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The Resources Agency
DEPARTMENT OF FISH AND GAME

Results of the 2007 Cottonwood Creek Video Station Fall-Run Chinook Salmon Escapement

By
Douglas Killam
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Sacramento River Salmon and Steelhead Assessment Project

SRSSAP Technical Report No. 08-3
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1/

Cover Photo: View from the overhead camera looking down on the fish passage opening of the 2007 Cottonwood Creek Video Station

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1/ This was a cooperative investigation between the California Department of Fish and Game (Department), the U.S. Fish and Wildlife Service's Red Bluff Fish and Wildlife Office (Service) the Western Shasta Resource Conservation District (WSRCD), and the Cottonwood Creek Watershed Group (CCWG). It was supported by funding from the Sport Fish Restoration Act Grant F-51-R-18 Project 57-(Department), and the Anadromous Fisheries Restoration Program.

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SUMMARY

This report provides first year results of the fish counting video station operated on Cottonwood Creek on the border between Shasta and Tehama Counties in California to estimate fall-run Chinook salmon numbers. The California Department of Fish and Game in cooperation with the Western Shasta Resource Conservation District, the U.S. Fish and Wildlife Service, and the Cottonwood Creek Watershed Group collaborated to conduct an escapement estimate of fall-run Chinook salmon, *Oncorhynchus tshawytscha*, in Cottonwood Creek using overhead video monitoring. A video camera suspended above Cottonwood Creek was used in conjunction with a partial weir to record the passage of upstream migrating salmonids from 17 September through 06 December 2007.

An estimated 1,250 salmon entered into Cottonwood Creek in 2007 based on the video station counts. Initial counts were adjusted for missing time periods and also as a result of a QC process that checks the original counts.

The number of fall-run salmon in Cottonwood Creek represented 1.3% of the total spawner escapement to California's Central Valley in 2007.

Future use of the video station would provide an annual estimate escapement of fall-run Chinook salmon in Cottonwood Creek. Use of similar stations may provide opportunities to easily monitor salmon escapement in other Central Valley streams that have no current monitoring programs due to staff or budget limitations, landowner permission, or inaccessible spawning areas.

INTRODUCTION

A video station was used to count fall-run Chinook salmon (fall-run) escapement into Cottonwood Creek, (Shasta and Tehama Counties, California), from 17 September through 06 December 2007. The station was constructed and operated cooperatively by the Red Bluff Sacramento River Salmon and Steelhead Assessment Project of the California Department of Fish and Game (Department), the Western Shasta Resource Conservation District (WSRCD), The Cottonwood Creek Watershed Group (CCWG), and the Red Bluff Fish and Wildlife Office of the U.S. Fish and Wildlife Service (Service). Funding for this project was provided in part by a Sport Fish Restoration Act (SFRA) Grant (Department) and by the Anadromous Fish Restoration Program (Service, WSRCD, and CCWG).

Objectives

- To obtain an estimate of fall-run escapement into Cottonwood Creek.
- Start collection of baseline data on salmon escapement that can be used to evaluate restoration activities occurring in the Cottonwood Creek watershed.

Background

Well-designed environmental monitoring programs are needed to provide information to guide sound decision-making processes for natural resource management in California's Central Valley. In the Cottonwood Creek watershed of the upper Sacramento River, reliable resource monitoring information is important to guide decisions and evaluate actions associated with an ecologically important watershed. Reliable data on salmon escapement in Cottonwood Creek are needed to interpret fishery responses to habitat restoration activities, and provide information to fisheries managers, landowners, and others interested in the Cottonwood Creek watershed.

The following description of the Cottonwood Creek watershed was excerpted from the Cottonwood Creek Watershed Assessment (CH2MHILL, 2002). "The Cottonwood Creek drainage area lies within Shasta and Tehama counties on the northwest side of northern California's Central Valley. The lower two-thirds of the drainage area lie in Central Valley uplands, and the upstream portion includes the east slope of the North Coast Mountain Range and Klamath Mountains and the southern slopes of the Trinity Mountains. The creek flows eastward through the valley to the Sacramento River, the confluence lying approximately 16 miles north of Red Bluff and about 150 miles northwest of Sacramento. The pear-shaped watershed has three main tributaries: North Fork, Middle Fork (flowing along the Shasta-Tehama County line), and South Fork. The watershed drains approximately 938 square miles. With an annual runoff of 586,000 acre-feet (ac-ft), Cottonwood Creek is the third largest watershed tributary west of the Sacramento River." The plan identifies the need for reliable and efficient monitoring of anadromous fisheries resources that collects baseline population data within the watershed. The video station on Cottonwood Creek serves this need and also the need of government fisheries agencies to have accurate population stock assessment for management of coast wide fisheries resources (i.e. ocean and in-river harvest management needs).

Historically, the Department has not monitored fall-run escapement into Cottonwood Creek on a consistent basis. Table 1 provides a summary of Cottonwood Creek fall-run escapement from 1953 to present. From 1953 to 1969 seventeen annual estimates were made based on carcass counts and occasional aerial redd (salmon nests) counts (Department, Annual Reports 1956-2005). The carcass surveys involved crews walking in the creek counting spawned out salmon carcasses during the few weeks of the salmon spawning season (October-November). Biologists would then expand the total carcasses counted based on their judgment of what percentage of the population they actually saw, (for example in 1961 three surveys reported 203 carcasses and this was expanded to 1,500 spawners based on the professional judgment of the counters. Carcass surveys today use a much more scientific methodology, but during the 1950's this "estimation by best judgment" was sufficient for management purposes. Similar estimates were made using aerial redd counts when no carcass surveys were conducted (e.g. 1962). A pilot and an observer in a small plane would count the number of new salmon redds in the creek and this number would be expanded based on "best judgment". Most early estimates made with these techniques will often be reported as numbers rounded to the nearest hundred or thousand figures. Monitoring efforts after 1969 were done sporadically (in 9 of 37 possible years) when budgets allowed and typically in response to a specific need (e.g. potential water storage projects, or hatchery evaluations, etc).

In more recent years budget constraints, staffing shortages, logistics and landowner trespass concerns have resulted in only two annual (1991, 1992) fall-run estimates being made for Cottonwood Creek. This data is presented in Table 1 and is updated annually in the Department's electronic Grandtab file (available currently on the website: Calfish.org) that summarizes salmon populations in the California Central Valley.

The video station estimate in 2007 represents a new method for estimating fall-run populations in Cottonwood Creek. A similar video station was constructed and operated since 2003 in Battle Creek and was successful in replacing the traditional carcass survey on that creek. The data from the Battle Creek video station allowed biologists to compare the results of a carcass mark-recapture study and hatchery counts to the video station results (Killam, 2006). Over a three-year period the counts from the two independent methods were similar enough to give fisheries biologists the confidence to halt the labor intensive carcass survey, (in 2006 and 2007 the video station was the only method used on Battle Creek). As a result of the success in Battle Creek the video station methodology was approved for use in other watersheds. In 2006 and again this year a station was operated on Cow Creek (Killam, 2008), and in 2007 a station was operated for the first time on Bear Creek.

In March of 2007 a joint meeting between the agencies involved was held to discuss the construction and operation of a Cottonwood Creek station. At this meeting there was a general consensus that the group was interested in operating a video station on

Table 1. Summary of fall-run escapement numbers into Cottonwood Creek from 1953 to 2007.

YEAR	Estimate	YEAR	Estimate
1953	3,000	**1981**	3,356
1954	1,000	**1982**	700
1955	800	**1983**	1,000
1956	660	**1984**	500
1957	358	**1985**	unknown
1958	600	**1986**	unknown
1959	3,300	**1987**	unknown
1960	350	**1988**	unknown
1961	1,500	**1989**	unknown
1962	6,000	**1990**	unknown
1963	3,500	**1991**	676
1964	3,450	**1992**	1,585
1965	900	**1993**	unknown
1966	2,900	**1994**	unknown
1967	600	**1995**	unknown
1968	8,540	**1996**	unknown
1969	4,967	**1997**	unknown
1970	unknown	**1998**	unknown
1971	unknown	**1999**	unknown
1972	unknown	**2000**	unknown
1973	unknown	**2001**	unknown
1974	unknown	**2002**	unknown
1975	unknown	**2003**	unknown
1976	2,427	**2004**	unknown
1977	1,512	**2005**	unknown
1978	1,120	**2006**	unknown
1979	unknown	**2007**	**1,250**
1980	unknown		
AVERAGE all years (1953-2007)			**2,094**
source Grandtab-Department			

Cottonwood Creek for the fall of 2007. As mediators for the group, the WSRCD arranged to coordinate the video station details with the Department and Service and the CCWG. In April of 2007 a survey of Cottonwood Creek was made to choose a site for the new video station. A single site just upstream of the confluence with the Sacramento River fit all the criteria for a video station. Criteria for the video station site included:

1. Limited public access to avoid vandalism and poaching opportunities.
2. A nearby power supply to run the station's VCR's and cameras.
3. Close to the mouth of the creek so that most salmon would spawn above the site.
4. Landowner permission to construct and access (daily) the video station site.
5. Suitable stream geology to place the weir (shallow with even stream bottom)

The chosen site was located approximately 1.2-miles (2 kilometers) upstream of the mouth of the Sacramento River (Figure 1). The station recorded the passage of fall-run salmon during most of their upstream migration period (mid-September through mid-November). Personnel from the Department, the WSRCD, the CCWG, and the Service cooperated to accomplish station set-up and removal, maintenance, tape changes, tape reading and quality control of tape reading.

METHODS and MATERIALS

The video station is comprised of two groups of equipment, these included:

- VCR trailer, camera, lights, video cassette recorders (VCR's), quad processor, 12-volt power supply, battery back-up, and power and video cables.
- Weir, camera support cables, camera tripod, erosion fencing and the fish passage plates on the stream bed.

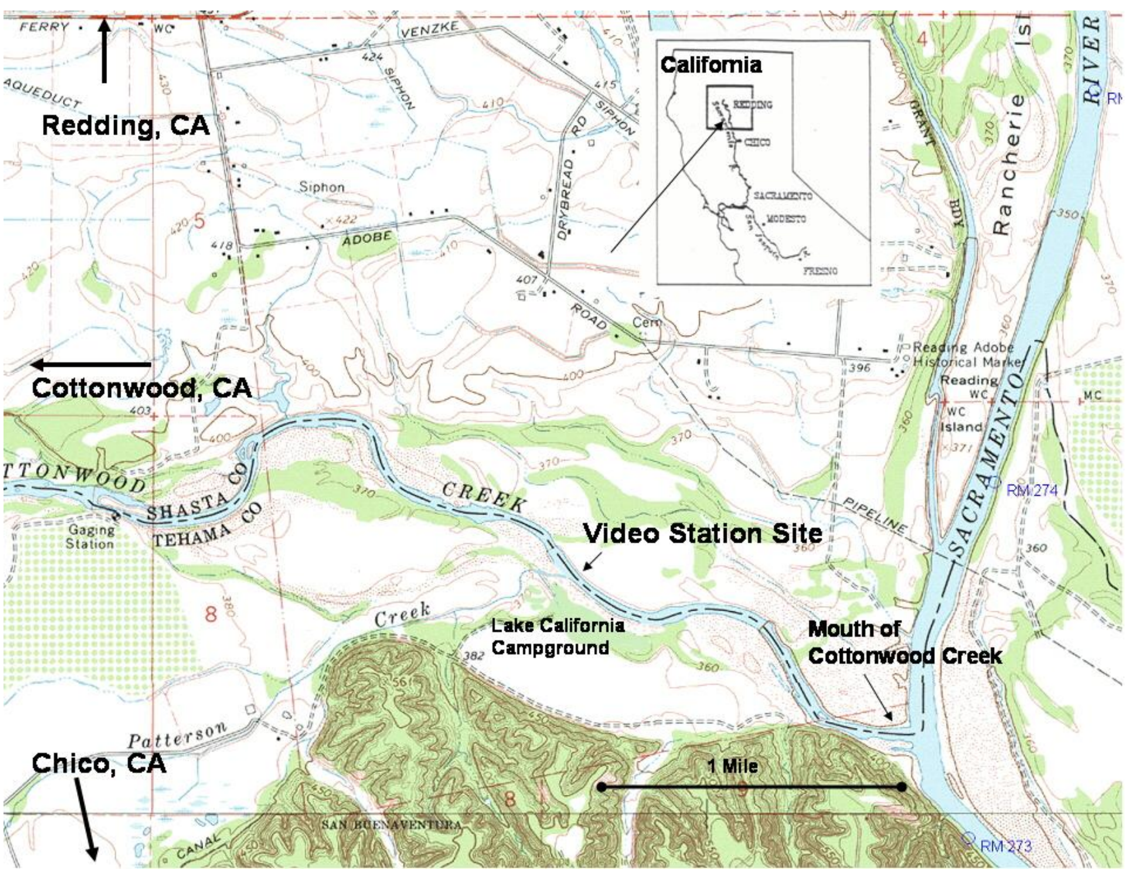

Figure 1. Map detailing the location of the video station on lower Cottonwood Creek.

Each of these components required different skills and abilities to construct. The use of commonly available retail equipment allowed us to avoid contracting out any of the work to complete the station. We were able to draw on the experience and backgrounds of current agency personnel to construct and operate the station.

One criteria of the Cottonwood Creek video station was that it be located near a conventional “on-grid” power supply. The Cottonwood Creek station did not have sufficient funding to purchase solar panels and related equipment similar to the remote Battle Creek station so it was necessary to select a site with existing power. The selected site was located at the Lake California Campground with an existing 120 volt incoming power supply. This provided a source of power to the station. A Service owned camping trailer was towed to the site and was used to house the VCR’s and other video equipment.

From the trailer, video (RG-6) and 120 volt cords were trenched approximately 750 feet (229 m) to the creek. An in-line Ground Fault Interrupt Circuit (GFIC) device was used to provide automatic shut-off of the system should the power supply short out or contact the water. A back-up power supply was constructed to provide power for a 1-2 day period should a power outage occur in the regular power supply. The backup power supply consisted of 4 six-volt “golf cart type” batteries linked to provide a 12volt DC power supply to a conventional computer battery backup system. The original batteries from the 300watt APC brand Uninterruptible Power Supply (UPS) were removed and the larger golf-cart batteries were connected giving a much greater power reserve if the grid power failed. All of the stations electronics were routed through the UPS to ensure continual video coverage in the event of a power failure.

Camera System

The camera box, (shown in Figure 2), was suspended over Cottonwood Creek at a height of about 15-feet (4.6 m) from the water’s surface using a cable system constructed of 5/16-inch (7.9 mm) galvanized steel cables. The cable system consisted of two main cables The two main cables, about 300-feet (91.4 m) each, were stretched across the creek and anchored in trees on one side of the creek and a welded tripod (Figure 2 background) on the other side. The tripod was constructed from 2.5 inch (6.3 cm) galvanized metal pipe, and anchored in place using fence posts driven into the ground and cabled to the legs of the tripod. The design of the cable system prevented side-to-side sway which allowed fish counting in all wind conditions. Tightening of the main cables was accomplished with a mechanical “come-along”. The end of the main cable closest to the campground was designed to allow easy movement up and down with an hand operated “come-along”. In this manner the camera was raised and lowered if an adjustment to lighting, or camera cleaning was required.

The camera box was attached by ropes to the main cables which reduced vibrations caused by wind. Power cords and camera co-axial cable were zip-tied to one of the two main cables.

Figure 2. Video station camera box, lights, weir and passage opening with white plates visible. Camera is suspended from two overhead cables which are anchored to riparian trees and to a tall pipe tripod. Inside camera box is wiring junctions for electrical and video systems, and photo cell to turn lights on at dusk.

We selected a PC88WR black and white camera that provided the adequate images in various lighting conditions. The low cost ($115) camera was vastly superior over color cameras in low-light situations. The weatherproof camera was attached on the outside of a larger box that contained remote lighting and other wiring hookups (Figure 2). We also constructed an underwater housing from PVC pipe fittings and used a second similar camera to operate underwater at the lower edge of the weir opening, (visible in cover photo at lower left of white plates), to aid in species identification. The underwater camera was also used to check the salmon passing close to the camera for adipose fin clips (hatchery origin).

The image from the cameras was inputted into a color quad processor (Supercircuits type QS-29) that merged the underwater camera image with that of the overhead camera onto one image (picture in picture mode). This image was then inputted into four VCR's. Three of the VCR's (Sony type SLV-D380P) were programmed to sequentially record eight hours periods, thereby providing 24-hours of continuous coverage each day. Video tapes were type T-160, set to record on extended play (EP) mode. A fourth "time-lapse

VCR" (Ganz type CTR-030NC-2) was programmed to record 4-hours each day at the end of the third 8-hour cycle. The purpose of this VCR was to ensure complete coverage in the event the personnel servicing the video station did not arrive before the last of the three 8-hour VCR's had finished recording. A small TV monitor was used observe the image from the camera and to check the hookup of all VCR's for proper operation throughout the season.

Lighting for the video camera was provided by two compact outdoor fluorescent spotlights (16 watt EDXR-30-16; available at retail stores) which were mounted on the overhead cable system (visible in Figure 2). These outdoor spotlights use very little power compared to conventional spotlight bulbs, which was an important consideration for the video station. A photocell sensor, similar to those used on streetlights, was used to turn on the lights at dusk and turn them off at dawn.

Weir System

A weir was constructed to channel salmon into the camera's view without causing passage delay (Figures 3). The weir was constructed of ten-foot (3m) long steel $1^{1/8}$ inch O.D. (28mm) pipes which were welded to uprights with 3" (76mm) spaces between pipes. Some taller panels used $1^{1/4}$ inch EMT conduit on the inner cross members to lighten the overall weight of the finished panel. The 10-foot (3m) wide horizontal pipe panels were designed to fit the depth of Cottonwood Creek at the station site (i.e. panels in shallow water had only 2 or 3 cross members while panels in deeper water had up to 12 cross members). The horizontal design and spacing between bars of the weir panels allowed leaves and sticks to pass through the weir while preventing salmon from passing the weir unmonitored. Panels were secured in place using rebar stakes and specially designed "dog leg" fittings developed by SRSSAP staff. The rebar stakes were pounded vertically through the panel uprights and into the stream bottom. The dogleg fittings were bolted to the uprights and a "weir arm" was slid through the fitting and pounded into the stream bottom at a 45 degree angle downstream (see Figure 2). Metal fencing was attached to the top of each weir panel to prevent salmon from jumping over the weir (Figure 2). Metal fencing was also laid underneath the weir panels (3-foot wide (0.9 m) chain link, various lengths) to prevent scour during high flows. The weir panel was laid on top of this fencing such that about 6 inches (15 cm) of fencing was upstream of the weir and the remainder (2.5 feet, (76 cm)) was exposed downstream.

Two weir panels were added as upstream facing guidance panels along the fish passage opening to prevent fish from skirting around the ends of the weir (visible in Figure 2). These guidance panels were placed along the outside edges of the white bottom plates just under the water surface and resulted in most fish swimming upstream along the entire length of the plates allowing for easier counting compared to similar weirs without these guidance panels (e.g. Battle Creek in 2003, (Killam 2006)).

White high density polyethylene (HDPE) sheets were staked to the creek bottom to make the observation of passing salmon easier. Two overlapping ¼ inch by 4 by 10 feet (6 mm x 1.2 m x 3 m) sheets were used to create a white background (see report cover photo).

These plates had ¾-inch (19 mm) holes drilled around their perimeters to allow staking. A metal frame plate was bolted to the upstream edge of both plates prior to placement in the creek. The entire assembly was then staked to the streambed underneath the camera. Stakes were 24 inch concrete form stakes with a 2-inch (50mm) washer welded to their tops to secure the plates.

A measuring device was constructed to allow tape readers to approximate the length of passing fish. A metal rectangle measuring 24-inches (61 cm) tall by 12-inches (30 cm) wide allowed tape readers to approximate fish lengths, (see cover photo). This "station brand" was custom welded (by author) from 3/8-inch (9.5 mm) rebar and incorporated the letters C and T into the center of the design to identify tape images as those belonging to Cottonwood Creek during future viewing.

Video Station Operation and Maintenance

The video station was checked once a day during operation. Daily activities included:

- Changing videotapes in the three daily VCR's.
- Checking power levels and normal operation of equipment (lights, VCRs, etc).
- Cleaning the weir and white plates of algae, debris, and carcasses.
- Recording comments and time of visit in the station logbook.
- Transporting video tapes to SRSSAP for processing and analysis.

Fish Counting Procedures

Tapes were played on VCR's that outputted into a Honeywell Fusion III digital video recorder (DVR). During periods of clear water, motion detection software was utilized to detect motion in the area of the white plates. The motion detection software eliminated periods of time when no fish were passing. During periods of turbid water the DVR software was set to record continuously for later analysis by staff. After the VCR tapes from the station were finished playing they were rewound and stored. The DVR software was then used by staff from the WSRCD and the Department to access the digital files containing the motion filtered and continuous recordings.

Each date was divided into 48 half-hour periods. The number of salmon passing upstream of the white plates was tallied on a datasheet for each period. There were categories for both up and down passing salmon. In some instances, salmon spawning adjacent to the weir area will actively pursue other salmon both up and down through the opening while defending their spawning area. Counters tallied the downstream fish as well as the upstream fish. Downstream passing salmon were subtracted from the upstream total for each period to maintain an accurate total upstream count.

Datasheets were transcribed into a Microsoft Excel file. The electronic Excel file was used to organize the data. Passage data was then transferred into a Microsoft Access file where it was analyzed by different categories of interest to readers. Categories included: passage by date, time, month and week. Also included in the Access file was analysis for the quality control check.

Quality Control Checks of Fish Passage Counts

Quality control (QC) checks on all half-hour periods with fish passage counts greater than nine were made by Department personnel. If counts for these periods were different from the original "reads" then a third count was made to determine a final count. Periods with less than 10 fish passing were stratified by initial reader and by two types of counts: Type 0 was = 1 or less fish and Type 1 was = 2 to 9 fish. A random sub sample of periods was chosen from these counts and these periods were QC reviewed by Department staff. An adjustment factor was created for each stratum (reader and type) to adjust all Type 0 and Type 1 counts (not just the QC reviewed periods). The adjustment factor was the percent difference between the sum of the total stratum QC counts and the sum of the total stratum original counts (within the sub sample). The adjustment factor and original counts were multiplied (for each stratum) to determine a "final QC" count. This count was summed for each period to calculate the total salmon passage for the station's operational period (17 September to 06 December).

RESULTS and DISCUSSION

Data Results

The final adjusted estimate of fall-run Chinook salmon that entered into the Cottonwood Creek watershed in 2007 was **1,250**. The daily passage data for the video station is presented in Table 2. Peak passage occurred on 10 October corresponding to a water temperature of 62.6 degrees Fahrenheit, (17^{o}C), (water temperature was obtained from thermograph at station). The total upstream passage estimate at the station was 1,214 salmon. The total in Table 2 includes 36 downstream spawners that constructed redds (n=18 redds, assume 2 adults per redd) between the station site and the mouth of Cottonwood Creek at the Sacramento River about 1.2 miles downstream. Table 2 also lists average flows by date (obtained via the internet (USGS, 2007) from the permanent stream gauge near Cottonwood, CA (CA. Data Exchange Center Station (CDEC): CWA)) and allows comparison for fish passage and flow events.

Table 3 presents the data by half-hour periods revealing that the peak of migration at the video station site occurred at 14:30 in the afternoon. This is somewhat unusual compared to the nearby Battle Creek station that typically has a lull in the afternoon and peaks in the morning and early evening (Killam, 2006). The data in Table 3 also reveal that salmon passage in Cottonwood Creek occurred at all time periods but was lowest from 08:30 to 11:00 in the morning.

Table 4 provides count data each month and for each week that the station was operated. The data in Table 4 reveals that the peak passage for the fall-run at Cottonwood Creek occurred in October, with the most fish passing in the second week of this month. This was generally similar to the other video monitored tributaries (Cow and Battle, (Bear peak was third week)) in the Upper Sacramento River Basin in 2007. Peak passage can vary a few weeks between years and waterways depending on the weather and type of year, (temperature and rainfall). Spawning would probably have commenced 1-2 weeks after passage so peak spawning activity in Cottonwood Creek may have occurred in late-October through early-November. The data in the first and last week of Table 4 are partial counts since the station was in operation only some portion of these weeks.

Table 2. Summary of daily passage for fall-run Chinook salmon, Cottonwood Creek flows (cfs), and water temperature at the 2007 Cottonwood Creek video station.

Date	Salmon Passage	Cumulative Percent	Flow (cfs)	Water Temp	Date	Salmon Passage	Cumulative Percent	Flow (cfs)	Water Temp
17-Sep	0	0.0%	51	72.6	28-Oct	5	84.2%	54	61.0
18-Sep	0	0.0%	51	72.3	29-Oct	11	85.1%	54	62.1
19-Sep	0	0.0%	51	68.9	30-Oct	14	86.2%	54	63.4
20-Sep	0	0.0%	62	67.3	31-Oct	5	86.7%	55	62.6
21-Sep	0	0.0%	55	69.1	1-Nov	7	87.2%	58	61.7
22-Sep	0	0.0%	55	66.4	2-Nov	12	88.2%	56	60.7
23-Sep	1	0.1%	64	67.3	3-Nov	9	89.0%	55	59.9
24-Sep	0	0.1%	66	67.3	4-Nov	5	89.4%	55	59.2
25-Sep	0	0.1%	65	66.9	5-Nov	14	90.5%	54	58.8
26-Sep	0	0.1%	58	67.1	6-Nov	13	91.6%	54	58.6
27-Sep	0	0.1%	49	68.3	7-Nov	8	92.3%	53	58.5
28-Sep	0	0.1%	55	66.7	8-Nov	7	92.8%	53	58.4
29-Sep	0	0.1%	55	64.6	9-Nov	6	93.3%	53	59.4
30-Sep	0	0.1%	64	63.9	10-Nov	4	93.7%	53	57.9
1-Oct	1	0.2%	66	66.3	11-Nov	8	94.3%	54	58.4
2-Oct	0	0.2%	69	65.8	12-Nov	9	95.1%	53	56.6
3-Oct	0	0.2%	59	65.8	13-Nov	11	96.0%	56	58.9
4-Oct	1	0.2%	55	64.1	14-Nov	4	96.3%	56	58.9
5-Oct	0	0.2%	51	62.1	15-Nov	1	96.4%	55	59.1
6-Oct	15	1.5%	53	61.4	16-Nov	4	96.7%	56	59.6
7-Oct	11	2.4%	52	62.4	17-Nov	1	96.8%	55	59.9
8-Oct	2	2.6%	50	63.5	18-Nov	3	97.0%	55	59.7
9-Oct	19	4.1%	55	62.9	19-Nov	3	97.3%	58	59.8
10-Oct	**344**	32.5%	79	62.6	20-Nov	2	97.4%	57	55.2
11-Oct	121	42.4%	107	60.1	21-Nov	5	97.9%	57	53.0
12-Oct	114	51.8%	**140**	**59.8**	22-Nov	3	98.1%	59	51.7
13-Oct	55	56.3%	110	60.1	23-Nov	-1	98.0%	52	51.0
14-Oct	5	56.8%	67	62.4	24-Nov	1	98.1%	45	50.0
15-Oct	9	57.5%	59	63.0	25-Nov	7	98.7%	52	51.3
16-Oct	118	67.2%	62	61.1	26-Nov	4	99.0%	50	50.5
17-Oct	27	69.4%	61	60.6	27-Nov	1	99.1%	51	52.0
18-Oct	22	71.3%	62	61.1	28-Nov	-1	99.0%	50	51.2
19-Oct	41	74.6%	74	61.1	29-Nov	2	99.2%	50	50.7
20-Oct	36	77.6%	102	60.1	30-Nov	1	99.3%	51	49.3
21-Oct	17	79.0%	105	59.2	1-Dec	1	99.3%	50	47.3
22-Oct	7	79.6%	82	61.0	2-Dec	0	99.3%	51	47.4
23-Oct	10	80.4%	69	62.4	3-Dec	3	99.6%	55	49.6
24-Oct	15	81.6%	63	62.8	4-Dec	3	99.8%	108	51.9
25-Oct	10	82.5%	60	62.3	5-Dec	2	100.0%	318	49.3
26-Oct	9	83.2%	57	59.6	6-Dec	0	100.0%	208	49.8
27-Oct	7	83.8%	55	59.9	**Totals**	**1,243**			

Table 3. Summary of fall-run Chinook salmon passage by time of day at the 2007 Cottonwood Creek video station. Peak passage was at 14:30 in the afternoon.

Time	Passage	Time	Passage
0:00	32	12:00	26
0:30	18	12:30	30
1:00	26	13:00	36
1:30	35	13:30	23
2:00	19	14:00	31
2:30	18	**14:30**	**77**
3:00	20	15:00	26
3:30	24	15:30	31
4:00	22	16:00	38
4:30	23	16:30	44
5:00	21	17:00	31
5:30	23	17:30	20
6:00	22	18:00	7
6:30	15	18:30	13
7:00	40	19:00	17
7:30	22	19:30	15
8:00	21	20:00	33
8:30	15	20:30	49
9:00	17	21:00	39
9:30	13	21:30	41
10:00	2	22:00	22
10:30	4	22:30	25
11:00	25	23:00	17
11:30	29	23:30	17

Table 4. Summary of fall-run Chinook salmon passage at the 2007 Cottonwood Creek video station. Data indicates that most salmon passed in the second week of October.

Month		Passage
September		1
October		1,051
November		153
December		9
Week	**Passage**	**Week Starts**
38	0	16-Sep
39	1	23-Sep
40	17	30-Sep
41	666	**7-Oct**
42	258	14-Oct
43	75	21-Oct
44	63	28-Oct
45	57	4-Nov
46	38	11-Nov
47	16	18-Nov
48	15	25-Nov
49	8	2-Dec
Total	**1,214**	

A chart of the passage count by week is provided in Figure 3. The total fall-run escapement to the Central Valley in 2007 was the second lowest on record since1952 (Department, Grandtab). Of note, is that despite the near record low returns, Cottonwood Creek's escapement comprised 1.3 percent of the total Central Valley fall-run escapement, including both hatchery counts and major rivers in the Valley.

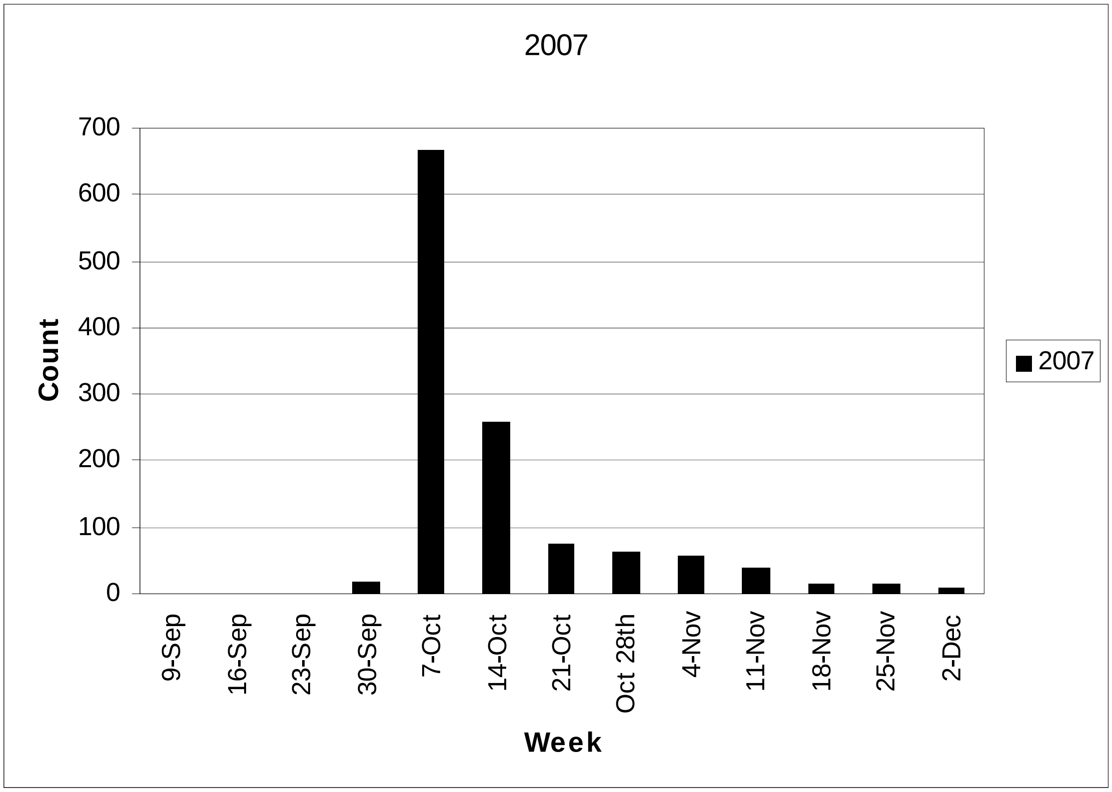

Figure 3. Chart of fall-run Chinook salmon counts by week at the Cottonwood Creek video station for 2007.

Data Adjustments

The 2007 video station estimate began as a count (n = 1,233) of all salmon (including adults and grilse) passing the station up to the time of weir removal on 06 December 2007. This count was for only those time periods where tapes were available. The video count was further adjusted to account for a number of factors that both raised and lowered the final estimate. This adjusted estimate included adjustments for periods when:

1. The taping malfunctioned (zero malfunctions for Cottonwood Creek in 2007).
2. The water was too turbid to visually count fish (added 8 salmon for 2 turbid hours).
3. Eighteen redds were observed downstream of the station site (added 36 salmon).
4. The QC process of tape reading (subtracted 27 salmon from the total count).

The first two adjustments are made to the database under the assumption that salmon would have been passing had the station been operating efficiently during the "problem" periods. There was a single turbid water adjustment totaling 2 hours (out of a total of 1,881 hours of operation or 0.1%). This occurred on 13 October during the flushing of a nearby irrigation ditch. Another turbid water period came during the final days of the station's operation (05-06 December).

The goal for all the video stations, prior to installation in 2007, was to operate (includes all stations: Cow, Bear, Battle and Cottonwood) through at least 1 November. Any operation after this date is considered a "bonus period" and careful attention is paid to the weather. At any time, when a major storm was forecast, a decision to remove the weir had to be considered. Concern for damage or loss of the weir and other in-stream equipment dictates that weather forecasts were closely observed during station operation. The first of November was used as a goal because experience has shown that the majority of fall-run Chinook in Battle and Cow Creeks have already passed by this date (Killam 2006, 2007). For Cottonwood Creek, Table 2 indicates that in 2007 over 87% of the total passage had occurred by this date. After 1 November a major predicted storm would likely have resulted in station removal due to possible flooding. In 2007, no major storms occurred until early December. The weir was removed on 6 December due to continuing rain and more storms forecasted. Counting was discontinued early on 5 December after turbid water made it impossible to view passing fish. This turbidity continued into 6 December when the decision to remove the station was made. No attempts at turbidity adjustments were made during this period (05-06 December) due to low salmon counts and lack of data following station removal.

Quality Control Checks of Fish Passage Counts

The quality control process resulted in the subtraction of 27 salmon from the total count. Table 5 provides a summary of the adjustment factors that were generated by the QC process. Nine readers participated in the original tape reading. One reader (reader 7 with the WSRCD) did the majority of the reading. The other readers assisted reader 7 in completing the tape reading. All periods above a count of nine (Type 2 = 11 periods (between 10-19) and Type 3 = 6 periods (greater than 19 fish) were reviewed during the QC process. The QC count for these periods was used as the final count if they were different from the original counts. The adjustments for these types in Table 5 are for reader informational purposes only. A random sample of 68 (2% of total) Type 0 periods, (1 or less fish), and 42 (21% of total) Type 1 periods (2 to 9 fish) were reviewed for accuracy. Table 5 presents the results of these QC checks stratified by type and reader. The adjustment factors in Table 5 were multiplied to each Type 0 and Type 1 original count made by the associated reader to determine the final count. (Note the calculated counts were not adjusted (i.e. turbid water)).

Use of the DVR to Read Tapes

The Honeywell Fusion II DVR was a useful addition to the video station equipment. The DVR allowed simultaneous recording of 9 VCR's to be inputted into the DVR. This allowed the tapes from Cottonwood Creek (as well as Bear and Cow stations) to be recorded digitally in an almost real-time fashion. The three daily tapes from the station were taken to the SRSSAP office and recorded simultaneously onto the hard drive of the DVR. The DVR was connected to 3 office VCR's allowing the recording of a 24-hour

Table 5. Results of the original tape reading fish counts compared to the quality control (QC) fish passage counts (summed) for selected periods for the 2007 Cottonwood Creek video station.

Reader	Count Type	Original Total	QC Total	Adjustment
3	0	3	4	0.33
4	0	1	1	0.00
6	0	1	1	0.00
7	0	31	31	0.00
7	1	170	170	0.00
7	2	90	88	-0.02
7	3	33	2	-0.94
9	0	0	0	0.00
9	1	27	29	0.07
9	2	62	63	0.02
9	3	140	139	-0.01

period to be finished in eight hours. The software design and motion detection capabilities of the DVR resulted in a reduction of the time it took to review tapes as compared to viewing them on a standard VCR.

Cottonwood Creek during station operation had a heavy filamentous algae load that was drifting downstream during most of the operational period. The algae in addition to clogging the weir, often "tripped" the motion detection software. Large clumps of floating algae would come through the passageway and trigger the motion detection software resulting in numerous false "hits" on Cottonwood Creek. As a result, readers were required to spend more time reading Cottonwood Creek files than was necessary for Cow and Bear Creek files. At this time no formal statistical analysis has been made to compare VCR reading with DVR reading due to staffing and time constraints. However, personnel that have experience with both types of equipment have reported significant (up to 75%) time saving improvements using the DVR with motion detection filtering

The DVR software allowed multiple readers to view recorded video simultaneously. In addition the software allowed viewing the digital files at remote locations by copying the files to an external hard drive and installing the software on a computer at the WSRCD office. In this way the staff at the WSRCD was able to read the tapes at their convenience. The software also allowed readers to view tapes without having to handle tapes or push buttons to rewind or fast forward to periods of fish passage. All previous tape reading functions that were done on a VCR were now done within the framework of the DVR software and the click of a computer mouse. The DVR also allowed tapes to be recorded at a variety of motion detection sensitivities.

Tapes were generally recorded using conservative motion detection sensitivities that resulted in many recorded periods with no fish passage. Some periods (slight turbidity, rain, etc) were also recorded with both continuous (complete recording) and with motion detection and the two types compared to "test" if the motion detection settings were missing fish passage events. The more conservative motion detection settings were found to capture all of the fish passage events during periods of ideal visibility. Staff found that during periods of turbid water or periods with excessive light reflection from rain or wind events that the motion detection did not function well. These periods were subsequently recorded continuously and the entire period was reviewed for passage events.

RECOMMENDATIONS

1. The video station proved to be a valuable and accurate tool in estimating salmon escapement into Cottonwood Creek. The installation of similar stations on waterways currently unmonitored in the Upper Sacramento River Basin should be investigated.

2. The operation of the video station should be continued again in 2008 to estimate the escapement of fall-run salmon to Cottonwood Creek.

3. The purchase of three low cost digital video recorders should be pursued to streamline the efficiency of station operations and replace the VCR and tapes.

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