

WESTERN SHASTA RESOURCE CONSERVATION DISTRICT



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



By  
James Chichester  
Western Shasta Resource Conservation District  
Anderson, California  
35-31 Project Report  
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Chinook Salmon Escapement<sup>1</sup>**

*Cover Photo: View looking downstream at the fish passage opening of the 2007  
Bear Creek Video Station*

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<sup>1</sup> This was a cooperative investigation between the California Department of Fish and Game (CDFG), the U.S. Fish and Wildlife Service's Red Bluff Fish and Wildlife Office (USFWS), the Western Shasta Resource Conservation District (WSRCD), the Bear Creek Watershed Group (BCWG), 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-(CDFG), and the USFWS Anadromous Fisheries Restoration Program

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## SUMMARY

In 2007 the Western Shasta Resource Conservation District (WSRCD) joined efforts with the California Department of Fish and Game (CDFG), the U. S. Fish and Wildlife Service (USFWS), the Cow Creek Watershed Management Group (CCWMG), the Bear Creek Watershed Group (BCWG), and the Cottonwood Creek Watershed Group (CCWG) to construct weirs and monitor fall-run Chinook escapement on three creeks: Cow Creek, Cottonwood Creek and Bear Creek in Shasta and Tehama Counties in northern California.

This report provides results of a new fish counting video station operated for the first time in 2007, from September 20th to December 17th, on Bear Creek in Shasta County California to estimate fall-run Chinook salmon numbers. The CDFG in cooperation with the WSRCD, the USFWS, the CCWG and the BCWG collaborated to conduct an escapement estimate of fall-run Chinook salmon, *Oncorhynchus tshawytscha*, in Bear Creek using overhead and under water video monitoring. Video cameras were used in conjunction with a partial weir to record the passage of upstream migrating salmonids from mid-September through mid-December.

The weir was removed after the WSRCD notified the CDFG that the funding for the video station operation was due to end. This was in addition to a poor weather forecast (rain) for the remainder of the week, and led to the decision to remove the weir on December 17th.

An estimated 140 salmon entered into Bear Creek in 2007 based on the video station counts. Initial counts were adjusted for missing time periods, downstream spawner (redds) estimates and also as a result of a QC process that checks the original counts. Future use of the video station would provide an annual estimate escapement of fall-run Chinook salmon in Bear 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 escapement into Bear Creek, (Shasta County, California), from September 20<sup>th</sup> through December 17<sup>th</sup> of 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 (CDFG), 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 (USFWS).

Funding for this project was provided in part by a Sport Fish Restoration Act (SFRA) Grant (CDFG) and by the USFWS Anadromous Fish Restoration Program.

### Objectives

- To determine if overhead and underwater video monitoring could be used as a viable technique to estimate fall-run Chinook salmon escapement into Bear Creek.
- To obtain, for the first time in decades, an estimate of fall-run escapement into Bear Creek.
- Provide a beginning of baseline data on salmon escapement that can be used to evaluate restoration activities occurring in the Bear Creek watershed.

### Background

The Bear Creek watershed encompasses approximately 157 square miles in Shasta County east of the Sacramento River. The elevation in the watershed ranges from 350 feet at the Sacramento River to approximately 6,740 feet at Latour Butte (ENPLAN, 2006).

The Bear Creek watershed has a diverse assemblage of wildlife habitats and wildlife species. Several special-status wildlife species are known to occur in the watershed and are protected by State and Federal laws (Table 1). Wildlife species and their habitats in the Bear Creek watershed have been affected by the introduction of non-native species and by a variety of land uses, such as timber harvesting, road construction, and prescribed burning.

The Bear Creek watershed is inhabited by a variety of anadromous fishes, resident native fishes, and introduced fishes. Anadromous fish such as Chinook salmon (*Onchorhynchus tshawytscha*) and Central Valley steelhead (*O. mykiss irideus*) are of great interest because of their unique life history as well as their recreational and economic value (ENPLAN, 2006).

**Table 1. Bear Creek Watershed Assessment 2005  
Special-Status Fish Species Reported In or Near the Bear Creek Watershed**

| SPECIAL STATUS FISH KNOWN TO OCCUR IN THE BEAR CREEK WATERSHED | <i>Status</i> | <i>Source</i>       |
|--|---------------|---------------------|
| Central Valley steelhead, <i>Oncorhynchus mykiss irideus</i>   | FT            | 1, 2, 4, 6, 7, 8, 9 |
| Chinook salmon, <i>Oncorhynchus tshawytscha</i>                |               |                     |
| Central Valley fall-run Chinook salmon                         | FSC, SSC      | 1, 2, 5             |
| Central Valley late fall-run Chinook salmon                    | FSC, SSC      | 1                   |
| Winter-run Chinook salmon                                      | FE, SE        | 1, 2                |
| Central Valley spring-run Chinook salmon                       | FT, ST        | 1, 2                |
| Pacific lamprey, <i>Lampetra tridentata</i>                    | FSC           | 3                   |
| SPECIAL STATUS FISH KNOWN OR EXPECTED TO OCCUR IN THE VICINITY |               |                     |
| Green sturgeon, <i>Acipenser medirostris</i>                   | FT            | 10, 11              |

Source

- 1 = CNDDDB
- 2 = Potter (1965)
- 3 = BLM Fisheries Survey (1979)
- 4 = W.M. Beaty & Associates, Inc.
- 5 = CalFish (2004)
- 6 = T. Moore (DFG, pers. memo, March 14, 2003)
- 7 = T. Moore (DFG, pers. memo, March 18, 2003)
- 8 = J. Williamson (USFWS, pers. memo, September 2, 2003)
- 9 = J. Williamson (USFWS, pers. memo, April 14, 2004)
- 10 = NOAA (nmfs.noaa.gov, Federal Register Pub., 2006)
- 11 = USFWS (ecos.fws.gov/tess\_public/SpeciesReport, 2006)

Status

- FE = Federal Endangered
- FT = Federal Threatened
- FSC = Federal Species of Concern
- SE = State Endangered
- ST = State Threatened
- SSC = State Species of Concern

Of the different runs of Chinook salmon, only fall-run Chinook salmon are observed to consistently return to Bear Creek in sizable numbers to spawn. Approximately 300 fall-run Chinook salmon and 200 Central Valley steelhead were estimated to spawn in Bear Creek in 1965 (Potter, 1965). The number of fish that return to spawn each year varies with stream flow, water temperature, ocean conditions, as well as other factors such as a gravel bar blockage at the mouth of Bear Creek due to low flows during fall-run migration periods. These factors are affected by the natural hydrologic regime of the watershed and by human activities, such as ground water pumping and the diversion of water to sustain agricultural operations locally (ENPLAN, 2006).

Fall-run escapement into Bear Creek has not been monitored on a consistent basis for decades. Table 2 provides a summary of Bear Creek fall-run Chinook salmon escapement from 1949 to 2005.

**Table 2. Bear Creek Watershed Assessment 2005  
Estimated Size of Fall-Run Chinook Salmon Spawning Runs in Bear Creek Between  
1949 and 2005**

| Year  | Source  |                        |  |  |
|-------|---|------------------------|--|--|
|       | <i>Year Azevedo &amp; Parkhurst<sup>1</sup></i> | <i>DFG<sup>2</sup></i> | <i>George Eichelberger<sup>3</sup></i> | <i>Western Shasta Resource Conservation District<sup>4</sup></i> |
| 1949  | 50  | -                      | 7,000                                  | -  |
| 1950  | 50  | -                      | 3,000                                  | -  |
| 1951  | 140   | -                      | -                                      | -  |
| 1952  | 100   | -                      | -                                      | -  |
| 1953  | 785   | 800*                   | -                                      | -  |
| 1954  | 450   | 500*                   | -                                      | -  |
| 1955  | 200   | 200*                   | -                                      | -  |
| 1956  | 5   | 5*                     | -                                      | -  |
| 1957  | -   | 30*                    | -                                      | -  |
| 1958  | -   | 200*                   | -                                      | -  |
| 1959  | -   | 10*                    | -                                      | -  |
| 1960  | -   | 50*                    | -                                      | -  |
| 1964  | -   | 50*                    | -                                      | -  |
| 1965  | -   | 350 <sup>▲</sup>       | -                                      | -  |
| 1966  | -   | 400*                   | -                                      | -  |
| 1967  | -   | 30*                    | -                                      | -  |
| 1968  | -   | 310*                   | -                                      | -  |
| 1969  | -   | 560*                   | -                                      | -  |
| 1976  | -   | 167 <sup>▲</sup>       | -                                      | -  |
| 1989  | -   | 36 <sup>†</sup>        | -                                      | -  |
| 1991  | -   | 7 <sup>†</sup>         | -                                      | -  |
| 1992  | -   | 0 <sup>†</sup>         | -                                      | -  |
| 2002  | -   | -                      | -                                      | 62   |
| 2004  | -   | -                      | -                                      | 8  |
| 2005  | -   | -                      | -                                      | 12   |
| 2006* | -   | -                      | -                                      | -  |

<sup>1</sup> Azevedo and Parkhurst counts were based on the number of redds observed.

<sup>2</sup> DFG's counts were based on the following count methods: unknown\*, carcass count expansion\*, redd and carcass count expansion<sup>▲</sup>, and actual physical counts<sup>†</sup>.

<sup>3</sup> Eichelberger's counts were based on shore-based observations and the accuracy of his counts is uncertain.

<sup>4</sup> WSRCD counts were based on the number of redds observed and the assumption that two adults build a redd ([sacriver.org/documents/watershed/bearcreek](http://sacriver.org/documents/watershed/bearcreek)).

\* There are no recorded fall-run estimates for the 2006 year.

In past decades, estimates were made based on carcass counts and occasional aerial redd (salmon nests) counts (CDFG, Annual Reports various years). 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.

Carcass surveys today use a much more scientific methodology, but during the late 1940's and 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. 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 (Killam, 2006).

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 Bear 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 Bear Creek are needed to interpret fishery responses to habitat restoration activities, and provide information to fisheries managers, landowners, and others interested in the Bear Creek watershed.

The video station estimate in 2007 represents a new method for estimating fall-run populations in Bear Creek. A similar video station was constructed and has 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 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. Video stations were installed and monitored in Cow Creek in 2006 and in Bear, Cow and Cottonwood creeks in 2007.

The WSRCD in collaboration with the BCWG implemented a plan to develop a weir in Bear Creek with the same methodology and criteria used previously for the Battle and Cow Creeks. The BCWG had expressed the need for the collection of fish quantity data as part of their Watershed Management Plan to improve the anadromous fish habitat. In coordination with the BCWG, the WSRCD began to locate land owners in the watershed that would be willing to participate by allowing a weir to be built on the main stem of Bear Creek and by allowing access to the site and power supply on a daily basis. A station location that fit the site selection criteria for a video station was found approximately 1.5 miles upstream of the mouth of the Sacramento River, beyond the Parkville Road Bridge (Figure 1).

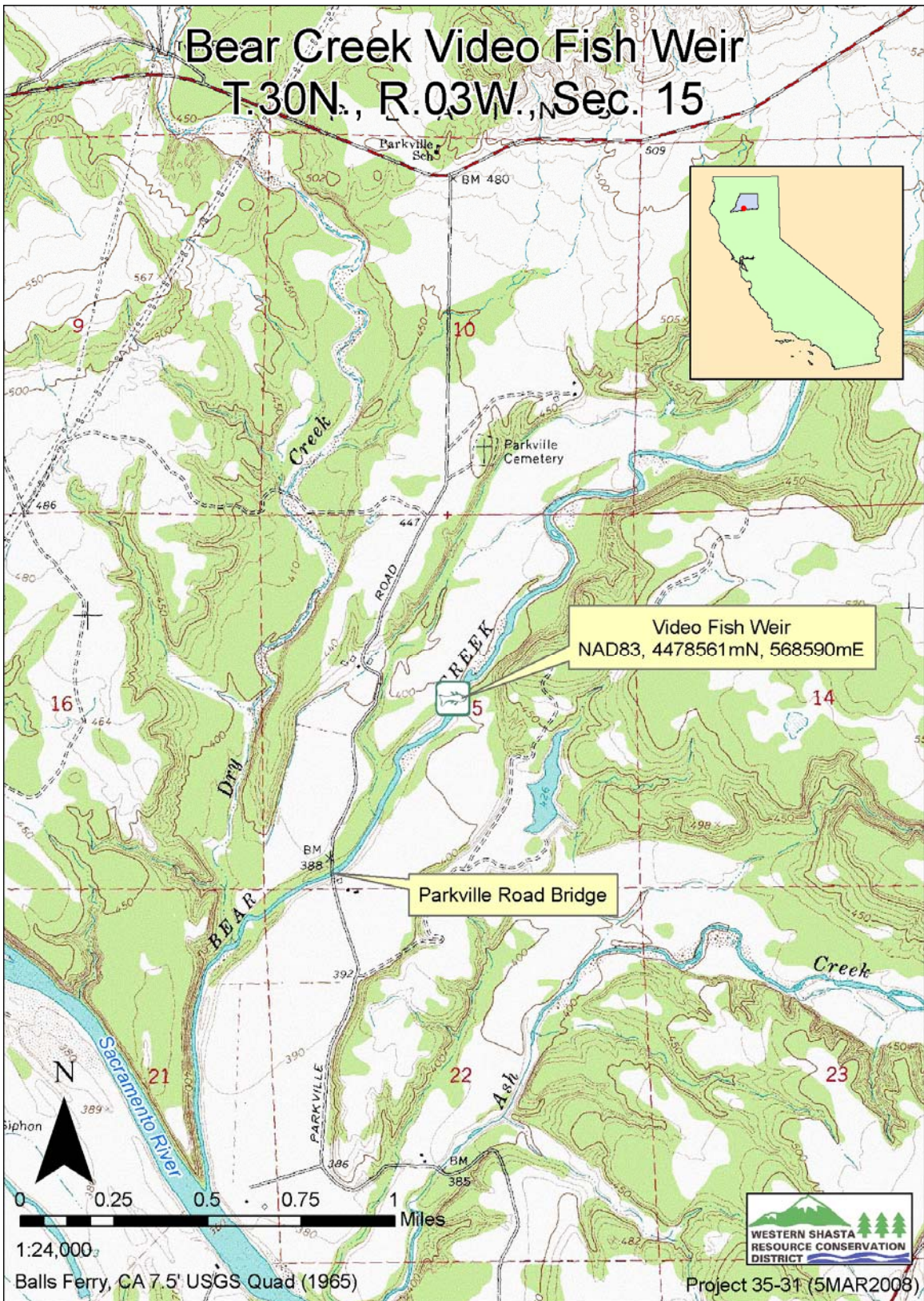


Figure 1. Map detailing the Location of the Video Station on Bear Creek.

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 Bear Creek to ensure that the majority of 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)

## **METHODS and MATERIALS**

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

- Power supply(s), overhead camera, underwater camera(s), lights, and video cassette recorders (VCR's).
- Weir, camera support cables, VCR lock box and the fish passage plates on the stream bed.

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.

Personnel from the CDFG, the WSRCD, the CCWG and the USWFS cooperated to accomplish station set-up and removal, maintenance, tape changes, tape reading and quality control of tape reading.

### **Power Supply**

One criteria of the Bear Creek Video Station was that it be located near a conventional "on-grid" power supply. A site was located on the property bordering the south shore of Bear Creek with an existing 240 volt incoming supply box (Figure 2). This box was at the time used to power an electric irrigation pump in the creek. A 240 to 120 volt transformer was installed next to the existing box and provided a 120 volt household AC power supply to run the cameral lights and equipment.

The VCR lock box was set up on the opposite side of the creek that was accessible to vehicles. About 250 feet (76 m) of wire was run along the camera support cables to power the station's equipment.

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 occurs in the regular power supply. The backup power supply consisted of 4 six-volt "golf cart type" batteries linked to provide a 12 volt DC power supply to a conventional computer battery backup system. The original batteries from the 300 watt 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.

## Overhead Camera system

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.

This camera box was suspended over Bear Creek at a height of about 12-feet (4 m) from the water's surface using a two main cable system constructed of 5/16-inch (8 mm) galvanized steel cables. The two main cables, about 200 feet (91 m) each, were stretched across the creek and anchored in two trees as shown in Figures 2 and 3.



*Figure 2. Bear Creek video station power supply box. An active box was available to power the station. A 240 to 120 AC volt transformer was installed to provide standard household power to station equipment. Also showing is the two main cables used to suspend the overhead camera. The VCR lock box is located to the right (not shown).*

Tightening of the main cables was accomplished with a mechanical “come-along.” The end of the main cable closest to the VCR-battery box was designed to allow easy movement up and down with the mechanical “come-along.” In this manner the camera was raised and lowered if an adjustment to lighting, or camera cleaning was required.



*Figure 3. Camera box suspended over Bear Creek at a height of about 12-feet (3.6 m) from the water's surface using a two main cable system constructed of 5/16-inch (7.9 mm) galvanized steel cables. Also showing the location of the two underwater cameras and the weir opening allowing fish passage.*

The camera box was attached by ropes to the main cables which reduced vibrations caused by wind. The camera was connected by co-axial (RG-6) cable to the station's VCR-lock box, which was located about 50 feet from the creek, above the flood plain. Power cords and camera co-axial cable were wired to one of the overhead support cables with short sections of insulated wire. Figure 4 shows the refurbished refrigerator used to secure and shelter the station's video equipment, electrical accessories and batteries:



*Figure 4. The video station's VCR-lock box. The modified refrigerator contained the four VCR's, the quad processor, the power controls, equipment and tape storage boxes, monitor and batteries. The cable above the lock box is the anchoring cable to the two main cables suspending the overhead camera over the creek.*

### **Underwater Camera System**

An underwater camera was installed at the upstream end of the background plates (Figures 3 and 5). This camera was the same type and cost as the overhead camera (PC88WR black and white). The underwater camera was useful for monitoring upstream and downstream movement and for species identification. From the overhead camera it

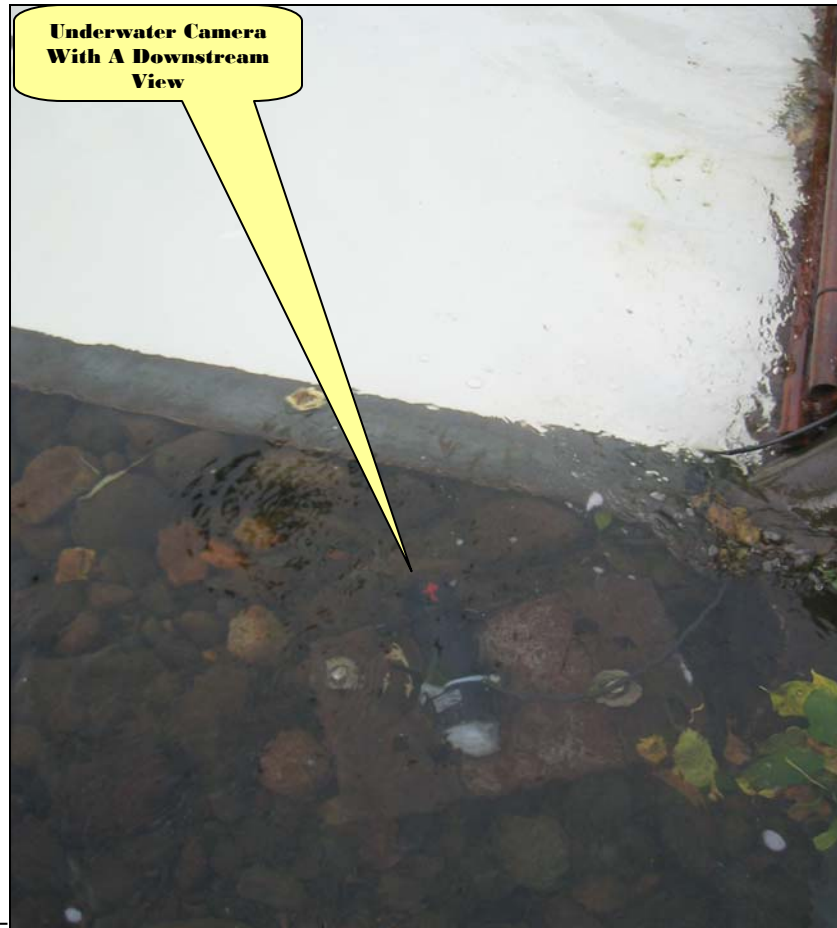
was difficult to differentiate among species. The underwater camera proved to be a resourceful tool for the viewer to identify the different types of large species (i.e. Chinook, carp or steelhead). By identifying the adipose fin and shape of the fish the reader was able to verify the species.

The camera was installed inside a custom-made PVC capsule. The capsule had to be built of high grade material for protection and sealed to not allow water inside of it. To ensure it would withstand the current, the capsule was strapped to a 20 pound metal plate and the metal plate anchored to the creek bed. The camera's co-axial cable ran atop the weir panels and once out of the creek it was buried underground to the lock box to prevent vandalism and provide an appearance suitable for the area where the station was located. Towards the end of the monitoring season a second underwater camera was installed at the right entrance to the weir (Figure 3). The design and installation followed the same criteria as the first camera. This camera became available to use on the Bear Creek video station after the Cottonwood Creek and Cow Creek video stations had been removed. The second camera allowed a second monitoring angle necessary to accurately record and identify the movement of fish during the time when the water became turbid, due to increasing flows, and had poor visibility.

The image from the cameras was inputted into a color quad processor (Supercircuits type QS-29) that merged the underwater camera(s) 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 8-hour 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 the fourth VCR was to ensure continuous video 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 VCR's for proper operation throughout the season.

### **Lights**

Lighting for the video cameras 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 3). These outdoor spotlights use very little power compared to conventional spotlight bulbs, 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. By reviewing the "night tape" we were able to check the lights for proper operation during daily weir maintenance.

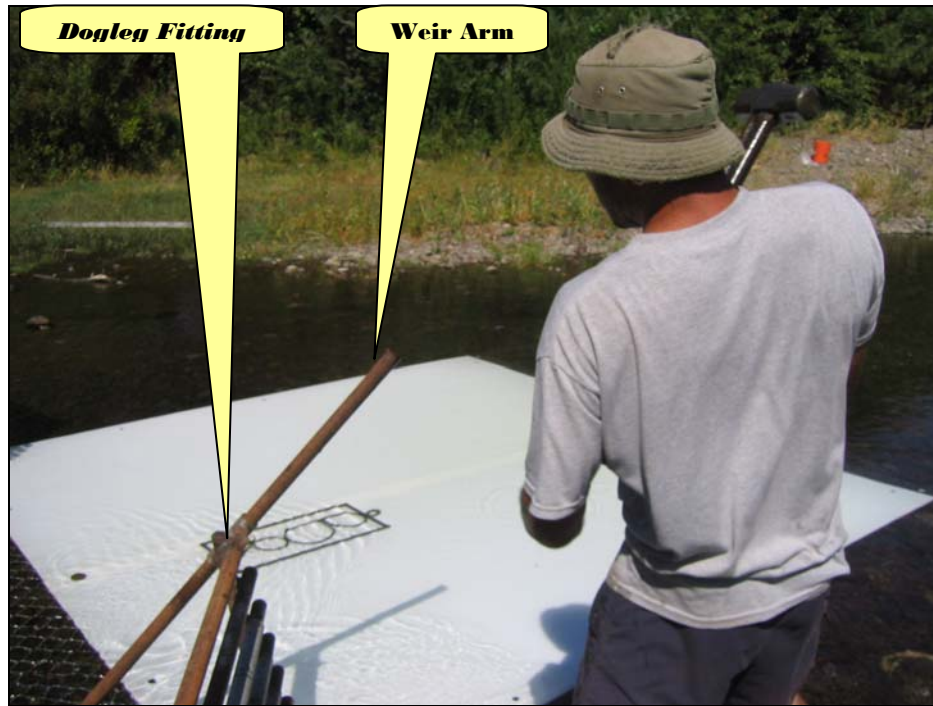


*Figure 5. The underwater camera is the same type as the overhead camera (PC88WR). Installed at the upstream end of the background plates, the underwater camera was useful for monitoring the movement of the fish up or down stream as well as for species identification.*

### **Weir system**

A weir was constructed to channel salmon into the camera's view without causing passage delay (Figure 3). The weir was constructed of 10-foot (3m) long steel 1 1/8 inch O.D. (28 mm) pipes which were welded to uprights with 3-inch (76 mm) 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 Bear 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 8 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 6).



*Figure 6. The construction of the weir. 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.*

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.

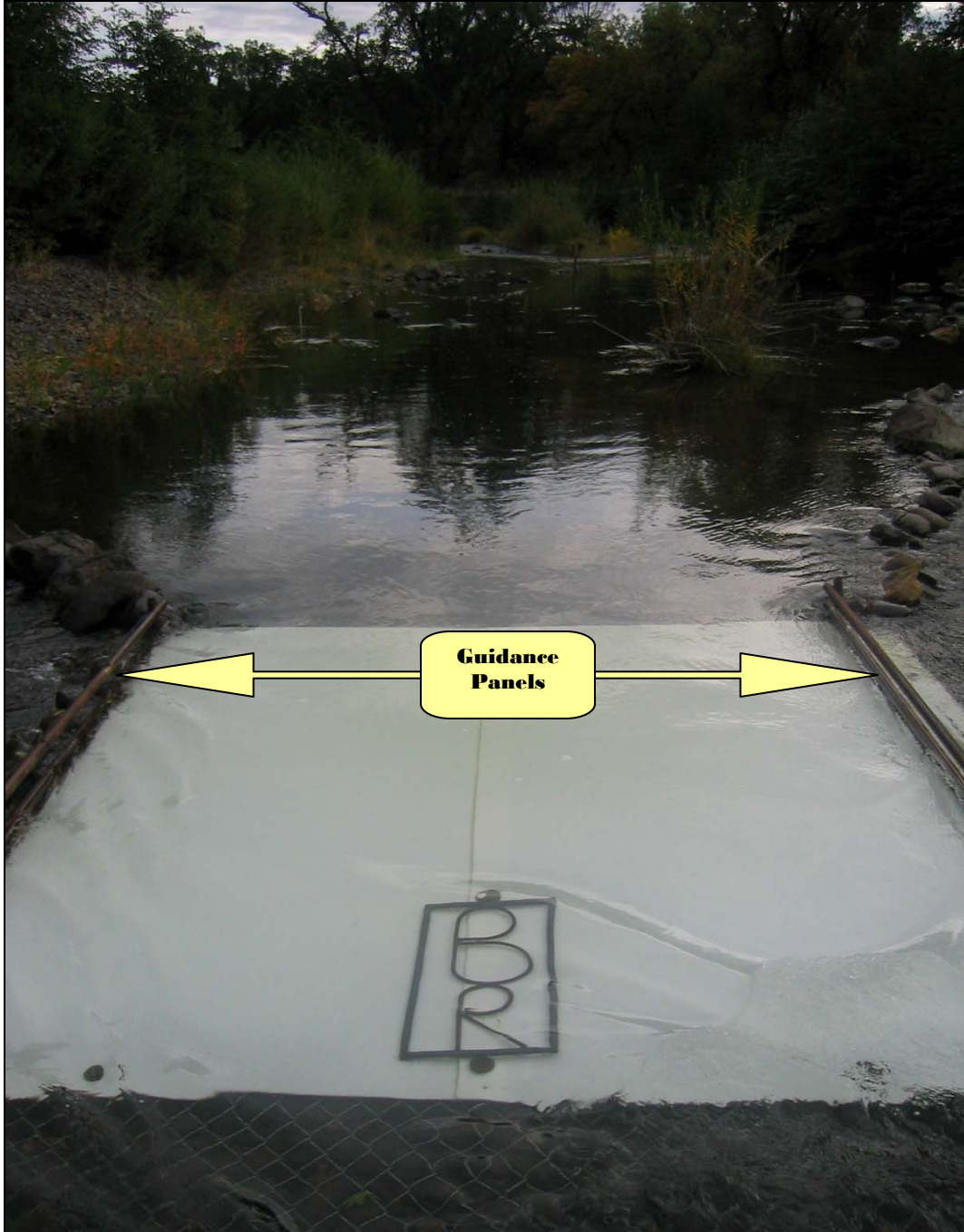
Two weir panels were added as upstream facing guidance panels along the fish passage opening to prevent fish from skirting around the ends of the weir (see Figure 8). These guidance panels were placed along the outside edges of the white bottom plates just above the water surface and resulted in all fish swimming upstream along the entire length of the plates allowing for easier counting compared to similar weirs without these guidance panels (i.e. as found in the 2003 Battle Creek study, (Killam 2006)).



*Figure 7. The Bear Creek partial weir showing: the construction of the weir, including the white high density polyethylene (HDPE) sheets staked to the creek bottom to make the observation of passing salmon easier.*

White high density polyethylene (HDPE) sheets were staked to the creek bottom to make the observation of passing salmon easier. Two overlapping  $\frac{1}{4}$  inch by 5-feet by 10-feet (6 mm x 1.2 m x 3 m) sheets were used to create a white background (see Figure 7). These sheets had  $\frac{3}{4}$ -inch (19 mm) holes drilled around their perimeters to allow staking. A metal frame plate was bolted to the upstream edge of both sheets prior to placement in the creek. The entire assembly was then staked to the streambed underneath the camera. Stakes were 24-inch (61 cm) concrete form stakes with a 2-inch (50 mm) washer welded to their tops to secure the sheets.

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 Figure 8). This “station brand” was designed and custom welded (by Doug Killam, D. S., CDFG) from  $\frac{3}{8}$ -inch (9.5 mm) rebar and incorporated the letters B and R into the center of the design. During future viewing tape readers will be able to identify tape images by the creek’s code name: BR= Bear Creek, (Figure 8).



*Figure 8. A metal rectangle measuring 24-inches (61 cm) tall by 12-inches (30 cm) wide allowed tape readers to approximate fish lengths as well as identify the creek by its code name: BR= Bear Creek. 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.*

## **Video Station Operation and Maintenance**

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

- Changing tapes in the three 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.

Recorded tapes were brought to the CDFG's office in Red Bluff, CA where they were stored until viewing. Tapes were first recorded to a DVR and then viewed and a database of fish passage was compiled. After the staff from the WSRCD completed the tape reading, the tapes were stored at the CDFG's Red Bluff office for re-use in later years.

## **Fish Counting Procedures**

Tapes were played on VCR's that outputted into a Honeywell Fusion III digital video recorder (DVR). 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 CDFG to access the digital files containing the motion filtered and continuous recordings. Each date was divided into 48 half-hour periods. Fish were counted as passing upstream once they exited the upper portion of the white bottom plates above the weir edges. 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.

## **Tape Reading and Data Collection**

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 Bear (as well as Cottonwood 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. Since storing of the data from all three creeks required a greater storing capacity than the DVR's capacity, the compiled data was then stored in four separate Mass Storage

External Hard Drives (MSEHD) with a capacity of 500GB each. The DVR was connected to 3 VCR's allowing the recording of a 24-hour period to be finished in eight hours. The DVR also allowed tapes to be recorded at a variety of motion detection sensitivities. 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.

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 were 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.

During the daily monitoring of the video stations the tape readings was done at the CDFG's Red Bluff office and, after the removal of the weirs, the reading took place also at the WSRCD. Data review at the WSRCD was possible by installing the Honeywell Fusion II Proprietary Viewer software unto a computer. The video data was then uploaded from the MSEHD to the Proprietary Viewer program through an USB 2 port. This program enabled the reader to watch the video at variable speeds and to quickly forward or reverse the video image while counting salmon.

The viewing of the tapes through the DVR system was effective and convenient since it was used not only for the viewing, but also allowed the storing of a significant amount of data which is in turn is readily accessible, chronologically, at any point.

## **RESULTS and DISCUSSION**

### **Data Results**

The final adjusted estimate of fall-run Chinook salmon that migrated upstream into the Bear Creek watershed in 2007 was **140**. The daily passage data for the video station is presented in Table 3. Peak passage occurred on October 20<sup>th</sup> corresponding to a water temperature of 55.6 Fahrenheit, (13.1 °C).

Tables 4 and 5 present the data from the video station in different formats. Table 4 breaks the data down by half-hour period revealing that the peak migration at the video station site occurred between 5:00 pm and 5:30 pm in the evening. The data shows that there were not any other specific peak times as in other creeks, but instead the passage of the fish occurred all throughout the day. It is worth noting that the highest peak time in Bear Creek does not correspond with patterns on Cow and Battle Creek (Killam, 2006).

The data in Table 5 reveals that the peak passage for the fall-run Chinook at Bear Creek occurred in October, with most fish passing between the third and fourth weeks of the month. This peak passage occurred a week or two later than other tributaries (e.g. Cow, Cottonwood and Battle Creeks) in the Upper Sacramento River Basin in 2007, (WSRCD, Author, personal observation). Peak passage can vary a few weeks between years depending on the water temperatures and rainfall of that year. Spawning would probably have commenced 1-2 weeks after passage, therefore it is estimated that peak spawning activity in Bear Creek may have occurred in early-November through mid-November.

### **Data Adjustments**

The 2007 video station estimate began as a count ( $n = 136$ ) of all Chinook salmon moving upstream of the station up to the time of weir removal on December 17, 2007. This count was only for those time periods where tapes were available. The video count was further adjusted to account for factors that could both raise and lower the final estimate. This adjusted estimate included adjustments for periods when:

1. The taping malfunctioned: only one tape (8 video hours) malfunctioned and no numbers were added.
2. The water was too turbid to count fish: no numbers were added.
3. Redd count downstream of weir: two redds were observed and four fish were added.
4. The quality control (QC) process of tape reading: the QC process determined that the original readers were accurate and resulted in the same as the original numbers.

The adjustments are made to the database under the assumption that salmon would have been passing had the station been operating during the “problem” periods. The net result of the adjustment to the raw counts was a net gain of no salmon resulting in an estimate of 136. Four additional salmon were added to the QC results based on the two redds observed downstream from the weir resulting in a total estimate of 140 (assuming two fish per redd).

Past experience on Battle Creek has shown that muddy water can trigger a migratory response in fall-run, although the review of the time periods before and after the high water event, late November, revealed that no fish migrated into Bear Creek, therefore the fish estimated during this period was zero.

Since the overall numbers of fish passage in Bear Creek were considerably lower than the other monitored creeks, the QC processing of all periods when fish were observed was justified. The final QC count showed the same passage numbers as the original counts.

Table 3. Summary of daily passage for fall-run Chinook salmon, cumulative total, and water temperature at the 2007 Bear Creek video station.

| Date   | Daily Total | Cumulative | Water Temp | Date          | Daily Total | Cumulative | Water Temp |
|--------|-------------|------------|------------|---------------|-------------|------------|------------|
| Sep 20 | 0           | 0          | 65.2       | Nov 4         | -2          | 107        | 52.4       |
| Sep 21 | 0           | 0          | 66.3       | Nov 5         | 4           | 111        | 51.3       |
| Sep 22 | 0           | 0          | 65.0       | Nov 6         | 1           | 112        | 50.9       |
| Sep 23 | 0           | 0          | 65.0       | Nov 7         | 0           | 112        | 50.5       |
| Sep 24 | 0           | 0          | 64.3       | Nov 8         | 0           | 112        | 50.4       |
| Sep 25 | 0           | 0          | 63.9       | Nov 9         | 1           | 113        | 51.9       |
| Sep 26 | 0           | 0          | 64.3       | Nov 10        | 2           | 115        | 51.7       |
| Sep 27 | 0           | 0          | 64.8       | Nov 11        | 4           | 119        | 52.7       |
| Sep 28 | 0           | 0          | 63.5       | Nov 12        | 4           | 123        | 50.9       |
| Sep 29 | 0           | 0          | 60.9       | Nov 13        | -1          | 122        | 53.0       |
| Sep 30 | 0           | 0          | 60.2       | Nov 14        | 0           | 122        | 53.0       |
| Oct 1  | 0           | 0          | 62.7       | Nov 15        | 1           | 123        | 52.9       |
| Oct 2  | 0           | 0          | 62.2       | Nov 16        | 2           | 125        | 54.1       |
| Oct 3  | 0           | 0          | 61.5       | Nov 17        | 0           | 125        | 55.2       |
| Oct 4  | 0           | 0          | 60.3       | Nov 18        | 0           | 125        | 55.1       |
| Oct 5  | 0           | 0          | 57.7       | Nov 19        | 4           | 129        | 56.1       |
| Oct 6  | 0           | 0          | 56.3       | Nov 20        | 0           | 129        | 51.5       |
| Oct 7  | 0           | 0          | 57.5       | Nov 21        | 1           | 130        | 47.8       |
| Oct 8  | 0           | 0          | 58.4       | Nov 22        | 0           | 130        | 45.3       |
| Oct 9  | 0           | 0          | 57.9       | Nov 23        | 1           | 131        | 44.3       |
| Oct 10 | 7           | 7          | 58.9       | Nov 24        | 0           | 131        | 42.3       |
| Oct 11 | 3           | 10         | 56.5       | Nov 25        | 0           | 131        | 43.0       |
| Oct 12 | 1           | 11         | 56.7       | Nov 26        | 0           | 131        | 42.7       |
| Oct 13 | 0           | 11         | 57.3       | Nov 27        | 0           | 131        | 44.6       |
| Oct 14 | 0           | 11         | 58.4       | Nov 28        | 1           | 132        | 44.1       |
| Oct 15 | 1           | 12         | 58.5       | Nov 29        | 0           | 132        | 42.9       |
| Oct 16 | 4           | 16         | 57.1       | Nov 30        | 0           | 132        | 41.5       |
| Oct 17 | 7           | 23         | 56.4       | Dec 1         | 0           | 132        | 39.0       |
| Oct 18 | 4           | 27         | 56.2       | Dec 2         | 0           | 132        | 39.1       |
| Oct 19 | 9           | 36         | 57.1       | Dec 3         | 0           | 132        | 43.5       |
| Oct 20 | 44          | 80         | 55.6       | Dec 4         | 4           | 136        | 47.6       |
| Oct 21 | 0           | 80         | 53.3       | Dec 5         | 0           | 136        | 47.3       |
| Oct 22 | 0           | 80         | 54.0       | Dec 6         | -1          | 135        | 47.8       |
| Oct 23 | 6           | 86         | 55.2       | Dec 7         | 1           | 136        | 48.5       |
| Oct 24 | 1           | 87         | 55.9       | Dec 8         | 0           | 136        | 44.3       |
| Oct 25 | 2           | 89         | 56.1       | Dec 9         | 0           | 136        | 42.1       |
| Oct 26 | 4           | 93         | 56.0       | Dec 10        | 0           | 136        | 41.3       |
| Oct 27 | 2           | 95         | 55.5       | Dec 11        | 0           | 136        | 40.0       |
| Oct 28 | 3           | 98         | 55.8       | Dec 12        | 0           | 136        | 40.4       |
| Oct 29 | 3           | 101        | 56.6       | Dec 13        | 0           | 136        | 39.4       |
| Oct 30 | 0           | 101        | 58.5       | Dec 14        | 0           | 136        | 39.0       |
| Oct 31 | 1           | 102        | 57.8       | Dec 15        | 0           | 136        | 40.1       |
| Nov 1  | 5           | 107        | 56.4       | Dec 16        | 0           | 136        | 41.7       |
| Nov 2  | 1           | 108        | 54.9       | Dec 17        | 0           | 136        | 44.9       |
| Nov 3  | 1           | 109        | 53.4       | <b>Totals</b> |             | <b>136</b> |            |

*Table 4. Summary of fall-run Chinook salmon passage by time of day at the 2007 Bear Creek video station. Peak passage occurred between 5:00 pm and 5:30 pm in the evening.*

| <b>Time</b> | <b>Passage</b> | <b>Time</b> | <b>Passage</b> |
|-------------|----------------|-------------|----------------|
| 0:00        | 2              | 12:00       | 0              |
| 0:30        | 5              | 12:30       | 0              |
| 1:00        | 0              | 13:00       | 3              |
| 1:30        | 3              | 13:30       | 1              |
| 2:00        | 4              | 14:00       | 8              |
| 2:30        | 2              | 14:30       | 2              |
| 3:00        | 1              | 15:00       | 5              |
| 3:30        | 0              | 15:30       | 2              |
| 4:00        | 1              | 16:00       | 1              |
| 4:30        | 5              | 16:30       | 2              |
| 5:00        | 1              | 17:00       | 11             |
| 5:30        | 3              | 17:30       | 2              |
| 6:00        | 6              | 18:00       | 9              |
| 6:30        | 1              | 18:30       | 1              |
| 7:00        | 2              | 19:00       | 3              |
| 7:30        | 2              | 19:30       | 1              |
| 8:00        | 3              | 20:00       | 3              |
| 8:30        | 1              | 20:30       | 2              |
| 9:00        | 0              | 21:00       | 3              |
| 9:30        | 4              | 21:30       | 3              |
| 10:00       | 8              | 22:00       | 2              |
| 10:30       | 4              | 22:30       | 2              |
| 11:00       | 1              | 23:00       | 3              |
| 11:30       | 3              | 23:30       | 0              |

Table 5. Summary of fall-run Chinook salmon passage at the 2007 Bear Creek video station. Data indicates that most salmon passed between the third and fourth weeks of October, on the 42<sup>nd</sup> week of the year.

| Month        |            | Passage         |
|--------------|------------|-----------------|
| September    |            | 0               |
| October      |            | 102             |
| November     |            | 30              |
| December     |            | 4               |
| Week         | Passage    | Dates           |
| 38           | 0          | Sept 20-22      |
| 39           | 0          | Sept 23-29      |
| 40           | 0          | Sept 30 – Oct 6 |
| 41           | 11         | Oct 7-13        |
| 42           | 69         | Oct 14-20       |
| 43           | 15         | Oct 21-27       |
| 44           | 14         | Oct 28 – Nov 3  |
| 45           | 6          | Nov 4-10        |
| 46           | 10         | Nov 11-17       |
| 47           | 6          | Nov 18-24       |
| 48           | 1          | Nov 25 - Dec 1  |
| 49           | 4          | Dec 2-8         |
| 50           | 0          | Dec 9-15        |
| 51           | 0          | Dec 16-17       |
| <b>Total</b> | <b>136</b> |                 |

## RECOMMENDATIONS

1. The video station proved to be a valuable and accurate tool in estimating salmon escapement into Bear 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 Bear 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.
4. The purchase and use of more underwater cameras should be considered. Ideally a system of 4 cameras would be best for accurately identify the species moving through the weir opening. Each camera would be installed at each corner of the 4 by 10 feet (6 mm x 1.2 m x 3 m) fish passage opening.
5. Install flow meter in Bear Creek to compare flow data with fish passage data.
6. Bear Creek video station should left in place as long as possible, if weather conditions permit, to obtain information on late fall-run Chinook as well as steelhead passage.

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