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FEDERAL ENERGY REGULATORY COMMISSION

Turlock Irrigation District	)	
	)	
and	)	Project No. 2299
	)	
Modesto Irrigation District	)	

2006 LOWER TUOLUMNE RIVER ANNUAL REPORT

Report 2006-4

2006 Rotary Screw Trap Report

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Outmigrant Trapping of Juvenile Salmonids in the Lower Tuolumne River, 2006

FINAL REPORT
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Submitted to
Turlock and Modesto Irrigation Districts

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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 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. 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.

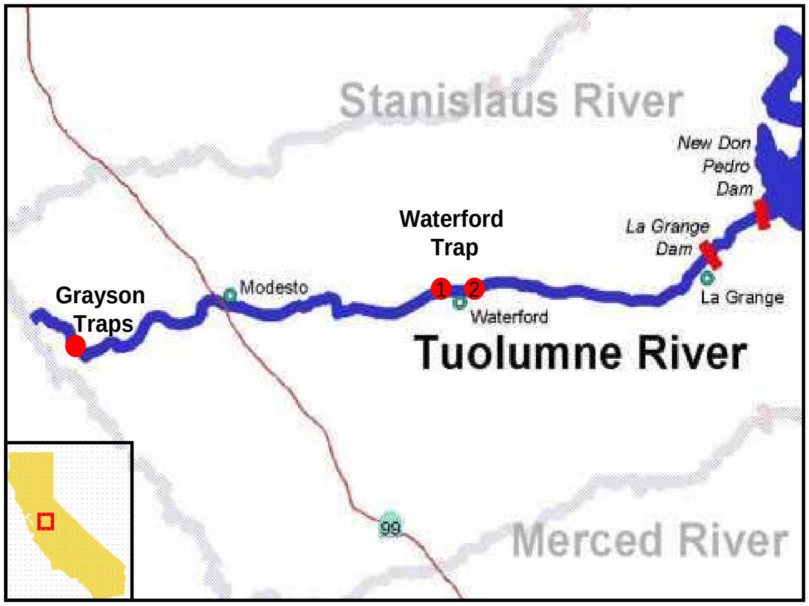

Figure 1. Location map of study area on the Tuolumne River.

Purpose and History of Study

Rotary screw traps have been operated at various locations in the Tuolumne River since 1995 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. 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. During 2006 sampling was initiated near the town of Waterford to provide comparative information in size, migration timing, and juvenile Chinook production at a site downstream from most Chinook spawning activity. The primary and secondary sampling sites used were the only locations in a 5 mile reach near Waterford with suitable water velocity, depth, and anchoring opportunities under the high flow conditions that occurred during 2006.

METHODS

Juvenile Outmigrant Monitoring

Sampling Gear and Trapping Site Locations

Rotary screw traps were installed and operated near Waterford and at Grayson River Ranch. 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 initially located at RM 29.8 approximately two miles downstream of the Hickman Bridge and sampled for more than one-half of the monitoring period at this location. 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. This configuration provided safe passage conditions for recreational river users at river flows less than 7,000 cfs, but resulted in unsafe boating conditions at flows exceeding 7,000 cfs due to inadequate clearance between the rising water surface elevation and the overhead cable. Therefore, the trap was relocated to the nearest suitable sampling location at RM 33.5 where it remained for the rest of the sampling season. The trap was held in place by 3/8 inch cables fastened to a large tree on the north bank immediately upstream. The downstream force of the water on the trap kept the cable taut near the water surface. The horizontal position of the trap was maintained or adjusted through the use of a river anchor which was deployed approximately 20-30 ft from the front of the starboard pontoon. Warning signs, flashing safety lights, and buoys marked the location of the trap and cable 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

The Waterford trap was initially installed at RM 29.8 on January 24 and began sampling on January 25. The trap was operated continuously (24 hours per day, 7 days per week) until April 12 when sampling was temporarily discontinued due to safety concerns. The trap was re-installed at a new site (RM 33.5) on April 21 and sampling resumed immediately. The trap was operated 47 out of 61 days until sampling was terminated on June 21.

The Grayson traps were installed on January 25 and sampling began immediately. The traps were operated continuously (24 hours per day, 7 days per week) from January 25 through May 7, and 33 out of 46 days from May 8 until sampling was terminated on June 22.

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, 50-79 mm= parr, and $\geq$ 80 mm= smolt. In addition, the smolting appearance of all measured salmon and trout was rated based on a scale of 1 through 6, where 1= yolk-sac fry, 2= fry, 3= parr, 4= silvery parr, 5= smolt, and 6= 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.

Trap Efficiency Releases

Trap efficiency tests were conducted to estimate the proportion of passing juvenile salmon that were sampled by the traps. Natural fish captured at each site were used when catches were sufficient to obtain a group of at least 20 fish. During 2006, groups of natural fish consisted of fish captured from a single day and catches were not accumulated over consecutive days to increase release group size. If low catches prevented the use of natural fish, hatchery-reared fish were obtained from the Merced River Hatchery. All hatchery and natural release groups were marked by dye inoculation using a photonic marking system.

Release sites were located 0.2 to 1 miles above trapping sites. The primary and seondary Waterford release sites were located at RM 30 and RM 33.9, respectively. The Grayson release site was located at RM 6.2. All marked fish were released at dusk from their respective release sites.

Four groups of fish (all natural release groups ranging in size from 120 to 240 marked fish) were released at RM 30 between January 31 and February 17 to estimate trap efficiencies at the primary Waterford site (RM 29.8). Seven groups of fish (all hatchery release groups ranging in size from 778 to 2,948 marked fish) were released at RM 33.9 between May 6 and June 15 to estimate trap efficiencies at the secondary Waterford site (RM 33.5). Ten groups of fish (five hatchery and five natural release groups ranging in size from 23 to 1,694 marked fish) were released at RM 6.2 between February 9 and June 14 to determine trap efficiencies at Grayson.

Holding Facility and Transport Method

Hatchery fish for trap efficiency releases were transported from Merced River Hatchery (MRH) to the Tuolumne River in a 200 gallon insulated aluminum hauling tank equipped with an oxygen supply (if needed) and an aerator. Fish were then transferred into 20-gallon insulated coolers equipped with aerators and transported by boat upstream to the release site.

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 (natural or hatchery) were held in free-standing net pens measuring 2 ft x 3 ft x 3 ft. Net pens consisted of 3/16 inch Delta mesh sewn on frames constructed of ½ inch diameter PVC pipe. The mesh on top of each net pen was lined with Velcro for access and canvas tops to provide necessary shade. Net pens were secured and kept in areas of low water velocity to reduce fish stress.

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. All wild fish at Grayson and all hatchery fish used for trap efficiency releases at each site were marked at the release locations.

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 (top or bottom lobe), dorsal or anal fin and dye was injected into the fin rays. While one mark was applied to each fish and all fish in a group received the same mark, the mark location was varied between groups so each group could be uniquely identified. Several different dye colors were used to differentiate the groups including green, orange, pink and yellow. 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 were randomly selected from each distinctly-marked group, anesthetized, and examined for marks; and the remaining fish in each group were enumerated. Mark retention was rated as present or absent. If any subsampled fish were unmarked, an additional 50 fish were sampled from that group. As long as all fish in the second subsample were marked, then the proportion of fish in a group found to have visible marks was used to estimate the actual number of marked fish released by the expression:

*number released = proportion mark retention * number in group*

If no marks were observed for any of the additional subsampled fish, then the entire release group was sorted and all unmarked fish were removed and released below the traps, and the number of unmarked fish was subtracted from the total number of fish.

Release Procedure

All fish were released directly from the net pens or from buckets if the net pens were several feet away from the specific release point. Fish were released by placing a dip net into the net pen or 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 a few minutes to approximately one hour 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 primary Waterford trapping site. 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 or YSI meter (model 550A) at the trap site. The closest hourly recording thermographs maintained by the Irrigation Districts were at Shiloh Road (RM 3.4) for the Grayson traps and at Ruddy Gravel (RM 36.7) for 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 2020. Turbidity was recorded in nephelometric turbidity units (NTU). Instantaneous dissolved oxygen was measured daily with a YSI model 550A meter at the trap site and recorded in mg/L.

Estimating Trap Efficiency and Chinook Abundance

Since sampling did not occur every day, catches at both trapping sites were first adjusted to account for missing values associated with days not sampled, with the exception of the extended non-sampling period from April 12 to April 21 at Waterford. Catches were also not adjusted for temporary trap stoppage which occurred more frequently at Grayson than at the Waterford sites.

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.

At Grayson, missing daily average forklength values were also calculated to account for days not sampled since the trap efficiency predictor equation used to expand the data at this site included fish size. 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 proportion of flow sampled (Waterford) or by a trap efficiency predictor equation (Grayson).

At Waterford, no trap efficiency tests were conducted prior to 2006 at either of the Waterford trapping locations and trap efficiency data was limited to only a few release groups during 2006 (Table 2). Therefore, no attempt was made to develop regression relationships between trap efficiency and predictor variables such as river flow, fish size, or turbidity. Instead, a rough estimate of salmon relative abundance for the sampling season was calculated by expanding the daily number of fish by the percentage of daily flow sampled through the trap:

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

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 during trapping at the primary site, and flow at La Grange only during trapping at the secondary site.

At Grayson, flow and trap efficiency data collected from 1999 through 2006 (Table 2) 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

RESULTS AND DISCUSSION

Chinook Salmon

Number of Unmarked Chinook Salmon Captured

Daily catches of juvenile salmon at Waterford between January 25 and June 21, ranged from zero to 397 fish and totaled 9,053 fish (Figure 2). Catches of juvenile salmon were highest from January through March and were dominated by fry (<50 mm).

At Grayson, daily catches of juvenile Chinook salmon ranged from 0 to 93 fish and totaled 1,557 fish between January 25 and June 22 (Figure 3). Similar to Waterford, catches of juvenile salmon were highest from January through March and were dominated by fry.

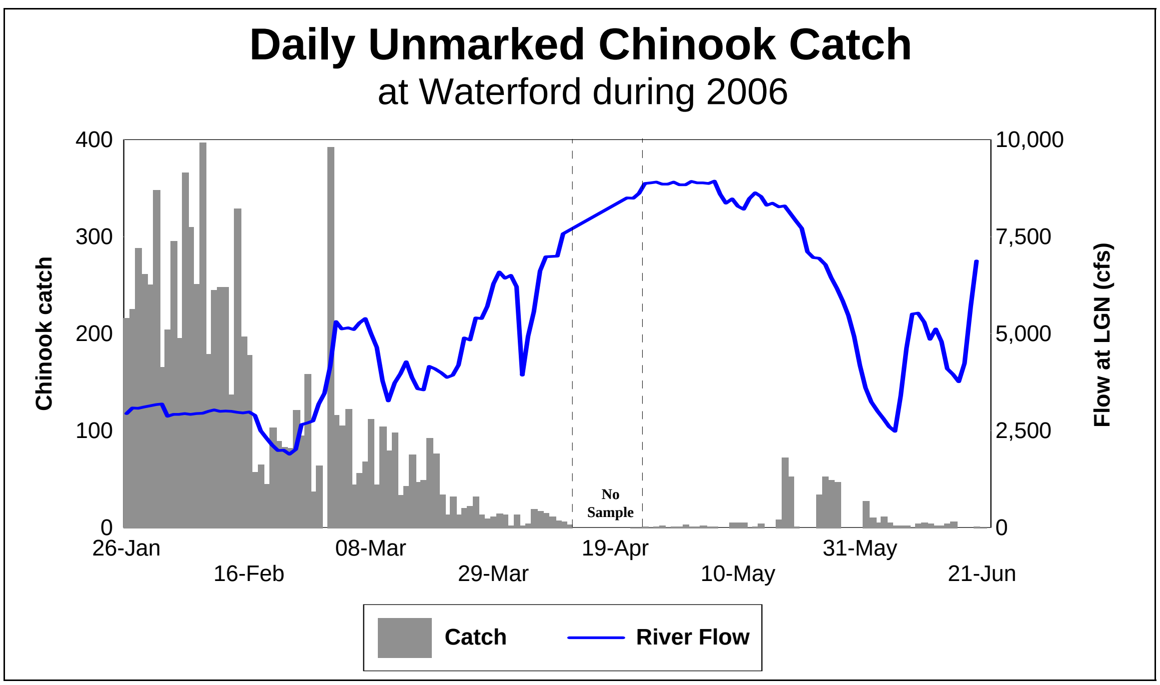

Figure 2. Daily catch of unmarked Chinook salmon at Waterford, and river flow at La Grange (LGN) during 2006.

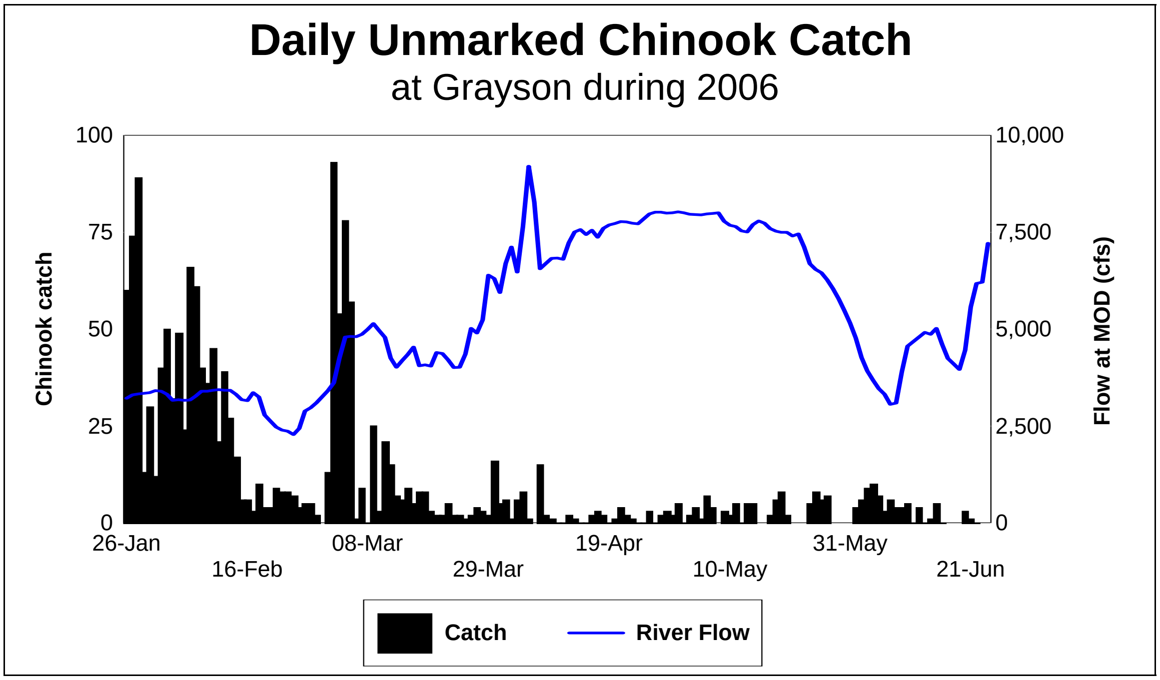

Figure 3. Daily catch of unmarked Chinook salmon at Grayson, and river flow at Modesto (MOD) during 2006.

Trap Efficiency and Estimated Chinook Salmon Abundance

Trap efficiency estimates for fry at the primary Waterford site ranged from 4.3% to 5.4% at flows (e.g., La Grange and Hickman spill combined) of 2,892 cfs to 3,171 cfs (Table 1; Figure 4). Average forklength at release ranged from 33.8 mm to 34.9 mm (Table 1), and releases were not conducted with parr or smolts at the primary Waterford site. At the secondary Waterford site, trap efficiency estimates for parr and smolts ranged from zero to 0.5% for releases at flows (e.g., La Grange only) ranging from 4,620 cfs to 8,870 cfs (Table 1; Figure 4). Average forklength at release ranged from 72.9 mm to 97.5 mm (Table 1), and no releases were conducted with fry at the secondary Waterford site.

At Grayson, trap efficiency estimates for fry ranged from 3.6% to 15.4% at flows (e.g., at Modesto) of 3,393 cfs to 4,261 cfs (Table 2; Figure 5). Average forklength at release for these groups ranged from 34.6 mm to 36.1 mm (Table 2). Trap efficiency estimates for parr and smolts ranged from zero to 0.4% at flows of 4,764 cfs to 7,942 cfs (Table 2; Figure 5). Average forklength at release for these groups ranged from 73.2 mm to 91.9 mm (Table 2; Figure 6). Combined with trap efficiency data from prior years observed trap efficiency estimates ranged from zero to 21.2% at flows of 280 cfs to 7,942 cfs (Table 2; Figure 7).

Predicted daily trap efficiencies at Grayson during 2006 are shown relative to observed efficiencies in Figure 9. Missing value estimates, daily predicted trap efficiency, and daily estimated passage at Waterford and Grayson in 2006 are provided in Appendices A and B, respectively.

Table 1. Trap efficiency results from both of the Waterford sampling sites during 2006.

Release Date	Origin	Mark	Adjusted Number Released	Number Recaptured	% Recaptured	Length at Release (mm)	Length at Recapture (mm)	Flow (cfs)
31-Jan-06	Wild	Caudal fin green	240	13	5.4%	34.9	35.3	3,171
8-Feb-06	Wild	Caudal fin green	225	11	4.9%	34.6	34.6	2,940
10-Feb-06	Wild	Caudal fin green	120	6	5.0%	34.7	35.2	3,027
17-Feb-06	Wild	Caudal fin green	163	7	4.3%	33.8	33.7	2,892
6-May-06	Hatchery	Caudal fin orange	778	0	0.0%	72.9	-	8,870
13-May-06	Hatchery	Caudal fin orange	1,581	0	0.0%	78.4	-	8,480
17-May-06	Hatchery	Caudal fin orange	2,442	11	0.5%	83.1	82.8	8,360
26-May-06	Hatchery	Top caudal orange	2,326	3	0.1%	85.9	73.7	6,960
3-Jun-06	Hatchery	Top caudal orange	2,948	1	0.0%	79.3	80.0	3,240
9-Jun-06	Hatchery	Top caudal orange	2,731	0	0.0%	85.0	-	4,620
15-Jun-06	Hatchery	Top caudal orange	2,163	1	0.0%	97.5	75.0	4,790

Table 2. 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
18-Jan-01	Hatchery	Top caudal blue	1810	120	6.6%	37		487
08-Feb-01	Hatchery	Bottom caudal blue	1980	276	13.9%	47		434
01-Mar-01	Hatchery	Top caudal yellow	2017	57	2.8%	41		2130
14-Mar-01	Hatchery	Bottom caudal yellow	1487	75	5.0%	46		703
21-Mar-01	Hatchery	Bottom caudal blue, Dorsal fin blue, Top caudal yellow	3025	207	6.8%	61		519
28-Mar-01	Hatchery	Anal fin blue	1954	219	11.2%	51		515

Release Date	Origin	Mark	Adjusted Number Released	Number Recaptured	% Recaptured	Length at Release (mm)	Length at Recap.ture (mm)	Flow (cfs)
11-Apr-01	Hatchery	Bottom caudal yellow, ad-clip	2021	141	7.0%	66		535
18-Apr-01	Hatchery	Top caudal blue, ad-clip	2060	95	4.6%	68		483
25-Apr-01	Hatchery	Ad-clip dorsal fin yellow, Bottom caudal blue, Dorsal fin blue	1515	34	2.2%	71		753
02-May-01	Hatchery	Anal fin blue, ad-clip	3053	163	5.3%	72		1460
09-May-01	Hatchery	Bottom caudal yellow, ad-clip	3002	147	4.9%	75		1160
16-May-01	Hatchery	Top caudal blue, ad-clip	2942	93	3.2%	76		1020
20-Feb-02	Hatchery	Bottom caudal red	2094	444	21.2%	57		265
06-Mar-02	Hatchery	Anal fin red	2331	316	13.6%	68		278
13-Mar-02	Hatchery	Top caudal red	2042	324	15.9%	65		300
20-Mar-02	Hatchery	Dorsal fin red	2105	242	11.5%	68		328
27-Mar-02	Hatchery	Bottom caudal red	2121	147	6.9%	68		314
03-Apr-02	Hatchery	Anal fin red, ad-clip	1962	130	6.6%	76		312
09-Apr-02	Hatchery	Top caudal red, ad-clip	1995	56	2.8%	79		319
17-Apr-02	Hatchery	Dorsal fin red, ad-clip	2048	40	2.0%	84		889
25-Apr-02	Hatchery	Bottom caudal red, ad-clip	2001	22	1.1%	86		1210
01-May-02	Hatchery	Anal fin red, ad-clip	2033	14	0.7%	89		1250
08-May-02	Hatchery	Dorsal fin red, ad-clip	2021	31	1.5%	95		798
15-May-02	Hatchery	Top caudal red, ad-clip	2047	26	1.3%	97		653
22-May-02	Hatchery	Bottom caudal red, ad-clip	2043	10	0.5%	94		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
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

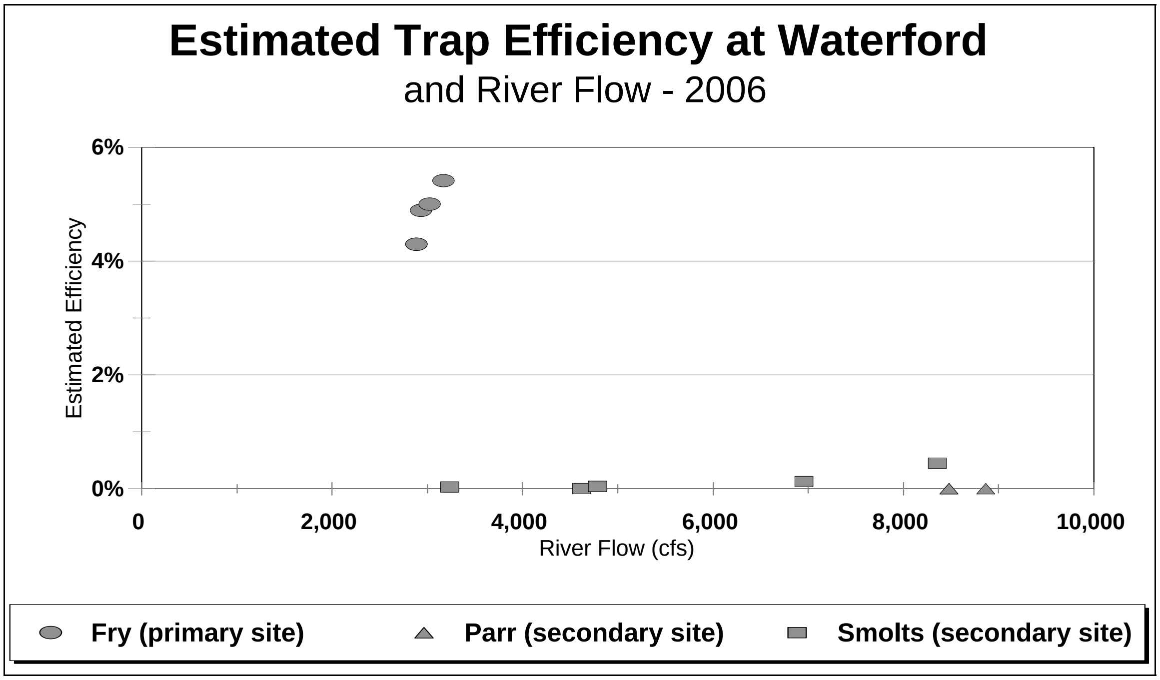

Figure 4. Trap efficiency estimates and river flow at the primary and secondary Waterford trapping sites during 2006.

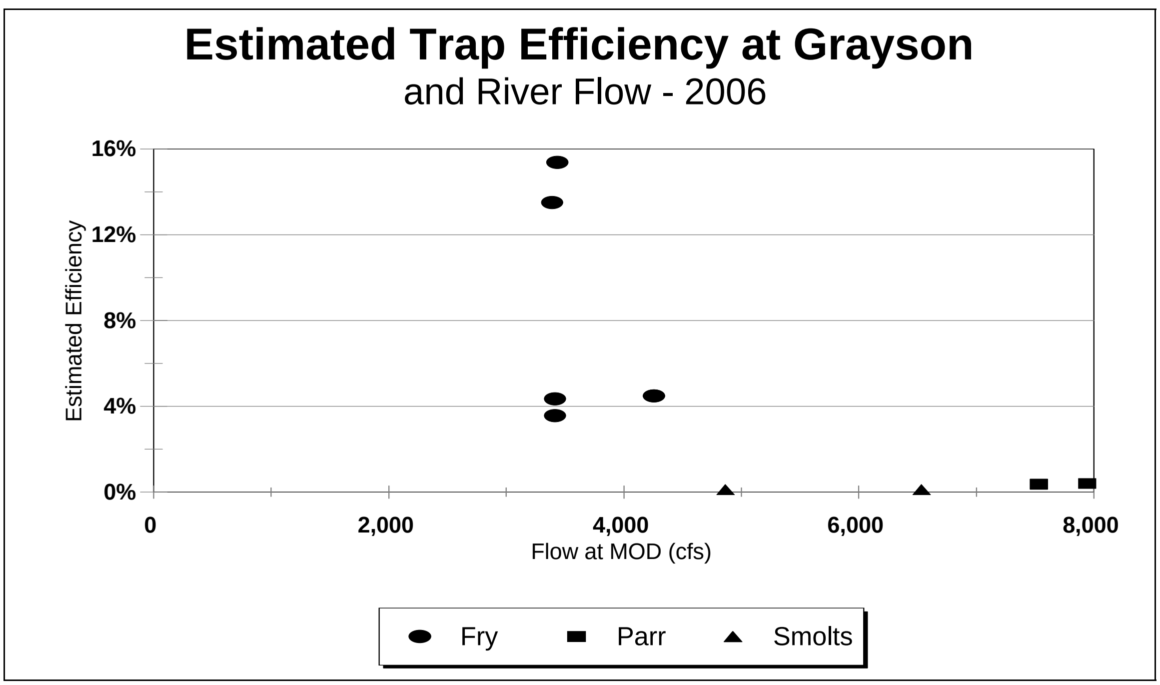

Figure 5. Trap efficiency estimates and river flow at Grayson during 2006.

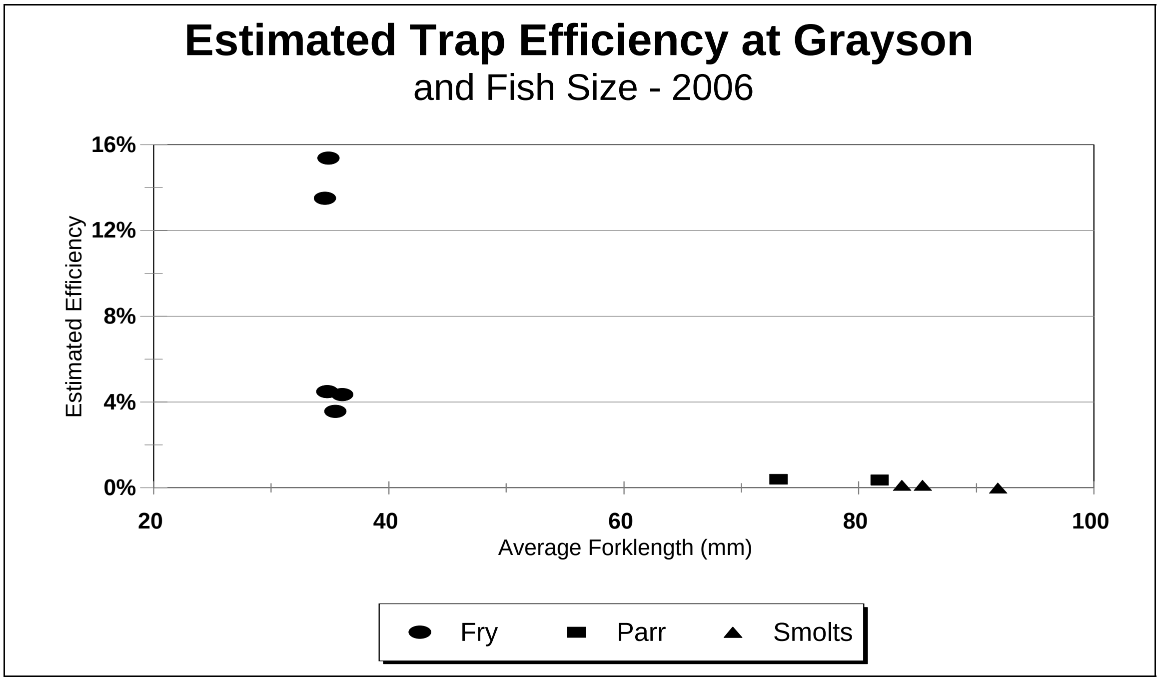

Figure 6. Trap efficiency estimates and average fish size at release at Grayson during 2006.

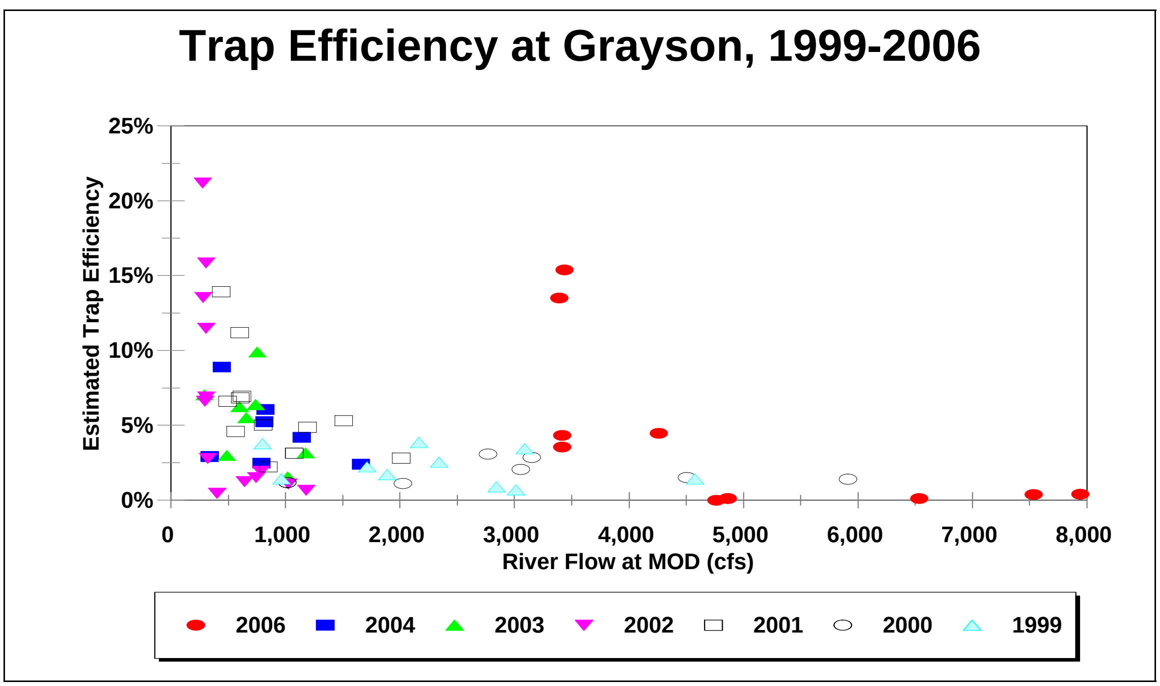

Figure 7. Trap efficiency observations at Grayson relative to river flow at Modesto, 1999-2006.

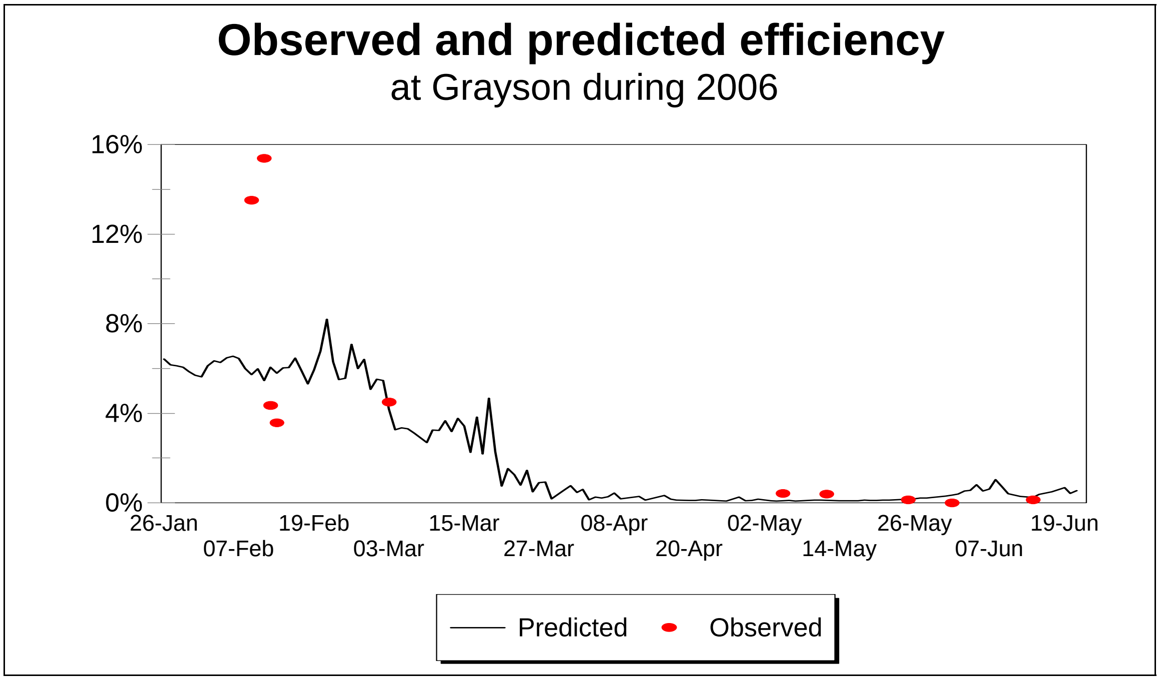

Figure 8. Observed and predicted trap efficiencies at Grayson during 2006.

Based on calculated daily passage estimates, an estimated 253,657 unmarked Chinook salmon passed Waterford during 2006. Similar to the pattern observed for catch, it is estimated that a majority (i.e., 75%) of the salmon passing Waterford during 2006 were fry (Table 3). Daily estimated passage at Waterford ranged from 0 to 12,050 salmon and peak passage occurred on March 1 (Figure 9).

An estimated 178,034 unmarked Chinook salmon passed Grayson during 2006. In contrast to the pattern observed for catch which was dominated by fry, it is estimated that a majority (i.e., 74%) of the salmon passing Grayson during 2006 were smolts (Table 3). Daily estimated passage at Grayson ranged from 0 to 6,627 salmon and peak passage occurred on May 19 (Figure 10).

For comparison, rough passage estimates were calculated by alternative methods at both Waterford and Grayson. At Waterford an estimate of 303,482 juvenile Chinook was calculated based on the average observed trap efficiency at the primary trapping site and the maximum observed trap efficiency at the secondary trapping site. At Grayson an estimate of 35,617 was calculated based on the estimated proportion of flow sampled. These estimates are provided for the purpose of comparison only and they are not reflected in the tables and figures presented in this report.

Table 3. Estimated passage by lifestage at Waterford and Grayson during 2006.

	Waterford		*Grayson*	
Fry	190,188	75%	29,046	16%
Parr	13,979	6%	17,150	10%
Smolts	49,490	20%	131,838	74%
TOTAL	253,657		178,034	

Estimated Chinook Salmon Abundance and Environmental Factors

An unknown number of juvenile salmon, mainly fry, likely passed both monitoring sites prior to the start of sampling as a result of high flows that began in December. Daily average river flows were relatively high throughout the 2006 outmigration season ranging from 1,892 cfs to 8,930 cfs at La Grange (Figure 9) due to flood control releases; and from 2,281 cfs to 9,193 cfs at Modesto (Figure 10) due to the combined effects of flood control releases, storm run-off (including Dry Creek), and irrigation return. Generally, river flow ranged from approximately 2,000 cfs to 3,000 cfs from late January through February, and passage was relatively stable at both Waterford and Grayson during this time. Flows at La Grange increased sharply from 4,189 cfs on February 27 to 6,590 cfs on March 5, and resulted in increased migration activity at Waterford on March 1 and at Grayson from March 2-5. Flows then increased to approximately 7,500 cfs to 9,000 cfs by late April. Daily passage at Waterford declined over this period, but was more variable at Grayson. Storm events resulted in three run-off spikes at Modesto between March 29 and April 6 and corresponding spikes in fish passage at Grayson were observed on March 30, April 4, and April 7. Flows remained at 7,500 cfs to 9,000 cfs through mid-May and then declined to approximately 3,000 in early June. Passage at Waterford increased and then decreased during this time, while passage at Grayson generally declined with the reduction in flow.

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 to 28.3 miles). During 2006, the survival index was 70%, and this does not account for fry that may have moved past the Waterford site, but not Grayson prior to the initiation of sampling. This index includes all lifestages of naturally-produced salmon, and is not comparable to and should not be confused with hatchery smolt survival indices. Additional years of monitoring over a range of water year types are needed to develop a context for this estimate, as well as further review of prior paired trap monitoring.

Comparison of daily passage estimates and passage estimates by lifestage between the two sites suggests that considerable fry rearing occurs between Waterford and Grayson in some years. Large numbers of fry passing Waterford were not immediately observed at Grayson and fry passage at Grayson was only 15% of the number estimated at Waterford. However, smolt passage at Grayson was nearly double the estimated smolt passage at Waterford indicating that a relatively high number of fry reared to smolt stage below Waterford prior to reaching Grayson.

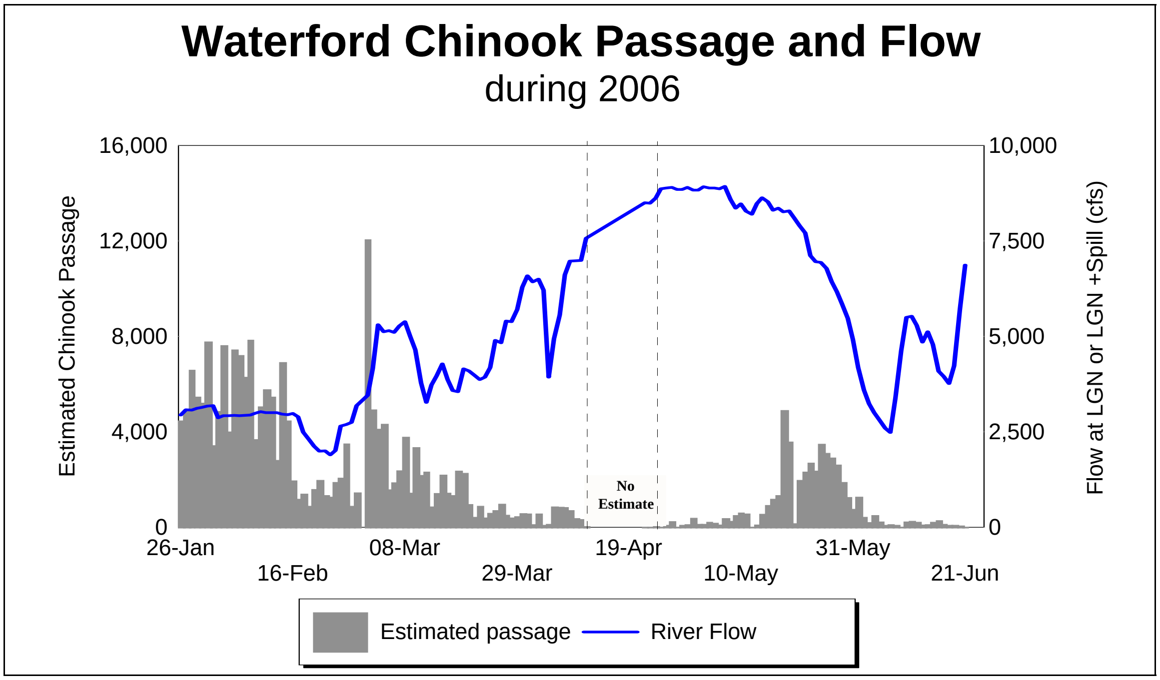

Figure 9. Daily estimated passage of unmarked Chinook salmon at Waterford and river flow at La Grange (LGN) during 2006.

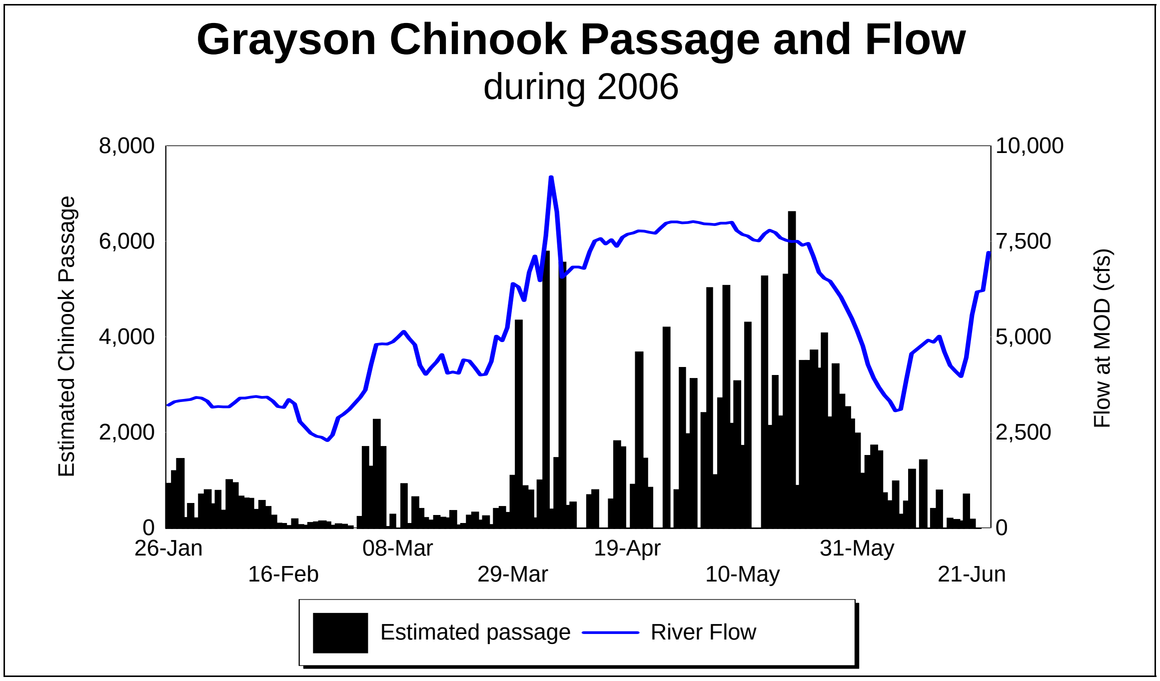

Figure 10. Daily estimated passage of unmarked Chinook salmon at Grayson and river flow at Modesto (MOD) during 2006.

During 2006 monitoring, daily average water temperatures near Waterford ranged from 49°F to 56°F (Figure 11), and were similar near Grayson ranging from 48°F to 59°F (Figure 12). From January through mid-April, water temperatures near both sites were relatively stable and fluctuated between 48°F and 53°F. Temperatures then gradually increased at both sites to 58°F to 59°F by the end of the monitoring period in late June. There were no obvious correlations between trends in passage and water temperature during 2006.

Background turbidity averaged 2.1 NTU at Waterford (Figure 13) and 3.1 NTU at Grayson (Figure 14) during the 2006 monitoring period. During storm events from late March through early April spikes in turbidity ranging from 5.0 NTU to 15.9 NTU were observed at Waterford, and from 16.6 NTU to 75.6 NTU were observed at Grayson. There was no apparent correlation between turbidity and trends in passage observed at Waterford during 2006. Spikes in turbidity coincided with increased passage at Grayson; however changes in flow occurred simultaneously so it is unclear whether migration was stimulated by changes in flow, elevated turbidity, or a combined influence of the two factors.

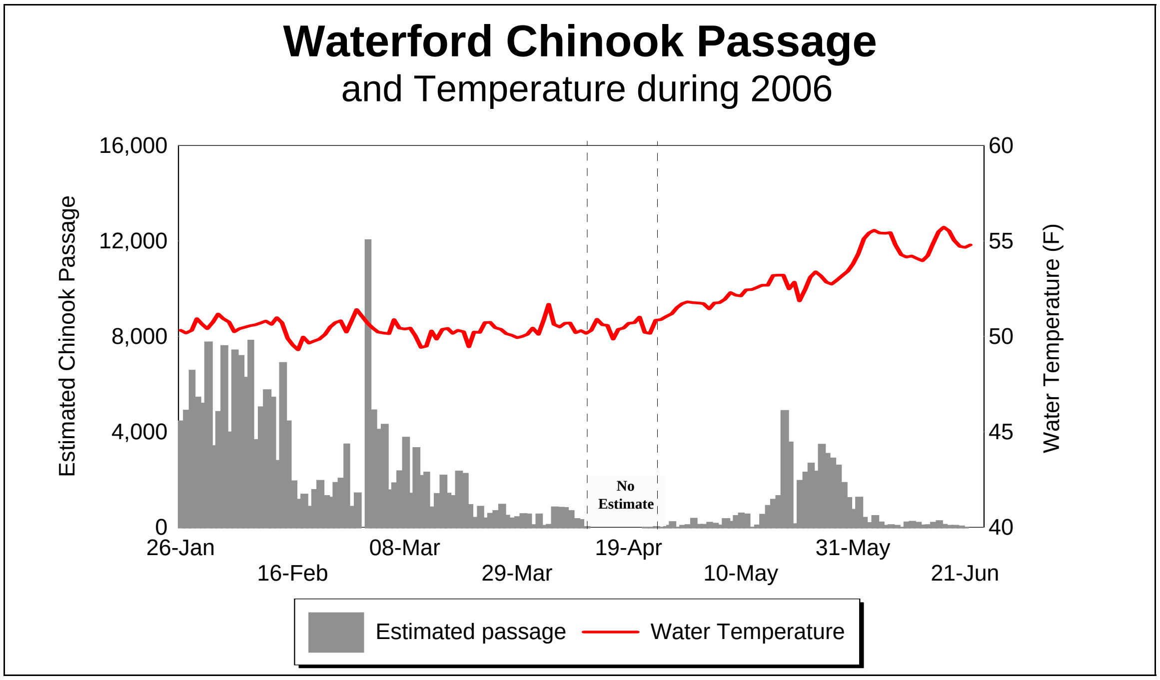

Figure 11. Daily estimated passage of unmarked Chinook salmon at Waterford and daily average water temperature at Ruddy Gravel (RM 36.7) during 2006.

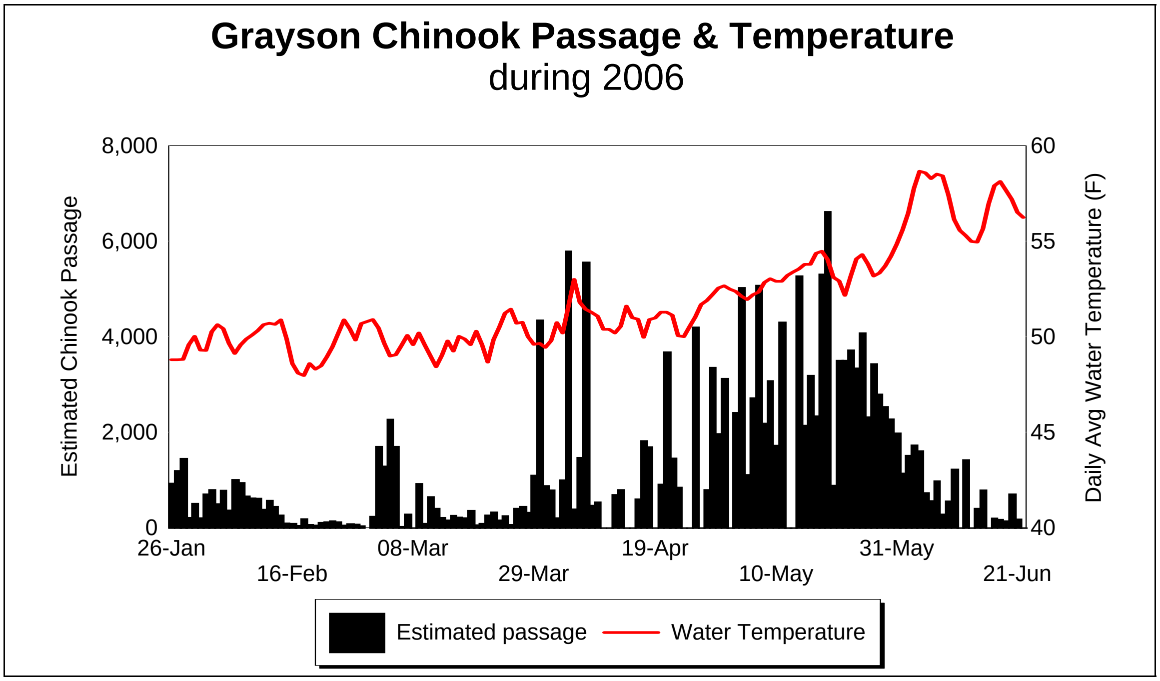

Figure 12. Daily estimated passage of unmarked Chinook salmon at Grayson and daily average water temperature at Shiloh during 2006.

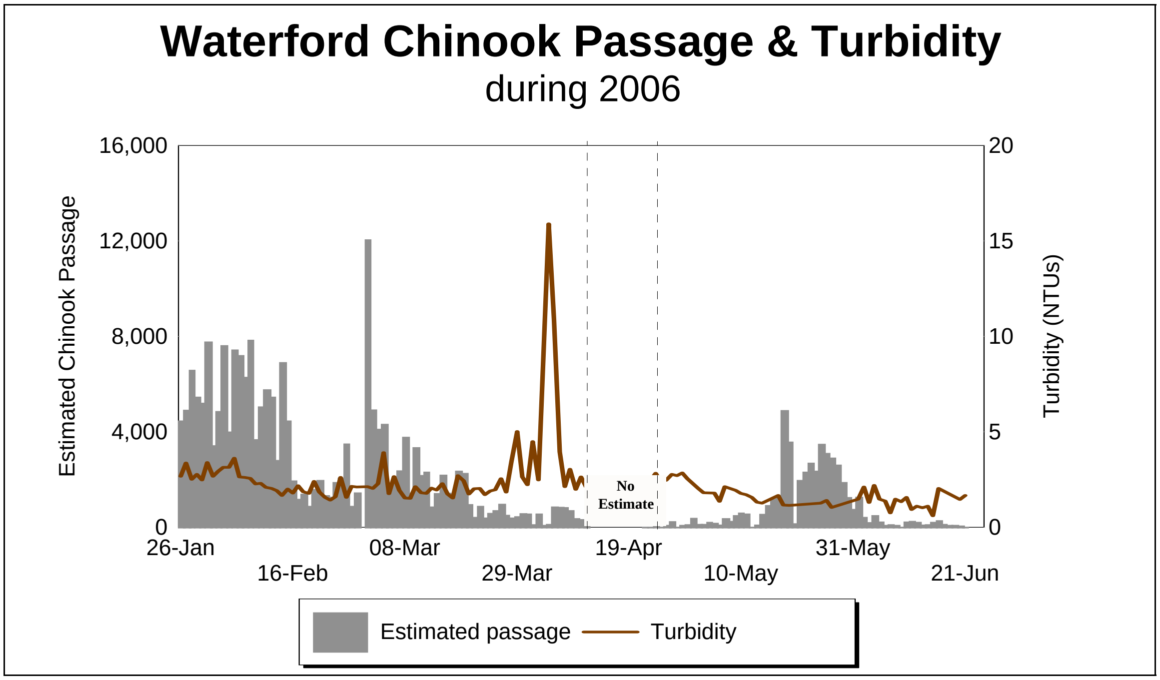

Figure 13. Daily estimated passage of unmarked Chinook salmon and instantaneous turbidity at Waterford during 2006.

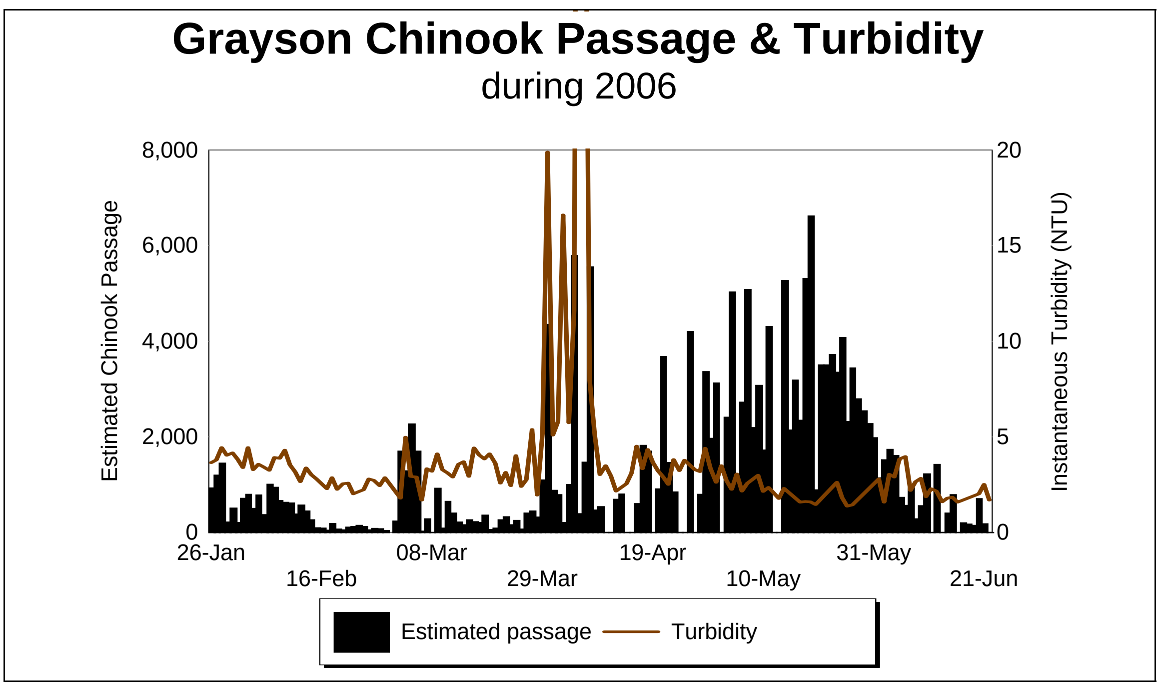

Figure 14. Daily estimated passage of unmarked Chinook salmon and instantaneous turbidity at Grayson during 2006. Turbidity peaked at 75.6 NTU on April 5.

Chinook Salmon Length at Migration

Individual forklengths of unmarked salmon captured at Waterford during 2006 ranged from 29 mm to 115 mm (Figure 15), and average length gradually increased from approximately 33.6 mm to 110.0 mm over the course of the sampling period (Figure 16 and Figure 17). Most (75%) of the juvenile salmon passing Waterford during 2006 were fry measuring 30-39 mm (Figure 20). In total, it is estimated that 190,188 fry (<50 mm), 13,979 parr (50-79 mm), and 49,490 smolts (>80 mm) passed Waterford during 2006.

Individual forklengths of unmarked Chinook salmon captured at Grayson during 2006 ranged from 27 mm to 120 mm (Figure 18), and average length gradually increased from approximately 33.7 mm to 106.0 mm over the course of the sampling period (Figure 17 and Figure 19). In contrast to the high proportion and number of fry migrants at Waterford, fry passage at Grayson was estimated to be only 29,046. Most (74%) juvenile salmon passing Grayson during 2006 were smolts (Figure 21) suggesting that rearing likely occurred between the two trapping sites.

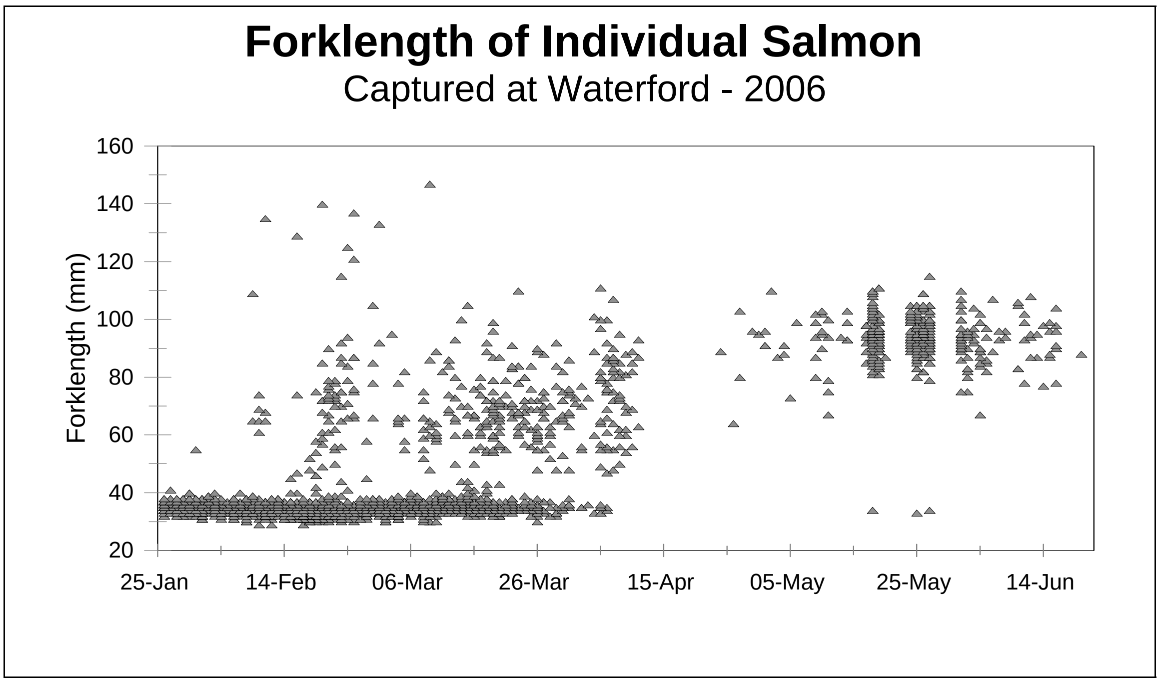

Figure 15. Individual forklengths of juvenile salmon captured at Waterford during 2006.

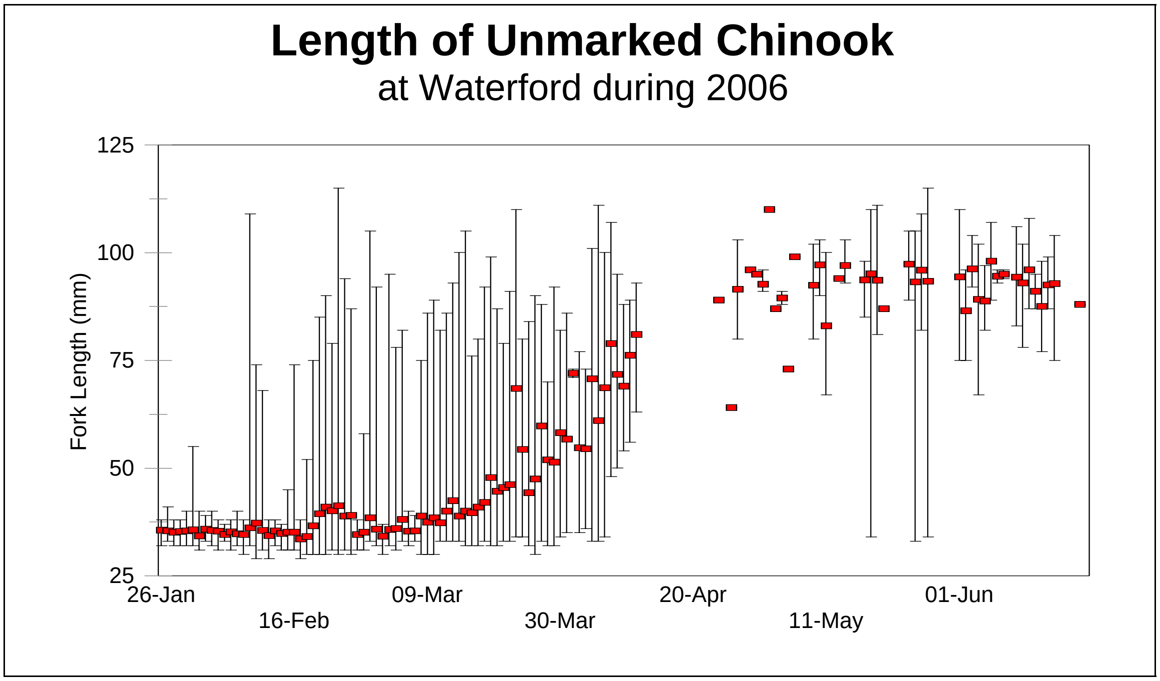

Figure 16. Daily minimum, average, and maximum fork lengths of unmarked Chinook salmon captured at Waterford during 2006.

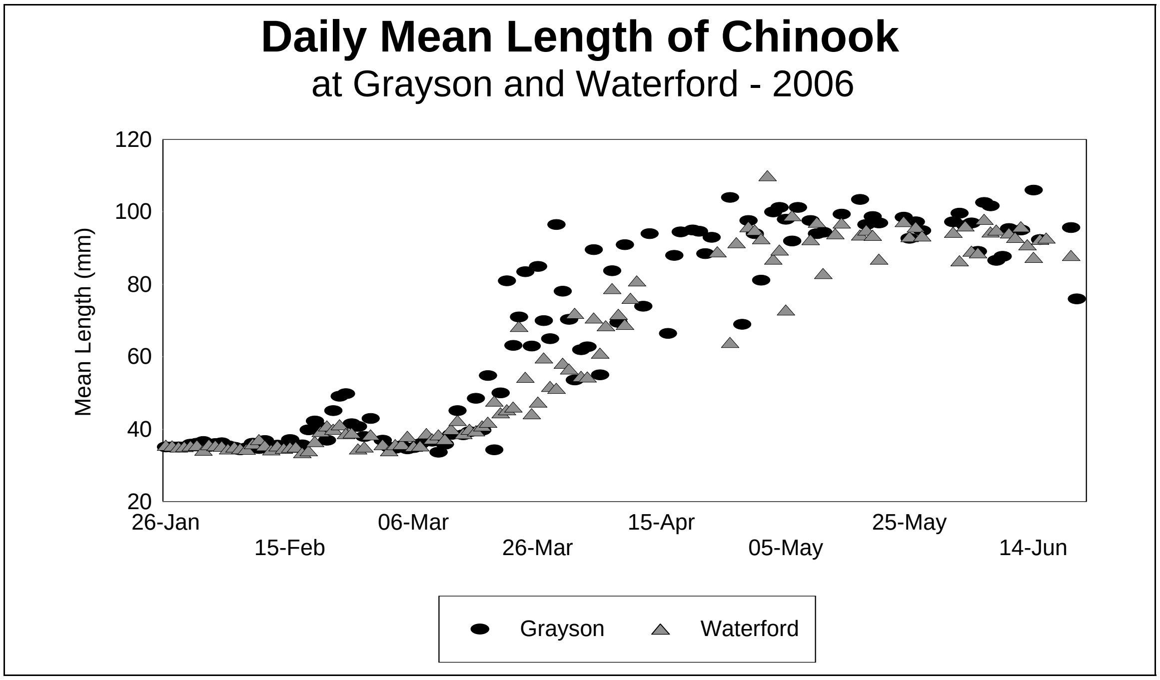

Figure 17. Daily average forklength of juvenile Chinook salmon captured at Waterford and Grayson during 2006.

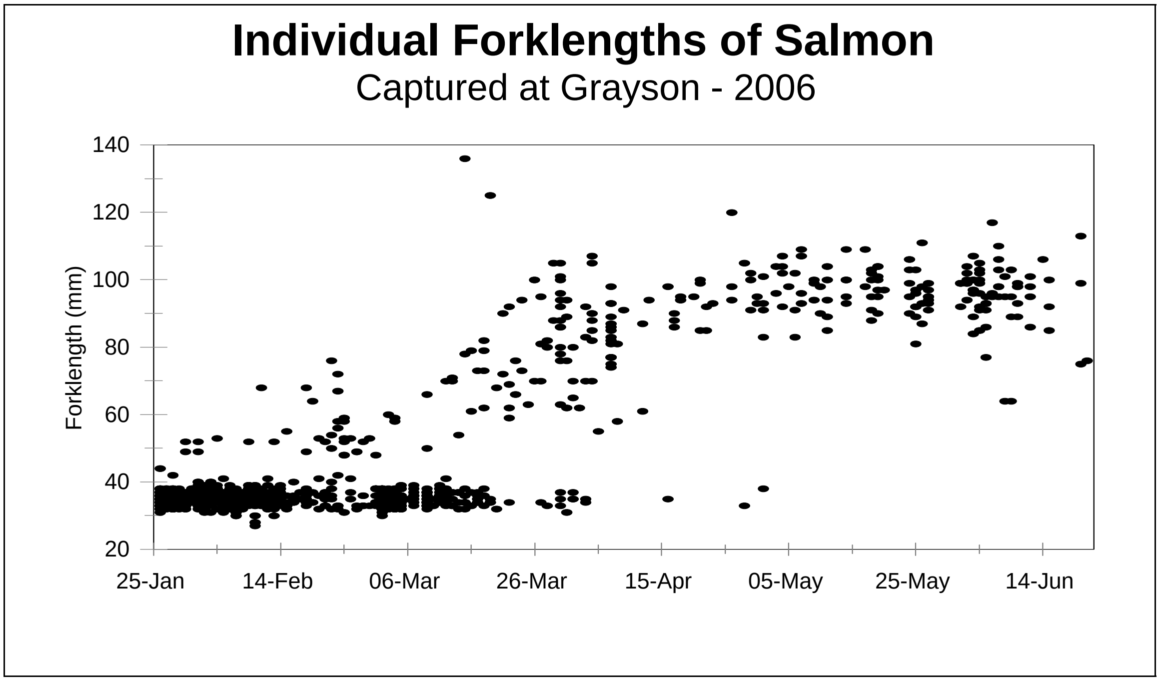

Figure 18. Individual forklengths of juvenile salmon captured at Grayson during 2006.

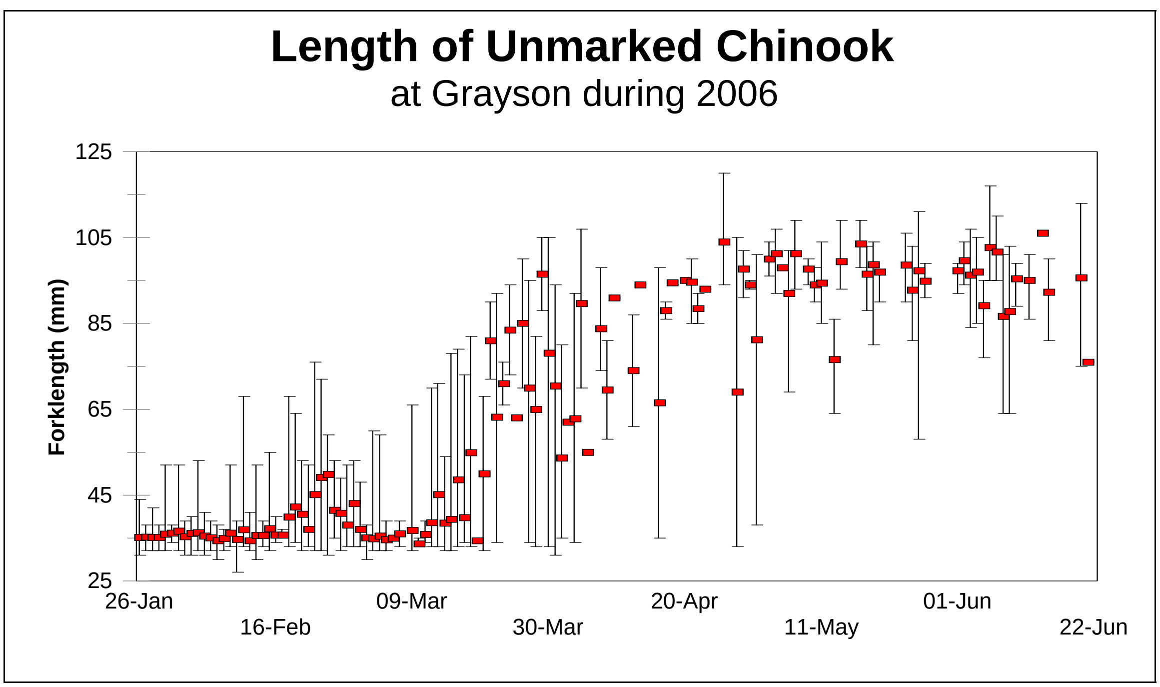

Figure 19. Daily minimum, average, and maximum fork lengths of unmarked Chinook salmon captured at Grayson during 2006.

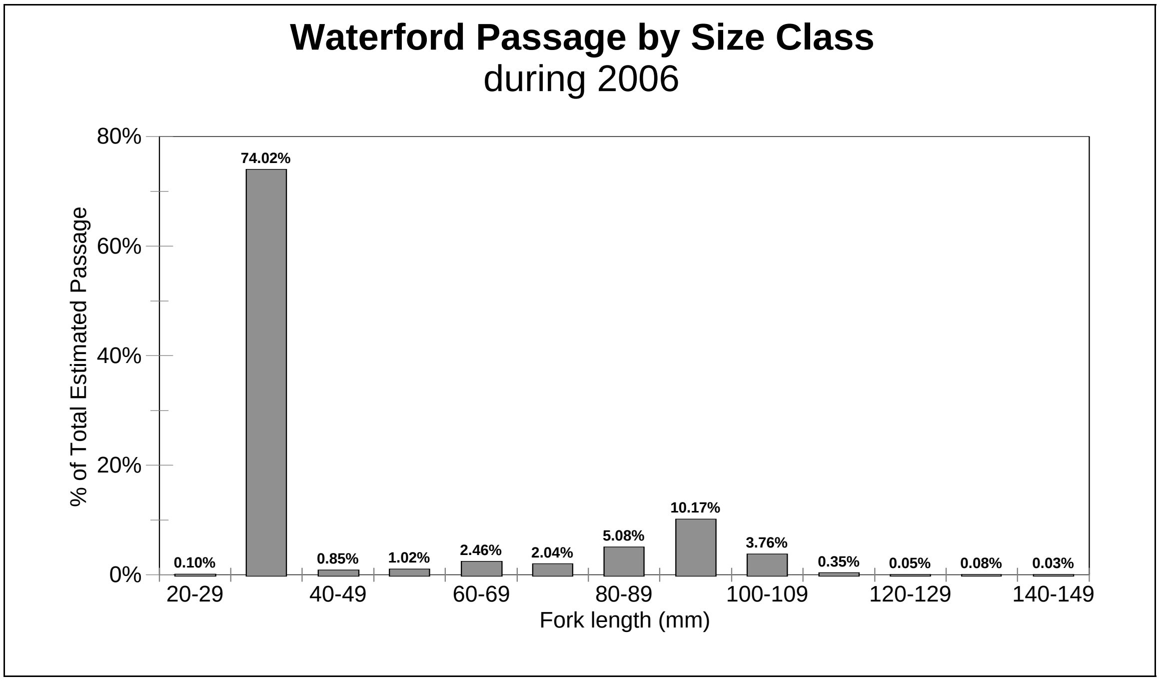

Figure 20. Estimated Chinook passage by 10 mm fork length intervals at Waterford during 2006.

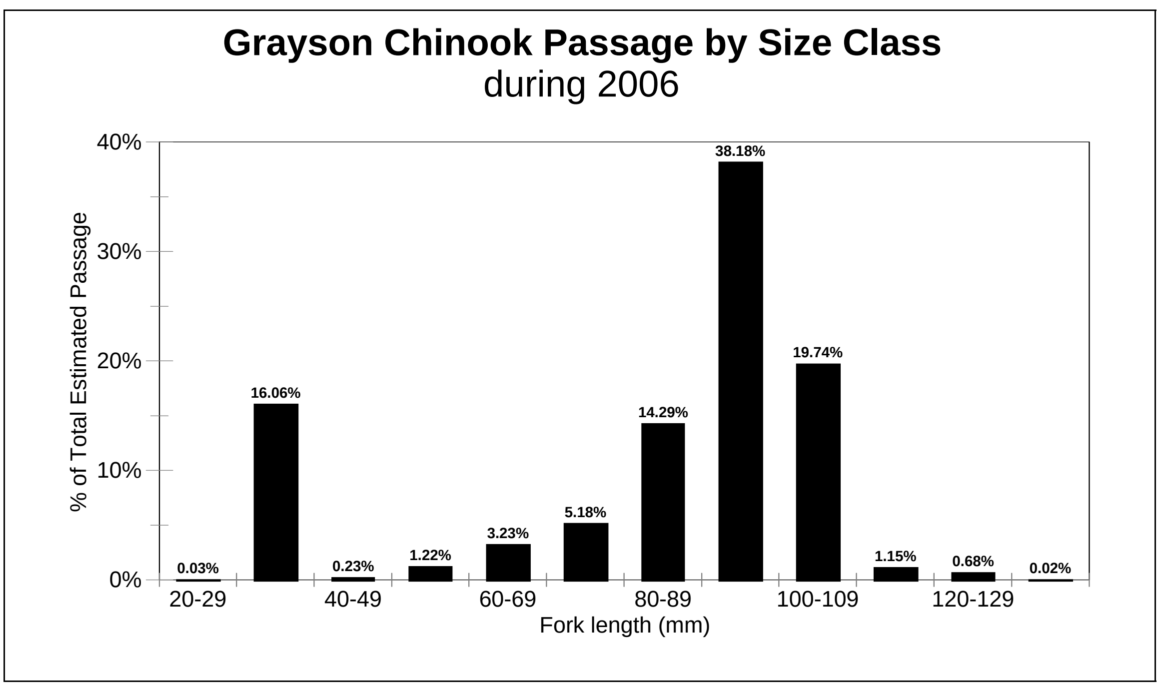

Figure 21. Estimated Chinook passage by 10 mm fork length intervals at Grayson during 2006.

Chinook Salmon Condition at Migration

Juveniles captured at both Waterford and Grayson during 2006 were generally healthy with no apparent signs of disease or stress. Trends in individual Chinook forklength to weight completely overlapped between Waterford and Grayson (Figure 22).

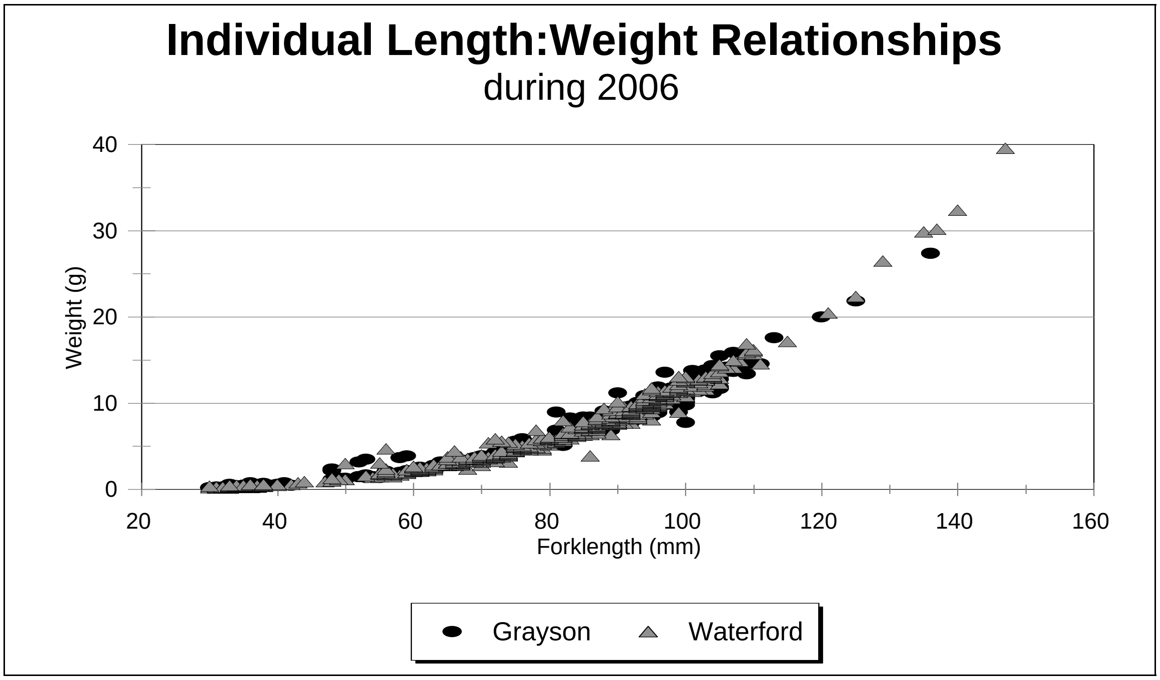

Figure 22. Individual forklength and weight of individual juvenile Chinook salmon measure at Waterford and Grayson during 2006.

Oncorhynchus mykiss

Eight *O. mykiss* were captured at Waterford between February 12 and June 11, 2006. Three *O. mykiss* were classified as Age 1+ (≥100 mm; range: 249 mm to 280 mm) and the remaining four *O. mykiss* were young-of-the-year (<100 mm; range: 66 mm to 90 mm). All Age 1+ *O. mykiss* were smolts (smolt index 5) and all young-of-year were parr (smolt index 3).

At Grayson, no *O. mykiss* were captured during 2006.

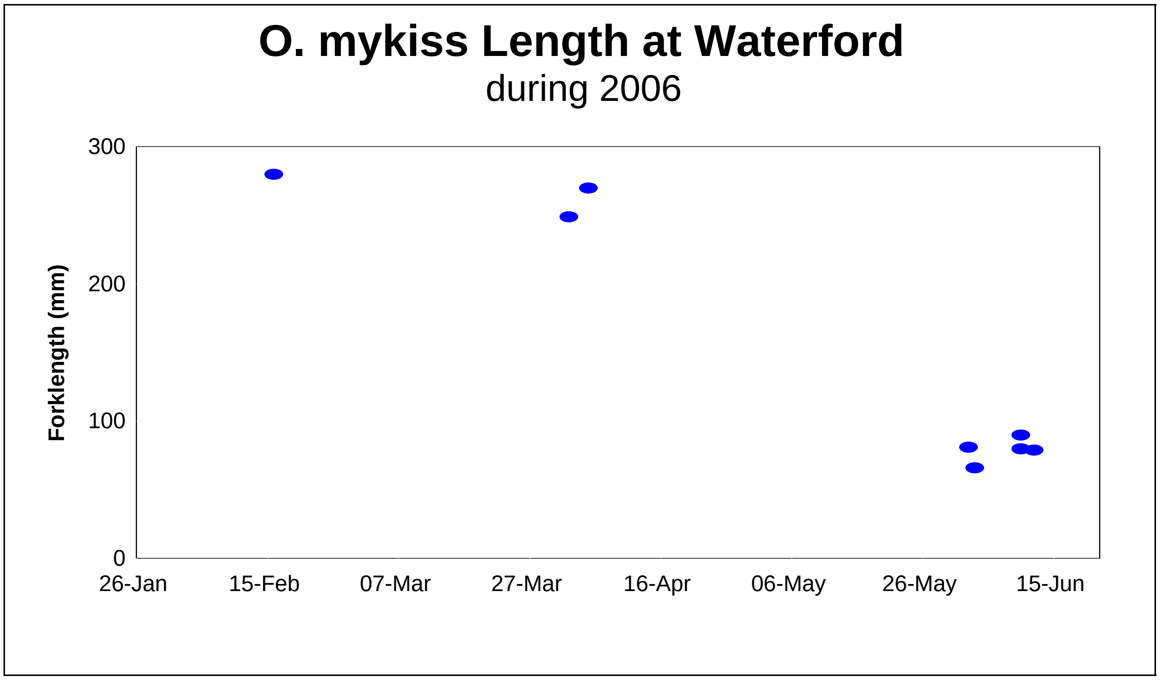

Figure 23. Individual lengths of *O. mykiss* captured at Waterford during 2006.

Other Fish Species Captured

A total of 42,376 non-salmonids representing at least 27 species (seven native, 20 introduced) were captured during operation of the Waterford and Grayson traps in 2006 (Table 4, Table 5 and Appendix B). Catch of non-salmonids was dominated by introduced species including black bullhead, brown bullhead, channel catfish, white catfish, threadfin shad, golden shiner, red shiner, goldfish, carp, bigscale logperch, black crappie, green sunfish, mosquitofish, inland silverside, bluegill, redear sunfish, warmouth, pumpkinseed, largemouth bass, and smallmouth bass. Native non-salmonid species captured included hardhead, hitch, Sacramento blackfish, Sacramento sucker, Sacramento pikeminnow, lamprey, and prickly sculpin. Species captured only at Waterford were brown bullhead and pumpkinseed, and those recorded only at Grayson were black bullhead, hitch, goldfish, bigscale logperch, and inland silverside. Lamprey captured in the traps were primarily ammocoetes and were not identified to species or measured.

Table 4. Non-salmonid species captured at Waterford during 2006. 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									
Black bullhead	*Ameiurus melas*	0	-	-	-	1	191	191.0	191
Brown Bullhead	*Ictalurus nebulosus*	2	219	225.5	232	0	-	-	-
Channel catfish	*Ictalurus punctatus*	2	50	61.5	73	6	25	70.5	142
White catfish	*Ictalurus catus*	4	62	115.3	270	55	19	51.1	230
Hering Family									
Threadfin shad	*Dorosoma petenense*	239	29	62.3	100	20	32	63.8	110
Lamprey Family									
Lamprey - unidentified species	**Not applicable**	**352**	**-**	**-**	**-**	**72**	**-**	**-**	**-**
Livebearer Family									
Mosquitofish	*Gambusia affinis*	8	24	32.1	43	9	25	29.1	37
Minnow Family									
Carp	*Cyprinus carpio*	2	40	395.0	750	39,286	20	38.5	88
Hardhead	***Mylopharodon conocephalus***	**42**	**27**	**36.0**	**49**	**66**	**24**	**34.8**	**62**
Hitch	***Lavinia exilicauda***	**0**	**-**	**-**	**-**	**3**	**35**	**44.7**	**52**
Golden shiner	*Notemigonus crysoleucas*	5	101	114.3	140	42	22	39.9	143
Goldfish	*Carassius auratus*	0	-	-	-	2	350	365.0	380
Red shiner	*Cyprinella lutrennsis*	4	63	89.0	153	17	28	52.9	86
Sacramento blackfish	***Orthodon microlepidotus***	**2**	**31**	**36.5**	**42**	**58**	**25**	**34.2**	**61**
Sacramento pikeminnow	***Ptychochelius grandis***	**131**	**28**	**41.0**	**120**	**149**	**21**	**38.2**	**86**
Perch Family									
Bigscale Logperch	*Percina macrolepida*	0	-	-	-	2	36	36.5	37
Sculpin Family									
Prickly Sculpin	***Cottus asper***	**2**	**50**	**55.0**	**60**	**6**	**29**	**32.0**	**39**

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)
Silverside Family									
Inland silverside	*Menidia beryllina*	0	-	-	-	8	22	38.9	63
Sucker Family									
Sacramento sucker	***Catostomus occidentalis***	**92**	**20**	**47.4**	**121**	**99**	**20**	**28.7**	**51**
Sunfish Family									
Bluegill	*Lepomis macrochirus*	192	22	44.0	180	33	24	51.5	170
Black Crappie	*Pomoxis nigromaculatus*	7	35	123.3	176	329	20	34.1	47
Green sunfish	*Lepomis cyanellus*	1	90	90.0	90	1	91	91.0	91
Largemouth bass	*Micropterus salmoides*	55	24	36.5	119	889	16	27.8	78
Pumpkinseed	*Lepomis gibbosus*	1	192	192.0	192	0	-	-	-
Redear Sunfish	*Lepomis microlophus*	1	117	117.0	117	5	54	149.4	195
Smallmouth bass	*Micropterus dolomieu*	3	37	65.3	120	39	21	33.6	217
Warmouth	*Lepomis gulosus*	6	36	69.2	120	5	27	76.2	175
Unidentified sunfish	Not applicable	1	22	22.0	22	0	-	-	-
Unidentified species	Not applicable	3	24	30.0	36	17	12	22.0	28

Appendix A. Daily Chinook catch, length, and passage at Waterford and environmental data from 2006.

	Unmarked Chinook Salmon										*Environmental Conditions*						
	Catch			Fork Length (mm)			Estimated Passage				Flow (cfs)						
Date	Observed	Missing Value	Adjusted	Min	Avg	Max	Fry	Parr	Smolt	Total	La Grange	Hickman spill	Trap site	Velocity (ft/s)	Estimated % Flow Sampled	Temperature at Ruddy Gravel	Turbidity
26-Jan	216		216	32	35.6	38	4467	0	0	4467	2,910	25	2,935	5.65	4.8%	50.31	2.67
27-Jan	225		225	33	35.4	41	4913	0	0	4913	2,900	182	3,082	5.62	4.6%	50.17	3.36
28-Jan	288		288	32	35.1	38	6565	17	0	6583	2,880	192	3,072	5.35	4.4%	50.32	2.51
29-Jan	261		261	32	35.3	38	5447	14	0	5461	2,920	191	3,111	5.92	4.8%	50.93	2.77
30-Jan	250		250	32	35.4	40	5198	14	0	5211	2,920	216	3,136	5.99	4.8%	50.65	2.47
31-Jan	348		348	32	35.6	55	7756	20	0	7776	2,880	291	3,171	5.65	4.5%	50.40	3.38
01-Feb	165		165	31	34.3	40	3418	9	0	3427	2,870	312	3,182	6.10	4.8%	50.75	2.66
02-Feb	204		204	33	35.8	39	4840	13	0	4853	2,560	308	2,868	4.80	4.2%	51.17	2.93
03-Feb	295		295	32	35.5	40	7598	20	0	7618	2,610	309	2,919	4.50	3.9%	50.94	3.14
04-Feb	195		195	31	35.4	38	3914	68	19	4001	2,610	312	2,922	5.67	4.9%	50.75	3.14
05-Feb	366		366	33	34.6	37	7273	126	36	7434	2,620	314	2,934	5.75	4.9%	50.24	3.62
06-Feb	310		310	31	35.2	38	7044	122	35	7200	2,610	313	2,923	5.01	4.3%	50.40	2.64
07-Feb	251		251	32	34.7	40	6153	106	30	6290	2,610	323	2,933	4.66	4.0%	50.47	2.61
08-Feb	397		397	30	34.5	38	7679	133	38	7850	2,580	360	2,940	5.92	5.1%	50.56	2.56
09-Feb	179		179	32	36.1	109	3600	62	18	3680	2,620	375	2,995	5.80	4.9%	50.62	2.26
10-Feb	245		245	29	37.2	74	4938	85	24	5047	2,650	377	3,027	5.85	4.9%	50.70	2.29
11-Feb	248		248	31	35.5	68	5716	31	16	5763	2,620	380	3,000	5.14	4.3%	50.80	2.09
12-Feb	248		248	29	34.3	38	5415	29	15	5459	2,620	383	3,003	5.43	4.5%	50.63	2.03
13-Feb	137		137	32	35.4	38	2784	15	8	2807	2,620	381	3,001	5.83	4.9%	50.98	1.91
14-Feb	329		329	31	34.8	37	6850	37	19	6906	2,590	379	2,969	5.63	4.8%	50.73	1.66
15-Feb	197		197	31	35.1	45	4429	24	12	4465	2,570	379	2,949	5.18	4.4%	49.89	2.00
16-Feb	178		178	31	35.1	74	1939	11	5	1955	2,600	380	2,980	10.80	9.1%	49.54	1.79
17-Feb	57		57	29	33.6	38	1173	6	3	1182	2,510	382	2,892	5.55	4.8%	49.29	2.18
18-Feb	65		65	30	34.1	52	1190	144	49	1384	2,110	382	2,492	4.66	4.7%	49.96	1.86
19-Feb	45		45	30	36.6	75	758	92	31	881	1,920	382	2,302	4.68	5.1%	49.65	1.77
20-Feb	103		103	30	39.4	85	1370	166	57	1593	1,740	381	2,121	5.46	6.5%	49.76	2.41
21-Feb	89		89	30	41.0	90	1689	204	70	1963	1,610	379	1,989	3.59	4.5%	49.85	1.85
22-Feb	83		83	31	40.1	79	1143	138	47	1329	1,620	379	1,999	4.97	6.2%	50.10	1.57
23-Feb	82		82	30	41.3	115	1082	131	45	1258	1,590	302	1,892	4.91	6.5%	50.49	1.42
24-Feb	121		121	31	38.8	94	1620	196	67	1882	1,630	383	2,013	5.15	6.4%	50.71	1.60
25-Feb	95		95	30	39.0	87	1990	39	28	2057	2,270	379	2,649	4.87	4.6%	50.83	2.61

	Unmarked Chinook Salmon										*Environmental Conditions*						
	Catch			Fork Length (mm)			Estimated Passage				Flow (cfs)						
Date	Observed	Missing Value	Adjusted	Min	Avg	Max	Fry	Parr	Smolt	Total	La Grange	Hickman spill	Trap site	Velocity (ft/s)	Estimated % Flow Sampled	Temperature at Ruddy Gravel	Turbidity
26-Feb	158		158	31	34.6	38	3375	66	47	3489	2,310	380	2,690	4.85	4.5%	50.23	1.57
27-Feb	37		37	31	35.1	58	857	17	12	886	2,360	382	2,742	4.56	4.2%	50.81	2.14
28-Feb	64		64	33	38.5	105	1396	27	20	1443	2,810	378	3,188	5.63	4.4%	51.41	2.11
01-Mar	392		392	32	35.8	92	11657	229	164	12050	3,080	379	3,459	4.48	3.3%	50.68	2.12
02-Mar	116		116	30	34.2	37	4766	94	67	4927	3,780	381	4,161	3.90	2.4%	50.44	2.04
03-Mar	105		105	32	35.8	95	3833	221	58	4111	4,930	381	5,311	5.40	2.6%	50.24	2.28
04-Mar	122		122	31	35.9	78	4031	232	61	4325	4,740	380	5,120	5.75	2.8%	50.18	3.92
05-Mar	44		44	33	38.1	82	1470	85	22	1577	4,770	380	5,150	5.72	2.8%	50.15	1.76
06-Mar	56		56	32	35.3	40	1739	100	26	1865	4,720	384	5,104	6.10	3.0%	50.87	2.65
07-Mar	68		68	33	35.4	39	2215	128	34	2376	4,890	385	5,275	6.01	2.9%	50.44	1.93
08-Mar	112		112	30	38.8	75	3524	203	53	3781	5,000	384	5,384	6.35	3.0%	50.39	1.53
09-Mar	44		44	30	37.4	86	1329	76	20	1425	4,620	384	5,004	6.15	3.1%	50.43	1.50
10-Mar	104		104	30	38.5	89	2869	377	99	3345	4,270	376	4,646	5.75	3.1%	50.03	2.12
11-Mar	79		79	33	37.3	82	1866	245	65	2176	3,410	374	3,784	5.47	3.6%	49.42	1.80
12-Mar	98		98	33	40.0	86	1984	261	69	2314	2,880	388	3,268	5.51	4.2%	49.49	1.78
13-Mar	33		33	33	42.4	93	737	97	26	860	3,340	391	3,731	5.70	3.8%	50.28	2.05
14-Mar	43		43	33	38.8	100	1219	160	42	1422	3,570	391	3,961	4.77	3.0%	49.86	1.95
15-Mar	75		75	32	40.0	105	1875	247	65	2186	3,960	316	4,276	5.84	3.4%	50.36	2.28
16-Mar	47		47	32	39.6	76	1222	161	42	1425	3,590	279	3,869	5.08	3.3%	50.42	1.73
17-Mar	49		49	32	41.0	80	833	402	102	1337	3,240	338	3,578	5.22	3.7%	50.16	1.53
18-Mar	92		92	33	42.0	92	1473	711	181	2364	3,200	350	3,550	5.50	3.9%	50.32	2.71
19-Mar	76		76	32	47.8	99	1404	677	172	2254	3,800	350	4,150	5.57	3.4%	50.25	2.43
20-Mar	34		34	32	44.6	87	590	285	73	948	3,730	367	4,097	5.85	3.6%	49.45	1.74
21-Mar	13		13	33	45.5	79	259	125	32	415	3,620	368	3,988	4.97	3.1%	50.23	2.02
22-Mar	32		32	33	46.2	91	549	265	67	881	3,540	331	3,871	5.60	3.6%	50.21	2.03
23-Mar	13		13	34	68.5	110	241	116	30	387	3,550	378	3,928	5.25	3.4%	50.72	1.70
24-Mar	20		20	34	54.4	80	266	285	44	596	3,810	379	4,189	5.60	3.4%	50.75	1.89
25-Mar	22		22	32	44.3	84	314	337	52	703	4,540	352	4,892	6.09	3.1%	50.46	1.96
26-Mar	32		32	30	47.5	90	433	464	72	968	4,530	305	4,835	6.36	3.3%	50.38	2.54
27-Mar	13		13	33	59.8	88	223	239	37	500	5,070	337	5,407	5.60	2.6%	50.14	1.84
28-Mar	9		9	32	51.9	70	172	185	29	386	5,080	306	5,386	5.00	2.3%	50.06	3.44
29-Mar	11		11	32	51.4	92	199	213	33	445	5,460	239	5,699	5.61	2.5%	49.94	5.02
30-Mar	14		14	34	58.2	82	255	273	42	570	6,130	157	6,287	6.15	2.5%	49.99	2.64

	Unmarked Chinook Salmon										*Environmental Conditions*						
	Catch			Fork Length (mm)			Estimated Passage				Flow (cfs)						
Date	Observed	Missing Value	Adjusted	Min	Avg	Max	Fry	Parr	Smolt	Total	La Grange	Hickman spill	Trap site	Velocity (ft/s)	Estimated % Flow Sampled	Temperature at Ruddy Gravel	Turbidity
31-Mar	13		13	35	56.7	86	124	233	210	567	6,410	180	6,590	6.01	2.3%	50.10	2.23
01-Apr	2		2	71	72.0	73	24	44	40	108	6,110	319	6,429	4.74	1.9%	50.43	4.49
02-Apr	13		13	35	54.7	77	123	230	207	560	6,220	281	6,501	6.01	2.3%	50.10	2.47
03-Apr	2		2	36	54.5	73	18	33	30	80	5,920	287	6,207	6.15	2.5%	50.85	-
04-Apr	4		4	33	70.8	101	28	53	48	129	3,610	316	3,926	4.84	3.1%	51.69	15.90
05-Apr	19		19	33	61.0	111	188	353	317	858	4,620	315	4,935	4.35	2.2%	50.64	10.90
06-Apr	17		17	34	68.6	100	183	344	310	837	5,250	315	5,565	4.50	2.0%	50.49	3.94
07-Apr	15		15	48	78.9	107	0	443	380	823	6,300	314	6,614	4.80	1.8%	50.68	2.13
08-Apr	11		11	50	71.7	95	0	378	324	702	6,660	314	6,974	4.35	1.6%	50.70	3.03
09-Apr	7		7	54	69.0	88	0	197	169	366	6,670	314	6,984	5.32	1.9%	50.20	1.99
10-Apr	6		6	56	76.2	89	0	176	151	328	6,680	314	6,994	5.10	1.8%	50.30	2.63
11-Apr	3		3	63	81.0	93	0	105	90	195	7,220	352	7,572	4.63	1.5%	50.16	2.10
12-Apr	ns		-	-	-	-					7,760	356	-	-		50.31	-
13-Apr	ns		-	-	-	-					7,790	357	-	-		50.89	-
14-Apr	ns		-	-	-	-					7,610	357	-	-		50.61	-
15-Apr	ns		-	-	-	-					7,330	299	-	-		50.58	-
16-Apr	ns		-	-	-	-					7,420	294	-	-		49.85	-
17-Apr	ns		-	-	-	-					7,580	295	-	-		50.36	-
18-Apr	ns		-	-	-	-					8,290	197	-	-		50.44	-
19-Apr	ns		-	-	-	-					8,270	177	-	-		50.69	-
20-Apr	ns		-	-	-	-					8,440	86	-	-		50.71	-
21-Apr	ns		-	-	-	-					8,450	75	-	4.44		51.01	-
22-Apr	0		0	-	-	-	0	0	0	0	8,500	75	8,500	2.88	0.9%	50.22	2.27
23-Apr	0		0	-	-	-	0	0	0	0	8,490	74	8,490	2.75	0.8%	50.16	2.42
24-Apr	1		1	89	89.0	89	0	20	81	101	8,620	75	8,620	3.41	1.0%	50.84	2.82
25-Apr	0		0	-	-	-	0	0	0	0	8,870	75	8,870	3.00	0.8%	50.87	2.38
26-Apr	1		1	64	64.0	64	0	17	67	84	8,890	75	8,890	4.21	1.2%	51.04	2.45
27-Apr	2		2	80	91.5	103	0	49	195	244	8,900	75	8,900	2.90	0.8%	51.19	2.78
28-Apr	0		0	-	-	-	0	0	0	0	8,850	75	8,850	3.00	0.9%	51.50	2.71
29-Apr	1		1	96	96.0	96	0	9	81	90	8,850	75	8,850	3.91	1.1%	51.71	2.85
30-Apr	1		1	95	95.0	95	0	11	98	109	8,900	75	8,900	3.25	0.9%	51.82	2.54
01-May	3		3	91	92.7	96	0	38	343	381	8,830	16	8,830	2.77	0.8%	51.78	-
02-May	1		1	110	110.0	110	0	12	109	122	8,830	0	8,830	2.89	0.8%	51.76	2.04

	Unmarked Chinook Salmon										*Environmental Conditions*						
	Catch			Fork Length (mm)			Estimated Passage				Flow (cfs)						
Date	Observed	Missing Value	Adjusted	Min	Avg	Max	Fry	Parr	Smolt	Total	La Grange	Hickman spill	Trap site	Velocity (ft/s)	Estimated % Flow Sampled	Temperature at Ruddy Gravel	Turbidity
03-May	1		1	87	87.0	87	0	12	108	120	8,920	0	8,920	2.95	0.8%	51.72	1.80
04-May	2		2	88	89.5	91	0	21	187	208	8,890	0	8,890	3.41	1.0%	51.43	-
05-May	1		1	73	73.0	73	0	30	139	169	8,890	0	8,890	2.10	0.6%	51.76	1.79
06-May	1		1	99	99.0	99	0	17	78	95	8,870	0	8,870	3.71	1.1%	51.78	1.35
07-May	-	2	2	-	-	-	0	65	303	368	8,930	0	8,930	1.93	0.5%	51.94	2.12
08-May	ns	2	2	-	-	-	0	45	211	256	8,590	0	8,590	2.67	0.8%	52.29	-
09-May	5		5	80	92.4	102	0	86	402	488	8,360	0	8,360	3.41	1.0%	52.15	1.93
10-May	5		5	90	97.2	103	0	106	496	602	8,470	0	8,470	2.80	0.8%	52.12	1.78
11-May	5		5	67	83.0	100	0	100	468	568	8,280	0	8,280	2.90	0.9%	52.43	1.71
12-May	0		0	-	-	-	0	0	0	0	8,200	0	8,200	3.73	1.1%	52.45	1.57
13-May	1		1	94	94.0	94	1	2	101	103	8,480	0	8,480	3.28	1.0%	52.56	1.31
14-May	4		4	93	97.0	103	4	8	537	550	8,630	0	8,630	2.50	0.7%	52.69	1.27
15-May	ns	6	6	-	-	-	7	14	885	906	8,530	0	8,530	2.25	0.7%	52.68	-
16-May	ns	8	8	-	-	-	9	18	1149	1176	8,310	0	8,310	2.25	0.7%	53.18	-
17-May	8		8	85	93.6	98	10	20	1300	1331	8,360	0	8,360	2.00	0.6%	53.22	1.67
18-May	72		72	34	95.1	110	38	75	4779	4892	8,260	0	8,260	4.84	1.5%	53.21	1.16
19-May	52		52	81	93.6	111	66	22	3487	3575	8,290	0	8,290	4.80	1.5%	52.49	1.14
20-May	1		1	87	87.0	87	3	1	151	155	8,100	0	8,100	2.08	0.6%	52.84	1.16
21-May	ns	19	19	-	-	-	36	12	1917	1966	7,900	0	7,900	3.04	1.0%	51.85	-
22-May	ns	23	23	-	-	-	43	14	2265	2322	7,710	0	7,710	3.04	1.0%	52.48	-
23-May	ns	29	29	-	-	-	50	17	2634	2700	7,110	0	7,110	3.04	1.1%	53.10	-
24-May	34		34	89	97.4	105	43	14	2303	2361	6,960	0	6,960	3.99	1.4%	53.39	-
25-May	52		52	33	93.2	105	64	21	3393	3479	6,940	0	6,940	4.13	1.5%	53.18	1.27
26-May	49		49	82	95.9	109	0	126	2971	3097	6,780	0	6,780	4.27	1.6%	52.85	1.41
27-May	47		47	34	93.4	115	0	119	2785	2903	6,440	0	6,440	4.15	1.6%	52.73	1.03
28-May	ns	41	41	-	-	-	0	107	2509	2616	6,170	0	6,170	3.85	1.6%	52.94	-
29-May	ns	31	31	-	-	-	0	77	1799	1875	5,850	0	5,850	3.85	1.7%	53.17	-
30-May	ns	22	22	-	-	-	0	51	1194	1244	5,470	0	5,470	3.85	1.8%	53.42	-
31-May	ns	15	15	-	-	-	0	31	732	763	4,920	3	4,920	3.85	2.0%	53.80	-
01-Jun	27		27	75	94.4	110	0	52	1217	1269	4,180	3	4,180	3.54	2.1%	54.32	1.48
02-Jun	10		10	75	86.5	96	0	21	404	425	3,600	3	3,600	3.37	2.4%	55.13	2.10
03-Jun	5		5	92	96.2	104	0	10	191	202	3,240	3	3,240	3.20	2.5%	55.43	1.30
04-Jun	11		11	67	89.2	102	0	25	469	494	3,000	3	3,000	2.66	2.2%	55.57	2.19

	Unmarked Chinook Salmon										*Environmental Conditions*						
	Catch			Fork Length (mm)			Estimated Passage				Flow (cfs)						
Date	Observed	Missing Value	Adjusted	Min	Avg	Max	Fry	Parr	Smolt	Total	La Grange	Hickman spill	Trap site	Velocity (ft/s)	Estimated % Flow Sampled	Temperature at Ruddy Gravel	Turbidity
05-Jun	5		5	82	88.8	97	0	11	214	226	2,810	3	2,810	2.48	2.2%	55.42	1.47
06-Jun	2		2	89	98.0	107	0	4	81	85	2,600	3	2,600	2.44	2.4%	55.41	1.37
07-Jun	2		2	93	94.5	96	0	6	108	113	2,480	3	2,480	1.74	1.8%	55.44	0.76
08-Jun	2		2	94	95.0	96	0	4	85	89	3,390	3	3,390	3.02	2.2%	54.79	1.47
09-Jun	0		0	-	-	-	0	0	0	0	4,620	3	4,620	3.87	2.1%	54.28	1.34
10-Jun	4		4	83	94.3	106	0	39	184	222	5,500	3	5,500	3.94	1.8%	54.17	1.57
11-Jun	5		5	78	93.0	102	0	43	205	248	5,530	3	5,530	4.44	2.0%	54.21	0.93
12-Jun	4		4	87	96.0	108	0	37	174	211	5,290	3	5,290	4.00	1.9%	54.09	1.10
13-Jun	2		2	87	91.0	95	0	18	85	103	4,850	3	4,850	3.75	1.9%	53.97	1.02
14-Jun	2		2	77	87.5	98	0	20	95	115	5,120	3	5,120	3.53	1.7%	54.22	1.10
15-Jun	4		4	87	92.5	99	0	38	179	217	4,790	3	4,790	3.52	1.8%	54.85	0.59
16-Jun	6		6	75	92.8	104	0	0	278	278	4,090	3	4,090	3.52	2.2%	55.49	2.03
17-Jun	ns	3	3	-	-	-	0	0	127	127	3,950	3	3,950	3.70	2.4%	55.72	-
18-Jun	ns	2	2	-	-	-	0	0	80	80	3,760	3	3,760	3.73	2.5%	55.53	-
19-Jun	ns	2	2	-	-	-	0	0	90	90	4,230	3	4,230	3.73	2.2%	55.04	-
20-Jun	1		1	88	88.0	88	0	0	61	61	5,700	3	5,700	3.73	1.6%	54.72	1.46
21-Jun	0		0	-	-	-	0	0	0	0	6,870	3	6,870	3.76	1.4%	54.67	1.67

Appendix B. Daily Chinook catch, length, predicted trap efficiency, and passage at Grayson and environmental data from 2006.

	Unmarked Chinook Salmon										*Environmental Conditions*					
	Catch			Fork Length (mm)			Estimated Passage						Velocity (ft/s)			
Date	Observed	Missing Value	Adjusted	Min	Avg	Max	Fry	Parr	Smolt	Total	Predicted Efficiency	Flow at MOD (cfs)	North	South	Temperature at Shiloh	Turbidity
26-Jan	60		60	31	35.1	44	935	0	0	935	0.0642	3,211	3.61	3.57	48.8	3.6
27-Jan	74		74	32	35.2	38	1201	0	0	1201	0.0616	3,302	3.40	3.26	48.8	3.8
28-Jan	89		89	32	35.1	42	1435	19	0	1454	0.0612	3,325	3.65	3.55	48.8	4.4
29-Jan	13		13	32	35.2	38	212	3	0	214	0.0606	3,345	3.62	3.54	49.6	4.0
30-Jan	30		30	32	35.9	52	504	7	0	511	0.0587	3,358	3.69	3.41	50.0	4.2
31-Jan	12		12	34	36.2	38	208	3	0	211	0.0569	3,408	3.50	3.50	49.3	3.8
01-Feb	40		40	32	36.7	52	702	9	0	712	0.0562	3,395	2.98	3.74	49.3	3.4
02-Feb	49		49	31	35.3	39	791	11	0	801	0.0611	3,313	2.80	3.10	50.3	4.4
03-Feb	32		32	31	36.1	40	498	7	0	504	0.0635	3,158	2.97	2.52	50.6	3.3
04-Feb	49		49	32	36.2	53	777	5	0	782	0.0626	3,174	3.60	3.30	50.4	3.6
05-Feb	24		24	31	35.5	41	369	2	0	371	0.0647	3,164	3.04	3.01	49.7	3.4
06-Feb	66		66	32	35.1	39	1001	7	0	1007	0.0655	3,166	3.19	3.16	49.1	3.2
07-Feb	61		61	30	34.4	38	941	6	0	947	0.0644	3,270	3.50	3.40	49.6	3.9
08-Feb	40		40	32	34.9	37	663	4	0	667	0.0600	3,391	3.82	3.43	49.9	3.9
09-Feb	36		36	33	36.1	52	624	4	0	628	0.0573	3,393	3.70	3.60	50.1	4.3
10-Feb	37		37	27	34.7	39	615	4	0	619	0.0598	3,421	3.85	3.54	50.3	3.5
11-Feb	21		21	33	37.0	68	373	12	0	384	0.0546	3,437	3.40	3.27	50.6	3.2
12-Feb	35		35	32	34.4	41	561	17	0	578	0.0605	3,416	2.80	2.65	50.7	2.7
13-Feb	26		26	30	35.6	52	436	13	0	449	0.0579	3,418	3.84	3.74	50.6	3.4
14-Feb	16		16	33	35.6	39	257	8	0	265	0.0603	3,317	3.75	3.70	50.9	3.0
15-Feb	6		6	32	37.2	55	96	3	0	99	0.0605	3,177	4.20	3.60	49.9	2.8
16-Feb	6		6	34	35.7	40	90	3	0	93	0.0645	3,152	3.70	3.50	48.6	-
17-Feb	3		3	35	35.7	37	49	2	0	51	0.0591	3,362	3.61	3.57	48.1	2.3
18-Feb	10		10	33	39.9	68	124	64	0	188	0.0531	3,249	2.84	2.95	48.0	2.9
19-Feb	4		4	34	42.3	64	44	23	0	67	0.0594	2,781	3.58	3.54	48.6	2.3
20-Feb	4		4	32	40.5	53	39	20	0	59	0.0677	2,621	3.54	3.18	48.3	2.6
21-Feb	9		9	33	37.0	52	72	37	0	110	0.0819	2,470	2.75	2.68	48.5	2.6
22-Feb	8		8	32	45.1	76	84	43	0	127	0.0630	2,391	3.10	3.07	48.9	2.0
23-Feb	8		8	32	49.1	72	96	50	0	145	0.0551	2,367	3.36	3.10	49.5	2.1
24-Feb	7		7	31	49.9	59	83	43	0	126	0.0556	2,281	3.01	2.99	50.2	2.2
25-Feb	4		4	35	41.5	53	55	1	0	57	0.0707	2,431	2.86	3.26	50.9	2.8

	Unmarked Chinook Salmon										*Environmental Conditions*					
	Catch			Fork Length (mm)			Estimated Passage						Velocity (ft/s)			
Date	Observed	Missing Value	Adjusted	Min	Avg	Max	Fry	Parr	Smolt	Total	Predicted Efficiency	Flow at MOD (cfs)	North	South	Temperature at Shiloh	Turbidity
26-Feb	5		5	32	40.8	49	82	2	0	83	0.0600	2,886	3.00	2.75	50.4	2.7
27-Feb	5		5	33	38.0	52	77	2	0	78	0.0640	2,971	3.60	3.54	49.8	2.4
28-Feb	2		2	33	43.0	53	39	1	0	40	0.0506	3,096	3.87	3.71	50.7	2.9
01-Mar	13		13	33	37.0	48	231	5	0	236	0.0552	3,409	4.11	3.98	50.9	-
02-Mar	93		93	30	35.0	38	1671	35	0	1706	0.0545	3,608	3.30	3.47	50.5	1.8
03-Mar	54		54	32	34.8	60	1270	22	0	1292	0.0418	4,261	4.20	4.40	49.7	5.0
04-Mar	74		74	32	35.5	59	2233	40	0	2273	0.0326	4,797	4.80	4.50	49.0	2.9
05-Mar	57		57	32	34.6	39	1676	30	0	1705	0.0334	4,813	4.48	4.62	49.1	2.9
06-Mar	1		1	35	35.0	35	30	1	0	30	0.0330	4,803	4.20	4.10	49.5	1.7
07-Mar	9		9	33	36.0	39	285	5	0	290	0.0310	4,865	4.10	4.51	50.1	3.3
08-Mar	0		0	-	-	-	0	0	0	0	-	4,990	4.60	4.60	49.6	3.2
09-Mar	25		25	32	36.8	66	912	16	0	928	0.0269	5,137	4.61	4.67	50.2	4.1
10-Mar	3		3	33	33.7	35	72	17	3	92	0.0325	4,960	4.41	4.39	49.6	3.3
11-Mar	21		21	34	35.9	39	508	121	22	651	0.0322	4,787	3.82	4.14	49.0	3.1
12-Mar	15		15	33	38.6	70	320	76	14	410	0.0366	4,250	3.87	3.80	48.4	2.9
13-Mar	7		7	33	45.1	71	172	41	7	220	0.0318	4,019	3.98	4.06	49.0	3.6
14-Mar	6		6	32	38.5	54	124	30	5	159	0.0377	4,187	4.10	4.17	49.8	3.7
15-Mar	9		9	32	39.3	78	205	49	9	263	0.0342	4,345	4.41	4.26	49.2	2.9
16-Mar	5		5	33	48.6	79	172	41	7	221	0.0226	4,531	4.24	4.39	50.0	4.4
17-Mar	8		8	34	39.8	73	58	105	47	209	0.0382	4,046	3.98	3.94	49.9	4.1
18-Mar	8		8	33	54.9	82	102	184	82	367	0.0218	4,077	3.97	4.04	49.6	3.8
19-Mar	3		3	34	34.3	35	18	32	14	64	0.0466	4,041	3.87	3.80	50.3	4.1
20-Mar	2		2	32	50.0	68	24	44	20	88	0.0227	4,397	4.27	4.19	49.6	3.6
21-Mar	2		2	72	81.0	90	74	134	60	268	0.0075	4,368	3.98	3.96	48.7	2.6
22-Mar	5		5	34	63.2	92	91	164	73	328	0.0153	4,204	4.05	3.90	49.8	3.1
23-Mar	2		2	66	71.0	76	44	80	36	160	0.0125	4,003	3.95	3.98	50.5	2.4
24-Mar	2		2	73	83.5	94	60	60	133	253	0.0079	4,016	3.90	3.90	51.2	4.0
25-Mar	1		1	63	63.0	63	16	16	36	69	0.0145	4,350	4.36	4.34	51.4	2.4
26-Mar	2		2	70	85.0	100	96	96	214	406	0.0049	5,015	4.41	4.37	50.7	2.8
27-Mar	4		4	34	70.0	95	106	106	236	449	0.0089	4,896	4.30	4.30	50.8	5.4
28-Mar	3		3	33	65.0	82	77	77	170	323	0.0093	5,234	4.35	4.50	50.0	1.9
29-Mar	2		2	88	96.5	105	261	261	579	1101	0.0018	6,393	4.59	4.49	49.6	5.2
30-Mar	16		16	33	78.1	105	1030	1030	2290	4351	0.0037	6,303	4.70	4.50	49.7	19.9

	Unmarked Chinook Salmon										*Environmental Conditions*					
	Catch			Fork Length (mm)			Estimated Passage						Velocity (ft/s)			
Date	Observed	Missing Value	Adjusted	Min	Avg	Max	Fry	Parr	Smolt	Total	Predicted Efficiency	Flow at MOD (cfs)	North	South	Temperature at Shiloh	Turbidity
31-Mar	5		5	31	70.4	94	55	276	552	883	0.0057	5,944	4.35	4.76	49.4	5.1
01-Apr	6		6	35	53.7	80	49	247	495	791	0.0076	6,694	4.17	3.89	49.8	5.8
02-Apr	1		1	62	62.0	62	13	67	133	213	0.0047	7,114	4.74	4.47	50.7	16.6
03-Apr	6		6	34	62.8	92	63	313	626	1001	0.0060	6,465	4.74	4.47	50.2	5.7
04-Apr	8		8	70	89.6	107	362	1812	3624	5798	0.0014	7,643	5.01	4.85	51.6	11.6
05-Apr	1		1	55	55.0	55	25	124	247	395	0.0025	9,193	4.74	4.47	53.0	75.6
06-Apr	ns	3	3	-	-	-	92	461	921	1474	0.0020	8,275	-	-	51.8	-
07-Apr	15		15	74	83.8	98	0	1391	4173	5563	0.0027	6,551	4.00	3.50	51.4	8.0
08-Apr	2		2	58	69.5	81	0	117	352	469	0.0043	6,696	4.11	3.34	51.3	5.1
09-Apr	1		1	91	91.0	91	0	135	405	540	0.0019	6,822	4.02	3.02	51.1	3.0
10-Apr	0		0	-	-	-	0	0	0	0	-	6,828	3.78	2.90	50.4	3.5
11-Apr	0		0	-	-	-	0	0	0	0	-	6,792	3.55	3.23	50.4	3.0
12-Apr	2		2	61	74.0	87	0	173	519	692	0.0029	7,232	3.80	3.35	50.2	2.2
13-Apr	1		1	94	94.0	94	0	201	602	803	0.0012	7,508	3.61	2.94	50.5	-
14-Apr	0		0	-	-	-	0	0	0	0	-	7,568	4.08	3.51	51.6	2.6
15-Apr	0		0	-	-	-	0	0	0	0	-	7,432	3.78	2.88	51.0	3.1
16-Apr	2		2	35	66.5	98	46	0	555	601	0.0033	7,546	3.30	3.56	50.9	4.5
17-Apr	3		3	86	88.0	90	140	0	1685	1825	0.0016	7,366	3.85	3.72	50.0	3.3
18-Apr	2		2	94	94.5	95	131	0	1571	1702	0.0012	7,603	4.04	3.07	50.9	4.3
19-Apr	0		0	-	-	-	0	0	0	0	-	7,688	4.10	3.50	51.0	3.7
20-Apr	1		1	95	95.0	95	70	0	841	911	0.0011	7,722	3.99	3.50	51.3	3.2
21-Apr	4		4	85	94.7	100	409	0	3272	3681	0.0011	7,775	4.13	3.18	51.3	2.9
22-Apr	2		2	85	88.5	92	163	0	1301	1463	0.0014	7,762	3.97	3.56	51.1	2.5
23-Apr	1		1	93	93.0	93	95	0	756	851	0.0012	7,733	4.00	3.50	50.1	3.8
24-Apr	0		0	-	-	-	0	0	0	0	-	7,713	4.30	3.59	50.0	3.2
25-Apr	0		0	-	-	-	0	0	0	0	-	7,842	4.00	3.50	50.5	3.8
26-Apr	3		3	94	104.0	120	467	0	3738	4205	0.0007	7,970	3.85	3.57	51.0	3.5
27-Apr	0		0	-	-	-	0	0	0	0	-	8,010	3.92	3.27	51.7	3.3
28-Apr	2		2	33	69.0	105	38	114	648	801	0.0025	8,013	4.33	3.78	51.9	3.2
29-Apr	3		3	91	97.7	102	160	480	2722	3362	0.0009	7,985	4.36	3.33	52.2	4.4
30-Apr	2		2	93	94.0	95	94	281	1594	1969	0.0010	7,994	3.98	3.45	52.5	3.4
01-May	5		5	38	81.2	101	149	447	2533	3129	0.0016	8,021	4.21	3.60	52.7	2.6
02-May	0		0	-	-	-	0	0	0	0	-	7,994	4.27	3.65	52.5	3.5

	Unmarked Chinook Salmon										*Environmental Conditions*					
	Catch			Fork Length (mm)			Estimated Passage						Velocity (ft/s)			
Date	Observed	Missing Value	Adjusted	Min	Avg	Max	Fry	Parr	Smolt	Total	Predicted Efficiency	Flow at MOD (cfs)	North	South	Temperature at Shiloh	Turbidity
03-May	2		2	96	100.0	104	115	345	1954	2414	0.0008	7,960	4.10	3.80	52.4	2.7
04-May	4		4	92	101.3	107	240	719	4074	5033	0.0008	7,951	4.33	4.16	52.1	2.3
05-May	1		1	98	98.0	98	0	176	938	1114	0.0009	7,942	3.98	3.78	51.9	3.1
06-May	3		3	69	92.0	102	0	430	2294	2724	0.0011	7,974	3.84	3.52	52.2	2.2
07-May	4		4	93	101.3	109	0	803	4281	5084	0.0008	7,975	4.28	3.34	52.3	2.6
08-May	ns	2	2	-	-	-	0	346	1846	2192	0.0009	7,998	4.15	3.55	52.8	-
09-May	3		3	94	97.7	100	0	486	2595	3081	0.0010	7,777	3.85	3.60	53.0	3.0
10-May	2		2	90	94.0	98	0	272	1451	1723	0.0012	7,676	4.31	3.71	52.9	2.1
11-May	5		5	85	94.4	104	0	681	3630	4311	0.0012	7,643	4.15	3.55	52.9	2.4
12-May	0		0	-	-	-	0	0	0	0	-	7,534	4.14	3.45	53.2	2.1
13-May	0		0	64	76.6	86	0	0	0	0	-	7,505	4.50	3.54	53.4	1.8
14-May	5		5	93	99.4	109	0	0	5274	5274	0.0009	7,691	4.03	3.32	53.5	2.3
15-May	ns	2	2	-	-	-	0	0	2145	2145	0.0009	7,791	4.03	3.32	53.8	-
16-May	ns	3	3	-	-	-	0	0	3189	3189	0.0009	7,727	4.15	3.55	53.8	-
17-May	2		2	98	103.5	109	0	0	2346	2346	0.0009	7,589	4.28	3.62	54.4	1.6
18-May	6		6	88	96.5	103	0	0	5313	5313	0.0011	7,525	3.77	3.14	54.5	1.6
19-May	7		7	80	98.7	104	0	255	6372	6627	0.0011	7,493	4.50	3.50	54.0	1.6
20-May	1		1	90	97.0	97	0	34	858	892	0.0011	7,499	4.30	4.00	53.1	1.5
21-May	ns	4	4	-	-	-	0	135	3374	3509	0.0011	7,399	-	-	52.9	-
22-May	ns	4	4	-	-	-	0	135	3373	3508	0.0011	7,450	-	-	52.2	-
23-May	ns	5	5	-	-	-	0	143	3581	3724	0.0013	7,113	-	-	53.1	-
24-May	5		5	90	98.6	106	0	129	3222	3351	0.0015	6,680	3.99	2.88	54.1	2.6
25-May	8		8	81	92.8	103	0	157	3925	4082	0.0020	6,537	3.74	2.78	54.3	1.8
26-May	4		4	58	97.3	111	0	0	2322	2322	0.0017	6,455	3.32	3.34	53.8	1.4
27-May	7		7	91	94.9	99	0	0	3442	3442	0.0020	6,266	3.92	3.35	53.2	1.4
28-May	ns	6	6	-	-	-	0	0	2800	2800	0.0021	6,043	-	-	53.3	-
29-May	ns	6	6	-	-	-	0	0	2544	2544	0.0024	5,780	-	-	53.7	-
30-May	ns	6	6	-	-	-	0	0	2280	2280	0.0026	5,485	-	-	54.2	-
31-May	ns	6	6	-	-	-	0	0	1987	1987	0.0030	5,157	-	-	54.9	-
01-Jun	4		4	92	97.3	99	0	0	1141	1141	0.0035	4,764	3.11	2.64	55.6	2.8
02-Jun	6		6	94	99.7	104	0	117	1402	1519	0.0040	4,270	3.11	2.64	56.5	1.6
03-Jun	9		9	84	96.3	107	0	134	1603	1737	0.0052	3,919	2.72	2.73	57.8	3.0
04-Jun	9		9	85	97.0	105	0	124	1491	1615	0.0056	3,681	2.95	3.02	58.7	2.9

	Unmarked Chinook Salmon										*Environmental Conditions*					
	Catch			Fork Length (mm)			Estimated Passage						Velocity (ft/s)			
Date	Observed	Missing Value	Adjusted	Min	Avg	Max	Fry	Parr	Smolt	Total	Predicted Efficiency	Flow at MOD (cfs)	North	South	Temperature at Shiloh	Turbidity
05-Jun	6		6	77	89.2	95	0	57	683	740	0.0081	3,464	2.70	2.65	58.6	3.8
06-Jun	3		3	95	102.7	117	0	44	524	568	0.0053	3,319	2.71	2.74	58.3	4.0
07-Jun	6		6	95	101.7	110	0	76	906	982	0.0061	3,058	2.54	2.57	58.5	2.2
08-Jun	3		3	64	86.7	101	0	22	267	289	0.0104	3,095	2.34	2.28	58.4	2.6
09-Jun	4		4	64	87.8	103	0	80	482	562	0.0071	3,898	2.89	3.03	57.4	2.8
10-Jun	5		5	89	95.4	99	0	175	1050	1225	0.0041	4,561	3.42	3.39	56.1	1.9
11-Jun	0		0	-	-	-	0	0	0	0	-	-	3.71	2.97	55.6	2.3
12-Jun	4		4	86	95.0	101	0	203	1218	1422	0.0028	5,481	3.80	3.70	55.3	2.2
13-Jun	0		0	-	-	-	0	0	0	0	-	4,913	3.70	3.70	55.0	1.6
14-Jun	1		1	106	106.0	106	0	58	350	409	0.0024	4,864	3.70	3.80	54.9	1.8
15-Jun	3		3	81	92.3	100	0	114	682	795	0.0038	5,014	4.03	3.85	55.7	1.8
16-Jun	0		0	-	-	-	0	0	0	0	-	4,603	3.40	3.80	57.0	1.6
17-Jun	ns	1	1	-	-	-	0	100	100	200	0.0050	4,243	-	-	57.9	-
18-Jun	ns	1	1	-	-	-	0	86	86	173	0.0058	4,102	-	-	58.1	-
19-Jun	ns	1	1	-	-	-	0	75	75	150	0.0067	3,958	-	-	57.7	-
20-Jun	3		3	75	95.7	113	0	355	355	711	0.0042	4,458	3.50	3.60	57.2	2.0
21-Jun	1		1	76	76.0	76	0	93	93	185	0.0054	5,574	3.95	3.97	56.5	2.5
22-Jun	0		0	-	-	-	0	0	0	0	-	6,174	3.80	3.75	56.2	1.7

Appendix C. Daily counts of non-salmonids captured at Waterford during 2006.

Date	BGS	BKS	BRB	C	CHC	GSF	GSN	HH	LAM	LMB	MQK	PKS	PRS	RES	RSN	SASQ	SASU	SCB	SMB	SNF	TFS	UNID	W	WHC
26-Jan		1																						
27-Jan	3																				3			
28-Jan									4												2			
29-Jan																								
30-Jan	2				1																1			
31-Jan									5												3			
01-Feb	2	1					1		2												2			
02-Feb																					2			
03-Feb	1																				3			
04-Feb																	1							
05-Feb									5		1										1			
06-Feb	1																							
07-Feb																	1				2			1
08-Feb									2															
09-Feb																					1			
10-Feb									1												1			
11-Feb									4		1					1					3			
12-Feb	1								1															
13-Feb									1												1			
14-Feb																								
15-Feb																								
16-Feb	1								1	1											1			
17-Feb																								
18-Feb																								
19-Feb																								
20-Feb	1								1	1						1								
21-Feb	1																							
22-Feb									2							1	1						1	
23-Feb								1	1															1
24-Feb									2					1			1							
25-Feb	1																							
26-Feb									2															

Date	BGS	BKS	BRB	C	CHC	GSF	GSN	HH	LAM	LMB	MQK	PKS	PRS	RES	RSN	SASQ	SASU	SCB	SMB	SNF	TFS	UNID	W	WHC
27-Feb						1																		
28-Feb																								
01-Mar									12								1							
02-Mar	1								3															
03-Mar									6												19			
04-Mar									52								1				20			
05-Mar									26												29			
06-Mar									1												25			
07-Mar	1						1		7												41			
08-Mar																1					21			
09-Mar																					10			
10-Mar	1								1												27			
11-Mar	1								3												10			
12-Mar									2															
13-Mar	2																							
14-Mar	1																							
15-Mar									1												1			
16-Mar																	2				3			
17-Mar									3															
18-Mar									17															
19-Mar									16															
20-Mar									3															
21-Mar									7						1									
22-Mar									2				1											
23-Mar									2															
24-Mar									2															
25-Mar																								
26-Mar									16												1			
27-Mar									8							1	3							
28-Mar		1							15		1						1							
29-Mar									35							3	1							
30-Mar									21							1								
31-Mar			1						11							1	2							

Date	BGS	BKS	BRB	C	CHC	GSF	GSN	HH	LAM	LMB	MQK	PKS	PRS	RES	RSN	SASQ	SASU	SCB	SMB	SNF	TFS	UNID	W	WHC
01-Apr	1							1	11															
02-Apr												1				2	2				1			
03-Apr									4							2								
04-Apr									9							1	1							
05-Apr		1					2	1	10							2					3			
06-Apr									4							3								
07-Apr									5						1	6	1				1			
08-Apr		1						2							1	5	1				1			
09-Apr		1						4							1	24	1							
10-Apr			1						1							7								
11-Apr								1								5								
12-Apr	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
13-Apr	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
14-Apr	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
15-Apr	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
16-Apr	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
17-Apr	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
18-Apr	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
19-Apr	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
20-Apr	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
21-Apr	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
22-Apr	2							3					1			6	3							
23-Apr	4							1								2	4							
24-Apr	1							1									1							
25-Apr	6							2								5	5							
26-Apr	1							3								4	3					1		
27-Apr	5															4								1
28-Apr	9							3								2	5							
29-Apr	7							3								5	5							
30-Apr	2															2	4							
01-May	1																2					2		
02-May	7							3								1	5							
03-May											1						2							

Date	BGS	BKS	BRB	C	CHC	GSF	GSN	HH	LAM	LMB	MQK	PKS	PRS	RES	RSN	SASQ	SASU	SCB	SMB	SNF	TFS	UNID	W	WHC
04-May	4							2								1	1							
05-May	3																							
06-May	2															1	1							
07-May	1															1								
08-May	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
09-May	2																							
10-May	3															1	5							
11-May	1										1						2							
12-May	2																1							
13-May	1									2							1							
14-May	2															1	3						1	
15-May	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
16-May	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
17-May	1																			1				
18-May	8									5						1								
19-May	6									6						1								
20-May																1	1							
21-May	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
22-May	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
23-May	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
24-May	1								1	3							1							
25-May	2				1		1			3														
26-May	4							1		4														
27-May	2								1	3	1							1	1					
28-May	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
29-May	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
30-May	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
31-May	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
01-Jun	6										1					2								
02-Jun	18							3		4							6							
03-Jun	9			1				1		3						2	4							
04-Jun	24							3		9						4	4		1					
05-Jun	2									3						3								

Date	BGS	BKS	BRB	C	CHC	GSF	GSN	HH	LAM	LMB	MQK	PKS	PRS	RES	RSN	SASQ	SASU	SCB	SMB	SNF	TFS	UNID	W	WHC
06-Jun	4	1								2						1	1		1				2	
07-Jun	3							1		2						1		1					1	
08-Jun	4							1		2	1					3								
09-Jun																							1	
10-Jun	2							1		1						6								1
11-Jun	3															1	1							
12-Jun																								
13-Jun	1			1																				
14-Jun	2																							
15-Jun	2									1														
16-Jun																2								
17-Jun	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
18-Jun	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
19-Jun	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
20-Jun																								
21-Jun																								
Total	192	7	2	2	2	1	5	42	352	55	8	1	2	1	4	131	92	2	3	1	239	3	6	4
	BGS	BKS	BRB	C	CHC	GSF	GSN	HH	LAM	LMB	MQK	PKS	PRS	RES	RSN	SASQ	SASU	SCB	SMB	SNF	TFS	UNID	W	WHC

Appendix D. Daily counts of non-salmonids captured at Grayson during 2006.

Date	BGS	BKB	BKS	C	CHC	GF	GSF	GSN	HCH	HH	LAM	LMB	LP	MQK	MSS	PRS	RES	RSN	SASQ	SASU	SCB	SMB	TFS	UNID	W	WHC
26-Jan																										1
27-Jan														1												
28-Jan											1															
29-Jan																		1								
30-Jan																										
31-Jan								1																		
01-Feb																										
02-Feb															1		1									
03-Feb											1															
04-Feb																										
05-Feb																										
06-Feb														1												
07-Feb															1			1								
08-Feb											1															
09-Feb						1																				1
10-Feb					1																					
11-Feb																										
12-Feb												1														
13-Feb														1												1
14-Feb																										
15-Feb											2						1									
16-Feb											1															
17-Feb																										
18-Feb		1																								
19-Feb																										
20-Feb											1															
21-Feb	2																		1							
22-Feb	1										1														1	
23-Feb	1																									
24-Feb	1													1												
25-Feb	2														1											2
26-Feb	1														1		1									1

Date	BGS	BKB	BKS	C	CHC	GF	GSF	GSN	HCH	HH	LAM	LMB	LP	MQK	MSS	PRS	RES	RSN	SASQ	SASU	SCB	SMB	TFS	UNID	W	WHC
27-Feb																										
28-Feb												1														
01-Mar					2							1														
02-Mar																										1
03-Mar							1											1								
04-Mar											1			1									10			
05-Mar											2												1			
06-Mar																										
07-Mar																							3			
08-Mar																										
09-Mar																			1							
10-Mar																										1
11-Mar								1															2			3
12-Mar									1																	1
13-Mar										1							1									1
14-Mar															1											1
15-Mar									1																	
16-Mar																										1
17-Mar											2															3
18-Mar											4							1								
19-Mar																										2
20-Mar																			1							
21-Mar																										
22-Mar						1			1		1															
23-Mar																										1
24-Mar	1																									
25-Mar																										
26-Mar																		2								3
27-Mar																										
28-Mar																										3
29-Mar																										
30-Mar	1				1						36							1					3			1
31-Mar										1	7								1							2

Date	BGS	BKB	BKS	C	CHC	GF	GSF	GSN	HCH	HH	LAM	LMB	LP	MQK	MSS	PRS	RES	RSN	SASQ	SASU	SCB	SMB	TFS	UNID	W	WHC
01-Apr	1																									
02-Apr											9												1			
03-Apr										1									1							
04-Apr																										
05-Apr																										
06-Apr	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
07-Apr	1									1		1		1				3	1					1		
08-Apr	2																		3							
09-Apr										1				1			1		2							1
10-Apr	1									3									12							
11-Apr										1									7							
12-Apr																			3							
13-Apr										3									6							
14-Apr																			17							
15-Apr																			12	1						
16-Apr																			7							
17-Apr																		1	6							1
18-Apr																									1	1
19-Apr																			3							
20-Apr										1									4							
21-Apr										6									6						2	
22-Apr										5									4							
23-Apr										9									5							
24-Apr																			5							
25-Apr														1					4	1						
26-Apr										2									1							
27-Apr																			7							
28-Apr										2									3							
29-Apr										1									1							
30-Apr	1													1	1											
01-May								1		2									1							
02-May																										
03-May																			3							1

Date	BGS	BKB	BKS	C	CHC	GF	GSF	GSN	HCH	HH	LAM	LMB	LP	MQK	MSS	PRS	RES	RSN	SASQ	SASU	SCB	SMB	TFS	UNID	W	WHC
04-May					1					2																
05-May	1									1									3							
06-May	1																	2	1	3						
07-May																			1							
08-May	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
09-May												5														
10-May											1															
11-May				1						2		1							1	1						
12-May				2						3		9							2						1	1
13-May	1										1	11								2				3		2
14-May				15						1		120						1		1				1		1
15-May	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
16-May	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
17-May				232						1		135														
18-May	2			207						1		147							1	3						
19-May				1,491						1		32							1	1						
20-May				1,364																						
21-May	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
22-May	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
23-May	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
24-May				1,430								26							1	6		2				
25-May	1			1,318								14								4				1		
26-May	1			1,880								35			1					2		2		4		
27-May				838								9								2						
28-May	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
29-May	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
30-May	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
31-May	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
01-Jun	2			2,121								19							4	20	1	3		1		
02-Jun	3		1	6,072				1				18							3	35	1	25		4		
03-Jun	3			4,596				1		1		5							1	2						
04-Jun			51	3,972						5		35				1		1		6	6					
05-Jun			8	2,013								2									1					

Date	BGS	BKB	BKS	C	CHC	GF	GSF	GSN	HCH	HH	LAM	LMB	LP	MQK	MSS	PRS	RES	RSN	SASQ	SASU	SCB	SMB	TFS	UNID	W	WHC
06-Jun			157	2,063								8	1								7					6
07-Jun			56	1,140								29	1								9					1
08-Jun				797								8									1	5				1
09-Jun			25	620				25				114								6	8	1				
10-Jun			7	1,185				9		4		43			1	1		1	1		1					
11-Jun				1,813				1		1		5				1					3					1
12-Jun	1		3	922								13				2			1	1	2					
13-Jun			9	2,590								1						1			2					
14-Jun	1		1	263				2		1		6				1				1	1					4
15-Jun			3	170						2		16								1	5			2		1
16-Jun			2	74	1							13														
17-Jun	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
18-Jun	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
19-Jun	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
20-Jun			5	55								3									10	1				2
21-Jun			1	42								3														1
22-Jun																										
Total	33	1	329	39286	6	2	1	42	3	66	72	889	2	9	8	6	5	17	149	99	58	39	20	17	5	55
	BGS	BKB	BKS	C	CHC	GF	GSF	GSN	HCH	HH	LAM	LMB	LP	MQK	MSS	PRS	RES	RSN	SASQ	SASU	SCB	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