911	59	F	11/5/2004	11/23/2004
SB1350	78	M	11/12/2004	12/3/2004
SB1799	72	F	11/19/2004	12/6/2004

Ninety (90) coho salmon were observed with lamprey attachments as they passed through the SRFCF. Since any lamprey attached to the fishes right side may not be visible on the video the number of coho salmon with lamprey attachments may actually be slightly greater. Nevertheless, approximately 24.1% of the coho salmon run had lamprey attached to them as they entered the SRFCF.

Other Species Observed

In addition to Chinook and coho salmon, the SRFCF also records the presence of other species that are recorded on the video tapes as they pass through the flume. Approximately 1,700 steelhead/rainbow trout (*Oncorhynchus mykiss*) was observed passing through the SRFCF facility during the season. These were comprised of both juvenile and adult fish. The data collected for steelhead trout was provided to the Department's Anadromous Fish Research and Monitoring Program (SRAMP) office in Yreka for analysis and reporting and is not discussed further in this report.

A total of 9 Centrarchid species were observed moving through the SRFCF from September 9th to September 21st. Two of these fish could be identified as largemouth bass (*Micropterus salmoides*), three were smallmouth bass (*Micropterus dolomieui*) and the remaining four fish were likely green sunfish (*Lepomis cyanellus*) or another common sunfish species.

A total of 180 Klamath smallscale sucker (*Catostomus rimiculus*) were observed at the SRFCF moving upstream into the Shasta River from the Klamath River between September 9th and November 11th. Migration of Klamath smallscale suckers peaked between October 1st and October 7th.

A total of 8 speckled dace (*Rhinichthys osculus*) were observed moving the SRFCF from September 11th to October 10th.

Flow

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. Complete flow records are available for this gauge for water years 1934 through 1941 and 1946 to present day. Flow data for the 2004-2005 water year is provisional at this time and may be subject to revision once these records have been finalized by the USGS. Annual discharge volumes in the Shasta River have ranged from a low of 56,299 acre feet (AF) in 1934 to a high of 263,128 AF in 1974.

Average daily flows in the Shasta River from September 1st through December 31st of 2004 ranged from a low of 39 cubic feet second (cfs) to a high of 797 cfs and averaged 174 cfs (Figure 6). The irrigation season on the Shasta River officially ends on October 1st of each year, after which time flows in the Shasta River typically increase dramatically. In September average daily flows in the Shasta River ranged from 39 to 100 cubic feet per second (cfs) and averaged 69 cfs. Flows gradually increased through the month of October and ranged from 100 cfs to 222

cfs and averaged 170 cfs. During November average daily flows remained fairly stable and ranged between 174 and 206 cfs.

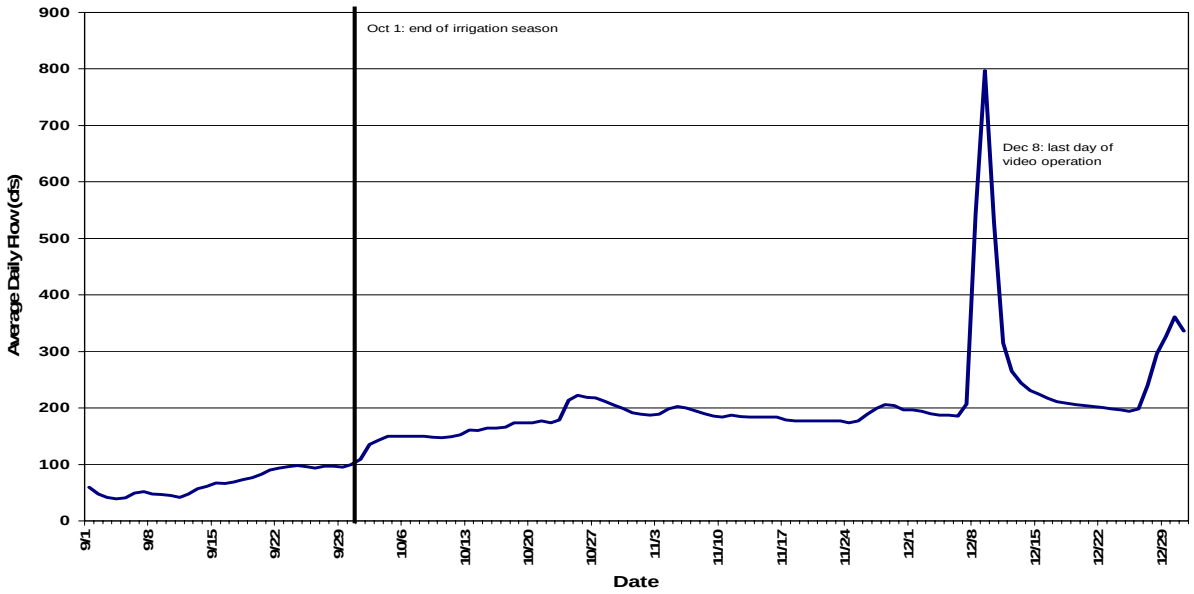

Figure 6. Average daily flows (cfs) in the Shasta River at USGS Gauge No. 11517500 from 1 September to 31 December, 2004. Data are provisional at this time and may be subject to revision.

The relationship between Chinook salmon and coho salmon migration timing and river flows is presented in Figures 7 and 8, respectively. Chinook migration into the Shasta River gradually increased in numbers between mid and late September which also coincided with gradual increases in river flow. At the end of the irrigation season river flows increased from 100cfs on September 30th to 150cfs on October 4th. During this same period migration of Chinook into the river also increased from 8 fish on September 30th to 60 fish on October 2nd. Migration numbers remained fairly stable through October 13th and then began to decrease in number until October 24th when another pulse of fish moved into the river in response to another increase in river flows (214cfs). After October 24th the numbers of Chinook entering the river decreased to very low levels until November 10th when the last Chinook was observed passing through the SRFCF for the season. Coho salmon began entering the Shasta River on October 13th. However, the majority of coho salmon entered the river after October 19th. River flows were fairly stable throughout most of the coho run, ranging from about 174cfs to 222cfs, until December 8th when high flows in excess of 1,000cfs (instantaneous flow) forced the termination of SRFCF. It does appear that coho migration into the Shasta River increased during period of minor increases in flow. The largest number of coho salmon (26 fish) that were observed entering the river in one day occurred during the onset of higher flows on December 7th. The SRFCF was unable to accurately document coho salmon movements on the morning of December 8th due to high turbidity levels. Therefore, the number of coho that may have entered the river during and after this period of high flow is unknown.

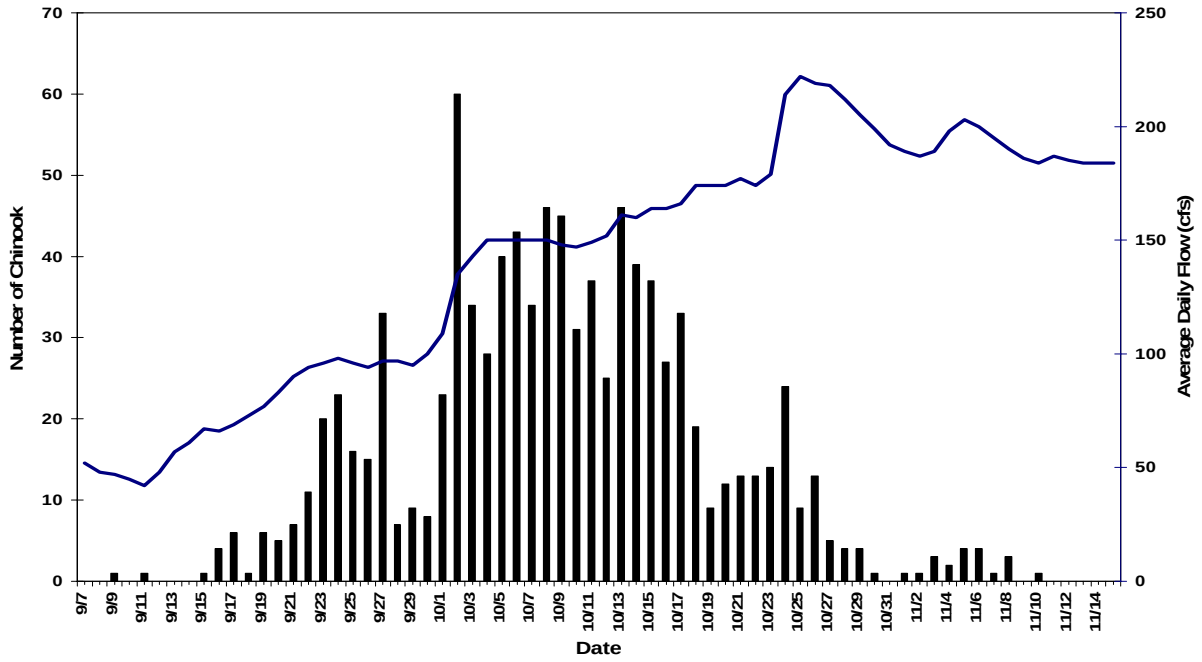

Figure 7. Chinook salmon run timing in relation to average daily flows (cfs) observed at the SRFCF during the 2004 season. Flows were obtained from the USGS Gauge on the Shasta River (No. 11517500) and are provisional at this time.

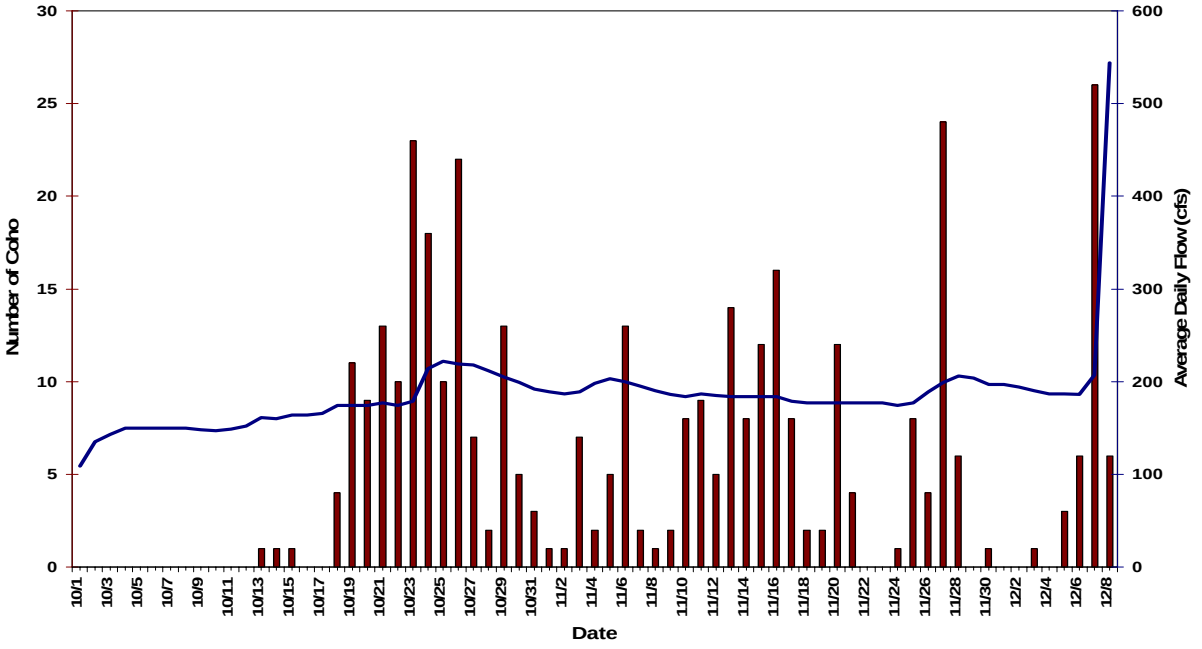

Figure 8. Coho salmon migration timing in relation average daily flows (cfs) observed at the SRFCF during the 2004 season. Flows were obtained from the USGS Gauge on the Shasta River (No. 11517500) and are provisional at this time.

DISCUSSION

Chinook Salmon

Since 1978 the average annual run size of fall Chinook salmon in the Shasta River has averaged 5,448 fish, and has ranged from a low of only 533 fish in 1990 to a high of 18,731 fish in 1978. The 2004 fall Chinook salmon run totaled 962 fish, approximately 4,486 fish less than the average run size for the Shasta River and ranks as the 4th lowest run ever recorded since 1978 (Figure 9). The Klamath River Technical Advisory Team (KRTAT) developed a description of the age structure for Shasta River Chinook salmon based on scale analysis conducted from a sample of 284 scales that were provided to the Yurok Tribal Fisheries Department from carcasses sampled at the SRFCF or during spawning ground surveys. The KRTAT estimated that the 2004 Chinook run was comprised of 129 grilse, 184 three year olds, 484 four year olds, and 166 five year old fish (KRTAT 2005). Based on this analysis, the four year old age class was the dominate year class present during the run. These four year old fish were be progeny from the 2000 brood year and the three year old adults were progeny from the 2001 brood year. Both the 2000 and 2001 Chinook runs on the Shasta River were very strong, and therefore, a strong return of adults was anticipated in 2004.

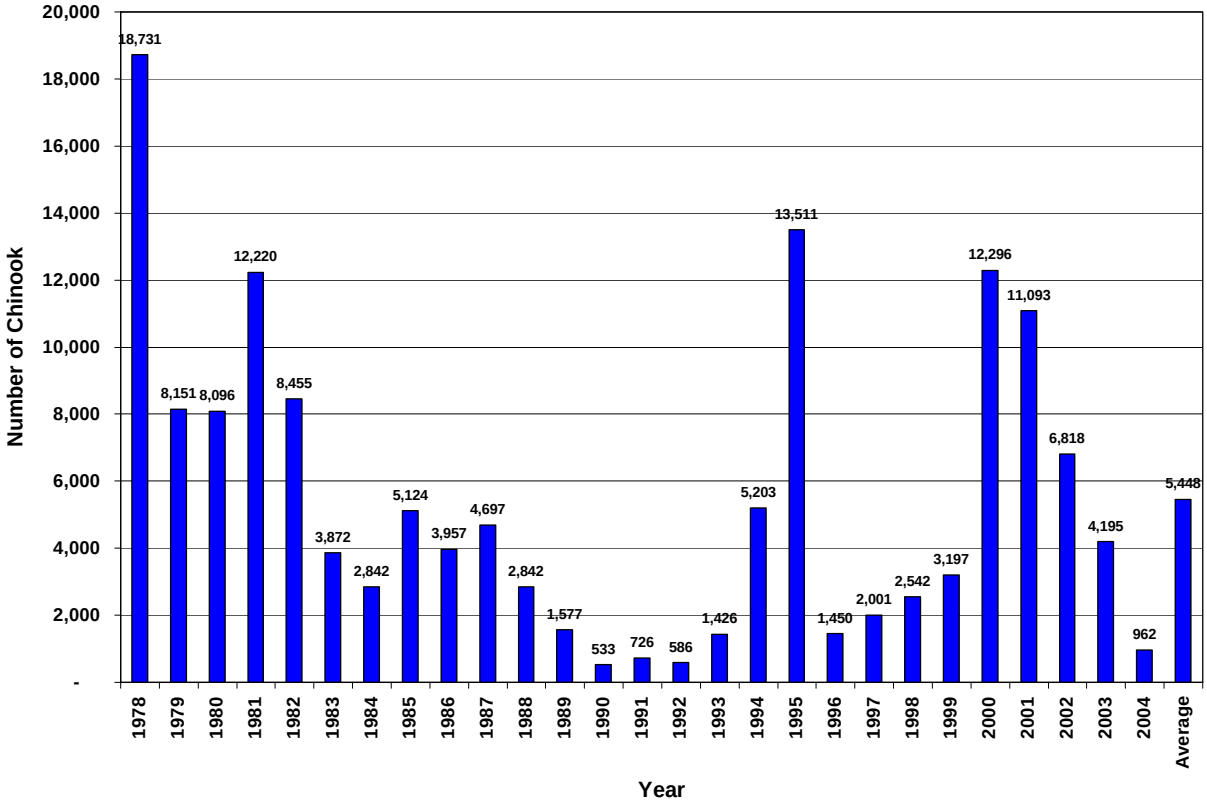

Figure 9. Chinook salmon run size estimates for the Shasta River from 1978 through 2004.

In recent years high incidence of disease infections have been documented in both natural and hatchery origin Chinook salmon juveniles within the main stem Klamath River (Foott et al 2002). The primary pathogens believed responsible for the disease outbreaks include two myxozoan parasites *Ceratomxya shasta* (C. Shasta) and *Parvicapsula minibicornix* (Parvicapsula) and the bacterial disease *Columnaris*. C. Shasta is endemic to the Klamath River and has a complex life cycle using both salmonids and a polychaete worm, *Manaynukia speciosa*, as host species. The polychaete worm is often associated with algae including attached periphyton species such as Cladophora which is commonly found in the Klamath River (Stocking and Bartholomew 2004). Stocking and Bartholomew hypothesize that the high incidence of C. Shasta in the Klamath River is related to increased populations of the polychaete worm in response to an increase in available habitat for the worm which is provided by Cladophora. Nutrient rich water, stable flow releases and lack of scouring flows in recent years have created favorable conditions for establishment and production of algae species which are used by the polychaete worm. Dry year conditions have prevailed in the Klamath River since the 2000 water year, and peak daily flows at Iron Gate have ranged from 5,060 cfs in 2000 to 2,120 cfs in 2001. The lack of scouring flows in recent years have likely benefited establishment of periphyton and may have resulted in an increase in polychaete worm populations. The low flow conditions that existed in the spring of 2002, combined with the lack of any scouring flows since 1999, probably created ideal conditions for the myxozoan parasite populations to flourish. This disease, combined with poor emigration conditions in the Klamath River, may be responsible for the poor survival of the 2001 Chinook brood year.

Although preliminary at this time, the total Klamath Basin in river fall Chinook salmon run size for 2004 is estimated to be 88,777 fish. This estimate includes those Chinook that were harvested by tribal and sport fisheries, returned to the basin's two hatcheries, and spawned naturally within the basin. Of the 88,777 Chinook salmon that returned to the basin in 2004, approximately 29,053 of these fish were estimated to have spawned naturally within the Klamath and Trinity Rivers and their tributary streams, including the Shasta River. Since 1978 the number of natural Chinook salmon spawners in the basin has ranged from a low of only 12,367 fish (1991) to a high of 179,118 fish (1995). Table 3 compares the percent contribution of Shasta River Chinook salmon relative the total natural Chinook salmon populations that have been recorded since 1978. The percent contribution of Shasta River Chinook salmon to the entire natural spawning population of Chinook salmon within the basin has ranged from 2% to 25% and has averaged 9%. The 2004 Chinook salmon run in the Shasta River comprised 3% of the total natural spawning population, and is substantially lower than has been observed over the last seven years when Shasta River Chinook salmon contributions ranged from 4% to 14% of the basin's run.

Table 3. Percent contribution of Shasta River Chinook compared to the total natural spawning populations of Chinook salmon in Klamath Basin since 1978.

Year	Chinook Natural 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	85,580	11,093	13%
2002	69,502	6,818	10%
2003	89,220	4,195	5%
2004	29,053	962	3%
Average	61,828	5,448	9%

Although none of the heads from ad-clipped salmon that were observed passing through the SRFCF were recovered this year, the KRP estimated the number of hatchery origin Chinook salmon that may have been present within this years run based on the assumption that if those heads had been recovered, the CWTs present would be similar to the distribution of tag recoveries that occurred at IGH. Based on that calculation the KRP estimated that the 2004 Chinook salmon run in the Shasta River may have included as many as 372 Chinook salmon hatchery fish, most likely from IGH progeny. If these assumptions are correct, approximately 38.7% of the 2004 Chinook salmon run in the Shasta River would have been composed of hatchery strays. In 2003 a total of 436 adipose fin clipped salmon out of a total run of 4,195 fish (10.4%) were observed passing through the SRFCF. The estimate of hatchery fish present in

2003 was conducted in the same manner as presented in this report (Hampton 2004). In years prior to 2003, the occurrence of ad-clipped fish at the SRFCF was extremely rare. The reason for the apparent increase in the percentage of ad-clipped Chinook observed in the last two years is unknown. In addition, the estimate of hatchery contribution rates is just that, an estimate, which cannot be verified without actual analysis of cwt recoveries from collected heads of ad-clipped Chinook salmon.

Coho Salmon

Since 1979 the KRP has operated the SRFCF with the primary purpose of monitoring the escapement of fall Chinook salmon entering the river. During the course of these efforts coho salmon have been observed passing through the facility on various occasions. Unfortunately, high flows, common during the coho migration period, have greatly compromised our ability to gather consistent data on coho salmon run sizes annually. Since 2001, the KRP has operated the SRFCF beyond the Chinook salmon migration period in an effort to better document coho salmon returns in the Shasta River. However, high flows and large volumes of debris have prevented the SRFCF from operating beyond mid December in both 2001 and 2002. In 2003 the Department was able to maintain operation of the SRFCF until December 28th when a power failure caused by heavy snow accumulations forced us to cease operation of the facility. This year high flows forced the removal of the SRFCF on the morning of December 8th. A pulse of 32 coho salmon passed through the SRFCF from December 7 until the early morning hours of December 8th. Additional coho salmon likely entered the Shasta River during the high flow and rescinding limb in the days that followed. Because of the inconsistencies in sampling duration over the years, direct comparisons of coho numbers observed between years should acknowledge this problem. Although sampling difficulties, usually associated with high flows, have often forced the removal of the SRFCF prior to the end of the coho run, the data collected is extremely important given the current status of coho salmon under the federal Endangered Species Act and California Endangered Species Act. A summary of coho salmon observations that have been documented by the KRP is presented in Table 4.

Coho salmon typically return to spawn at age three and therefore cohort populations can be tracked based on this three year cycle. During the 2001 season a total of 291 coho salmon were observed at the SRFCF and the operation of the SRFCF ended on December 14th of that year. Based on those returns, a fairly large run of coho salmon, relatively speaking, was anticipated in the Shasta River during the 2004 season. A total of 373 coho salmon were documented passing through the SRFCF in 2004. As stated earlier, the operation of the SRFCF ended early in the season this year and therefore, the actual number of coho salmon may be substantially higher. Table 4 provides a summary of coho salmon observations that have been recorded at the SRFCF since 1979.

Table 4. Number of coho salmon that have been observed at the SRFCF from 1979 through 2004.

Year	# Coho	Last Day of Operations	Year	# Coho	Last Day of Operations
1979	355		1992	3	11/11/92
1981	418	1/6/82	1993	6	11/12/93
1982	263	2/28/83	1994	17	11/6/94
1983	36	1/19/84	1995	12	11/11/95
1984	69	11/19/84	1996	1	11/4/96
1985	3	Unknown	1997	0	10/28/97
1986	0	11/3/86	1998	0	11/4/98
1987	0	10/12/87	1999	27	11/10/99
1988	3	11/2/88	2000	1	11/7/00
1989	6	10/21/89	2001	291	12/14/01
1990	2	10/28/90	2002	86	12/17/02
1991	9	11/11/91	2003	187	12/28/03
			2004	373	12/8/04

The operation of the video camera at the SRFCF in recent years has greatly improved the Departments ability to accurately monitor salmon escapement numbers as these fish enter the river. As a result, mark and recapture carcass surveys are no longer needed to estimate run sizes in the Shasta River. On the Scott and Salmon Rivers, where flow conditions and remote locations greatly complicate installation and operation of a video fish counting station, the need to conduct extensive spawning ground surveys is crucial for estimating salmon run size numbers. Unfortunately, since extensive spawning ground surveys are not conducted on the Shasta River, information describing the spawning distribution of the run throughout the river is not collected. In addition, the vast majority of the Shasta River, upstream of the lower canyon, flows through private agriculture lands and access to these areas requires landowner permission. Insufficient funding levels combined with the large areas of private land in the Shasta River basin greatly complicate the Department's ability to conduct large scale spawning ground surveys which would otherwise provide valuable information necessary to describe spawning distributions and habitat use. With additional resources, collection of this information would benefit habitat restoration efforts and improve our knowledge of habitat use and salmon life cycle traits specific to the Shasta River.

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