Outmigrant Trapping of Juvenile Salmonids in the Lower Tuolumne River, 2009

Submitted To:
Turlock Irrigation District
Modesto Irrigation District

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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 in Yosemite National Park 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 fish migration since at least 1871.

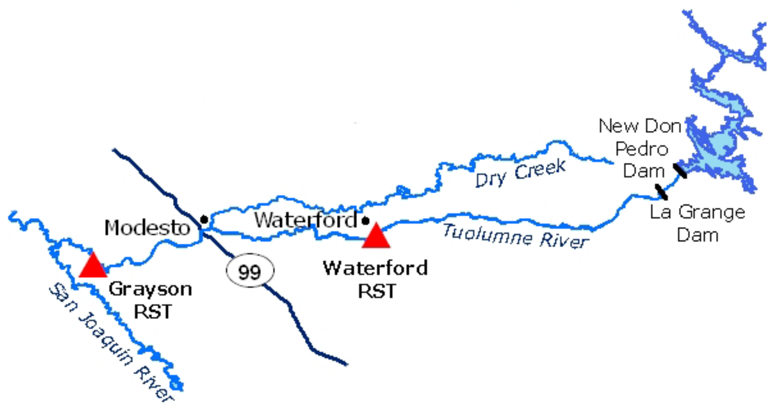

Figure 1. Location map of study area on the Tuolumne River.

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). The Turlock Irrigation District and Modesto Irrigation District (Districts), and the City and County of San Francisco, funded the entire RST program in 1995-97 and 2003-2009 and at 2-3 upstream sites in 1998-2000.

Current sampling locations include Grayson River Ranch (Grayson – RM 5) near the mouth of the Tuolumne River and downstream of Waterford (RM 30). Rotary screw trap monitoring has been conducted annually near the mouth since 1995 (Shiloh in 1995-1998 and Grayson in 1999-2009) 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 of the Grayson site, 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.

Table 1. Rotary screw trap monitoring in the Lower Tuolumne River, 1995-2009.

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	755,604[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	99,797[2]	Multiple regression	Vasques and Kundargi 2001
2001	Grayson	Jan 03-May 29	97%	6,478	99,584[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 and 2008 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	14,135[2]	Multiple regression	Blakeman 2004b
2003	Grayson	Apr 01-Jun 06	40%	359	9,091[2]	Multiple regression	Blakeman 2004c
2004	Grayson	Apr 01-Jun 09	40%	509	17,771[2]	Multiple regression	Fuller 2005
2005	Grayson	Apr 02-Jun 17	39%	1,317	255,710[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	71,670[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	Fuller 2008
	Grayson	Mar 23-May 29	45%	27	923[2]	Multiple regression	Fuller 2008
2008	Waterford	Jan 8-Jun 2	96%	3,350	24,894[1]	Average trap efficiency	Palmer and Sonke 2008
	Grayson	Jan 29-Jun 4	82%	193	3,283[2]	Multiple regression	Palmer and Sonke 2008
2009	Waterford	Jan 7-June 9	96%	3,725	37,174[1]	Average trap efficiency	This report
	Grayson	Jan 8-Jun 11	95%	155	4,677[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 and 2008 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. Similar to 2008, two "wings" were attached at 45-degree angles to the outer edge of each pontoon near the upstream end of the trap (Figure 2). The "wings" consisted of 4 ft x 4 ft aluminum frames with removable plywood inserts. The "wings" were created to increase velocity at the trap, as well as improve catch efficiency. These wings were also in place in 2009 until they sustained damage caused by high flows on April 21. The damaged wings were removed and were not re-installed for the remainder of the sampling season.

Figure 2. Waterford rotary screw trap with "wings" attached to the upstream end of the pontoons.

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. Similar to 2008, a flow deflection structure was constructed and placed in the river approximately 50 ft upstream of the Grayson traps on the south bank in order to divert more water towards the traps and thereby increasing velocity at the traps (Figure 3). The “deflector” was constructed of three 4 ft x 8 ft sheets of plywood attached to t-posts that were set in the substrate at an angle to the flow.

Figure 3. Grayson rotary screw traps with “weir” structure approximately 50 feet upstream of the traps on the opposite bank.

Trap Monitoring

Sampling at Waterford began on January 7, 2009. The trap was operated continuously (24 hours per day, 7 days per week) until June 9, 2009, 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 four feet deep and velocity of at least 1.5 ft/s for the cone to rotate.

Sampling at Grayson began on January 8, 2009. The traps were operated continuously (24 hours per day, 7 days per week) until sampling was terminated on June 11, 2009, 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 $\geq$ 70 mm= smolt. In addition, the smolting appearance of all measured salmon and trout was rated based on a seven category 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 (to nearest tenth of a gram) were taken from up to 50 salmon each week (i.e., Monday through Sunday) and from all trout using an Ohaus digital balance. Fish were weighed in a small, plastic container partially filled with stream water, which was tared each time prior to measuring individual fish. Fish were then placed in a container with freshwater and allowed to recover prior to release.

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.

Trap Efficiency Releases

Trap efficiency tests using natural juvenile salmon were conducted to estimate the proportion of migrating juvenile salmon sampled by the Waterford trap. Catches of natural fish were insufficient for trap efficiency tests to be conducted at Grayson. Natural salmon captured in the Waterford trap were used to conduct tests whenever catches were sufficient to obtain a group of at least 30 fish over no more than two days. Hatchery fish were not available for trap efficiency tests during 2009.

Nine groups of fish (all natural release groups ranging in number from 31 to 263 marked fish) were released at RM 30 (about 0.2 miles upstream of the trap) between January 20 and March 20. 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 4). 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 4. Live car used for holding trap efficiency test fish.

Marking Procedure

At the Waterford trapping site, natural fish were marked on shore 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. A total of zero fish were found to have no marks upon examination. All fish released in 2009 had visible marks.

Release Procedure

Livecars were located several feet away from the specific release point and fish were poured from the live cars 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 a "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 eight minutes to 30 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. The Modesto flow station is below Dry Creek, the largest seasonal tributary entering the river downstream of La Grange Dam. As a result, that site includes flow associated with major winter runoff events. 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 Districts at both trapping sites. 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 trap checks with an Exstick II D600 Dissolved Oxygen Meter at the trapping sites and recorded in mg/L.

Estimating Trap Efficiency and Chinook Abundance

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 2006-2009, and the dataset is limited for developing 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. Trap efficiency releases were only conducted for the fry lifestage in 2009 due to insufficient catch during the parr/smolt lifestage. Parr/smolt abundance was calculated using past trap efficiency results conducted at similar flows. Trap efficiency was 15.1% (111 recoveries from 733 released) for fry, 12.2% (five recoveries from 41 released in 2008) for parr/smolt captured through April 20 when the deflector "wings" were attached to the pontoons on the upstream end of the trap, and 5.3% (29 recoveries from 545 released in 2007) for parr/smolt after April 20 when the "wings" were removed from the trap.

At Grayson, flow and trap efficiency data collected from 1999 through 2008 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(-0.29176+(-0.00042*Flow at MOD)+(-0.03410*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 catch (DC) to estimate daily passage as follows:

Estimated Daily Passage= DC/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; 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

An estimated 372 salmon (212 females) spawned in the fall of 2008 (Ford and Kirihara 2009), which produced the majority of the juvenile salmon sampled in the 2009 RST operation. The fall-run juvenile salmon outmigration in the San Joaquin Basin typically occurs during the winter and spring, extending mainly from January through May. The young-of-the-year (YOY) migration occurs largely as fry migrants in winter that are typically less than 50 mm forklength, and as smolts in spring which are typically greater than 69 mm forklength. There are also some larger fish that migrate mostly in winter and some fry observed in late spring which may be from early spawning fall-run or from salmon with different spawn timing than fall-run.

During 2009, consecutive day catches of juvenile salmon at Waterford were highest in early to mid-March and primarily consisted of fry (<50 mm)(Figure 5). Chinook catch for a single day peaked on May 3 (mainly smolts ≥ 70 mm) following a small decrease in flow during the spring pulse flow period. Daily catches of juvenile salmon at Waterford between January 7 and June 9 ranged from zero to 565 fish and totaled 3,725 fish (Figure 5).

At Grayson, catches of juvenile salmon were highest in early May. Daily catches of juvenile salmon at Grayson between January 8 and June 11 ranged from zero to 79 fish and totaled 155 fish, mainly smolts ≥ 70 mm (Figure 6). Catch peaked on May 5, two days after a season peak in catch was observed at Waterford. Table 2 has the comparative catch numbers by lifestage for the two locations.

Table 2. Catch by lifestage at Waterford and Grayson, 2009.

	Fry (<50 mm)	Parr (50-69 mm)	Smolt (≥ 70 mm)
Waterford	1,905	613	1,207
Grayson	6	7	142

Sampling at Waterford is considered comprehensive and covers January through May each year the trap was sampled. However, in 2006, the sampling was initiated a few weeks later and there was an extended non-sampling period (April 12-21) due to high flows; therefore, outmigration was not fully sampled during the 2006 season. Total annual catch of juvenile salmon has been consistent between years at Waterford with the exception of 2006 when annual catch was almost three times greater (Table 1; Figure 7).

Total trap catch at Waterford ranged from a high of 9,106 during 2006 to a low of 3,312 during 2007, and averaged 4,862 juvenile salmon (Figure 7). The variation in catch during 2006 is likely due to environmental conditions, specifically high flows that averaged approximately 5,300 cfs during the juvenile migration season (i.e., January-May/June) and higher abundance.

Total annual catch of juvenile salmon has varied substantially between years at Grayson/Shiloh (Table 1; Figure 8). This variation is likely due to differences in one or more factors including the duration and timing of the sampling periods, environmental conditions, and overall fish abundance and survival (Table 1; Figure 8). 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, 2006, and 2008-2009, 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 8). 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 those 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.

Of the winter/spring sampling years, total trap catch at Grayson ranged from a high of 19,327 during 1999 to a low of 155 during 2009, and averaged 4,348 juvenile salmon (Figure 8). 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 Jan-May outmigration period monitored each year ranged from 81.5% to 98% during winter/spring sampling years, from 24% to 44% during spring-only sampling years, and was 70% in the intermediate sampling year (Table 1). 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.

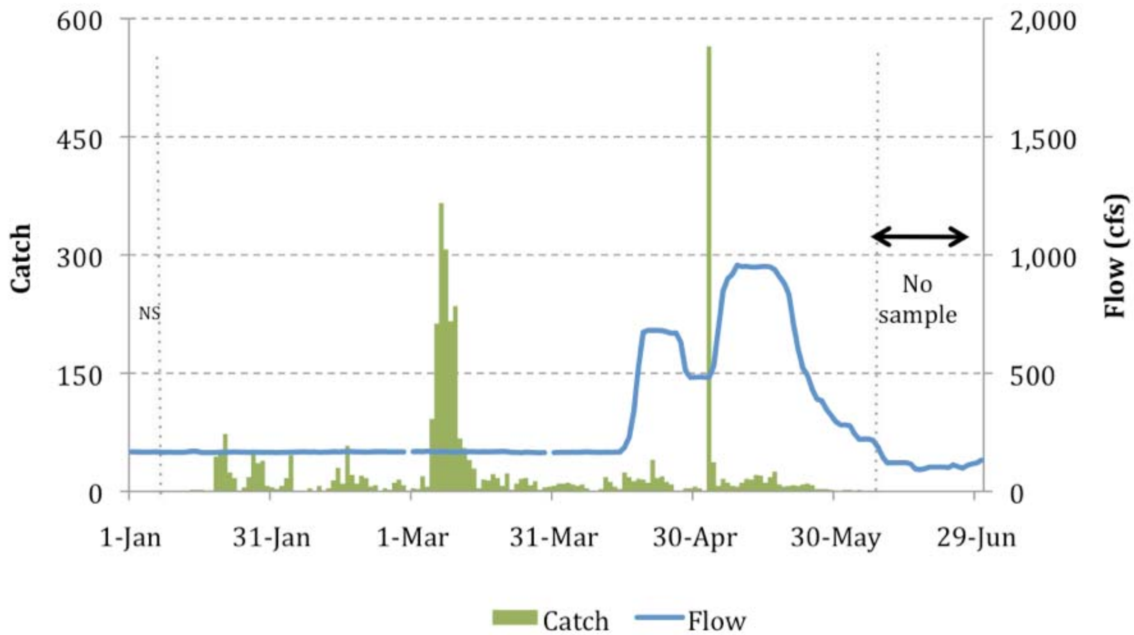

Figure 5. Daily catch of unmarked Chinook salmon at Waterford and river flow at La Grange (LGN) during 2009.

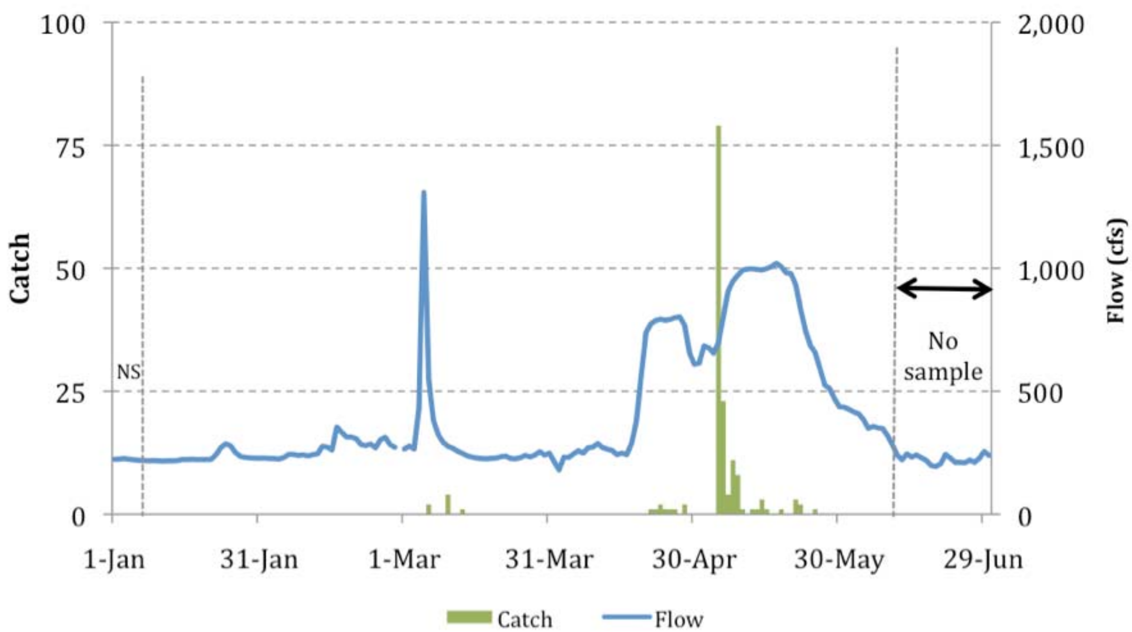

Figure 6. Daily catch of unmarked Chinook salmon at Grayson and river flow at Modesto (MOD) during 2009.

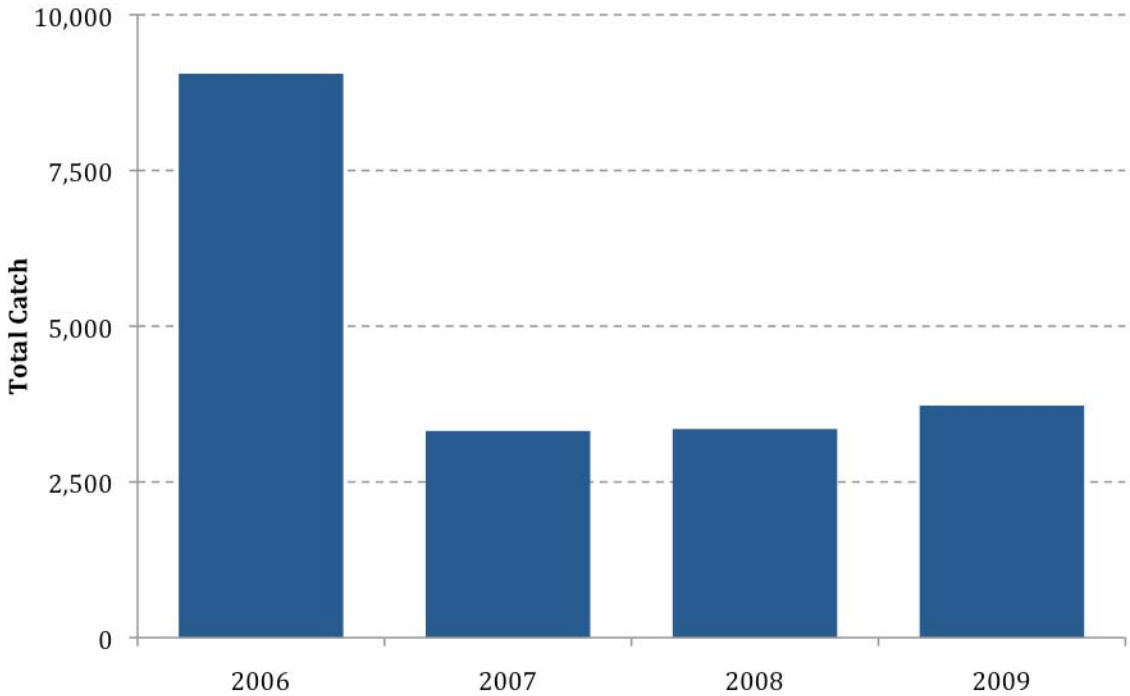

Figure 7. Total annual salmon catch at Waterford during 2006-2009.

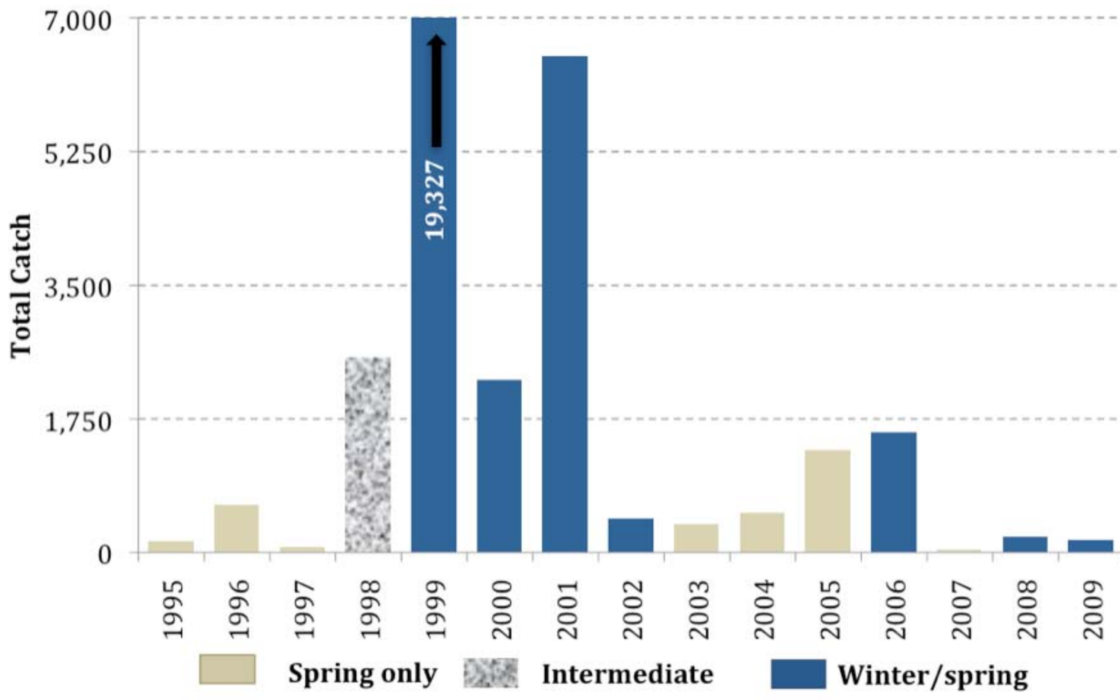

Figure 8. Total annual salmon catch at Shiloh/Grayson during 1995-2009.

Trap Efficiency

In 2009, 11 trap efficiency estimates for natural fry at Waterford ranged from 2.8% to 34.4% at flows (La Grange) ranging between 167 cfs and 173 cfs (Table 3; Figure 9). No trap efficiency estimates were obtained for the parr/smolt lifestage due to insufficient catch in the Waterford trap. Average forklength at release of the eleven trap efficiency test groups in 2009 ranged from 35 mm to 50 mm (Table 3).

At Grayson, observed trap efficiency estimates from 1999-2008 ranged from zero to 21.2% at flows (Modesto) ranging between 280 cfs and 7,942 cfs (Table 4; Figure 10). No trap efficiency estimates were obtained at Grayson during 2009 due to insufficient catch in the Grayson traps and the lack of hatchery fish available for releases.

Daily predicted trap efficiency, and daily estimated passage at Waterford and Grayson in 2009 are provided in Appendices A and B, respectively.

Table 3. Trap efficiency results used to estimate daily trap efficiencies at Waterford. Note: Only releases for the fry lifestage were conducted in 2009. Results from 2007 and 2008 were used for predicting daily trap efficiencies during the parr/smolt lifestages. 2008 data was used through April 20 and 2007 data was used after April 20.

Lifestage	Release Date	Origin	Adjusted # Released	Number Recaptured	% Recaptured	Length at Release (mm)	Length at Recap. (mm)	Flow (cfs) at LGN	Turbidity
Fry	1/20/09	Wild	42	2	4.8%	43	35	168	0.46
	1/22/09	Wild	70	5	7.1%	36	36	168	0.77
	1/28/09	Wild	47	7	14.9%	35	35	167	1.36
	1/30/09	Wild	37	7	18.9%	37	36	167	0.76
	2/6/09	Wild	47	6	12.8%	37	37	169	0.75
	2/16/09	Wild	36	1	2.8%	36	36	170	5.07
	2/21/09	Wild	31	5	16.1%	37	37	168	2.02
	3/6/09	Wild	74	20	27.0%	44	44	169	48.7
	3/9/09	Wild	263	53	20.2%	40	45	168	4.71
	3/13/09	Wild	51	4	7.8%	49	49	170	1.18
	3/20/09	Wild	35	1	2.9%	50	34	170	2.36
		TOTAL	733	111	15.1%				
Parr/smolt	5/16/08	Wild	41	5	12.2%	88	88	811	
		TOTAL	41	5	12.2%				
Parr/smolt	3/5/07	Wild	75	3	4.0%	56.2	59.7	341	0.62
	3/29/07	Wild	48	3	6.3%	60.3	57.1	337	0.65
	3/31/07	Wild	75	3	4.0%	58.4	47.3	337	0.43
	4/5/07	Wild	50	2	4.0%	76.0	75.0	337	0.64
	4/11/07	Wild	63	6	9.5%	80.6	80.2	343	1.07
	4/24/07	Wild	63	3	4.8%	81.9	80.3	869	0.82
	4/26/07	Wild	171	9	5.3%	80.2	79.1	646	0.88
	3/5/07	Wild	75	3	4.0%	56.2	59.7	341	0.62
		TOTAL	545	29	5.3%				

Table 4. Trap efficiency results from 1999- 2008 used to derive the regression equation for predicting daily trap efficiencies at Grayson.

Release Date	Origin	Mark	Adjusted # Released	Number Recaptured	% Recaptured	Length at Release (mm)	Length at Recap. (mm)	Flow (cfs) at MOD
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
7-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

Release Date	Origin	Mark	Adjusted # Released	Number Recaptured	% Recaptured	Length at Release (mm)	Length at Recap. (mm)	Flow (cfs) at MOD
4-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
1-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
6-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
18-Jan-01	Hatchery	Top caudal blue	1810	120	6.6%	37	np	487
8-Feb-01	Hatchery	Bottom caudal blue	1980	276	13.9%	47	np	434
1-Mar-01	Hatchery	Top caudal yellow	2017	57	2.8%	41	np	2130
14-Mar-01	Hatchery	Bottom caudal yellow	1487	75	5.0%	46	np	703
21-Mar-01	Hatchery	Bottom caudal blue, Dorsal fin blue, Top caudal yellow	3025	207	6.8%	61	np	519
28-Mar-01	Hatchery	Anal fin blue	1954	219	11.2%	51	np	515
11-Apr-01	Hatchery	Bottom caudal yellow, ad-clip	2021	141	7.0%	66	np	535
18-Apr-01	Hatchery	Top caudal blue, ad-clip	2060	95	4.6%	68	np	483
25-Apr-01	Hatchery	Ad-clip dorsal fin yellow, Bottom caudal blue, Dorsal fin blue	1515	34	2.2%	71	np	753
2-May-01	Hatchery	Anal fin blue, ad-clip	3053	163	5.3%	72	np	1460
9-May-01	Hatchery	Bottom caudal yellow, ad-clip	3002	147	4.9%	75	np	1160
16-May-01	Hatchery	Top caudal blue, ad-clip	2942	93	3.2%	76	np	1020
20-Feb-02	Hatchery	Bottom caudal red	2094	444	21.2%	57	np	265
6-Mar-02	Hatchery	Anal fin red	2331	316	13.6%	68	np	278
13-Mar-02	Hatchery	Top caudal red	2042	324	15.9%	65	np	300
20-Mar-02	Hatchery	Dorsal fin red	2105	242	11.5%	68	np	328
27-Mar-02	Hatchery	Bottom caudal red	2121	147	6.9%	68	np	314
3-Apr-02	Hatchery	Anal fin red, ad-clip	1962	130	6.6%	76	np	312
9-Apr-02	Hatchery	Top caudal red, ad-clip	1995	56	2.8%	79	np	319
17-Apr-02	Hatchery	Dorsal fin red, ad-clip	2048	40	2.0%	84	np	889
25-Apr-02	Hatchery	Bottom caudal red, ad-clip	2001	22	1.1%	86	np	1210
1-May-02	Hatchery	Anal fin red, ad-	2033	14	0.7%	89	np	1250

Release Date	Origin	Mark	Adjusted # Released	Number Recaptured	% Recaptured	Length at Release (mm)	Length at Recap. (mm)	Flow (cfs) at MOD
		clip						
8-May-02	Hatchery	Dorsal fin red, ad-clip	2021	31	1.5%	95	np	798
15-May-02	Hatchery	Top caudal red, ad-clip	2047	26	1.3%	97	np	653
22-May-02	Hatchery	Bottom caudal red, ad-clip	2043	10	0.5%	94	np	403
10-Apr-03	Hatchery	Top caudal green	1956	138	7.1%	77	np	297
17-Apr-03	Hatchery	Bottom caudal green	2047	65	3.2%	77	np	1350
24-Apr-03	Hatchery	Anal fin green	1979	31	1.6%	88	np	1210
1-May-03	Hatchery	Dorsal fin green	2044	113	5.5%	96	np	685
8-May-03	Hatchery	Top caudal green	2078	206	9.9%	83	np	726
15-May-03	Hatchery	Bottom caudal green	1996	125	6.3%	83	np	559
20-May-03	Hatchery	Anal fin green	1989	60	3.0%	89	np	317
28-May-03	Hatchery	Dorsal fin green	1950	125	6.4%	94	np	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
4-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
9-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
3-Mar-06	Wild	Caudal fin green	89	4	4.5%	34.8	35.3	4261
5-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
1-Jun-06	Hatchery	Top caudal yellow	1,694	0	0.0%	91.9	-	
14-Jun-06	Hatchery	Top caudal yellow	1,507	2	0.1%	85.4	83.0	4864
3/1/08	Wild	Caudal fin yellow	73	5	6.9%	38	38	342
4/15/08	Hatchery	Caudal fin orange	1131	109	9.6%	77	76	300
4/25/08	Hatchery	Dorsal fin orange	1005	17	1.7%	86	84	1290
5/7/08	Hatchery	Anal fin orange	526	8	1.5%	96	96	1310
5/14/08	Hatchery	Caudal fin orange	519	13	2.5%	93	91	941
5/21/08	Hatchery	Lower caudal orange, anal fin orange	515	19	3.7%	92	91	678

np= not provided

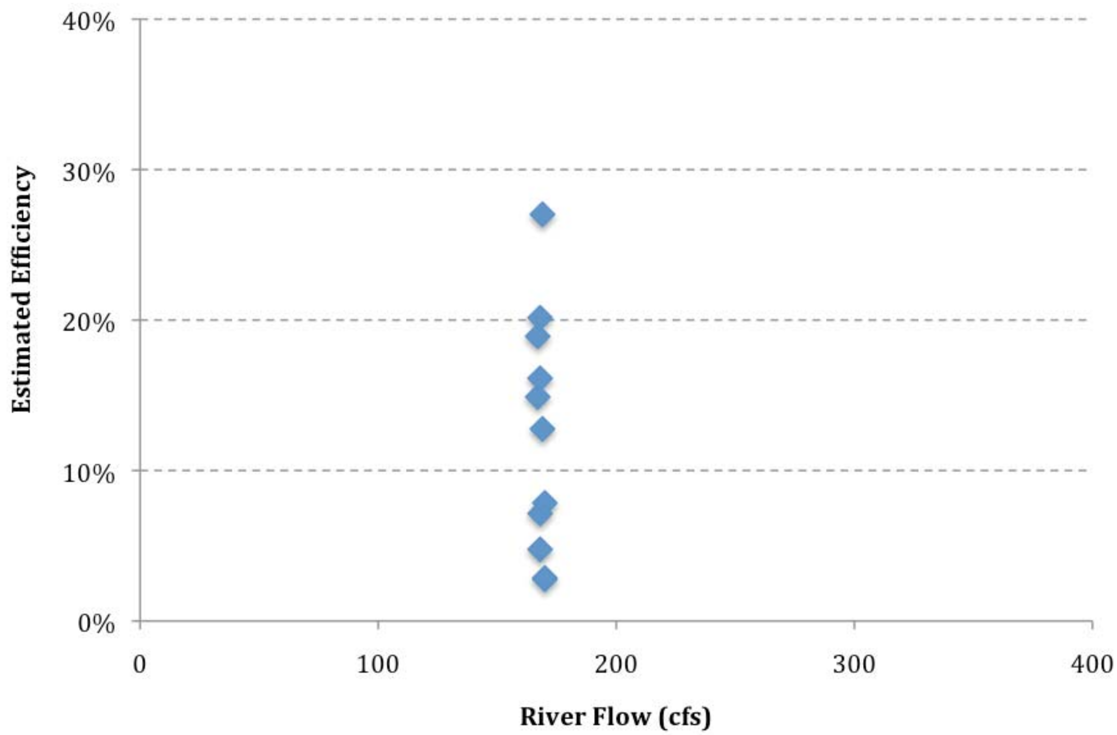

Figure 9. Trap efficiency estimates at Waterford relative to river flow at La Grange (LGN) during 2009.

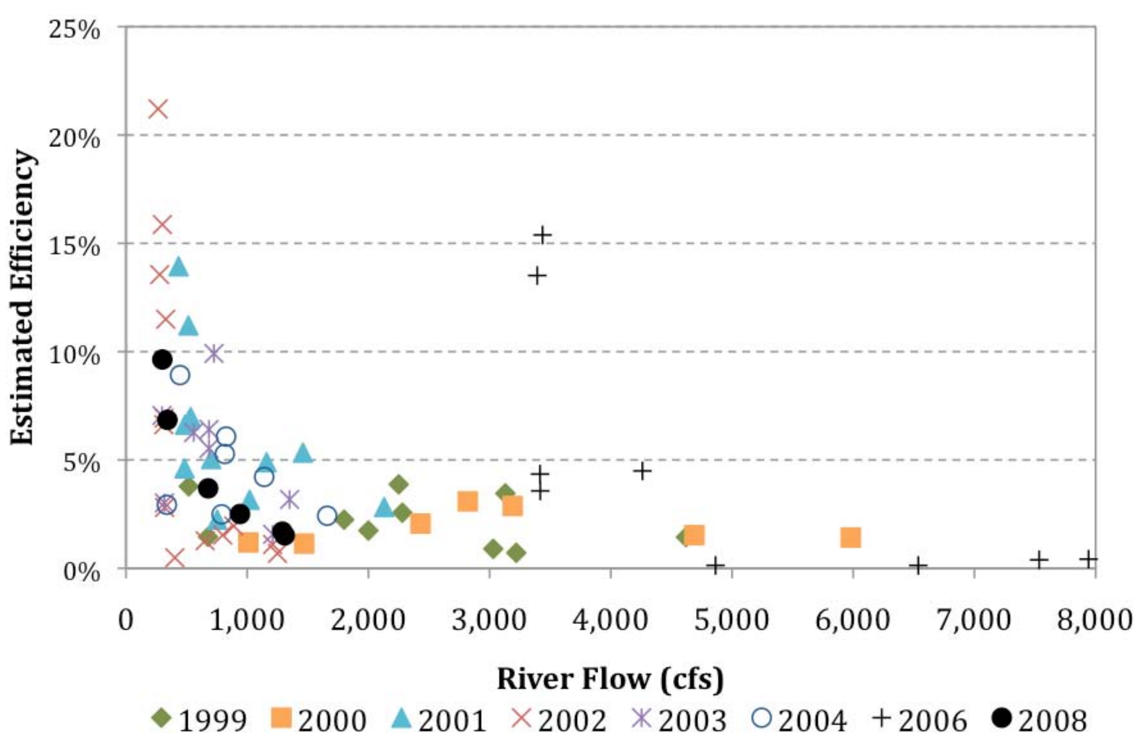

Figure 10. Trap efficiency observations at Grayson relative to river flow at Modesto (MOD), 1999-2008.

Estimated Chinook Salmon Abundance

Based on calculated daily passage estimates, an estimated 37,174 Chinook salmon passed Waterford during 2009 and 51.7% were smolts (Table 5). In comparison, the percentage of fish passing Waterford as smolts were 34% in 2008 and were 51% in 2007. In 2006, sampling efforts were affected by high spring flows resulting in passage estimates that were likely underestimated (particularly for smolts). Similar to the pattern observed for catch, it is estimated that a majority of the salmon passing Waterford in 2009 prior to mid-March were fry and catch was then dominated by smolts from late-March through May (Table 5; Figure 11). Daily estimated passage at Waterford ranged from zero to 10,660 salmon. Peaks in daily passage for fry occurred on March 7 and smolt passage peaked on May 3 (Figure 11; Figure 12). Approximately 175 juveniles were produced per female spawner relative to the estimated 212 female spawners, compared to 311 juveniles in 2008 and 205 in 2007 (Table 6).

Table 5. Estimated passage by lifestage at Waterford and Grayson during 1995-2009.

		Sampling Period	Fry		Parr		Smolts		Total
			Number	%	Number	%	Number	%	
Waterford	2006	w/s	163,805	54.0%	6,550	2.2%	133,127	43.9%	303,482
	2007	w/s	20,633	35.7%	7,614	13.2%	29,554	51.1%	57,801
	2008	w/s	15,259	61.3%	1,102	4.4%	8,534	34.3%	24,894
	2009	w/s	13,399	36.0%	4,562	12.3%	19,213	51.7%	37,174
Grayson	1995	spring	-	-	-	-	22,067	100%	22,067
	1996	spring	-	-	-	-	16,533	100%	16,533
	1997	spring	-	-	-	-	1,280	100%	1,280
	1998	intermediate	1,196,625	74.1%	327,422	20.3%	91,626	5.7%	1,615,673
	1999	w/s	716,858	94.9%	8,452	1.1%	30,293	4.0%	755,604
	2000	w/s	48,338	48.4%	8,431	8.4%	43,028	43.1%	99,797
	2001	w/s	59,153	59.4%	12,480	12.5%	27,951	28.1%	99,584
	2002	w/s	75	0.5%	696	4.9%	13,364	94.5%	14,135
	2003	spring	27	0.3%	0	0%	9,064	99.7%	9,091
	2004	spring	155	0.9%	732	4.1%	16,884	95.0%	17,771
	2005	spring	-	-	416	0.2%	255,294	99.8%	255,710
	2006	w/s	62,901	87.8%	1,536	2.1%	7,233	10.1%	71,670
	2007	spring	-	-	-	-	937	100%	937
	2008	w/s	917	27.9%	14	0.4%	2,352	71.6%	3,283
	2009	w/s	145	3.1%	200	4.3%	4,332	92.6%	4,677

Table 6. Estimated number of juvenile salmon produced per female spawner, 2006-2009.

	Females	Juveniles/female spawner
2006	478	635
2007	282	205
2008	80	311
2009	212	175

An estimated 4,677 unmarked Chinook salmon passed Grayson during 2009 and 92.6% of these were smolts (Table 5). Daily estimated passage at Grayson ranged from 0 to 2,253 salmon. Peak daily passage for smolts occurred on May 5 (Figure 13). During comparable seasonal sampling in previous years at Grayson (i.e., winter/spring sampling in 1999-2002, 2006, and 2008-2009), total estimated passage ranged from a high of 755,604 in 1999 to a low of 3,283 in 2008 (Table 1; Figure 15); the proportion of passage as smolts was the highest in 2002 (94.5%) and the lowest in 1999 (4%). In spring-only sampling years at Grayson/Shiloh (i.e., 2003-2005 and 2007 at Grayson and 1995-1997 at Shiloh), total estimated passage ranged from a high of 255,710 in 2005 to a low of 937 in 2007 (Table 1; Figure 15); the majority of spring migrants in all years were smolts (>95.0%; Table 5). Among all years, estimated passage was the highest during 1998 (Table 1; Figure 15) and the proportion passing as smolts was low (5.7%) when sampling effort was intermediate. However, the 1998 passage estimate of 1,615,673 fish may be inflated and the proportion passing as smolts may be underestimated because no trap efficiency tests were conducted with fry.

For comparison, passage estimates were also calculated based on the estimated proportion of flow sampled at each site during 2009. This method produced estimates of 21,964 salmon at Waterford and 1,116 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.

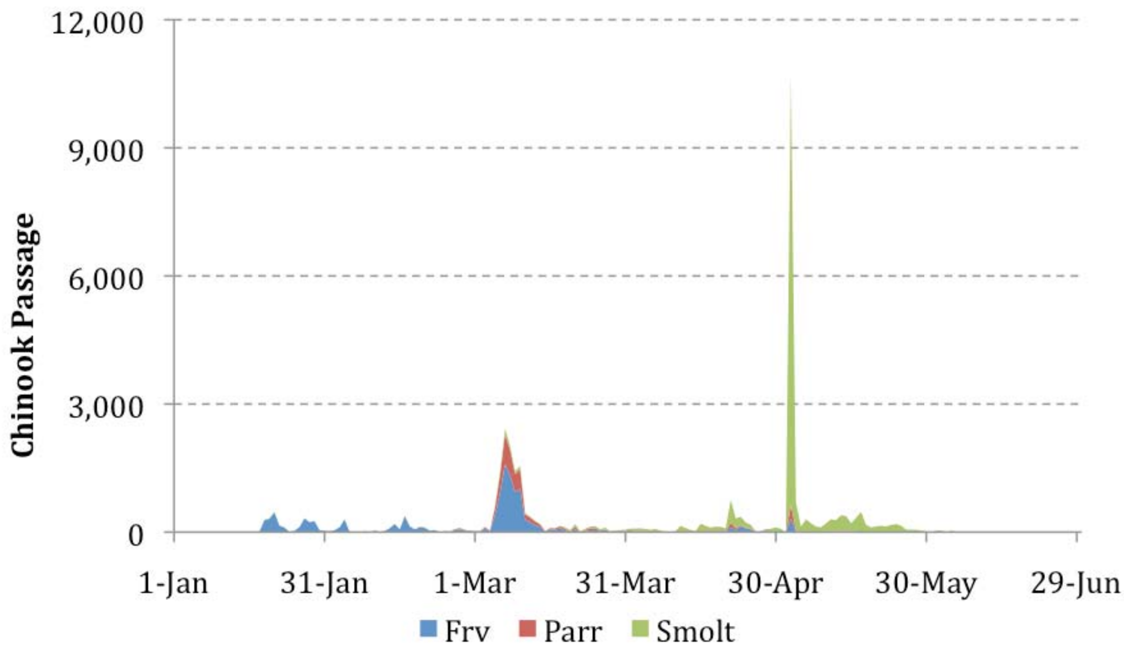

Figure 11. Juvenile salmon passage by lifestage at Waterford during 2009.

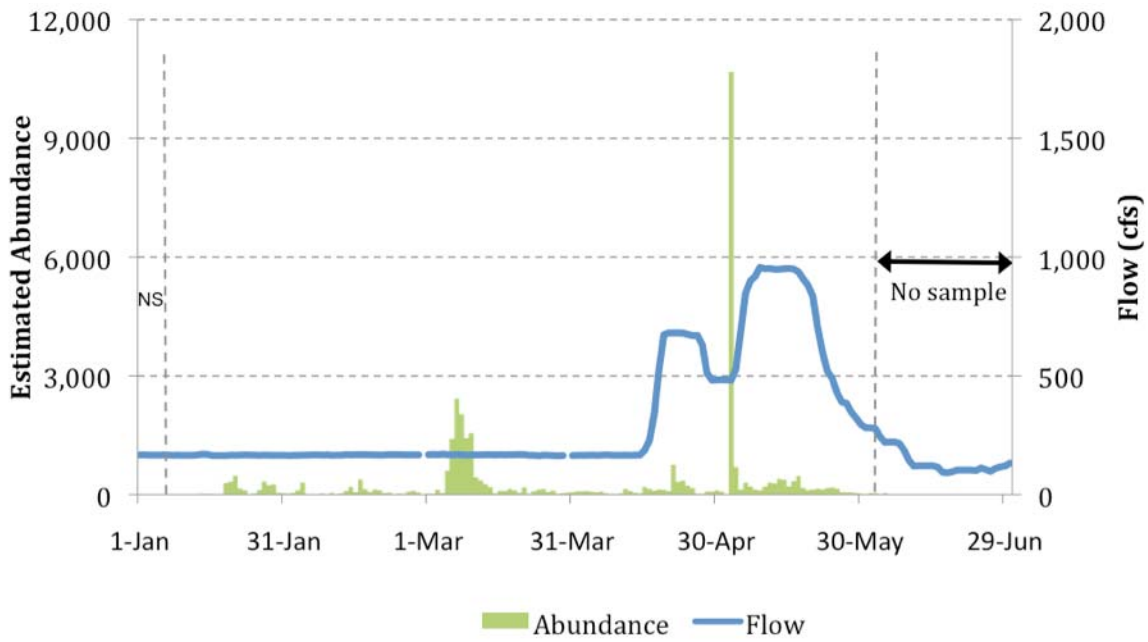

Figure 12. Daily estimated passage of unmarked Chinook salmon at Waterford and river flow at La Grange (LGN) during 2009.

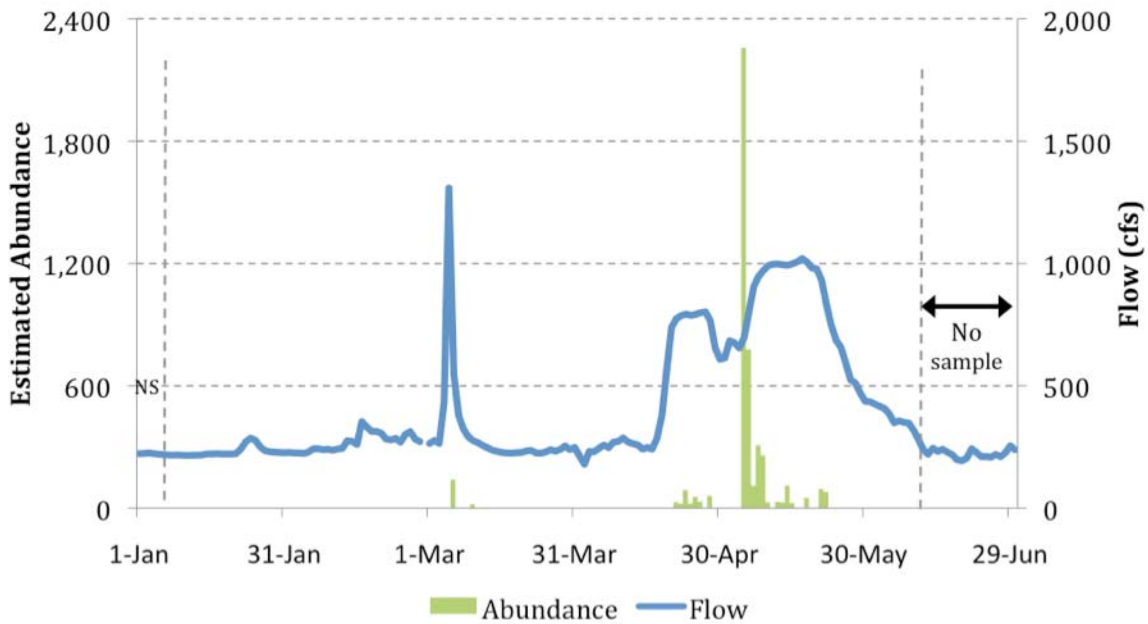

Figure 13. Daily estimated passage of unmarked Chinook salmon at Grayson and river flow at Modesto (MOD) during 2009.

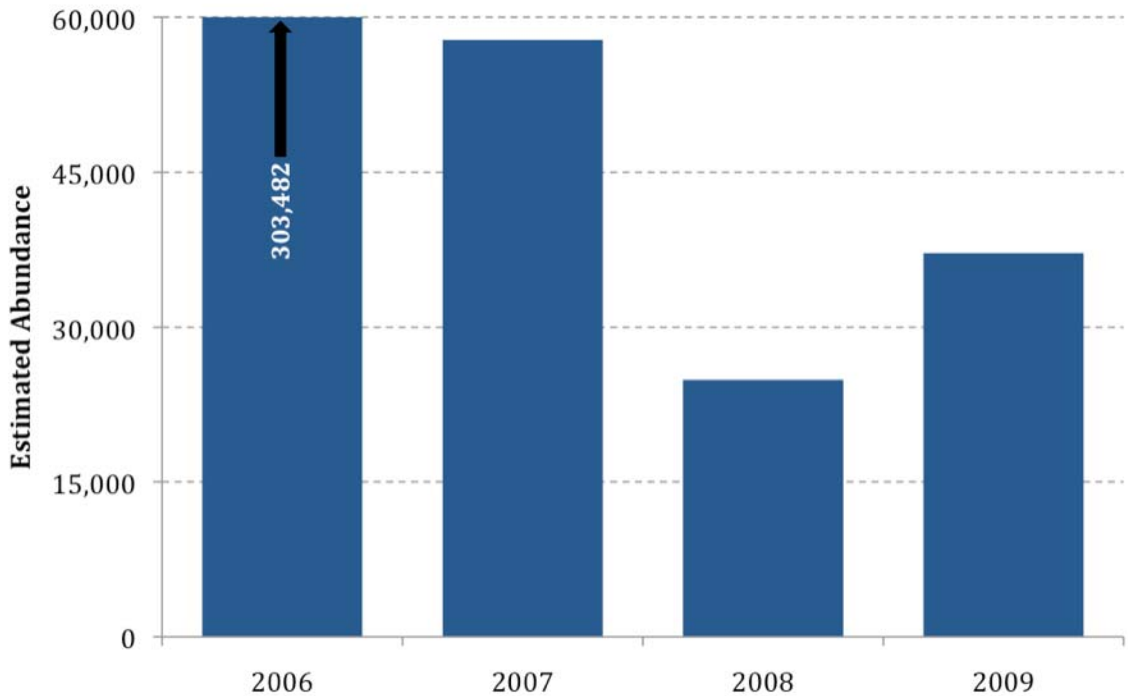

Figure 14. Total estimated Chinook passage at Waterford, 2006-2009.

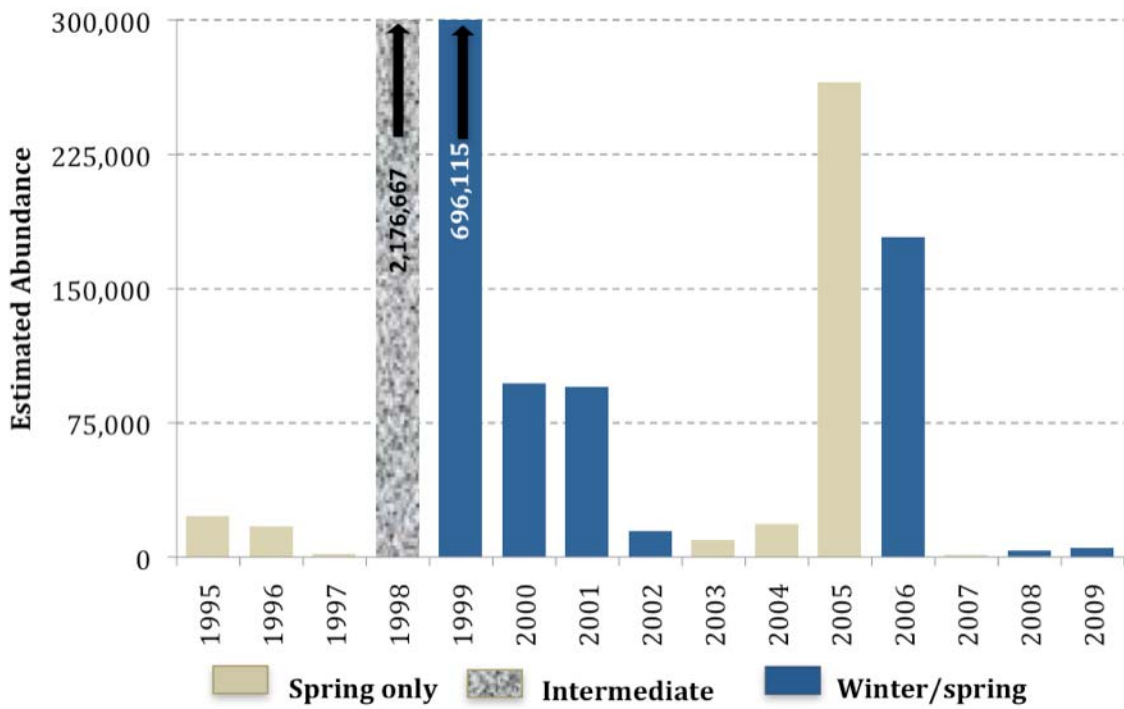

Figure 15. Total estimated Chinook passage at Shiloh and Grayson during 1995-2009.

Estimated Chinook Salmon Abundance and Environmental Factors

Trends in passage at Waterford and Grayson during 2009 were similar to the trends described for catch, and peaks in juvenile salmon passage were strongly associated with extreme turbidity conditions that coincided with storm events and an early May pulse flow event. River releases during January through mid-April ranged only from 163 cfs to 186 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 180 cfs to 1,308 cfs.

During 2009 monitoring, daily average water temperatures ranged from 47.8°F to 69.3°F at the Waterford trap (Figure 16) and from 48.6°F to 73.0°F at the Grayson traps (Figure 17). 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 2009.

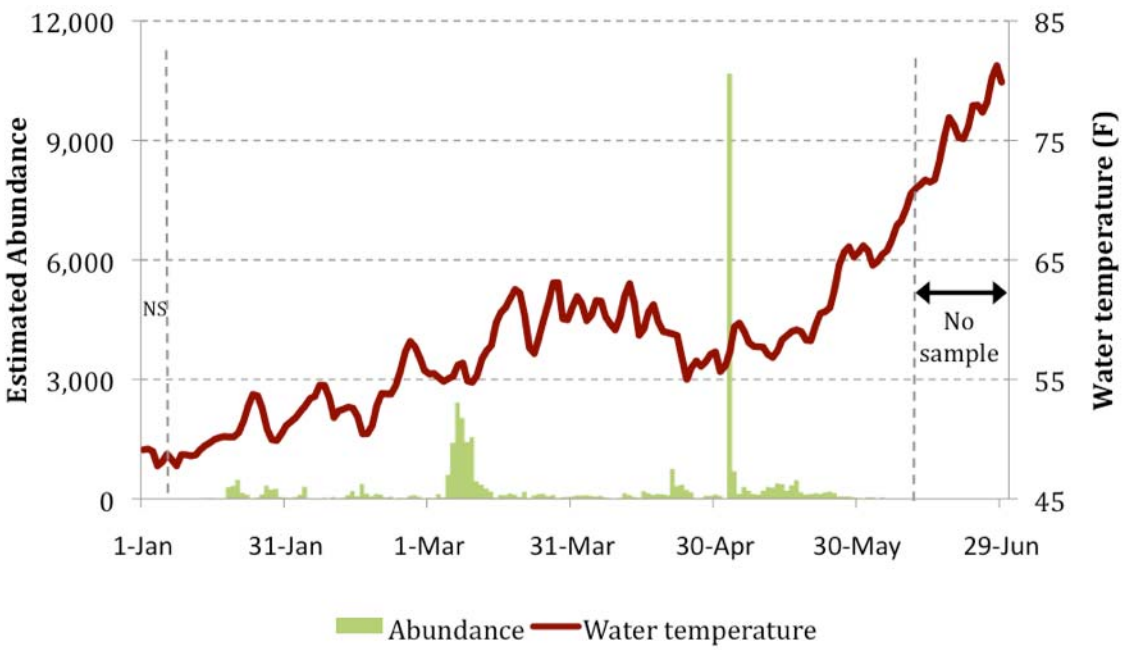

Figure 16. Daily estimated passage of unmarked Chinook salmon at Waterford and daily average water temperature at the Waterford trap during 2009.

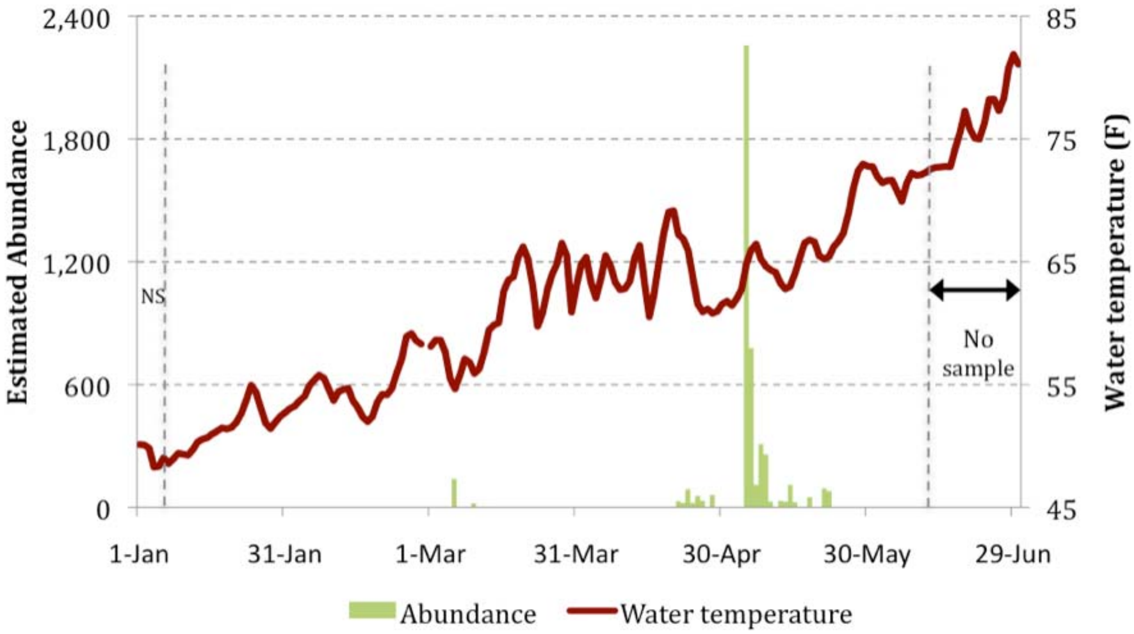

Figure 17. Daily estimated passage of unmarked Chinook salmon at Grayson and daily average water temperature at the Grayson trap during 2009.

Background turbidity was generally less than 6 NTU at Waterford (Figure 18) and less than 10 NTU at Grayson (Figure 19) during the 2009 monitoring period. During several storm events, extreme spikes in turbidity were observed at Waterford ranging as high as 321 NTU, and at Grayson ranging as high as 256 NTU. The highly turbid conditions were associated with runoff containing excessive sediment levels entering the river near RM 45 from the Peaslee Creek watershed (Figure 20), as also occurred in 2008 (CARWQCB 2009). Peaks in passage on March 5-9 and May 3-7 at Waterford, and 5-7 at Grayson coincided with periods of elevated turbidity.

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. The survival index estimated for 2009 was 11.9%. An index of 23.6% and 13.2% were calculated for 2006 and 2008, respectively. A survival index was not calculated for 2007 because sampling did not begin until mid-March.

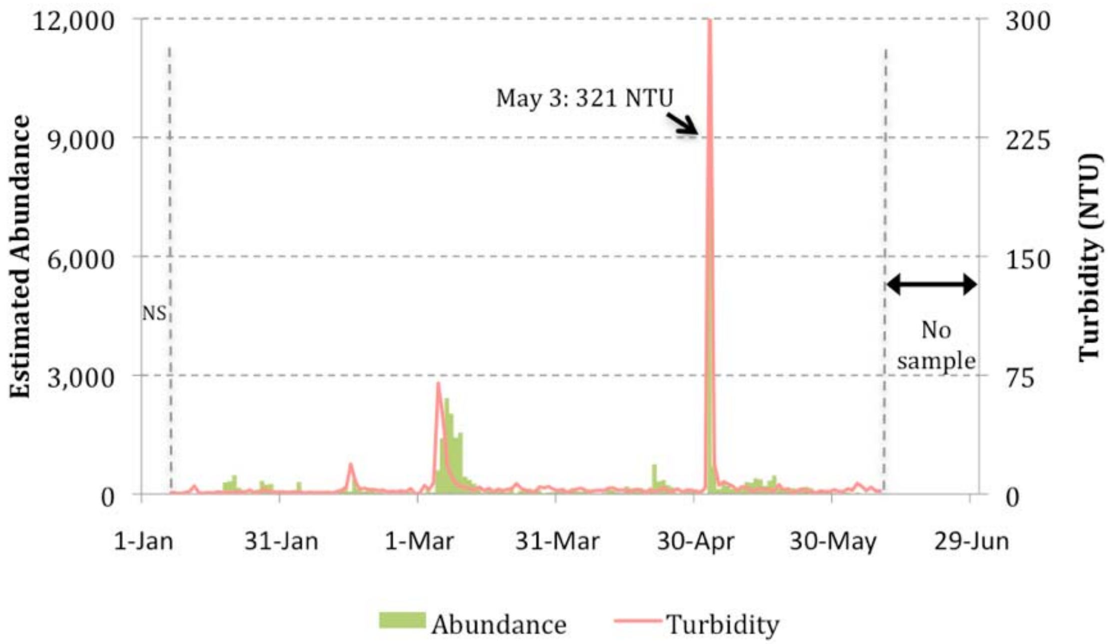

Figure 18. Daily estimated passage of unmarked Chinook salmon and instantaneous turbidity at Waterford during 2009.

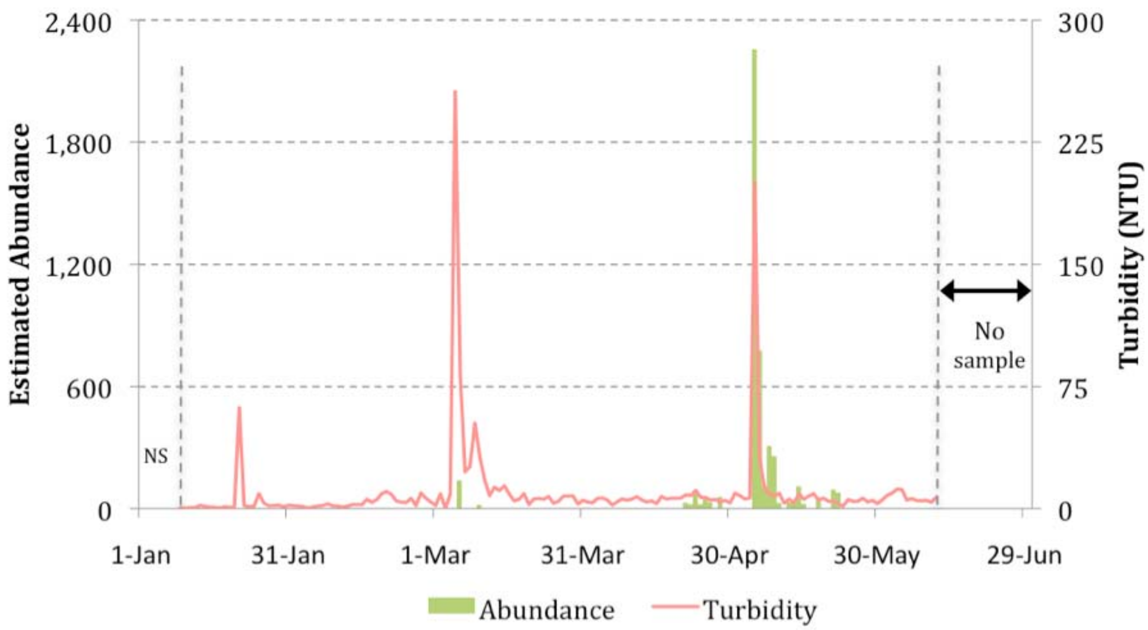

Figure 19. Daily estimated passage of unmarked Chinook salmon and instantaneous turbidity at Grayson during 2009.

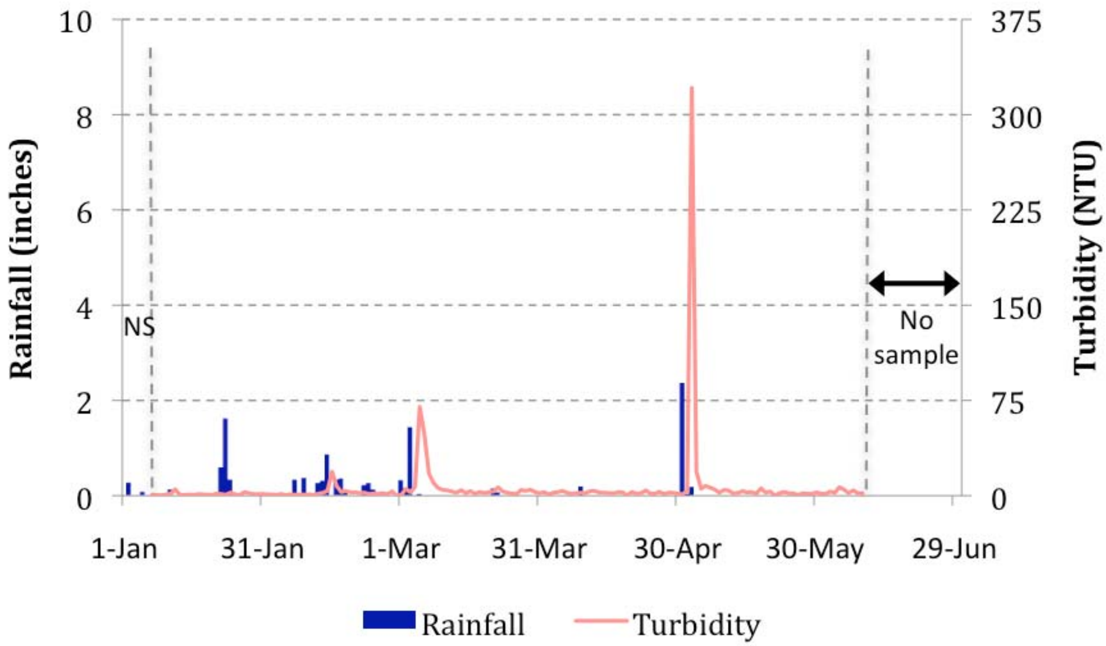

Figure 20. Daily rainfall measured at Don Pedro Reservoir and instantaneous turbidity at Waterford during 2009.

Chinook Salmon Length at Migration

Individual forklengths of unmarked salmon captured at Waterford during 2009 ranged from 30 mm to 135 mm (Figure 21), and daily average length gradually increased from approximately 36 mm to 90 mm over the course of the sampling period (Figure 22 and Figure 23). Most of the juvenile salmon passing Waterford during 2009 were smolts measuring 70-99 mm, followed by fry measuring 30-39 mm (Figure 24). In total, it is estimated that 13,339 fry (<50 mm), 4,562 parr (50-69 mm), and 19,213 smolts (≥70 mm) passed Waterford during 2009 (Table 5). There were also a number of fish captured throughout the season that were atypical sizes for fall-run Chinook salmon production. For instance, during January through mid-March there were 47 fish much larger than the majority of juvenile salmon captured during that period (average size of larger fish was over 50 mm larger than majority of juvenile salmon captured) and 55 fish in the spring that were much smaller than other juvenile salmon captured during that period (33-39 mm versus 50-120 mm).

Individual forklengths of unmarked Chinook salmon captured at Grayson during 2009 ranged from 35 mm to 125 mm (Figure 25), and daily average length fluctuated between 35 mm and 110 mm during the sampling period (Figure 23 and Figure 26). Nearly 91% of the salmon estimated to have passed Grayson during 2009 were smolts measuring 70-99 mm (Figure 27). In total, it is estimated that 145 fry (<50 mm), 200 parr (50-69 mm), and 4,332 smolts (≥70 mm) passed Grayson during 2009 (Table 5). Similar to Waterford, two much larger sized Chinook were also captured during January through early March.

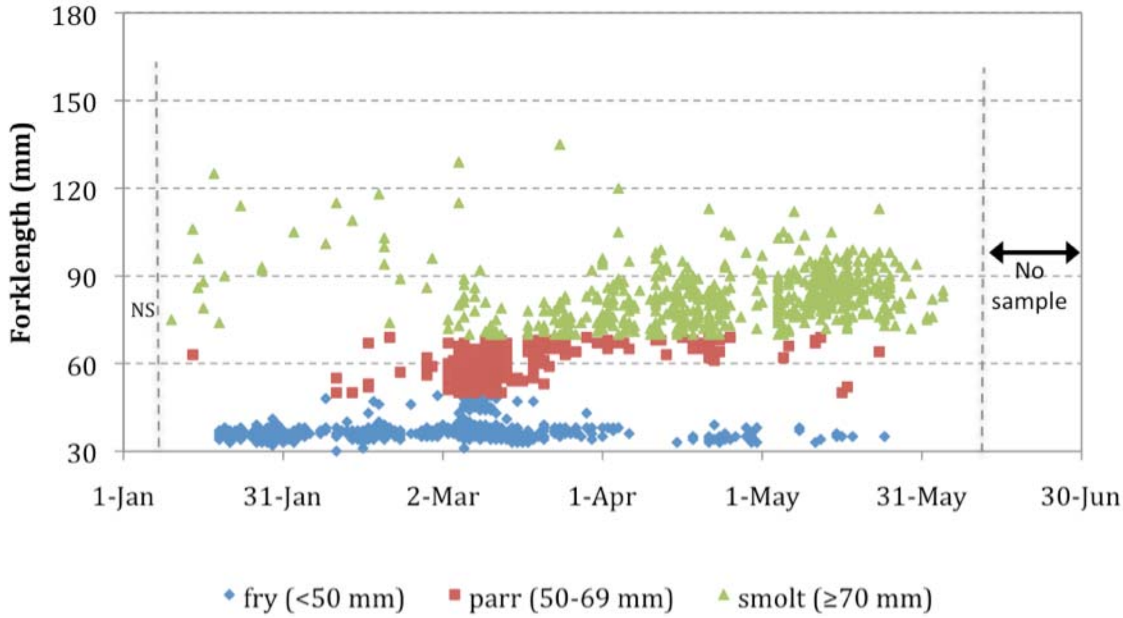

Figure 21. Individual forklengths of juvenile salmon captured at Waterford during 2009.

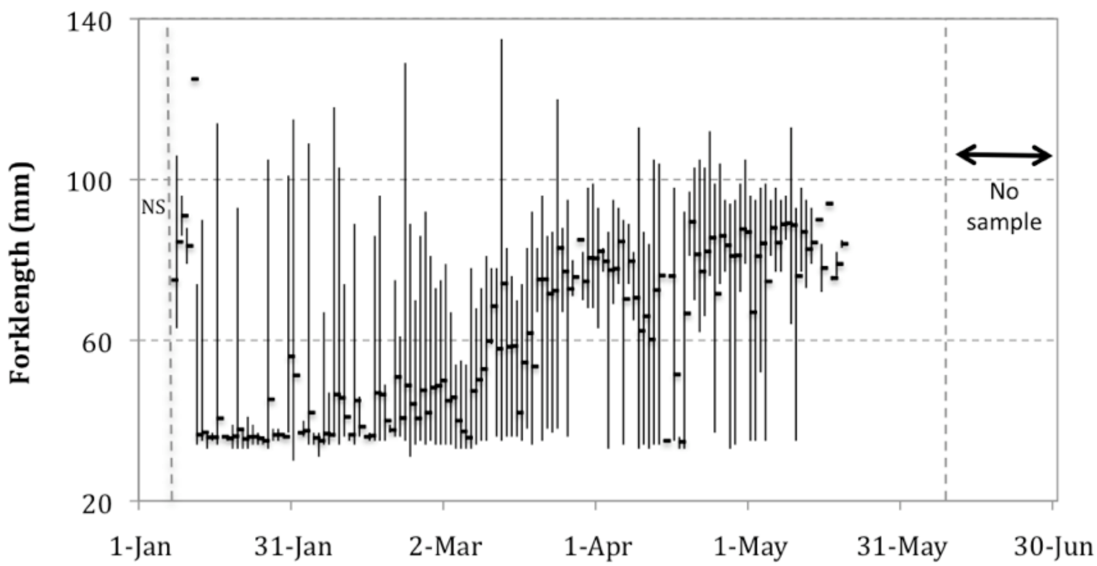

Figure 22. Daily minimum, average, and maximum fork lengths of unmarked Chinook salmon captured at Waterford during 2009.

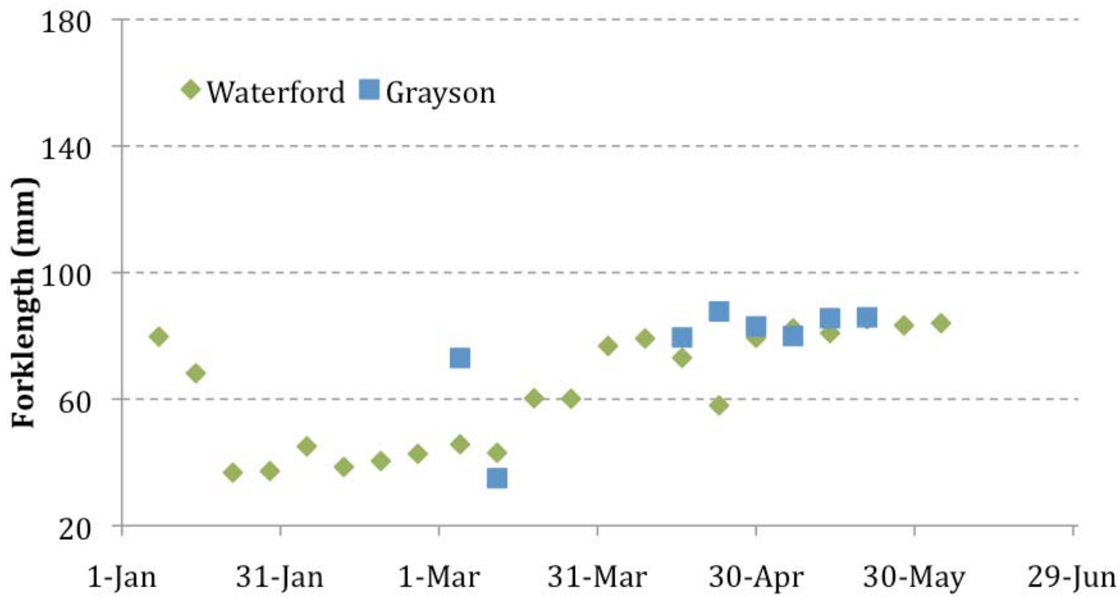

Figure 23. Average forklength of juvenile Chinook salmon captured at Waterford and Grayson by Julian week during 2009.

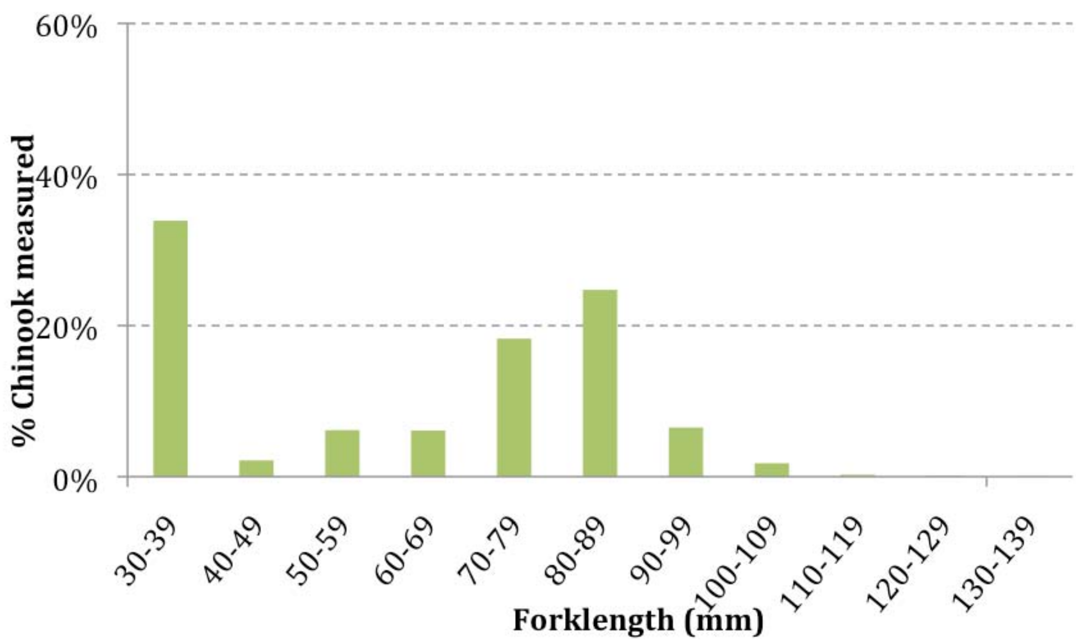

Figure 24. Estimated Chinook passage by 10 mm fork length intervals at Waterford during 2009.

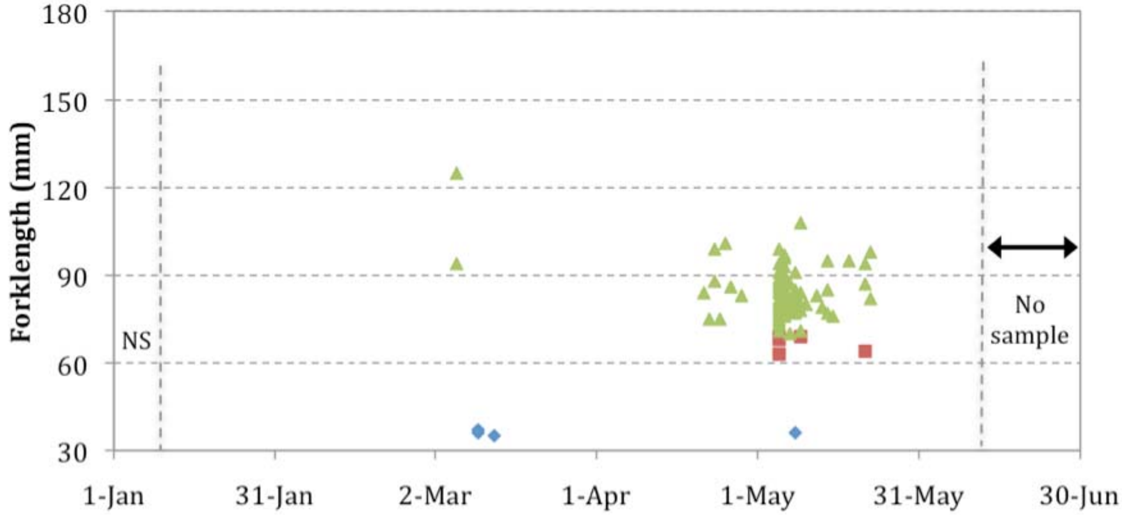

Figure 25. Individual forklengths of juvenile salmon captured at Grayson during 2009.

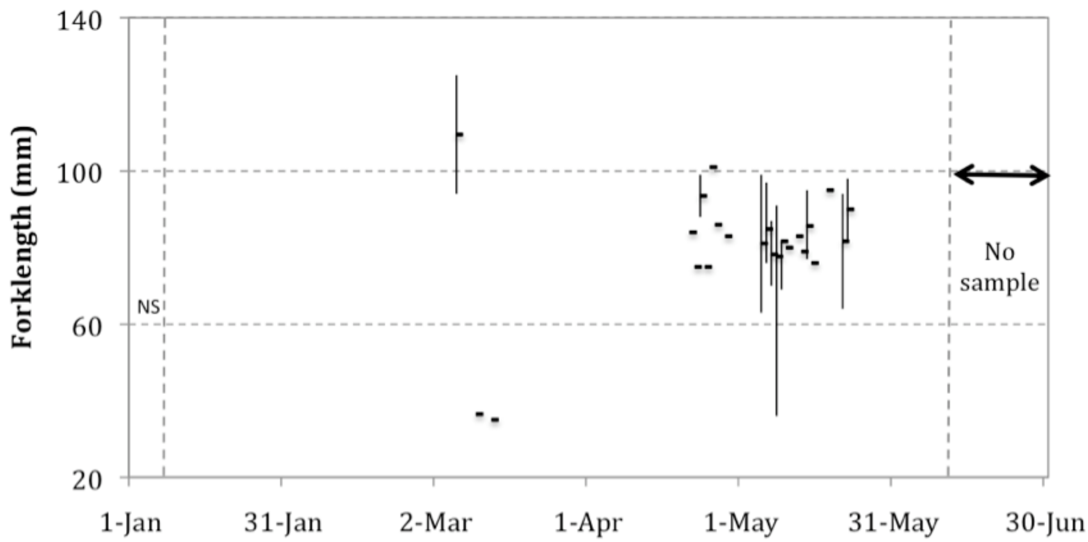

Figure 26. Daily minimum, average, and maximum fork lengths of unmarked Chinook salmon captured at Grayson during 2009.

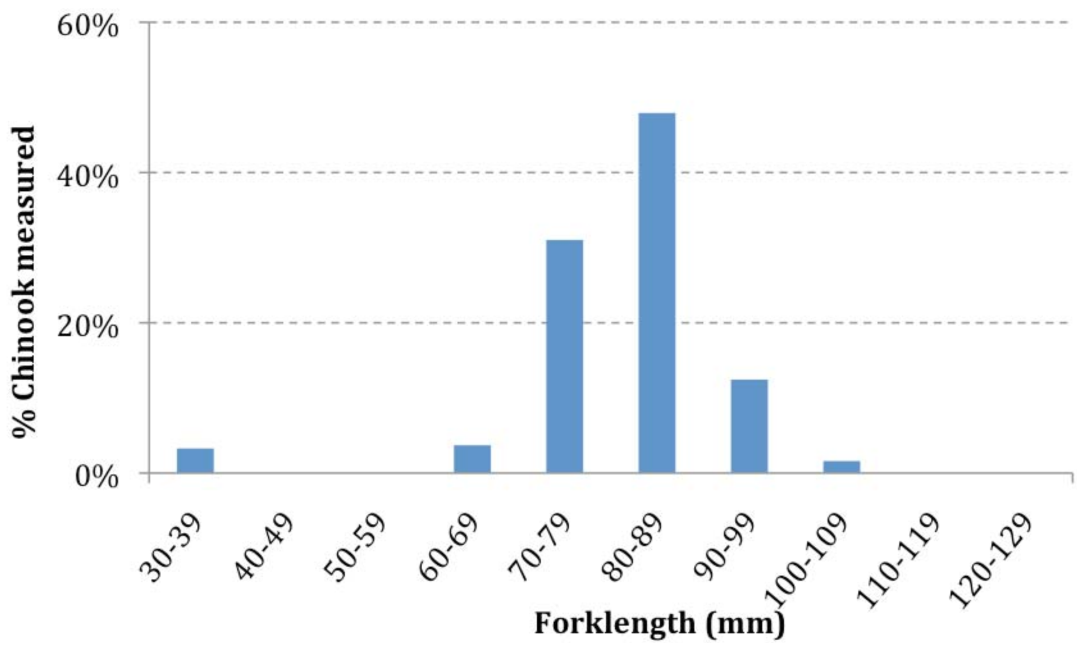

Figure 27. Estimated Chinook passage by 10 mm fork length intervals at Grayson during 2009.

Chinook Salmon Condition at Migration

Juveniles captured at both Waterford and Grayson during 2009 were generally healthy with no apparent signs of disease or stress except during excessive turbidity periods in early May. Turbidity reached 321 NTU on May 3 causing the fish in the trap to gasp for air and easily shed their scales. High turbidity events may irritate the gills of the fish causing them to respond with this type of behavior. Handling was minimized during this event to prevent further stress on the fish. Trends in individual salmon forklength to weight completely overlapped between Waterford and Grayson (Figure 27).

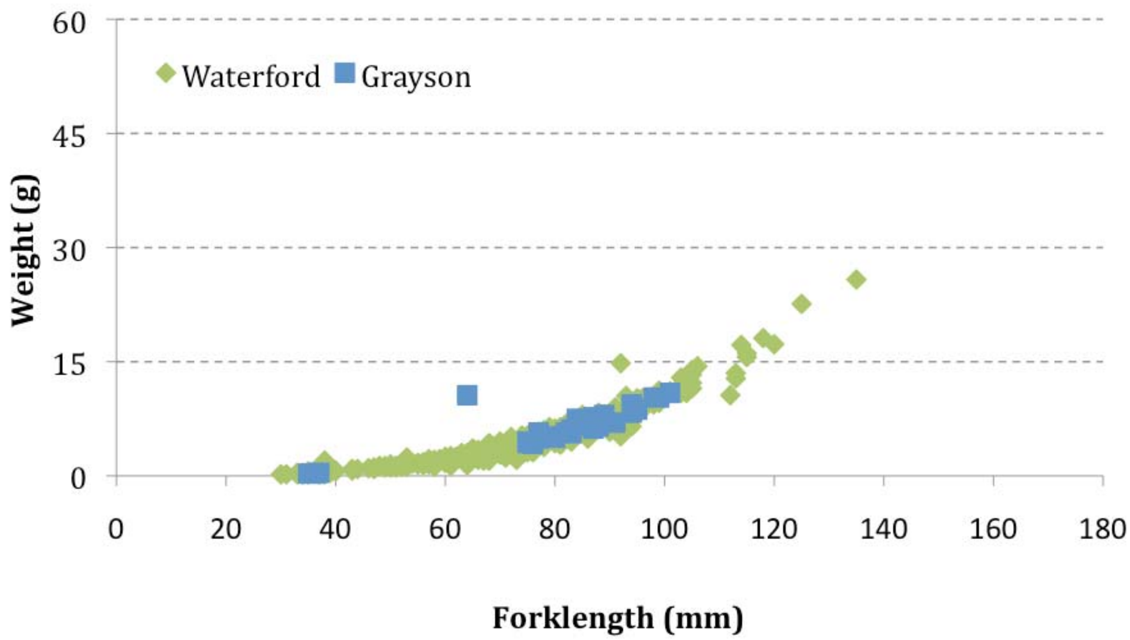

Figure 28. Individual forklength and weight of individual juvenile Chinook salmon measured at Waterford and Grayson during 2009.

Oncorhynchus mykiss (Rainbow Trout)

One *O. mykiss* was captured at Waterford on February 17, 2009 (120 mm; Table 7). Zero *O. mykiss* were captured at Grayson in 2009.

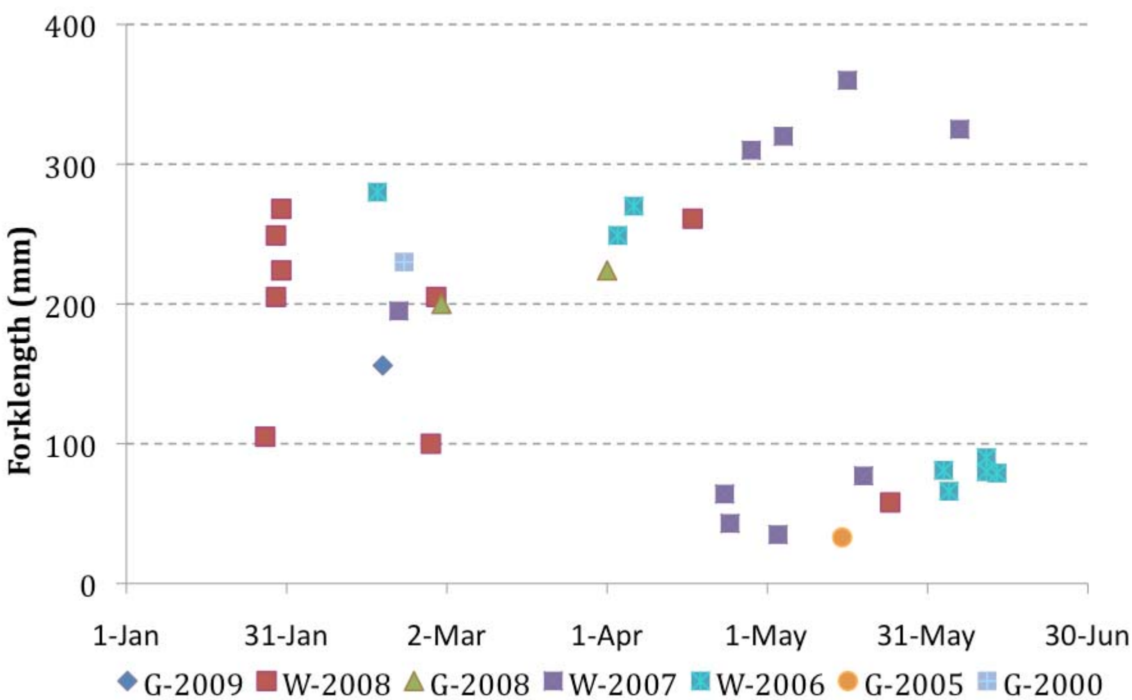

Figure 29. Date, size and location of *O. mykiss* captured at Waterford (W) and Grayson (G).

Table 7. Length, weight, and smolt index of *O. mykiss* captured at Waterford and Grayson [a] during 2009.

Date	Fork Length (mm)	Total Length (mm)	Weight (g)	Smolt Index*	Mortality
2/17/2009	105	120	89.2	5	No

*Smolt index 1=yolk-sac fry; 2=fry; 3=parr, 4=silvery parr;, 5=smolt, 6=mature adult; IAD= immature adult; np= not provided

Other Fish Species Captured

A total of 35,334 non-salmonids representing at least 26 species (5 native, 21 introduced) were captured during operation of the Waterford and Grayson traps in 2009 (Table 8; Appendices C and D). Native species comprised 82% of the total non-salmonid catch, consisting primarily of lamprey (n= 28,435). Most species captured at Waterford were all also recorded at Grayson. Additional species only recorded at Waterford were fathead minnow, hardhead, and bigscale logperch. Additional species only recorded at Grayson were American shad, black crappie, goldfish, inland silverside, striped bass, black crappie, carp, green sunfish, and inland silverside. Lampreys captured in the traps were primarily ammocoetes and were not identified to species or measured. No adult lamprey were captured at either trapping location.

Table 8. Non-salmonid species captured at Waterford and Grayson during 2009. 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*	65	176	177	178	1	195	195	195
Channel catfish	*Ictalurus punctatus*	40	42	73	445	29	45	88	411
White catfish	*Ictalurus catus*	1080	33	65	296	1867	19	64	350
unidentified catish	Not applicable	0	-	-	-	13	14	16	17
Hering Family									
Threadfin shad	*Dorosoma petenense*	2	107	111	114	4	101	110	119
American shad	*Alosa sapidissima*	0	-	-	-	1	125	125	
Lamprey Family									
Lamprey - unidentified	**Not applicable**	19499	-	-	-	8936	-	-	-
Livebearer Family									
Mosquitofish	*Gambusia affinis*	21	28	33	39	418	18	30	54
Minnow Family									
Carp	*Cyprinus carpio*	1	-	-	-	8	17	22	29
Fathead minnow		1	48	48	48	0	-	-	-
Golden shiner	*Notemigonus crysoleucas*	17	34	85	172	0	-	-	-
Goldfish	*Carassius auratus*	0	-	-	-	24	44	66	115
Hardhead	***Mylopharodon conocephalus***	21	37	177	388	0	-	-	-
Red shiner	*Cyprinella lutrennsis*	8	30	40	52	212	21	43	76
Sacramento pikeminnow	***Ptychochelius grandis***	115	30	94	282	18	45	91	128
Perch Family									
Bigscale logperch	*Percina macrolepida*	3	104	117	124	0	-	-	-
Temperate Bass Family									
Striped bass	*Morone saxatilis*	0	-	-	-	1	188	188	188

Common Name	Scientific Name	Waterford				Grayson			
		Total Catch	Minimum Length (mm)	Average Length (mm)	Maximum Length (mm)	Total Catch	Minimum Length (mm)	Average Length (mm)	Maximum Length (mm)
Sculpin Family									
Prickly Sculpin	***Cottus asper***	7	45	77	100	6	71	91	105
Silverside Family									
Inland silverside	*Menidia beryllina*	0	-	-	-	4	45	66	95
Sucker Family									
Sacramento sucker	***Catostomus occidentalis***	12	24	234	451	511	16	24	289
Sunfish Family									
Bluegill	*Lepomis macrochirus*	364	28	91	201	67	38	114	165
Black crappie	*Pomoxis annularis*	0	-	-	-	1	50	50	50
Green sunfish	*Lepomis cyanellus*	8	46	74	134	2	41	63	85
Largemouth bass	*Micropterus salmoides*	9	64	92	158	20	20	105	280
Redear sunfish	*Lepomis microlophus*	286	36	88	175	7	40	91	150
Smallmouth bass	*Micropterus dolomieu*	256	30	142	383	151	26	117	384
Warmouth	*Lepomis gulosus*	23	49	79	168	1	136	136	136
Unidentified bass	Not applicable	1	25	25	25	1190	15	22	45
Unidentified sunfish	Not applicable	2	27	27	27	0	-	-	-
Unidentified species	Not applicable	0	-	-	-	1	17	17	17

Total Species Captured = 26 (21 introduced, 5 native)

Total Native Individuals Captured = 29,125 (19,654 at Waterford, 8,936 at Grayson)

Total Introduced Individuals Captured = 5,002 (2,184 at Waterford, 2,818 at Grayson)

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.

CARWQCB (California Regional Water Quality Control Board). 2009. Central Valley Region - Administrative Civil Liability Complaint R5-2009-0563

Ford, T., and S. Kirihara. 2009. Spawning survey summary update. Prepared by Turlock and Modesto Irrigation Districts, California and Stillwater Sciences, Berkeley, California for Federal Energy Regulatory Commission, Washington, D.C. http://tuolumnerivertac.com/Documents/20082%20Spawning%20Summary%20Update.pdf

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.

Palmer, M. L., and C. L. Sonke. 2008. Outmigrant trapping of juvenile salmonids in the lower Tuolumne River, 2008. Prepared by FISHBIO Environmental, Chico, California for Turlock Irrigation District and Modesto Irrigation Districts. http://tuolumnerivertac.com/Documents/2008%20Tuolumne%20Annual%20RST%20Report_FINAL.pdf

Palmer, M., and C. Sonke. 2008. Outmigrant trapping of juvenile salmonids in the lower Tuolumne River at Grayson 2008. 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, J., 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 estimated passage at Waterford and environmental data from 2009.

	Unmarked Chinook Salmon									*Environmental Conditions*			
		Fork Length (mm)				Estimated Passage				Flow (cfs)			
Date	Catch	Min	Avg	Max	Est. Efficiency	Fry	Parr	Smolt	Total	La Grange	Velocity (ft/s)	Temperature at Trap	Turbidity
7-Jan	0	-	-	-	0.1514	0	0	0	0	166	1.39	48.3	0.9
8-Jan	0	-	-	-	0.1514	0	0	0	0	165	1.15	47.8	0.61
9-Jan	0	-	-	-	0.1514	0	0	0	0	166	1.12	48.7	0.28
10-Jan	1	75	75	75	0.1514	0	2	4	7	165	1.31	48.7	0.91
11-Jan	0	-	-	-	0.1514	0	0	0	0	165	1.36	48.6	1.59
12-Jan	0	-	-	-	0.1514	0	0	0	0	165	1.23	48.7	5.07
13-Jan	0	-	-	-	0.1514	0	0	0	0	167	1.46	49.1	0.76
14-Jan	2	63	85	106	0.1514	0	4	9	13	170	1.4	49.5	0.5
15-Jan	2	86	91	96	0.1514	13	0	1	13	169	1.5	49.7	0.87
16-Jan	2	79	84	88	0.1514	13	0	1	13	164	1.18	50.0	0.57
17-Jan	0	-	-	-	0.1514	0	0	0	0	164	1.28	50.1	1.26
18-Jan	1	125	125	125	0.1514	6	0	0	7	164	1.19	50.2	1.04
19-Jan	44	34	37	74	0.1514	279	0	12	291	164	1.21	50.2	0.8
20-Jan	49	35	37	90	0.1514	310	0	13	324	166	1.15	50.2	0.69
21-Jan	73	33	36	37	0.1514	462	0	20	482	165	1.2	50.5	1.58
22-Jan	24	35	36	37	0.1514	155	0	3	159	166	1.39	51.5	1.28
23-Jan	17	34	41	114	0.1514	110	0	2	112	167	1.35	52.7	0.76
24-Jan	1	36	36	36	0.1514	6	0	0	7	166	1.52	53.7	2.45
25-Jan	5	35	36	36	0.1514	32	0	1	33	166	1.2	53.6	1.06
26-Jan	18	33	36	39	0.1514	116	0	2	119	165	1.32	52.5	0.56
27-Jan	50	33	38	93	0.1514	324	0	7	330	166	1.35	50.8	2.84
28-Jan	36	33	35	38	0.1514	233	0	5	238	165	1.27	49.9	1.89
29-Jan	39	33	36	41	0.1514	256	0	2	258	165	1.22	49.9	1.25
30-Jan	7	34	36	39	0.1514	46	0	0	46	165	1.19	50.4	1.18
31-Jan	5	34	36	37	0.1514	33	0	0	33	165	1.19	51.1	1.36
1-Feb	3	34	35	36	0.1514	20	0	0	20	164	1.19	51.5	1.01
2-Feb	7	33	45	105	0.1514	46	0	0	46	165	-	51.8	0.99
3-Feb	17	35	36	38	0.1514	111	0	1	112	165	1.31	52.3	0.63
4-Feb	46	35	37	38	0.1514	301	0	2	304	166	1.33	52.8	1.37
5-Feb	1	36	36	36	0.1514	5	1	1	7	166	1.3	53.4	0.54

	Unmarked Chinook Salmon									Environmental Conditions			
		Fork Length (mm)				Estimated Passage				Flow (cfs)			
Date	Catch	Min	Avg	Max	Est. Efficiency	Fry	Parr	Smolt	Total	La Grange	Velocity (ft/s)	Temperature at Trap	Turbidity
6-Feb	0	-	-	-	0.1514	0	0	0	0	167	1.4	53.6	1.08
7-Feb	0	-	-	-	0.1514	0	0	0	0	167	1.18	54.5	0.8
8-Feb	4	37	56	101	0.1514	18	4	4	26	166	1.25	54.5	0.93
9-Feb	0	-	-	-	0.1514	0	0	0	0	167	1.27	53.5	0.83
10-Feb	7	30	51	115	0.1514	32	7	7	46	165	1.3	51.8	1.06
11-Feb	1	37	37	37	0.1514	5	1	1	7	166	1.39	52.4	0.56
12-Feb	4	36	38	40	0.1514	25	1	0	26	166	1.21	52.5	1.53
13-Feb	14	34	42	109	0.1514	89	3	1	92	168	1.21	52.7	2.26
14-Feb	30	34	36	37	0.1514	190	5	3	198	167	-	52.6	3.88
15-Feb	10	31	35	37	0.1514	63	2	1	66	168	1.33	51.8	18.9
16-Feb	58	34	37	67	0.1514	367	10	5	383	168	1.27	50.4	7.67
17-Feb	21	34	36	47	0.1514	133	4	2	139	168	1.6	50.5	2.91
18-Feb	10	36	47	118	0.1514	63	2	1	66	167	1.27	51.1	3.73
19-Feb	20	34	46	103	0.1514	116	5	12	132	167	1.55	52.8	2.67
20-Feb	17	36	41	74	0.1514	98	4	10	112	166	1.34	53.8	2.72
21-Feb	6	35	37	37	0.1514	35	1	3	40	167	1.21	53.8	2.05
22-Feb	8	34	45	89	0.1514	46	2	5	53	168	1.42	53.8	2.37
23-Feb	0	-	-	-	0.1514	0	0	0	0	168	-	54.5	1.29
24-Feb	4	36	39	46	0.1514	23	1	2	26	168	1.49	55.8	1.74
25-Feb	2	36	36	36	0.1514	12	0	1	13	167	1.39	57.4	1.37
26-Feb	11	35	36	37	0.1514	50	19	4	73	167	1.36	58.2	2.03
27-Feb	15	35	47	86	0.1514	68	26	6	99	167	1.13	57.7	1.21
28-Feb	8	35	47	96	0.1514	36	14	3	53	167	1.29	56.8	3.42
1-Mar	4	35	40	49	0.1514	18	7	2	26	168	1.44	55.7	0.6
2-Mar	3	37	38	39	0.1514	14	5	1	20	169	1.43	55.5	5.35
3-Mar	19	36	51	75	0.1514	86	32	8	125	168	1.57	55.5	2.76
4-Mar	6	36	41	61	0.1514	27	10	2	40	170	1.32	55.1	7.02
5-Mar	92	35	49	129	0.1514	399	179	29	608	168	1.32	54.8	69.9
6-Mar	213	31	44	89	0.1514	924	415	67	1407	167	1.37	55.1	48.7
7-Mar	366	34	41	70	0.1514	1588	713	116	2417	169	1.54	55.3	17.6
8-Mar	307	35	48	86	0.1514	1332	598	97	2028	167	1.12	56.2	9.92
9-Mar	216	34	42	92	0.1514	937	421	68	1427	166	1.18	56.4	6.07

	Unmarked Chinook Salmon									*Environmental Conditions*			
		Fork Length (mm)				Estimated Passage				Flow (cfs)			
Date	Catch	Min	Avg	Max	Est. Efficiency	Fry	Parr	Smolt	Total	La Grange	Velocity (ft/s)	Temperature at Trap	Turbidity
10-Mar	235	35	48	81	0.1514	1020	458	74	1552	167	1.31	54.9	4.53
11-Mar	67	34	49	73	0.1514	291	131	21	443	167	1.15	54.8	4.24
12-Mar	55	34	50	75	0.1514	229	112	22	363	167	1.18	55.3	3.28
13-Mar	40	34	45	79	0.1514	167	81	16	264	168	1.13	56.7	2.47
14-Mar	29	34	46	67	0.1514	121	59	12	192	168	1.01	57.4	4.38
15-Mar	4	33	40	54	0.1514	17	8	2	26	167	1.41	57.8	1.94
16-Mar	15	33	37	55	0.1514	63	30	6	99	168	1.1	59.7	3.61
17-Mar	14	33	36	54	0.1514	58	28	6	92	167	1.21	60.6	1.43
18-Mar	22	33	47	78	0.1514	92	45	9	145	168	1.22	61.0	2.98
19-Mar	17	34	50	68	0.1514	36	39	37	112	168	1.08	61.8	2.05
20-Mar	7	35	53	73	0.1514	15	16	15	46	169	1.35	62.5	2.82
21-Mar	23	35	60	81	0.1220	61	65	63	189	168	1.27	62.2	3.32
22-Mar	2	59	69	78	0.1220	5	6	5	16	165	1.03	60.3	6.55
23-Mar	10	36	58	78	0.1220	26	28	27	82	165	1.12	57.6	3.53
24-Mar	16	35	74	135	0.1220	42	45	44	131	163	1.29	57.2	2.32
25-Mar	17	36	58	83	0.1220	45	48	46	139	166	1.06	58.5	1.69
26-Mar	8	36	59	76	0.1220	31	4	31	66	165	1.12	60.0	1.32
27-Mar	13	36	42	70	0.1220	50	7	50	107	164	1.19	61.4	4.53
28-Mar	2	35	55	74	0.1220	8	1	8	16	163	1.14	63.1	3.8
29-Mar	5	38	62	83	0.1220	19	3	19	41	164	1.19	63.1	4.69
30-Mar	6	34	54	92	0.1220	23	3	23	49	--	1.09	60.1	2.96
31-Mar	7	67	75	83	0.1220	27	4	27	57	164	1.46	60.0	1.92
1-Apr	10	35	75	96	0.1220	38	5	38	82	165	1.22	61.0	2.84
2-Apr	10	38	72	86	0.1220	8	11	62	82	165	1.28	61.9	0.9
3-Apr	11	37	72	87	0.1220	9	13	69	90	165	1.29	61.3	2.37
4-Apr	9	38	83	120	0.1220	7	10	56	74	166	1.23	59.9	2.89
5-Apr	7	67	77	88	0.1220	6	8	44	57	165	0.96	60.4	3.71
6-Apr	9	36	73	95	0.1220	7	10	56	74	166	1.46	61.6	2.25
7-Apr	4	71	76	80	0.1220	3	5	25	33	167	1.22	61.5	1.52
8-Apr	1	85	85	85	0.1220	1	1	6	8	166	1.19	60.2	2.08
9-Apr	0	-	-	-	0.1220	0	0	0	0	165	1.41	59.6	2.3
10-Apr	3	70	75	82	0.1220	0	1	23	25	165	1.3	59.1	2.06

	Unmarked Chinook Salmon									Environmental Conditions			
		Fork Length (mm)				Estimated Passage				Flow (cfs)			
Date	Catch	Min	Avg	Max	Est. Efficiency	Fry	Parr	Smolt	Total	La Grange	Velocity (ft/s)	Temperature at Trap	Turbidity
11-Apr	18	68	81	98	0.1220	2	7	138	148	166	1.18	60.2	3.68
12-Apr	12	68	80	99	0.1220	2	5	92	98	165	1.21	62.0	3.78
13-Apr	6	63	82	93	0.1220	1	2	46	49	166	1.2	63.0	2.42
14-Apr	3	77	80	83	0.1220	0	1	23	25	166	1.25	61.4	2.32
15-Apr	24	33	77	87	0.1220	3	9	185	197	186	1.25	58.7	2.19
16-Apr	18	69	78	95	0.1220	22	20	106	148	228	1.28	59.2	1.73
17-Apr	13	74	85	93	0.1220	16	14	77	107	339	1.14	60.7	2.85
18-Apr	16	34	70	90	0.1220	19	18	94	131	529	2.79	61.3	2.76
19-Apr	15	74	80	89	0.1220	18	17	88	123	673	2.23	59.8	-
20-Apr	11	65	71	82	0.1220	13	12	65	90	681	2.11	59.0	2.91
21-Apr	40	33	62	113	0.0530	110	102	542	755	681	2.95	58.9	1.53
22-Apr	17	34	66	87	0.0530	47	43	231	321	681	3.16	58.8	1.98
23-Apr	19	33	60	84	0.0530	139	22	198	358	680	3.22	58.7	4.2
24-Apr	12	34	73	105	0.0530	88	14	125	226	675	3.17	56.7	1.75
25-Apr	9	34	76	104	0.0530	66	10	94	170	669	3.45	55.0	1.52
26-Apr	1	35	35	35	0.0530	7	1	10	19	670	3.44	56.0	3.16
27-Apr	1	76	76	76	0.0530	7	1	10	19	630	2.88	56.5	1.22
28-Apr	4	35	52	98	0.0530	29	5	42	75	511	3.07	56.1	2.42
29-Apr	4	33	35	36	0.0530	29	5	42	75	482	2.73	56.5	2.3
30-Apr	6	33	67	92	0.0530	3	3	106	113	483	2.99	57.1	1.62
1-May	4	81	90	97	0.0530	2	2	71	75	484	2.77	57.3	1.14
2-May	0	-	-	-	0.0530	0	0	0	0	483	2.82	55.7	3.72
3-May	565	-	-	-	0.0530	318	318	10024	10660	482	2.99	56.1	321
4-May	37	70	81	103	0.0530	21	21	656	698	530	3.32	57.3	18.9
5-May	7	62	77	105	0.0530	4	4	124	132	689	3.28	59.4	5.57
6-May	16	66	82	103	0.0530	9	9	284	302	848	3.72	59.7	7.72
7-May	11	76	86	112	0.0530	10	7	191	208	900	4.19	59.0	6.32
8-May	7	37	72	99	0.0530	6	5	121	132	919	4.07	58.1	4.83
9-May	6	74	86	104	0.0530	5	4	104	113	957	4.09	57.8	2.38
10-May	11	77	84	95	0.0530	10	7	191	208	951	4.19	57.7	4.57
11-May	16	33	81	94	0.0530	14	10	278	302	952	4.51	57.7	4.08
12-May	15	34	81	95	0.0530	13	10	260	283	949	3.72	57.1	1.73

	Unmarked Chinook Salmon									Environmental Conditions			
		Fork Length (mm)				Estimated Passage				Flow (cfs)			
Date	Catch	Min	Avg	Max	Est. Efficiency	Fry	Parr	Smolt	Total	La Grange	Velocity (ft/s)	Temperature at Trap	Turbidity
13-May	21	72	88	99	0.0530	18	14	364	396	949	3.96	56.8	2.24
14-May	20	79	87	105	0.0530	28	8	342	377	951	3.82	57.4	3.58
15-May	11	35	67	96	0.0530	15	4	188	208	952	4.22	58.3	2.58
16-May	18	35	81	95	0.0530	25	7	308	340	950	4.14	58.7	2.88
17-May	25	52	84	98	0.0530	34	10	427	472	938	4.32	59.0	1.59
18-May	9	35	75	99	0.0530	12	4	154	170	908	4.16	59.1	5.88
19-May	6	81	88	95	0.0530	8	2	103	113	881	4.09	59.0	2.5
20-May	7	77	84	98	0.0530	10	3	120	132	834	3.41	58.3	3.32
21-May	8	77	89	95	0.0530	3	3	145	151	705	3.49	58.2	0.19
22-May	7	85	89	96	0.0530	3	3	127	132	600	3.19	59.5	1.94
23-May	9	64	89	113	0.0530	4	4	163	170	521	2.61	60.5	3.01
24-May	10	35	76	93	0.0530	4	4	181	189	490	3.04	60.7	1.89
25-May	8	77	87	98	0.0530	3	3	145	151	431	2.99	61.0	1.75
26-May	3	73	83	95	0.0530	1	1	54	57	390	2.6	62.6	0.65
27-May	3	79	84	93	0.0530	1	1	54	57	384	2.51	64.6	1.85
28-May	3	90	90	90	0.0530	0	0	57	57	347	2.53	65.7	1.54
29-May	2	72	78	84	0.0530	0	0	38	38	322	2.49	66.1	1.42
30-May	1	94	94	94	0.0530	0	0	19	19	295	2.4	65.3	2.55
31-May	0	-	-	-	0.0530	0	0	0	0	281	2.13	65.6	1.57
1-Jun	2	75	76	76	0.0530	0	0	38	38	281	2.49	66.2	1.38
2-Jun	2	76	79	82	0.0530	0	0	38	38	278	2.88	65.8	3.31
3-Jun	0	-	-	-	0.053	0	0	0	0	243	2.26	64.6	2.28
4-Jun	2	83	84	85	0.053	0	0	38	38	220	2.15	64.9	6.72
5-Jun	0	-	-	-	0.053	0	0	0	0	221	2.09	65.5	4.82
6-Jun	0	-	-	-	0.053	0	0	0	0	221	2.34	65.8	2.05
7-Jun	0	-	-	-	0.053	0	0	0	0	215	2.08	66.7	4.3
8-Jun	0	-	-	-	0.053	0	0	0	0	186	2.11	67.9	1.91
9-Jun	0	-	-	-	0.053	0	0	0	0	144	2.18	68.3	1.86

Appendix B. Daily Chinook catch, length, predicted trap efficiency, and estimated passage at Grayson and environmental data from 2009.

	Unmarked Chinook Salmon									*Environmental Conditions*				
		Fork Length (mm)				Estimated Passage				Flow (cfs)	Velocity (ft/s)			
Date	Catch	Min	Avg	Max	Est. Efficiency	Fry	Parr	Smolt	Total	Modesto Flow	North	South	Temperature at the traps	Turbidity
8-Jan	0	-	-	-	-	0	0	0	0	217	1.1	1.2	49.0	0.6
9-Jan	0	-	-	-	-	0	0	0	0	218	1.1	1.2	49.4	0.2
10-Jan	0	-	-	-	-	0	0	0	0	217	1.1	1.2	49.3	0.5
11-Jan	0	-	-	-	-	0	0	0	0	216	1.2	1.2	49.2	0.7
12-Jan	0	-	-	-	-	0	0	0	0	217	1.1	1.4	49.7	2.0
13-Jan	0	-	-	-	-	0	0	0	0	217	1.2	1.2	50.3	1.4
14-Jan	0	-	-	-	-	0	0	0	0	218	1.3	1.5	50.5	0.9
15-Jan	0	-	-	-	-	0	0	0	0	222	1.5	1.6	50.7	0.8
16-Jan	0	-	-	-	-	0	0	0	0	222	1.2	1.3	51.0	0.5
17-Jan	0	-	-	-	-	0	0	0	0	223	1.3	1.3	51.2	1.1
18-Jan	0	-	-	-	-	0	0	0	0	222	1.3	1.3	51.5	0.8
19-Jan	0	-	-	-	-	0	0	0	0	222	1.2	1.3	51.4	0.5
20-Jan	0	-	-	-	-	0	0	0	0	222	1.3	1.4	51.5	62.0
21-Jan	0	-	-	-	-	0	0	0	0	223	1.4	1.4	51.9	1.9
22-Jan	0	-	-	-	-	0	0	0	0	242	1.4	1.5	52.7	1.2
23-Jan	0	-	-	-	-	0	0	0	0	271	1.6	1.5	53.7	1.4
24-Jan	0	-	-	-	-	0	0	0	0	286	1.5	1.6	55.0	9.2
25-Jan	0	-	-	-	-	0	0	0	0	278	1.3	1.3	54.4	3.5
26-Jan	0	-	-	-	-	0	0	0	0	251	1.4	1.3	53.1	1.8
27-Jan	0	-	-	-	-	0	0	0	0	235	1.2	1.3	51.8	1.9
28-Jan	0	-	-	-	-	0	0	0	0	231	1.3	1.3	51.4	2.3
29-Jan	0	-	-	-	-	0	0	0	0	229	1.3	1.3	51.9	1.1
30-Jan	0	-	-	-	-	0	0	0	0	228	1.3	1.4	52.4	2.2
31-Jan	0	-	-	-	-	0	0	0	0	227	1.4	1.4	52.7	1.8
1-Feb	0	-	-	-	-	0	0	0	0	228	1.4	1.5	53.0	1.6
2-Feb	0	-	-	-	-	0	0	0	0	226	1.3	1.4	53.2	1.2
3-Feb	0	-	-	-	-	0	0	0	0	226	1.2	1.3	53.7	0.4
4-Feb	0	-	-	-	-	0	0	0	0	224	1.2	1.3	54.0	1.1
5-Feb	0	-	-	-	-	0	0	0	0	230	1.4	1.3	54.9	1.6
6-Feb	0	-	-	-	-	0	0	0	0	243	1.3	1.4	55.4	2.0

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	Unmarked Chinook Salmon										*Environmental Conditions*				
		Fork Length (mm)				Estimated Passage				Flow (cfs)	Velocity (ft/s)			
Date	Catch	Min	Avg	Max	Est. Efficiency	Fry	Parr	Smolt	Total	Modesto Flow	North	South	Temperature at the traps	Turbidity
7-Feb	0	-	-	-	-	0	0	0	0	243	1.5	1.3	55.8	3.1
8-Feb	0	-	-	-	-	0	0	0	0	239	1.4	1.3	55.5	1.8
9-Feb	0	-	-	-	-	0	0	0	0	241	1.4	1.3	54.6	1.6
10-Feb	0	-	-	-	-	0	0	0	0	237	1.4	1.4	53.7	0.9
11-Feb	0	-	-	-	-	0	0	0	0	242	1.4	1.4	54.4	1.4
12-Feb	0	-	-	-	-	0	0	0	0	245	1.4	1.3	54.6	2.5
13-Feb	0	-	-	-	-	0	0	0	0	276	1.4	1.5	54.7	2.5
14-Feb	0	-	-	-	-	0	0	0	0	273	1.2	1.3	53.7	2.5
15-Feb	0	-	-	-	-	0	0	0	0	261	1.4	1.5	53.1	5.8
16-Feb	0	-	-	-	-	0	0	0	0	354	2.0	1.5	52.3	3.9
17-Feb	0	-	-	-	-	0	0	0	0	333	1.7	1.8	52.0	5.5
18-Feb	0	-	-	-	-	0	0	0	0	314	1.5	1.6	52.4	9.2
19-Feb	0	-	-	-	-	0	0	0	0	314	1.6	1.5	53.6	10.6
20-Feb	0	-	-	-	-	0	0	0	0	307	1.7	1.7	54.2	8.8
21-Feb	0	-	-	-	-	0	0	0	0	283	1.6	1.5	54.2	4.8
22-Feb	0	-	-	-	-	0	0	0	0	279	1.3	1.4	54.7	4.0
23-Feb	0	-	-	-	-	0	0	0	0	285	1.6	1.3	56.0	3.8
24-Feb	0	-	-	-	-	0	0	0	0	270	1.4	1.4	57.1	6.4
25-Feb	0	-	-	-	-	0	0	0	0	302	1.4	1.4	58.9	1.9
26-Feb	0	-	-	-	-	0	0	0	0	313	1.5	1.4	59.2	9.7
27-Feb	0	-	-	-	-	0	0	0	0	283	1.5	1.5	58.6	6.5
28-Feb	0	-	-	-	-	0	0	0	0	272	1.3	1.4	58.3	4.2
1-Mar	0	-	-	-	-	0	0	0	0	265	1.5	1.5	58.1	2.0
2-Mar	0	-	-	-	-	0	0	0	0	277	1.3	1.3	58.6	9.1
3-Mar	0	-	-	-	-	0	0	0	0	265	1.5	1.4	58.6	-
4-Mar	0	-	-	-	-	0	0	0	0	433	1.5	1.3	57.6	9.3
5-Mar	0	-	-	-	-	0	0	0	0	1308	-	-	55.5	256.0
6-Mar	2	94	110	125	0.0142	94	0	47	141	548	2.0	1.9	54.7	82.9
7-Mar	0	-	-	-	-	0	0	0	0	380	1.7	1.5	55.8	22.6
8-Mar	0	-	-	-	-	0	0	0	0	323	1.6	1.4	57.1	26.0
9-Mar	0	-	-	-	-	0	0	0	0	292	1.5	1.4	56.8	52.6
10-Mar	4	36	37	37	0.1916	14	0	7	21	276	1.5	1.3	55.9	31.7

	Unmarked Chinook Salmon										Environmental Conditions				
		Fork Length (mm)				Estimated Passage				Flow (cfs)	Velocity (ft/s)			
Date	Catch	Min	Avg	Max	Est. Efficiency	Fry	Parr	Smolt	Total	Modesto Flow	North	South	Temperature at the traps	Turbidity
11-Mar	0	-	-	-	-	0	0	0	0	268	1.3	1.2	56.3	17.6
12-Mar	0	-	-	-	-	0	0	0	0	256	1.4	1.4	57.7	8.1
13-Mar	1	35	35	35	0.2041	5	0	0	5	247	1.5	1.2	59.5	13.2
14-Mar	0	-	-	-	-	0	0	0	0	237	1.3	1.2	59.8	11.2
15-Mar	0	-	-	-	-	0	0	0	0	232	0.9	1.3	60.0	14.1
16-Mar	0	-	-	-	-	0	0	0	0	228	1.1	1.2	62.6	9.0
17-Mar	0	-	-	-	-	0	0	0	0	226	1.2	1.3	63.5	4.9
18-Mar	0	-	-	-	-	0	0	0	0	225	1.2	1.2	63.8	5.9
19-Mar	0	-	-	-	-	0	0	0	0	227	1.1	1.2	65.4	9.3
20-Mar	0	-	-	-	-	0	0	0	0	228	1.1	1.4	66.2	2.6
21-Mar	0	-	-	-	-	0	0	0	0	234	1.0	1.1	65.2	6.0
22-Mar	0	-	-	-	-	0	0	0	0	236	1.4	1.2	63.1	6.4
23-Mar	0	-	-	-	-	0	0	0	0	226	1.3	1.1	59.7	5.8
24-Mar	0	-	-	-	-	0	0	0	0	225	1.3	1.3	60.8	7.6
25-Mar	0	-	-	-	-	0	0	0	0	230	1.2	1.2	62.7	3.4
26-Mar	0	-	-	-	-	0	0	0	0	239	1.2	1.1	64.0	4.5
27-Mar	0	-	-	-	-	0	0	0	0	233	1.2	1.1	64.9	7.7
28-Mar	0	-	-	-	-	0	0	0	0	240	1.2	1.1	66.5	7.9
29-Mar	0	-	-	-	-	0	0	0	0	254	1.3	1.1	65.5	7.9
30-Mar	0	-	-	-	-	0	0	0	0	240	1.2	1.1	60.9	2.8
31-Mar	0	-	-	-	-	0	0	0	0	248	1.3	1.1	63.1	5.2
1-Apr	0	-	-	-	-	0	0	0	0	213	1.2	1.1	64.8	4.1
2-Apr	0	-	-	-	-	0	0	0	0	180	1.1	1.1	65.4	3.7
3-Apr	0	-	-	-	-	0	0	0	0	232	1.3	1.2	63.3	6.4
4-Apr	0	-	-	-	-	0	0	0	0	231	1.3	1.1	62.1	6.6
5-Apr	0	-	-	-	-	0	0	0	0	245	1.3	1.2	63.6	5.2
6-Apr	0	-	-	-	-	0	0	0	0	258	1.4	1.4	65.5	2.2
7-Apr	0	-	-	-	-	0	0	0	0	248	1.4	1.1	64.7	4.3
8-Apr	0	-	-	-	-	0	0	0	0	270	1.4	1.3	63.3	6.1
9-Apr	0	-	-	-	-	0	0	0	0	273	1.6	1.3	62.7	5.2
10-Apr	0	-	-	-	-	0	0	0	0	287	1.4	1.4	62.8	5.9
11-Apr	0	-	-	-	-	0	0	0	0	271	1.4	1.2	63.4	7.4

	Unmarked Chinook Salmon										*Environmental Conditions*				
		Fork Length (mm)				Estimated Passage				Flow (cfs)	Velocity (ft/s)				
Date	Catch	Min	Avg	Max	Est. Efficiency	Fry	Parr	Smolt	Total	Modesto Flow	North	South	Temperature at the traps	Turbidity
12-Apr	0	-	-	-	-	0	0	0	0	264	-	-	65.3	5.4
13-Apr	0	-	-	-	-	0	0	0	0	259	1.2	1.1	66.3	4.2
14-Apr	0	-	-	-	-	0	0	0	0	242	1.3	1.1	63.4	4.8
15-Apr	0	-	-	-	-	0	0	0	0	248	1.3	1.1	60.5	3.1
16-Apr	0	-	-	-	-	0	0	0	0	242	1.3	1.2	62.4	7.5
17-Apr	0	-	-	-	-	0	0	0	0	287	1.6	1.3	65.0	6.0
18-Apr	0	-	-	-	-	0	0	0	0	377	1.5	1.5	67.4	6.5
19-Apr	0	-	-	-	-	0	0	0	0	563	1.9	1.6	69.1	6.5
20-Apr	0	-	-	-	-	0	0	0	0	739	2.3	2.1	69.1	6.6
21-Apr	1	84	84	84	0.0308	0	0	32	32	774	2.6	2.2	67.2	8.6
22-Apr	1	75	75	75	0.0416	0	0	24	24	787	2.2	2.0	66.9	8.2
23-Apr	2	88	94	99	0.0221	0	0	91	91	793	2.3	2.1	65.9	11.2
24-Apr	1	75	75	75	0.0416	0	0	24	24	788	2.0	1.9	63.6	7.0
25-Apr	1	101	101	101	0.0171	0	0	58	58	792	2.2	2.0	61.5	6.9
26-Apr	1	86	86	86	0.0284	0	0	35	35	799	2.2	1.9	60.9	5.3
27-Apr	0	-	-	-	-	0	0	0	0	802	2.0	1.9	61.2	5.7
28-Apr	2	83	83	83	0.0319	0	0	63	63	767	2.1	1.7	60.8	4.2
29-Apr	0	-	-	-	-	0	0	0	0	656	2.2	1.8	61.0	5.1
30-Apr	0	-	-	-	-	0	0	0	0	609	2.0	1.7	61.6	3.6
1-May	0	-	-	-	-	0	0	0	0	614	1.9	1.8	61.8	9.6
2-May	0	-	-	-	-	0	0	0	0	684	2.1	2.0	61.4	8.0
3-May	0	-	-	-	-	0	0	0	0	676	2.0	1.7	62.0	6.0
4-May	0	-	-	-	-	0	0	0	0	655	1.9	1.9	62.8	6.7
5-May	79	63	81	99	0.0351	0	98	2155	2253	698	2.2	1.7	64.8	200.0
6-May	23	76	85	97	0.0295	0	34	745	779	803	2.4	2.0	66.0	30.6
7-May	4	70	78	87	0.0354	5	5	104	113	907	2.3	2.2	66.4	12.7
8-May	11	36	78	91	0.0354	13	13	285	311	948	2.3	2.2	65.2	9.0
9-May	8	69	82	69	0.0307	11	11	239	261	972	2.4	2.1	64.6	7.8
10-May	1	80	80	80	0.0322	1	1	28	31	992	2.7	2.3	64.3	9.5
11-May	0	-	-	-	-	0	0	0	0	997	2.8	2.4	64.2	3.5
12-May	1	83	83	83	0.0290	1	1	32	35	998	2.2	2.6	63.3	5.8
13-May	1	79	79	79	0.0333	1	1	28	30	995	2.6	2.6	62.8	3.7

	Unmarked Chinook Salmon									*Environmental Conditions*				
		Fork Length (mm)				Estimated Passage				Flow (cfs)	Velocity (ft/s)			
Date	Catch	Min	Avg	Max	Est. Efficiency	Fry	Parr	Smolt	Total	Modesto Flow	North	South	Temperature at the traps	Turbidity
14-May	3	77	86	95	0.0265	0	0	113	113	993	2.8	2.6	63.0	9.1
15-May	1	76	76	76	0.0368	0	0	27	27	999	2.7	2.4	64.1	5.8
16-May	0	-	-	-	-	0	0	0	0	1007	2.5	2.1	65.3	7.8
17-May	0	-	-	-	-	0	0	0	0	1020	2.2	2.4	66.5	9.3
18-May	1	95	95	95	0.0192	0	0	52	52	1006	2.6	2.3	66.8	5.4
19-May	0	-	-	-	-	0	0	0	0	982	2.6	2.6	66.6	6.6
20-May	0	-	-	-	-	0	0	0	0	978	2.4	2.2	65.5	4.5
21-May	3	64	82	94	0.0312	0	19	77	96	932	2.5	2.3	65.2	4.7
22-May	2	82	90	98	0.0245	0	16	65	82	833	2.2	2.1	65.4	3.2
23-May	0	-	-	-	-	0	0	0	0	747	2.3	1.8	66.2	1.5
24-May	0	-	-	-	-	0	0	0	0	686	2.1	2.1	66.7	5.6
25-May	1	-	-	-	-	0	0	0	0	657	2.2	1.8	67.4	4.6
26-May	0	-	-	-	-	0	0	0	0	592	2.0	1.8	68.9	4.6
27-May	0	-	-	-	-	0	0	0	0	525	2.0	1.8	70.9	6.6
28-May	0	-	-	-	-	0	0	0	0	511	1.9	1.8	72.4	4.2
29-May	0	-	-	-	-	0	0	0	0	470	1.7	1.6	73.0	5.2
30-May	0	-	-	-	-	0	0	0	0	437	1.7	1.5	72.8	3.1
31-May	0	-	-	-	-	0	0	0	0	435	1.6	1.4	72.7	5.5
1-Jun	0	-	-	-	-	0	0	0	0	426	1.7	1.5	71.9	8.2
2-Jun	0	-	-	-	-	0	0	0	0	416	1.56	1.5	71.4	9.6
3-Jun	0	-	-	-	-	0	0	0	0	408	1.58	1.43	71.6	12.0
4-Jun	0	-	-	-	-	0	0	0	0	385	1.58	1.45	71.6	11.7
5-Jun	0	-	-	-	-	0	0	0	0	349	1.71	1.27	70.8	5.3
6-Jun	0	-	-	-	-	0	0	0	0	357	1.62	1.23	69.9	6.25
7-Jun	0	-	-	-	-	0	0	0	0	351	1.63	1.55	71.4	5.01
8-Jun	0	-	-	-	-	0	0	0	0	348	1.55	1.52	72.2	4.91
9-Jun	0	-	-	-	-	0	0	0	0	319	1.42	1.31	72.0	5.14
10-Jun	0	-	-	-	-	0	0	0	0	282	1.62	1.41	72.1	4.04
11-Jun	0	-	-	-	-	0	0	0	0	240	1.51	1.35	72.3	7.09

Appendix C. Daily counts of non-salmonids captured at Waterford during 2009.

Batch Date	BAS	BGS	BKB	BRB	C	CHC	FHM	GSF	GSN	HH	LAM	LMB	LP	MQK	PRS	RES	RSN	SASQ	SASU	SMB	SNF	TFS	W	WHC
1/7/2009		1							1															3
1/8/2009																								
1/9/2009																								1
1/10/2009		1																						
1/11/2009																								
1/12/2009																								1
1/13/2009																								1
1/14/2009		3																						
1/15/2009		3														1								
1/16/2009		2				1												1					1	1
1/17/2009		2				1										1								
1/18/2009		3																						
1/19/2009																								
1/20/2009																1								
1/21/2009		3													1	1								1
1/22/2009																							1	4
1/23/2009		1																						3
1/24/2009		1								2														1
1/25/2009		6												2		2								6
1/26/2009		3												1	1	2				1				6
1/27/2009		3								1						2								4
1/28/2009		2									1			1		1								8
1/29/2009		2																						2
1/30/2009										1				1		1								3
1/31/2009		1				1									1	1								8
2/1/2009		1								1														1
2/2/2009		1													1									2
2/3/2009																								2
2/4/2009		1		1																				2
2/5/2009										1														
2/6/2009		1																						1
2/7/2009																								

Batch Date	BAS	BGS	BKB	BRB	C	CHC	FHM	GSF	GSN	HH	LAM	LMB	LP	MQK	PRS	RES	RSN	SASQ	SASU	SMB	SNF	TFS	W	WHC
2/8/2009		1						1								2								
2/9/2009								1																1
2/10/2009																2								1
2/11/2009		2																						1
2/12/2009										1														2
2/13/2009		1																						1
2/14/2009				1						1														1
2/15/2009		1												1										2
2/16/2009		1		1					1	1			1											10
2/17/2009				1					1				1		2									2
2/18/2009																								1
2/19/2009				1																				2
2/20/2009																								3
2/21/2009				2																				
2/22/2009		1														1								1
2/23/2009																								
2/24/2009		1		1		1										2								4
2/25/2009																1				1				1
2/26/2009		1												1		3								5
2/27/2009		2		1												2				1				14
2/28/2009		6		2										1		3		1						9
3/1/2009		3														1								6
3/2/2009		1				1										2								4
3/3/2009		2		1					1							5								3
3/4/2009		3														1								2
3/5/2009		29				1			1		6	1		1		9	1	3	2					12
3/6/2009		14		2						1	8,000			1		2		15	2	3				26
3/7/2009		3		1		1					550					2		4					1	13
3/8/2009		14		2					1	1				1		4	1	4						23
3/9/2009		17		1												2		3						19
3/10/2009		11				1			1		21					4		1						26
3/11/2009		3		1				1								3				2				1
3/12/2009		3		1												3		1						6

Batch Date	BAS	BGS	BKB	BRB	C	CHC	FHM	GSF	GSN	HH	LAM	LMB	LP	MQK	PRS	RES	RSN	SASQ	SASU	SMB	SNF	TFS	W	WHC
3/13/2009									1		1													1
3/14/2009		2		1												2								14
3/15/2009																2			1					6
3/16/2009		4														2								4
3/17/2009		1		3												3				2				15
3/18/2009		3														3				2				18
3/19/2009		4		1							1					6		1	1					17
3/20/2009		4		2												4		1		1				16
3/21/2009		1		1												9			1	1				14
3/22/2009		2		2							1					5								5
3/23/2009		6		1												1				1				3
3/24/2009		1		2												1							1	2
3/25/2009		2		1																				4
3/26/2009		2		1		1			1							3								4
3/27/2009		1		2		1										3								6
3/28/2009		4		2		1										3				3				16
3/29/2009		4				2										8				1			2	29
3/30/2009		4														3				3			1	23
3/31/2009		2		1												3								3
4/1/2009		2		1					1							3				2				4
4/2/2009		4														1								9
4/3/2009		2		1												2				2				5
4/4/2009		11		2				1		1						1								7
4/5/2009		6				1							1			1			1					3
4/6/2009		1		1					1									1						3
4/7/2009		4		3					1	1						2								6
4/8/2009		2		2							5	1				3								6
4/9/2009		4		1		1					3					1								3
4/10/2009		3		1							3													2
4/11/2009		2														3		1						6
4/12/2009												1				2	1			1				4
4/13/2009		5		3						2						3				1				16
4/14/2009		5		1							2					5		1					1	6

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Batch Date	BAS	BGS	BKB	BRB	C	CHC	FHM	GSF	GSN	HH	LAM	LMB	LP	MQK	PRS	RES	RSN	SASQ	SASU	SMB	SNF	TFS	W	WHC
4/15/2009		1		3					1	1	5													7
4/16/2009		2		1							3					2								1
4/17/2009		1		1		1										2				1				2
4/18/2009		2				1		1								2					1			16
4/19/2009		1				1					12			1		7		4		1			1	27
4/20/2009		6									45					1								6
4/21/2009		6				2			1		25			3		16				1			1	69
4/22/2009		6									9	1		1		3							1	23
4/23/2009		1									1					7		1						15
4/24/2009		5				1			2		2			1		6								11
4/25/2009						1				3						1					1			4
4/26/2009											3					2		1						3
4/27/2009																1								2
4/28/2009		1		1		1					3					2			1					10
4/29/2009		1				1					3					1	1							7
4/30/2009		2				1																		3
5/1/2009		2																						1
5/2/2009		1																						2
5/3/2009		2		2		2				1	8,000					6		25		217			1	54
5/4/2009		9				1					1,000	3				11		4		3				43
5/5/2009						1					249						1			1				35
5/6/2009		1				2			1		5					3		1		2				44
5/7/2009		2									15					6		9					1	32
5/8/2009		6										1				5		10		2			1	14
5/9/2009		7				1					2					6		4						3
5/10/2009																7		5						8
5/11/2009		6				1					4			1		1	1	4	1				3	11
5/12/2009		3				1										4		1				1		7
5/13/2009																2		2						9
5/14/2009						1					5	1				1		1	1					3
5/15/2009		2						1			1			1		2						1		11
5/16/2009											3					4								5
5/17/2009		1				1					2					1	1							4

Batch Date	BAS	BGS	BKB	BRB	C	CHC	FHM	GSF	GSN	HH	LAM	LMB	LP	MQK	PRS	RES	RSN	SASQ	SASU	SMB	SNF	TFS	W	WHC
5/18/2009																3		2						1
5/19/2009																								2
5/20/2009		1									2					1								
5/21/2009																1								3
5/22/2009						1																		
5/23/2009		1								1						1								2
5/24/2009		1														1							1	5
5/25/2009		1															1	1	1					2
5/26/2009								1															1	
5/27/2009		4									3													2
5/28/2009						1								1		1								3
5/29/2009		6			1						3				1	3								1
5/30/2009		1														3							1	1
5/31/2009		2																						1
6/1/2009																								
6/2/2009		1																						
6/3/2009		1				1	1									3							1	1
6/4/2009																							1	1
6/5/2009		2																					1	
6/6/2009		3																						
6/7/2009		1																						
6/8/2009				1												1								1
6/9/2009	1					1		1																2
Totals	1	361	0	65	1	40	1	8	17	21	17,999	9	3	20	7	285	8	113	12	256	2	2	23	1,063
	BAS	**BGS**	**BKB**	**BRB**	**C**	**CHC**	**FHM**	**GSF**	**GSN**	**HH**	**LAM**	**LMB**	**LP**	**MQK**	**PRS**	**RES**	**RSN**	**SASQ**	**SASU**	**SMB**	**SNF**	**TFS**	**W**	**WHC**

Appendix D. Daily counts of non-salmonids captured at Grayson during 2009.

Batch Date	AMS	BAS	BGS	BKS	BRB	C	CAT	CHC	GSF	GSN	LAM	LMB	MQK	MSS	PRS	RES	RSN	SASQ	SASU	SMB	TFS	UNID	W	WHC
1/8/2009																								
1/9/2009																								
1/10/2009																	1							
1/11/2009														1			1							1
1/12/2009																								
1/13/2009																								
1/14/2009																								1
1/15/2009																	1							1
1/16/2009																								
1/17/2009																								1
1/18/2009															1									1
1/19/2009																								2
1/20/2009																								
1/21/2009																								
1/22/2009																								
1/23/2009											2													4
1/24/2009													4											12
1/25/2009											4		11				1							5
1/26/2009			1										4											8
1/27/2009			1										1											1
1/28/2009																								
1/29/2009																								2
1/30/2009													1		1		1							5
1/31/2009																	1							3
2/1/2009															1									2
2/2/2009																	3							
2/3/2009											1													1
2/4/2009																								3
2/5/2009																								1
2/6/2009																	1							
2/7/2009																				1				2
2/8/2009																								4

Batch Date	AMS	BAS	BGS	BKS	BRB	C	CAT	CHC	GSF	GSN	LAM	LMB	MQK	MSS	PRS	RES	RSN	SASQ	SASU	SMB	TFS	UNID	W	WHC
2/9/2009																								1
2/10/2009			1																					2
2/11/2009																	1							3
2/12/2009																								2
2/13/2009																								1
2/14/2009																	1							7
2/15/2009											1													6
2/16/2009											2													4
2/17/2009			1					2			88		3											17
2/18/2009			1					2			9													20
2/19/2009				1								1	1				2							20
2/20/2009													2		1		3							14
2/21/2009			1										1	1			2							5
2/22/2009								2									3							3
2/23/2009																								5
2/24/2009			3														1							20
2/25/2009													3				2							13
2/26/2009			1					1					13											36
2/27/2009			2										3				2							15
2/28/2009			1							1			2				3							31
3/1/2009																	1							17
3/2/2009			1										1				1							9
3/3/2009											15		1				2							31
3/4/2009													1											10
3/5/2009											114		6				1			1				65
3/6/2009			11							4	61	5	46		1	1	1			6				38
3/7/2009			7							1	3	5	66				1			2			1	24
3/8/2009			3					3		2			87				6			2				131
3/9/2009			3					2		3			2				1			4				62
3/10/2009			1					2		1			1				1			1				24
3/11/2009			2										3				2			2				25
3/12/2009			1					1				1	3				2							22
3/13/2009													1				2							33

Batch Date	AMS	BAS	BGS	BKS	BRB	C	CAT	CHC	GSF	GSN	LAM	LMB	MQK	MSS	PRS	RES	RSN	SASQ	SASU	SMB	TFS	UNID	W	WHC
3/14/2009									1				2				8							23
3/15/2009								1									5			1				27
3/16/2009													1				6			1				22
3/17/2009								1					1				5							27
3/18/2009								1									2							8
3/19/2009			2										3			1				1				9
3/20/2009													1				5							23
3/21/2009			1										1				3							15
3/22/2009			1										1											15
3/23/2009																	3							10
3/24/2009								1							1									7
3/25/2009																				1				7
3/26/2009																	5							3
3/27/2009																								11
3/28/2009			1													1	2			1				9
3/29/2009																	2							6
3/30/2009																	2			1				8
3/31/2009																	1			2				6
4/1/2009																								7
4/2/2009																				1				1
4/3/2009																	1							2
4/4/2009																	1							2
4/5/2009			2										4											1
4/6/2009																								2
4/7/2009													2				8							9
4/8/2009											4						5							1
4/9/2009											4						5							2
4/10/2009								1									1							3
4/11/2009																								2
4/12/2009																	1							4
4/13/2009																								6
4/14/2009																			1	1				5
4/15/2009																	1							5

Batch Date	AMS	BAS	BGS	BKS	BRB	C	CAT	CHC	GSF	GSN	LAM	LMB	MQK	MSS	PRS	RES	RSN	SASQ	SASU	SMB	TFS	UNID	W	WHC
4/16/2009																								
4/17/2009																								4
4/18/2009								1																7
4/19/2009													1											18
4/20/2009													1							1				27
4/21/2009			1							1	5		5				1							42
4/22/2009										5	9	1	37				4			1				81
4/23/2009								1		1	2		9				4							40
4/24/2009										2			6				3							22
4/25/2009																	1			3				2
4/26/2009			1																					8
4/27/2009			1														4							12
4/28/2009													3				1		1					4
4/29/2009		1											1				1							4
4/30/2009													2				3					1		9
5/1/2009													1				5							1
5/2/2009																	3				1			4
5/3/2009																	1							6
5/4/2009												2					1							4
5/5/2009	1	21	2							1	7927	1						2	8	68				97
5/6/2009		19	1		1			1			640						1		1	21				33
5/7/2009		148							1		43		10				6	1		1				77
5/8/2009		39	1									2	4				1		4	4				100
5/9/2009		1											2			1	1	1	3	1				35
5/10/2009		1						1					2	1		1	1	7	2		1			35
5/11/2009		1						1					5				1	3						19
5/12/2009		2											2				4	1						14
5/13/2009		1											2				1	1			1			8
5/14/2009		1						1				1	2				1							6
5/15/2009		2											3				3	1	1		1			12
5/16/2009		3											5				5	1		2				10
5/17/2009													1											1
5/18/2009																	2		1					7

Batch Date	AMS	BAS	BGS	BKS	BRB	C	CAT	CHC	GSF	GSN	LAM	LMB	MQK	MSS	PRS	RES	RSN	SASQ	SASU	SMB	TFS	UNID	W	WHC
5/19/2009		4								1						1	4							6
5/20/2009		2											1						1					3
5/21/2009																	1							3
5/22/2009																	1							2
5/23/2009		2						1												1				7
5/24/2009		3											1				1							1
5/25/2009		14															3							1
5/26/2009		4														1	4							5
5/27/2009		4											1											2
5/28/2009		1															1							3
5/29/2009													2				3							5
5/30/2009		2				1							3				3			1				2
5/31/2009		3									1		1				1		6					3
6/1/2009			1														1							1
6/2/2009		55									1		2				3		35					1
6/3/2009		119	2			1						1	1						2					
6/4/2009		91								1			1				1		13					3
6/5/2009		106	3										1				1		21					1
6/6/2009		109				2							5	1					264	15				
6/7/2009		111	1			2							3						56					1
6/8/2009		84	1				7	1					2				1		39	2				
6/9/2009		43	1										5				1		20					1
6/10/2009		111	3			2	2						1						11	1				1
6/11/2009		82					4	1					3						21					2
Total	**1**	**1190**	**68**	**1**	**1**	**8**	**13**	**29**	**2**	**24**	**8936**	**20**	**420**	**4**	**6**	**7**	**212**	**18**	**511**	**151**	**4**	**1**	**1**	**1867**
	AMS	**BAS**	**BGS**	**BKS**	**BRB**	**C**	**CAT**	**CHC**	**GSF**	**GSN**	**LAM**	**LMB**	**MQK**	**MSS**	**PRS**	**RES**	**RSN**	**SASQ**	**SASU**	**SMB**	**TFS**	**UNID**	**W**	**WHC**

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Key to species codes

AMS	American shad
BAS	Unidentified bass
BGS	Bluegill
BKS	Black crappie
BRB	Brown bullhead
C	Common carp
CHC	Channel catfish
CHN	Chinook
FHM	Fathead minnow
GF	Goldfish
GSF	Green sunfish
GSN	Golden shiner
HH	Hardhead
LAM	Lamprey, unidentified species
LMB	Largemouth bass
LP	Bigscale logperch
MQK	Mosquitofish
MSS	Inland silverside
PRS	Prickly sculpin
RBT	Rainbow trout
RES	Redear sunfish
RSN	Red shiner
SASQ	Sacramento pikeminnow
SASU	Sacramento sucker
SMB	Smallmouth bass
STB	Striped bass
TFS	Threadfin shad
UNID	Unidentified species
W	Warmouth
WHC	White catfish

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