Ref ID 90955

Outmigrant Trapping of Juvenile Salmonids in the Lower Tuolumne River, 2007

FINAL REPORT
March 2008

Prepared by
Andrea N. Fuller

Submitted to
Turlock and Modesto Irrigation Districts

FISHBIO Environmental, LLC
3188 Wood Creek Drive · Chico, CA 95928 · (530) 342-9262

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

Study Area Description

The Tuolumne River is the largest of the three major tributaries (Tuolumne, Merced, and Stanislaus Rivers) to the San Joaquin River, originating in the central Sierra Nevada and flowing west between the Merced River to the south and the Stanislaus River to the north (Figure 1). The San Joaquin River itself flows north and joins the Sacramento River in the Sacramento-San Joaquin Delta within California's Central Valley. The Tuolumne River is dammed at several locations for generation of power, water supply, and flood control – the largest impoundment is Don Pedro Reservoir.

The lower Tuolumne River corridor extends from its confluence with the San Joaquin River to La Grange Dam at river mile (RM) 52.2. The La Grange Dam site has been the upstream limit for anadromous migration since 1871.

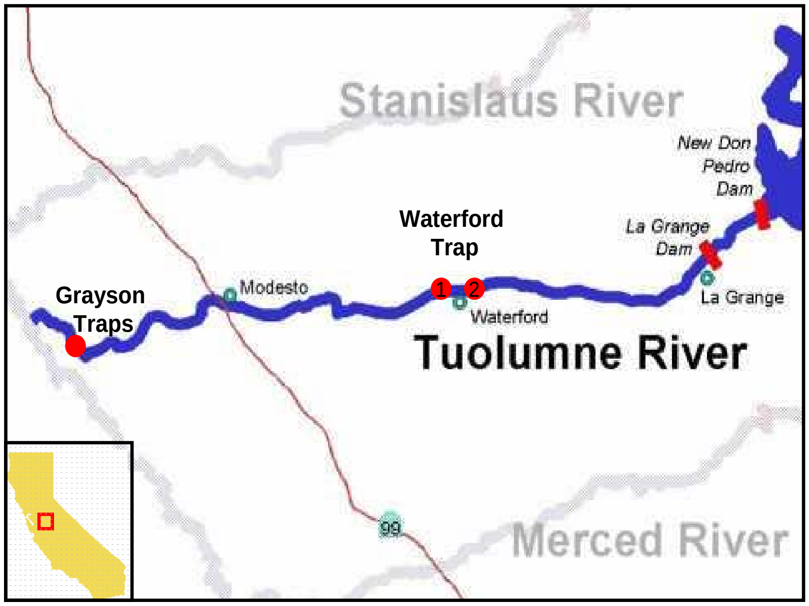

Figure 1. Location map of study area on the Tuolumne River.

Purpose and History of Study

Rotary screw traps have been operated at various locations in the Tuolumne River since 1995 within the winter/spring period to meet several objectives including monitoring the abundance and migration characteristics of juvenile salmonids and other fishes, and evaluation of reach-specific survival relative to environmental conditions (Table 1). Rotary screw trap monitoring has been conducted annually near the mouth of the Tuolumne River since 1995 for the purpose of monitoring the abundance and migration characteristics of juvenile salmonids and other fishes. Since 2006 sampling has also been conducted annually near the town of Waterford, about 25 miles upstream, to provide comparative information in size, migration timing, and juvenile fall-run Chinook salmon production at a site downstream from most Chinook spawning activity, along with data on other fishes. An estimated 625 salmon (289 females) spawned in fall 2006.

Table 1. Rotary screw trap monitoring in the Lower Tuolumne River.

Year	*Site*	*Period Sampled*	*Proportion of Outmigration Period Sampled*	*Total Catch*	*Total Estimated Passage*	*Method of Passage Estimation*	*Results Reported In*
1995	Shiloh (RM 3.4)	Apr 25-Jun 01	24%	141	15,667[1]		Heyne and Loudermilk 1997
1996	Shiloh	Apr 18 - May 29	27%	610	40,385[1]		Heyne and Loudermilk 1997
1997	Shiloh	Apr 18 - May 24	24%	57	2,850[1]		Heyne and Loudermilk 1998
1998	Turlock Lake State Rec. (RM 42.0)	Feb 11-Apr 13	41%	7,125	259,581[1]	Mean efficiency	Vick and others 1998
	7/11 (RM 38.5)	Apr 15-May 31	31%	2,413			Vick and others 1998
	Charles Road (RM 25.0)	Mar 27-Jun 01	43%	981	66,848[1]	Mean efficiency	Vick and others 1998
	Shiloh	Feb 15-Jul 01	70%	2,546	1,615,673[1]	Regression	Blakeman 2004a
1999	7/11	Jan 19-May 17	79%	80,792	1,737,052[1]	%Flow sampled	Vick and others 2000
	Hughson (RM 23.7)	Apr 08-May 24	31%	449	7,175[1]	%Flow sampled	Vick and others 2000
	Grayson (RM 5.2)	Jan 12-Jun 06	93%	19,327	696,115[2]	Multiple regression	Vasques and Kundargi 2001
2000	7/11	Jan 10-Feb 27	32%	61,196	298,755[1]	%Flow sampled	Hume and others 2001
	Deardorff (RM 35.5)	Apr 09-May 25	31%	634	15,845[1]	%Flow sampled	Hume and others 2001
	Hughson	Apr 09-May 25	31%	264	2,942[1]	%Flow sampled	Hume and others 2001
	Grayson	Jan 09-Jun 12	95%	2,250	96,195[2]	Multiple regression	Vasques and Kundargi 2001
2001	Grayson	Jan 03-May 29	97%	6,478	94,752[2]	Multiple regression	Vasques and Kundargi 2002

[1] Passage estimate reported in the annual report cited in the last column to the right.
[2] Passage estimate derived from multiple regression equation based on data collected from 1999-2006 as described in this report.

Year	Site	Period Sampled	Proportion of Outmigration Period Sampled	Total Catch	Total Estimated Passage	Method of Passage Estimation	Results Reported In
2002	Grayson	Jan 15-Jun 06	91%	436	14,315[2]	Multiple regression	Blakeman 2004b
2003	Grayson	Apr 01-Jun 06	40%	359	9,104[2]	Multiple regression	Blakeman 2004c
2004	Grayson	Apr 01-Jun 09	40%	509	17,943[2]	Multiple regression	Fuller 2005
2005	Grayson	Apr 02-Jun 17	39%	1,317	209,431[2]	Multiple regression	Fuller and others 2006
2006	Waterford 1 (RM 29.8)	Jan 25-Apr 12	79%	8,648	178,034[1]	%Flow sampled	Fuller and others 2007
	Waterford 2 (RM 33.5)	Apr 21-Jun 21		458	178,034[1]		
	Grayson	Jan 25-Jun 22	84%	1,594	178,034[2]	Multiple regression	Fuller and others 2007
2007	Waterford (RM 29.8)	Jan 11-Jun 05	93%	3,312	57,801[1]	Average trap efficiency	This report
	Grayson	Mar 23-May 29	45%	27	937[2]	Multiple regression	This report

[1] Passage estimate reported in the annual report cited in the last column to the right.
[2] Passage estimate derived from multiple regression equation based on data collected from 1999-2006 as described in this report.

METHODS

Juvenile Outmigrant Monitoring

Sampling Gear and Trapping Site Locations

Rotary screw traps were installed and operated near Waterford and at Grayson River Ranch (Grayson). The traps, manufactured by E.G. Solutions in Eugene, Oregon, consist of a funnel-shaped core suspended between two pontoons. Traps are positioned in the current so that water enters the 8 ft wide funnel mouth and strikes the internal screw core, causing the funnel to rotate. As the funnel rotates, fish are trapped in pockets of water and forced rearward into a livebox, where they remain until they are processed by technicians.

The single Waterford trap was located at RM 29.8 approximately two miles downstream of the Hickman Bridge. The trap was held in place by a 3/8 inch overhead cable strung between two large trees located on opposing banks. Cables fastened to the front of each pontoon were attached to the overhead cable. Warning signs, flashing safety lights, and buoys marked the location of the trap and cables for public safety.

At Grayson (RM 5.2), two traps were held in place by an overhead cable strung between two large trees located on opposing banks. Leader cables descended from the overhead cable and were attached to the front of each of four trap pontoons. The downstream force of the water on the traps kept the leader cables taut.

Trap Monitoring

Sampling at Waterford began on January 11. The trap was operated intermittently (e.g., 3-7 days per week) until February 19, and then continuously (24 hours per day, 7 days per week) until June 5 when sampling was terminated due to low catch and inadequate depth and water velocity for trap operation. Rotary screw traps with 8-ft. diameter cones generally require water at least 4 feet deep and velocity of at least 1.5 ft/s for the cone to rotate.

Sampling at Grayson began on March 23. The traps were operated continuously (24 hours per day, 7 days per week) until sampling was terminated on May 29 due to low catch and inadequate depth and water velocity for trap operation.

Regardless of location, each trap was checked at least every morning throughout the sampling period, with additional trap checks conducted as conditions required. During each trap check, contents of the liveboxes were removed; all fish were identified and counted; and any marked fish were noted. In addition, random samples of up to 50 salmon and 20 of each non-salmon species during each morning check and up to 20 salmon and 10 of each non-salmon species during each evening check were anesthetized, measured (forklengths in millimeters), and recorded. Salmon were assigned to lifestage category based on a forklength scale, where <50 mm= fry, 50-69 mm= parr, and ≥ 70 mm= smolt. In addition, the smolting appearance of all measured salmon and trout was rated based on a scale, where 1= yolk-sac fry, 2= fry, 3= parr, 4= silvery parr, 5= smolt, 6= mature adult, and IAD= immature adult (Interagency Ecological Program unpublished). Weights were taken from up to 50 salmon each week (i.e., Monday through Sunday) and from all trout. A weight boat partially filled with stream water was placed on an Ohaus digital balance and the balance was tared. One fish was placed in the weigh boat and after the weight was recorded to the nearest tenth of a gram, the balance was tared again before adding the next fish. Several fish were weighed before the weigh boat was emptied into a recovery bucket.

Salmon daily catch was equivalent to the number of salmon captured during a morning trap check plus the number of salmon captured during any trap check(s) that occurred within the period after the previous morning check. For example, the daily salmon catch for April 10 is the sum of salmon from the morning trap check on April 10 and the evening trap check conducted on April 9. Separate daily catch data was maintained for marked and unmarked salmon.

After all fish were measured and recorded, the traps were cleaned to prevent accumulation of debris that might impair trap rotation or cause fish mortality within the liveboxes. Trap cleaning included removal of debris from all trap surfaces and from within the liveboxes. The amount of debris load in the liveboxes was estimated and recorded whenever traps were checked.

<u>*Trap Efficiency Releases*</u>

Trap efficiency tests were conducted to estimate the proportion of passing juvenile salmon that were sampled by the Waterford trap. Natural fish captured in the trap were used when catches were sufficient to obtain a group of at least 30 fish over no more than two days. Hatchery fish were not made available for trap efficiency tests during 2007, and catches of natural fish were insufficient for trap efficiency tests to be conducted at Grayson.

Twelve groups of fish (all natural release groups ranging in size from 35 to 238 marked fish) were released at RM 30 (about 0.2 miles upstream of the trap) between February 13 and April 26 to estimate trap efficiencies at the Waterford trap. All marked fish were released after dark.

Holding Facility and Transport Method

Natural fish were transferred from liveboxes into either 5-gallon buckets or 20-gallon insulated coolers depending on the number of fish, temperatures, and distance traveled and transported by boat upstream to the release site.

At release sites, fish were held in live cars constructed of 15" diameter PVC pipe cut into 34" length (Figure 2). A rectangle approximately 6" wide by 23" long was cut longitudinally along the pipe and fitted with aluminum or stainless mesh. Live cars were tethered to vegetation or other structures and kept in areas of low water velocity to reduce fish stress.

Figure 2. Livecar used for holding trap efficiency test fish.

Marking Procedure

At Waterford, natural fish were marked on the trap or immediately adjacent to the trap and were then transported to the release site where they were held until release. A photonic marking system was used for marking all of the release groups because of the high quality of marks and the ability to use the marking equipment in rapid succession. All fish were anesthetized with Tricaine-S before the appropriate mark was applied. With this method, a marker tip was placed against the caudal fin and orange photonic dye was injected into the fin rays. The photonic dye was chosen because of its known ability to provide a highly visible, long-lasting mark. The photonic dyes were purchased from Day-Glo, Cleveland, OH.

Pre-release Sampling

Prior to release, marked fish were sampled for mean length and mark retention. Fifty fish (or the entire release group if fewer than 50 fish) were randomly selected from each release group, anesthetized, and examined for marks; and the remaining fish in each group were enumerated. Mark retention was rated as present or absent. All fish examined during pre-release were found to have marks during 2007.

Release Procedure

Livecars were located several feet away from the specific release point and fish were poured from the livecars into buckets for release. Fish were released by placing a dip net into the bucket, scooping up a "net-full" of fish, and then emptying the fish into the river so they could swim away. After releasing a "net-full" of fish, about 30 seconds to 3 minutes elapsed before another group of about "net-full" of fish was released. Amount of time between “net-full” releases varied depending on how fast fish swam away after their release. Total release time for marked groups ranged from five minutes to 18 minutes depending on the size of the group.

Monitoring Environmental Factors

Flow Measurements and Trap Speed

Provisional daily average flow for the Tuolumne River at La Grange was obtained from USGS at http://waterdata.usgs.gov/ca/nwis/dv/?site_no=11265000&agency_cd=USGS. Provisional daily average flow for the Tuolumne River at Modesto was obtained from the USGS at http://waterdata.usgs.gov/ca/nwis/dv/?site_no=11290000&agency_cd=USGS. Flow data was also provided by the Turlock Irrigation District for the Hickman spill which affected flows observed at the Waterford trap. Velocity of water entering the traps was measured using two methods. First, the water velocity entering the traps was measured daily with a Global Flow Probe, manufactured by Global Water (Fair Oaks, CA). Second, an average daily trap rotation speed was calculated for each trap by recording the time (in seconds) for three continuous revolutions of the cone both before and after the morning trap cleaning, then averaging the two times per revolution recorded.

River Temperature, Relative Turbidity and Dissolved Oxygen

Instantaneous water temperature was measured daily with a mercury thermometer at the trap site. Data was also available from hourly recording thermographs maintained by the Irrigation Districts at Shiloh Road (RM 3.4) near the Grayson traps and by California Department of Fish and Game at Hickman Bridge (RM 32) near the Waterford trap. To measure daily instantaneous turbidity a water sample was collected each morning and later tested at the field station with a LaMotte turbidity meter, model 2020e. Turbidity was recorded in nephelometric turbidity units (NTU). Instantaneous dissolved oxygen was measured during some trap checks with a YSI Model 556 meter at the trap site and recorded in mg/L.

Estimating Trap Efficiency and Chinook Abundance

Since sampling did not occur every day at Waterford, catches were first adjusted to account for missing values associated with days not sampled. Catches were not adjusted for temporary trap stoppage which occurred infrequently at both Waterford and Grayson during 2007.

If no sampling occurred on a given day, catch was estimated using the combined daily counts for up to five days prior to and immediately following the period of no sampling days. The estimation procedures involved the following steps:

1. Adding one to the combined counts from the five previous and five subsequent days,
2. Taking the natural logs of the resulting values,
3. Computing the weighted mean of those natural logs, and
4. Re-transforming the resulting mean.

The computation is summarized in the following equation:

$$\bar{c}(i) = \exp\left\{ \frac{\sum_{j=1}^{5} w(i+j)*\ln[c(i+j)+1] + \sum_{j=1}^{5} w(i-j)*\ln[c(i-j)+1]}{\sum_{j=1}^{5} w(i+j) + \sum_{j=1}^{5} w(i-j)} \right\} - 1$$

wherein, ln[ ] represents natural log of the function within [ ], exp{ } represents the exponential constant raised to the power within{ }, and w( ) represents a weighting variable. The weights are greater for more proximal days, specifically,

$$w(i+1) = w(i-1) = 5,$$
$$w(i+2) = w(i-2) = 4,$$
$$w(i+3) = w(i-3) = 3,$$
$$w(i+4) = w(i-4) = 2,$$
$$w(i+5) = w(i-5) = 1$$

unless the count on the day associated with the weight is also missing, the associated weight is 0.

After all missing daily values were calculated, the estimated daily number of fish passing each site was generated by either expanding the catch data by the average estimated trap efficiency for the lifestage captured (Waterford) or by a trap efficiency predictor equation (Grayson).

At Waterford, the trap efficiency dataset is limited because sampling has only been conducted during 2006 and 2007, and the dataset is not yet sufficient to develop meaningful regression relationships between trap efficiency and predictor variables such as river flow, fish size, or turbidity. In the interim, an estimate of salmon relative abundance for the sampling season was calculated by expanding the daily number of fish by the average observed trap efficiency for each lifestage during 2007, or 7.7% (47 recoveries from 612 released) for fry and 5.3% (29 recoveries from 545 released) for parr/smolts.

At Grayson, flow and trap efficiency data collected from 1999 through 2006 were used to develop a multiple regression equation to estimate daily trap efficiencies. Specifically, average daily river flow at Modesto, average fish size at release, and transformed (e.g., natural log) proportions of fish recovered from each release event were used to develop the following trap efficiency predictor equation with an adjusted R^2 of 0.64:

Daily Predicted Trap Efficiency= EXP(-0.12171+(-0.00042*Flow at MOD)+(-0.03631*Fish size))

Where Flow at MOD= daily average river flow at Modesto
Fish Size= daily average forklength of fish captured at Grayson

These daily predicted trap efficiencies (DPTE) were then applied to the daily adjusted catch (DAC; actual catch plus missing values) to estimate daily passage as follows:

Estimated Daily Passage= DAC/DPTE

Rough estimates of daily passage were also calculated using the proportion of flow sampled by the trap(s) as a surrogate for trap efficiency. The proportion of flow sampled at each site was estimated by the following equation:

$$N_e = C_d \sqrt{\frac{V_d\left(3.14 * \frac{r^2}{2}\right)}{F_d}}$$

where, N_e is the expanded daily number of fish; C_d is the daily catch (actual catch and missing values); V_d is the daily velocity, r is the radius of the trap; and F_d is the daily flow measured at La Grange plus flow from the Hickman spill.

RESULTS AND DISCUSSION

Chinook Salmon

Number of Unmarked Chinook Salmon Captured

Juvenile salmon outmigration in the San Joaquin Basin typically occurs during the winter and spring, extending from January through May. The winter migration period is dominated by fry migrants that are typically less than 50 mm forklength, and the spring period is dominated by smolts which are typically greater than 70 mm forklength. During 2007 catches of juvenile salmon at Waterford were highest from mid-February through mid-April, and daily catches through mid-March primarily consisted of fry (<50 mm). Daily catches of juvenile salmon at Waterford between January 12 and June 5 ranged from zero to 253 fish and totaled 3,312 fish (Figure 3).

At Grayson, catches of juvenile salmon were highest during the latter half of April and coincident to a ten day pulse flow event of 700-1,000 cfs. Daily catches of juvenile salmon at Grayson during 2007 ranged from zero to six fish and totaled 27 fish between March 24 and May 29 (Figure 4). All salmon captured at Grayson during 2007 were smolts (>70mm); however sampling was not conducted during the winter when fry migration typically occurs.

Total annual catch of juvenile salmon has varied substantially between years at Grayson/Shiloh (Table 1; Figure 5); and this variation is likely due to differences in one or more factors including the duration and timing of the sampling periods, flow conditions, and overall fish abundance (Table 1; Figure 5). Sampling periods have varied between years with sampling initiated as early as January or as late as April and continuing through May/June.

During 1999-2002 and 2006, sampling at Grayson encompassed the majority of the expected winter/spring outmigration season (i.e., January-May/June) and can be described as comprehensive (Table 1; Figure 5). In contrast, sampling was only conducted during the spring smolt outmigration period (i.e., April-May/June) in 1995-1997 at Shiloh and 2003-2005 and 2007 at Grayson, so sampling was incomplete for these years. Sampling during 1998 began in February but was limited to a single trap (note: two traps were operated in all other years); thus, 1998 sampling covered an intermediate proportion of the entire outmigration period relative to all other years of monitoring.

Of the winter/spring sampling years, total trap catch at Grayson ranged from a high of 19,327 during 1999 to a low of 436 during 2002, and averaged 7,123 juvenile salmon (Figure 5). In all years of spring-only sampling, catches ranged from a high of 1,239 during 2001 to a low of 27 during 2007. The proportion of the typical outmigration period monitored each year ranged from 91% to 97% during winter/spring sampling years, from 24% to 45% during spring-only sampling years, and was 70% in the intermediate sampling year (Table 1). These proportions were calculated by taking the total number of sampling days in a given year and dividing by the total number of days for a typical complete outmigration period (i.e., January 1 through May 31). The proportion of the outmigration period sampled may not be representative of the proportion of the juvenile population migrating during the sample period because migration timing can be influenced by environmental factors such as flow.

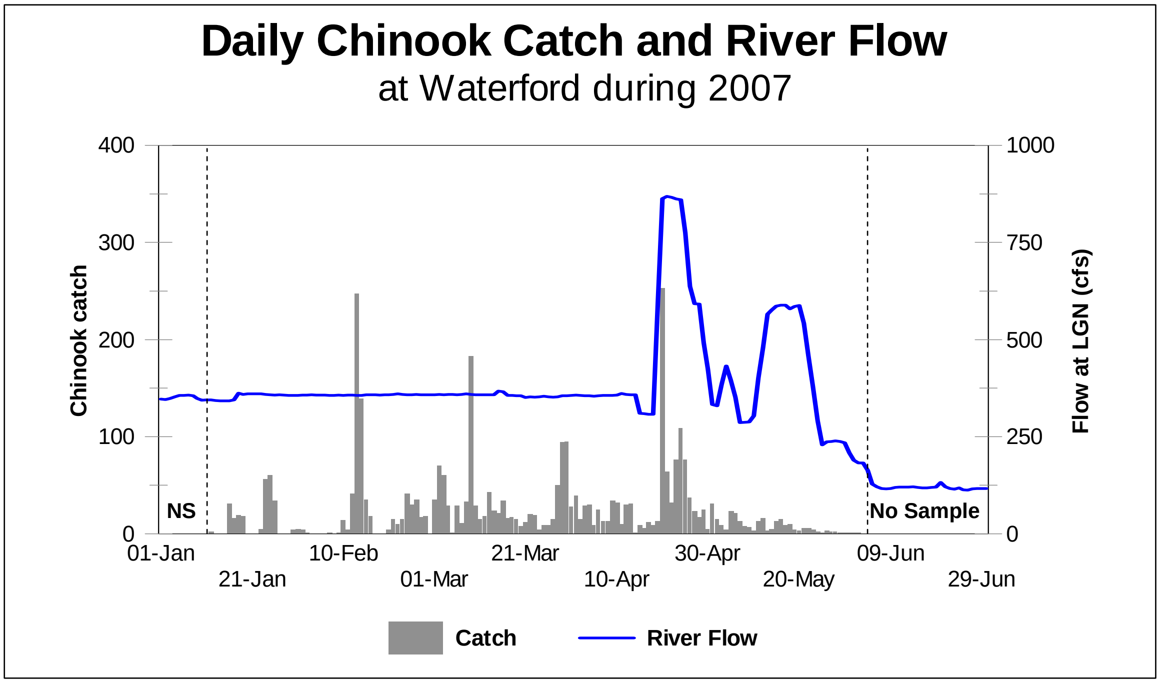

Figure 3. Daily catch of unmarked Chinook salmon at Waterford and river flow at La Grange (LGN) during 2007.

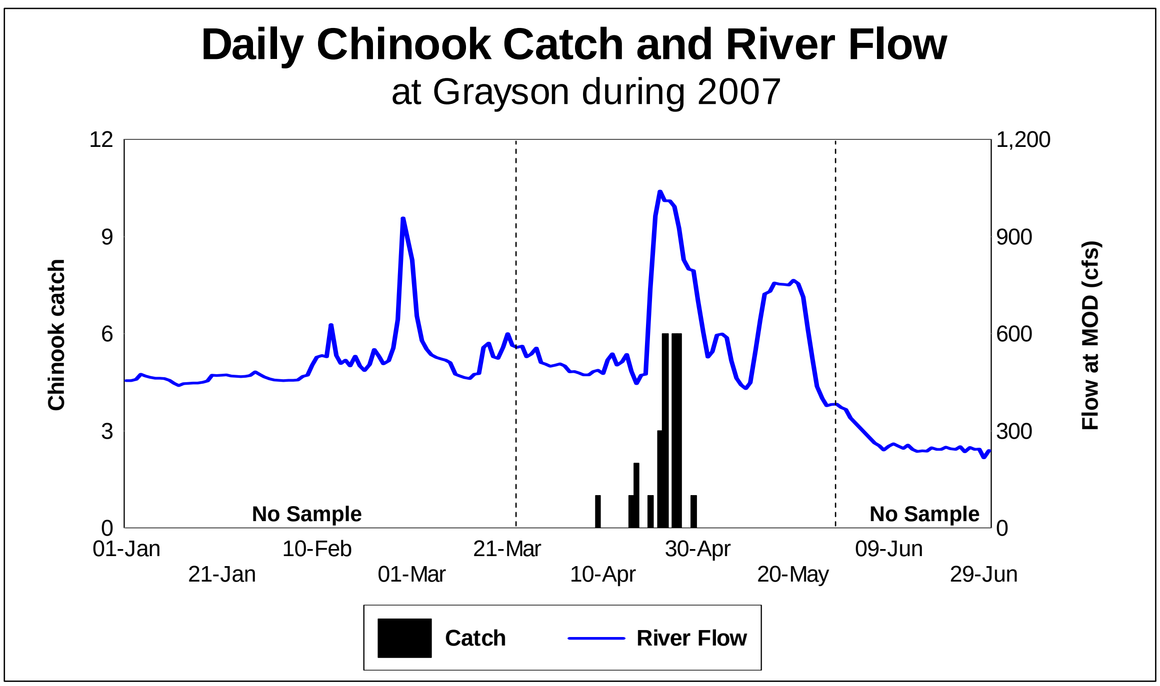

Figure 4. Daily catch of unmarked Chinook salmon at Grayson and river flow at Modesto (MOD) during 2007.

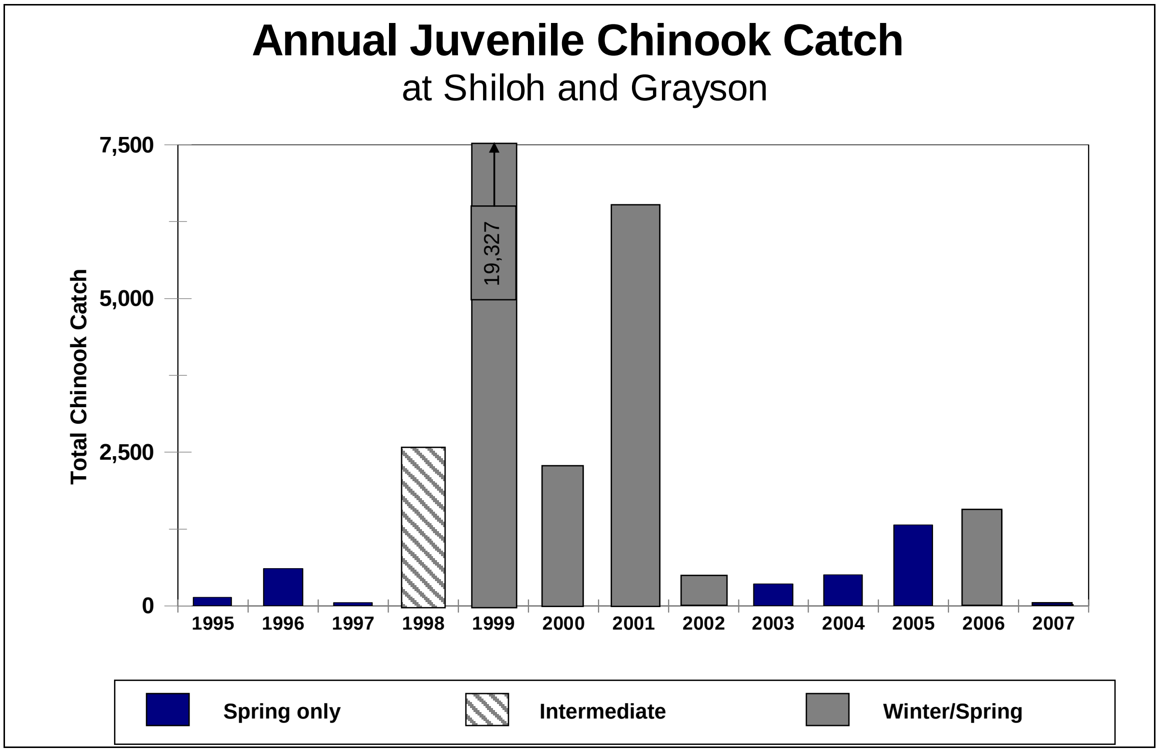

Figure 5. Total annual salmon catch at Shiloh/Grayson during 1995-2007.

<u>Trap Efficiency and Estimated Chinook Salmon Abundance</u>

Trap efficiency estimates for fry at Waterford ranged from 2.9% to 9.2% at flows (e.g., La Grange and Hickman spill combined) of 338 cfs to 350 cfs (Table 2; Figure 6). Trap efficiency estimates for parr and smolt sized fish ranged from 4.0% to 9.5% at flows of 337 cfs to 869 cfs. Average forklength at release of the 12 trap efficiency test groups ranged from 34.9 mm to 84.9 mm (Table 2).

At Grayson, observed trap efficiency estimates during 1999-2006 ranged from zero to 21.2% at flows of 280 cfs to 7,942 cfs (Table 3; Figure 7). Catches of naturally produced salmon in the traps were insufficient to obtain suitable numbers for trap efficiency releases and hatchery fish were not available during 2007; therefore trap efficiency releases were not conducted at Grayson during 2007.

Missing value estimates, daily predicted trap efficiency, and daily estimated passage at Waterford and Grayson in 2007 are provided in Appendices A and B, respectively.

Table 2. Trap efficiency results from Waterford during 2007.

Lifestage	Release Date	Origin	Adjusted # Released	Number Recaptured	% Recaptured	Length at Release (mm)	Length at Recap. (mm)	Flow (cfs) at Trap	Turbidity
Fry	2/13/2007	Wild	35	1	2.9%	35.1	37.0	339	5.13
	2/14/2007	Wild	238	22	9.2%	34.9	34.7	338	1.48
	3/3/2007	Wild	98	7	7.1%	46.4	48.6	340	1.41
	3/10/2007	Wild	180	13	7.2%	38.1	36.6	340	0.35
	3/15/2007	Wild	61	4	6.6%	36.0	36.3	350	0.7
		TOTAL	612	47	7.7%				
Parr/smolt	3/5/2007	Wild	75	3	4.0%	56.2	59.7	341	0.62
	3/29/2007	Wild	48	3	6.3%	60.3	57.1	337	0.65
	3/31/2007	Wild	75	3	4.0%	58.4	47.3	337	0.43
	4/5/2007	Wild	50	2	4.0%	76.0	75.0	337	0.64
	4/11/2007	Wild	63	6	9.5%	80.6	80.2	343	1.07
	4/24/2007	Wild	63	3	4.8%	81.9	80.3	869	0.82
	4/26/2007	Wild	171	9	5.3%	80.2	79.1	646	0.88
		TOTAL	545	29	5.3%				

Table 3. Trap efficiency results from 1999- 2006 used to derive the regression equation for predicting daily trap efficiencies at Grayson.

Release Date	Origin	Mark	Adjusted Number Released	Number Recaptured	% Recaptured	Length at Release (mm)	Length at Recap.ture (mm)	Flow (cfs)
11-Mar-99	Hatchery	Anal fin blue	1946	28	1.4%	54	53	4620
24-Mar-99	Hatchery	Bottom caudal blue, ad-clip	1938	67	3.5%	61	61	3130
31-Mar-99	Hatchery	Top caudal blue, ad-clip	1885	73	3.9%	65	64	2250
07-Apr-99	Hatchery	Bottom caudal blue, ad-clip	1949	50	2.6%	68	68	2280
14-Apr-99	Hatchery	Anal fin blue, ad-clip	1953	34	1.7%	73	72	2000
20-Apr-99	Hatchery	Top caudal blue, ad-clip	2007	45	2.2%	73	75	1800
29-Apr-99	Hatchery	Bottom caudal blue, ad-clip	1959	14	0.7%	79	80	3220
04-May-99	Hatchery	Anal fin blue, ad-clip	2008	18	0.9%	83	82	3030
18-May-99	Hatchery	Top caudal blue, ad-clip	2001	29	1.4%	86	84	677
26-May-99	Hatchery	Bottom caudal blue, ad-clip	1984	75	3.8%	96	92	518
01-Mar-00	Hatchery	Top caudal blue	1964	30	1.5%	56	53	4690
16-Mar-00	Hatchery	Bottom caudal blue	1548	22	1.4%	56	56	5980
23-Mar-00	Hatchery	Anal fin blue	1913	55	2.9%	59	60	3190
30-Mar-00	Hatchery	Top caudal blue	1942	60	3.1%	62	63	2820
29-Apr-00	Hatchery	Top caudal blue, ad-clip	1931	22	1.1%	81	82	1470
06-May-00	Hatchery	Bottom caudal blue, ad-clip	1987	41	2.1%	85	85	2430
24-May-00	Hatchery	Top caudal blue, ad-clip	2010	24	1.2%	85	85	1010

Release Date	Origin	Mark	Adjusted Number Released	Number Recaptured	% Recaptured	Length at Release (mm)	Length at Recap.ture (mm)	Flow (cfs)
18-Jan-01	Hatchery	Top caudal blue	1810	120	6.6%	37	Not provided	487
08-Feb-01	Hatchery	Bottom caudal blue	1980	276	13.9%	47	Not provided	434
01-Mar-01	Hatchery	Top caudal yellow	2017	57	2.8%	41	Not provided	2130
14-Mar-01	Hatchery	Bottom caudal yellow	1487	75	5.0%	46	Not provided	703
21-Mar-01	Hatchery	Bottom caudal blue, Dorsal fin blue, Top caudal yellow	3025	207	6.8%	61	Not provided	519
28-Mar-01	Hatchery	Anal fin blue	1954	219	11.2%	51	Not provided	515
11-Apr-01	Hatchery	Bottom caudal yellow, ad-clip	2021	141	7.0%	66	Not provided	535
18-Apr-01	Hatchery	Top caudal blue, ad-clip	2060	95	4.6%	68	Not provided	483
25-Apr-01	Hatchery	Ad-clip dorsal fin yellow, Bottom caudal blue, Dorsal fin blue	1515	34	2.2%	71	Not provided	753
02-May-01	Hatchery	Anal fin blue, ad-clip	3053	163	5.3%	72	Not provided	1460
09-May-01	Hatchery	Bottom caudal yellow, ad-clip	3002	147	4.9%	75	Not provided	1160
16-May-01	Hatchery	Top caudal blue, ad-clip	2942	93	3.2%	76	Not provided	1020
20-Feb-02	Hatchery	Bottom caudal red	2094	444	21.2%	57	Not provided	265
06-Mar-02	Hatchery	Anal fin red	2331	316	13.6%	68	Not provided	278
13-Mar-02	Hatchery	Top caudal red	2042	324	15.9%	65	Not provided	300
20-Mar-02	Hatchery	Dorsal fin red	2105	242	11.5%	68	Not provided	328
27-Mar-02	Hatchery	Bottom caudal red	2121	147	6.9%	68	Not provided	314
03-Apr-02	Hatchery	Anal fin red, ad-clip	1962	130	6.6%	76	Not provided	312
09-Apr-02	Hatchery	Top caudal red, ad-clip	1995	56	2.8%	79	Not provided	319
17-Apr-02	Hatchery	Dorsal fin red, ad-clip	2048	40	2.0%	84	Not provided	889
25-Apr-02	Hatchery	Bottom caudal red, ad-clip	2001	22	1.1%	86	Not provided	1210
01-May-02	Hatchery	Anal fin red, ad-clip	2033	14	0.7%	89	Not provided	1250
08-May-02	Hatchery	Dorsal fin red, ad-clip	2021	31	1.5%	95	Not provided	798
15-May-02	Hatchery	Top caudal red, ad-clip	2047	26	1.3%	97	Not provided	653
22-May-02	Hatchery	Bottom caudal red, ad-clip	2043	10	0.5%	94	Not provided	403
10-Apr-03	Hatchery	Top caudal green	1956	138	7.1%	77	Not provided	297
17-Apr-03	Hatchery	Bottom caudal green	2047	65	3.2%	77	Not provided	1350
24-Apr-03	Hatchery	Anal fin green	1979	31	1.6%	88	Not provided	1210
01-May-03	Hatchery	Dorsal fin green	2044	113	5.5%	96	Not provided	685
08-May-03	Hatchery	Top caudal green	2078	206	9.9%	83	Not provided	726
15-May-03	Hatchery	Bottom caudal green	1996	125	6.3%	83	Not provided	559
20-May-03	Hatchery	Anal fin green	1989	60	3.0%	89	Not provided	317
28-May-03	Hatchery	Dorsal fin green	1950	125	6.4%	94	Not provided	685
13-Apr-04	Hatchery	Dorsal fin green	1992	84	4.2%	79	74	1140
20-Apr-04	Hatchery	Anal fin green	1980	48	2.4%	81	79	1660
27-Apr-04	Hatchery	Top caudal green	1941	118	6.1%	86	85	826
04-May-04	Hatchery	Bottom caudal green	2008	50	2.5%	90	87	789
11-May-04	Hatchery	Anal fin green	1972	104	5.3%	86	79	815
18-May-04	Hatchery	Dorsal fin green	1996	178	8.9%	88	77	446
25-May-04	Hatchery	Top caudal green	2013	59	2.9%	92	90	337

Release Date	Origin	Mark	Adjusted Number Released	Number Recaptured	% Recaptured	Length at Release (mm)	Length at Recap.ture (mm)	Flow (cfs)
09-Feb-06	Wild	Caudal fin pink	37	5	13.5%	34.6	35.2	3393
11-Feb-06	Wild	Caudal fin pink	26	4	15.4%	34.9	37.3	3437
12-Feb-06	Wild	Caudal fin pink	23	1	4.3%	36.1	37.0	3416
13-Feb-06	Wild	Caudal fin pink	28	1	3.6%	35.5	33.0	3418
03-Mar-06	Wild	Caudal fin green	89	4	4.5%	34.8	35.3	4261
05-May-06	Hatchery	Caudal fin yellow	949	4	0.4%	73.2	74.3	7942
12-May-06	Hatchery	Caudal fin yellow	1,286	5	0.4%	81.8	76.6	7534
25-May-06	Hatchery	Top caudal yellow	1,532	2	0.1%	83.7	69.5	6537
14-Jun-06	Hatchery	Top caudal yellow	1,507	2	0.1%	85.4	83.0	4864

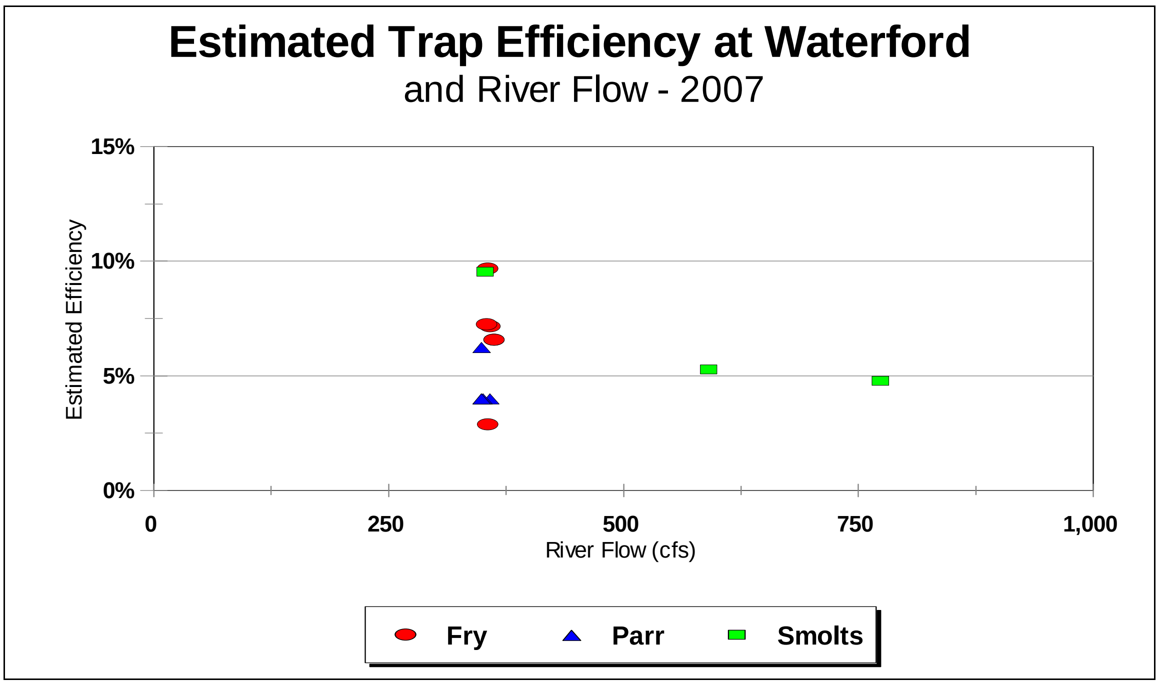

Figure 6. Trap efficiency estimates and river flow at Waterford during 2007.

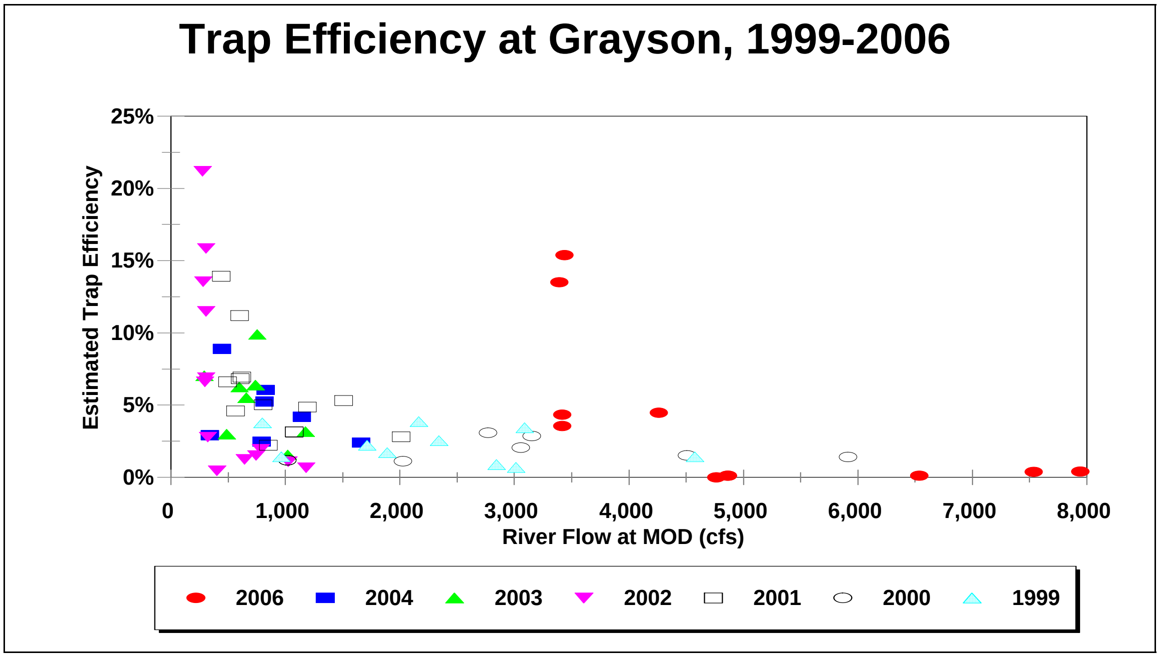

Figure 7. Trap efficiency observations at Grayson relative to river flow at Modesto, 1999-2006.

Based on calculated daily passage estimates, an estimated 57,801 unmarked Chinook salmon passed Waterford during 2007, an average of approximately 200 juveniles per female spawner, and 51% of these were smolts (Table 4). Similar to the pattern observed for catch, it is estimated that a majority of the salmon passing Waterford prior to mid-March were fry and catch was then dominated by smolts from late-March through May (Table 4; Figure 8). Daily estimated passage at Waterford ranged from zero to 4,755 salmon. Peaks in daily passage for fry occurred on February 13 and smolt passage peaked on April 20 (Figure 8; Figure 10).

Table 4. Estimated passage by lifestage at Waterford and Grayson during 2007.

	Waterford		*Grayson*	
Fry	20,633	35.7%	NS	NS
Parr	7,614	13.2%	0	0%
Smolts	29,554	51.1%	937	100%
TOTAL	57,801		937	

An estimated 937 smolts passed Grayson during 2007. Daily estimated passage at Grayson ranged from 0 to 217 salmon and peak passage occurred from April 23 to April 26 (Figure 11). Since 1995 total estimated passage at Grayson during winter/spring sampling years ranged from a high of 696,115 during 1999 to a low of 14,315 during 2002 (Table 1; Figure 9). During spring-only sampling years at Grayson/Shiloh, estimated passage ranged from a high of 264,376 in 2005 to a low of 937 during 2007 (Table 1; Figure 9). Estimated passage was highest during 1998 (Table 1; Figure 9) when sampling effort was intermediate (i.e., February-July). However, the 1998 passage estimate may be inflated because no trap efficiency tests were conducted with fry.

For comparison, rough passage estimates were also calculated based on the estimated proportion of flow sampled at each site during 2007. This method produced estimates of 19,404 salmon at Waterford and 270 salmon at Grayson. These estimates are provided for the purpose of comparison only and they are not reflected in the tables and figures presented in this report.

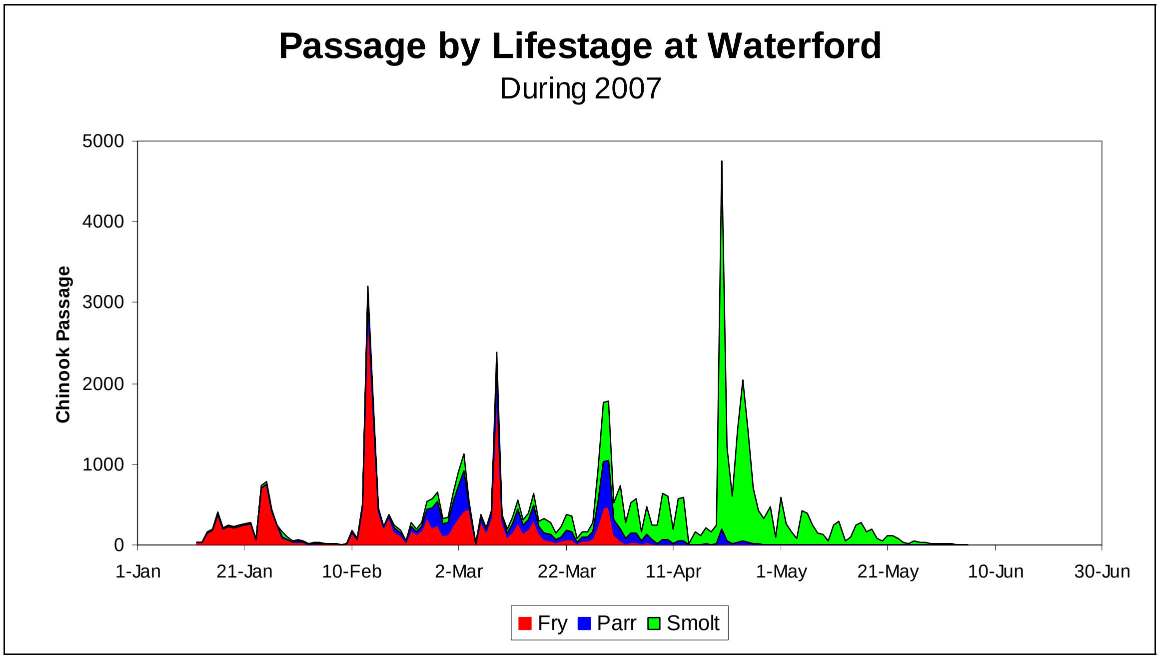

Figure 8. Juvenile salmon passage by lifestage at Waterford during 2007.

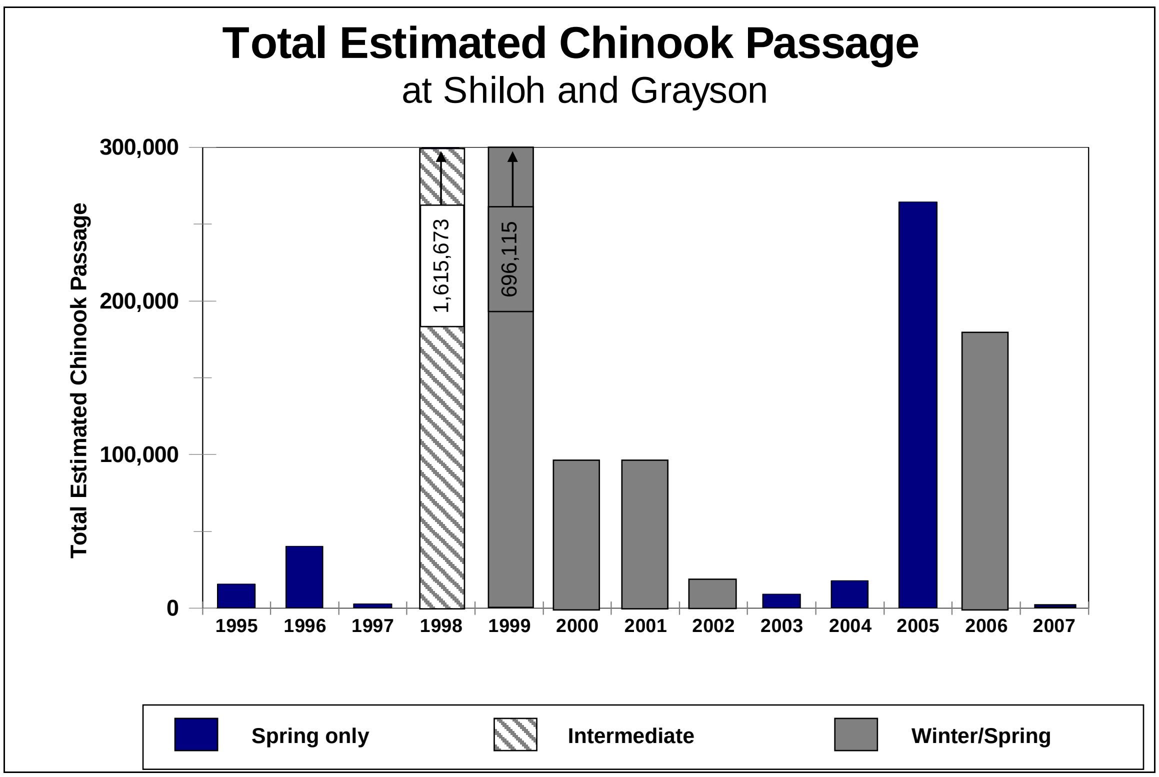

Figure 9. Total estimated Chinook passage at Shiloh and Grayson during 1995-2007.

Estimated Chinook Salmon Abundance and Environmental Factors

Trends in passage at Waterford and Grayson during 2007 were similar to the trends described for catch, and peaks in juvenile salmon passage coincided with storm events and a late April pulse flow event. River releases during January through mid-April ranged only from 308 cfs to 367 cfs which translated to relatively stable flow conditions in the river at Waterford. Higher pulse flows with two peaks occurred during the spring. River flow was more variable near Grayson as a result of storm run-off, particularly from Dry Creek entering at Modesto, and ranged from 439 cfs to 957 cfs. The Grayson traps were not operated during the winter storm run-off events so salmon passage during these periods was not estimated.

During 2007 monitoring, daily average water temperatures near Waterford ranged from 45.7°F to 70.4°F (Figure 12), and from 55.2°F to 71.4°F near Grayson (Figure 13). Water temperatures generally increased through the outmigration season as ambient air temperatures increased. There were no obvious correlations between trends in passage and water temperature during 2007, but comparisons between years indicate that migration occurs over a more extended timeframe during years when late spring water temperatures in the lower Tuolumne River remain cooler. Relative to earlier migrants, late spring migrants may be exposed to higher water temperatures in the Delta and higher export rates.

Background turbidity was less than 2 NTU at Waterford (Figure 14) and 3 NTU at Grayson (Figure 15) during the 2007 monitoring periods. During several storm events from mid-February through late April spikes in turbidity ranging from 2.9 NTU to 6.8 NTU were observed at Waterford, and from 4.8 NTU to 7.8 NTU were observed at Grayson. Peaks in passage on February 13, March 29-30, and April 20 at Waterford, and April 22-26 at Grayson coincided with periods of elevated turbidity. All turbidity events coincided with changes in flow so it is unclear whether migration was stimulated by changes in flow, elevated turbidity, or a combined influence of the two factors.

The ratio of estimated total passage at Grayson relative to the estimated total passage at Waterford provides an index of survival through the river between the sites (24.6 miles) during years when the majority of the outmigration period is sampled. However, sampling at Grayson began in late March during 2007 and an unknown number of salmon may have moved past the site prior to the initiation of sampling, particularly during run-off events in mid-February and late February/early March. Consequently, an index was not calculated for 2007.

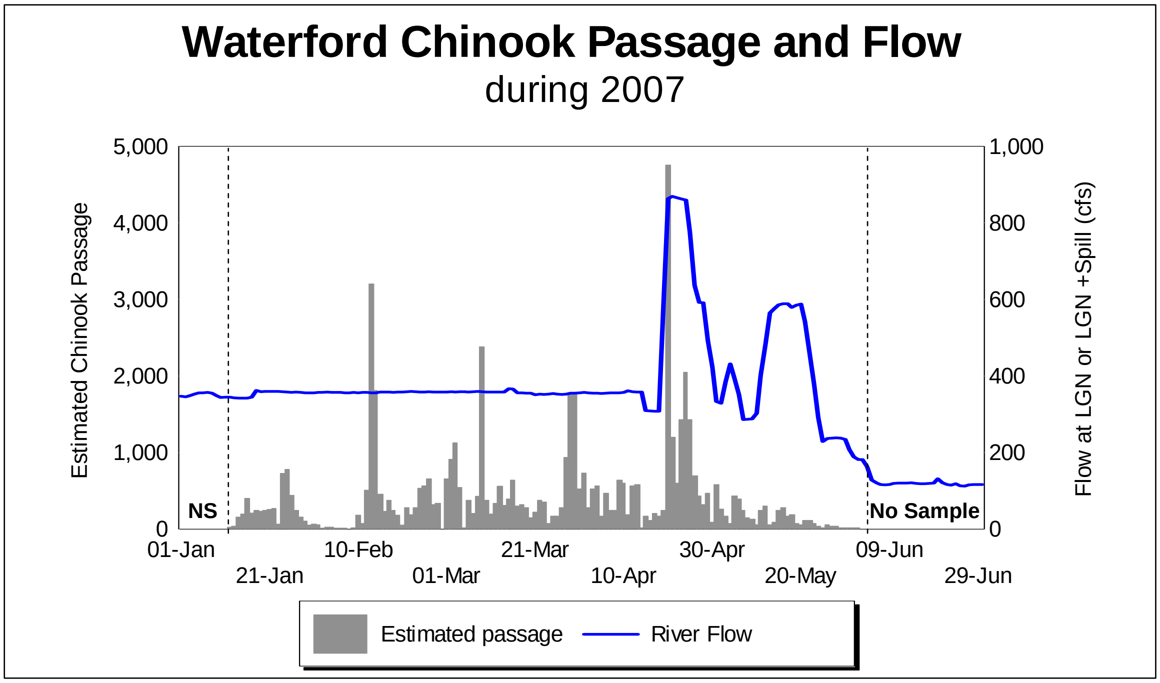

Figure 10. Daily estimated passage of unmarked Chinook salmon at Waterford and river flow at La Grange (LGN) during 2007.

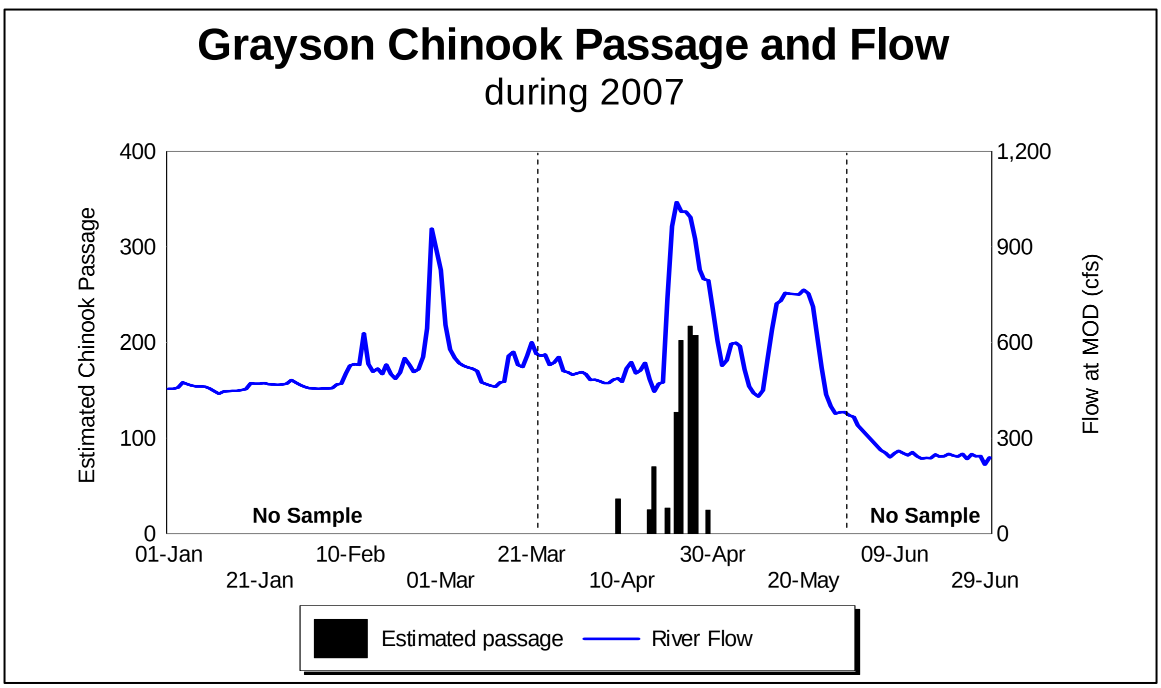

Figure 11. Daily estimated passage of unmarked Chinook salmon at Grayson and river flow at Modesto (MOD) during 2007.

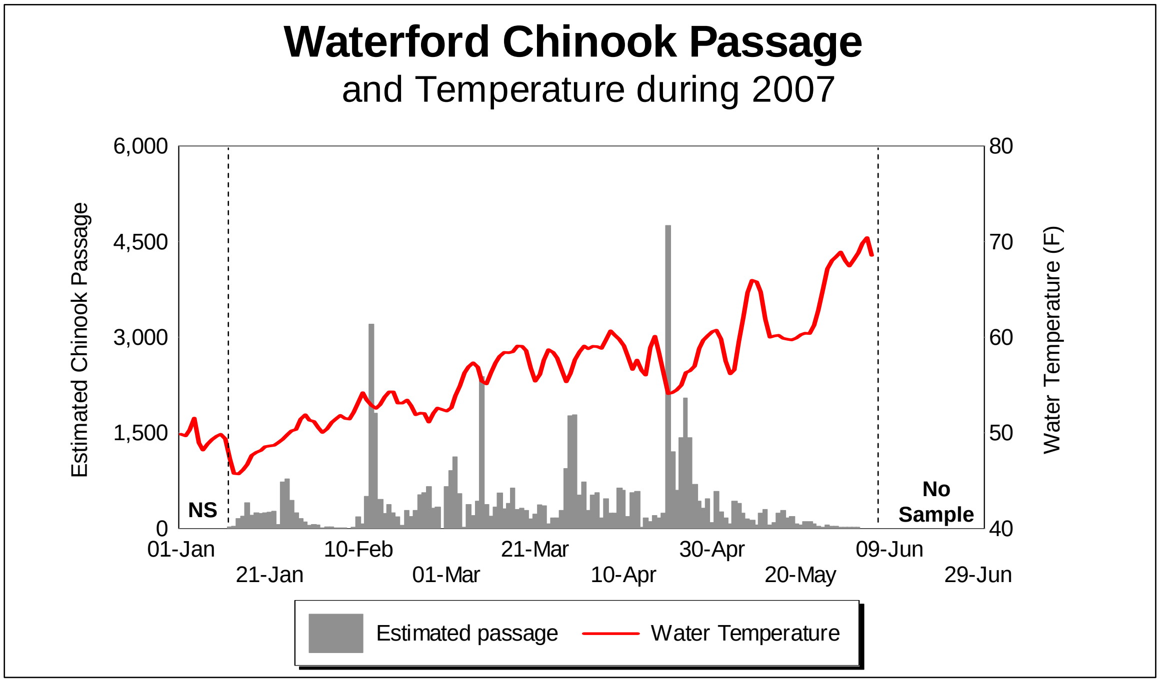

Figure 12. Daily estimated passage of unmarked Chinook salmon at Waterford and daily average water temperature at Hickman Bridge (RM 32) during 2007.

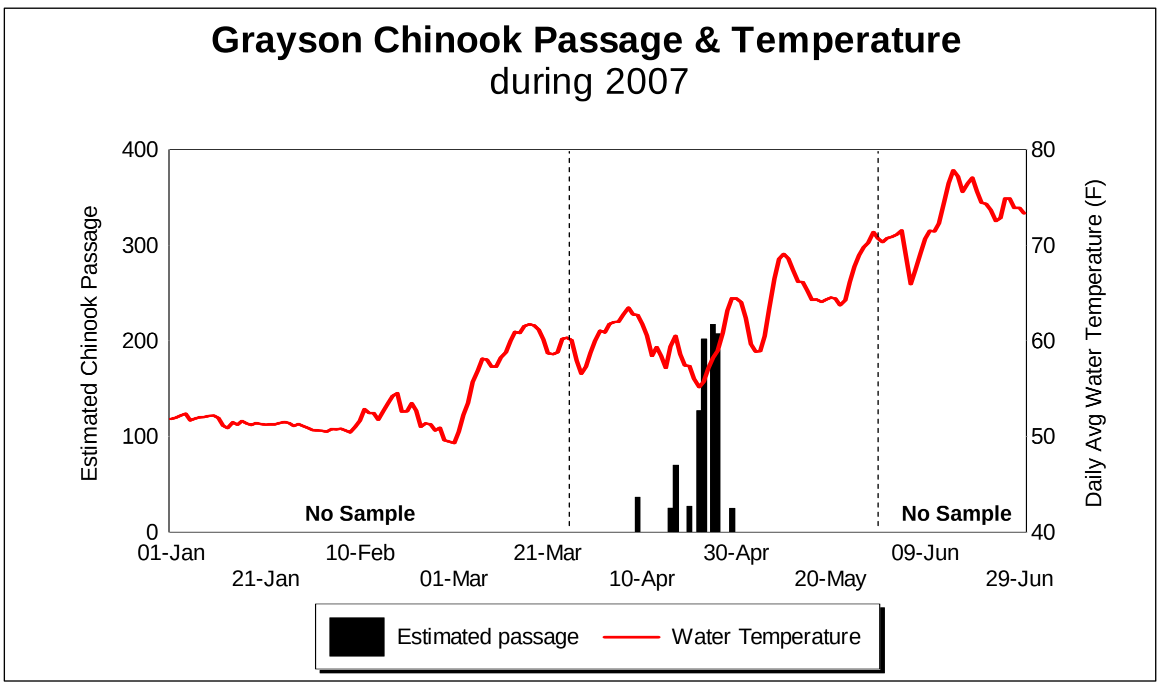

Figure 13. Daily estimated passage of unmarked Chinook salmon at Grayson and daily average water temperature at Shiloh during 2007.

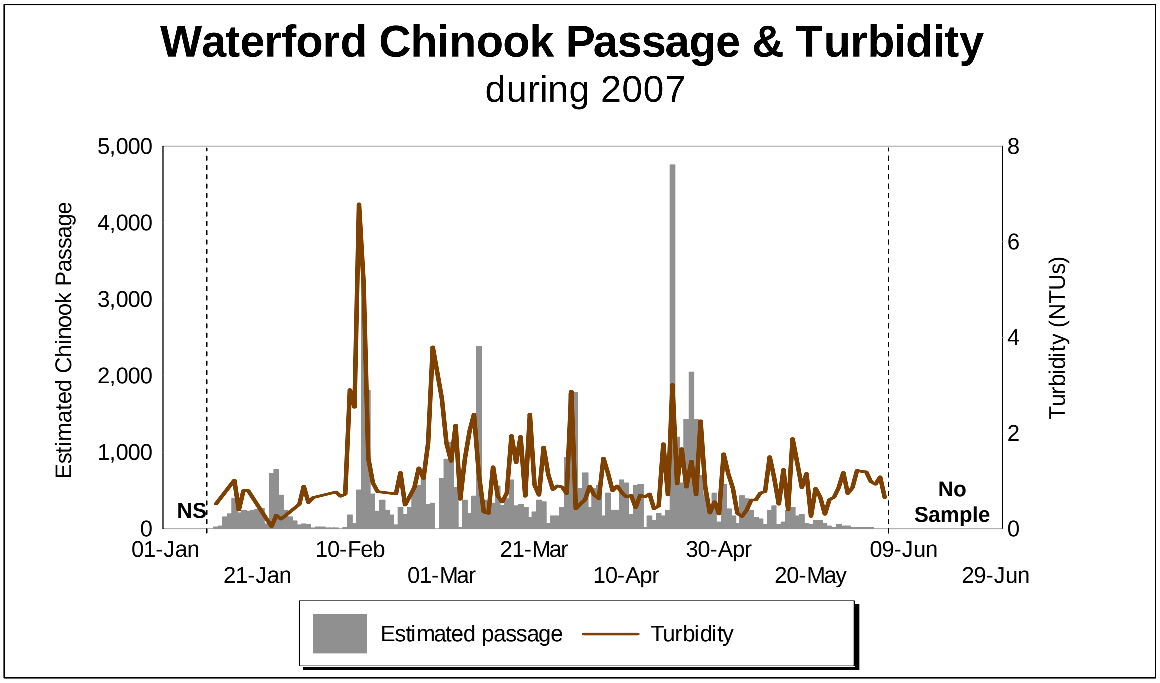

Figure 14. Daily estimated passage of unmarked Chinook salmon and instantaneous turbidity at Waterford during 2007.

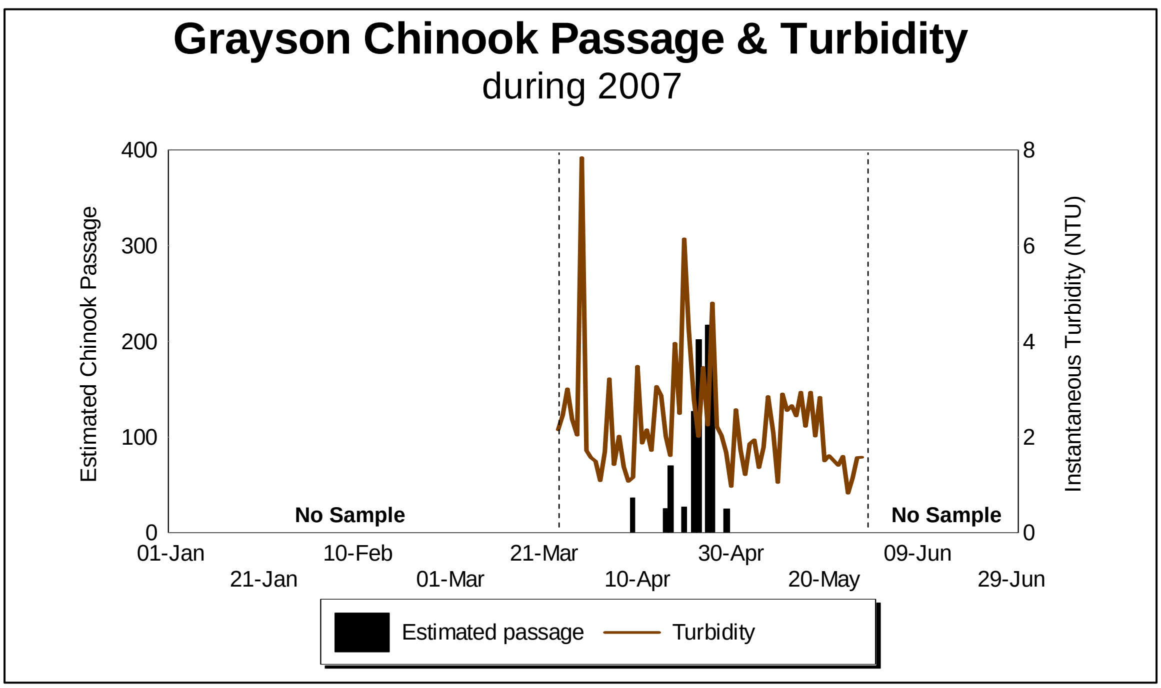

Figure 15. Daily estimated passage of unmarked Chinook salmon and instantaneous turbidity at Grayson during 2007.

Chinook Salmon Length at Migration

Individual forklengths of unmarked salmon captured at Waterford during 2007 ranged from 29 mm to 166 mm (Figure 16), and average length gradually increased from approximately 34 mm to 89 mm over the course of the sampling period (Figure 17 and Figure 18). Most of the juvenile salmon passing Waterford during 2007 were smolts measuring 70-89 mm or fry measuring 30-39 mm (Figure 21). In total, it is estimated that 20,633 fry (<50 mm), 7,614 parr (50-69 mm), and 29,554 smolts (≥70 mm) passed Waterford during 2007.

Individual forklengths of unmarked Chinook salmon captured at Grayson during 2007 ranged from 76 mm to 91 mm (Figure 19), and average length fluctuated between 76 mm and 90 mm during the sampling period (Figure 18 and Figure 20). Nearly 75% of the salmon estimated to have passed Grayson during 2007 measured 80-89 mm, however, the length frequency distribution does not include salmon which may have migrated prior to the initiation of sampling in late March and may not accurately represent the 2007 outmigration.

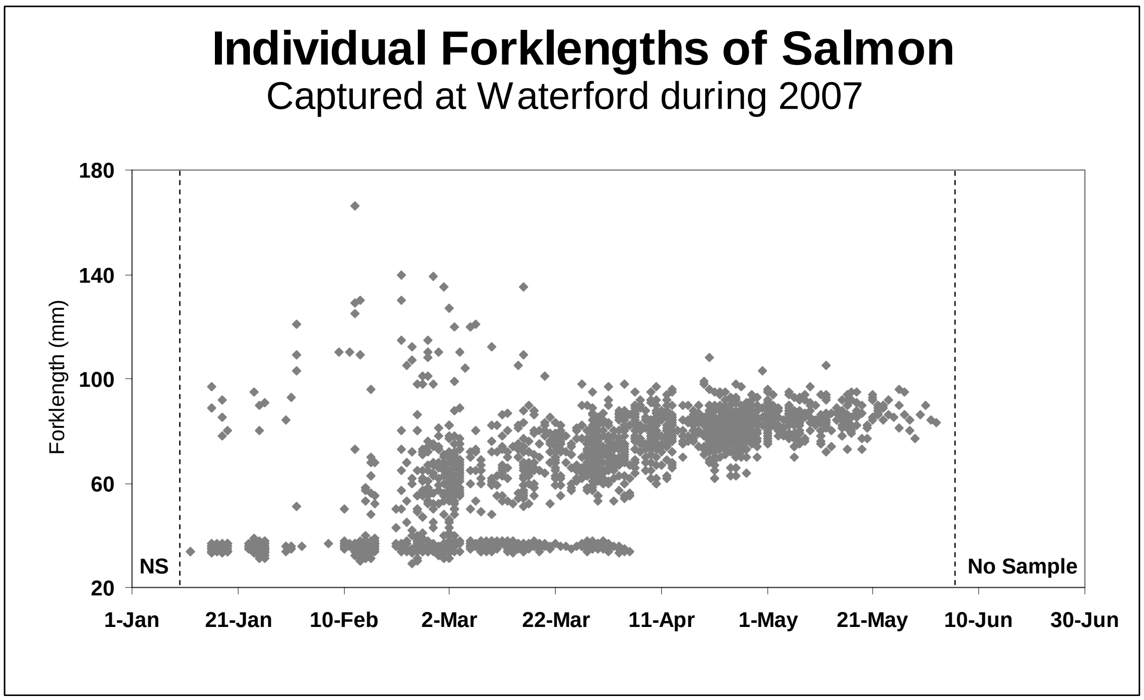

Figure 16. Individual forklengths of juvenile salmon captured at Waterford during 2007.

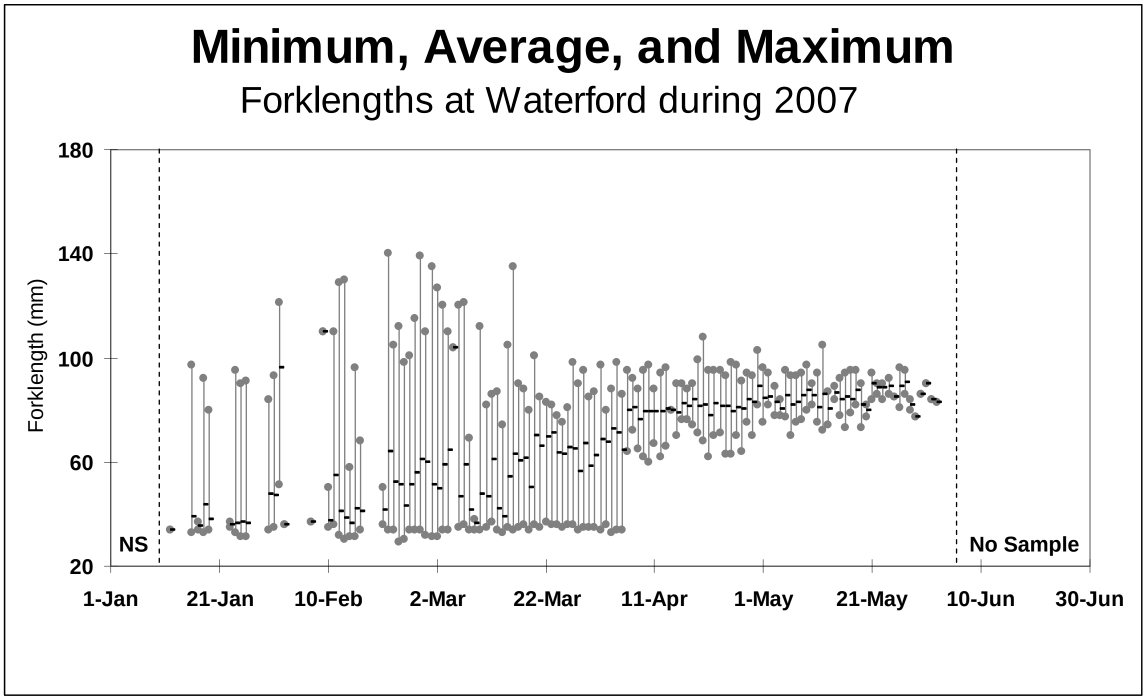

Figure 17. Daily minimum, average, and maximum fork lengths of unmarked Chinook salmon captured at Waterford during 2007.

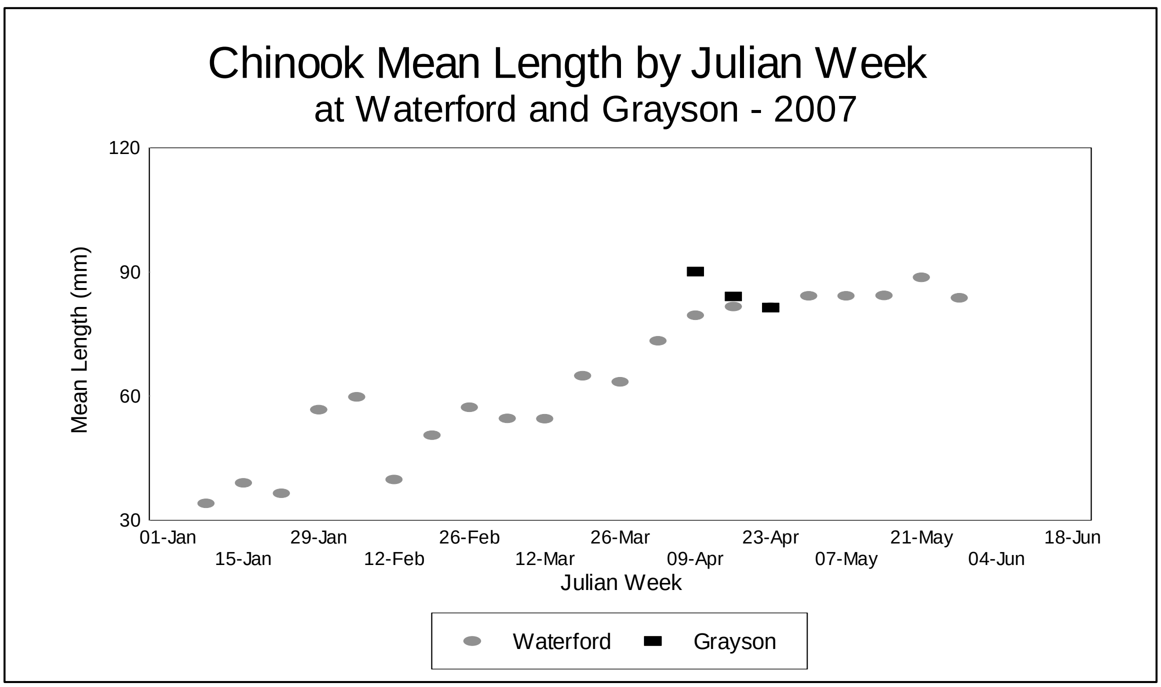

Figure 18. Average forklength of juvenile Chinook salmon captured at Waterford and Grayson by Julian week during 2007.

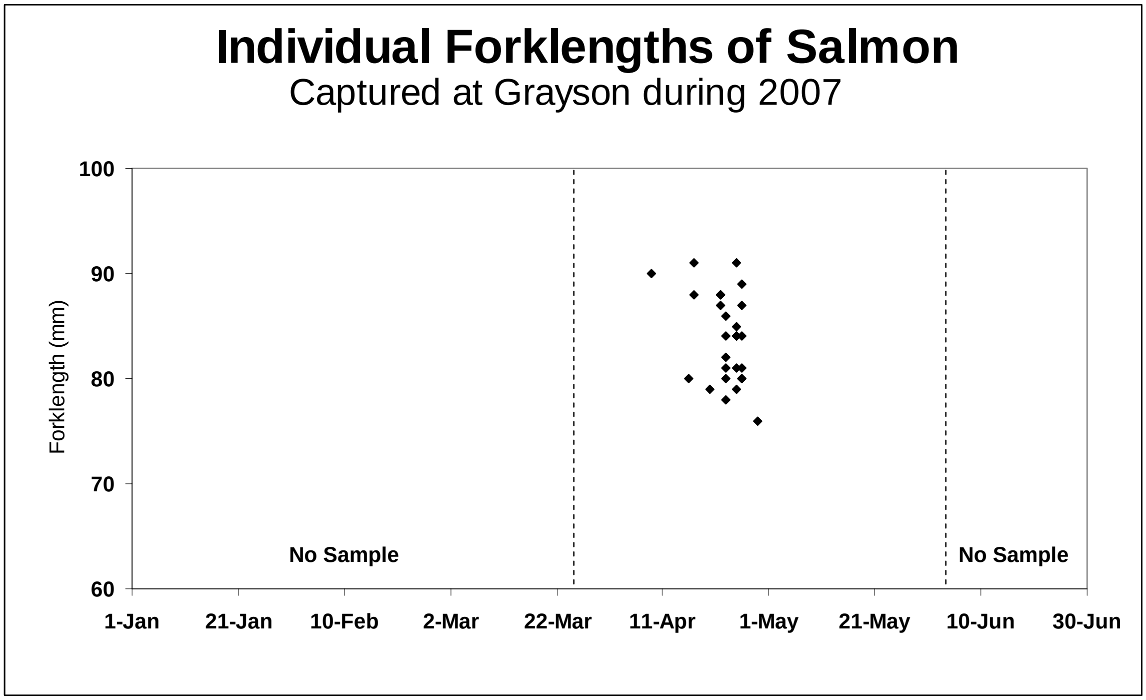

Figure 19. Individual forklengths of juvenile salmon captured at Grayson during 2007.

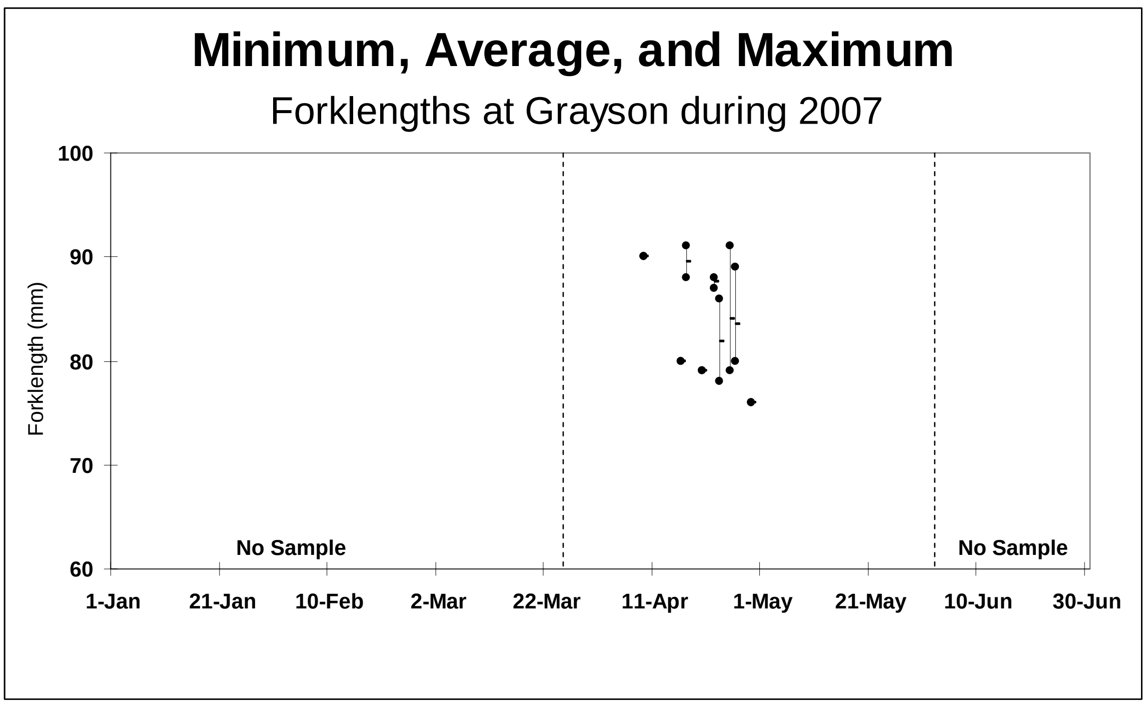

Figure 20. Daily minimum, average, and maximum fork lengths of unmarked Chinook salmon captured at Grayson during 2007.

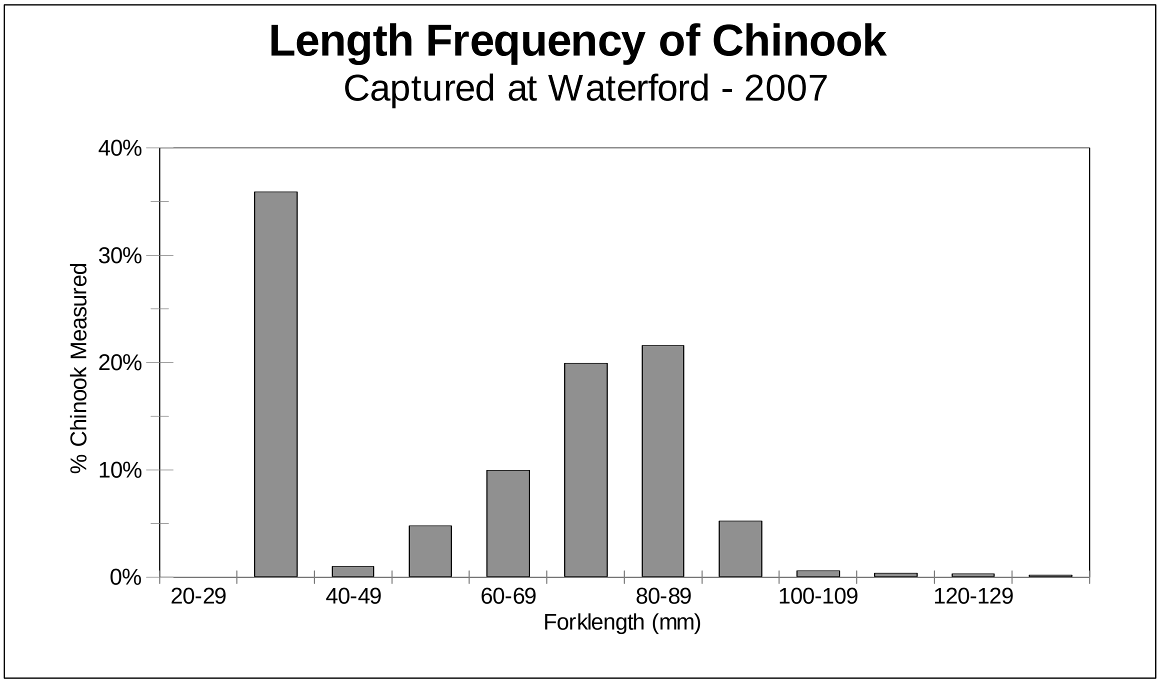

Figure 21. Estimated Chinook passage by 10 mm fork length intervals at Waterford during 2007.

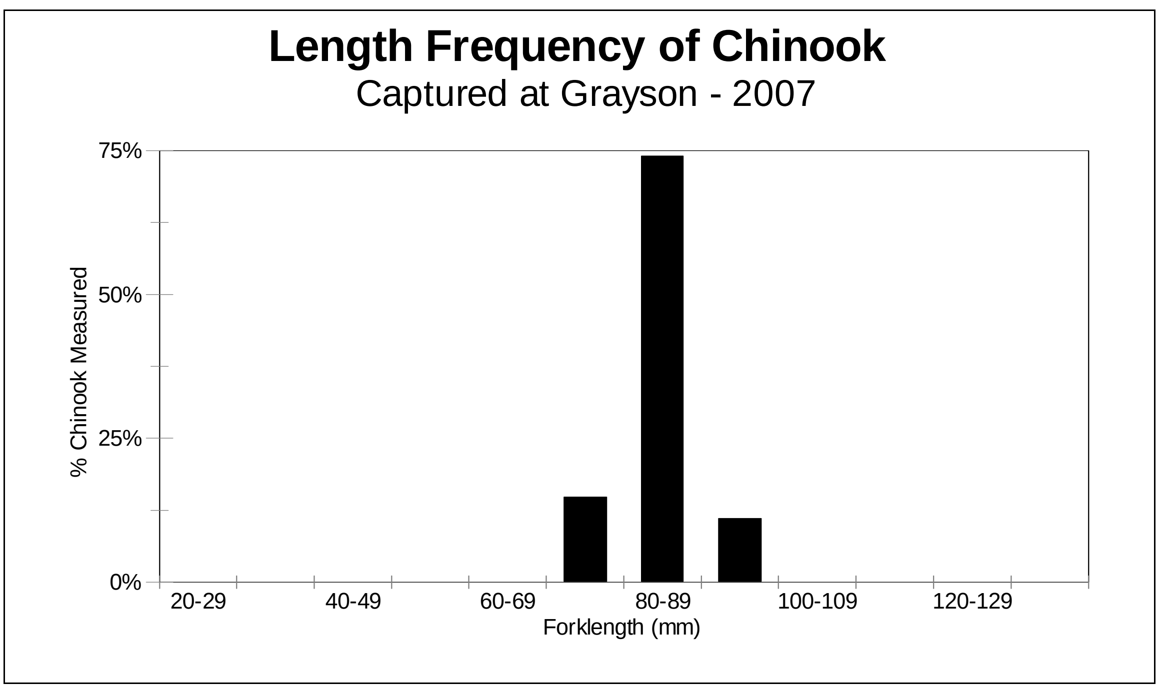

Figure 22. Estimated Chinook passage by 10 mm fork length intervals at Grayson during 2007.

Chinook Salmon Condition at Migration

Juveniles captured at both Waterford and Grayson during 2007 were generally healthy with no apparent signs of disease or stress. Trends in individual salmon smolt forklength to weight completely overlapped between Waterford and Grayson (Figure 23).

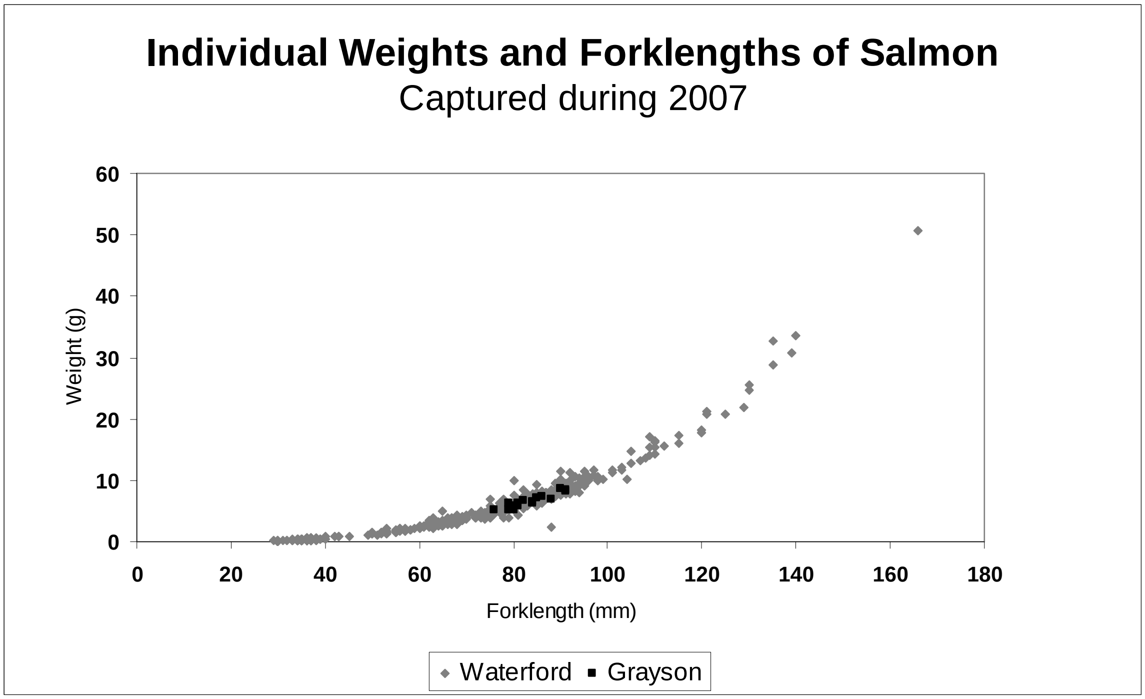

Figure 23. Individual forklength and weight of individual juvenile Chinook salmon measure at Waterford and Grayson during 2007.

Oncorhynchus mykiss (Rainbow Trout)

Nine *O. mykiss* were captured at Waterford between February 20 and June 5, 2007 (Table 5). Four *O. mykiss* were classified as young-of-the-year (<100 mm; range: 35 mm to 77 mm), one was classified as Age 1+ (100 mm-299 mm; range: 195 mm) and the remaining four *O. mykiss* were classified as adults ($\geq$300 mm; range: 310 mm to 360 mm).

At Grayson, no *O. mykiss* were captured during 2007.

Table 5. Length, weight, and smolt index of O. mykiss captured at Waterford during 2007.

Date	Fork Length (mm)	Total Length (mm)	Weight (g)	Smolt Index*	Mortality
20-Feb-07	195.0	205.0	74.2	5	No
22-Apr-07	64.0	67.0	2.2	3	No
23-Apr-07	43.0	45.0	0.8	2	No
27-Apr-07	310.0	315.0	317.6	IAD	No
2-May-07	35.0	36.0	0.3	2	No
3-May-07	320.0	334.0	433.7	IAD	No
15-May-07	360.0	375.0	621.7	IAD	No
18-May-07	77.0	80.0	5.4	3	No
5-Jun-07	325.0	345.0	439.0	IAD	No

*Smolt index 1=yolk-sac fry; 2=fry; 3=parr; 4=silvery parr; 5=smolt; 6=mature adult; IAD= immature adult

Other Fish Species Captured

A total of 4,944 non-salmonids representing at least 18 species (6 native, 12 introduced) were captured during operation of the Waterford and Grayson traps in 2007 (Table 6; Appendices C and D). Native species comprised 94% of the total non-salmonid catch, consisting primarily of Sacramento sucker (n= 3,784). Species captured only at Waterford were brown bullhead, prickly sculpin, riffle sculpin, and lamprey; and those recorded only at Grayson were channel catfish, carp, smallmouth bass, and warmouth. Lamprey captured in the traps were primarily ammocoetes and were not identified to species or measured.

Table 6. Non-salmonid species captured at Waterford and Grayson during 2007. Native species are indicated in bold.

		Waterford				Grayson			
Common Name	Scientific Name	Total Catch	Minimum Length (mm)	Average Length (mm)	Maximum Length (mm)	Total Catch	Minimum Length (mm)	Average Length (mm)	Maximum Length (mm)
Catfish Family									
Brown Bullhead	*Ictalurus nebulosus*	1	190	190	190	0	-	-	-
Channel catfish	*Ictalurus punctatus*	0	-	-	-	9	49	286	550
White catfish	*Ictalurus catus*	7	172	216	270	78	30	84	278
Hering Family									
Threadfin shad	*Dorosoma petenense*	1	109	109	109	1	98	98	98
Lamprey Family									
Lamprey - unidentified species	**Not applicable**	**26**	-	-	-	**0**	-	-	-
Livebearer Family									
Mosquitofish	*Gambusia affinis*	1	28	28	28	2	29	34	38
Minnow Family									
Carp	*Cyprinus carpio*	0	-	-	-	2	24	272	520
Hardhead	***Mylopharodon conocephalus***	**557**	**28**	**41**	**145**	**41**	**30**	**44**	**60**
Golden shiner	*Notemigonus crysoleucas*	3	44	63	100	3	66	77	83
Red shiner	*Cyprinella lutrennsis*	7	36	47	60	18	30	48	115
Sacramento pikeminnow	***Ptychochelius grandis***	**150**	**30**	**50**	**137**	**25**	**28**	**52**	**78**
Sculpin Family									
Prickly Sculpin	***Cottus asper***	**87**	**53**	**72**	**100**	**0**	-	-	-
Riffle sculpin	***Cottus gulosus***	**6**	**69**	**80**	**87**	**0**	-	-	-
Sucker Family									
Sacramento sucker	***Catostomus occidentalis***	**128**	**24**	**48**	**427**	**3,656**	**13**	**27**	**46**
Sunfish Family									
Bluegill	*Lepomis macrochirus*	9	47	66	134	3	116	139	160
Largemouth bass	*Micropterus salmoides*	4	23	25	25	54	18	28	85
Smallmouth bass	*Micropterus dolomieu*	0	-	-	-	49	18	35	142
Warmouth	*Lepomis gulosus*	0	-	-	-	2	67	74	80
Unidentified bass	Not applicable	0	-	-	-	6	18	22	27
Unidentified species	Not applicable	0	-	-	-	8	10	22	26

REFERENCES CITED

Blakeman, D. 2004a. 1998 juvenile Chinook salmon capture and production indices using rotary-screw traps on the lower Tuolumne River. California Department of Fish and Game, Technical report submitted to Tuolumne River Technical Advisory Committee, Turlock, CA.

Blakeman, D. 2004b. 2002 juvenile Chinook salmon capture and production indices using rotary-screw traps on the lower Tuolumne River. California Department of Fish and Game, Technical report submitted to Tuolumne River Technical Advisory Committee, Turlock, CA.

Blakeman, D. 2004c. 2003 juvenile Chinook salmon capture and production indices using rotary-screw traps on the lower Tuolumne River. California Department of Fish and Game, Technical report submitted to Tuolumne River Technical Advisory Committee, Turlock, CA.

Fuller, A.N. 2005. Outmigrant trapping of juvenile salmonids in the lower Tuolumne River at Grayson 2004. S.P. Cramer & Associates, Gresham, OR. Final Report submitted to Turlock and Modesto Irrigation Districts.

Fuller, A.N., M. Simpson, and C. Sonke. 2006. Outmigrant trapping of juvenile salmonids in the lower Tuolumne River at Grayson 2005. S.P. Cramer & Associates, Gresham, OR. Final Report submitted to Turlock and Modesto Irrigation Districts.

Fuller, A.N., M. Simpson, and C. Sonke. 2007. Outmigrant trapping of juvenile salmonids in the lower Tuolumne River at Grayson 2006. FISHBIO Environmental, Chico, CA. Final Report submitted to Turlock and Modesto Irrigation Districts.

Heyne, T. and W. Loudermilk. 1997. Rotary screw trap capture of Chinook salmon smolts on the Tuolumne River in 1995 and 1996: Contribution of assessment of survival and production estimates. Federal Energy Regulatory Commission annual report, FERC project #2299-024.

Heyne, T. and W. Loudermilk. 1998. Rotary screw trap capture of Chinook salmon smolts with survival and production indices for the Tuolumne River in 1997. Federal Energy Regulatory Commission annual report, FERC project #2299-024.

Hume, N., P. Baker, A. Keith, J. Vick, and T. Ford. 2001. 2000 Lower Tuolumne River annual Report, Report 2000-4 2000, Lower Tuolumne River Smolt Survival and Upper Screw Traps Report. March 2001.

Vasques, J. and K. Kundargi. 2001. 1999-2000 Grayson Screw Trap Report. California Department of Fish and Game Anadromous Fisheries Project, San Joaquin Valley Southern Sierra Region (Region 4). March 2001.

Vasques, J. and K. Kundargi. 2002. 2001 Juvenile Chinook capture and production indices using rotary screw traps on the lower Tuolumne River. California Department of Fish and Game, San Joaquin Valley Southern Sierra Region, Anadromous Fisheries Program.

Vick, J., P. Baker, and T. Ford. 1998. 1998 Lower Tuolumne river Annual Report, Report 98-3, 1998 Tuolumne River Outmigrant Trapping Report. December 1998

Vick., V, A. Keith, and P. Baker. 2000. 1999 Lower Tuolumne River Annual Report, Report 99-5, 1999 Tuolumne River Upper Rotary Screw Trap Report. March 2000.

Appendix A. Daily Chinook catch, length, and passage at Waterford and environmental data from 2007.

	Unmarked Salmon											*Environmental Conditions*					
	Catch			Forklength (mm)				Estimated Passage				Flow					
Date	Observed	Missing	Adjusted	Min	Avg	Max	Est. Efficiency	Fry	Parr	Smolt	Total	La Grange	Hickman Spill	Trap Site	Velocity (ft/s)	Temperature at Hickman Bridge	Turbidity
12-Jan	2		2	34	34.0	34	0.0768	26	0	0	26	345	0	345	3.00	47.26	0.52
13-Jan	ns	3	3	-	-	-	0.0768	39	0	0	39	343	0	343	ns	45.75	ns
14-Jan	ns	12	12	-	-	-	0.0768	145	0	11	156	342	0	342	ns	45.71	ns
15-Jan	ns	15	15	-	-	-	0.0768	181	0	14	195	342	0	342	ns	46.14	ns
16-Jan	31		31	33	39.1	97	0.0768	375	0	29	404	342	0	342	2.26	46.72	1.02
17-Jan	16		16	34	35.4	37	0.0768	193	0	15	208	345	0	345	3.07	47.66	0.39
18-Jan	19		19	33	43.5	92	0.0768	230	0	18	247	362	0	362	2.80	47.96	0.80
19-Jan	18		18	34	37.8	80	0.0768	218	0	17	234	359	0	359	3.40	48.19	0.80
20-Jan	ns	19	19	-	-	-	0.0768	230	0	18	247	360	0	360	ns	48.57	ns
21-Jan	ns	20	20	-	-	-	0.0768	253	0	7	260	360	0	360	ns	48.62	ns
22-Jan	ns	21	21	-	-	-	0.0768	266	0	8	273	360	0	360	ns	48.70	ns
23-Jan	5		5	35	35.8	37	0.0768	63	0	2	65	360	0	360	2.58	48.98	0.21
24-Jan	56		56	33	36.5	95	0.0768	709	0	21	729	359	0	359	-	49.33	0.05
25-Jan	60		60	31	36.7	90	0.0768	759	0	22	781	358	0	358	-	49.81	0.29
26-Jan	34		34	31	36.5	91	0.0768	430	0	12	443	357	0	357	3.00	50.22	0.20
27-Jan	ns	19	19	-	-	-	0.0768	240	0	7	247	358	0	358	ns	50.37	ns
28-Jan	ns	12	12	-	-	-	0.0768	89	11	56	156	357	0	357	ns	51.44	ns
29-Jan	ns	8	8	-	-	-	0.0768	60	7	37	104	356	0	356	ns	51.88	ns
30-Jan	4		4	34	47.5	84	0.0768	30	4	19	52	356	0	356	ns	51.34	0.51
31-Jan	5		5	35	47.0	93	0.0768	37	5	23	65	356	0	356	ns	51.19	0.89
1-Feb	3		3	51	96.0	121	0.0532	32	4	20	56	357	0	357	ns	50.51	0.55
2-Feb	1		1	36	36.0	36	0.0768	7	1	5	13	357	0	357	ns	50.03	0.65
3-Feb	ns	2	2	-	-	-	0.0768	15	2	9	26	358	0	358	ns	50.43	ns
4-Feb	ns	2	2	-	-	-	0.0768	22	1	3	26	357	0	357	ns	51.09	ns
5-Feb	ns	1	1	-	-	-	0.0768	11	1	1	13	357	0	357	ns	51.45	ns
6-Feb	ns	1	1	-	-	-	0.0768	11	1	1	13	357	0	357	ns	51.83	ns
7-Feb	1		1	37	37.0	37	0.0768	11	1	1	13	356	0	356	ns	51.52	0.77
8-Feb	0		0	-	-	-	0.0768	0	0	0	0	356	0	356	2.74	51.45	0.68
9-Feb	1		1	110	110.0	110	0.0532	16	1	2	19	357	0	357	2.75	52.15	0.72

	Unmarked Salmon												Environmental Conditions					
	Catch			Forklength (mm)				Estimated Passage				Flow					
Date	Observed	Missing	Adjusted	Min	Avg	Max	Est. Efficiency	Fry	Parr	Smolt	Total	La Grange	Hickman Spill	Trap Site	Velocity (ft/s)	Temperature at Hickman Bridge	Turbidity
10-Feb	14		14	35	37.2	50	0.0768	155	9	18	182	356	0	356	3.25	53.17	2.91
11-Feb	4		4	36	54.8	110	0.0532	69	4	2	75	357	0	357	2.90	54.19	2.54
12-Feb	39		39	32	40.8	129	0.0768	464	28	16	508	357	0	357	-	53.43	6.79
13-Feb	246		246	30	38.3	130	0.0768	2927	175	102	3203	356	0	356	2.90	52.87	5.13
14-Feb	139		139	31	36.6	58	0.0768	1654	99	58	1810	356	0	356	2.54	52.57	1.48
15-Feb	35		35	31	41.8	96	0.0768	416	25	15	456	358	0	358	3.10	52.94	0.96
16-Feb	18		18	34	41.1	68	0.0768	214	13	7	234	358	0	358	3.26	53.74	0.78
17-Feb	ns	29	29	-	-	-	0.0768	345	21	12	378	358	0	358	ns	54.29	ns
18-Feb	ns	19	19	-	-	-	0.0768	161	45	41	247	357	0	357	ns	54.28	ns
19-Feb	ns	14	14	-	-	-	0.0768	119	33	30	182	358	0	358	ns	53.13	ns
20-Feb	4		4	36	41.5	50	0.0768	34	10	9	52	358	0	358	3.10	53.13	0.73
21-Feb	15		15	34	63.9	140	0.0532	184	51	47	282	359	0	359	2.95	53.45	1.18
22-Feb	10		10	34	52.0	105	0.0532	123	34	31	188	360	0	360	3.20	52.84	0.50
23-Feb	15		15	29	50.9	112	0.0532	184	51	47	282	359	0	359	3.00	51.91	-
24-Feb	41		41	30	43.2	98	0.0768	348	97	88	534	358	0	358	3.38	52.07	0.86
25-Feb	30		30	34	51.1	101	0.0532	211	246	108	564	358	0	358	3.30	52.03	1.28
26-Feb	35		35	34	55.7	115	0.0532	246	287	126	658	359	0	359	3.48	51.12	1.05
27-Feb	17		17	34	60.9	139	0.0532	119	139	61	319	358	0	358	3.30	52.06	1.79
28-Feb	18		18	32	59.8	110	0.0532	126	147	65	338	358	0	358	3.10	52.59	3.80
1-Mar	35		35	31	51.4	135	0.0532	246	287	126	658	358	0	358	2.83	52.27	2.72
2-Mar	70		70	31	49.5	127	0.0768	340	397	174	911	359	0	359	3.20	52.62	1.78
3-Mar	60		60	34	58.6	120	0.0532	421	491	215	1128	358	0	358	3.27	53.89	1.41
4-Mar	29		29	34	64.4	110	0.0532	435	62	49	545	359	0	359	3.34	54.90	2.17
5-Mar	1		1	104	104.0	104	0.0532	15	2	2	19	359	0	359	3.30	56.28	0.62
6-Mar	29		29	35	46.8	120	0.0768	301	43	34	378	358	0	358	2.74	56.91	1.47
7-Mar	11		11	36	58.8	121	0.0532	165	23	18	207	359	0	359	2.93	57.33	2.04
8-Mar	33		33	34	41.6	69	0.0768	343	49	38	430	360	0	360	3.20	56.88	2.40
9-Mar	183		183	34	36.3	38	0.0768	1901	269	213	2383	357	0	357	2.92	55.40	1.18
10-Mar	29		29	34	47.8	112	0.0768	301	43	34	378	355	0	355	2.92	55.12	0.35

	Unmarked Salmon												*Environmental Conditions*				
	Catch			Forklength (mm)				Estimated Passage				Flow					
Date	Observed	Missing	Adjusted	Min	Avg	Max	Est. Efficiency	Fry	Parr	Smolt	Total	La Grange	Hickman Spill	Trap Site	Velocity (ft/s)	Temperature at Hickman Bridge	Turbidity
11-Mar	15		15	35	46.3	82	0.0768	96	56	43	195	355	0	355	3.23	56.33	0.32
12-Mar	18		18	37	60.7	86	0.0532	167	97	75	338	355	0	355	3.00	57.33	1.30
13-Mar	43		43	34	42.0	87	0.0768	277	160	123	560	355	0	355	2.70	57.98	0.69
14-Mar	24		24	33	38.9	74	0.0768	154	89	69	313	355	0	355	2.92	58.41	0.56
15-Mar	21		21	35	54.3	105	0.0532	195	113	87	395	364	0	364	2.73	58.39	0.75
16-Mar	34		34	34	62.9	135	0.0532	316	183	141	639	363	0	363	3.04	58.50	1.95
17-Mar	16		16	35	60.3	90	0.0532	149	86	66	301	353	0	353	2.86	59.08	1.38
18-Mar	17		17	36	61.6	88	0.0532	62	84	173	319	353	0	353	3.00	59.05	1.93
19-Mar	15		15	34	50.3	80	0.0532	55	75	152	282	352	0	352	2.70	58.61	0.68
20-Mar	8		8	36	70.1	101	0.0532	29	40	81	150	352	0	352	2.66	56.76	2.40
21-Mar	12		12	35	66.2	85	0.0532	44	60	122	226	348	0	348	3.12	55.40	0.92
22-Mar	20		20	37	69.5	83	0.0532	73	99	203	376	350	0	350	2.80	56.11	0.70
23-Mar	19		19	36	70.9	82	0.0532	70	94	193	357	349	0	349	2.50	57.63	1.71
24-Mar	4		4	36	63.5	78	0.0532	15	20	41	75	350	0	350	2.35	58.69	1.14
25-Mar	9		9	35	63.0	75	0.0532	45	54	71	169	351	0	351	2.57	58.43	0.82
26-Mar	9		9	36	65.7	81	0.0532	45	54	71	169	350	0	350	2.50	57.83	0.90
27-Mar	15		15	36	65.2	98	0.0532	74	90	118	282	349	0	349	2.57	56.57	0.88
28-Mar	50		50	34	56.1	90	0.0532	248	299	393	940	348	0	348	2.40	55.34	0.74
29-Mar	94		94	35	67.3	95	0.0532	466	561	739	1767	349	0	349	2.56	56.21	2.88
30-Mar	95		95	35	58.1	85	0.0532	471	567	747	1785	349	0	349	2.40	57.66	0.42
31-Mar	28		28	35	62.6	87	0.0532	139	167	220	526	350	0	350	2.87	58.49	0.52
1-Apr	39		39	34	68.4	97	0.0532	44	154	535	733	351	0	351	2.83	59.08	0.61
2-Apr	15		15	36	67.6	80	0.0532	17	59	206	282	350	0	350	2.70	58.80	0.89
3-Apr	28		28	33	72.5	88	0.0532	32	111	384	526	349	0	349	2.90	59.04	0.71
4-Apr	30		30	34	70.9	98	0.0532	34	119	411	564	349	0	349	2.65	59.02	0.63
5-Apr	9		9	34	64.3	86	0.0532	10	36	123	169	348	0	348	2.86	58.84	1.48
6-Apr	25		25	64	80.0	95	0.0532	28	99	343	470	349	0	349	2.80	59.73	1.15
7-Apr	13		13	72	80.8	92	0.0532	15	51	178	244	350	0	350	2.88	60.66	0.79
8-Apr	13		13	65	76.4	88	0.0532	0	23	221	244	350	0	350	3.12	60.25	0.90

Date	Unmarked Salmon											Environmental Conditions					
	Catch			Forklength (mm)				Estimated Passage				Flow					
Date	Observed	Missing	Adjusted	Min	Avg	Max	Est. Efficiency	Fry	Parr	Smolt	Total	La Grange	Hickman Spill	Trap Site	Velocity (ft/s)	Temperature at Hickman Bridge	Turbidity
9-Apr	34		34	62	79.3	95	0.0532	0	61	578	639	350	0	350	2.80	59.78	0.76
10-Apr	32		32	60	79.2	97	0.0532	0	57	544	601	351	0	351	2.60	59.13	0.67
11-Apr	10		10	67	79.3	88	0.0532	0	18	170	188	355	0	355	3.20	57.99	0.70
12-Apr	30		30	62	79.2	94	0.0532	0	54	510	564	353	0	353	3.08	56.63	0.44
13-Apr	31		31	66	80.5	96	0.0532	0	55	527	583	352	0	352	2.89	57.62	0.71
14-Apr	1		1	80	80.0	80	0.0532	0	2	17	19	352	0	352	2.82	56.53	0.67
15-Apr	9		9	70	78.8	90	0.0532	0	7	162	169	304	0	304	3.15	56.02	0.73
16-Apr	6		6	76	82.3	90	0.0532	0	5	108	113	303	0	303	2.50	58.93	0.42
17-Apr	11		11	76	81.5	88	0.0532	0	9	198	207	303	0	303	2.75	60.11	0.48
18-Apr	9		9	74	83.9	90	0.0532	0	7	162	169	303	0	303	2.50	58.41	1.78
19-Apr	13		13	71	81.3	99	0.0532	0	10	234	244	590	0	590	2.40	56.25	0.71
20-Apr	253		253	68	81.9	108	0.0532	0	202	4553	4755	863	0	863	4.56	54.09	3.02
21-Apr	64		64	62	77.6	95	0.0532	0	51	1152	1203	870	0	870	4.33	54.22	0.94
22-Apr	32		32	70	82.1	95	0.0532	0	14	588	601	870	0	870	4.32	54.51	1.68
23-Apr	76		76	71	81.5	95	0.0532	0	33	1396	1428	866	0	866	4.06	54.99	0.87
24-Apr	109		109	63	81.2	93	0.0532	0	47	2002	2048	860	0	860	4.09	56.32	1.42
25-Apr	76		76	63	79.1	98	0.0532	0	33	1396	1428	774	0	774	3.90	56.48	0.71
26-Apr	37		37	70	80.8	97	0.0532	0	16	679	695	637	0	637	3.90	56.98	2.26
27-Apr	23		23	64	80.3	91	0.0532	0	10	422	432	592	0	592	3.40	58.85	0.88
28-Apr	17		17	75	83.6	94	0.0532	0	7	312	319	591	0	591	4.06	59.67	0.33
29-Apr	25		25	70	83.0	93	0.0532	0	0	470	470	486	0	486	3.60	60.17	0.57
30-Apr	5		5	82	88.8	103	0.0532	0	0	94	94	406	0	406	3.44	60.58	0.31
1-May	31		31	75	84.6	96	0.0532	0	0	583	583	326	0	326	3.16	60.74	1.57
2-May	14		14	82	85.0	94	0.0532	0	0	263	263	322	0	322	2.87	59.81	1.15
3-May	9		9	78	82.8	89	0.0532	0	0	169	169	372	0	372	2.95	57.53	0.85
4-May	4		4	78	80.5	84	0.0532	0	0	75	75	412	0	412	3.31	56.19	0.32
5-May	23		23	77	85.4	95	0.0532	0	0	432	432	377	0	377	3.00	56.59	0.26
6-May	21		21	70	81.9	93	0.0532	0	0	395	395	341	0	341	3.21	59.58	0.39
7-May	13		13	75	83.0	93	0.0532	0	0	244	244	286	0	286	3.16	62.10	0.60

Date	*Unmarked Salmon*												*Environmental Conditions*					
	Catch			Forklength (mm)				Estimated Passage				Flow					
	Observed	Missing	Adjusted	Min	Avg	Max	Est. Efficiency	Fry	Parr	Smolt	Total	La Grange	Hickman Spill	Trap Site	Velocity (ft/s)	Temperature at Hickman Bridge	Turbidity
8-May	8		8	76	85.5	94	0.0532	0	0	150	150	287	0	287	2.81	64.67	0.60
9-May	7		7	80	87.7	97	0.0532	0	0	132	132	288	0	288	2.49	65.95	0.75
10-May	3		3	82	85.3	90	0.0532	0	0	56	56	301	0	301	2.55	65.77	0.78
11-May	13		13	75	81.1	94	0.0532	0	0	244	244	385	0	385	3.10	64.73	1.51
12-May	16		16	72	86.0	105	0.0532	0	0	301	301	469	0	469	3.00	61.89	1.07
13-May	3		3	74	80.3	87	0.0532	0	0	56	56	565	0	565	4.06	59.99	0.51
14-May	5		5	84	86.6	89	0.0532	0	0	94	94	579	0	579	4.16	60.12	1.24
15-May	13		13	78	84.1	92	0.0532	0	0	244	244	590	0	590	3.89	60.21	0.40
16-May	15		15	73	85.1	94	0.0532	0	0	282	282	593	0	593	3.68	59.88	1.89
17-May	9		9	79	84.1	95	0.0532	0	0	169	169	593	0	593	3.81	59.81	1.38
18-May	10		10	82	87.7	95	0.0532	0	0	188	188	583	0	583	3.80	59.71	0.86
19-May	4		4	73	81.8	90	0.0532	0	0	75	75	589	0	589	3.65	59.95	1.16
20-May	3		3	77	80.0	82	0.0532	0	0	56	56	591	0	591	4.04	60.26	0.26
21-May	6		6	84	90.0	94	0.0532	0	0	113	113	541	0	541	3.85	60.43	0.85
22-May	6		6	86	88.3	90	0.0532	0	0	113	113	447	0	447	3.00	60.38	0.66
23-May	4		4	84	88.3	90	0.0532	0	0	75	75	363	0	363	2.36	61.25	0.30
24-May	2		2	86	89.0	92	0.0532	0	0	38	38	290	0	290	2.21	62.81	0.61
25-May	1		1	85	85.0	85	0.0532	0	0	19	19	229	0	229	1.45	64.93	0.66
26-May	3		3	81	89.0	96	0.0532	0	0	56	56	232	0	232	1.49	67.14	0.86
27-May	2		2	86	90.5	95	0.0532	0	0	38	38	234	0	234	1.67	68.02	1.18
28-May	2		2	80	82.0	84	0.0532	0	0	38	38	234	0	234	1.40	68.41	0.74
29-May	1		1	77	77.0	77	0.0532	0	0	19	19	234	0	234	1.10	68.92	0.86
30-May	1		1	86	86.0	86	0.0532	0	0	19	19	229	0	229	1.61	67.98	1.22
31-May	1		1	90	90.0	90	0.0532	0	0	19	19	203	0	203	1.40	67.44	1.20
1-Jun	1		1	84	84.0	84	0.0532	0	0	19	19	187	0	187	1.35	68.10	1.19
2-Jun	1		1	83	83.0	83	0.0532	0	0	19	19	180	0	180	1.50	68.84	0.99
3-Jun	0		0	-	-	-	0.0532	0	0	0	0	180	0	180	1.46	69.83	0.93
4-Jun	0		0	-	-	-	0.0532	0	0	0	0	161	0	161	1.20	70.43	1.09
5-Jun	0		0	-	-	-	0.0532	0	0	0	0	126	0	126	1.00	68.57	0.65

Appendix B. Daily Chinook catch, length, predicted trap efficiency, and passage at Grayson and environmental data from 2007.

	Unmarked Salmon									*Environmental Conditions*				
	Catch	Forklength (mm)				Estimated Passage					Velocity (ft/s)			
Date	Observed	Min	Avg	Max	Est. Efficiency	Fry	Parr	Smolt	Total	Flow at Modesto (CFS)	North	South	Temperature at Shiloh Bridge	Turbidity
24-Mar	0	-	-	-	-	0	0	0	0	562	1.32	1.37	60.19	2.15
25-Mar	0	-	-	-	-	0	0	0	0	529	1.19	1.20	60.32	2.46
26-Mar	0	-	-	-	-	0	0	0	0	537	1.30	1.10	60.06	3.01
27-Mar	0	-	-	-	-	0	0	0	0	555	1.26	1.22	57.92	2.38
28-Mar	0	-	-	-	-	0	0	0	0	511	1.01	1.36	56.55	2.04
29-Mar	0	-	-	-	-	0	0	0	0	506	1.20	1.10	57.29	7.84
30-Mar	0	-	-	-	-	0	0	0	0	499	1.10	1.50	58.72	1.72
31-Mar	0	-	-	-	-	0	0	0	0	503	1.32	1.31	60.02	1.57
1-Apr	0	-	-	-	-	0	0	0	0	507	1.15	1.21	61.05	1.49
2-Apr	0	-	-	-	-	0	0	0	0	501	1.40	1.30	60.89	1.09
3-Apr	0	-	-	-	-	0	0	0	0	482	1.30	1.30	61.75	1.70
4-Apr	0	-	-	-	-	0	0	0	0	483	1.10	1.27	61.95	3.22
5-Apr	0	-	-	-	-	0	0	0	0	479	1.10	1.10	62.01	1.42
6-Apr	0	-	-	-	-	0	0	0	0	473	1.10	1.30	62.72	2.02
7-Apr	0	-	-	-	-	0	0	0	0	473	1.27	1.48	63.48	1.38
8-Apr	0	-	-	-	-	0	0	0	0	483	1.21	1.33	62.77	1.07
9-Apr	1	90	90.0	90	0.032471	0	0	36	36	487	1.14	1.35	62.68	1.16
10-Apr	0	-	-	-	-	0	0	0	0	477	1.00	1.20	61.76	3.48
11-Apr	0	-	-	-	-	0	0	0	0	519	1.20	1.10	60.57	1.87
12-Apr	0	-	-	-	-	0	0	0	0	538	1.50	1.50	58.42	2.15
13-Apr	0	-	-	-	-	0	0	0	0	503	1.10	1.10	59.35	1.72
14-Apr	0	-	-	-	-	0	0	0	0	513	1.26	1.44	58.44	3.06
15-Apr	0	-	-	-	-	0	0	0	0	536	1.34	1.54	57.17	2.87
16-Apr	1	80	80.0	80	0.046883	0	0	25	25	484	1.17	1.20	59.41	2.01
17-Apr	2	88	89.5	91	0.034924	0	0	70	70	446	0.91	1.10	60.53	1.61
18-Apr	0	-	-	-	-	0	0	0	0	471	1.10	1.20	58.60	3.96
19-Apr	0	-	-	-	-	0	0	0	0	475	1.20	1.20	57.45	2.49
20-Apr	1	79	79.0	79	0.048637	0	0	27	27	737	1.40	1.40	57.37	6.14
21-Apr	0	-	-	-	-	0	0	0	0	964	1.81	2.02	56.03	4.26
22-Apr	3	87	87.7	88	0.036243	0	0	127	127	1040	2.13	2.28	55.15	2.77
23-Apr	6	78	81.8	86	0.050375	0	0	202	202	1010	1.98	2.13	55.73	2.01
24-Apr	0	-	-	-	-	0	0	0	0	1010	2.06	2.03	57.13	3.46
25-Apr	6	79	84.0	91	0.048535	0	0	217	217	993	1.62	1.72	58.22	2.25

Date	Unmarked Salmon									Environmental Conditions				
	Catch	Forklength (mm)				Estimated Passage					Velocity (ft/s)			
	Observed	Min	Avg	Max	Est. Efficiency	Fry	Parr	Smolt	Total	Flow at Modesto (CFS)	North	South	Temperature at Shiloh Bridge	Turbidity
26-Apr	6	80	83.5	89	0.046814	0	0	207	207	925	1.80	1.95	58.94	4.80
27-Apr	0	-	-	-	-	0	0	0	0	828	1.74	1.78	60.81	2.22
28-Apr	0	-	-	-	-	0	0	0	0	799	1.55	1.56	63.15	2.03
29-Apr	1	76	76.0	76	0.054302	0	0	25	25	795	1.49	1.85	64.45	1.68
30-Apr	0	-	-	-	-	0	0	0	0	703	1.53	1.60	64.41	0.97
1-May	0	-	-	-	-	0	0	0	0	605	1.35	1.40	64.02	2.57
2-May	0	-	-	-	-	0	0	0	0	527	1.15	1.33	62.38	1.73
3-May	0	-	-	-	-	0	0	0	0	544	1.35	1.45	59.64	1.21
4-May	0	-	-	-	-	0	0	0	0	596	1.43	1.47	58.89	1.86
5-May	0	-	-	-	-	0	0	0	0	599	1.42	1.65	58.92	1.94
6-May	0	-	-	-	-	0	0	0	0	588	1.43	1.57	60.49	1.36
7-May	0	-	-	-	-	0	0	0	0	516	1.37	1.55	63.45	1.79
8-May	0	-	-	-	-	0	0	0	0	462	1.05	1.32	66.50	2.85
9-May	0	-	-	-	-	0	0	0	0	441	1.13	1.05	68.56	2.08
10-May	0	-	-	-	-	0	0	0	0	430	1.13	1.15	69.08	1.05
11-May	0	-	-	-	-	0	0	0	0	449	1.10	1.10	68.60	2.90
12-May	0	-	-	-	-	0	0	0	0	548	1.20	1.30	67.43	2.55
13-May	0	-	-	-	-	0	0	0	0	641	1.49	1.57	66.18	2.66
14-May	0	-	-	-	-	0	0	0	0	722	1.38	1.46	66.15	2.44
15-May	0	-	-	-	-	0	0	0	0	731	1.20	1.40	65.28	2.94
16-May	0	-	-	-	-	0	0	0	0	756	1.60	1.50	64.27	2.22
17-May	0	-	-	-	-	0	0	0	0	753	1.50	1.70	64.32	2.94
18-May	0	-	-	-	-	0	0	0	0	752	1.35	1.38	64.09	2.02
19-May	0	-	-	-	-	0	0	0	0	750	1.55	1.60	64.32	2.83
20-May	0	-	-	-	-	0	0	0	0	765	1.58	1.64	64.53	1.50
21-May	0	-	-	-	-	0	0	0	0	754	1.35	1.42	64.43	1.61
22-May	0	-	-	-	-	0	0	0	0	713	1.50	1.60	63.72	-
23-May	0	-	-	-	-	0	0	0	0	613	1.60	1.22	64.26	1.41
24-May	0	-	-	-	-	0	0	0	0	521	1.12	1.21	66.13	1.60
25-May	0	-	-	-	-	0	0	0	0	437	1.10	1.25	67.76	0.83
26-May	0	-	-	-	-	0	0	0	0	400	1.19	1.21	68.94	1.15
27-May	0	-	-	-	-	0	0	0	0	377	1.13	1.21	69.77	1.57
28-May	0	-	-	-	-	0	0	0	0	381	0.97	1.25	70.26	1.58
29-May	0	-	-	-	-	0	0	0	0	382	0.90	1.00	71.38	-

Appendix C. Daily counts of non-salmonids captured at Waterford during 2007.

Date	BGS	BRB	GSN	HH	LAM	LMB	MQK	PRS	RFS	RSN	SASQ	SASU	TFS	WHC
12-Jan											5	1		
13-Jan	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
14-Jan	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
15-Jan	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
16-Jan				1										
17-Jan				1				2						
18-Jan				4							1			
19-Jan				2										
20-Jan	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
21-Jan	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
22-Jan	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
23-Jan														
24-Jan														
25-Jan				6					1		1			
26-Jan				3					1		2			
27-Jan	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
28-Jan	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
29-Jan	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
30-Jan				5										
31-Jan				3										
1-Feb				3						1				
2-Feb				3										
3-Feb	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
4-Feb	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
5-Feb	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
6-Feb	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
7-Feb														
8-Feb											1			
9-Feb														
10-Feb				1										
11-Feb								1						
12-Feb				3				4						
13-Feb				6										
14-Feb				4				4						
15-Feb				3				4						
16-Feb				1				3			1			
17-Feb	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
18-Feb	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
19-Feb	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
20-Feb				3				2						
21-Feb											2			
22-Feb														
23-Feb				1										
24-Feb				1								2		
25-Feb				1				1						
26-Feb	1							1			1	1		
27-Feb														
28-Feb								1				1		

Date	BGS	BRB	GSN	HH	LAM	LMB	MQK	PRS	RFS	RSN	SASQ	SASU	TFS	WHC
1-Mar								1						
2-Mar				2								1		
3-Mar											2			
4-Mar								3			1	1		
5-Mar				1				2						
6-Mar				2										
7-Mar											1			
8-Mar				1				1						
9-Mar				1							1			
10-Mar								4						
11-Mar								2			1			
12-Mar														
13-Mar								2						
14-Mar				1				3						1
15-Mar				2				2			1	1		
16-Mar				2				5	1					
17-Mar				2				4			1			1
18-Mar				2							1			
19-Mar	1				1						2	4		
20-Mar				1								1		
21-Mar								3			1			
22-Mar								1						
23-Mar												3		
24-Mar				1						1		1		
25-Mar				1				1			2	2		
26-Mar								1			2			
27-Mar								2		1	2	1		
28-Mar	1													
29-Mar				2				3			2			
30-Mar				5							3	2		
31-Mar				1							1	1		
1-Apr	1			8				1				1		
2-Apr				10							2			
3-Apr				6							8	1		
4-Apr		1		23							1	1		
5-Apr				4						1				
6-Apr				7				1			2	1		
7-Apr	1			5										
8-Apr				4								2		
9-Apr				5							1	1		
10-Apr				5				1			1	2	1	
11-Apr				2	1			1			2			
12-Apr											1	1		
13-Apr					2							1		
14-Apr								1			1			
15-Apr	1										1	1		
16-Apr	1			1				2			1			
17-Apr				13				3			3	2		
18-Apr				26	2			2	2		2	1		

Date	BGS	BRB	GSN	HH	LAM	LMB	MQK	PRS	RFS	RSN	SASQ	SASU	TFS	WHC
19-Apr				18				1						
20-Apr				3							1	2		
21-Apr				38	5						13	11		
22-Apr			2	4	4						1	8		
23-Apr				10	5						10	17		
24-Apr				11	1			1	1		6	5		
25-Apr			1	13	1					2	7	9		
26-Apr				27	1	1	1			1	9	3		
27-Apr				113		3						1		
28-Apr	2			37				1				5		
29-Apr				24							2	3		
30-Apr				2							6			
1-May				5							8	1		
2-May				10							6			
3-May														
4-May				5				1						
5-May				6							2			
6-May				2							1			
7-May											1			
8-May				1				1			2			
9-May				1				1			1			
10-May				1				1						
11-May					2			1			1			
12-May								1						
13-May														
14-May												1		
15-May				2				2						
16-May														
17-May											1	2		
18-May											1			
19-May												1		
20-May												1		
21-May												1		
22-May				1							2	6		
23-May				8								8		
24-May				9	1						1	1		
25-May				4							2			1
26-May								1						
27-May														1
28-May				1								1		
29-May											1			
30-May												2		
31-May											1			
1-Jun														
2-Jun														1
3-Jun														1
4-Jun												1		1
5-Jun														
Totals	**9**	**1**	**3**	**557**	**26**	**4**	**1**	**87**	**6**	**7**	**150**	**128**	**1**	**7**
	BGS	**BRB**	**GSN**	**HH**	**LAM**	**LMB**	**MQK**	**PRS**	**RFS**	**RSN**	**SASQ**	**SASU**	**TFS**	**WHC**

Appendix D. Daily counts of non-salmonids captured at Grayson during 2007.

Date	BAS	BGS	C	CHC	GSN	HH	LMB	MQK	RSN	SASQ	SASU	SMB	TFS	UNID	W	WHC
3/25/2007																1
3/26/2007											2					1
3/27/2007																
3/28/2007							1				1					3
3/29/2007																1
3/30/2007									1		4					2
3/31/2007									1		1					
4/1/2007							1									1
4/2/2007																
4/3/2007									1		5			1		
4/4/2007									1							
4/5/2007											2					
4/6/2007				1		1					3					1
4/7/2007											2					
4/8/2007											3					
4/9/2007											1					
4/10/2007											3					
4/11/2007											5	1				1
4/12/2007											2					1
4/13/2007									2		29					
4/14/2007											10					2
4/15/2007											4					1
4/16/2007					1						3					
4/17/2007											1					
4/18/2007										1	9					
4/19/2007							1				9				1	1
4/20/2007											8					2
4/21/2007							1		1		13					2
4/22/2007					1		1				136					
4/23/2007				1	1	4	1		1	2	1,127					4
4/24/2007				1		2			1		800	1				2
4/25/2007						10	1		1	6	1,050	1			1	11
4/26/2007						8			1							6
4/27/2007						3	1		4	3	318					3

Date	BAS	BGS	C	CHC	GSN	HH	LMB	MQK	RSN	SASQ	SASU	SMB	TFS	UNID	W	WHC
4/28/2007						5	3			5	52		1			2
4/29/2007						3				1	6	2				1
4/30/2007		1				2			1	4	12	1				1
5/1/2007								1	1		6					
5/2/2007				1						1	7					1
5/3/2007						1						1				1
5/4/2007									1	1		1				
5/5/2007						1					1					1
5/6/2007											4					1
5/7/2007						1	2			1	1					1
5/8/2007																
5/9/2007																1
5/10/2007							1									
5/11/2007		1		1												
5/12/2007																1
5/13/2007							1									1
5/14/2007							2				1					3
5/15/2007		1														
5/16/2007				2			1									5
5/17/2007											1					5
5/18/2007							1				1					1
5/19/2007							1									
5/20/2007							7				2					
5/21/2007	4										4			7		2
5/22/2007				1			1					16				
5/23/2007	1						12	1			2					1
5/24/2007	1		1				6				5	14				
5/25/2007				1			4					4				1
5/26/2007			1				4					5				
5/27/2007												2				2
5/28/2007																
5/29/2007																
Total	**6**	**3**	**2**	**9**	**3**	**41**	**54**	**2**	**18**	**25**	**3,656**	**49**	**1**	**8**	**2**	**78**
	BAS	**BGS**	**C**	**CHC**	**GSN**	**HH**	**LMB**	**MQK**	**RSN**	**SASQ**	**SASU**	**SMB**	**TFS**	**UNID**	**W**	**WHC**

Key to species codes

BGS	Bluegill
CHC	Channel catfish
CHNF	Chinook
FHM	Fathead minnow
GF	Goldfish
GSF	Green sunfish
GSN	Golden shiner
HH	Hardhead
HCH	Hitch
LAM	Lamprey, unidentified species
LMB	Largemouth bass
MQK	Mosquitofish
MSS	Inland silverside
RBT	Rainbow trout
RES	Redear sunfish
RSN	Red shiner
SASQ	Sacramento pikeminnow
SASU	Sacramento sucker
SMB	Smallmouth bass
TP	Tule perch
UNID	Unidentified species
W	Warmouth
WHC	White catfish