Monitoring Adult Chinook Salmon, Rainbow Trout, and Steelhead in Battle Creek, California, from March through November 2007

USFWS Report

Prepared by:

Jess M. Newton
Laurie A. Stafford
Matthew R. Brown

U.S. Fish and Wildlife Service
Red Bluff Fish and Wildlife Office
Red Bluff, California 96080

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Monitoring Adult Chinook salmon, Rainbow Trout, and Steelhead in Battle Creek, California, from March through November 2007

Jess M. Newton, Laurie A. Stafford, and Matt R. Brown

U.S. Fish and Wildlife Service, Red Bluff Fish and Wildlife Office
10950 Tyler Road, Red Bluff, CA 96080, (530)527-3043

Abstract- The purpose of our monitoring project was to provide fisheries information for the adaptive management of anadromous salmonid restoration projects in Battle Creek including the Interim Flow Project and the Battle Creek Salmon and Steelhead Restoration Project. Our adult salmonid monitoring investigations included (1) salmonid escapement estimates at the Coleman National Fish Hatchery (CNFH) barrier weir fish ladder and (2) stream surveys documenting salmonid spawning distributions upstream of the barrier weir. Monitoring activities occurred from March through November, 2007.

In 2007, we estimated five clipped and 291 unclipped Chinook salmon *Oncorhynchus tshawytscha*, passed through the Coleman National Fish Hatchery barrier weir (rm 5.8) to the middle portion of Battle Creek, from March 1 to August 1. This was the highest passage estimate for unclipped Chinook since monitoring began in 1995. We used the unclipped passage total to estimate the "maximum potential spring Chinook" escapement. It is likely that a proportion of this maximum estimate were actually winter, fall, and late-fall Chinook due to overlap in migration periods. Run-specific Chinook salmon population estimates presented in previous annual reports were based, in part, on genetic analyses, which classified proportions of a sample group as winter, spring, fall, or late-fall run. At the time of writing this report, genetic analysis had not been performed. CNFH personnel released an additional 72 unclipped Chinook above the barrier weir prior to opening the barrier weir fish ladder on March 1. While these 72 Chinook could have been from any of the four runs, they were most likely late-fall Chinook. Based on stream survey redd counts (132 total redds), we estimate a spawning population of 264 spring Chinook.

We estimated that three clipped and 216 unclipped rainbow trout passed upstream of the barrier weir fish ladder between March 1 and August 1, 2007. CNFH released an additional 130 unclipped rainbow trout above the barrier weir prior to March 1.

Overall, water temperatures in 2007 were adequate for spring Chinook to successfully produce juveniles but at a reduced number due to high temperatures during the spring Chinook holding period. During the holding period, 61% of mean daily water temperatures were categorized as fair or poor in the most utilized holding pool which likely led to some reduced fertility and adult mortality. During the holding period, a minimum of 38.5% of the days were categorized as fair or poor in all reaches except a portion of the uppermost North Fork reach. During the egg incubation period, mean daily water temperatures at redds were categorized as excellent for 97.0 to 99.4% of the days, suggesting there was little or no temperature-related egg mortality.

Stream surveys corroborated other studies suggesting that there is a nearly impassable barrier on the North Fork. From 2001 through 2007, no live fish, redds, or carcasses were observed above the potential barrier at rm 5.06.

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Introduction

Battle Creek is important to the conservation and recovery of federally listed anadromous salmonids in the Central Valley of California. Restoration actions and projects planned or underway in Battle Creek focus on providing habitat for three federally listed species in the Central Valley Evolutionary Significant Unit (ESU); the endangered winter Chinook salmon *Oncorhynchus tshawytscha*, threatened spring Chinook salmon (Chinook), and threatened steelhead *Oncorhynchus mykiss*. Currently, the geographic range of the winter Chinook ESU is limited to a small area in the mainstem of the Sacramento River between Keswick Dam and Red Bluff, California, where it may be susceptible to catastrophic loss (Figure 1). Establishing a second population in Battle Creek could reduce the possibility of extinction. Battle Creek also has the potential to support significant, self-sustaining populations of spring Chinook and steelhead, which is crucial to their recovery.

Since the early 1900's, a hydroelectric power generating system of dams, canals, and powerhouses, now owned by Pacific Gas and Electric Company (PG&E), has operated in the Battle Creek watershed in Shasta and Tehama Counties, California. The hydropower system has had severe impacts upon anadromous salmonids and their habitat (Ward and Kier 1999). In 1992, the Central Valley Project Improvement Act (CVPIA) federally legislated efforts to double populations of Central Valley anadromous salmonids. The CVPIA Anadromous Fisheries Restoration Program outlined several actions necessary to restore Battle Creek, including the following: "to increase flows past PG&E's hydropower diversions in two phases, to provide adequate holding, spawning, and rearing habitat for anadromous salmonids (USFWS 2001a)."

The Ecological Restoration Program (ERP) of the federal and State of California interagency program known as CALFED, PG&E, and other contributors funded the Battle Creek Salmon and Steelhead Restoration Project (Restoration Project). The Restoration Project will provide large increases in minimum instream flows in Battle Creek, remove five dams, and construct fish ladders and fish screens at three other dams. Planning, designing, and permitting of the Restoration Project had taken longer than originally anticipated.

PG&E is required under its current Federal Energy Regulatory Commission (FERC) license to provide minimum instream flows of 3 cubic feet per second (cfs) downstream of diversions on the North Fork Battle Creek (North Fork) and 5 cfs downstream of diversions on the South Fork Battle Creek (South Fork). Beginning in 1995, the CVPIA Water Acquisition Program (1995 to 2000) and ERP (2001 to present) contracted with PG&E to increase minimum instream flows in the lower reaches of the North Fork and South Fork. In general, flows are increased to 30 cfs plus or minus 5 cfs below Eagle Canyon Dam on the North Fork and below Coleman Diversion Dam on the South Fork. Increased flows were not provided on the South Fork in 2001 and most of 2002, due in part to lack of funds. Based on an agreement in 2003, flows can be redistributed between the forks to improve overall conditions for salmonids, based on water temperatures and the distribution of live Chinook and redds.

The ERP funded Interim Flow Project will continue until the Restoration Project construction begins (currently scheduled for 2009). The intent of the Interim Flow Project is to provide immediate habitat improvement in the lower reaches of Battle Creek to sustain current natural salmonid populations while implementation of the more comprehensive Restoration Project moves forward.

The goal of our monitoring project is to provide fisheries information for the adaptive management of anadromous salmonid restoration in Battle Creek including the Interim Flow

Project and the Restoration Project when it comes online. The Red Bluff Fish and Wildlife Office (RBFWO) carried out the current investigations in 2007, under a 3-year grant from ERP. This grant was designed to support most of the monitoring needs of the Restoration Project's Adaptive Management Plan (Terraqua Inc. 2004). Our monitoring investigations included (1) salmonid escapement estimates at the Coleman National Fish Hatchery (CNFH) barrier weir fish ladder, (2) stream surveys documenting salmonid spawning distributions upstream of the barrier weir, and (3) juvenile salmonid production estimates (not included in this report). Tables summarizing data from previous years are included in this report (Tables 1-6).

Study Area

Battle Creek is located in northern Tehama and southern Shasta counties, California, and is fed by the volcanic slopes of Lassen Peak in the southern Cascade Range and numerous springs (Figure 2). Battle Creek eventually enters the Sacramento River (river mile (rm) 272) east of the town of Cottonwood, California. Battle Creek is comprised of the North Fork (approx. 29.5 miles in length from head waters to confluence), the South Fork (approx. 28 miles in length from headwaters to confluence), the mainstem Battle Creek (16.6 miles from the confluence of the north and south forks to the Sacramento River), and many tributaries. Battle Creek has been identified as having high potential for fisheries restoration because of its relatively high and consistent flow of cold water. It has the highest base flow (dry-season flow) of any tributary to the Sacramento River between the Feather River and Keswick Dam (Ward and Kier, 1999). Our study areas were at the CNFH barrier weir on the mainstem Battle Creek (rm 5.8), the North Fork below Eagle Canyon Dam (5.3 miles in length), the South Fork below Coleman Diversion Dam (2.5 miles in length), and the mainstem Battle Creek above rm 5.8 (10.8 miles in length)(Figure 2). Eagle Canyon Dam and Coleman Diversion Dam were considered the upstream limits of anadromous salmonid distribution during the study because fish ladders on the dams were closed.

Methods

We used the CNFH barrier weir fish trap and video counts along with stream surveys to monitor adult salmonids in Battle Creek between March and November. Chinook salmon and steelhead returning to Battle Creek were classified as either unclipped (adipose fin present) or clipped (adipose fin absent). We considered all clipped Chinook and rainbow trout to be hatchery-origin and unclipped Chinook to be either natural-origin or hatchery-origin (not all hatchery Chinook are clipped). We considered all unclipped rainbow trout to be natural-origin as CNFH has clipped 100% of their steelhead production since 1998. It is likely that unclipped Chinook returning to Battle Creek during our monitoring period are mostly spring Chinook. However, it is possible that some unclipped Chinook are late-fall, winter, or fall run due to overlapping periods of migration. Therefore, we chose not to classify all unclipped Chinook as spring run. We use the term "rainbow trout" to refer to all *Oncorhynchus mykiss*, including anadromous steelhead, because of the difficulties in differentiating the anadromous and resident forms in the field.

Coleman National Fish Hatchery Barrier Weir

Operation of the CNFH barrier weir (the barrier weir) blocked upstream passage of fish through the fish ladder from August 1, 2006 to March 1, 2007. During this period, fish were periodically directed into holding ponds at CNFH, where fall and late-fall Chinook and steelhead were used in propagation programs. Fish passage upstream of the barrier weir in Battle Creek was afforded from March 1 through August 1, 2007 by opening the fish ladder. We monitored upstream fish passage from March 1 through August 1 by initially using a live trap and later switching to underwater videography.

Trapping.—A false bottom fish trap, located at the upstream end of the fish ladder, was used to capture Chinook, rainbow trout, and other non-target species as they migrated upstream. The trap operated approximately 8 h a day, 7 d a week. To decrease potential passage delays for Chinook, we implemented two time shifts based on diel movement patterns observed in previous years: 0930-1730 (PST) from March 1 to mid-April and 0430-1230 (PDT) from mid-April until May 9 when video monitoring began. During hours when the trap was not operated, fish were allowed to enter the trap, but the exit was closed blocking upstream passage. Prior to operation each morning, the trap was cleaned, weather conditions were noted, and water temperature and stream stage elevation were documented. Every 2 h, water temperature and stage gauge levels were recorded. When water temperature exceeded 60ºF, we stopped trapping for that day to minimize the stress caused by handling fish at high temperatures. Trapping was terminated for the season and videography began when water temperatures exceeded 60ºF for a majority of the daily trap operation period.

During operation, the trap was checked every 30 min. We identified non-target fish species, counted, and released upstream. Salmonids were netted from the trap and immediately transferred to a holding tank. Water temperature in the holding tank was maintained within 2ºF of Battle Creek water temperatures.

Salmonids were measured (fork length) to the nearest 0.5 cm, examined for scars and tissue damage, examined for the presence or absence of a mark (an adipose-fin clip or floy tag), and identified to gender when possible. A tissue sample was taken from unclipped Chinook and rainbow trout for genetic analysis. All clipped Chinook were sacrificed and coded-wire tags (CWTs) extracted and decoded to determine run designation, hatchery of origin, and age. Since only a fraction of clipped rainbow trout are tagged with a CWT, they were first scanned using a V-detector or a handheld wand detector (Northwest Marine Technology). Clipped trout with a CWT were sacrificed for tag recovery. Clipped trout without a CWT were transported live to a CNFH raceway.

Video counts.—An underwater video camera (Lorex CVC-6991) was used to record Chinook, rainbow trout, and other non-target species as they passed through the fish ladder. The camera was placed in the modified fish trap at the upstream end of the fish ladder. Video monitoring of fish passage was conducted from May 9-August 1. A lighting system allowed for 24-h monitoring. We used a digital video recorder (DVR, Honeywell Fusion DVR model HFDVR1612012) to record fish passage. The DVR setting ranges included; 11 to 15 frames per second, “normal” to “fine” quality, and 640X240 to 640X480 resolution. Each night the DVR was programmed to transfer and store the video data to a 1 terabyte external hard drive (Maxtor OneTouch™ III). In conjunction with the DVR, we also used a time-lapse analog videocassette recorder (VCR) as a backup incase the DVR computer crashed. The time mode on the videocassette recorder was set to 24 h, and 160-min VHS tapes were used. A time-date stamp was recorded on the video.

Digital video footage was later viewed in fast-forward mode until a fish was observed, then reviewed at slow playback speed or "freeze frame" mode to assist in species identification and mark detection. The certainty of the observation was rated as good, fair, or poor. A good rating signified complete confidence in determining species and the presence or absence of an adipose fin; fair suggested confidence in determining species and the presence or absence of an adipose fin but additional review was needed; and poor suggested uncertainty in determining species and the presence or absence of an adipose fin.

Picture quality was also rated as good, fair, or poor. Good signified a clear picture; fair indicated that objects were discernable but extra review was needed; and poor indicated that some objects were indistinguishable. Passage was estimated for periods of poor picture quality based on passage rates during adjacent periods of good and fair picture quality.

Five-second clips of all Chinook and rainbow trout passing the barrier weir were recorded onto a DVD, which was reviewed by more experienced personnel to confirm species identification and the presence or absence of an adipose fin. The total number of clipped and unclipped Chinook and rainbow trout observed was recorded. If the adipose fin was unidentifiable, then Chinook and rainbow trout were classified as unknown clip status. Additionally, the hours of possible fish passage and the hours of video-recorded fish passage were logged.

For quality assurance (QA) purposes, every third day of video monitoring was viewed a second time by a separate staff member. Annual error rates were calculated for primary viewers and QA viewers as the percent of salmonids not seen. We used the combined observations from both groups to derive the estimated total number of salmonids seen. QA measures were used to identify training needs and give a general indication amount of negative bias in our passage estimates during the video monitoring period. Observations from the QA process were included in official counts for those days but error rates were not used as correction factors for non-QA days.

Passage estimation.—We estimated the number of clipped and unclipped Chinook and rainbow trout passing through the barrier weir fish ladder. For each week of trapping, total passage of clipped and unclipped salmonids was estimated by apportioning unknown clip status Chinook or rainbow trout counts (e.g., fish that accidently escaped the trap prior to being examined for an adipose fin) according to the proportion of clipped and unclipped fish captured during the same week. For each week of video monitoring, total passage was estimated by apportioning any unknown clip status fish and then expanding observed counts according to the amount of time passage was allowed, but not recorded due to poor video quality or equipment malfunction. Total passage was calculated by summing weekly passage estimates at the barrier weir as well as the number of clipped and unclipped Chinook and rainbow trout released into upper Battle Creek by CNFH prior to March 1. The equations used for estimating passage during barrier weir trapping were

$$P_{tu} = \sum_{i=1}^{n}\left(\left[\frac{u_i}{c_i + u_i} \cdot unk_i\right] + u_i\right)$$

and

$$P_{tc} = \sum_{i=1}^{n}\left(\frac{c_i}{c_i + u_i} \cdot unk_i\right)$$

where P_{tu} = passage estimate for unclipped Chinook or rainbow trout during barrier weir fish trap operation; P_{tc} = passage estimate for clipped Chinook or rainbow trout during barrier weir fish trap operation; c_i = actual number of clipped Chinook or rainbow captured at the barrier weir during week *i* (not passed upstream); u_i = actual number of unclipped Chinook or rainbow trout observed passing the barrier weir during week *i*; and unk_i = actual number of unknown clip status Chinook or rainbow trout observed passing the barrier weir during week *i*. The equations used for estimating passage during barrier weir video counting were

$$P_{vu} = \sum_{i=1}^{n}\left(\left[\frac{u_i}{c_i + u_i}\cdot unk_i\right] + u_i\right)\cdot\left(\frac{T_i}{V_i}\right)$$

and

$$P_{vc} = \sum_{i=1}^{n}\left(\left[\frac{c_i}{c_i + u_i}\cdot unk_i\right] + c_i\right)\cdot\left(\frac{T_i}{V_i}\right)$$

where P_{vu} = passage estimate for unclipped Chinook or rainbow trout during barrier weir video monitoring; P_{vc} = passage estimate for clipped Chinook or rainbow trout during barrier weir video monitoring; c_i = actual number of clipped Chinook or rainbow trout observed passing the barrier weir during week *i*; u_i = actual number of unclipped Chinook or rainbow trout observed passing the barrier weir during week *i*; unk_i = actual number of unknown clip status Chinook or rainbow trout observed passing the barrier weir during week *i*; T_i = number of hours of unrestricted fish passage at the barrier weir during week *i*; and V_i = number of hours of actual good and fair video recorded fish passage at the barrier weir during week *i*.

Migration timing.—Migration timing past the barrier weir was determined using fish trap and video counting data. The number of clipped and unclipped Chinook and rainbow trout passing the barrier weir was summed weekly and plotted. Peak as well as onset and termination of migration were noted.

Size, sex, and age composition.—We recorded fork length and sex of Chinook and rainbow trout captured in the barrier weir fish trap and from Chinook carcasses retrieved during stream surveys. Length-frequency distributions were developed and male to female sex ratios were calculated. The age of returning Chinook was determined for coded-wire tagged fish and length-at-age plots were developed.

Stream Surveys

Similar to previous years, the annual spring-Chinook snorkel survey season was initially scheduled to run from May into November. Surveys were generally scheduled monthly from May through August and twice-a-month from September to November. The primary purpose of these surveys was to collect data on the spatial and temporal distribution of spring Chinook. The 18.6-mile survey was divided into six reaches upstream of the barrier weir (Table 7; Figure 2) and usually required 4 d to complete, depending on personnel availability and flow conditions. Surveys were scheduled on consecutive weekdays beginning at the uppermost reaches and working downstream.

While moving downstream with the current, three snorkelers counted Chinook, carcasses, and redds. Generally, snorkelers were adjacent to each other in a line perpendicular to the flow.

When entering large plunge pools where Chinook could be concealed below bubble curtains, one snorkeler would portage around and enter at the pool tail to count Chinook, while the other two snorkelers would enter at the head of the pool through the bubble curtain. When groups of Chinook were encountered, snorkelers would confer with each other to make sure salmon were not missed or double counted.

When survey personnel encountered carcasses, they would collect tissue for genetic analyses, scales for age determination, and record biological information such as fork length, sex, egg retention, and presence or absence of a tag and an adipose fin. Heads were collected from all adipose-fin clipped carcasses and from carcasses where the presence of a fin clip could not be determined due to decomposition or lack of a complete carcass. Coded-wire tags were later extracted from heads in the laboratory.

Stream flow, water turbidity, and water temperature can all influence the effectiveness of snorkel surveys (Thurow 1994). We collected data on these three parameters for each snorkel survey. Stream flow was measured at three gauging stations operated by California Department of Water Resources (DWR) or the US Geological Survey. The gauging stations on the North Fork, South Fork, and mainstem Battle Creek were at Wildcat Road Bridge (rm 0.9), Manton Road Bridge (rm 1.7), and CNFH (rm 5.8), respectively. Turbidity samples were taken at the beginning and end of each reach and analyzed the same day using a Model 2100 Hach Turbidimeter. An average turbidity value was calculated for each survey day. For surveys when only one turbidity sample was taken, we used that value. Water temperatures were measured at the beginning and end of each reach using a hand held submersible thermometer.

Holding location.—We located holding areas of Chinook through snorkel surveys. The date and number of Chinook observed per reach were recorded and exact coordinates of holding locations were documented using a hand held Global Positioning System (GPS) receiver. We used thermal criteria presented by Ward and Kier (1999) to evaluate the suitability of water temperatures in Battle Creek for adult spring Chinook holding from June 1 through September 30. We labeled Ward and Kier's Kiers' four categories as good, fair, poor, and very poor. Continuous water temperature data was collected at three locations on the South Fork (reach 3), four locations on the North Fork (reaches 1 and 2), and five locations on the mainstem (reaches 4-6). Temperature data was obtained from Onset Stowaway™ temperature loggers installed and maintained by the RBFWO and from two DWR gauging stations located at the Manton Road Bridge on the South Fork and the Wildcat Road Bridge on the North Fork. Evaluating temperatures at these sites provided a range of conditions Chinook may have been exposed to when holding in Battle Creek.

Spawning location and timing.—We located Chinook spawning areas and estimated time of spawning. The number of redds per reach and the date each redd was first observed were recorded. Coordinates of redds were documented using a GPS receiver. All redds were marked in the field with flagging and given a unique identification number in order to differentiate between old and new redds. An attempt was made to determine the beginning, peak, and end of Chinook spawning.

We used thermal criteria modified from Ward and Kier (1999) to evaluate the suitability of water temperatures in Battle Creek for spring Chinook egg incubation. We added an additional category of 56°F to Ward and Kier's four-category system for water temperatures (Table 8). This additional category was added because other Central Valley streams have 56°F as a temperature target for Chinook egg incubation (NMFS 2002, USFWS 2001a). We labeled the five categories as excellent, good, fair, poor, and very poor.

We evaluated the potential effect of water temperature on egg survival at each individual Chinook redd by estimating the number of days eggs were exposed to each temperature category. Mean daily temperatures (MDTs) at redd locations were estimated by plotting daily temperature monitoring data (X-axis = river mile, Y-axis = MDT) and using the equation of a straight line connecting two adjacent monitoring sites to interpolate MDT for a redd at a given river mile. Estimated days of exposure to each temperature category was based on the criteria that 1,850 Daily Temperature Units (DTU = MDT$^{\circ}$F - 32°F) were required for egg incubation to time of emergence. The 1,850 DTU requirement is within the reported range for juvenile Chinook (Heming 1982, Murray and McPhail 1988) and was estimated specifically for Battle Creek based on rotary screw trap catch data and stream survey data (Earley and Brown 2004). The best-case scenario was calculated based on a redd construction date of the day preceding the survey when the redd was first observed. The worst-case scenario was calculated based on a redd construction date of the day following the preceding survey because water temperatures are generally warmer earlier in the spawning season.

We measured spring Chinook redd dimensions, depths, water velocities, and dominant substrate size. Redd dimensions included maximum length and maximum width. Redd area was calculated using the formula for an ellipse (area = π•½ width•½ length). Depth measurements were maximum depth (redd pit), minimum depth (redd tailspill), and pre-redd depth (measured immediately upstream of the redd). Mean column velocity was measured at the same location as the pre-redd depth. Velocity measurements were taken with a General Oceanics model 2030 mechanical flow meter. Dominant substrate size was classified using methods described by USFWS (2005).

Tissue Collection for Genetic Analyses

Tissue samples were collected from unclipped Chinook captured at the fish trap and from carcasses collected during stream surveys. We used either scissors or a hole punch to obtain four small pieces of fin tissue. Three pieces were stored in small vials containing ethanol and one was dried and stored in a scale envelope (not collected from weir trap samples). Samples were archived at the RBFWO. At the time this report was written, genetic results were not available. Future genetic analyses will classify individual fish as spring, winter, fall, or late-fall Chinook.

Age Structure

Age determination of returning spring Chinook was done by reading scales collected from carcasses recovered upstream of the CNFH barrier weir. Scales were removed from the left side of the fish and from the second or third row above the lateral line in the region bisected by a line drawn between the back of the dorsal fin and the front of the anal fin. Scales were dried for about 24 h and stored in scale envelopes. Scales were prepared for reading by rehydrating and cleaning them in soapy water. Scales were mounted sculptured side up between two glass microscope slides held together with tape. A microfiche reader was used to count the number of annuli. The age was determined to be the number of annuli plus one (Borgerson 1998). Two readers independently aged each scale. If results were different, the scale was read a third time cooperatively by the same two readers. If an agreement was not reached, that scale was not included in our data set. Scale readers were trained using fall and late-fall Chinook of known age from CNFH.

Spring Chinook Population Trend Analysis

Passage of adult spring Chinook into upper Battle Creek has been monitored for 13 consecutive years (1995-2007). We used simple linear regression to determine the population trend for this period. Year was treated as the independent (predictor) variable and the annual total number of unclipped Chinook (a.k.a., maximum potential spring run) was treated as the dependent (response) variable. The slope of the regression line can be taken as a measure of trend. In this case, the slope parameter is similar to a single data point in that is has no associated measurement error or sampling variation (Urquhart et al. 1998). The absence of error and variation terms is a result of having only one data point at each value of the independent variable. Therefore, traditional hypothesis testing cannot be performed on the slope parameter.

We investigated the potential influence of stream flow and water temperature on the survival of spring Chinook salmon in Battle Creek. The metric "redds per female" was the index for annual adult survival through the hot summer holding period (May-October). The metric "juveniles per redd" was the index for egg survival during incubation (October-February). The metric "juveniles per female" was the index for overall annual productivity. The number of adult females used for these indexes was estimated to be half the number of unclipped Chinook passing above to Coleman NFH barrier weir. Juvenile abundance data was obtained from an associated FWS monitoring program (Whitton et al. 2007). We calculated Mean Monthly Flow (MMF) and Mean Monthly Temperature (MMT) at two locations: lower Battle Creek near rm 5.8 and middle Battle Creek near the confluence of the forks (approx. 12.1 miles upstream of rm 5.8). Middle Battle Creek MMF and MMT was calculated by combining information from two gauging stations; one at North Fork Battle Creek rm 0.9 and one at South Fork Battle Creek rm 1.7. Conditions in lower Battle Creek represent annual environmental conditions for the entire watershed. Conditions near the confluence of the forks represent conditions in the holding and spawning reach represent altered or managed conditions due to flow reductions associated with a hydroelectric project.

We used correlation matrices to explore the strength of the linear relationship between the independent variables (MMF and MMT) and the dependant variables (survival metrics). Correlation coefficients (r) range from -1 to 1 with values near zero indicating a weak linear relationship and values near -1 or 1 indicating a strong negative or positive relationship, respectively.

Results

Coleman National Fish Hatchery Barrier Weir

Trapping.—A total of 332 Chinook were captured in the barrier weir trap between March 1 and May 9, 2007. Of these, 229 were clipped and 103 were unclipped (Table 9). We retrieved coded-wire tags (CWT) from 213 clipped Chinook captured in the trap. Tag codes revealed that 100% were late-fall run from CNFH (Table A1).

A total of 94 rainbow trout were captured in the barrier weir trap and 74 unclipped trout were released upstream (escapement). Of the 94 that were captured, 18 were clipped and 76 were unclipped (Table 10). There were two mortalities of unclipped rainbow trout. One clipped rainbow trout had a CWT and was from CNFH (brood year 2003, Table A1). Other species captured in the trap and passed upstream included 5,649 Sacramento sucker (*Catostomus* *occidentalis*), 82 Sacramento pikeminnow (*Ptychocheilus grandis),* 63 hardhead (*Mylopharodon conocephalus),* and 1 smallmouth bass (*Micropterus dolomieui).*

We documented that two rainbow trout that were passed above the barrier weir fell back downstream of the weir and were recaptured in the trap. Both fish were initially passed upstream during the trapping period and not during CNFH's steelhead propagation program prior to March 1.

Video counts.—A total of 192 Chinook were observed passing through the barrier weir fish ladder between May 9 and August 1, 2007. Of these, 186 were unclipped, 5 were clipped, and 1 was of unknown clip status (Table 9). Extrapolation for poor picture quality or video equipment malfunction resulted in a passage estimate of 188 unclipped Chinook and 5 clipped. No Chinook were observed passing above the barrier weir for an 8-day period from July 10 through July 17 (Figure 8). Similar periods of no fish passage from mid-July through early August occurred in 2000-2006 (Brown and Newton 2002; Brown et al. 2005; Brown and Alston 2007; Alston et al. 2007; Newton et al. 2007).

We observed a total 144 rainbow trout passing through the barrier weir fish ladder during the video monitoring period. Of these, 138 were unclipped, 3 were clipped, and 3 were of unknown clip status (Table 10). Extrapolation for poor viewing quality or equipment malfunction resulted in a passage estimate of 142 unclipped and 3 clipped rainbow trout. Other species observed passing upstream included 334 Sacramento suckers, 47 Sacramento pikeminnow, 310 hardheads, 16 Pacific lamprey (*Lampetra tridentate),* and 2 smallmouth bass.

During the video monitoring period, 99% of the period was video recorded with a good or fair picture quality. The DVR successfully recorded 93% of the period. VCR backup tapes covered an additional 6% of the period. About 1% of the period was unmonitored due to power outages and high turbidity.

Every third day of video monitoring was selected to be viewed a second time by a separate staff member for quality assurance (QA) purposes. QA checks showed that the average error rates (i.e., percent not seen) for primary and QA viewers were 3.9% for Chinook, 13.6% for rainbow trout, and 8.5% for Chinook and rainbow trout combined.

Video data showed that unclipped Chinook preferred certain times of day to migrate past the CNFH barrier weir (χ^2= 139.26, P<0.001). The pattern of diel passage timing seen in 2007 (Figure 4) was very similar to ten years of aggregated data from 1998-2007 (Figure 4). Passage frequency increased after 22:00, peaked around sunrise (4:00-6:00), and returned to a low level after 8:00. In 2007, 66% of passage occurred during 33% (8 h) of the day (0:00-8:00). Chinook passage frequency began increasing after dark when water temperatures began to fall. Passage frequency returned to base levels about two hours after sunrise while temperatures were still at their lowest levels of the day.

Video data showed that rainbow trout also preferred certain times of day to migrate past the CNFH barrier weir (χ^2= 29.16, P=0.002) but their preference was the opposite of Chinook. The pattern of diel passage timing seen in 2007 (Figure 6) was similar, but not identical, to ten years of aggregated data from 1998-2007 (Figure 7). Passage frequency increased after sunrise, peaked in the afternoon (12:00-16:00), and returned to a low level by dark. In 2007, 51% of passage occurred during 33% (8 h) of the day (10:00-18:00). Rainbow trout passage frequency increased as water temperatures increased with peak water temperatures occurring during the hours 16:00-18:00.

Passage estimation. — Passage estimates for unclipped salmonids are higher than actual numbers observed due to estimates made for periods of poor video quality. We estimated that 5 clipped and 291 unclipped Chinook passed through the barrier weir fish ladder into upper Battle Creek between March 1 and August 1, 2007 (Table 9). CNFH personnel released an additional 72 unclipped Chinook above the barrier weir prior to opening the barrier weir fish ladder on March 1 (Table 1). These 72 Chinook were diverted from lower Battle Creek into the hatchery as part of the late-fall Chinook propagation program. Since, CNFH personnel attempt to mark 100% of their late-fall production with an adipose-fin clip and CWT, these 72 Chinook were considered natural-origin and were released into Battle Creek upstream of the barrier weir to spawn naturally.

We estimated that 3 clipped and 216 unclipped rainbow trout passed upstream of the barrier weir fish ladder between March 1 and August 1, 2007 (Table 2 and 10). CNFH released an additional 130 unclipped rainbow trout above the barrier weir prior to March 1 (Tables 1). These rainbow trout were taken into the hatchery as part of the steelhead propagation program, but were not used as brood stock.

Migration timing. — The migration of unclipped Chinook past the barrier weir began March 9th and peaked the week of May 13 (Table 9, Figure 8). The middle 50% of the run passed between April 29 and June 9. Only one Chinook migrated above the weir during the nine days preceding the ladder closure on August 1. This Chinook passed during the morning of July 30.

The temporal distribution of clipped Chinook observed at the barrier weir is different from that of unclipped Chinook. Observations of clipped Chinook also began March 1, peaked during the first 2 weeks of trap operation and declined steadily through April (Figure 8). We observed the last clipped Chinook on April 17.

Rainbow trout migrating past the barrier weir exhibited a bimodal migration pattern. The two periods of peak passage were March 1-10, when trap operation began, and May 13-June 16 (Figure 7).

Size, sex, and age composition.— Chinook captured in the barrier weir trap had a mean fork length of 83.7 cm and ranged in length from 42.5 to 107.5 cm (n =331). The length-frequency distribution was continuous and was approximately normal with a mode at about 86-90 cm (Figure 9). Rainbow trout captured in the barrier weir trap had a mean fork length of 45.2 cm and ranged from 28.5 to 62 cm (n = 101). The length-frequency distribution for rainbow trout was continuous and was approximately normal with a mode at about 36 to 40 cm (Figure 10).

The ratio of male to female clipped Chinook captured in the barrier weir was 1:2.75 (n=229). The sex ratio for unclipped Chinook was not determined due to the difficulty in determining the sex of spring Chinook before the appearance of secondary sex characteristics. For clipped steelhead the sex ratio was 1:2.0 (n=21) and for unclipped steelhead it was 1:1.4 (n=80).

We used tagging records to determine the age of most coded-wire tagged Chinook captured in the barrier weir trap. The ages of tagged Chinook included, 2-year-old (n=1), 3-year-olds (n = 17), 4-year-olds (n = 192), 5-year-olds (n = 3) and 6-year-old (n=1). There was overlap in fork length between Chinook of ages three through five (Figure 12, Table A1). Age was not determined for unclipped Chinook.

Stream Surveys

We conducted snorkel surveys in 2007 from May 26-November 7. Surveys were conducted once a month, except for October, where two surveys were completed. There was no

July survey due to warm water temperatures. For surveys conducted in reaches 1-6, observations of live adult Chinook peaked at 62 in October (Tables 11 and 12). In addition, we observed 132 redds above the barrier weir, of which 6 were observed in September and 126 were in October. We observed 49 carcasses above the barrier weir, of which 2 were observed in June, and the remaining 47 were all recovered in October.

Conditions for snorkel surveys were good. The average creek flows on the north fork (reach 1-2) during surveys was 43 cfs (Figures 15 and 17). On the south fork (reach 3) the average flow was 54 cfs, the average is high because of one survey in August that was completed at 139 cfs (Figures 15 and 18). That one survey was poor because of low visibility. Stream flows were always <100 cfs on reaches 4-6a (Figure 16). Temperatures ranged from 48º to 71ºF. Average turbidity was 2.0 NTU with a range of 0.5 to 4.9 NTU. The presence or absence of an adipose fin usually could not be determined for Chinook seen during our surveys.

Holding location.—Barrier weir counts and snorkel survey observations of live Chinook and redds indicated that most spring Chinook held in Battle Creek for 3 to 5 months (between early May and late September) prior to spawning (Figure 8, Table 11). Surveys indicated that most Chinook spawned in late September to mid October (Table 11).

Using the Ward and Kier (1999) thermal criteria for holding (Table 8), we evaluated MDTs for the holding period at three locations on the South Fork, four locations on the North Fork and five locations on the mainstem (Table 13). On the South Fork, the percentage of MDTs categorized as good ranged from 55.7% at the upstream most site to 36.9% at the downstream most site. On the North Fork, the percentage of MDTs categorized as good ranged from 100% at the upstream most site to 18.9% at the downstream most site. On the mainstem, the percentage of MDTs categorized as good ranged from 26.2% at the upstream most site to 9.0% at the downstream most site.

We identified one large holding pool where Chinook commonly congregated during the summer. This pool is informally named B. Pool and is located on the mainstem. Estimated MDTs at B. Pool (Reach 4) were categorized as follows; 38.5% good and 54.9% fair.

The upstream most observation of a Chinook on the North Fork was a carcass observed on October 30 at rm 4.65. This is below a potential natural barrier identified as "nearly impassable by all fish at all flows (TRPA 1998, barrier NF5.14)" (Figure 2). The upstream most observation of a live Chinook on the South Fork was immediately below Coleman Diversion Dam, which blocks fish passage.

Spawning location and timing.— We observed 78 redds in the North Fork, 21 in the South Fork, and 34 in the mainstem (Tables 5 and 11). In the North Fork, South Fork, and mainstem Battle Creek, Chinook began spawning sometime between August 30 and September 17. Chinook likely finished spawning by the end of October because the numbers of new redds observed on our final survey (November 7) were greatly reduced (Table 11). On the North Fork, an open fish ladder allowed Chinook to pass above Wildcat Dam (rm 2.50) and potentially continue up as far as Eagle Canyon Dam (rm 5.25). Unlike 2004 and 2005 we observed redds above Wildcat Dam on the North Fork (Reach 1). We observed six redds in Reach 1 and the upstream most redd was located at approximately rm 3.8. The upstream most redd on the South Fork was located at about rm 2.1, downstream of Coleman Diversion Dam.

We estimated MDT at each Chinook redd during the egg incubation period. In the best-case scenario, the incubation period averaged approximately 109 days, based on an 1,850 DTU requirement. During the incubation period, the average percentage of days that redds were exposed to each temperature category were 99.4% excellent; 0.5% good, 0.1% fair, and no days at poor or very poor (Table 14, Table A4). The worst-case scenario had more days in the good, fair, poor, and very poor categories, with average exposure being 97% excellent, 2.4% good, 0.5% fair, and 0.1% very poor. Temperature exposures were similar between survey reaches on the forks. Reach 5 redds had a minimum of 93.4% of days classified as excellent (mainstem).

In addition to estimating water temperatures at each redd, we also evaluated spawning temperatures at our fixed sites. We used spawning criteria modified from Ward and Kier (1999) for the dates of September 15 through October 31, 2007. On the North Fork, the percentage of MDTs categorized as good or excellent was 100% at the two upstream-most sites and 95% at the two downstream sites (Table 15). On the South Fork, the percentage categorized as good or excellent was 100% at the upstream-most and downstream-most sites (Table 15). On the mainstem, the percentage categorized as good or excellent ranged from 100% at the upstream-most site to 59% at the downstream-most site (rm 9.3).

Measurements were taken on 102 spring Chinook redds (Table A3). Redd area ranged from 12 to 347 square feet (ft^2) with an average of 97 ft^2. Redd depths (pre-construction) ranged from 0.3 to 3.1 ft with an average of 1.5 ft. Water velocities ranged from 0.13 to 5.2 ft/s with an average of 1.6 ft/s. All measurements of redd area, depth, and water velocity were within the ranges reported for stream type (spring run) Chinook (Healey 1991). Redd substrate particles had a median size range of 2-3 in., a minimum of 1 in, and a maximum range of 3-5 inches.

Of the 49 Chinook carcasses observed during snorkel surveys, 46 were recovered and spawning status was determined for 18. Of the 18 carcasses, all of them were spawned. Spawning status frequently could not be determined due an advanced state of decay or carcasses being partially eaten by scavengers.

Tissue Collection for Genetic Analyses

We collected 148 Chinook salmon genetic samples, with 102 of the samples being from the Barrier Weir trap and the remaining 46 samples from snorkel surveys. The samples are currently stored at the RBFWO facility. Once a contract is initiated, the samples will be analyzed and results will be presented at that time.

Age Structure

Estimated age was obtained from scale samples collected from adult Chinook carcasses recovered on snorkel surveys. There were 39 scale samples collected in 2007, of which 37 were readable. The percent of ages were classified as the following: 8.1% were 2-year-olds, 81.1% were 3-year-olds, and 10.8% were 4-year-olds.

Spring Chinook Population Trend Analysis

We used simple linear regression to measure the spring Chinook population trend from 1995 to 2007. The slope of the regression line was 12.75 indicating that, on average, the population increased by about 13 Chinook per year (Figure 13). The 95% confidence interval for the slope estimate was 1.96 to 23.53. There was some evidence that two of the standard assumptions for simple linear regression were not met; that population estimates were (1) independent and (2) had constant variance. Data diagnostics gave some indication that population estimates were autocorrelated (i.e., 2-year-lag negative autocorrelation) and had increasing variance over time.

We explored correlations of MMF and MMT with annual survival metrics for spring Chinook including "redds per female," "juveniles per redd," and "juveniles per female."

Monitoring data allowed us to calculate “redds per female” for seven years (2001-2007), a measure of adult survival during the hot summer holding period, May through October. In all cases, MMT was negatively correlated with “redds per female” and MMF was positively correlated (Table A2). (In this case, MMF was transformed by taking its natural logarithm in order make the data linear.) The highest correlations were in May and June for both MMT and MMF and both locations, ranging from 0.68 to 0.79 (absolute values, Figure 14). On average, flow was slightly more correlated with “redds per female” than temperature. There was little or no difference between variables from the two different locations; lower Battle Creek and middle Battle Creek.

Monitoring data allowed us to calculate “juveniles per redd” in four years (2001-2004). With four data points, we calculated correlation coefficients for 40 independent variables (MMT and MMF for May-February at two locations). Therefore, obtaining a number of high coefficients by random chance is plausible and results should be evaluated in this context. MMF in December and January was negatively correlated with “juveniles per redd” (-0.99<r<-0.77, Table A2, Figure 14) indicating that, in these years, higher winter flows corresponded with lower juvenile production per redd. In addition, MMT in June and July in middle Battle Creek showed a strong negative correlation with “juveniles per redd” (r=-0.82 and -0.98, respectively). The highest water temperatures of the year occur in July, prior to the spawning period.

Monitoring data allowed us to calculate “juveniles per female” in five years (1999 and 2001-2004). MMF and MMT data were available for all of these years in lower Battle Creek but only the latter four years in middle Battle Creek. Again, we derived 40 correlation coefficients for 4 or 5 data points and results should be interpreted in this context. MMF showed a strong positive correlation with “juveniles per female” for May-August in middle Battle Creek (0.84<r<0.96, Table A2) and August-November in lower Battle Creek (0.87<r<0.95, Figure 14). These months correspond to the holding and spawning period for adult spring Chinook. Also, MMT showed a strong negative correlated for June in middle Battle Creek (r=-0.99) and June-August and December in lower Battle Creek (-0.94<r<-0.87). These months coincide with the adult holding period, except for December.

Discussion

Chinook Salmon Population and Passage Estimates

We estimated that five clipped and 291 unclipped Chinook passed the CNFH barrier weir between March 1 and August 1, 2007. This was the highest passage estimate for unclipped Chinook since monitoring began in 1995. We generally use the unclipped passage total to estimate the “maximum potential spring Chinook” escapement. Based on run timing (Vogel and Marine 1991) and genetic results from previous years, the majority of these unclipped Chinook are likely spring run with a minority possibly being winter, fall, or late-fall Chinook due to overlap in migration periods. Run-specific Chinook salmon population estimates presented in previous annual reports were based, in part, on Genetic Stock Identification analyses (Brown and Newton 2002, Brown et al. 2005, Brown and Alston 2007). Genetic results were not available in time for this report. We will make run-specific escapement estimates when genetic results become available.

The five clipped Chinook that passed during video monitoring were likely late returning CNFH late-fall Chinook but may have also been spring Chinook from Feather River Hatchery or Butte Creek (natural-origin fish, McReynolds et al. 2007). In previous years, we have captured clipped CNFH late-fall Chinook as late as June 14. Of the five clipped Chinook in 2007, four passed prior to June 6 and one passed on July 6.

The total escapement estimate for rainbow trout was lower in 2007 than escapement estimates from 2001 through 2004 (Table 1). This decrease was largely due to the continuation of clipped steelhead not being released in the upper watershed. Regarding escapement estimates for unclipped rainbow trout only, 2007 was about average for the period 2001-2007.

With the trap installed in March, there is always the possibility for storms and associated high flow events. In flow events higher then 2,000 cfs, we cannot safely check the trap; therefore, we have to temporarily shut down our operation. Adult salmonids can swim over the weir at higher flows, circumventing the fish ladder. This suggests that escapement is underestimated in years with higher flows. In spring of 2007, there were no high flow events that forced us to close the trap. Since, the trap was never closed at times when fish could pass, our passage estimate should be highly accurate.

In 2007, we continued investigating diel passage timing of salmonids through the barrier weir fish ladder. Similar to previous years, we observed clipped Chinook passing early in the season in the afternoon, with the exception of fish caught in the first trap check of the day. The Chinook captured in the first trap check may have resulted from fish being allowed to congregate in the trap while it was not being operated. Unclipped fish primarily passed a few hours after sunrise later in the season. Operating the trap at an earlier time of day from late April through early June resulted in a reduced potential for delaying fish passage, lower water temperatures during trapping, less stress on trapped fish, and a longer trapping season.

Video monitoring data showed that unclipped Chinook preferred to migrate past the CNFH barrier weir at night and early morning when water temperatures were falling (but not at their lowest levels). The 8-hr period with the most passage was 0:00-8:00. At this location, Chinook did not appear to select the coolest part of the day because passage frequency returned to its lowest level after 8:00 when water temperatures were at their daily minimum. Prior to the video monitoring period, we operated a fish trap for 8 hrs/d and prevented passage the rest of the day. Unclipped Chinook generally start migrating past the weir around middle or late April. Shifting our hours of trap operation to 4:30-12:30 after April 21 included the hours of peak passage for unclipped Chinook (4:00-8:00) and minimized the delay for those attempting to pass during the period 0:00-4:00.

During video monitoring, we observed an unusual spike in passage of Chinook in mid-July. This may be due to a storm on July 18, with 1.15 inches of rain recorded at the Redding Airport. It is very rare for our area to receive that much precipitation in the summer. The average monthly rainfall for July is 0.18 inches at the Redding Airport. There was a 65-cfs increase in flow and the turbidity levels were higher then normal. In July, there have been years with higher base flows than in 2007, but no significant increase in flow. Often in the summer time (June-August), PG&E powerhouse outages cause brief spikes in flow with no associated spike in Chinook passage. A total of 28 Chinook and 3 rainbow trout were observed passing the weir from July 18 to July 21. Of the 28 Chinook, 15 fish passed on July 19. These fish moved upstream throughout the day, and there was no diel pattern in their migration. It has been observed that Atlantic salmon pass through ladders during hours of darkness while the water is clear. In the time of floods when the water is turbid, the diurnal pattern seemed reversed with the greatest movement during the hours of daylight (Hellawell et al. 1974). This is similar to our observation of the fish moving throughout the morning after sunrise. These fish still fall into the spring-run category according to Vogel and Marine, but there is a possibility that the fish were early fall-run Chinook due to it being late July. In many years, early arrival of some fall-run adults to the upper river is observed by early July, but the time of first arrival can vary by as much as a month (Vogel and Marine 1991).

Video monitoring from May through July showed rainbow trout preferred to migrate during daylight hours. The 8-hr period with the most passage was 10:00-18:00 PDT with the peak being 12:00-16:00. Trout passing during the video monitoring period are likely resident trout as opposed to the anadromous form, the threatened steelhead trout. Central Valley steelhead are considered winter steelhead that mature in the ocean and spawn shortly after river entry (McEwan 2001, Moyle 2002). Steelhead typically spawn from December through April with peaks from January through March. From March 1 through April 21, we operated the trap during the hours 10:30-18:30 PDT which encompasses the peak passage hours for rainbow trout in the summer. We are uncertain if passage patterns for rainbow trout in the summer are similar to steelhead patterns in the spring. If they are similar, our hours of trap operation during this period minimized any delay for steelhead passage.

Evaluation and Adaptive Management of Battle Creek Stream Flow

Increase North Fork flows to test barrier hypothesis.— A potential low-flow barrier (Figure 3) at rm 3.04 on the North Fork (Reach 1) was identified in 2001 and 2002 as potentially impassible to Chinook at about 30 cfs, the current interim flow level (Brown and Newton 2002; Brown et al. 2005). This raised concern as to whether it would be impassable at the future Restoration Project flow level of 35 cfs from May through November (NMFS et al. 1999). From 2001 through 2007, redds were observed above rm 3.04 only in 2003 (8% of all redds), 2006 (14% of redds) and 2007 (4% of all redds). Years 2003, 2006 and 2007 were unique because the total number of redds over all reaches was higher than the other years (Table 5), possibly causing fish to spawn farther upstream. In the 2006 report (Newton et al. 2007) we hypothesized that fish were only able to pass this potential barrier in 2003 and 2006 because of relatively high spring flows in those years. However, spring flows in 2007 were relatively low from May through September, similar to the dry years of 2001 and 2002 (Figure 14), and fish passage was confirmed. But, flows in 2007 were higher than 2001 and 2002 in April when some early upstream migration may have occurred. Therefore, evidence from 2007 suggested that the cascade at rm 3.04 is not a complete barrier to all spring Chinook at low flows near 30 cfs but it may limit fish passage, as evidenced by the low percentage of upstream redds (4%) in conjunction with a record high population estimate. As the population increases better information will become available as to whether this cascade is impeding passage.

In a survey of fish barriers in Battle Creek, Thomas R. Payne and Associates (TRPA) identified a nearly impassable barrier on the North Fork at rm 5.06. TRPA (1998) suggested this barrier may be passable to steelhead and spring Chinook in good condition at flows >88 cfs. Also, in the Final Restoration Plan For The Anadromous Fish Restoration Program (USFWS 2001), actions identified to increase natural production of anadromous fish in Battle Creek included improving fish passage at this natural barrier. As in previous years, we did not observe live Chinook or redds above this barrier in 2007. Therefore, we continue to believe this barrier may block salmonid passage at moderate and low flows.

The effect of Interim Flows on South Fork Battle Creek.— In 2001 and most of 2002, interim flows of 30 cfs were not provided in the South Fork which resulted in higher water temperatures during the spring Chinook holding and early spawning periods. Coincidentally, in 2001 and 2002, an above average proportion of Chinook held and spawned in the South Fork

(Tables 4 and 5). Since most spring Chinook return as 3-year-olds and some as 4-year-olds (Fisher 1994), most of the progeny from these two year classes would be expected to have returned in 2004 and 2005. In 2006, escapement of unclipped Chinook (March 1-August 1) was 2.4 times greater than 2004 and 3.0 times greater than 2005 (Table 3). In 2007, the escapement of unclipped Chinook was 3.2 times greater then 2004, 4.0 times greater then 2005. This increase in escapement in 2006 and 2007 may be a beneficial result of providing interim flows of 30 cfs in both the North Fork and South Fork.

Holding and spawning water temperatures.—Water temperature data has been collected since 1998 near a large spring-Chinook holding pool on the mainstem (rm 16.0). MDTs at rm 16.0 for the period June 1-August 17, the hottest time of the year, in 2007 was an average of 0.5 ºF warmer than the average of 1998-2005. Due to warm water and air temperatures, we did not conduct a July snorkel survey. Holding temperatures for the period June 1-September 30 were categorized as "poor" and "fair" for more then 50% of the time in the lower sections of the forks and in the mainstem (Table 13). Poor water temperatures could lead to no successful spawning and fair water temperatures may lead to some mortality and infertility. Reach 5 and the lower section of Reach 4 were the two sections that had the most days in the 'poor' category. There were fish observed in this section of the creek, but typically, the majority of the fish were observed holding above this section. The downstream portions of the forks had no more than eight days in the "poor" category. Exposure to unsuitably high water temperatures by adult Chinook prior to spawning likely led to some reduction in reproductive success. So although some Chinook were exposed to both 'poor' and 'fair' water temperatures, the duration of exposure should have had minimal negative impacts on the Chinook.

Our temperature analysis of each individual redd indicated that Chinook egg incubation temperatures under our worst-case-scenario were categorized as "excellent" for 97.0% of the days, on average. The range of "excellent" days for individual redds ranged from 100% to 84.4%. The data indicate that incubating eggs experienced minimal adverse effects from water temperatures. Even though water temperatures were higher than other years, the spawners possibly waited until water temperatures were suitable before spawning or selected more upstream locations where there were cooler water temperatures.

In the past seven years of stream surveys, Chinook redd density (redds/mile) was highest in Reach 2 (lower North Fork) with the exception of 2001 (Table 6). In 2007, half of the redds observed were in Reach 2. Spawning density in Reach 1, located upstream of Reach 2, has been relatively low although it has the most suitable water temperatures for holding and spawning and it has the greatest quantity of spawning gravel (Ward and Kier 1999). Possible explanations as to why Chinook appear to prefer Reach 2 over Reach 1 include (1) proximity to large holding pools, (2) differences in the quality of spawning gravel, (3) potential passage problems at the six low-flow barriers in reaches 1 and 2 identified by TRPA (1998), and (4) potential passage problems at Wildcat Dam fish ladder. In 2007, observations of live Chinook and redds in Reach 1 documented that Chinook were using the Wild Cat Dam fish ladder and there was no observations of the ladder being blocked by debris. Debris removal and maintenance of this fish ladder is important until Wild Cat Dam is removed, possibly in 2009.

Spring Chinook Population Trend Analysis

Linear regression techniques indicated that the population of spring Chinook in Battle Creek increased by about 13 fish per year, on average, from 1995 to 2007. This suggests that environmental conditions in Battle Creek have been suitable to maintain and lead to a modest increase in the population. Interim flows, provided by PG&E, CVPIA, and CALFED since 1995, have likely been a primary contributing factor to this increase.

Correlation matrices indicated that increases in annual estimates of spring Chinook "redds per female" were associated with increased flow and decreased water temperature, especially during the summer months. Increased flow increases the area of holding habitat, reduces stressfully high water temperatures, and likely improves predator (otter) avoidance behavior. These factors may result in more females surviving the summer to spawn in the fall.

"Juveniles per redd" was negatively correlated with flows in December and January. One possible explanation is that higher flows resulted in more redd scour and egg mortality. The highest MDF and lowest estimate of "juveniles per redd" occurred in brood year 2002. The maximum MDF was 3,340 cfs on January 14, 2003. The peak flow for this storm was 5,120 cfs. A flow of this magnitude occurs about every two years on average (Greimann 2001). If Chinook evolved under these conditions, we are hesitant to conclude that redd scour led to significant egg mortality for brood year 2002. Another explanation is that higher flows lead to inaccurately low juvenile production estimates and indirectly lead to inaccurately low "juveniles per redd" estimates. MMT in June and July in middle Battle Creek showed a strong negative correlation with "juveniles per redd." Although July is prior to the egg incubation period, progeny of adult females exposed to high water temperatures have shown increased rates of pre-hatch mortality and developmental abnormalities and decreased alevin size (Berman 1990; as cited in McCullough 1999). Therefore, elevated temperatures in July may have directly affected our estimates of "juveniles per redd."

"Juveniles per female" was used to describe the overall annual productivity of spring Chinook while in Battle Creek. Overall productivity was most highly correlated with flows during the holding and spawning period and temperatures during the holding period. During the egg incubation period, winter flows are suitably high and temperatures are suitably low, likely having little negative impact on productivity or survival. Conversely, temperatures are typically higher than optimal during the holding period and flows are typically at their lowest levels during the holding and spawning periods, creating conditions that can lead to reduced survival.

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Tables

TABLE 1-Multi-year summary of the number of adult late-fall Chinook and steelhead trout released upstream of Coleman National Fish Hatchery (CNFH) barrier weir during the CNFH broodstock collection and spawning program (R. Null, US Fish and Wildlife, unpublished data). Late-fall Chinook are generally passed from late December through February and steelhead from October through February.

Year	Late-fall Chinook		Steelhead	
	Clipped	Unclipped	Clipped	Unclipped
1994-**1995**	0	0	0	
1995-**1996**	0	0	276 [a]	
1996-**1997**	0	0	295 [a]	
1997-**1998**	0	0	418 [a]	
1998-**1999**	0	0	1163 [a]	
1999-**2000**	0	0	1416 [a]	
2000-**2001**	0	98	1352	131
2001-**2002**	0	216	1428	410
2002-**2003**	0	57	769	416
2003-**2004**	0	40	314	179
2004-**2005**	0	23	0	270
2005-**2006**	0	50	0	249
2006-**2007**	0	72	0	130

[a] A comprehensive marking program for juvenile steelhead produced at Coleman NFH began in 1998, therefore, differentiation between natural and hatchery adults based on mark status was not entirely possible until the 2001-2002 return year.

TABLE 2-Multi-year summary of estimated escapement in Battle Creek of clipped and unclipped Chinook salmon and rainbow trout/steelhead passing upstream through the Coleman National Fish Hatchery (CNFH) barrier weir fish ladder between March and August.

Year	Ladder Open (m/dd)	Chinook		Rainbow trout /steelhead	
		Clipped	Unclipped	Clipped	Unclipped
1995	3/30-6/30	74	66	34 [a]	127 [a]
1996	3/26-7/01	151	35	1 [a]	40 [a]
1997	3/05-7/01	130	107	0 [a]	49 [a]
1998	3/04-7/01	40	178	0 [a]	51 [a]
1999	3/09-7/01	3	73	6 [a]	100 [a]
2000	3/07-9/01	7	78	18 [a]	86 [a]
2001	3/03-8/31	5	111	30	94
2002	3/01-8/30	0	222	14	183
2003	3/03-8/29	13	221	3	118
2004	3/02-8/01	2	90	15	125
2005	3/01-8/01	0	73	0	74
2006	3/01-8/01	0	221	1	189
2007	3/01-8/01	5	291	3	216

[a] A comprehensive marking program for juvenile steelhead produced at Coleman NFH began in 1998, therefore, differentiation between natural and hatchery adults based on mark status was not entirely possible until the 2001-2002 return year.

TABLE 3-Multi-year summary of total estimated escapement in Battle Creek of all four runs of Chinook salmon and rainbow trout/steelhead passing upstream of Coleman National Fish Hatchery (CNFH) barrier weir. Total estimated escapement includes Chinook salmon and steelhead passed during the CNFH broodstock collection and spawning program prior to March and fish passed through the barrier weir fish ladder between March 1 and August 31 (period of ladder operation was shorter in some years). Maximum potential spring Chinook includes all unclipped salmon passed during the ladder operation period. Estimated spring Chinook escapement is a reduced estimate based on apportioning some Chinook to the winter, fall, and late-fall runs.

Year	Winter Chinook	Spring Chinook		Fall Chinook	Late-fall Chinook	Rainbow trout / steelhead	
		Maximum	Estimate			Clipped	Unclipped
1995		66				161 [a]	
1996		35				317 [a]	
1997		107				344 [a]	
1998		178				469 [a]	
1999		73				1263 [a]	
2000		78				1520 [a]	
2001	0+	111	100	9 to 14	98 to 102	1382	225
2002	3	222	144	42	249	1442	593
2003	0	221	100	130	61	772	534
2004	0	90	70	20	42	329	304
2005	0	73	67	6	23	0	344
2006	1	221	154	66	50	1	438
2007		291				3	346

[a] Clip status was not used to differentiate hatchery- and natural-origin adult steelhead until 2001 because Coleman National Fish Hatchery did not begin marking all of their production until brood year 1998.

TABLE 4-Multi-year summary of total live Chinook (n) observed in August and their distribution among the North Fork, South Fork, and mainstem Battle Creek. Observations were made during August snorkel surveys.

Year	n =	North Fork	South Fork	Mainstem
1995	15	27%	0%	73%
1996	10	40%	0%	60%
1997	4	50%	0%	50%
1998	16	19%	50%	31%
1999	-	-	-	-
2000	-	-	-	-
2001	27	0 %	63 %	37 %
2002	88	0 %	58 %	42 %
2003	94	7 %	33 %	60 %
2004	26	0 %	8 %	92 %
2005	6	33%	33%	33%
2006	143	14%	20%	66%
2007	33	9%	49%	42%

TABLE 5-Multi-year summary of total Chinook redds (n) observed between August and November[a] and their distribution among the North Fork, South Fork, and mainstem Battle Creek. Observations were made during spring Chinook snorkel surveys.

Year	n =	North Fork	South Fork	Mainstem
1995 [b]	13	46%	54%	0%
1996 [c]	21	52%	0%	48%
1997	66	53%	15%	32%
1998	247	33%	34%	33%
1999 [d]	-	-	-	-
2000	-	-	-	-
2001	32	34%	38%	28%
2002	78	35%	21%	45%
2003	176	45%	15%	40%
2004	34	73%	9%	18%
2005	47	51%	13%	36%
2006	122	61%	19%	20%
2007	132	59%	16%	25%

[a] Some redds were observed prior to August in 1995, 1996, 1997, and 2003 and are not included in this table.
[b] In 1995, surveys were not conducted after the last week of September.
[c] In 1996, surveys were not conducted in Reach 6 after August.
[d] In 1999, only one survey was conducted in reaches 1-3 in September.

TABLE 6- Multi-year summary of Chinook redd density (redds/mile) in Battle Creek snorkel survey reaches.

Year	North Fork (Reaches 1-2)	South Fork (Reach 3)	Mainstem (Reaches 4-6)	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6
1995 [a]	-	-	-	-	-	-	-	-	-
1996	2	0	1	0	4	0	2	0	1
1997	7	4	2	5	8	4	4	1	1
1998	15	33	8	12	19	33	13	4	6
1999 [a]	-	-	-	-	-	-	-	-	-
2000 [a]	-	-	-	-	-	-	-	-	-
2001	2	5	1	1	3	5	1	1	1
2002	5	6	3	3	8	6	4	4	2
2003	15	10	7	5	26	10	12	3	5
2004	5	1	1	0	10	1	2	0	0
2005	5	2	2	0	10	2	3	2	<1
2006	14	9	2	7	22	9	6	<1	<1
2007	15	8	3	2	29	8	7	2	0

[a] Survey frequency was inadequate to obtain a total count of redds.

TABLE 7-Reach numbers and locations with associated river miles (rm) for Battle Creek stream surveys.

Reach	Reach length (miles)	Upstream Location	Upstream rm	Downstream Location	Downstream rm
1 (North Fork)	2.75	Eagle Canyon Dam	5.25	Wildcat Dam	2.50
2 (North Fork)	2.50	Wildcat Dam	2.50	Confluence of forks	0.00
3 (South Fork)	2.54	Coleman Diversion Dam	2.54	Confluence of forks	0.00
4	3.82	Confluence of forks	16.61	Mt. Valley Ranch	12.79
5	3.47	Mt. Valley Ranch	12.79	Ranch road	9.32
6	3.49	Ranch road	9.32	Barrier weir	5.83

TABLE 8-Temperature criteria used to evaluate the suitability of Battle Creek water temperatures for Spring Chinook. Criteria are modified from Ward and Kier (1999).

Life Stage	Mean Daily Water Temperature (°F)	Response	Suitability Category
Adult Holding	≤60.8	Optimum	Good
	>60.8 to 66.2	Some Mortality and Infertility	Fair
	>66.2	No Successful Spawning	Poor
	≥80	Lethal	Very Poor
Egg Incubation	≤56	Optimum	Excellent
	>56 to ≤58	<8% Mortality	Good
	>58 to ≤60	15 to 25% Mortality	Fair
	>60 to ≤62	50 to 80% Mortality	Poor
	>62	100% Mortality	Very Poor

TABLE 9-**Chinook salmon** video-recorded passing the Coleman National Fish Hatchery barrier weir and associated passage estimated for 2007. Passage estimates include estimated passage during hours not video recorded.

Dates	Week number	Monitoring method	Hours of passage	Hours of taped passage	Actual number clipped	Actual number unclipped	Actual number unknown	Passage estimate: clipped	Passage estimate: unclipped
March 1-3	1	Trap			42	0	0	0	0
March 4-10	2	Trap			84	2	0	0	2
March 11-17	3	Trap			48	4	0	0	4
March 18-24	4	Trap			27	9	0	0	9
March 25-31	5	Trap			16	5	0	0	5
April 1-7	6	Trap			6	10	0	0	10
April 8-14	7	Trap			4	8	0	0	8
April 15-21	8	Trap			2	13	0	0	13
April 22-28	9	Trap			0	20	0	0	20
April 29-May 5	10	Trap			0	25	0	0	25
May 6-9	11	Trap			0	7	0	0	7
May 9-12	11	Video	79.2	79.2	0	24	0	0.0	24.0
May13-19	12	Video	168.0	168.0	0	37	0	0.0	37.0
May 20-26	13	Video	168.0	164.7	1	15	1	1.1	16.3
May 27-June 2	14	Video	168.0	168.0	1	20	0	1.0	20.0
June 3-9	15	Video	168.0	166.0	2	18	0	2.0	18.2
June10-16	16	Video	168.0	165.9	0	13	0	0.0	13.2
June17-23	17	Video	168.0	165.8	0	17	0	0.0	17.2
June 24-30	18	Video	168.0	166.1	0	5	0	0.0	5.1
July 1-7	19	Video	168.0	168.0	1	6	0	1.0	6.0
July 8-14	20	Video	168.0	168.0	0	1	0	0.0	1.0
July 15-21	21	Video	168.0	168.0	0	28	0	0.0	28.0
July 22-28	22	Video	168.0	168.0	0	1	0	0.0	1.0
July 29-August 1	23	Video	80.9	79.9	0	1	0	0.0	1.0
Totals			2008.1	1995.6	234	289	1	5	291

TABLE 10-**Rainbow trout/steelhead** video-recorded passing the Coleman National Fish Hatchery barrier weir fish ladder and associated passage estimates for 2007. Passage estimates include passage during hours not video recorded.

Dates	Week number	Monitoring method	Hours of passage	Hours of taped passage	Actual number clipped	Actual number unclipped	Actual number unknown	Passage estimate: clipped	Passage estimate: unclipped
March 1-3	1	Trap			8	26	0	0	25 [a]
March 4-10	2	Trap			2	21	0	0	21
March 11-17	3	Trap			4	11	0	0	11
March 18-24	4	Trap			1	4	0	0	3 [b]
March 25-31	5	Trap			1	6	0	0	6
April 1-7	6	Trap			2	3	0	0	3
April 8-14	7	Trap			0	0	0	0	0
April 15-21	8	Trap			0	1	0	0	1
April 22-28	9	Trap			0	2	0	0	2
April 29-May 5	10	Trap			0	0	0	0	0
May 6-9	11	Trap			0	2	0	0	2
May 9-12	11	Video	79.2	79.2	1	22	0	1.0	22.0
May13-19	12	Video	168.0	168.0	0	12	1	0.0	13.0
May 20-26	13	Video	168.0	164.7	0	17	0	0.0	17.3
May 27-June 2	14	Video	168.0	168.0	0	20	0	0.0	20.0
June 3-9	15	Video	168.0	166.0	0	5	0	0.0	5.1
June10-16	16	Video	168.0	165.9	0	23	1	0.0	24.3
June17-23	17	Video	168.0	165.8	0	8	0	0.0	8.1
June 24-30	18	Video	168.0	166.1	0	5	0	0.0	5.1
July 1-7	19	Video	168.0	168.0	0	12	1	0.0	13.0
July 8-14	20	Video	168.0	168.0	0	9	0	0.0	9.0
July 15-21	21	Video	168.0	168.0	0	3	0	0.0	3.0
July 22-28	22	Video	168.0	168.0	2	1	0	2.0	1.0
July 29-August 1	23	Video	80.9	79.9	0	1	0	0.0	1.0
Totals			2008.1	1995.6	21	215	3	3	217

[a] One unclipped rainbow trout/steelhead was sacrificed because a coded-wire tag was detected with a wand detector in the field. No tag was detected in laboratory processing.
[b] One unclipped rainbow trout/steelhead mortality occurred in the traps moving parts.

TABLE 11-Chinook salmon live adults, carcasses and redds observed during the 2007 Battle Creek stream surveys.

Reach	Date	Chinook	Redds	Carcasses
1	5/29/07	4	0	0
1	6/26/07	1	0	2
1	8/27/07	2	0	0
1	9/17/07	1	0	0
1	10/01/07	2	6	0
1	10/15/07	0	0	1
1	10/29/07	0	0	0
2	5/30/07	5	0	0
2	06/27/07	3	0	0
2	8/28/07	1	0	0
2	9/18/07	3	1	0
2	10/2/07	35	36	4
2	10/16/07	17	34	9
2	10/30/07	0	1	9
3	05/30/07	1	0	0
3	06/27/07	2	0	0
3	8/28/07	16	0	0
3	9/18/07	4	3	0
3	10/03/07	8	14	9
3	10/17/07	3	4	2
3	11/7/2007	0	0	0
4	05/31/07	7	0	0
4	06/28/07	15	0	0
4	8/31/07	13	0	0
4	9/19/07	42	0	0
4	10/04/07	17	26	3
4	10/17&18/07	5	1	8
4	11/7/07	0	0	0
5	05/31/07	2	0	0
5	06/28/07	1	0	0
5	8/31/07	1	0	0
5	9/20/07	1	2	0
5	10/04/07	0	3	0
5	10/18/07	0	1	1

TABLE 11—Continued

Reach	Date	Chinook	Redds	Carcasses
5	10/31/07	0	0	1
6	06/04/07	0	0	0
6	06/29/07	5	0	0
6	8/30/07	0	0	0
6	9/20/07	0	0	0
6	10/04/07	0	0	0
6	10/19/07	0	1	0
6	11/1/07	0	0	0
Totals			132	49

TABLE 12-Total monthly counts of live Chinook observed on 2007 Battle Creek stream surveys.

Reaches 1-6	May 5/29-6/4	June 6/26-6/29	August 8/27-8/30	September 9/17-9/20	October (1st) 10/1-10/4	October (2nd) 10/15-10/19	November 10/29-11/7
1	4	1	2	1	2	0	0
2	5	3	1	3	35	17	0
3	1	2	16	4	8	3	0
4	7	15	13	42	17	5	0
5	2	1	1	1	0	0	0
6	0	5	0	0	0	0	0
Totals	19	27	33	51	62	25	0

TABLE 13-Number of days mean daily temperatures met Ward and Kier's (1999) suitability categories for spring Chinook holding from June 1 through September 30, 2007 at select monitoring site in Battle Creek.

Site Name	Location	River Mile	No Data	Very Poor	Poor	Fair	Good
Eagle Canyon Dam	North Fork	5.3[a]	0	0	0	0	122
Wildcat Dam	North Fork	2.5[a]	0	0	0	47	75
Wildcat Road Bridge	North Fork	0.9[a]	0	0	7	91	24
Above confluence of forks	North Fork	0.05[a]	0	0	8	91	23
Coleman Diversion Dam	South Fork	2.5[a]	0	0	0	54	68
Manton Road Bridge	South Fork	1.7[a]	0	0	0	62	60
Above confluence of forks	South Fork	0.1[a]	0	0	8	69	45
Below confluence of forks	Mainstem	16.0[b]	0	0	9	81	32
Reach 4 Upper	Mainstem	15.9[b]	0	0	8	67	47
Reach 4 Lower	Mainstem	12.9[b]	0	0	30	73	19
Reach 5 Lower	Mainstem	9.3[b]	0	0	69	42	11

[a] From confluence of the North Fork and South Fork Battle Creek
[b] From confluence with the Sacramento River

TABLE 14-Estimated range for percent of days that incubating spring Chinook eggs fell within water temperature suitability categories in Battle Creek in 2007. The left and right numbers of the range represent the average for the worst-case scenario and best-case scenario respectively[a]. Presented in the parentheses are the ranges of average number of days that redds were exposed to each temperature category based on the worst-case and best-case scenarios.

Reach	Location	n = (Redds)	Very Poor	Poor	Fair	Good	Excellent
1	North Fork	6	0%	0%	0%	0%	100.0% (96-103)
2	North Fork	72	0%	0%	0.1-0% (<1-0)	0.7-0% (<1-0)	99.2-100.0% (103-111)
3	South Fork	21	0%	0%	0.9-0% (1-0)	0.7-0.1% (<1)	98.4-99.9% (107-119)
4	Mainstem	27	0%	0%	0.5-0.1% (<1)	7.6-1.5% (7-2)	91.9-98.5% (87-102)
5	Mainstem	6	1.9-0% (2-0)	1.9-0% (2-0)	5-1% (4-1)	10.7-5.6% (9-6)	80.5-93.4% (70-92)
6	Mainstem	0					
Total		132	0.1-0% (<1)	0.1-0% (<1)	0.5-0.1% (<1)	2.4-0.5% (3-<1)	97.0-99.4% (99-109)

[a] Previous annual reports included only the best-case scenario.

TABLE 15-Number of days mean daily temperatures met Ward and Kier's (1999) suitability categories for spring Chinook egg incubation from September 15 through October 31, 2007 at the select monitoring sites in Battle Creek.

Site Name	Location	River Mile	No Data	Very Poor	Poor	Fair	Good	Excell-ent
Eagle Canyon Dam	North Fork	5.3[a]	0	0	0	0	0	47
Wildcat Dam	North Fork	2.5[a]	0	0	0	0	2	45
Wildcat Road Bridge	North Fork	0.9[a]	0	0	0	4	4	39
Above confluence of forks	North Fork	0.05[a]	0	0	0	2	5	40
Coleman Diversion Dam	South Fork	2.5[a]	0	0	0	0	4	43
Manton Road Bridge	South Fork	1.7[a]	0	0	0	0	4	43
Above confluence of forks	South Fork	0.1[a]	0	0	0	0	5	42
Below confluence of forks	Mainstem	16.0[b]	0	0	0	0	9	38
Reach 4 Upper	Mainstem	15.9[b]	0	0	0	0	6	41
Reach 4 Lower	Mainstem	12.9[b]	0	0	0	4	11	32
Reach 5 Lower	Mainstem	9.3[b]	2	4	3	10	16	12
Total			2	4	3	20	66	422

[a] From confluence of the North Fork and South Fork Battle Creek
[b] From confluence with the Sacramento River

Figures

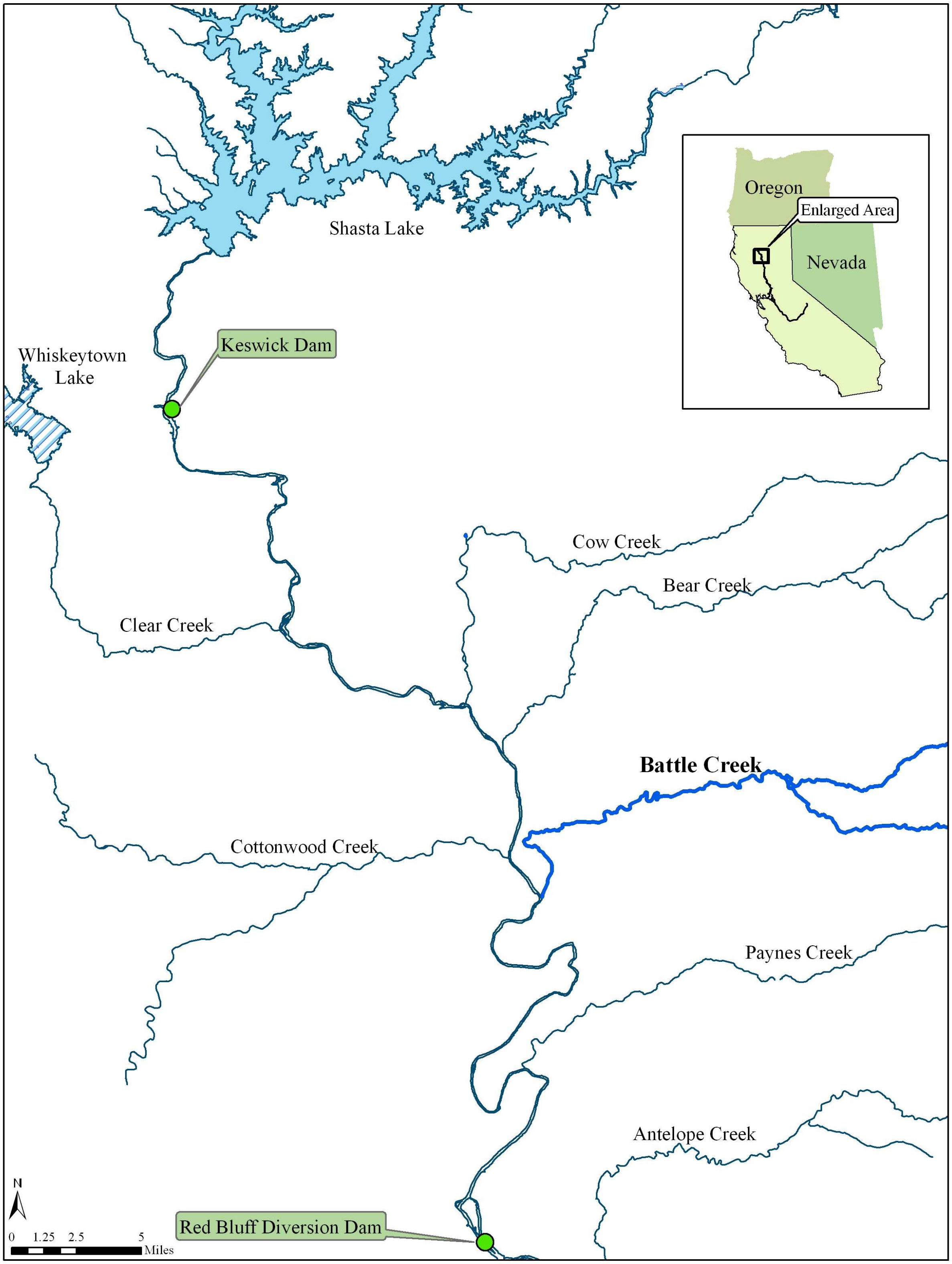


FIGURE 1-Map of the Sacramento River and its tributaries (including Battle Creek) between Keswick Dam and Red Bluff, California.

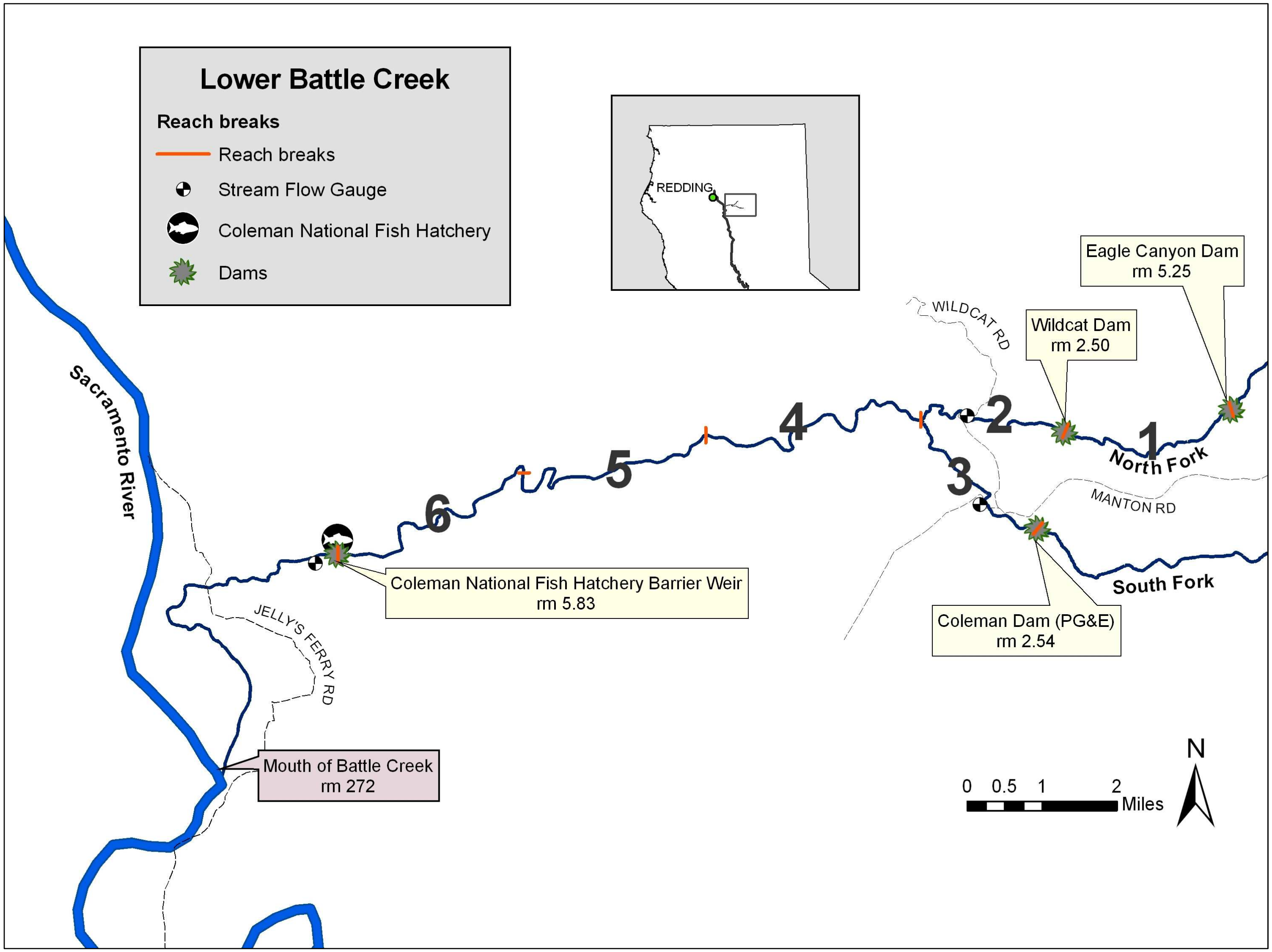


FIGURE 2-Map of Battle Creek depicting the location of the Coleman National Fish Hatchery barrier weir and stream survey reaches.

FIGURE 3-Pictures showing the upper and lower potential barriers on the North Fork of Battle Creek. Picture A, is the upper barrier and picture B is the lower (low-flow) barrier.

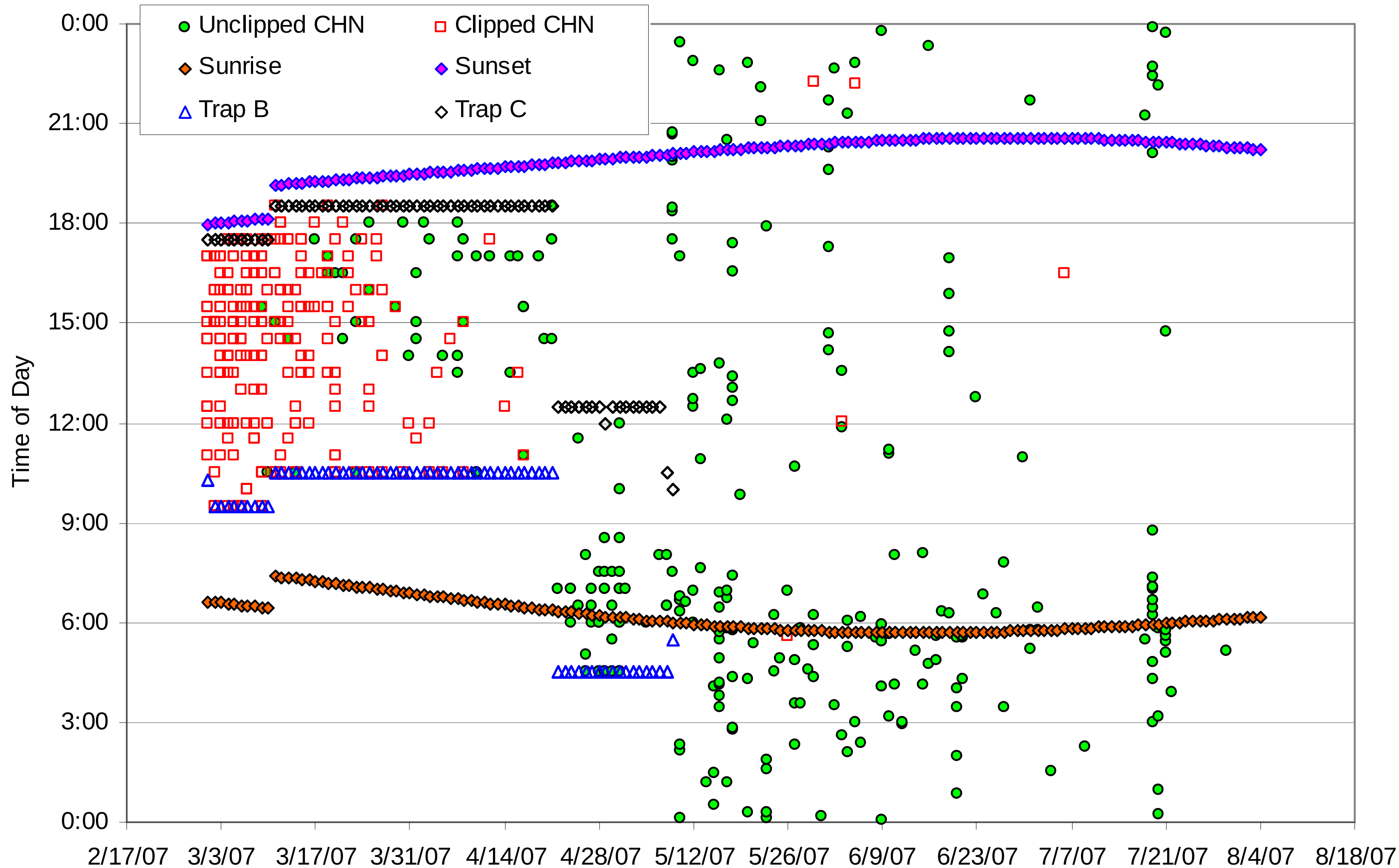


FIGURE 4-Diel migration of Chinook salmon (CHN, clipped and unclipped) observed at the Coleman National Fish Hatchery barrier weir during periods of trap operation (March 1-May 9) and video monitoring (May 9-August 1) in 2007. Also included are times of sunrise, sunset, beginning of trap operation (Trap B) and end of trap operation (Trap E).

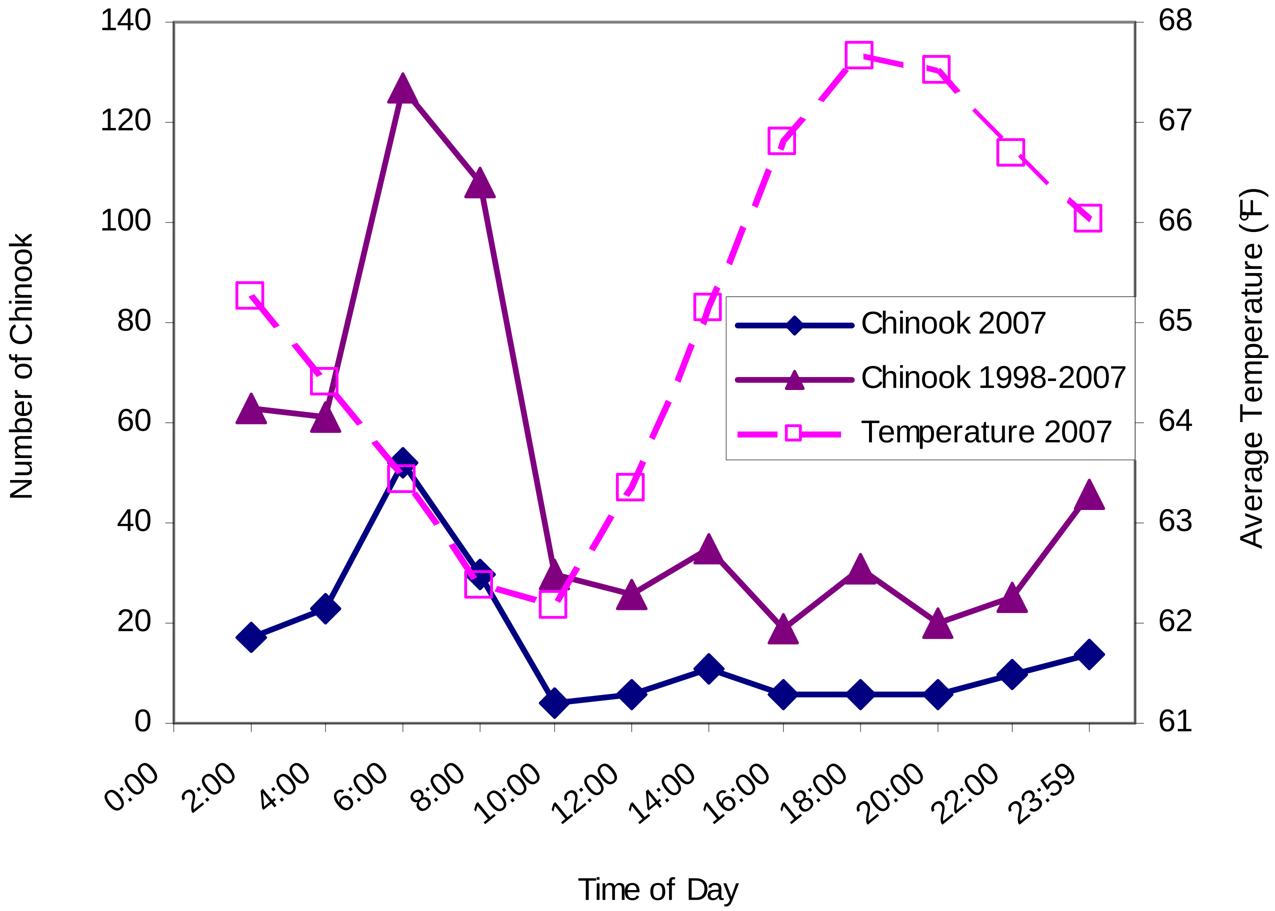


FIGURE 5-Diel migration of unclipped Chinook salmon observed at the Coleman National Fish Hatchery barrier weir during periods of video monitoring. Data include Chinook passing in 2007 for May 10-July 31, the ten-year sum of Chinook passing from May or June (depending on the year) through July 31, and the average temperature per time category for May 10-July 31, 2007. Labels are the upper end of the two-hour rime categories.

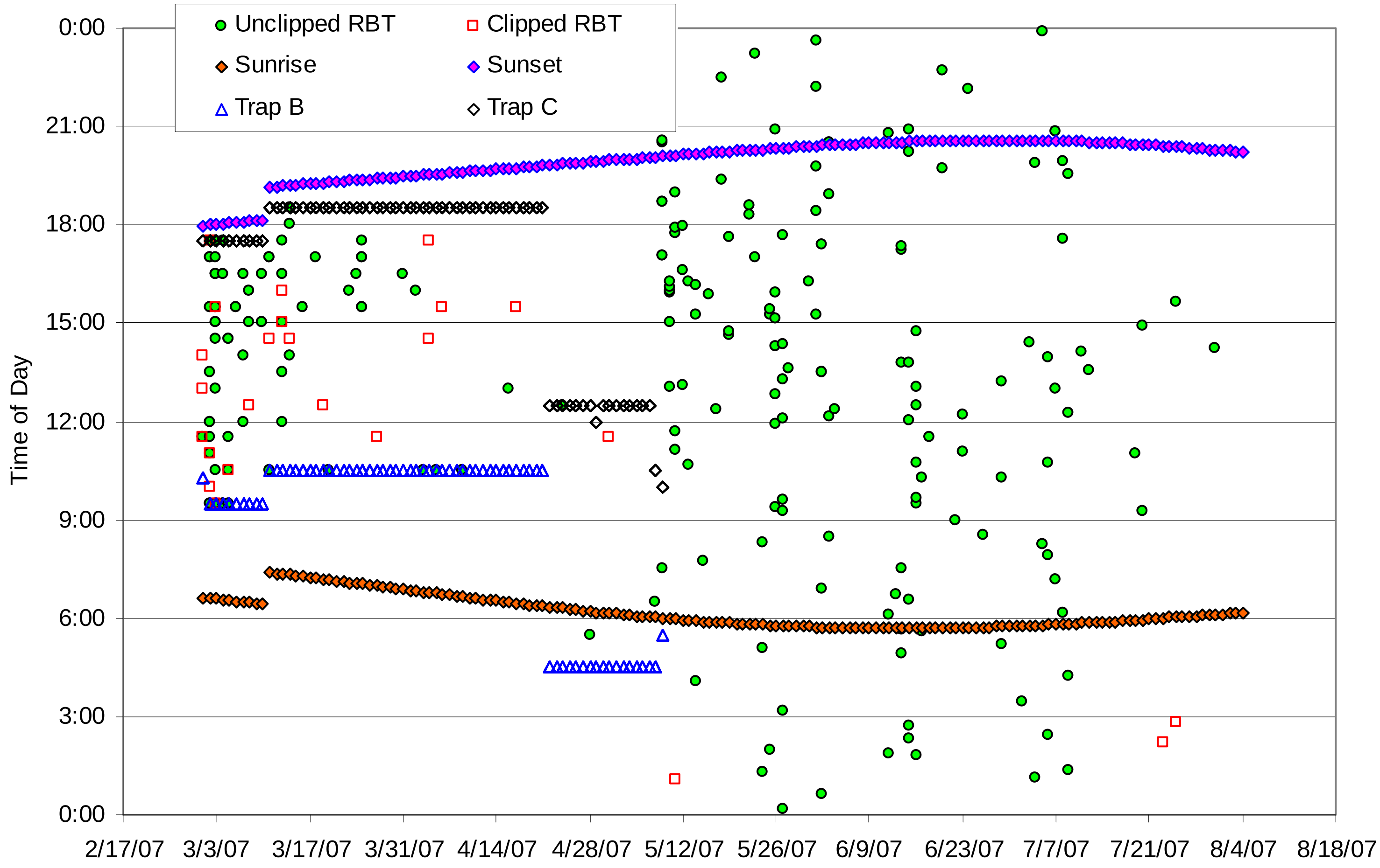


FIGURE 6-Diel migration of rainbow trout/steelhead (RBT, clipped and unclipped) observed at the Coleman National Fish Hatchery barrier weir during periods of trap operation (March 1-May 9) and video monitoring (May 9-August 1) in 2007. Also included are time of sunrise, sunset, beginning of trap operation (Trap B) and end of trap operation (Trap E).

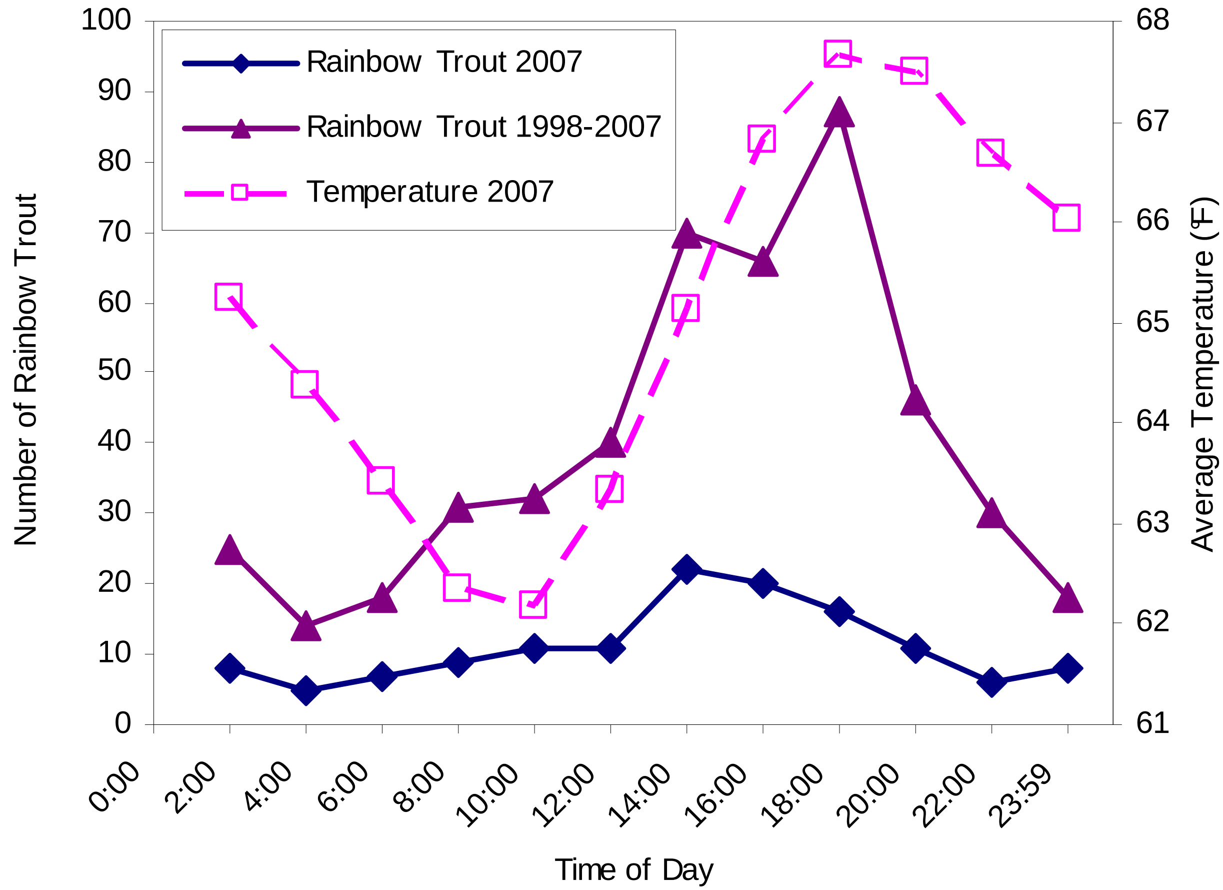


FIGURE 7-Diel migration of rainbow trout observed at the Coleman National Fish Hatchery barrier weir during periods of video monitoring. Data includes rainbow trout passing in 2007 for May 10-July 31, the ten-year sum of rainbow trout passing from May or June (depending on the year) through July 31, and the average temperature per time category for May 10-July 31, 2007. Labels are the upper end of the two-hour time categories.

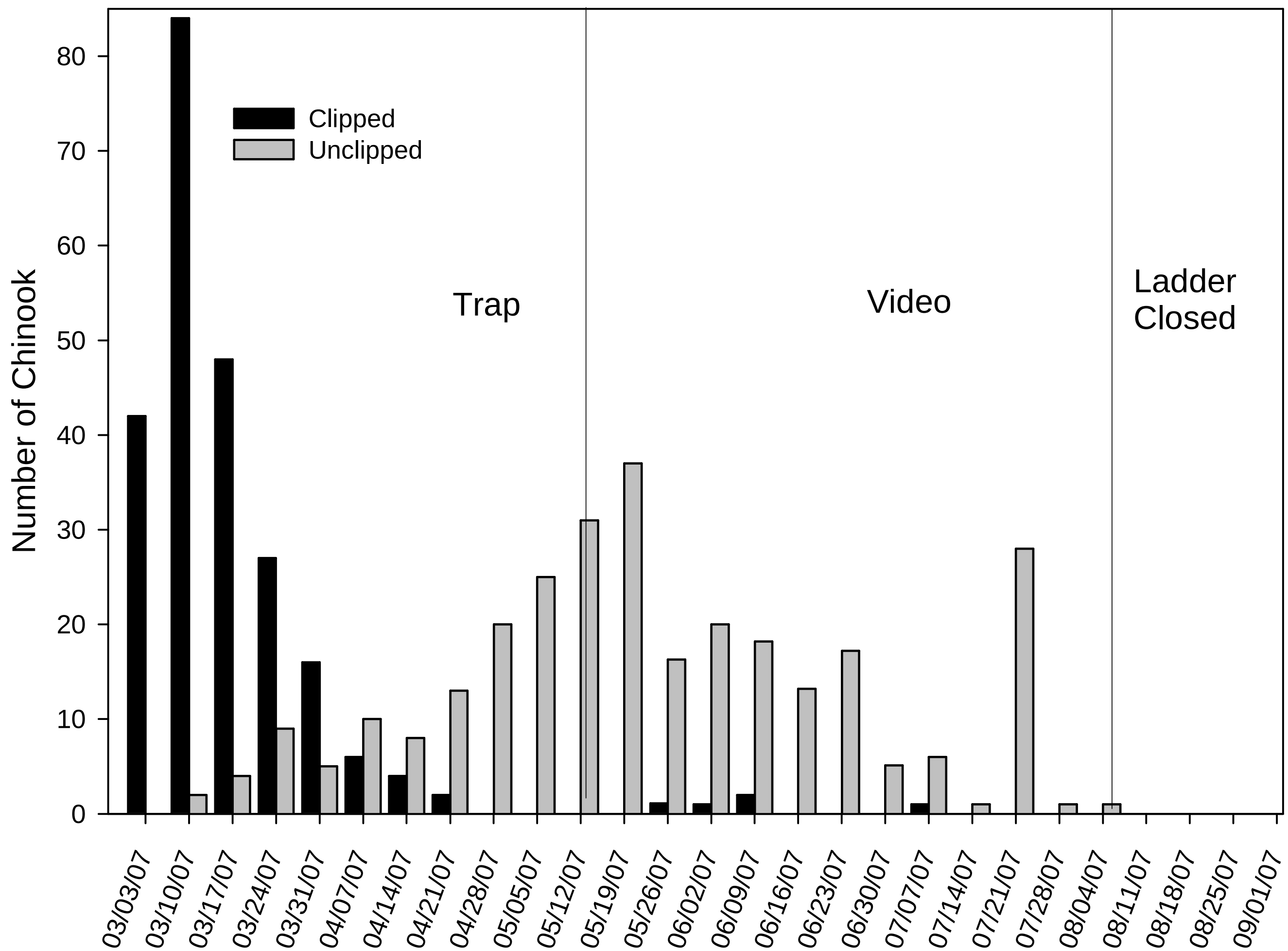


FIGURE 8-Number of clipped and unclipped Chinook salmon observed at the Coleman National Fish Hatchery barrier weir fish ladder in 2007, by week. Dates indicate the last day of the week. The first week is a partial week.

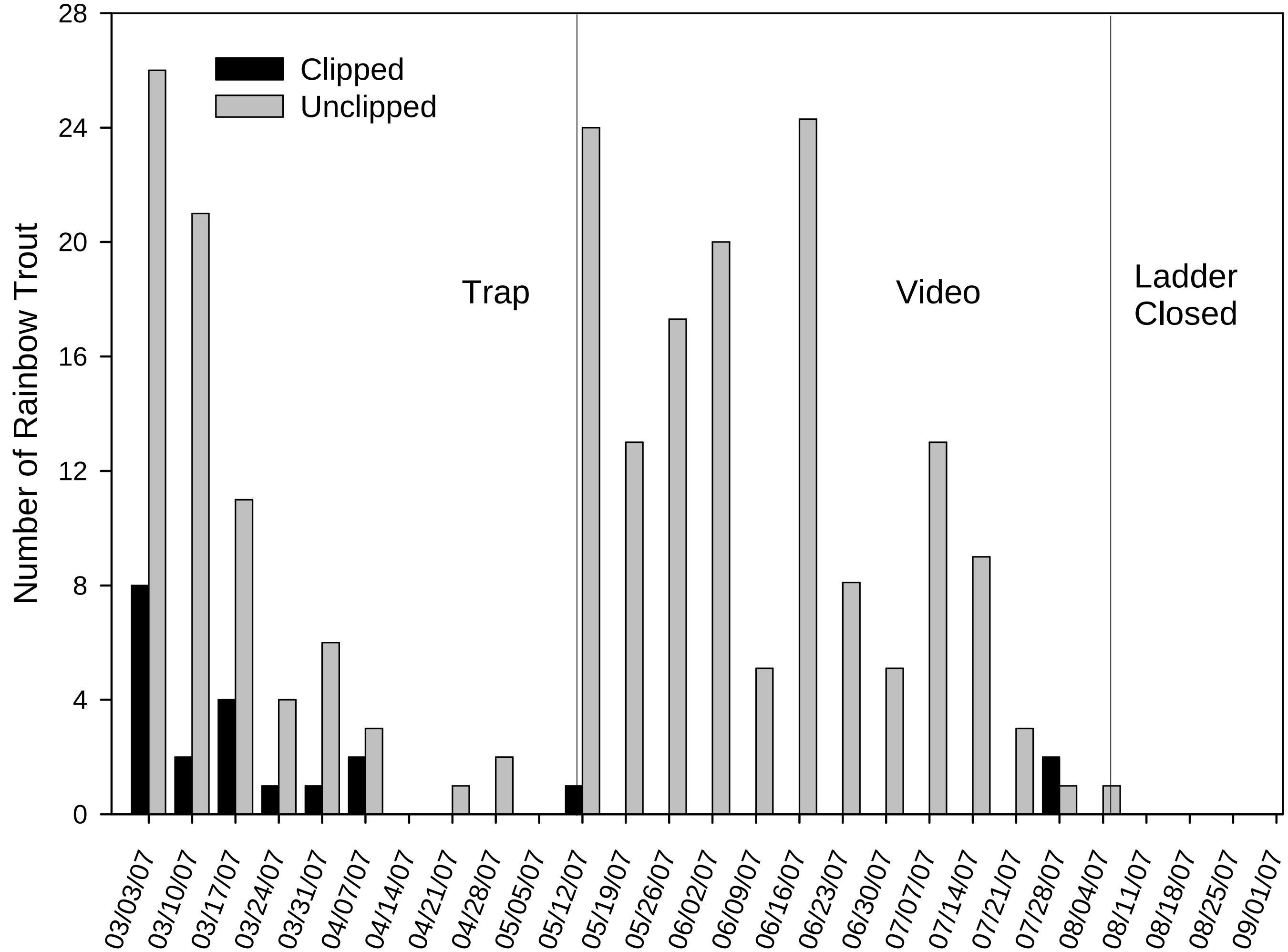


FIGURE 9-Number of clipped and unclipped rainbow trout/steelhead observed at the Coleman National Fish Hatchery barrier weir fish ladder in 2007, by week. Dates indicate the last day of the week. The first week is a partial week.

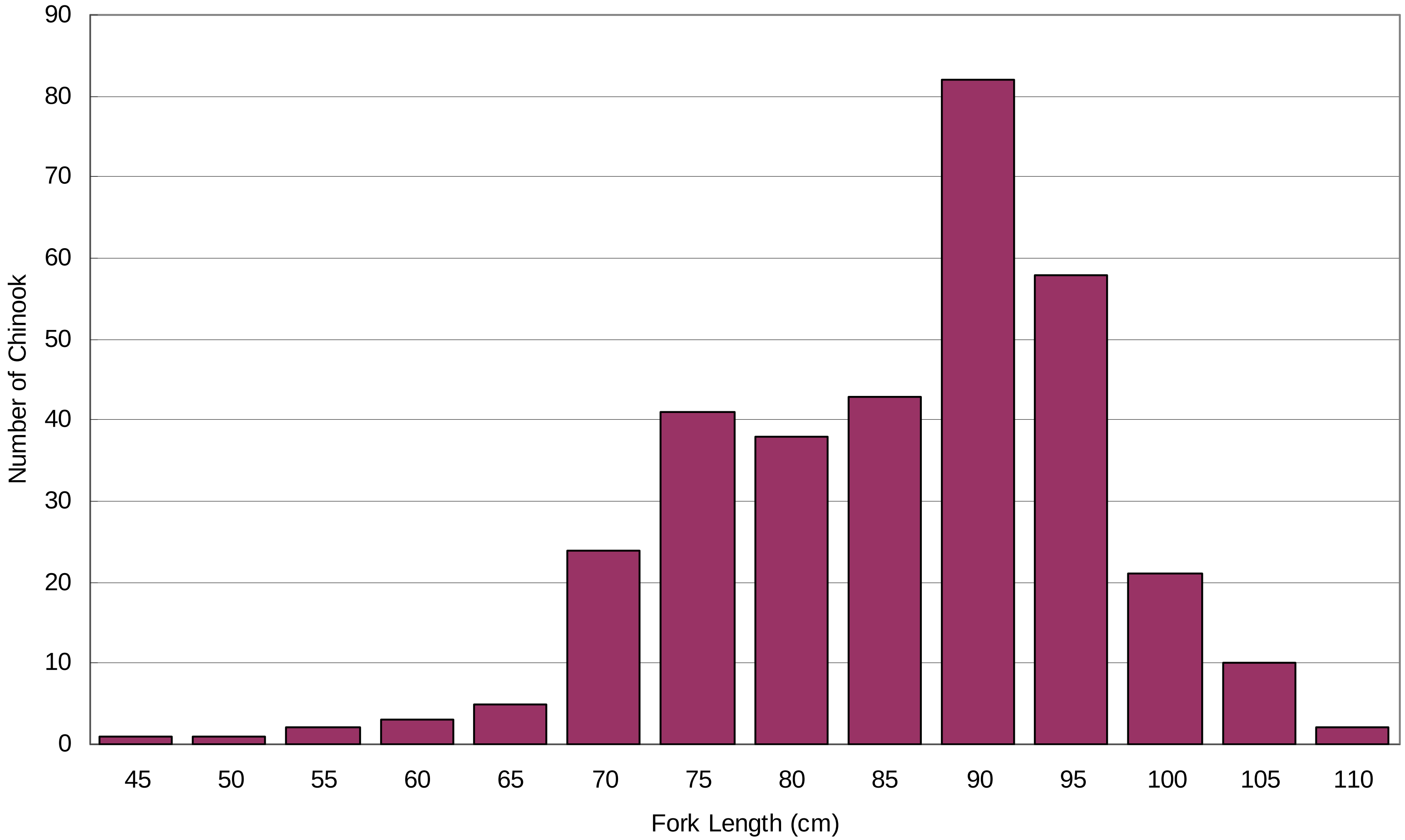


FIGURE 10-Length-frequency distribution of Chinook captured in the Coleman National Fish Hatchery barrier weir trap in 2007. Fork length labels are the upper end of the size category.

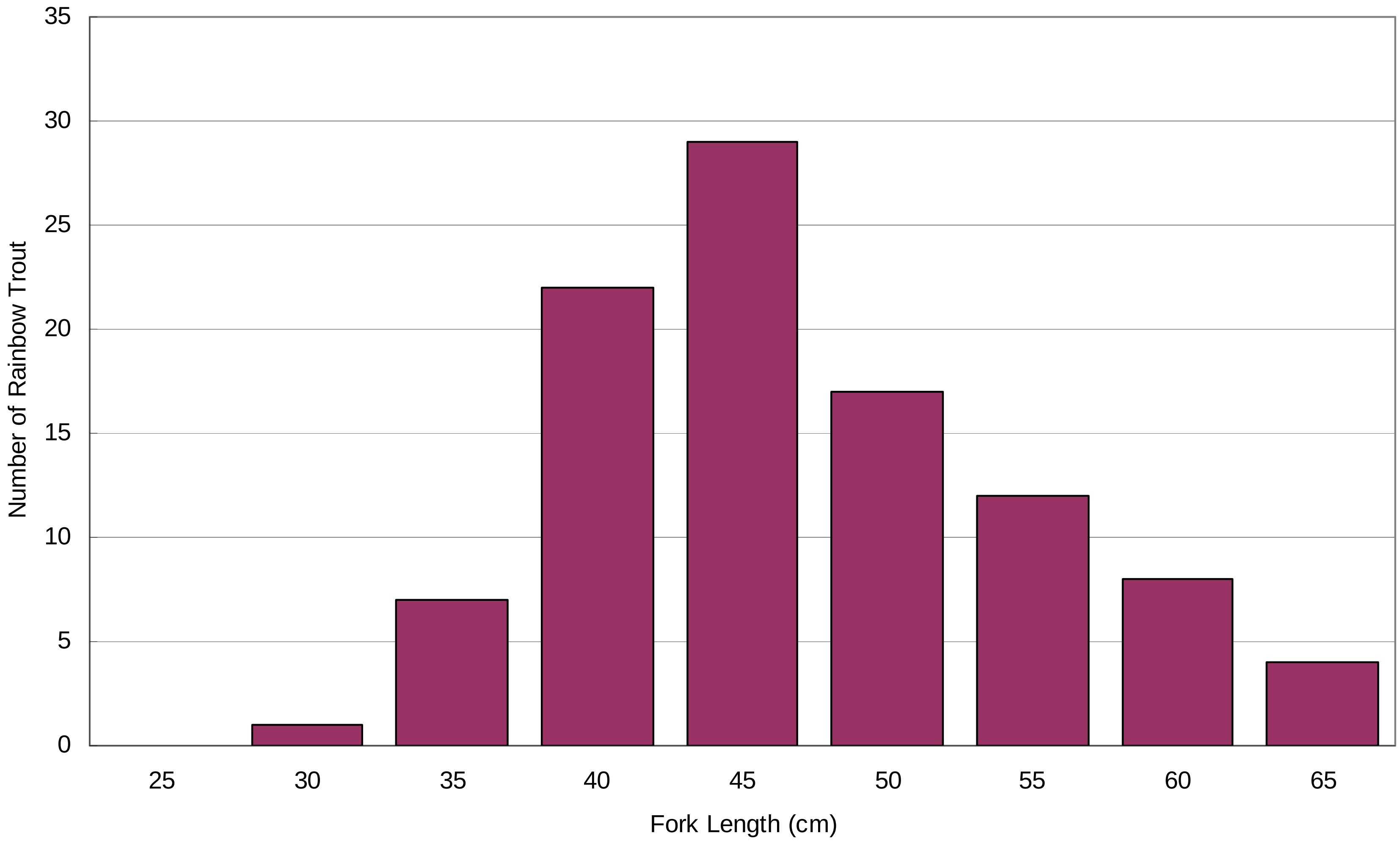


FIGURE 11-Length-frequency distribution of rainbow trout/steelhead captured in Coleman National Fish Hatchery barrier weir trap in 2007. Fork length labels are the upper end of the size category.

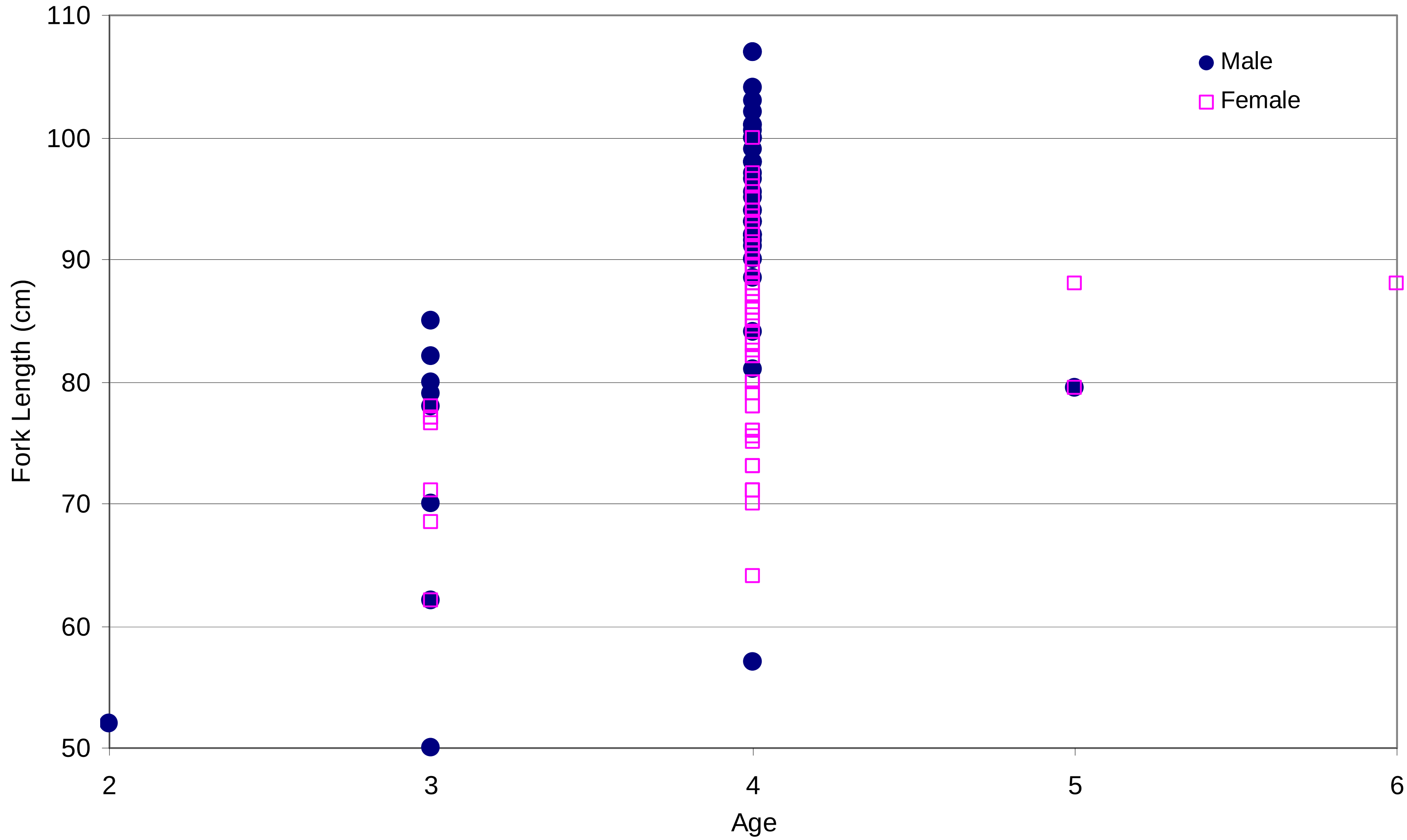


FIGURE 12-Relationship between fork length and age for coded-wire tagged Chinook captured in the Coleman National Fish Hatchery barrier weir trap in 2007.

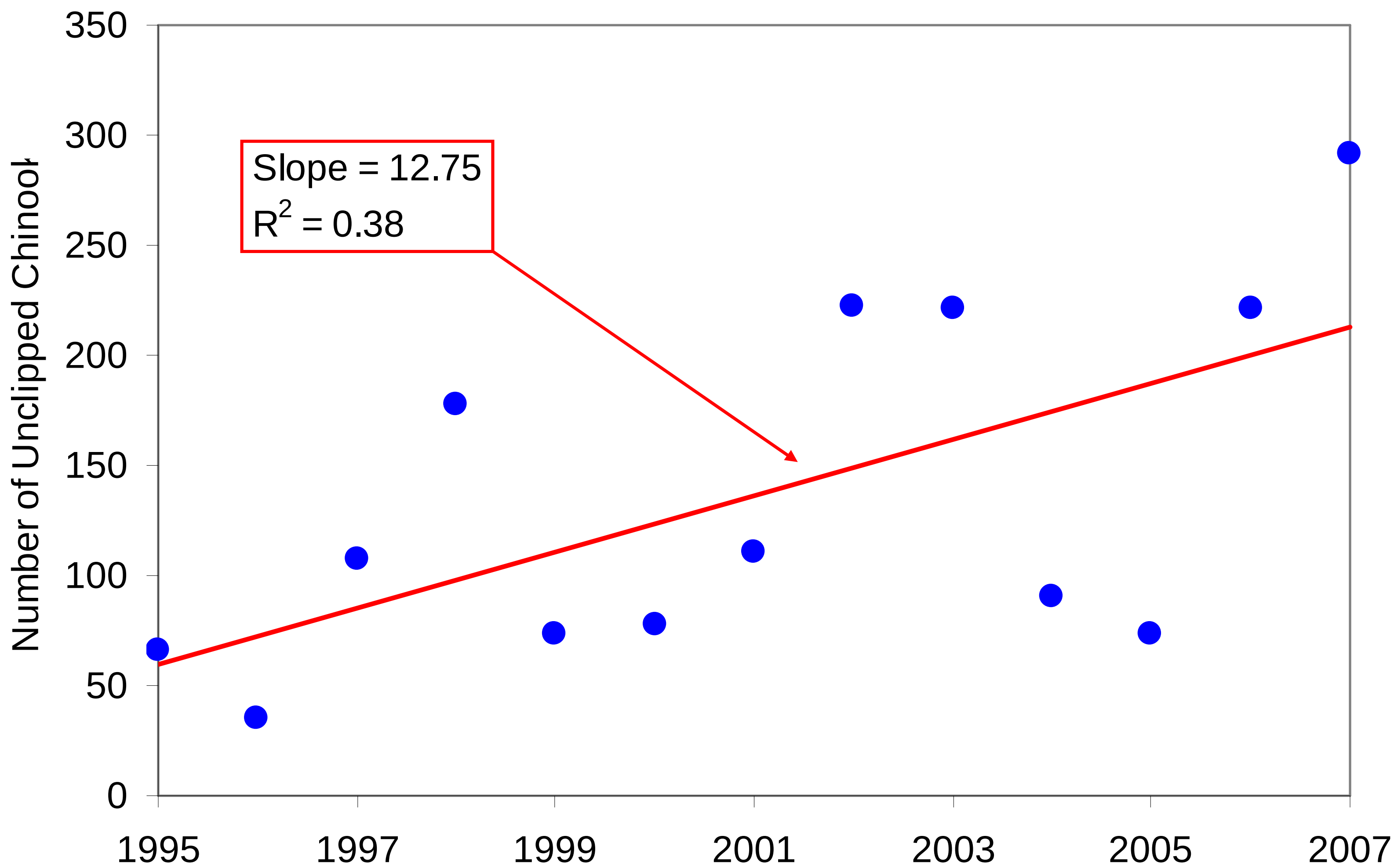


FIGURE 13-The annual total number of unclipped Chinook (i.e., maximum potential spring Chinook) passed above the Coleman National Fish Hatchery barrier weir on Battle Creek from 1995 to 2007. The population trend for this period is described by the simple linear regression line.

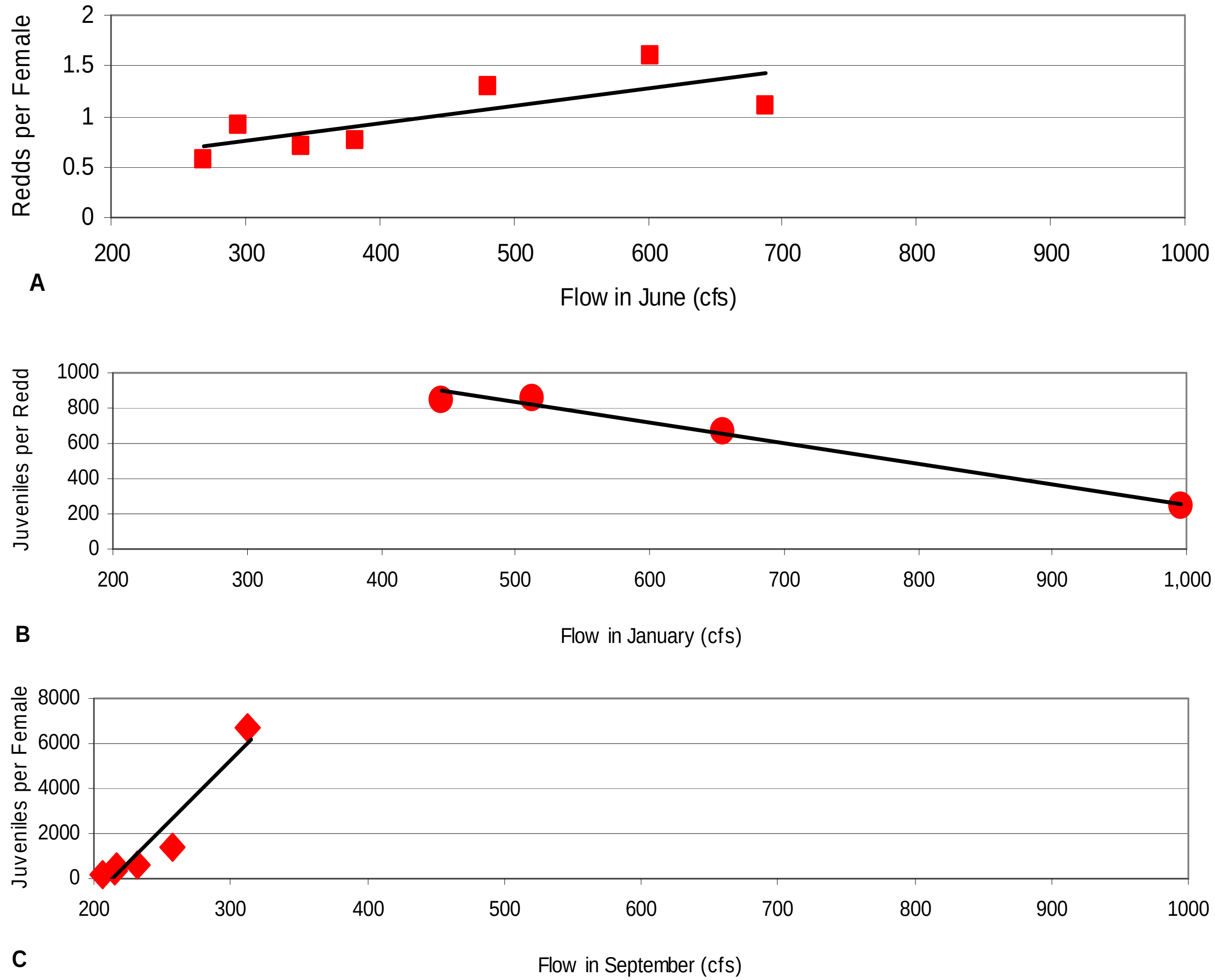
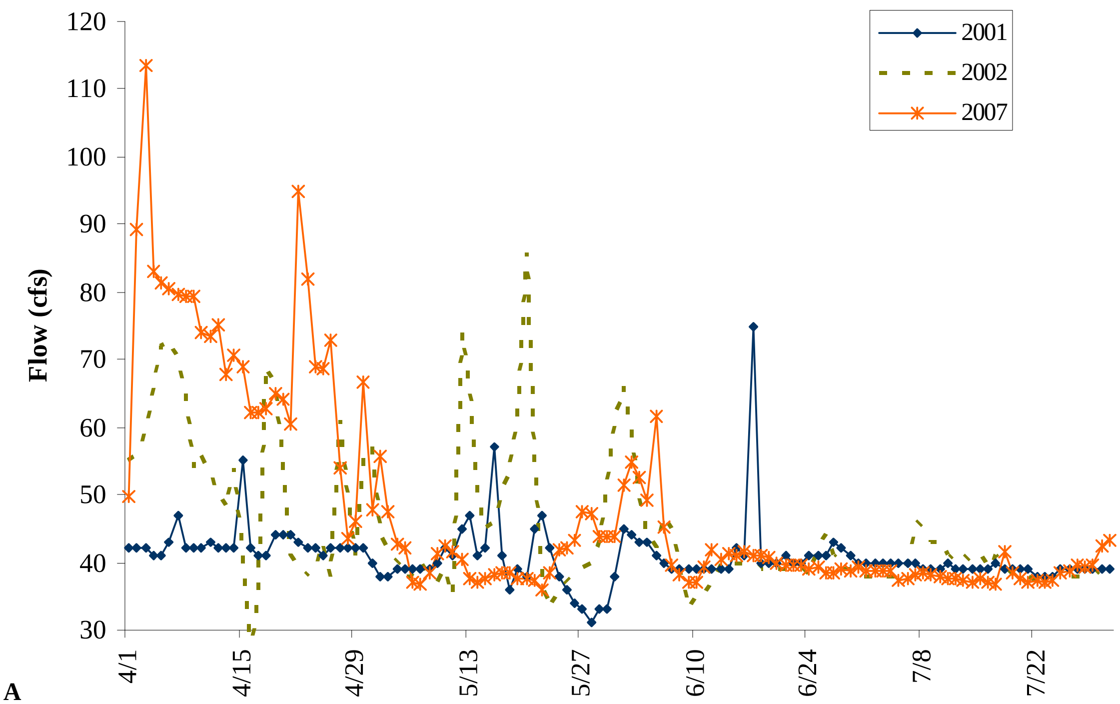
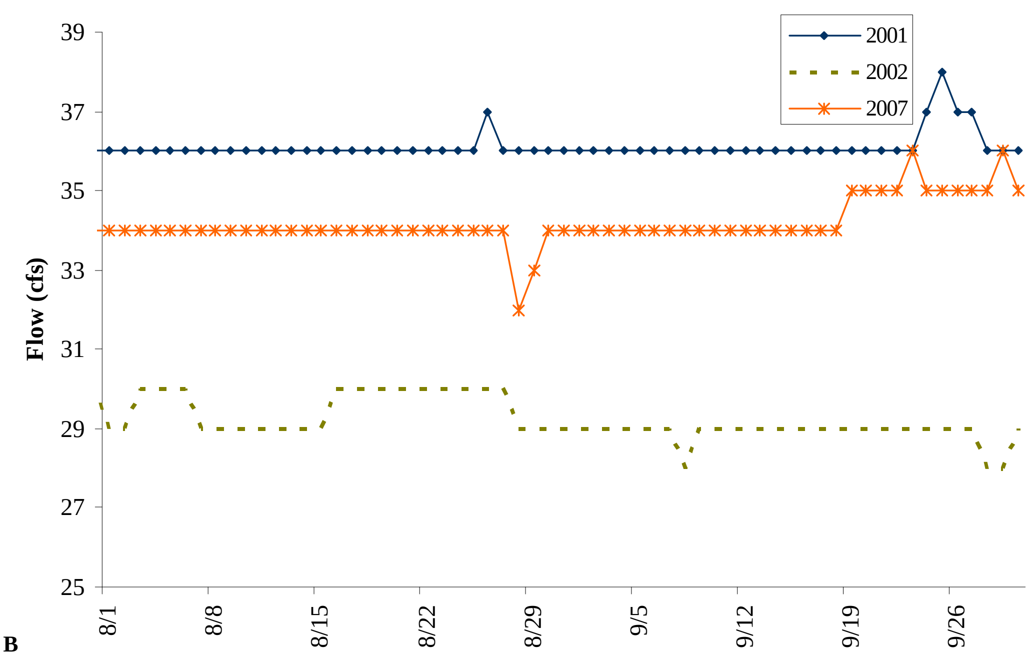


FIGURE 14-Select graphs showing the correlation between three survival metrics for spring Chinook salmon in Battle Creek and mean monthly flow (MMF) in lower Battle Creek; redds-per-female vs. MMF in June (A, r=0.783), juveniles-per-redd vs. MMF in January (B, r=-0.991), and juveniles-per-female vs. MMF in September (C, r=0.951).



A



B

FIGURE 15-Mean daily flows (MDF) for 2007 and two previous dry years (2001 and 2002). April through July flows are represented by figure A, using the Wildcat Bridge gauge. Figure B, are the flows for the same years August through September, using a low flow gauge located closer to the potential low-flow barrier.

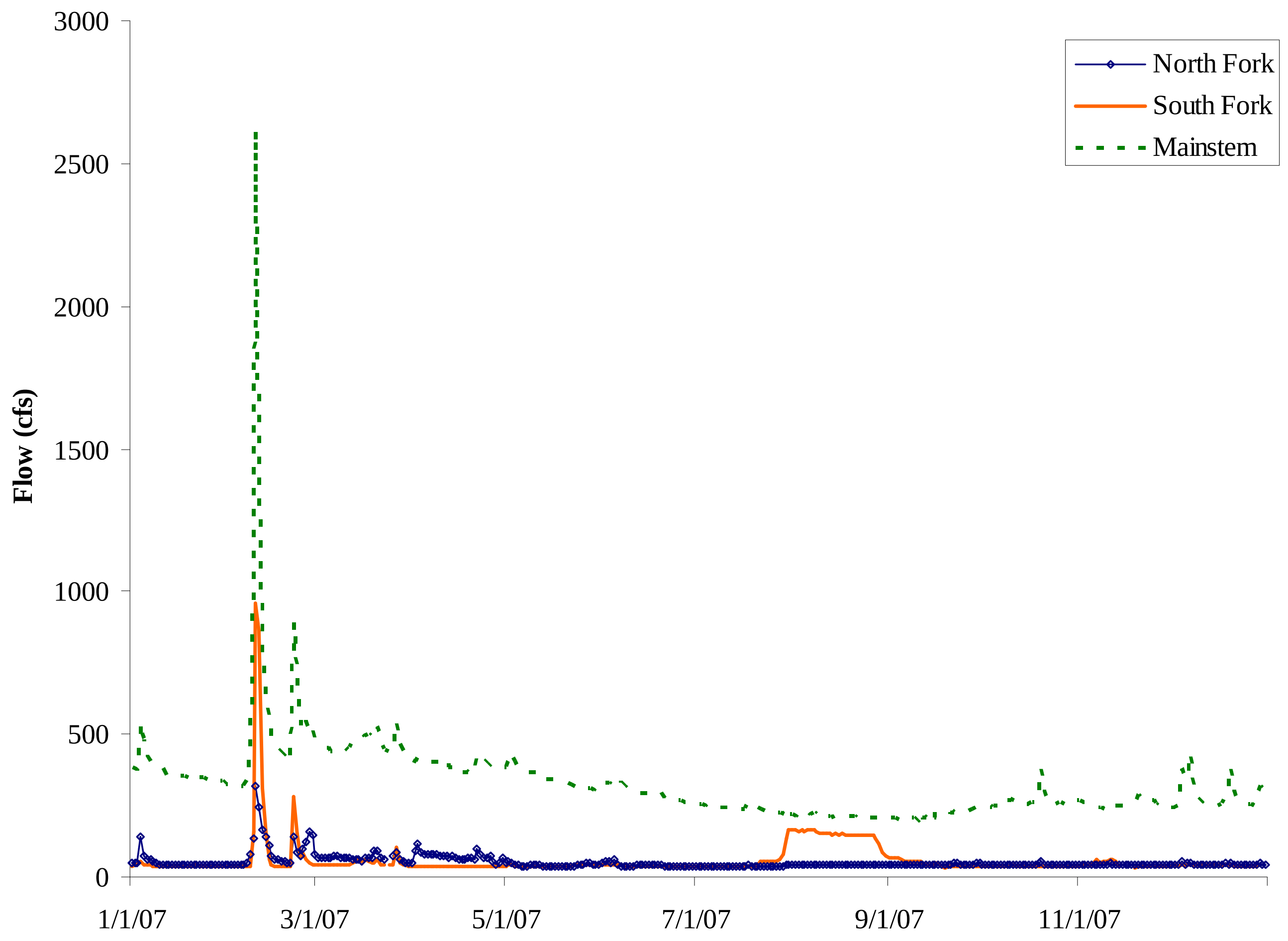


FIGURE 16-Mean daily flows (MDF) at the Coleman National Fish Hatchery barrier weir on the mainstem of Battle Creek (rm 5.8), Wildcat Road Bridge on the North Fork (rm 0.9), and Manton Road Bridge on the South Fork (rm 1.7) in 2007.

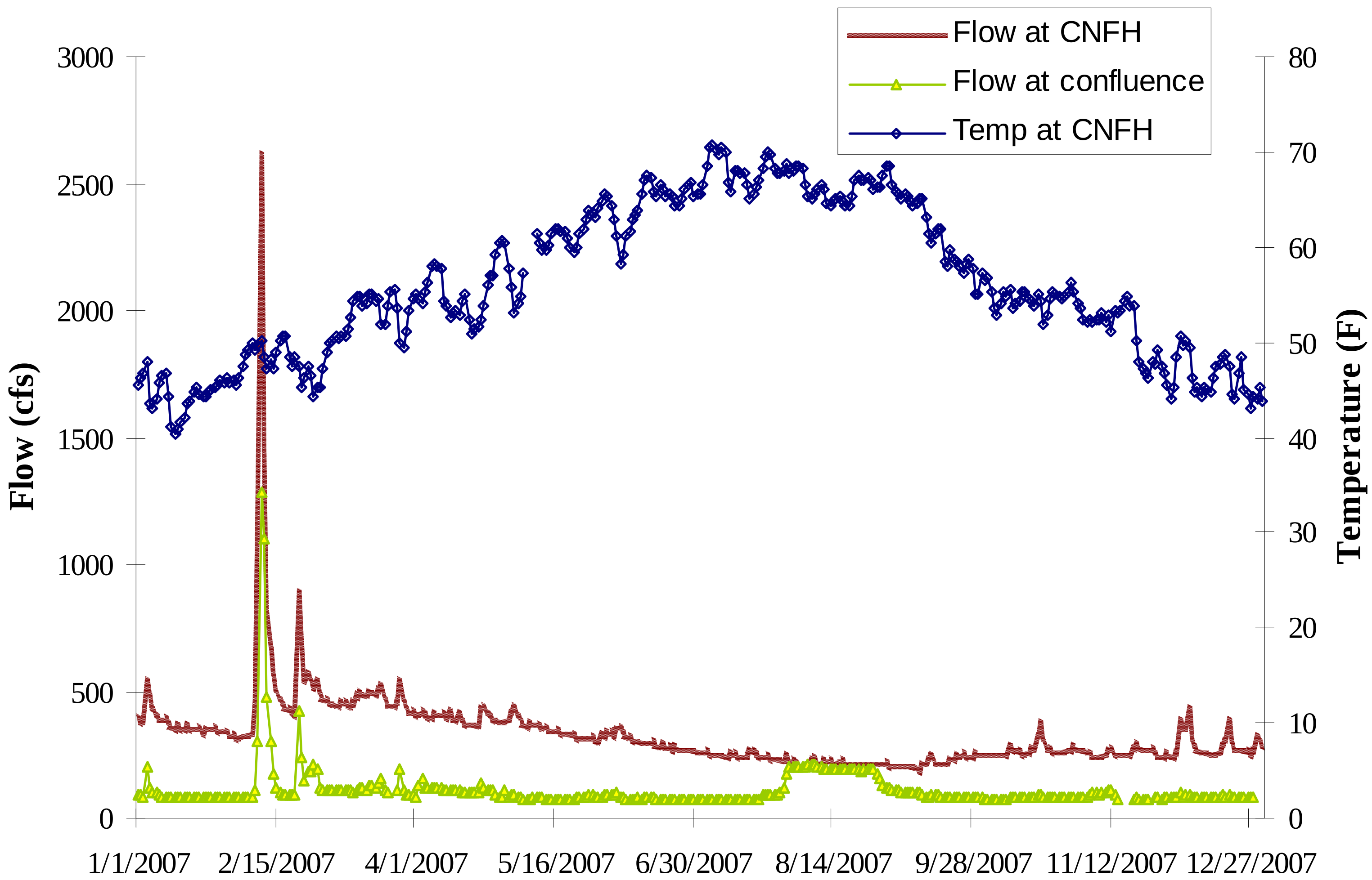


FIGURE 17- Mainstem Battle Creek mean daily flow and water temperature at the Coleman National Fish Hatchery barrier weir and the flow at the confluence of the forks in 2007.

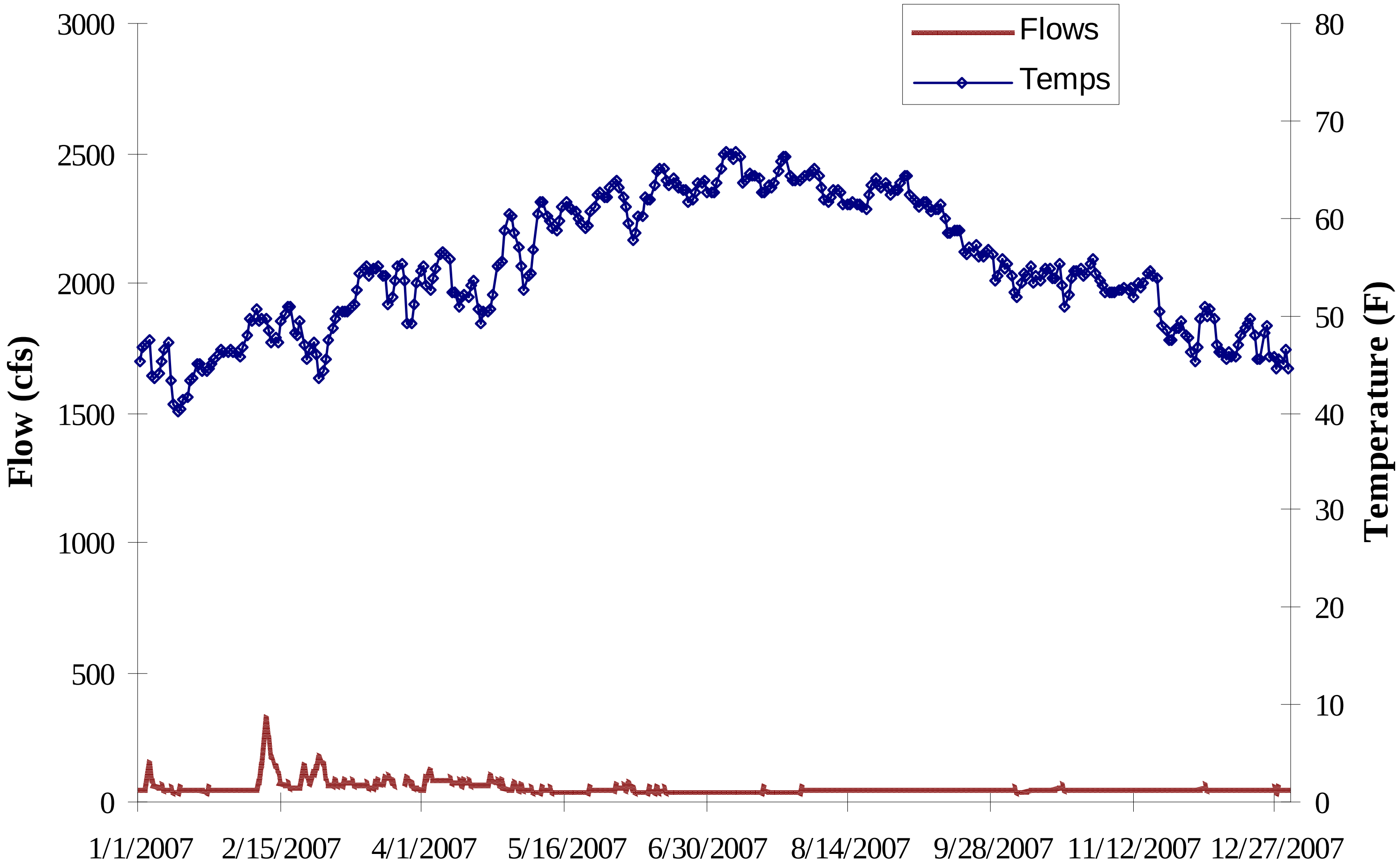


FIGURE 18-North Fork Battle Creek mean daily flow and water temperature at Wildcat Road Bridge in 2007.

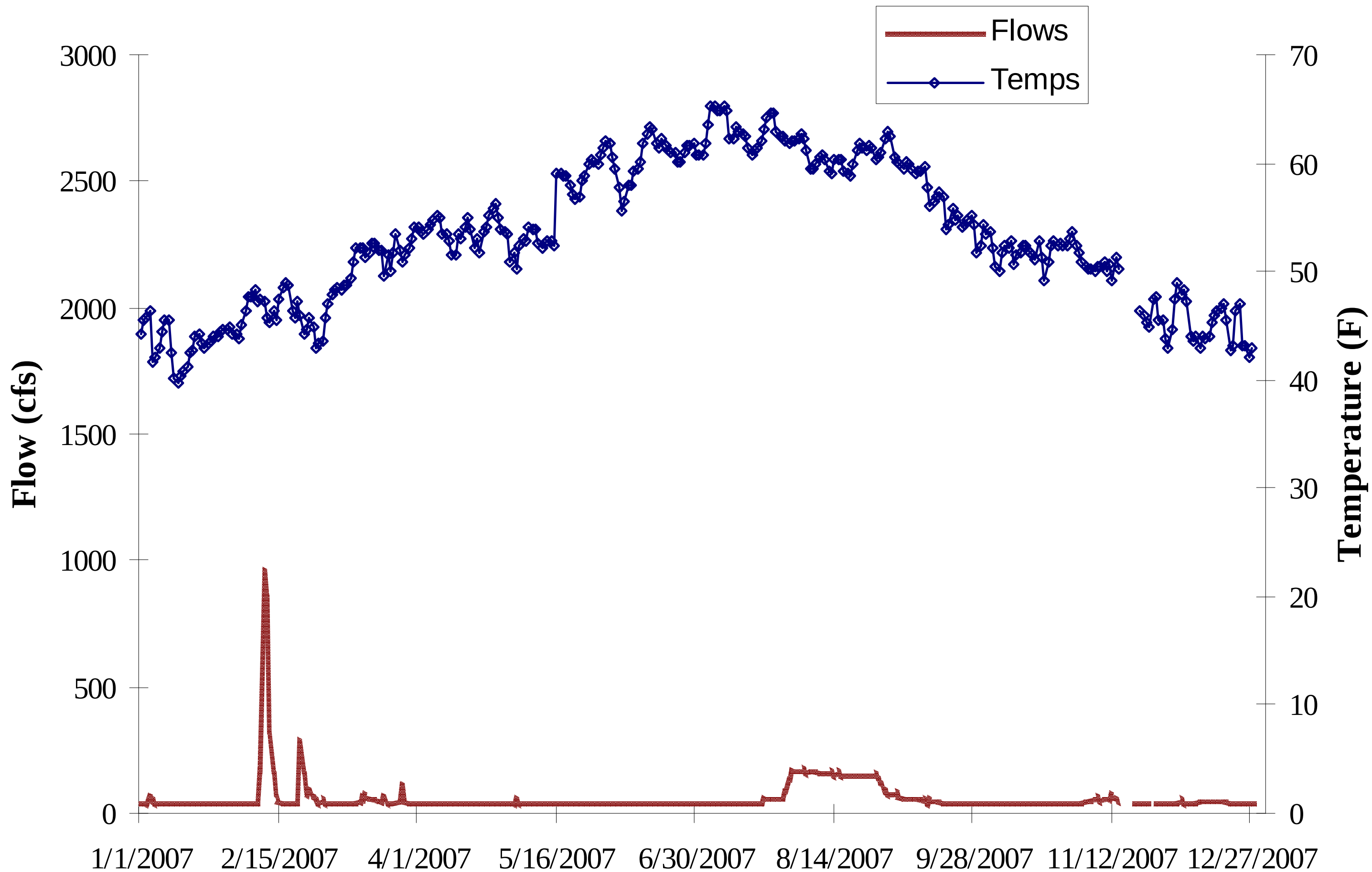


FIGURE 19-South Fork Battle Creek mean daily flow and water temperature at Manton Road Bridge in 2007.

Appendix A

APPENDIX A1-Coded-wire tags recovered during Coleman National Fish Hatchery (CNFH) barrier weir trap monitoritng in 2007.

Collection date	Collection location and method	Species	Sex	Fork length (cm)	Tag code [a]	Hatchery or creek of origin [b]	Run	Brood year
3/2/2007	Barrier Weir Trap	Rainbow	M	48	NTD			
3/1/2007	Barrier Weir Trap	Chinook	M	102	051776	CNFH	Late Fall	2003
3/1/2007	Barrier Weir Trap	Chinook	F	94	051770	CNFH	Late Fall	2003
3/1/2007	Barrier Weir Trap	Chinook	F	88	051770	CNFH	Late Fall	2003
3/1/2007	Barrier Weir Trap	Chinook	M	99	051776	CNFH	Late Fall	2003
3/1/2007	Barrier Weir Trap	Chinook	M	89	051776	CNFH	Late Fall	2003
3/1/2007	Barrier Weir Trap	Chinook	M	87	051775	CNFH	Late Fall	2003
3/1/2007	Barrier Weir Trap	Chinook	F	74	052278	CNFH	Late Fall	2004
3/1/2007	Barrier Weir Trap	Chinook	F	87	051769	CNFH	Late Fall	2003
3/1/2007	Barrier Weir Trap	Chinook	F	84	051776	CNFH	Late Fall	2003
3/1/2007	Barrier Weir Trap	Chinook	F	95	051768	CNFH	Late Fall	2003
3/1/2007	Barrier Weir Trap	Chinook	M	87	051769	CNFH	Late Fall	2003
3/1/2007	Barrier Weir Trap	Chinook	M	100	051768	CNFH	Late Fall	2003
3/1/2007	Barrier Weir Trap	Chinook	M	100	051776	CNFH	Late Fall	2003
3/1/2007	Barrier Weir Trap	Chinook	F	78	051769	CNFH	Late Fall	2003
3/2/2007	Barrier Weir Trap	Chinook	M	102	051777	CNFH	Late Fall	2003
3/2/2007	Barrier Weir Trap	Chinook	M	84	051768	CNFH	Late Fall	2003
3/2/2007	Barrier Weir Trap	Chinook	F	94	051775	CNFH	Late Fall	2003
3/2/2007	Barrier Weir Trap	Rainbow	M	42	051568	CNFH		2003
3/2/2007	Barrier Weir Trap	Chinook	M	95	NTD			
3/2/2007	Barrier Weir Trap	Chinook	F	89	051776	CNFH	Late Fall	2003
3/2/2007	Barrier Weir Trap	Chinook	M	92	051776	CNFH	Late Fall	2003

APPENDIX A1—Continued

Collection date	Collection location and method	Species	Sex	Fork length (cm)	Tag code [a]	Hatchery or creek of origin [b]	Run	Brood year
3/2/2007	Barrier Weir Trap	Chinook	M	85	051776	CNFH	Late Fall	2003
3/2/2007	Barrier Weir Trap	Chinook	M	102	051777	CNFH	Late Fall	2003
3/2/2007	Barrier Weir Trap	Chinook	F	88	051770	CNFH	Late Fall	2003
3/2/2007	Barrier Weir Trap	Chinook	M	95	051766	CNFH	Late Fall	2003
3/2/2007	Barrier Weir Trap	Chinook	M	104	051775	CNFH	Late Fall	2003
3/2/2007	Barrier Weir Trap	Chinook	F	88	051768	CNFH	Late Fall	2003
3/3/2007	Barrier Weir Trap	Chinook	F	70	052286	CNFH	Late Fall	2004
3/3/2007	Barrier Weir Trap	Chinook	F	70	051766	CNFH	Late Fall	2003
3/3/2007	Barrier Weir Trap	Chinook	F	86	NTD			
3/3/2007	Barrier Weir Trap	Chinook	F	84	051776	CNFH	Late Fall	2003
3/3/2007	Barrier Weir Trap	Chinook	F	85	051775	CNFH	Late Fall	2003
3/3/2007	Barrier Weir Trap	Chinook	M	102	051765	CNFH	Late Fall	2003
3/3/2007	Barrier Weir Trap	Chinook	F	90	051770	CNFH	Late Fall	2003
3/3/2007	Barrier Weir Trap	Chinook	F	94	051777	CNFH	Late Fall	2003
3/3/2007	Barrier Weir Trap	Chinook	F	90	051768	CNFH	Late Fall	2003
3/3/2007	Barrier Weir Trap	Chinook	F	84	051776	CNFH	Late Fall	2003
3/3/2007	Barrier Weir Trap	Chinook	M	78	Lost Tag			
3/3/2007	Barrier Weir Trap	Chinook	F	78	051776	CNFH	Late Fall	2003
3/3/2007	Barrier Weir Trap	Chinook	F	89	051768	CNFH	Late Fall	2003
3/3/2007	Barrier Weir Trap	Chinook	F	86	051766	CNFH	Late Fall	2003
3/3/2007	Barrier Weir Trap	Chinook	F	88	051766	CNFH	Late Fall	2003

APPENDIX A1—Continued

Collection date	Collection location and method	Species	Sex	Fork length (cm)	Tag code [a]	Hatchery or creek of origin [b]	Run	Brood year
3/3/2007	Barrier Weir Trap	Chinook	M	107	051764	CNFH	Late Fall	2003
3/4/2007	Barrier Weir Trap	Chinook	F	97	051776	CNFH	Late Fall	2003
3/4/2007	Barrier Weir Trap	Chinook	M	90	051777	CNFH	Late Fall	2003
3/4/2007	Barrier Weir Trap	Chinook	F	83	051765	CNFH	Late Fall	2003
3/4/2007	Barrier Weir Trap	Chinook	F	79	051766	CNFH	Late Fall	2003
3/4/2007	Barrier Weir Trap	Chinook	F	89	051764	CNFH	Late Fall	2003
3/4/2007	Barrier Weir Trap	Chinook	F	95	051776	CNFH	Late Fall	2003
3/4/2007	Barrier Weir Trap	Chinook	F	100	051775	CNFH	Late Fall	2003
3/4/2007	Barrier Weir Trap	Chinook	M	100	051777	CNFH	Late Fall	2003
3/4/2007	Barrier Weir Trap	Chinook	F	94	051777	CNFH	Late Fall	2003
3/4/2007	Barrier Weir Trap	Chinook	F	90	051776	CNFH	Late Fall	2003
3/4/2007	Barrier Weir Trap	Chinook	F	91	051770	CNFH	Late Fall	2003
3/4/2007	Barrier Weir Trap	Chinook	F	91	051767	CNFH	Late Fall	2003
3/5/2007	Barrier Weir Trap	Chinook	M	84	051765	CNFH	Late Fall	2003
3/5/2007	Barrier Weir Trap	Chinook	F	90	051770	CNFH	Late Fall	2003
3/5/2007	Barrier Weir Trap	Chinook	F	83	051769	CNFH	Late Fall	2003
3/5/2007	Barrier Weir Trap	Chinook	F	88	051768	CNFH	Late Fall	2003
3/5/2007	Barrier Weir Trap	Chinook	M	82	052279	CNFH	Late Fall	2004
3/5/2007	Barrier Weir Trap	Chinook	F	87	051776	CNFH	Late Fall	2003
3/5/2007	Barrier Weir Trap	Chinook	F	87	051775	CNFH	Late Fall	2003
3/5/2007	Barrier Weir Trap	Chinook	F	93	051776	CNFH	Late Fall	2003

APPENDIX A1—Continued

Collection date	Collection location and method	Species	Sex	Fork length (cm)	Tag code [a]	Hatchery or creek of origin [b]	Run	Brood year
3/5/2007	Barrier Weir Trap	Chinook	M	78	052286	CNFH	Late Fall	2004
3/5/2007	Barrier Weir Trap	Chinook	F	86	051777	CNFH	Late Fall	2003
3/5/2007	Barrier Weir Trap	Chinook	M	101	051777	CNFH	Late Fall	2003
3/5/2007	Barrier Weir Trap	Chinook	F	85	051765	CNFH	Late Fall	2003
3/5/2007	Barrier Weir Trap	Chinook	F	92	051768	CNFH	Late Fall	2003
3/5/2007	Barrier Weir Trap	Chinook	F	88	051777	CNFH	Late Fall	2003
3/5/2007	Barrier Weir Trap	Chinook	F	80	051776	CNFH	Late Fall	2003
3/5/2007	Barrier Weir Trap	Chinook	F	94	051769	CNFH	Late Fall	2003
3/5/2007	Barrier Weir Trap	Chinook	M	103	051775	CNFH	Late Fall	2003
3/6/2007	Barrier Weir Trap	Chinook	F	83	051765	CNFH	Late Fall	2003
3/6/2007	Barrier Weir Trap	Chinook	F	88	NTD			
3/6/2007	Barrier Weir Trap	Chinook	M	99	051775	CNFH	Late Fall	2003
3/6/2007	Barrier Weir Trap	Chinook	F	92	051770	CNFH	Late Fall	2003
3/6/2007	Barrier Weir Trap	Chinook	M	92	051766	CNFH	Late Fall	2003
3/6/2007	Barrier Weir Trap	Chinook	M	62	052278	CNFH	Late Fall	2004
3/6/2007	Barrier Weir Trap	Chinook	F	91	051777	CNFH	Late Fall	2003
3/6/2007	Barrier Weir Trap	Chinook	F	86	051777	CNFH	Late Fall	2003
3/6/2007	Barrier Weir Trap	Chinook	F	89	051776	CNFH	Late Fall	2003
3/6/2007	Barrier Weir Trap	Chinook	M	100	051768	CNFH	Late Fall	2003
3/6/2007	Barrier Weir Trap	Chinook	F	90	051777	CNFH	Late Fall	2003
3/6/2007	Barrier Weir Trap	Chinook	F	88	051770	CNFH	Late Fall	2003

APPENDIX A1—Continued

Collection date	Collection location and method	Species	Sex	Fork length (cm)	Tag code [a]	Hatchery or creek of origin [b]	Run	Brood year
3/7/2007	Barrier Weir Trap	Chinook	F	96	Lost Tag			
3/7/2007	Barrier Weir Trap	Chinook	F	82	051776	CNFH	Late Fall	2003
3/7/2007	Barrier Weir Trap	Chinook	F	92	051765	CNFH	Late Fall	2003
3/7/2007	Barrier Weir Trap	Chinook	F	96	051776	CNFH	Late Fall	2003
3/7/2007	Barrier Weir Trap	Chinook	M	101	051765	CNFH	Late Fall	2003
3/7/2007	Barrier Weir Trap	Chinook	F	93	051766	CNFH	Late Fall	2003
3/7/2007	Barrier Weir Trap	Chinook	F	76	051776	CNFH	Late Fall	2003
3/7/2007	Barrier Weir Trap	Chinook	M	104	051775	CNFH	Late Fall	2003
3/7/2007	Barrier Weir Trap	Chinook	F	93	051777	CNFH	Late Fall	2003
3/7/2007	Barrier Weir Trap	Chinook	F	86	051776	CNFH	Late Fall	2003
3/7/2007	Barrier Weir Trap	Chinook	F	95	Lost Tag			
3/8/2007	Barrier Weir Trap	Chinook	F	78	051775	CNFH	Late Fall	2003
3/8/2007	Barrier Weir Trap	Chinook	F	89	051766	CNFH	Late Fall	2003
3/8/2007	Barrier Weir Trap	Chinook	F	79	051766	CNFH	Late Fall	2003
3/8/2007	Barrier Weir Trap	Chinook	F	62	052278	CNFH	Late Fall	2004
3/8/2007	Barrier Weir Trap	Chinook	F	90	051775	CNFH	Late Fall	2003
3/8/2007	Barrier Weir Trap	Chinook	M	92	051777	CNFH	Late Fall	2003
3/8/2007	Barrier Weir Trap	Chinook	M	98	051777	CNFH	Late Fall	2003
3/8/2007	Barrier Weir Trap	Chinook	F	73	051699	CNFH	Late Fall	2003
3/8/2007	Barrier Weir Trap	Chinook	F	95	051766	CNFH	Late Fall	2003
3/8/2007	Barrier Weir Trap	Chinook	F	88	050772	CNFH	Late Fall	**2001**

APPENDIX A1—Continued

Collection date	Collection location and method	Species	Sex	Fork length (cm)	Tag code [a]	Hatchery or creek of origin [b]	Run	Brood year
3/8/2007	Barrier Weir Trap	Chinook	M	92	051766	CNFH	Late Fall	2003
3/8/2007	Barrier Weir Trap	Chinook	F	82	051768	CNFH	Late Fall	2003
3/9/2007	Barrier Weir Trap	Chinook	F	87	051764	CNFH	Late Fall	2003
3/9/2007	Barrier Weir Trap	Chinook	F	80	NTD			
3/9/2007	Barrier Weir Trap	Chinook	F	86	051766	CNFH	Late Fall	2003
3/9/2007	Barrier Weir Trap	Chinook	M	70	052287	CNFH	Late Fall	2004
3/9/2007	Barrier Weir Trap	Chinook	F	92	051766	CNFH	Late Fall	2003
3/9/2007	Barrier Weir Trap	Chinook	F	73	051766	CNFH	Late Fall	2003
3/9/2007	Barrier Weir Trap	Chinook	F	88	051765	CNFH	Late Fall	2003
3/9/2007	Barrier Weir Trap	Chinook	F	86	NTD			
3/9/2007	Barrier Weir Trap	Chinook	M	94	051770	CNFH	Late Fall	2003
3/9/2007	Barrier Weir Trap	Chinook	F	83	051776	CNFH	Late Fall	2003
3/9/2007	Barrier Weir Trap	Chinook	F	88	051776	CNFH	Late Fall	2003
3/9/2007	Barrier Weir Trap	Chinook	F	90	051769	CNFH	Late Fall	2003
3/9/2007	Barrier Weir Trap	Chinook	F	80	051777	CNFH	Late Fall	2003
3/9/2007	Barrier Weir Trap	Chinook	F	77	052273	CNFH	Late Fall	2004
3/9/2007	Barrier Weir Trap	Chinook	F	86	051766	CNFH	Late Fall	2003
3/10/2007	Barrier Weir Trap	Chinook	M	92	051766	CNFH	Late Fall	2003
3/10/2007	Barrier Weir Trap	Chinook	F	88	051775	CNFH	Late Fall	2003
3/10/2007	Barrier Weir Trap	Chinook	F	86	051766	CNFH	Late Fall	2003
3/10/2007	Barrier Weir Trap	Chinook	F	87	051775	CNFH	Late Fall	2003

APPENDIX A1—Continued

Collection date	Collection location and method	Species	Sex	Fork length (cm)	Tag code [a]	Hatchery or creek of origin [b]	Run	Brood year
3/10/2007	Barrier Weir Trap	Chinook	F	90	051776	CNFH	Late Fall	2003
3/11/2007	Barrier Weir Trap	Chinook	F	75	051770	CNFH	Late Fall	2003
3/11/2007	Barrier Weir Trap	Chinook	F	90	NTD			
3/11/2007	Barrier Weir Trap	Chinook	M	92	051769	CNFH	Late Fall	2003
3/11/2007	Barrier Weir Trap	Chinook	M	80	052278	CNFH	Late Fall	2004
3/11/2007	Barrier Weir Trap	Chinook	F	83	NTD			
3/11/2007	Barrier Weir Trap	Chinook	F	88	051768	CNFH	Late Fall	2003
3/11/2007	Barrier Weir Trap	Chinook	M	98	051765	CNFH	Late Fall	2003
3/11/2007	Barrier Weir Trap	Chinook	F	79	051770	CNFH	Late Fall	2003
3/12/2007	Barrier Weir Trap	Chinook	F	92	051777	CNFH	Late Fall	2003
3/12/2007	Barrier Weir Trap	Chinook	F	85	051765	CNFH	Late Fall	2003
3/12/2007	Barrier Weir Trap	Chinook	M	93	051776	CNFH	Late Fall	2003
3/12/2007	Barrier Weir Trap	Chinook	F	71	051770	CNFH	Late Fall	2003
3/12/2007	Barrier Weir Trap	Chinook	F	87	051766	CNFH	Late Fall	2003
3/12/2007	Barrier Weir Trap	Chinook	M	100	051777	CNFH	Late Fall	2003
3/12/2007	Barrier Weir Trap	Chinook	F	84	Lost Tag			
3/12/2007	Barrier Weir Trap	Chinook	F	78	052286	CNFH	Late Fall	2004
3/12/2007	Barrier Weir Trap	Chinook	F	80	051766	CNFH	Late Fall	2003
3/12/2007	Barrier Weir Trap	Chinook	F	90	051777	CNFH	Late Fall	2003
3/13/2007	Barrier Weir Trap	Chinook	F	76	051775	CNFH	Late Fall	2003
3/13/2007	Barrier Weir Trap	Chinook	F	90	051777	CNFH	Late Fall	2003

APPENDIX A1—Continued

Collection date	Collection location and method	Species	Sex	Fork length (cm)	Tag code [a]	Hatchery or creek of origin [b]	Run	Brood year
3/13/2007	Barrier Weir Trap	Chinook	M	93	051766	CNFH	Late Fall	2003
3/13/2007	Barrier Weir Trap	Chinook	F	88	051766	CNFH	Late Fall	2003
3/13/2007	Barrier Weir Trap	Chinook	F	90	051776	CNFH	Late Fall	2003
3/13/2007	Barrier Weir Trap	Chinook	M	57	051764	CNFH	Late Fall	2003
3/13/2007	Barrier Weir Trap	Chinook	F	87.5	051776	CNFH	Late Fall	2003
3/13/2007	Barrier Weir Trap	Chinook	M	95.5	051775	CNFH	Late Fall	2003
3/14/2007	Barrier Weir Trap	Chinook	M	79	052278	CNFH	Late Fall	2004
3/14/2007	Barrier Weir Trap	Chinook	F	92.5	051777	CNFH	Late Fall	2003
3/14/2007	Barrier Weir Trap	Chinook	F	71	052278	CNFH	Late Fall	2004
3/14/2007	Barrier Weir Trap	Chinook	F	71	051770	CNFH	Late Fall	2003
3/14/2007	Barrier Weir Trap	Chinook	F	88.5	051776	CNFH	Late Fall	2003
3/14/2007	Barrier Weir Trap	Chinook	F	92	051777	CNFH	Late Fall	2003
3/14/2007	Barrier Weir Trap	Chinook	F	77	052286	CNFH	Late Fall	2004
3/15/2007	Barrier Weir Trap	Chinook	F	88	051768	CNFH	Late Fall	2003
3/15/2007	Barrier Weir Trap	Chinook	M	98	051776	CNFH	Late Fall	2003
3/15/2007	Barrier Weir Trap	Chinook	M	94	051764	CNFH	Late Fall	2003
3/15/2007	Barrier Weir Trap	Chinook	F	90	051764	CNFH	Late Fall	2003
3/15/2007	Barrier Weir Trap	Chinook	F	88	051775	CNFH	Late Fall	2003
3/15/2007	Barrier Weir Trap	Chinook	F	86	051777	CNFH	Late Fall	2003
3/15/2007	Barrier Weir Trap	Chinook	F	90.5	051776	CNFH	Late Fall	2003
3/15/2007	Barrier Weir Trap	Chinook	F	87	051770	CNFH	Late Fall	2003

APPENDIX A1—Continued

Collection date	Collection location and method	Species	Sex	Fork length (cm)	Tag code [a]	Hatchery or creek of origin [b]	Run	Brood year
3/16/2007	Barrier Weir Trap	Chinook	M	95	051775	CNFH	Late Fall	2003
3/16/2007	Barrier Weir Trap	Chinook	M	93	051770	CNFH	Late Fall	2003
3/16/2007	Barrier Weir Trap	Chinook	F	75.5	051775	CNFH	Late Fall	2003
3/16/2007	Barrier Weir Trap	Chinook	F	86	051765	CNFH	Late Fall	2003
3/16/2007	Barrier Weir Trap	Chinook	F	71	051766	CNFH	Late Fall	2003
3/17/2007	Barrier Weir Trap	Chinook	F	96.5	051770	CNFH	Late Fall	2003
3/17/2007	Barrier Weir Trap	Chinook	F	90	051770	CNFH	Late Fall	2003
3/18/2007	Barrier Weir Trap	Chinook	M	90	051777	CNFH	Late Fall	2003
3/19/2007	Barrier Weir Trap	Chinook	F	92	051777	CNFH	Late Fall	2003
3/19/2007	Barrier Weir Trap	Chinook	F	77	NTD	CNFH		
3/19/2007	Barrier Weir Trap	Chinook	F	86	051770	CNFH	Late Fall	2003
3/19/2007	Barrier Weir Trap	Chinook	F	91	051776	CNFH	Late Fall	2003
3/19/2007	Barrier Weir Trap	Chinook	F	89	051775	CNFH	Late Fall	2003
3/19/2007	Barrier Weir Trap	Chinook	F	85.5	NTD			
3/19/2007	Barrier Weir Trap	Chinook	F	89.5	NTD			
3/19/2007	Barrier Weir Trap	Chinook	M	10	051777	CNFH	Late Fall	2003
3/19/2007	Barrier Weir Trap	Chinook	F	89.5	051769	CNFH	Late Fall	2003
3/20/2007	Barrier Weir Trap	Chinook	F	89.5	051776	CNFH	Late Fall	2003
3/20/2007	Barrier Weir Trap	Chinook	F	79.5	NTD			
3/20/2007	Barrier Weir Trap	Chinook	M	50	052278	CNFH	Late Fall	2004
3/20/2007	Barrier Weir Trap	Chinook	M	91	051766	CNFH	Late Fall	2003

APPENDIX A1—Continued

Collection date	Collection location and method	Species	Sex	Fork length (cm)	Tag code [a]	Hatchery or creek of origin [b]	Run	Brood year
3/20/2007	Barrier Weir Trap	Chinook	M	97	051776	CNFH	Late Fall	2003
3/20/2007	Barrier Weir Trap	Chinook	M	94.5	NTD			
3/20/2007	Barrier Weir Trap	Chinook	F	82.5	051776	CNFH	Late Fall	2003
3/20/2007	Barrier Weir Trap	Chinook	F	85	051768	CNFH	Late Fall	2003
3/20/2007	Barrier Weir Trap	Chinook	F	94	051776	CNFH	Late Fall	2003
3/22/2007	Barrier Weir Trap	Chinook	M	96.5	051765	CNFH	Late Fall	2003
3/21/2007	Barrier Weir Trap	Chinook	F	88	051776	CNFH	Late Fall	2003
3/22/2007	Barrier Weir Trap	Chinook	F	90	051776	CNFH	Late Fall	2003
3/22/2007	Barrier Weir Trap	Chinook	F	68.5	052278	CNFH	Late Fall	2004
3/23/2007	Barrier Weir Trap	Chinook	F	90.5	051777	CNFH	Late Fall	2003
3/23/2007	Barrier Weir Trap	Chinook	F	91	051776	CNFH	Late Fall	2003
3/24/2007	Barrier Weir Trap	Chinook	M	85	052294	CNFH	Late Fall	2004
3/24/2007	Barrier Weir Trap	Chinook	F	92.5	051770	CNFH	Late Fall	2003
3/25/2007	Barrier Weir Trap	Chinook	M	810	051775	CNFH	Late Fall	2003
3/25/2007	Barrier Weir Trap	Chinook	F	90.5	051766	CNFH	Late Fall	2003
3/25/2007	Barrier Weir Trap	Chinook	F	90.5	051775	CNFH	Late Fall	2003
3/25/2007	Barrier Weir Trap	Chinook	F	79.5	051165	CNFH	Late Fall	2002
3/25/2007	Barrier Weir Trap	Chinook	F	84	051766	CNFH	Late Fall	2003
3/25/2007	Barrier Weir Trap	Chinook	F	89.5	051776	CNFH	Late Fall	2003
3/26/2007	Barrier Weir Trap	Chinook	F	85	051775	CNFH	Late Fall	2003
3/26/2007	Barrier Weir Trap	Chinook	F	96	051775	CNFH	Late Fall	2003

APPENDIX A1—Continued

Collection date	Collection location and method	Species	Sex	Fork length (cm)	Tag code [a]	Hatchery or creek of origin [b]	Run	Brood year
3/27/2007	Barrier Weir Trap	Chinook	F	85	051777	CNFH	Late Fall	2003
3/27/2007	Barrier Weir Trap	Chinook	F	90.5	051776	CNFH	Late Fall	2003
3/27/2007	Barrier Weir Trap	Chinook	F	88	051099	CNFH	Late Fall	2002
3/27/2007	Barrier Weir Trap	Chinook	F	88	051776	CNFH	Late Fall	2003
3/27/2007	Barrier Weir Trap	Chinook	F	90	051765	CNFH	Late Fall	2003
3/29/2007	Barrier Weir Trap	Chinook	M	88.5	051775	CNFH	Late Fall	2003
3/30/2007	Barrier Weir Trap	Chinook	F	64	051770	CNFH	Late Fall	2003
3/31/2007	Barrier Weir Trap	Chinook	M	91.5	051768	CNFH	Late Fall	2003
4/1/2007	Barrier Weir Trap	Chinook	F	84.5	051765	CNFH	Late Fall	2003
4/3/2007	Barrier Weir Trap	Chinook	M	79.5	055139	CNFH	Late Fall	2002
4/3/2007	Barrier Weir Trap	Chinook	M	107	051777	CNFH	Late Fall	2003
4/4/2007	Barrier Weir Trap	Chinook	F	86.5	051777	CNFH	Late Fall	2003
4/5/2007	Barrier Weir Trap	Chinook	F	93.5	051776	CNFH	Late Fall	2003
4/6/2007	Barrier Weir Trap	Chinook	F	86	051766	CNFH	Late Fall	2003
4/8/2007	Barrier Weir Trap	Chinook	F	85	051774	CNFH	Late Fall	2003
4/8/2007	Barrier Weir Trap	Chinook	M	52	052782	CNFH	Late Fall	2005
4/12/2007	Barrier Weir Trap	Chinook	F	88	051765	CNFH	Late Fall	2003
4/14/2007	Barrier Weir Trap	Chinook	F	82	051775	CNFH	Late Fall	2003
4/16/2007	Barrier Weir Trap	Chinook	F	76.5	052278	CNFH	Late Fall	2004
4/17/2007	Barrier Weir Trap	Chinook	F	93.5	051775	CNFH	Late Fall	2003

[a] NTD means No Tag Detected.

[b] Hatcheries include Coleman National Fish Hatchery (CNFH), Livingston Stone National Fish Hatchery (LSFH), and Feather River Fish Hatchery (FRH).

APPENDIX A2-Table of Correlation Coefficients (r) based on simple linear relationships between independent variables and dependant variables. Independent variables include Mean Monthly Temperature (MMT) and Mean Monthly Flow (MMF) at two locations. MMF was transformed to its natural logarithm for correlation with "redd per female."

Lower Battle Creek	Redds per female	Juveniles per redd	Juveniles per female
MMT May	-0.754	-0.180	-0.428
MMT June	-0.677	-0.515	-0.876
MMT July	-0.589	-0.735	-0.866
MMT August	-0.622	-0.493	-0.891
MMT September	-0.584	-0.390	-0.582
MMT October	-0.083	0.298	-0.487
MMT November		-0.319	0.463
MMT December		-0.841	-0.937
MMT January		-0.722	-0.025
MMT February		0.249	0.200
MMF May	0.779	0.526	0.457
MMF June	0.**783**	0.480	0.620
MMF July	0.699	0.683	0.791
MMF August	0.644	0.653	0.901
MMF September	0.614	0.796	**0.951**
MMF October	0.363	0.908	0.940
MMF November		0.468	0.872
MMF December		-0.771	-0.666
MMF January		**-0.991**	-0.221
MMF February		0.243	0.548
Middle Battle Creek			
MMT May	-0.793	-0.294	-0.737
MMT June	-0.792	-0.826	-0.990
MMT July	-0.229	-0.985	-0.701
MMT August	-0.664	-0.626	-0.786
MMT September	-0.389	-0.446	-0.351
MMT October	-0.131	0.194	0.087
MMT November		-0.270	-0.617
MMT December		-0.878	-0.743
MMT January		-0.501	-0.359
MMT February		0.285	-0.385
MMF May	0.684	0.433	0.921
MMF June	0.713	0.538	0.961
MMF July	0.365	0.764	0.844
MMF August	0.684	0.767	0.919
MMF September	0.544	0.734	0.663
MMF October	0.392	0.594	0.461
MMF November		0.428	0.345
MMF December		-0.907	-0.402
MMF January		-0.985	-0.644
MMF February		0.299	0.849

APPENDIX A3-Chinook redd measurements taken during USFWS Battle Creek snorkel surveys in 2007.

Date	Reach	Max Length (ft)	Max Width (ft)	Area (ft^2)	Depth: Pre-redd (ft)	Depth: Pit (ft)	Depth: Tailspill (ft)	Velocity (ft/s)	Substrate code[a]
9/18/2007	2	14.58	7.08	81.13	1.33	1.92	0.92	0.95	1.3
9/18/2007	3	18.25	8.50	121.83	0.71	1.00	0.29	1.51	2.4
9/18/2007	3	5.58	4.00	17.54	0.77	1.18	0.33	1.34	2.4
9/18/2007	3	9.08	3.92	27.94	1.17	1.58	1.08	1.80	2.4
9/20/2007	5	11.25	6.33	55.96	1.92	2.42	1.50	1.56	1.3
9/20/2007	5	6.42	5.58	28.14	1.33	1.92	0.83	2.18	1.3
10/1/2007	1	7.33	2.50	14.40	1.08	1.50	0.50	1.32	2.3
10/1/2007	1	8.67	4.33	29.50	1.25	1.83	1.17	2.01	2.4
10/1/2007	1	10.17	4.42	35.27	0.83	1.33	0.75	1.50	1.3
10/1/2007	1	16.92	7.42	98.54	0.83	1.17	0.50	1.55	2.4
10/1/2007	1	17.50	5.92	81.32	0.83	1.17	0.58	2.22	2.4
10/1/2007	1	16.75	6.50	85.51	1.54	2.13	1.21	1.41	2.3
10/2/2007	2	7.00	6.50	35.74	1.67	1.83	0.67	1.18	2.4
10/2/2007	2	15.00	5.83	68.72	2.33	3.08	1.42	0.93	2.4
10/2/2007	2	17.33	12.17	165.63	2.92	3.00	1.42	1.97	1.3
10/2/2007	2	27.92	6.42	140.69	1.42	2.17	0.67	2.33	2.4
10/2/2007	2	21.67	7.00	119.12	1.67	2.67	1.08	1.92	1.3
10/2/2007	2	37.92	11.67	347.43	2.42	2.92	0.42	0.98	1.3
10/2/2007	2	18.33	8.75	125.99	2.33	2.58	0.83	0.68	1.3
10/2/2007	2	26.92	13.33	281.87	0.33	1.08	0.42	2.78	1.3
10/2/2007	2	16.67	7.92	103.63	1.42	1.75	0.75	1.74	1.3
10/2/2007	2	16.17	10.00	126.97	1.25	1.33	0.33	2.22	1.3
10/2/2007	2	27.50	12.92	278.98	1.25	2.58	0.83	0.74	2.3
10/2/2007	2	6.50	4.25	21.70	1.04	1.33	0.75	1.79	1.3
10/2/2007	2	7.83	3.83	23.58	0.83	1.42	0.92	3.33	2.3
10/2/2007	2	21.83	9.67	165.76	2.33	2.17	0.50	0.96	1.2
10/2/2007	2	17.42	13.67	186.95	2.08	2.25	0.08	1.34	3.5
10/2/2007	2	22.75	12.42	221.86	2.25	2.17	0.58	0.13	1.2
10/2/2007	2	16.75	13.08	172.12	2.00	2.25	0.33	1.01	2.4
10/2/2007	2	15.33	19.25	231.82	2.58	2.75	0.75	1.67	2.4
10/2/2007	2	15.17	16.25	193.57	2.50	2.75	0.50	1.83	1.3
10/2/2007	2	7.25	4.75	27.05	1.33	1.79	0.50	1.70	1.2
10/2/2007	2	11.25	4.92	43.44	1.67	2.83	2.75	2.41	1.3
10/2/2007	2	7.75	7.92	48.19	1.08	1.67	0.33	1.64	1.2
10/2/2007	2	6.92	2.42	13.13	0.58	1.17	0.50	1.79	1.2
10/2/2007	2	5.42	2.83	12.05	1.00	1.46	0.67	2.06	1.3
10/2/2007	2	15.67	11.25	138.43	1.00	1.75	0.33	1.00	1.2
10/2/2007	2	14.00	9.92	109.04	2.33	2.83	0.75	1.01	1.2
10/3/2007	3	18.33	22.50	323.98	1.63	2.33	1.33	1.24	2.4
10/3/2007	3	7.92	10.00	62.18	1.42	1.58	1.17	1.82	1.3
10/3/2007	3	10.58	5.50	45.72	0.67	1.17	0.25	1.70	2.4
10/3/2007	3	9.83	5.17	39.90	1.17	1.42	0.79	0.94	1.3
10/3/2007	3	10.00	6.50	51.05	0.83	1.17	0.71	1.07	2.4
10/3/2007	3	9.92	8.33	64.90	0.71	1.08	0.21	1.30	1.3
10/3/2007	3	12.50	9.58	94.08	1.25	1.88	1.29	3.54	2.3
10/3/2007	3	18.17	8.17	116.52	1.25	1.58	0.75	1.36	2.4
10/3/2007	3	9.25	9.50	69.02	1.33	1.50	0.42	0.56	2.4
10/3/2007	3	13.17	5.67	58.60	1.50	2.08	1.58	1.46	1.3
10/3/2007	3	17.50	8.50	116.83	1.08	1.50	0.50	2.44	2.4
10/3/2007	3	14.67	7.67	88.31	1.00	2.25	0.75	2.43	2.4

APPENDIX A3—Continued

Date	Reach	Max Length (ft)	Max Width (ft)	Area (ft^2)	Depth: Pre-redd (ft)	Depth: Pit (ft)	Depth: Tailspill (ft)	Velocity (ft/s)	Substrate code[a]
10/3/2007	3	15.08	7.42	87.86	1.25	1.50	0.50	1.10	1.2
10/4/2007	4	13.75	5.75	62.10	1.33	1.58	0.83	1.25	2.4
10/4/2007	4	13.08	9.42	96.76	1.33	1.67	0.33	0.64	2.4
10/4/2007	4	15.00	8.50	100.14	2.17	1.75	0.42	0.86	2.4
10/4/2007	4	9.67	3.42	25.94	0.83	1.58	1.42	1.80	2.4
10/4/2007	4	15.67	8.92	109.72	1.33	1.33	0.42	0.88	2.4
10/4/2007	4	20.00	6.58	103.41	2.00	2.38	1.58	1.23	1.3
10/4/2007	4	18.75	9.08	133.76	1.17	2.00	0.58	1.28	1.3
10/4/2007	4	20.83	9.67	158.17	1.08	1.75	0.83	2.10	2.4
10/4/2007	4	17.42	4.92	67.26	2.17	2.58	1.75	5.24	2.4
10/4/2007	4	21.17	11.08	184.25	2.17	3.00	1.25	1.75	3.5
10/4/2007	4	21.75	8.50	145.20	1.67	2.33	0.33	0.85	1.2
10/4/2007	4	9.17	4.50	32.40	0.75	1.08	0.67	1.67	2.4
10/4/2007	4	19.42	13.83	210.96	0.92	1.50	0.50	1.17	1.2
10/4/2007	4	22.33	9.58	168.10	0.83	1.17	0.50	1.18	2.3
10/4/2007	4	22.50	13.08	231.20	1.08	1.92	0.33	1.43	2.4
10/4/2007	4	11.08	4.58	39.90	1.33	1.75	1.17	1.54	1.3
10/4/2007	4	8.75	7.83	53.83	1.50	1.50	0.67	1.92	2.4
10/4/2007	4	12.17	7.33	70.07	2.25	2.58	1.71	1.81	1.2
10/4/2007	4	15.75	8.17	101.02	2.25	2.50	1.17	1.84	2.4
10/4/2007	4	24.83	10.00	195.04	1.58	2.50	1.25	2.04	3.5
10/4/2007	4	8.67	5.42	36.87	2.00	2.17	1.33	1.74	3.5
10/4/2007	4	21.25	8.00	133.52	1.50	1.92	0.75	2.52	3.4
10/4/2007	4	21.08	6.08	100.73	2.08	2.42	1.08	1.10	1.2
10/4/2007	4	7.67	5.75	34.62	2.25	2.67	1.92	1.58	2.4
10/4/2007	4	12.67	7.67	76.27	2.42	2.67	2.25	1.31	2.4
10/4/2007	5	5.08	3.58	14.31	1.42	1.67	0.92	1.43	1.2
10/4/2007	5	8.17	4.92	31.54	1.33	1.75	1.25	1.78	1.3
10/4/2007	5	3.83	4.17	12.54	2.67	2.83	1.67	1.74	1.3
10/16/2007	2	13.25	4.50	46.83	2.21	2.54	1.08	0.97	2.4
10/16/2007	2	17.83	13.17	184.42	1.42	1.92	0.21	0.27	2.3
10/16/2007	2	19.17	6.67	100.36	2.92	3.17	0.75	1.10	2.4
10/16/2007	2	12.92	5.42	54.95	2.17	2.50	1.17	1.80	2.4
10/16/2007	2	11.25	7.08	62.59	2.08	2.25	1.50	2.18	1.3
10/16/2007	2	16.50	6.50	84.23	1.75	2.08	0.58	2.86	2.4
10/16/2007	2	10.50	6.00	49.48	1.75	2.00	1.92	1.32	2.4
10/16/2007	2	12.33	8.67	83.95	3.13	3.42	2.00	0.88	2.4
10/16/2007	2	20.00	8.33	130.90	1.92	2.08	1.17	2.25	2.4
10/16/2007	2	9.58	5.42	40.77	1.58	2.08	0.83	1.23	2.4
10/16/2007	2	15.50	10.92	132.90	1.42	2.04	0.79	1.84	2.4
10/16/2007	2	9.92	4.83	37.64	1.42	1.83	0.83	1.25	1.2
10/16/2007	2	14.17	5.83	64.90	2.08	2.08	1.00	1.26	2.4
10/16/2007	2	13.75	5.58	60.30	1.58	2.25	0.92	2.75	1.2
10/16/2007	2	8.75	5.50	37.80	1.08	1.33	0.75	1.85	2.4
10/16/2007	2	21.67	7.92	134.72	1.83	2.00	1.17	1.20	1.3
10/17/2007	3	15.92	13.08	163.55	1.71	2.00	0.54	1.59	2.4
10/17/2007	3	7.08	5.42	30.13	1.08	2.50	1.33	1.91	2.3
10/17/2007	3	13.92	5.00	54.65	1.75	2.00	0.75	1.49	1.3
10/17/2007	3	18.67	5.67	83.08	0.63	1.08	0.33	1.13	1.2
10/17/2007	4	17.58	8.50	117.38	1.00	1.50	0.75	1.69	2.4
10/18/2007	5	7.92	6.67	41.45	0.83	1.50	0.33	2.16	1.3
10/30/2007	2	6.67	2.92	15.27	1.08	1.58	0.75	1.25	1.3

APPENDIX A3—Continued

Date	Reach	Max Length (ft)	Max Width (ft)	Area (ft^2)	Depth: Pre-redd (ft)	Depth: Pit (ft)	Depth: Tailspill (ft)	Velocity (ft/s)	Substrate code[a]
Average		14.41	7.74	96.48	1.53	1.96	0.88	1.60	2.3[b]
Minimum		3.83	2.42	12.05	0.33	1.00	0.08	0.13	1.2
Maximum		37.92	22.50	347.43	3.13	3.42	2.75	5.24	3.5

[a] Dominant substrate codes are described by USFWS (2005)and are generally defined as follows; 1=1 in., 2.3= 2-3 in., 3.5=3-5 in., etc.
[b] The median substrate code was used instead of average

APPENDIX A4-Estimated number of days that egg incubation fell within the five water-temperature suitability categories for each spring Chinook redd in 2007. The incubation period was calculated using a cumulative 1,850 Daily Temperature Units (DTU). Days listed under 'B' and 'W' are the best-case scenarios and worst-case scenarios, respectively.

Location	Reach	River Mile	Date	Very Poor		Poor		Fair		Good		Excellent		Total Days	
				B	W	B	W	B	W	B	W	B	W	B	W
North Fork	1	3.82	10/1/2007	0	0	0	0	0	0	0	0	102	96	**102**	**96**
North Fork	1	3.82	10/1/2007	0	0	0	0	0	0	0	0	102	96	**102**	**96**
North Fork	1	3.26	10/1/2007	0	0	0	0	0	0	0	0	103	96	**103**	**96**
North Fork	1	3.26	10/1/2007	0	0	0	0	0	0	0	0	103	96	**103**	**96**
North Fork	1	3.26	10/1/2007	0	0	0	0	0	0	0	0	103	96	**103**	**96**
North Fork	1	2.88	10/1/2007	0	0	0	0	0	0	0	0	103	97	**103**	**97**
North Fork	2	1.41	9/18/2007	0	0	0	0	0	7	0	4	106	82	**106**	**93**
North Fork	2	2.37	10/2/2007	0	0	0	0	0	0	0	0	105	98	**105**	**98**
North Fork	2	2.28	10/2/2007	0	0	0	0	0	0	0	0	106	99	**106**	**99**
North Fork	2	2.08	10/2/2007	0	0	0	0	0	0	0	0	107	101	**107**	**101**
North Fork	2	2.02	10/2/2007	0	0	0	0	0	0	0	0	107	101	**107**	**101**
North Fork	2	1.82	10/2/2007	0	0	0	0	0	0	0	0	106	102	**106**	**102**
North Fork	2	1.75	10/2/2007	0	0	0	0	0	0	0	0	107	103	**107**	**103**
North Fork	2	1.71	10/2/2007	0	0	0	0	0	0	0	0	107	103	**107**	**103**
North Fork	2	1.64	10/2/2007	0	0	0	0	0	0	0	0	110	104	**110**	**104**
North Fork	2	1.64	10/2/2007	0	0	0	0	0	0	0	0	110	104	**110**	**104**
North Fork	2	1.64	10/2/2007	0	0	0	0	0	0	0	0	110	104	**110**	**104**
North Fork	2	1.64	10/2/2007	0	0	0	0	0	0	0	0	110	104	**110**	**104**
North Fork	2	1.61	10/2/2007	0	0	0	0	0	0	0	0	110	109	**110**	**109**
North Fork	2	1.40	10/2/2007	0	0	0	0	0	0	0	0	112	106	**112**	**106**
North Fork	2	1.36	10/2/2007	0	0	0	0	0	0	0	0	112	106	**112**	**106**
North Fork	2	1.28	10/2/2007	0	0	0	0	0	0	0	0	113	107	**113**	**107**
North Fork	2	1.11	10/2/2007	0	0	0	0	0	0	0	0	114	108	**114**	**108**
North Fork	2	1.01	10/2/2007	0	0	0	0	0	0	0	0	115	109	**115**	**109**
North Fork	2	1.01	10/2/2007	0	0	0	0	0	0	0	0	115	109	**115**	**109**
North Fork	2	1.01	10/2/2007	0	0	0	0	0	0	0	0	115	109	**115**	**109**
North Fork	2	0.88	10/2/2007	0	0	0	0	0	0	0	3	101	90	**101**	**93**
North Fork	2	0.88	10/2/2007	0	0	0	0	0	0	0	3	101	90	**101**	**93**
North Fork	2	0.88	10/2/2007	0	0	0	0	0	0	0	3	101	90	**101**	**93**
North Fork	2	0.88	10/2/2007	0	0	0	0	0	0	0	3	101	90	**101**	**93**
North Fork	2	0.72	10/2/2007	0	0	0	0	0	0	0	3	102	90	**102**	**93**
North Fork	2	0.72	10/2/2007	0	0	0	0	0	0	0	3	102	90	**102**	**93**
North Fork	2	0.61	10/2/2007	0	0	0	0	0	0	0	3	102	91	**102**	**94**
North Fork	2	0.55	10/2/2007	0	0	0	0	0	0	0	3	102	91	**102**	**94**
North Fork	2	0.53	10/2/2007	0	0	0	0	0	0	0	3	102	91	**102**	**94**
North Fork	2	0.48	10/2/2007	0	0	0	0	0	0	0	3	102	91	**102**	**94**
North Fork	2	0.44	10/2/2007	0	0	0	0	0	0	0	3	103	91	**103**	**94**
North Fork	2	0.41	10/2/2007	0	0	0	0	0	0	0	3	103	91	**103**	**94**
North Fork	2	0.40	10/2/2007	0	0	0	0	0	0	0	3	103	91	**103**	**94**
North Fork	2	0.40	10/2/2007	0	0	0	0	0	0	0	3	103	91	**103**	**94**

APPENDIX A4—Continued

Location	Reach	River Mile	Date	Very Poor		Poor		Fair		Good		Excellent		Total Days	
				B	W	B	W	B	W	B	W	B	W	B	W
North Fork	2	0.27	10/2/2007	0	0	0	0	0	0	0	3	103	92	**103**	**95**
North Fork	2	0.15	10/2/2007	0	0	0	0	0	0	0	3	103	92	**103**	**95**
North Fork	2	0.15	10/2/2007	0	0	0	0	0	0	0	3	103	92	**103**	**95**
North Fork	2	2.29	10/16/2007	0	0	0	0	0	0	0	0	113	106	**113**	**106**
North Fork	2	2.28	10/16/2007	0	0	0	0	0	0	0	0	113	107	**113**	**107**
North Fork	2	2.28	10/16/2007	0	0	0	0	0	0	0	0	113	107	**113**	**107**
North Fork	2	2.28	10/16/2007	0	0	0	0	0	0	0	0	113	107	**113**	**107**
North Fork	2	2.28	10/16/2007	0	0	0	0	0	0	0	0	113	107	**113**	**107**
North Fork	2	2.26	10/16/2007	0	0	0	0	0	0	0	0	113	107	**113**	**107**
North Fork	2	2.23	10/16/2007	0	0	0	0	0	0	0	0	113	107	**113**	**107**
North Fork	2	2.23	10/16/2007	0	0	0	0	0	0	0	0	113	107	**113**	**107**
North Fork	2	2.08	10/16/2007	0	0	0	0	0	0	0	0	114	108	**114**	**108**
North Fork	2	1.95	10/16/2007	0	0	0	0	0	0	0	0	115	109	**115**	**109**
North Fork	2	1.83	10/16/2007	0	0	0	0	0	0	0	0	116	110	**116**	**110**
North Fork	2	1.83	10/16/2007	0	0	0	0	0	0	0	0	116	110	**116**	**110**
North Fork	2	1.82	10/16/2007	0	0	0	0	0	0	0	0	116	110	**116**	**110**
North Fork	2	1.82	10/16/2007	0	0	0	0	0	0	0	0	116	110	**116**	**110**
North Fork	2	1.75	10/16/2007	0	0	0	0	0	0	0	0	116	111	**116**	**111**
North Fork	2	1.66	10/16/2007	0	0	0	0	0	0	0	0	117	111	**117**	**111**
North Fork	2	1.66	10/16/2007	0	0	0	0	0	0	0	0	117	111	**117**	**111**
North Fork	2	1.65	10/16/2007	0	0	0	0	0	0	0	0	117	111	**117**	**111**
North Fork	2	1.65	10/16/2007	0	0	0	0	0	0	0	0	117	111	**117**	**111**
North Fork	2	1.61	10/16/2007	0	0	0	0	0	0	0	0	117	111	**117**	**111**
North Fork	2	1.40	10/16/2007	0	0	0	0	0	0	0	0	118	113	**118**	**113**
North Fork	2	1.36	10/16/2007	0	0	0	0	0	0	0	0	118	113	**118**	**113**
North Fork	2	1.26	10/16/2007	0	0	0	0	0	0	0	0	119	114	**119**	**114**
North Fork	2	1.26	10/16/2007	0	0	0	0	0	0	0	0	119	114	**119**	**114**
North Fork	2	1.15	10/16/2007	0	0	0	0	0	0	0	0	119	115	**119**	**115**
North Fork	2	1.00	10/16/2007	0	0	0	0	0	0	0	0	120	116	**120**	**116**
North Fork	2	1.00	10/16/2007	0	0	0	0	0	0	0	0	120	116	**120**	**116**
North Fork	2	1.00	10/16/2007	0	0	0	0	0	0	0	0	120	116	**120**	**116**
North Fork	2	1.00	10/16/2007	0	0	0	0	0	0	0	0	120	116	**120**	**116**
North Fork	2	0.92	10/16/2007	0	0	0	0	0	0	0	0	121	117	**121**	**117**
North Fork	2	0.92	10/16/2007	0	0	0	0	0	0	0	0	121	117	**121**	**117**
North Fork	2	0.87	10/16/2007	0	0	0	0	0	0	0	0	109	102	**109**	**102**
North Fork	2	0.85	10/16/2007	0	0	0	0	0	0	0	0	109	102	**109**	**102**
North Fork	2	0.60	10/16/2007	0	0	0	0	0	0	0	0	110	103	**110**	**103**
North Fork	2	2.11	10/30/2007	0	0	0	0	0	0	0	0	117	114	**117**	**114**
South Fork	3	2.22	9/18/2007	0	0	0	0	0	7	1	5	106	82	**107**	**94**
South Fork	3	2.11	9/18/2007	0	0	0	0	0	7	1	5	106	82	**107**	**94**

APPENDIX A4—Continued

Location	Reach	River Mile	Date	Very Poor		Poor		Fair		Good		Excellent		Total Days	
				B	W	B	W	B	W	B	W	B	W	B	W
South Fork	3	2.11	9/18/2007	0	0	0	0	0	7	1	5	106	82	**107**	**94**
South Fork	3	2.17	10/3/2007	0	0	0	0	0	0	0	0	119	109	**119**	**109**
South Fork	3	2.15	10/3/2007	0	0	0	0	0	0	0	0	120	109	**120**	**109**
South Fork	3	2.11	10/3/2007	0	0	0	0	0	0	0	0	120	109	**120**	**109**
South Fork	3	1.93	10/3/2007	0	0	0	0	0	0	0	0	121	110	**121**	**110**
South Fork	3	1.74	10/3/2007	0	0	0	0	0	0	0	0	123	111	**123**	**111**
South Fork	3	1.74	10/3/2007	0	0	0	0	0	0	0	0	123	111	**123**	**111**
South Fork	3	1.74	10/3/2007	0	0	0	0	0	0	0	0	123	111	**123**	**111**
South Fork	3	1.67	10/3/2007	0	0	0	0	0	0	0	0	123	111	**123**	**111**
South Fork	3	1.12	10/3/2007	0	0	0	0	0	0	0	0	121	109	**121**	**109**
South Fork	3	0.83	10/3/2007	0	0	0	0	0	0	0	0	120	109	**120**	**109**
South Fork	3	0.83	10/3/2007	0	0	0	0	0	0	0	0	120	109	**120**	**109**
South Fork	3	0.71	10/3/2007	0	0	0	0	0	0	0	0	120	108	**120**	**108**
South Fork	3	0.49	10/3/2007	0	0	0	0	0	0	0	0	120	108	**120**	**108**
South Fork	3	0.11	10/3/2007	0	0	0	0	0	0	0	0	118	107	**118**	**107**
South Fork	3	2.16	10/17/2007	0	0	0	0	0	0	0	0	126	121	**126**	**121**
South Fork	3	1.92	10/17/2007	0	0	0	0	0	0	0	0	128	126	**128**	**126**
South Fork	3	1.46	10/17/2007	0	0	0	0	0	0	0	0	129	124	**129**	**124**
South Fork	3	0.35	10/17/2007	0	0	0	0	0	0	0	0	127	121	**127**	**121**
Mainstem	4	16.60	10/4/2007	0	0	0	0	1	3	8	12	83	73	**92**	**88**
Mainstem	4	16.60	10/4/2007	0	0	0	0	1	3	8	12	83	73	**92**	**88**
Mainstem	4	16.51	10/4/2007	0	0	0	0	0	2	1	9	98	78	**99**	**89**
Mainstem	4	16.51	10/4/2007	0	0	0	0	0	2	1	9	98	78	**99**	**89**
Mainstem	4	16.50	10/4/2007	0	0	0	0	0	2	5	9	89	78	**94**	**89**
Mainstem	4	16.38	10/4/2007	0	0	0	0	0	0	1	10	100	81	**101**	**91**
Mainstem	4	16.27	10/4/2007	0	0	0	0	0	0	3	9	96	85	**99**	**94**
Mainstem	4	16.27	10/4/2007	0	0	0	0	0	0	2	9	103	85	**105**	**94**
Mainstem	4	16.27	10/4/2007	0	0	0	0	0	0	2	9	103	85	**105**	**94**
Mainstem	4	16.25	10/4/2007	0	0	0	0	0	0	0	8	104	86	**104**	**94**
Mainstem	4	16.05	10/4/2007	0	0	0	0	0	0	0	3	108	96	**108**	**99**
Mainstem	4	16.04	10/4/2007	0	0	0	0	0	0	0	3	109	96	**109**	**100**
Mainstem	4	15.98	10/4/2007	0	0	0	0	0	0	0	3	110	97	**110**	**99**
Mainstem	4	15.86	10/4/2007	0	0	0	0	0	0	0	3	109	96	**109**	**99**
Mainstem	4	15.86	10/4/2007	0	0	0	0	0	0	0	3	109	96	**109**	**99**
Mainstem	4	15.84	10/4/2007	0	0	0	0	0	0	0	5	109	92	**109**	**97**
Mainstem	4	14.82	10/4/2007	0	0	0	0	0	0	1	5	102	92	**103**	**97**
Mainstem	4	14.44	10/4/2007	0	0	0	0	0	0	0	5	107	91	**107**	**96**
Mainstem	4	14.44	10/4/2007	0	0	0	0	0	0	0	5	107	91	**107**	**96**
Mainstem	4	13.80	10/4/2007	0	0	0	0	0	0	3	9	97	86	**100**	**95**
Mainstem	4	13.80	10/4/2007	0	0	0	0	0	0	0	9	105	86	**105**	**95**
Mainstem	4	13.55	10/4/2007	0	0	0	0	0	0	0	9	105	85	**105**	**94**

APPENDIX A4—Continued

Location	Reach	River Mile	Date	Very Poor		Poor		Fair		Good		Excellent		Total Days	
				B	W	B	W	B	W	B	W	B	W	B	W
Mainstem	4	13.55	10/4/2007	0	0	0	0	0	0	0	0	0	0	**105**	**94**
Mainstem	4	13.25	10/4/2007	0	0	0	0	0	0	2	9	96	84	**98**	**93**
Mainstem	4	13.25	10/4/2007	0	0	0	0	0	0	2	9	96	84	**98**	**93**
Mainstem	4	12.92	10/4/2007	0	0	0	0	0	0	2	9	96	84	**98**	**93**
Mainstem	4	16.01	10/17/2007	0	0	0	0	0	0	0	0	118	109	**118**	**109**
Mainstem	5	11.93	9/20/2007	0	5	0	5	3	5	11	12	76	51	**90**	**78**
Mainstem	5	11.93	9/20/2007	0	5	0	5	3	5	11	12	76	51	**90**	**78**
Mainstem	5	11.92	10/4/2007	0	0	0	0	0	3	2	11	99	76	**101**	**90**
Mainstem	5	11.92	10/4/2007	0	0	0	0	0	3	2	11	99	76	**101**	**90**
Mainstem	5	10.44	10/4/2007	0	0	0	0	0	10	6	8	92	68	**98**	**86**
Mainstem	5	11.92	10/18/2007	0	0	0	0	0	0	0	2	112	100	**112**	**102**

Appendix B

(Previously unpublished weekly salmonid passage tables for the Coleman National Fish Hatchery barrier weir fish ladder from 1995-2000)

APPENDIX B1-Chinook salmon observed at and passed above the Coleman National Fish Hatchery barrier weir fish ladder in 1995. Passage estimates include estimated passage during hour nots video recorded.

Dates	Week number	Monitoring method	Hours of allowed passage	Hours of taped passage	Actual number clipped [a]	Actual number unclipped [a]	Actual number unknown [a]	Passage estimate: clipped	Passage estimate: unclipped
March 30-April 1	5	Video	36.3	17.8	2 [b]	0	0	4.08	0.00
April 2-8	6	Video	64.6	52.4	4	2	0	4.88	2.44
April 9-15	7	Video	79.1	47.6	4	3	0	6.65	4.99
April 16-22	8	Video	71.7	62.0	1	0	0	1.16	0.00
April 23-29	9	Video	144.2	78.0	2	2	0	3.70	3.70
April 30-May 6	10	Video	168.0	0.0	-	-	-	5.30 [c]	4.15 [d]
May 7-13	11	Video	168.0	0.0	-	-	-	5.30 [c]	4.15 [d]
May 14-20	12	Video	168.0	0.0	-	-	-	5.30 [c]	4.15 [d]
May 21-27	13	Video	78.7	44.0	3	2	0	5.36	3.58
May 28-June 3	14	Video	145.9	21.3	2	0	0	13.68	0.00
June 4-10	15	Video	168.0	132.8	5	4	1 [e]	7.59	5.06
June 11-17	16	Video	168.0	72.0	1	6	0	2.33	14.00
June 18-24	17	Video	168.0	144.0	6	7	0	7.00	8.17
June 25-30	18	Video	133.0	72.0	1	2	0	1.85	3.69
Additions									7 [f]
Total			1761.4	744.0	31	28	1	74	66

[a] The Actual Number Clipped, Unclipped, and Unknown were taken from USFWS 1996.
[b] A review of the data sheets done in 2007 indicated three clipped Chinook were observed instead of two as reported in USFWS 1996.
[c] Based on the total passage estimate for clipped Chinook reported in USFWS 1996, clipped fish for these weeks apparently were estimated to be the average of all the other weeks.
[d] Estimated passage of unclipped Chinook for these weeks may have been estimated to be the average of all the other weeks but this is unclear from USFWS 1996 and the total passage estimate could not be replicated.
[e] Based on USFWS 1996, this individual apparently was estimated to be a clipped fish.
[f] The complete estimation methods used by USFWS (1996) are unclear and the original estimated total for unclipped Chinook was 66. We could not replicate the original estimate and we could not account for 7 unclipped fish.

APPENDIX B2-Chinook salmon observed at and passed above the Coleman National Fish Hatchery barrier weir fish ladder in 1996. Passage estimates include estimated passage during hours no video recorded.

Dates	Week number	Monitoring method	Hours of allowed passage	Hours of taped passage	Actual number clipped	Actual number unclipped	Actual number unknown	Passage estimate: clipped	Passage estimate: unclipped
March 26-30	5	Video	130.0	128.0	3	1	0	3.05	1.02
March 31-April 6	6	Video	168.0	144.0	7	4	3	10.39	5.94
April 7-13	7	Video	168.0	168.0	9	1	2	10.80	1.20
April 14-20	8	Video	168.0	115.0	4	0	0	5.84	0.00
April 21-27	9	Video	168.0	137.0	15	0	0	18.39	0.00
April 28-May 4	10	Video	168.0	167.0	10	2	0	10.06	2.01
May 5-11	11	Video	168.0	168.0	7	1	0	7.00	1.00
May12-18	12	Video	168.0	20.0	2	0	0	16.80	0.00
May 19-25	13	Video	168.0	59.0	3	1	0	8.54	2.85
May 26-June 1	14	Video	168.0	126.0	15	4	0	20.00	5.33
June 2-8	15	Video	168.0	141.0	9	1	0	10.72	1.19
June 9-15	16	Video	168.0	153.0	13	3	0	14.27	3.29
June 16-22	17	Video	168.0	167.0	5	1	1	5.87	1.17
June 23-29	18	Video	168.0	144.0	8	5	0	9.33	5.83
June 30-July 1	19	Video	38.0	34.0	0	3	1	0.00	4.47
Total			2352.0	1871.0	110	27	7	151	35

APPENDIX B3-Chinook salmon observed at and passed above the Coleman National Fish Hatchery barrier weir fish ladder in 1996. Passage estimates include estimated passage during hours no video recorded

Dates	Week number	Monitoring method	Hours of allowed passage	Hours of taped passage	Actual number clipped	Actual number unclipped	Actual number unknown	Passage estimate: clipped	Passage estimate: unclipped
March 5-10	2 & 3	Video	114.5	80.4	33	3	1	48.32	4.39
March 11-15	3	Trap			10	0	0	0.00	0.00
March 16-22	4	Trap			33	3	4	3.67	3.33
March 23-29	5	Trap			4	1	1	0.80	1.20
March 30-April 5	6	Trap			6	2	0	0.00	2.00
April 6-12	7	Trap			0	1	0	0.00	1.00
April 13-19	8	Trap			21	2	1	0.91	2.09
April 20-26	9	Trap			23	2	6	5.52	2.48
April 27-May 3	10	Trap			5	2	0	0.00	2.00
May 4-9 [a]	11	Trap			0	1	1	0.00	2.00
May 12-17	12	Video	134.8	125.9	7	9	1	7.96	10.24
May 18-24	13	Video	168.0	167.6	11	11	1	11.53	11.53
May 25-31	14	Video	168.0	160.0	13	14	7	17.19	18.51
June 1-7	15	Video	168.0	131.1	4	11	1	5.47	15.04
June 8-14	16	Video	168.0	165.6	11	9	5	13.95	11.42
June 15-21	17	Video	168.0	143.2	6	4	3	9.15	6.10
June 22-28	18	Video	168.0	167.5	2	9	3	2.55	11.49
June 29-July 1	19	Video	56.8	31.8	1	1	1	2.68	2.68
Total			1314.1	1172.9	190	85	36	130	107

[a] No data sheets are available for May 10 and 11 prior to trap removal and video installation on May 12. Based on sampling protocols, passage was likely blocked on May 10 and 11.

APPENDIX B4- Chinook salmon observed at and passed above Coleman National Fish Hatchery barrier weir fish ladder and associated passage estimates for 1998.

Dates	Week number	Monitoring method	Hours of allowed passage	Hours of monitored passage	Actual number clipped	Actual number unclipped	Actual number unknown	Passage estimate: clipped	Passage estimate: unclipped
March 4-7	1	Trap [a]	86.3	86.3	13	1	5	4.64	1.36
March 8-14	2	Trap	168.0	168.0	38	2	4	3.80	2.20
March 15-21	3	Trap	168.0	168.0	14	1	3	2.80	1.20
March 22-28	4	Trap	168.0	16.5	0	0	0	11.32 [c]	1.19 [d]
March 29-April 4	5	Trap	168.0	168.0	5	1	1	0.83	1.17
April 5-11	6	Trap	168.0	144.0	3	1	0	0.50	1.17
April 12-18	7	Trap	168.0	168.0	2	3	3	1.20	4.80
April 19-25	8	Trap	168.0	168.0	3	11	7	1.50	16.50
April 26-May 2	9	Trap	168.0	151.5	4	6	5	2.65	9.98
May 3-9	10	Trap	168.0	126.5	1	3	4	1.66	7.97
May 10-16	11	Trap	168.0	98.2	0	0	0	2.47 [c]	6.27 [d]
May 17-23	12	Trap	168.0	147.5	1	2	3	1.28	4.56
May 24-30	13	Trap	168.0	31.5	0	0	0	2.49 [c]	18.46 [d]
May 31- June 1	14	Trap	34.4	0.0	0	0	0	0.56 [e]	6.73 [e]
June 1-6	14	Video [b]	131.0	84.9	1	12	5	2.13	25.62
June 7-13	15	Video	168.0	42.7	0	5	5	0.00	39.31
June 14-20	16	Video	168.0	88.0	0	1	5	0.00	11.46
June 21-28	17	Video	168.0	166.6	0	5	6	0.00	11.09
June 28-July 1	18	Video	79.9	79.5	0	4	3	0.00	7.04
Total			714.9 [f]	461.8 [f]	85	58	59	40	178

[a] Due to an unusual frequency of high flow events, the trap was either open (unmonitored passage allowed) or flooded (unmonitored passage likely) for 23.1% of the trapping period. In 1998, passage during the trapping period was estimated for unmonitored periods using the same methods as for video estimates.
[b] Video counts include observations made during poor video quality throughout the period 6/1/98-6/24/98. Including periods of poor video quality, only 65% of allowed passage time was recorded during the video monitoring period.
[c] Due to the minimal trap operation time in these weeks, passage of clipped fish was estimated as the average of the previous and following weeks, including fish which were captured but not passed.
[d] Due to the minimal trap operation time in these weeks, passage of unclipped fish was estimated as the average of the previous and following weeks.
[e] Due to the absence of trap data during Week 14, passaged-per-hour was estimated from the video portion of Week 14 and extrapolated to the trapping portion of Week 14.
[f] Totals only include the video period, as is standard in tables for other years.

APPENDIX B5- Chinook salmon observed at and passed above Coleman National Fish Hatchery barrier weir fish ladder and associated passage estimates for 1999. Passage estimates include estimated passage during hours not video recorded.

Dates	Week number	Monitoring method	Hours of passage	Hours of taped passage	Actual number clipped	Actual number unclipped	Actual number unknown	Passage estimate: clipped	Passage estimate: unclipped
March 9-13	2	Trap			12	0	0	0.00	0.00
March 14-20	3	Trap			22	0	0	0.00	0.00
March 21-27	4	Trap			16	0	0	0.00	0.00
March 28-April 3	5	Trap			0	2	0	0.00	2.00
April 4-10	6	Trap			1	1	0	0.00	1.00
April 11-17	7	Trap			6	1	0	0.00	1.00
April 18-24	8	Trap			3	1	0	0.00	1.00
April 25-May 1	9	Trap			1	2	0	0.00	2.00
May 2-8	10	Trap			2	0	0	0.00	0.00
May 9-15	11	Trap			0	0	0	0.00	0.00
May 16-22	12	Trap			0	0	0	0.00	0.00
May 23-26	13	Trap			0	0	0	0.00	0.00
May 26-29	13	Video	84.5	48.0	0	1	0	0.00	1.76
May 30-June 5	14	Video	168.0	167.9	1	7	0	1.00	7.00
June 6-12	15	Video	168.0	143.9	1	4	0	1.17	4.67
June 13-19	16	Video	168.0	150.8	0	18	0	0.00	20.06
June 20-26	17	Video	168.0	167.2	0	15	0	0.00	15.07
June 27-July 1	18	Video	104.2	104.0	1	17	0	1.00	17.02
Totals			860.6	781.7	66	69	0	3	73

APPENDIX B6- Chinook salmon observed at and passed above Coleman National Fish Hatchery barrier weir fish ladder and associated passage estimates for 2000. Passage estimates include estimated passage during hours not video recorded.

Dates	Week number	Monitoring method	Hours of allowed passage	Hours of taped passage	Actual number clipped	Actual number unclipped	Actual number unknown	Passage estimate: clipped	Passage estimate: unclipped
March 7-11	2	Trap			22	0	0	0.00	0.00
March12-18	3	Trap			11	0	0	0.00	0.00
March 19-25	4	Trap			5	0	0	0.00	0.00
March 26-April 1	5	Trap			4	2	0	0.00	2.00
April 2-8	6	Trap			2	1[a]	0	0.00	0.00
April 9-15	7	Trap			0	3	0	0.00	3.00
April 16-22	8	Trap			1	0	0	0.00	0.00
April 23-29	9	Trap			0	0	0	0.00	0.00
April 30-May 6	10	Trap			1	1	0	0.00	1.00
May 7-13	11	Trap			1	1	0	0.00	1.00
May 14-20	12	Trap			0	0	0	0.00	0.00
May 21-22	13	Trap			0	0	0	0.00	0.00
May 22-27	13	Video	133.1	133.1	2	11	0	2.00	11.00
May 28-June 3	14	Video	168.0	152.0	0	4	0	0.00	4.42
June 4-10	15	Video	168.0	168.0	1	8	0	1.00	8.00
June 11-17	16	Video	168.0	160.6	1	8	0	1.05	8.37
June 18-24	17	Video	168.0	136.3	0	1	0	0.00	1.23
June 25-July 1	18	Video	168.0	160.0	0	0	0	0.00	0.00
July 2-8	19	Video	168.0	168.0	1	1	0	1.00	1.00
July 9-15	20	Video	168.0	168.0	0	1	0	0.00	1.00
July 16-22	21	Video	168.0	147.5	0	0	0	0.00	0.00
July 23-29	22	Video	168.0	168.0	0	0	0	0.00	0.00
July 30-August 5	23	Video	168.0	166.1	0	0	0	0.00	0.00
August 6-12	24	Video	168.0	160.4	0	0	0	0.00	0.00
August 13-19	25	Video	168.0	168.0	0	8	0	0.00	8.00
August 20-26	26	Video	168.0	168.0	1	10	0	1.00	10.00
August 27-September 1	27	Video	129.4	119.4	1	16	1	1.15	18.36
Totals			2446.5	2343.2	54	76	1	7	78

[a] This fish was found dead on top of trap.

APPENDIX B7- Rainbow trout/steelhead observed at and passed above Coleman National Fish Hatchery barrier weir fish ladder and associated passage estimates for 1995. Passage estimates include estimated passage during hours not video recorded.

Dates	Week number	Monitoring method	Hours of allowed passage	Hours of taped passage	Actual number clipped [a]	Actual number unclipped [a]	Actual number unknown [a]	Passage estimate: clipped [b]	Passage estimate: unclipped [b]
March 30-April	5	Video	36.3	17.8	0	2	2	0.00	8.15
April 2-8	6	Video	64.6	52.4	0	4	1	0.00	6.10
April 9-15	7	Video	79.1	47.6	0	6	0	0.00	9.97
April 16-22	8	Video	71.7	62.0	0	9	1	0.00	11.56
April 23-29	9	Video	144.2	78.0	0	1	0	0.00	1.85
April 30-May 6	10	Video	168.0	0.0				2.42 [c]	9.10 [c]
May 7-13	11	Video	168.0	0.0				2.42 [c]	9.10 [c]
May 14-20	12	Video	168.0	0.0				2.42 [c]	9.10 [c]
May 21-27	13	Video	78.7	44.0	0	0	0	0.00	0.00
May 28-June 3	14	Video	145.9	21.3	2	4	1	15.96	31.91
June 4-10	15	Video	168.0	132.8	1	0	13 [d]	6.75	10.96
June 11-17	16	Video	168.0	72.0	1	2	2	3.89	7.78
June 18-24	17	Video	168.0	144.0	0	3	4	0.00	8.17
June 25-30	18	Video	133.0	72.0	0	1	1	0.00	3.69
Total			1761.4	744.0	4	32	25	34	127

[a] The Actual Number Clipped, Unclipped, and Unknown were taken from USFWS 1996.
[b] Clip status was not used to differentiate hatchery- and natural-origin adult steelhead until 2001 because Coleman National Fish Hatchery did not begin marking all of their production until brood year 1998.
[c] Passage for these weeks was estimated passage to be the average of all the other weeks.
[d] The 13 unknown fish were apportioned according to the average proportions of clipped and unclipped fish from the previous and following weeks.

APPENDIX B8- Rainbow trout/steelhead observed at and passed above Coleman National Fish Hatchery barrier weir fish ladder and associated passage estimates for 1996. Passage estimates include estimated passage during hours not video recorded.

Dates	Week number	Monitoring method	Hours of allowed passage	Hours of taped passage	Actual number clipped	Actual number unclipped	Actual number unknown	Passage estimate: clipped [a]	Passage estimate: unclipped [a]
March 26-30	5	Video	130.0	128.0	0	0	0	0.00	0.00
March 31-April 6	6	Video	168.0	144.0	1	2	0	1.17	2.33
April 7-13	7	Video	168.0	168.0	0	1	1	0.00	2.00
April 14-20	8	Video	168.0	115.0	0	0	0	0.00	0.00
April 21-27	9	Video	168.0	137.0	0	1	1	0.00	2.45
April 28-May 4	10	Video	168.0	167.0	0	3	1	0.00	4.02
May 5-11	11	Video	168.0	168.0	0	4	1	0.00	5.00
May12-18	12	Video	168.0	20.0	0	1	0	0.00	8.40
May 19-25	13	Video	168.0	59.0	0	0	0	0.00	0.00
May 26-June 1	14	Video	168.0	126.0	0	1	0	0.00	1.33
June 2-8	15	Video	168.0	141.0	0	4	0	0.00	4.77
June 9-15	16	Video	168.0	153.0	0	6	0	0.00	6.59
June 16-22	17	Video	168.0	167.0	0	0	0	0.00	0.00
June23-29	18	Video	168.0	144.0	0	1	0	0.00	1.17
June 30-July 1	19	Video	38.0	34.0	0	2	0	0.00	2.24
Total			2352.0	1871.0	1	26	4	1	40

[a] Clip status was not used to differentiate hatchery- and natural-origin adult steelhead until 2001 because Coleman National Fish Hatchery did not begin marking all of their production until brood year 1998.

APPENDIX B9- Rainbow trout/steelhead observed at and passed above Coleman National Fish Hatchery barrier weir fish ladder and associated passage estimates for 1997. Passage estimates include estimated passage during hours not video recorded.

Dates	Week number	Monitoring method	Hours of allowed passage	Hours of taped passage	Actual number clipped	Actual number unclipped	Actual number unknown	Passage estimate: clipped [a]	Passage estimate: unclipped [a]
March 5-10	2 & 3	Video	114.5	80.4	0	3	0	0.00	4.27
March 11-15	3	Trap			0	0	9	0.00	9.00
March 16-22	4	Trap			0	2	3	0.00	5.00
March 23-29	5	Trap			0	2	3	0.00	5.00
March 30-April 5	6	Trap			0	0	1 [b]	0.00	1.00
April 6-12	7	Trap			0	1	0	0.00	1.00
April 13-19	8	Trap			0	0	0	0.00	0.00
April 20-26	9	Trap			0	2	0	0.00	2.00
April 27-May 3	10	Trap			0	0	2 [b]	0.00	2.00
May 4-9 [c]	11	Trap			0	0	1 [b]	0.00	1.00
May 12-17	12	Video	134.8	125.9	0	2	2	0.00	4.28
May 18-24	13	Video	168.0	167.6	0	0	2 [b]	0.00	2.00
May 25-31	14	Video	168.0	160.0	0	0	0	0.00	0.00
June 1-7	15	Video	168.0	131.1	0	3	0	0.00	3.85
June 8-14	16	Video	168.0	165.6	0	1	2	0.00	3.04
June 15-21	17	Video	168.0	143.2	0	1	3	0.00	4.69
June 22-28	18	Video	168.0	167.5	0	0	1 [b]	0.00	1.00
June 29-July 1	19	Video	56.8	31.8	0	0	0	0.00	0.00
Total			1314.1	1172.9	0	17	29	0	49

[a] Clip status was not used to differentiate hatchery- and natural-origin adult steelhead until 2001 because Coleman National Fish Hatchery did not begin marking all of their production until brood year 1998.
[b] The average proportions of clipped and unclipped from the previous and/or following weeks were used to estimate the clip status of the one unknown fish.
[c] No data sheets are available for May 10 and 11 prior to trap removal and video installation on May 12. Based on sampling protocols, passage was likely blocked on May 10 and 11.

APPENDIX B10- Rainbow trout/steelhead observed at and passed above Coleman National Fish Hatchery barrier weir fish ladder and associated passage estimates for 1998. Passage estimates include poor quality video footage between the dates of 6/1/98-6/24/98.

Dates	Week number	Monitoring method	Hours of allowed passage	Hours of monitored passage	Actual number clipped	Actual number unclipped [a]	Actual number unknown	Passage estimate: clipped	Passage estimate: unclipped
March 4-7	1	Trap [b]	86.3	86.3	0	1	0	0.00	1.00
March 8-14	2	Trap	168.0	168.0	0	2	5	0.00	7.00
March 15-21	3	Trap	168.0	168.0	0	0	1	0.00	1.00
March 22-28	4	Trap	168.0	16.5	0	0	0	0.00	1.50 [d]
March 29-April 4	5	Trap	168.0	168.0	0	2	0	0.00	2.00
April 5-11	6	Trap	168.0	144.0	0	0	2	0.00	2.33
April 12-18	7	Trap	168.0	168.0	0	1	0	0.00	1.00
April 19-25	8	Trap	168.0	168.0	0	0	1	0.00	1.00
April 26-May 2	9	Trap	168.0	151.5	0	2	4	0.00	6.65
May 3-9	10	Trap	168.0	126.5	0	0	3	0.00	3.98
May 10-16	11	Trap	168.0	98.2	0	0	0	0.00	3.13 [d]
May 17-23	12	Trap	168.0	147.5	0	0	2	0.00	2.28
May 24-30	13	Trap	168.0	31.5	0	0	0	0.00 [d]	5.04 [d]
May 31- June 1	14	Trap	34.4	0.0	0	0	0	0.00 [e]	1.62 [e]
June 1-6	14	Video [c]	131.0	84.9	0	0	4	0.00	6.17
June 7-13	15	Video	168.0	42.7	0	0	0	0.00	0.00
June 14-20	16	Video	168.0	88.0	0	0	0	0.00	0.00
June 21-28	17	Video	168.0	166.6	0	0	3	0.00	3.02
June 28-July 1	18	Video	79.9	79.5	0	1	1	0.00	2.01
Total			714.9 [f]	461.8 [f]	0	9	26	0	51

[a] The proportion of clipped and unclipped for the nearest surrounding weeks was used to estimate the clip status of the unknown fish. Clip status was not used to differentiate hatchery- and natural-origin adult steelhead until 2001 because Coleman National Fish Hatchery did not begin marking all of their production until brood year 1998.

[b] Due to an unusual frequency of high flow events, the trap was either open (unmonitored passage allowed) or flooded (unmonitored passage likely) for 23.1% of the trapping period. In 1998, passage during the trapping period was estimated for unmonitored periods using the same methods as for video estimates.

[c] Video counts include observations made during poor video quality throughout the period 6/1/98-6/24/98. Including periods of poor video quality, only 65% of allowed passage time was recorded during the video monitoring period.

[d] Due to the minimal trap operation time in these weeks, passage of unclipped fish was estimated as the average of the previous and following weeks.

[e] Due to the absence of trap data during Week 14, passaged-per-hour was estimated from the video portion of Week 14 and extrapolated to the trapping portion of Week 14.

[f] Totals only include the video period, as is standard in tables for other years.

APPENDIX B11-Rainbow trout/steelhead observed at and passed above Coleman National Fish Hatchery barrier weir fish ladder and associated passage estimates for 1999. Passage estimates include estimated passage during hours not video recorded.

Dates	Week number	Monitoring method	Hours of allowed passage	Hours of taped passage	Actual number clipped	Actual number unclipped	Actual number unknown	Passage estimate: clipped [a]	Passage estimate: unclipped [a]
March 9-13	2	Trap			0	4	2	0.00	6.00
March 14-20	3	Trap			1	4	1	1.20	4.80
March 21-27	4	Trap			1	8	1	1.11	8.89
March 28-April	5	Trap			0	0	0	0.00	0.00
April 4-10	6	Trap			0	2	0	0.00	2.00
April 11-17	7	Trap			1	1	0	1.00	1.00
April 18-24	8	Trap			1	1	0	1.00	1.00
April 25-May 1	9	Trap			1	7	3	1.38	9.63
May 2-8	10	Trap			0	2	0	0.00	2.00
May 9-15	11	Trap			0	0	1	0.00	1.00 [b]
May 16-22	12	Trap			0	3	2	0.00	5.00
May 23-26	13	Trap			0	0	0	0.00	0.00
May 26-29	13	Video	84.5	48.0	0	1	0	0.00	1.76
May 30-June 5	14	Video	168.0	167.9	0	5	1	0.00	6.00
June 6-12	15	Video	168.0	143.9	0	1	4	0.00	5.84
June 13-19	16	Video	168.0	150.8	0	2	16	0.00	20.06
June 20-26	17	Video	168.0	167.2	0	1	9	0.00	10.05
June 27-July 1	18	Video	104.2	104.0	0	0	15	0.00	15.02
Totals			860.6	781.7	5	42	55	6	100

[a] Clip status was not used to differentiate hatchery- and natural-origin adult steelhead until 2001 because Coleman National Fish Hatchery did not begin marking all of their production until brood year 1998.
[b] The proportion of clipped and unclipped for the nearest surrounding weeks was used to estimate the clip status of the unknown fish.

APPENDIX B12- Rainbow trout/steelhead observed at and passed above Coleman National Fish Hatchery barrier weir fish ladder and associated passage estimates for 2000. Passage estimates include estimated passage during hours not video recorded.

Dates	Week number	Monitoring method	Hours of allowed passage	Hours of taped passage	Actual number clipped	Actual number unclipped	Actual number unknown	Passage estimate: clipped [a]	Passage estimate: unclipped [a]
March 7-11	2	Trap			5	9	0	5.00	9.00
March12-18	3	Trap			0	1	2	0.00	3.00
March 19-25	4	Trap			1	8	0	1.00	8.00
March 26-April 1	5	Trap			0	2	0	0.00	2.00
April 2-8	6	Trap			3	2	0	3.00	2.00
April 9-15	7	Trap			0	1	0	0.00	1.00
April 16-22	8	Trap			0	0	0	0.00	0.00
April 23-29	9	Trap			0	1	0	0.00	1.00
April 30-May 6	10	Trap			0	0	0	0.00	0.00
May 7-13	11	Trap			0	2	0	0.00	2.00
May 14-20	12	Trap			0	3	0	0.00	3.00
May 21-22	13	Trap			0	1	0	0.00	1.00
May 22-27	13	Video	133.2	133.1	3	6	2	3.67	7.33
May 28-June 3	14	Video	168.0	152.0	1	6	1	1.26	7.58
June 4-10	15	Video	168.0	168.0	0	6	1	0.00	7.00
June 11-17	16	Video	168.0	160.6	1	10	0	1.05	10.46
June 18-24	17	Video	168.0	136.3	0	7	0	0.00	8.63
June 25-July 1	18	Video	168.0	160.0	3	8	0	3.15	8.40
July 2-8	19	Video	168.0	168.0	0	0	0	0.00	0.00
July 9-15	20	Video	168.0	168.0	0	1	0	0.00	1.00
July 16-22	21	Video	168.0	147.5	0	0	0	0.00	0.00
July 23-29	22	Video	168.0	168.0	0	1	0	0.00	1.00
July 30-August 5	23	Video	168.0	166.1	0	0	0	0.00	0.00
August 6-12	24	Video	168.0	160.4	0	0	0	0.00	0.00
August 13-19	25	Video	168.0	168.0	0	0	0	0.00	0.00
August 20-26	26	Video	168.0	168.0	0	3	0	0.00	3.00
August 27-September 1	27	Video	129.4	119.4	0	0	0	0.00	0.00
Totals			2446.5	2343.2	17	78	6	18	86

[a] Clip status was not used to differentiate hatchery- and natural-origin adult steelhead until 2001 because Coleman National Fish Hatchery did not begin marking all of their production until brood year 1998.