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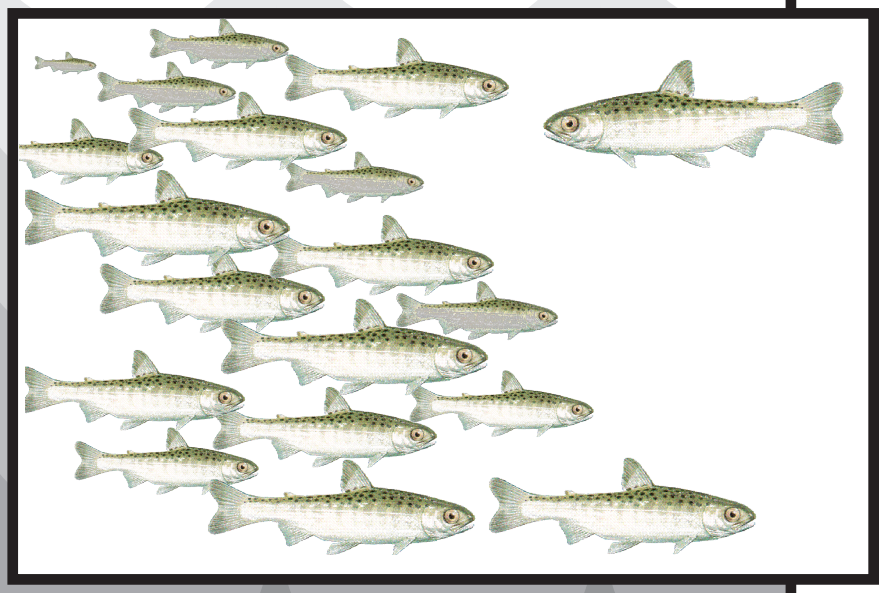
Green River Juvenile Salmonid Production Evaluation: 2009-2010 Annual Report



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Washington Department of
Fish and Wildlife
Fish Program
Science Division

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Acknowledgements

Measuring juvenile salmon production from large river systems like the Green River involves a tremendous amount of work. Developing these estimates was possible due to the long hours of trap operation provided by our dedicated scientific technicians: Bob Green, Josh Weinheimer, Matt Pollack, Jeff Loveland and Paul Lorenz. Logistical support was provided by Wild Salmon Production Evaluation Unit biologist Mike Ackley.

A number of other individuals and agencies contributed to this project. Bill Mosby, the adjacent landowner, provided access to the trap site. Mike Wilson, manager of the WDFW Soos Creek hatchery, provided logistical support and a secure staging site near the trap. Steve Foley and Darcy Wildermuth, WDFW Region 4, provided Chinook spawner survey data.

The juvenile salmonid production study on the Green River was initiated in 2000. This study was funded by the Washington State legislature between 2000 and 2002, by the Washington Salmon Recovery Funding Board (SRFB) between 2002 and 2007, and by Tacoma Public Utilities, Water Division between 2008 and 2010.

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Executive Summary

This report provides the 2009 and 2010 results from the juvenile salmonid monitoring study conducted on the Green River in central Puget Sound, Washington. The primary objective of this study was to estimate the juvenile abundance natural-origin Chinook in the Green River. Additional objectives were to estimate the juvenile migrants produced by other salmonid species and to describe life history characteristics of all juvenile migrants. Juvenile salmonids were captured in a five-foot screw trap located at river mile 34.5 (55 rkm). Catch was expanded to a total migration estimate using a time-stratified approach that relied on release and recapture of marked fish throughout the outmigration period. The number of juvenile migrants and associated variance were derived using a Bailey estimator.

The trap was operated from January 27 through July 15 in 2009 and from January 19 through July 14 in 2010. During these periods, the trap fished 87% and 92% of the time, respectively. Production (abundance) estimates of juvenile migrants were derived for Chinook, coho, and steelhead. Abundance of juvenile pink salmon was estimated in 2010 only (Table 1).

TABLE 1.—Catch and production (abundance) estimates for juvenile salmonids leaving the Green River in 2009 and 2010. Data represent freshwater production above the Green River screw trap, which is located at river mile 34.5.

	Chinook 0+		Coho	Steelhead	Pink	Chum
	Natural	Hatchery	Natural	Natural		
Migration Year 2009						
Total Catch	17,377	527	2,904	779		88,554
Production	196,118	8,649	81,120	26,174		
Low95% C.I	171,929	7,029	56,563	10,151		
High95%C.I	220,307	10,270	105,677	42,198		
CV	6.29%	8.05%	11.86%	19.37%		
Migration Year 2010						
Total Catch	4,325	356	1,842	2,026	1,787,184	142,498
Production	55,547	4,590	43,763	69,737	9,670,461	
Low95% C.I	39,508	3,115	32,663	47,969	7,094,350	
High95%C.I	71,586	6,065	54,864	91,505	12,246,573	
CV	14.73%	16.39%	12.94%	15.93%	13.59%	

Chinook salmon spawn above and below the juvenile trap and a basin-wide production was derived by applying survival estimated above the trap to spawning below the trap (main stem and above the Big Soos Creek weir). Egg-to-migrant survival of Green River Chinook for the 2009 outmigration (2008 brood) was estimated to be 2.1%, yielding a basin-wide production estimate of 269,277 juveniles. Egg-to-migrant survival of the 2010 outmigration (2009 brood) was estimated to be 5.7%, yielding a basin-wide production estimate of 263,466 juveniles.

Juvenile migrant Chinook in the Green River are predominantly sub yearlings. Outmigration timing of sub yearling Chinook was bimodal in both years. In 2009, fry (<45-mm fork length) represented 61% of all sub yearling migrants and peaked between March 30 and April 5, whereas parr migrants (45+ mm fork length) peaked between June 15 and 21. In 2010, fry migrants represented just 10% of total sub yearling migrants and peaked between March 29 and April 4. Parr migrants peaked between June 7 and 13 in 2010.

Introduction

This report provides the 2009 and 2010 results from the juvenile salmonid monitoring study conducted on the Green River in central Puget Sound, Washington. Throughout this report, the number of juvenile migrants estimated for a given year will be referred to as "freshwater production" because they are the offspring of naturally spawning salmon and steelhead in the Green River. The Green River study was initiated in 2000 with a focus on freshwater production and survival of Chinook salmon but has also provided description of the abundance and biological characteristics of juvenile migrant coho, pink, chum, and steelhead in this watershed. Results from this study contribute to at least two types of management needs for Puget Sound. First, juvenile abundance and life history descriptions of Chinook and steelhead in the Green River contribute to the ongoing status evaluation of Puget Sound Chinook and steelhead, both listed as *threatened* under the Endangered Species Act by the National Marine Fisheries Service (NMFS). Second, the freshwater production estimates for all species provide a baseline to evaluate impacts of the Additional Water Storage (AWS) project for Howard Hanson dam.

Under NMFS Listing Status Decision Framework, listing status of a species under the Endangered Species Act (ESA) will be evaluated based on biological criteria (abundance, productivity, spatial distribution, and diversity) and threats to population viability (i.e., harvest, habitat, etc) (Crawford 2007). The Green River has one of the largest stocks of Chinook in Puget Sound and is designated a *contributing* population to the recovery of the Puget Sound Chinook Evolutionary Significant Unit (ESU, Governor's_Salmon_Recovery_Office 2006, National_Marine_Fisheries_Service 2006). Puget Sound steelhead were as *threatened* in May of 2007; however, population designations for the Puget Sound steelhead ESU are still being evaluated.

The Green River watershed is distinguished by a number of factors including canyon geomorphology in a portion of the upper watershed, dikes and development in the lower watershed, regulated flows from Howard Hanson dam, and large-scale hatchery production. The productivity of salmonid populations, including Chinook salmon, is influenced by the cumulative effect of these natural and human-influenced features. From 2000 to present, a floating fish trap has operated in the main stem Green River (river mile 34.5, rkm 55), approximately one half mile upstream of the mouth of Big Soos Creek. The trap was located upstream of Big Soos Creek in order to avoid the capture of large numbers of hatchery fish produced in the Soos Creek hatchery. This study has produced a long-term data set on juvenile migrants produced by naturally spawning Chinook salmon as well as other salmonids in the Green River.

The combination of spawner and juvenile migrant abundance for Green River Chinook allows brood-specific survival to be partitioned between the freshwater and marine environment. Spawner abundance is currently derived by WDFW Region 4 staff, although methodology for analyzing spawner data continues to be developed. Monitoring freshwater production over a range of spawner abundances should provide a measure of watershed capacity and stock productivity through the spawner-recruit function. This information will be critical to reducing the impacts of harvest, habitat, and hatchery stressors on this stock.

Results from the Green River juvenile salmonid monitoring study also provide baseline data useful for evaluating impacts of a large-scale water storage project at Howard Hanson reservoir. In the mid-1990s U.S. Army Corps of Engineers and Tacoma Water began planning for the Howard Hanson Dam Additional Water Storage Project. The project includes raising the reservoir surface elevation in order to increase water storage for municipal and industrial use.

The final design for the project was developed between 1999 and 2001. Construction began in 2001 and Phase 1 water storage was initiated in the spring of 2007. Downstream migrant trapping in the Green River was considered important for evaluating the impacts and success of mitigation elements from the AWS project on the abundance, freshwater survival, and downstream migrant timing of juvenile Chinook.

Objectives

The primary objective of this study was to estimate the abundance of juvenile migrants produced by Chinook salmon spawning naturally in the Green River. Additional objectives were to estimate the juvenile migrants produced by other salmonid species in the Green River and to describe life history characteristics of all juvenile migrants. This report includes results from the 2009 and 2010 field seasons. In addition, this report includes a re-analysis of Chinook data from the previous nine years of study on the Green River. The reason for this revision was to apply a uniform and consistent approach for the abundance estimation and the description of the two sub yearling life histories – fry and parr migrants. Consistency in the analytical approach should help our ability to recognize the factors that influence freshwater limitations to abundance and survival of Green River Chinook.

Methods

Trap Operation

A floating screw trap (5-ft or 1.5-m diameter) was used to capture juvenile migrants on the Green River (Seiler et al. 2002). The trap was located on the left bank at river mile 34.5 (rkm 55), approximately 3,200 ft (975-m) upstream of the Highway-18 bridge (Figure 1).

In 2009, the trap operated between January 27 and July 15 for a total of 3,526 of 4,049 possible hours (87% of the time). Over the course of the season, trapping was suspended 35 times; the duration of outages ranged from 7.5 to 26.5 hours. Trapping was suspended 10 times for high water, 9 times for hatchery fish releases, and 16 times late in the season because daytime recreational use of the river was high and few fish were being captured.

In 2010, the trap operated between January 19 and July 14 for a total of 3,821 of 4,217 possible hours (91% of the time). Over the course of the season, trapping was suspended 25 times; duration of outages ranged from 0.75 to 36.5 hours. Trapping was suspended 4 times for high water, 2 times for repairs, 2 nights in July due to a state mandated staff furloughs, and 17 times late in the season because daytime recreational use of the river was high and few fish were being captured.

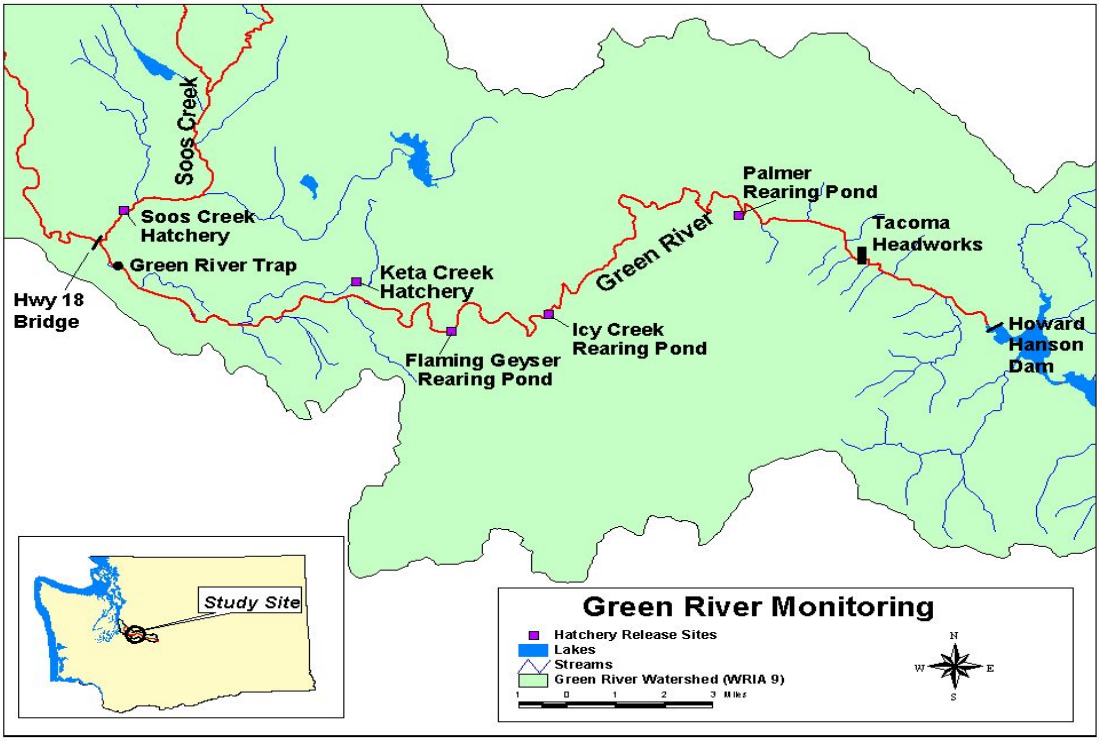

FIGURE 1.—Location of Green River screw trap in relation to existing hatchery release sites and Howard Hanson dam.

Fish Collection

The trap was checked for fish at dawn and dusk each day and at additional times when required by heavy debris loads or large catches. At the end of each trapping period, all captured

fish were identified to species and enumerated. Marking status (adipose fin clips or coded-wire tags) was recorded for each fish. Fork length (FL) was measured from a sub sample of juvenile migrants of natural origin.

Trap efficiency trials were conducted for Chinook, coho, and steelhead in 2009 and for these species and pink salmon in 2010. In both years, trials were conducted with maiden-caught fish (fish captured for the first time) of natural origin throughout the season. Captured fish were anesthetized with tricaine methanesulfonate (MS-222) and marked with either Bismarck-brown dye or with a partial caudal fin clip. Small Chinook (January to mid-May) and pink fry were marked with Bismarck Brown dye, whereas the large Chinook parr, coho, and steelhead were marked with a partial caudal fin clip. The fin clip position was periodically changed in order to stratify releases. Marked fish were released 150-m upstream of the trap after being allowed to recover in fresh water. Marked fish were released at dusk into fast flowing water upstream of a bend in the river. The release site was selected to maximize mixing of marked and unmarked fish while minimizing in-river predation between release and recapture. Dyed or clipped fish caught in the trap were recorded as recaptures.

Freshwater Production Estimate

Freshwater production is the number of juvenile migrants leaving freshwater in a given year. In most cases, freshwater production corresponds to a single brood year of spawners; however, in some cases (e.g., steelhead) freshwater production may represent more than one brood year.

Freshwater production was estimated using a single partial-capture trap design (Volkhardt et al. 2007). Data were stratified by time over the outmigration period in order to accommodate for temporal changes in trap efficiency. The general approach was to estimate (1) missed catch, (2) efficiency strata, (3) time-stratified abundance, (4) extrapolated migration outside the trapping season, and (5) total abundance.

(1) Missed catch. Total catch ($\hat{u}$) was the actual catch (n_i) for period *i* summed with missed catch ($\hat{n}_i$) during periods of trap outages.

Equation 1

$$\hat{u}_i = n_i + \hat{n}_i$$

Missed catch for a given period *i* was estimated as:

Equation 2

$$\hat{n}_i = \overline{R} * T_i$$

where:

$\overline{R}$ = Mean catch rate (fish/hour) from adjacent fished periods, and

T_i = time (hours) during the missed fishing period.

Variance associated with $\hat{u}_i$ was the sum of estimated catch variances for this period. Catch variance was:

Equation 3

$$Var(\hat{u}_i) = Var(\hat{n}_i) = Var(\overline{R}) * T_i^2$$

where:

Equation 4

$$V(\overline{R}) = \frac{\sum_{i=1}^{i=k}(R_i - \overline{R}\ )^2}{k(k-1)}$$

(2) Efficiency strata. A *G*-test (Sokal and Rohlf 1981) was used to determine whether adjacent efficiency trials were statistically different. *A priori* pooling prior to the *G*-test occurred for efficiency trials with expected frequencies of less than five (Sokal and Rohlf 1981). Of the marked fish released in each efficiency trial (*M)*, a portion are recaptured (*m*) and a portion are not seen (*M*-*m*). If the *seen:unseen* [*m*:(*M*-*m*)] ratio differed between trials, the trial periods were considered as separate strata. However, if the ratio did not differ between trials, the two trials were pooled into a single stratum. A *G*-test determined whether adjacent efficiency trials were statistically different ($\alpha = 0.05$). Trials that did not differ were pooled and the pooled group compared to the next adjacent efficiency trial. Trials that did differ were held separately. Pooling of time-adjacent efficiency trials continued iteratively until the *seen:unseen* ratio differed between time-adjacent trials. Once a significant difference is identified, the pooled trials are assigned to one strata and the significantly different trial is the beginning of the next stratum.

(3) Time-stratified abundance. Abundance for a given stratum *h* ($\hat{U}_h$) was calculated from maiden catch ($\hat{u}_h$), marked fish released (M_h), and marked fish recaptured (m_h). Abundance was estimated with a Bailey estimator (Carlson et al. 1998, Volkhardt et al. 2007).

Equation 5

$$\hat{U}_h = \frac{\hat{u}_h(M_h + 1)}{m_h + 1}$$

Variance associated with the Bailey estimator was modified to account for variance of the estimated catch during trap outages (derivation in Appendix A):

Equation 6

$$V(\hat{U}_h) = V(\hat{u}_h)\left(\frac{(M_h+1)(M_h m_h + 3M_h + 2)}{(m_h+1)^2(m_i+2)}\right) + \left(\frac{(M_h+1)(M_h - m_h)\hat{u}_h(\hat{u}_h + m_h + 1)}{(m_h+1)^2(m_h+2)}\right)$$

(4) Extrapolated migration. Migration outside the trapping period ($\hat{N}_e$) was estimated based on an assumed number of days (*t*) outside the trapping period that the migration was assumed to occur. Extrapolation was used for Chinook salmon (January 1 – July 31) due to their extended outmigration period and the low levels of catch occurring at the beginning and end of the trapping season. Extrapolation was calculated based on the estimated daily migration ($\hat{N}_d$) for the first *k* days of trapping (and the last *k* days of trapping).

Equation 7

$$\hat{N}_e = \frac{\sum_{d=1}^{d=k}\hat{N}_d}{k} * \frac{t}{2}$$

Variance associated with the extrapolated migration was:

Equation 8

$$V(\hat{N}_e) = \frac{\sum_{d=1}^{d=k}(\hat{N}_d - \overline{N})^2}{k(k-1)} * \left(\frac{t}{2}\right)^2$$

(5) Total abundance. Total abundance of juvenile migrants was the sum of in-season stratified estimates and extrapolated estimates.

Equation 9

$$\hat{N}_T = \sum_{h=1}^{h=k}\hat{U}_h + \sum \hat{N}_e$$

Variance was the sum of variances associated with all in-season and extrapolated estimates:

Equation 10

$$V(\hat{N}_T) = \sum_{h=1}^{h=k}V(\hat{U}_h) + \sum V(\hat{N}_e)$$

Confidence intervals were calculated from the variance:

Equation 11

$$\hat{N}_{95\%ci} = \hat{N}_T \pm 1.96\sqrt{V(\hat{N}_T)}$$

Coefficient of variation was:

Equation 12

$$CV = \frac{\hat{N}_T}{\sqrt{V(\hat{N}_T)}}$$

Freshwater Life History Diversity for Chinook Salmon

Most juvenile Chinook leave the Green River as sub yearling fish. Sub yearling Chinook migrate between January and August and increase in body size over the season. In addition, a few juvenile Chinook rear in freshwater for an entire year and leave the Green River as yearling migrants. Yearling Chinook out migrate between January and April and range in size from 85 to 150-mm FL.

Among the sub yearling migrants, smaller "fry" are defined as being less than 45-mm fork length. The length cutoff of 45-mm fork length was selected Chinook migrants during the first seven weeks of trapping were consistently 45-mm FL or less and were presumed to have begun their outmigration soon after emergence. Larger "parr" can be as long as 100-mm fork length when caught in June or July and are assumed to rear in freshwater for a period of several months.

In order to compare these two freshwater rearing strategies among years, the sub yearling Chinook production was divided into fry and parr migrants. For a given statistical week, the proportion of Chinook within each size class (< 45-mm FL, > 45-mm FL) was applied to the migration estimate for that week.

Egg-to-Migrant Survival for Sub Yearling Chinook

Egg-to-migrant survival was estimated for sub yearling Chinook. Egg-to-migrant survival was the number of migrants divided by potential egg deposition (P.E.D.). Chinook migrants were estimated as described above. Potential egg deposition was based on estimated female spawners above the trap site and an estimated Chinook fecundity of 4,500 eggs per female. Female spawners were based on foot and aerial surveys of Chinook redds conducted by WDFW Region 4 staff. These estimates assume one female per redd (personal communication, Steve Foley, WDFW Region 4). Fecundity was the average Chinook fecundity measured at Soos Creek Hatchery (personal communication, Mike Wilson, WDFW Hatchery Division).

Basin-wide Abundance of Sub Yearling Chinook

A portion of the Chinook spawning occurs below the juvenile trap in the main stem Green River and above the hatchery rack on Soos Creek. In order to make a basin-wide abundance estimate for juvenile migrant Chinook, egg-to-migrant survival above the trap was applied to the number of eggs deposited in the lower river and in Soos Creek. Egg deposition was estimated as described above.

2009 Results

Sub Yearling Chinook

The total estimated catch of natural-origin Chinook ($\hat{u}$ = 17,377) included 16,767 captures in the trap and 610 missed catch estimated for trap outage periods (Table 2, Appendix B). A total of 118 efficiency trials, ranging from 6 to 530 fish, were conducted and used a total of 11,215 natural-origin Chinook. These trials were summed by statistical week to form 23 efficiency groups. The *G*-test pooled the 23 groups into nine strata, with trap efficiencies ranging between 3.0% and 30.9% (Table 2).

The trapping season of January 27 through July 15 encompassed the majority of the Chinook migration. However, some fish were already migrating when trapping began and at the end of the season. A total of 3,675 Chinook were estimated to have migrated prior to the trapping season and 51 migrants were estimated following the trapping season.

A total of 196,118 ± 24,189 (95% C.I.) sub yearling Chinook of natural origin were estimated to have migrated past the screw trap between January 1 and July 31, 2009. Coefficient of variation for this estimate was 6.29%.

TABLE 2.─Catch, marked and recaptured fish, and estimated abundance of sub yearling Chinook migrants at the Green River screw trap in 2009. Release groups were pooled to form nine strata. Missed catch and associated variance were calculated for periods that the trap did not fish.

		Catch					Abundance	
Strata	Date	Actual	Missed	Variance	Marked	Recaptured	Estimated	Variance
Before	1/1-1/27						3,675	8.04E+05
1	1/28-2/8	933	0	0.00E+00	859	102	7,790	5.70E+05
2	2/9-3/15	7,200	0	0.00E+00	5,520	844	47,043	2.48E+06
3	3/16-3/22	2,041	0	0.00E+00	594	72	16,636	3.40E+06
4	3/23-3/30	887	118	1.39E+02	461	35	12,898	4.29E+06
5	3/31-5/20	1,776	435	4.76E+03	1,156	35	71,059	1.34E+08
6	5/21-5/31	793	0	0.00E+00	798	60	10,387	1.73E+06
7	6/1-6/7	654	32	2.36E+02	402	124	2,212	3.17E+04
8	6/8-6/21	1,941	16	9.80E+01	1,030	128	15,641	1.75E+06
9	6/22-7/15	542	9	1.24E+01	395	24	8,728	2.87E+06
After	7/16-7/31						51	9.63E+02
	Season Total	16,767	610	5.24E+03	11,215	1,424	196,118	1.52E+08

Egg-to-migrant survival of natural-origin Chinook (brood year 2008) was estimated to be 2.07%. This calculation was based on the number of sub yearling Chinook passing the trap ($\hat{N}_T$ = 196,118) divided by the P.E.D above the trap site of 9,481,500 eggs. The P.E.D. was based on an estimated 2,107 female spawners above the trap site in fall of 2008 (personal communication, Steve Foley, WDFW Region 4).

Basin-wide abundance of sub yearling Chinook of natural origin was estimated to be 269,277 juvenile migrants. This included 196,118 migrants from above the trap, 26,248 juveniles from the main stem below the trap, and 46,911 from Big Soos Creek.

Timing of the outmigration was bimodal (Figure 2). The first peak was mostly fry migrants and occurred during statistical week 14 (March 30 to April 5), when 23,000 Chinook migrants were estimated to have passed the trap in one week. The second migration peak was mostly parr migrants and occurred during statistical week 25 (June 15 to June 21), when 11,200 Chinook were estimated to have migrated in a single week. An estimated 61% (119,406) of the Chinook migrated as fry and 39% (76,712) migrated as parr. The fry and parr migration periods overlapped from early February through the middle of May.

The weekly average lengths of the sub yearling Chinook were consistent through statistical week 14 (March 30 to April 5), ranging between 39.9-mm and 43.3-mm FL. Beginning in mid-April, sub yearling Chinook increased in size by an average of 3 mm per week, and averaged 86-mm FL by the end of the trapping season (Figure 3, Appendix C).

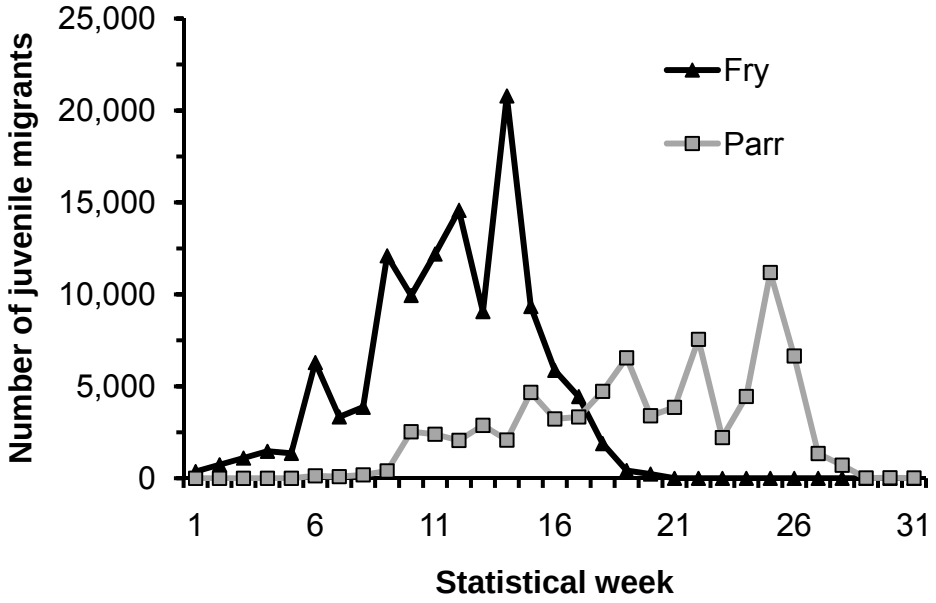

FIGURE 2.—Weekly migration of sub yearling Chinook migrants of natural origin at the Green River screw trap in 2009. The outmigration is partitioned into two freshwater rearing strategies - fry and parr migrants.

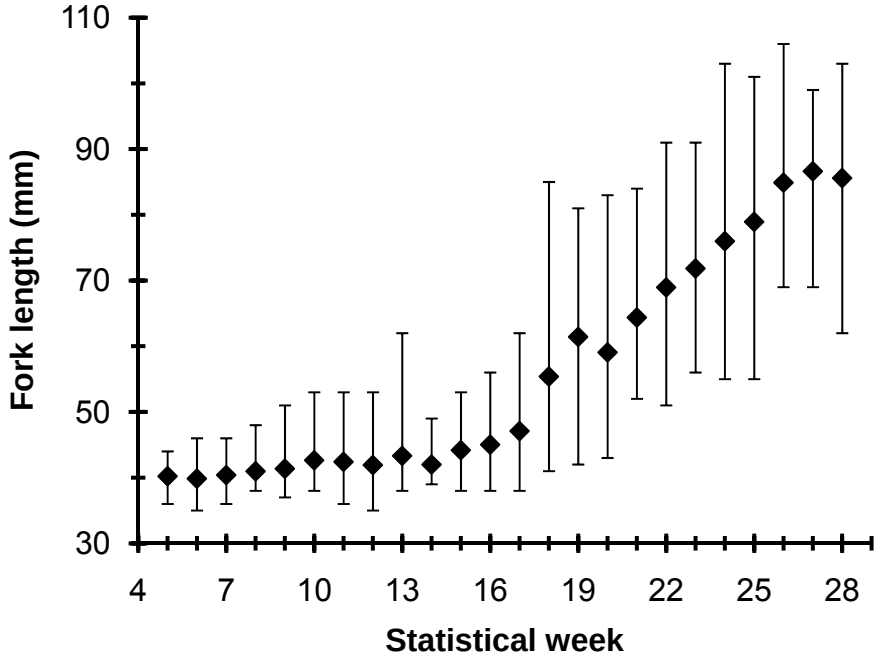

FIGURE 3.─Fork lengths (mm) of sub yearling Chinook migrants of natural origin captured in the Green River screw trap in 2009. Data are mean, minimum, and maximum values by statistical week.

Yearling Chinook

No natural-origin yearling Chinook were captured during the 2009 season.

Coho

The total estimated catch of natural-origin coho ($\hat{u}$=2,904) included 2,127 captures in the trap and 777 missed catch estimated for trap outage periods (Table 3, Appendix D). Trap efficiency trials (103 in total) were conducted over the entire trapping season. Prior to stratification, the individual trials were summed by statistical week or until a minimum of 5 recoveries were achieved. *G*-test comparisons of these efficiency groups resulted in two strata. An efficiency of 8.3% was applied to the January 27 through April 26 catch and an efficiency of 3.1% applied to the April 27 through July 15 catch.

A total of 81,079 ± 24,557 (95% C.I.) natural-origin coho smolts are estimated to have migrated past the screw trap (Table 3). Coefficient of variation for this estimate was 11.9%. No estimate was made for migration before or after the trapping period or for coho rearing below the screw trap.

TABLE 3.─Catch, marked and recaptured fish, and estimated abundance of natural-origin coho smolts at the Green River screw trap in 2009. Release groups were pooled to form two strata. Missed catch and associated variance were calculated for periods that the trap did not fish.

		Catch			Abundance			
Strata	Date	Actual	Missed	Variance	Marked	Recaptured	Estimated	Variance
1	1/27-4/26	409	36	1.66E+02	349	29	5,192	8.72E+05
2	4/27-7/14	1,718	741	3.38E+03	1,110	35	75,887	1.56E+08
	Season Total	2,127	777	3.54E+03	1,459	64	81,079	1.57E+08

The first coho smolt was captured on January 7, 2009. Daily migration of coho was low and averaged 55 smolts per day through April 25 (Figure 4). Peak daily migration occurred on May 10 when 3,951 smolts are estimated to have passed the trap in a single night. Daily catch declined gradually through the remainder of May and early June. The last natural-origin coho was captured on July 5, 2009.

Lengths of natural-origin coho smolts ranged from 61 to 141-mm FL (average = 103-mm FL) with no apparent seasonal trend (Figure 5, Appendix E).

Tacoma Public Utilities (Tacoma Water) conducted a study to evaluate juvenile salmon passage over the 23.5 foot high Headworks Dam located below Howard Hanson Dam. Hatchery coho from Keta Creek Hatchery were marked with one of two pelvic fin clips - a left ventral (LV) or right ventral (RV) - for the evaluation. In total, 387 (178 LV and 209 RV) of the study fish were recaptured in our trap (Volkhardt et al. 2010).

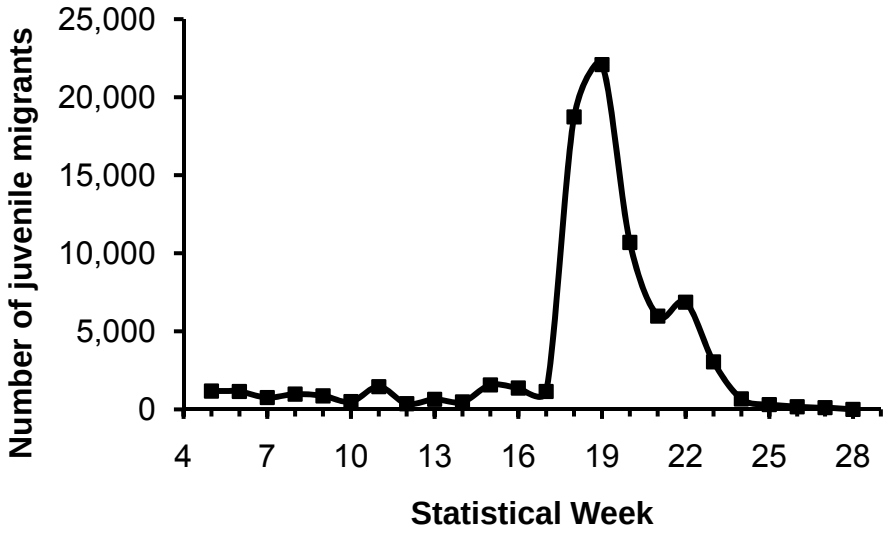

FIGURE 4.—Weekly migration of natural-origin coho smolts rearing above the Green River screw trap in 2009. Data are number of juvenile migrants by statistical week.

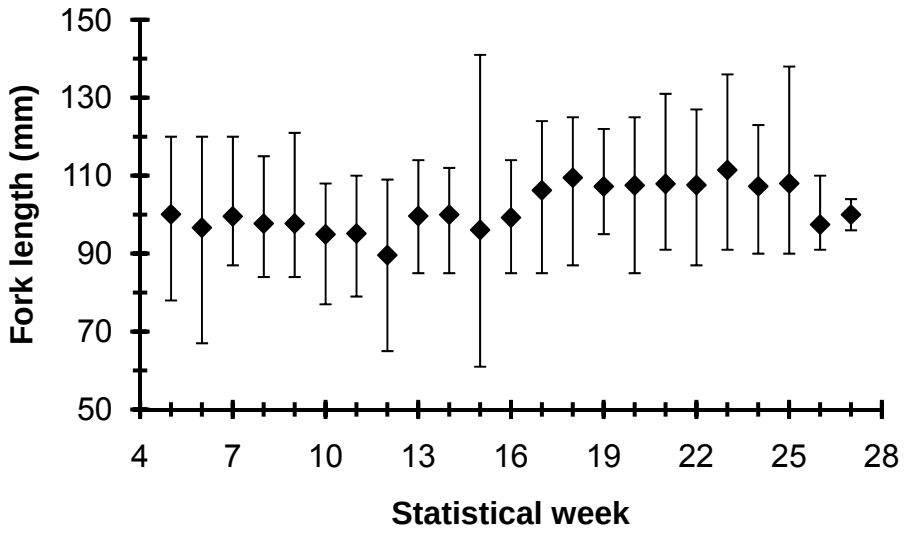

FIGURE 5.—Fork lengths (mm) of natural-origin coho captured in the Green River screw trap in 2009. Data are mean, minimum, and maximum values by statistical week.

Steelhead

The total estimated catch of natural-origin steelhead ($\hat{u} = 779$) included 520 captures in the trap and 259 missed catch estimated for trap outage periods (Table 4, Appendix D). Trap efficiency trials (23 in total) were conducted between May 11 and June 14. Prior to stratification, individual trials were summed by statistical week or until a minimum of 4 recoveries were achieved. A single stratum was formed for the season, with an estimated efficiency rate of 2.7%.

A total of 26,174 ± 16,023 (95% C.I.) natural-origin steelhead smolts were estimated to have reared above the screw trap (Figure 6). Coefficient of variation for this estimate was 19.4%. No estimate was made for migration before or after the trapping period or for steelhead rearing below the screw trap location.

TABLE 4.—Catch, marked and recaptured fish, and abundance estimate for steelhead smolts rearing above the Green River screw trap in 2009. Release groups were pooled to form one strata. Missed catch and associated variance were calculated for periods that the trap did not fish.

		Catch					Abundance	
Strata	Date	Actual	Missed	Variance	Marked	Recaptured	Estimated	Variance
1	1/27-7/14	520	259	4.58E+03	335	9	26,174	6.68E+07

The first steelhead was captured on January 27, 2009. However, daily migration of steelhead was low (average of 27 fish per day) through April 30, 2009 (Figure 6). By late April, migrants were captured on a daily basis. Peak migration occurred during the first week of May with an estimated 9,341 unmarked steelhead passing the trap between May 1 and May 6. During this entire period the trap was spot fished because of large catches of hatchery yearling Chinook and steelhead. The migration peaked a second time during the last week of May with an estimated 4,000 unmarked smolts passing the trap between May 25 and May 28. Daily migration quickly

declined and was intermittent by mid June. The last steelhead smolt was captured on July 11, 2009.

Natural-origin steelhead smolt lengths ranged from 127-mm to 270-mm FL and averaged 171.0 mm FL (Figure 7, Appendix F).

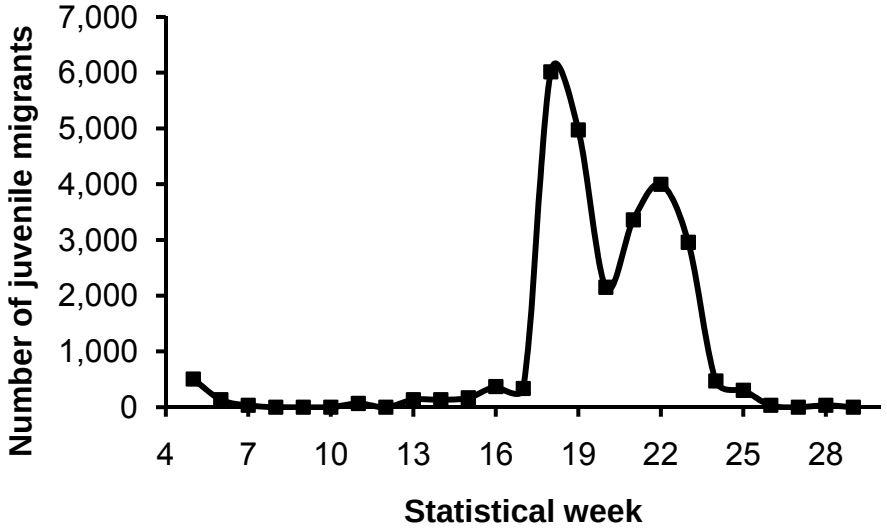

FIGURE 6.—Weekly migration of steelhead smolts of natural origin rearing above the Green River screw trap in 2009. Data are number of juvenile migrants by statistical week.

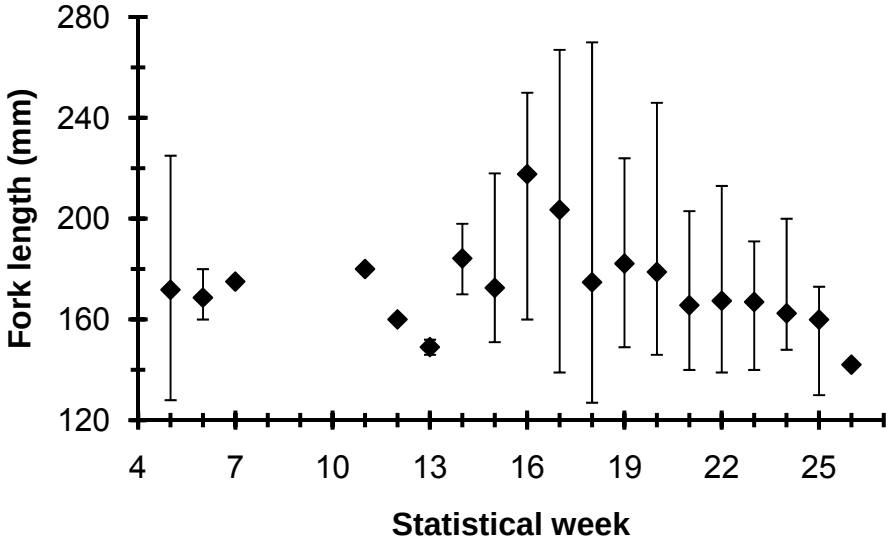

FIGURE 7.—Fork lengths (mm) of natural-origin steelhead at the Green River screw trap in 2009. Data are mean, minimum, and maximum values by statistical week.

Chum

The total estimated catch of chum fry ($\hat{u}$ = 88,554) included 74,246 captures in the trap and 14,308 missed catch estimated for trap outage periods (Appendix D). Chum migrants were

captured between February 9 and July 9, 2009. Portions of this catch were unmarked hatchery fish released from Keta Creek hatchery.

Other Species

In addition to species and age classes described above, catch during the trapping season included 791 coho fry, 270 trout parr, 23 cutthroat smolts, and 1 cutthroat adult. Smolts were distinguished from parr by their size and silvery coloration. Non-salmonid species captured included sculpin (*Cottus* spp.), three-spine sticklebacks (*Gasterosteus aculeatus*), longnose dace (*Rhynichthys cataractae*), and lamprey ammocoetes.

2010 Results

Sub Yearling Chinook

The total estimated catch of natural-origin Chinook ($\hat{u}$ =4,325) included 3,852 captures in the trap and 473 missed catch estimated for trap outage periods (Table 5, Appendix G). Forty eight efficiency trials were conducted with 2,699 natural-origin Chinook and ranged in size from 10 to 229 fish. The trials were summed by statistical week forming 20 groups prior to stratification. The *G*-test pooled these trials into eight strata, with trap efficiencies ranging between 2.2% and 27.6% (Table 5).

The trapping season of January 19 through July 14 encompassed the majority of the Chinook migration. Only a single Chinook was captured in the first week of operation. When trapping ended, migration was still underway at a low level with just 4 fish caught in final week of trapping. A total of 11 Chinook were estimated to have migrated prior to the trapping season and 417 migrants were estimated following the trapping season.

A total of 55,547 ± 16,039 (95% C.I.) sub yearling Chinook of natural origin were estimated to have migrated past the screw trap between January 1 and July 31, 2010. Coefficient of variation for this estimate was 14.73%.

TABLE 5.─Catch, marked and recaptured fish, and estimated abundance of sub yearling Chinook migrants at the Green River screw trap in 2010. Release groups were pooled to form 8 strata. Missed catch and associated variance were calculated for periods that the trap did not fish.

		Catch					Abundance	
Strata	Date	Actual	Missed	Variance	Marked	Recaptured	Estimated	Variance
Before	1/1-1/19						11	2.49E+02
1	1/20-3/16	463	0	0.00E+00	332	56	2,705	1.17E+05
2	3/17-4/4	483	0	0.00E+00	421	47	4,246	3.59E+05
3	4/5-5/1	265	0	0.00E+00	135	24	1,442	7.14E+04
4	5/2-5/16	290	85	1.06E+03	263	28	3,414	3.73E+05
5	5/17-6/5	1,107	352	3.27E+04	427	118	5,247	1.79E+05
6	6/6	38	0	0.00E+00	50	6	277	9.85E+03
7	6/7-6/14	735	0	0.00E+00	594	13	31,238	6.47E+07
8	6/15-7/14	471	36	4.30E+01	477	36	6,550	1.12E+06
After	7/15-7/31						417	4.10E+03
	Season Total	3,852	473	3.38E+04	2,699	328	55,547	6.70E+07

Egg-to-migrant survival of natural-origin Chinook (brood year 2009) was estimated to be 5.66%. This calculation was based on the number of sub yearling Chinook passing the trap ($\hat{N}_T$ = 55,547) divided by the P.E.D above the trap site of 981,000 eggs. The P.E.D. was based on an estimated 218 female spawners above the trap site in fall of 2009 (personal communication, Darcy Wildermuth, WDFW Region 4).

Basin-wide abundance of sub yearling Chinook of natural origin was estimated to be 263,466 juvenile migrants. This included 55,547 migrants from above the trap, 14,524 juveniles from the main-stem below the trap, and 193,395 from Big Soos Creek.

Timing of the outmigration was bimodal. The first peak was mostly fry migrants and occurred during statistical week 14 (March 29 to April 4), when 1,987 Chinook migrants were estimated to have passed the trap in one week (Figure 8). The second migration peak was mostly parr migrants and occurred during statistical week 24 (June 7 to June 13), when 29,963 Chinook were estimated to have migrated in a single week. An estimated 10% (5,559) of the Chinook migrated as fry and 90% (49,988) migrated as parr. The fry and parr migration periods over lapped from the last week of February thru the last week of April.

The weekly average lengths of the sub yearling Chinook were consistent through statistical week 13 (March 22 to March 28), ranging between 39-mm and 44-mm FL. Beginning in mid April, sub yearling Chinook increased in size by an average of 3 mm per week, and averaged 104 mm by the end of the trapping period (Figure 9, Appendix H).

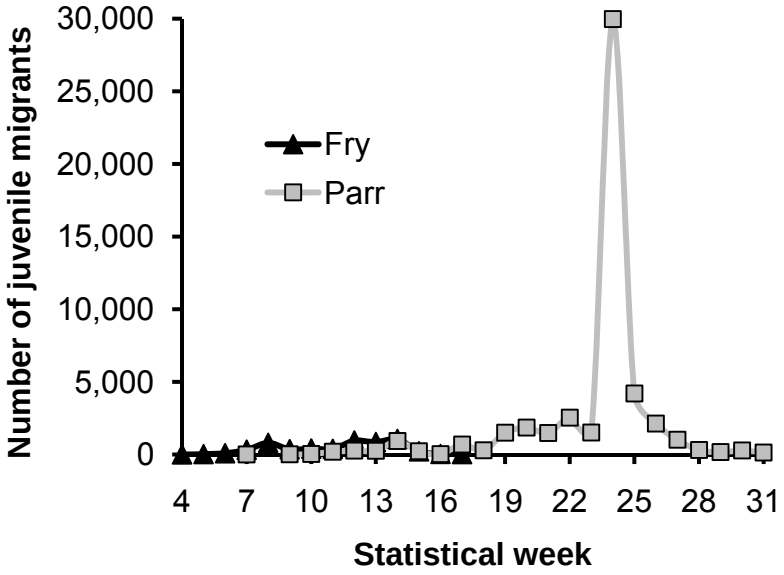

FIGURE 8.—Weekly migration of sub yearling natural-origin Chinook past the Green River screw trap in 2010. The outmigration is partitioned into two freshwater rearing strategies – fry and parr migrants.

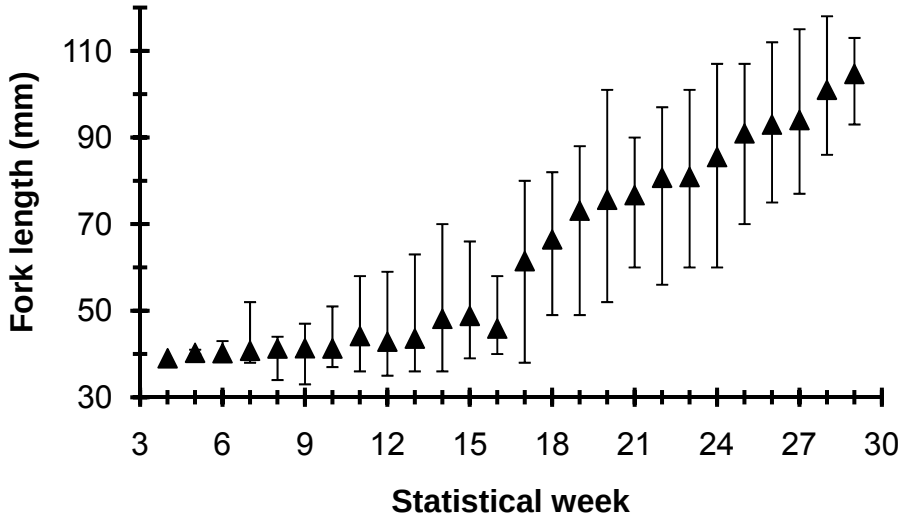

FIGURE 9.─ Fork lengths (mm) of sub yearling Chinook migrants of natural origin captured in the Green River screw trap in 2010. Data are mean, minimum, and maximum values by statistical week.

Yearling Chinook

A total of 14 yearling Chinook of natural origin were captured between February 15 and April 29. No more than one yearling was caught in a single day. No missed catch was estimated for periods when the trap was not fishing. Fork lengths ranged from 86-mm to 150-mm FL and averaged 110.9-mm FL.

Coho

The total estimated catch of natural-origin coho ($\hat{u}$ = 1,842) included 1,740 captures in the trap and 102 missed catch estimated for trap outage periods (Table 6, Appendix I). Trap efficiency trials (82 in total) were conducted over the entire coho migration period. Prior to stratification, the individual trials were summed by statistical week or until a minimum of 5 recoveries were achieved. *G*-test comparisons of these efficiency groups resulted in a single strata with an estimated efficiency rate of 4.1% (Table 6).

A total migration of 43,763 ± 11,100 (95% C.I.) natural-origin coho smolts were estimated to have migrated past the screw trap (Figure 10). Coefficient of variation for this estimate was 12.94%. No estimate was made for migration before or after the trapping period or for coho rearing below the screw trap site.

TABLE 6.─ Catch, marked and recaptured fish, and estimated abundance of natural-origin coho smolts at the Green River screw trap in 2010. Release groups were pooled to form a single stratum. Missed catch and associated variance were calculated for periods that the trap did not fish.

Strata	Date	Catch					Abundance	
		Actual	Missed	Variance	Marked	Recaptured	Estimated	Variance
1	1/19-7/14	1,740	102	2.24E+02	1,377	57	43,763	3.21E+07

The first coho was captured on January 24, 2010. Daily migration of coho smolts was less than 58 coho per day through April 18 (Figure 10). Peak daily migration occurred on May 8 when 2,875 smolts passed the trap on a single night. By the first week of June, daily migration of coho averaged less than 91 fish per day. The last natural-origin coho was captured on July 3, 2010.

Lengths of natural-origin coho smolts ranged from 75-mm to 155-mm FL and averaged 115.9-mm FL (Figure 11, Appendix J). Weekly average fork lengths were greatest for smolts migrating mid-season. Between statistical week 4 and 19, weekly average fork lengths increased from 97.5 mm to 121.5 mm. During the final three weeks of outmigration (statistical week 24 to 26), weekly average coho lengths returned to 100-mm smolts.

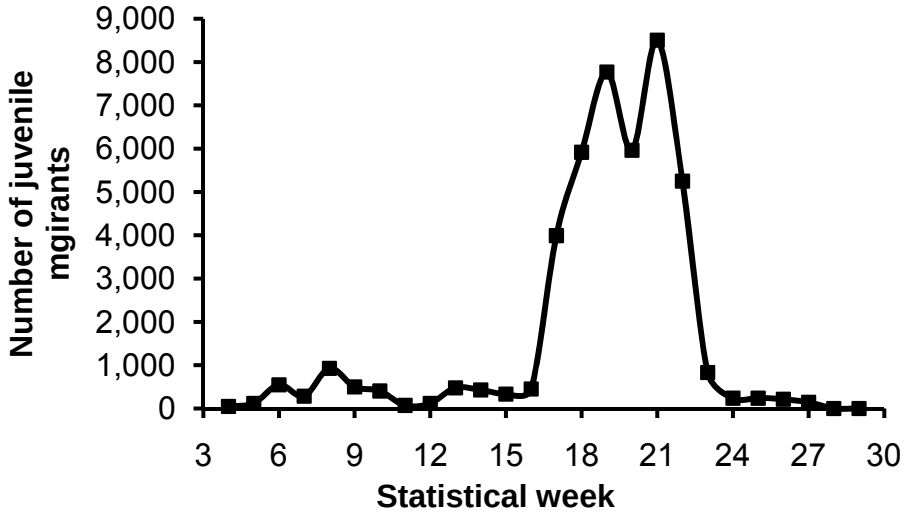

FIGURE 10.—Weekly migration of natural-origin coho smolts rearing above the Green River screw trap in 2010. Data are number of juvenile migrants by statistical week.

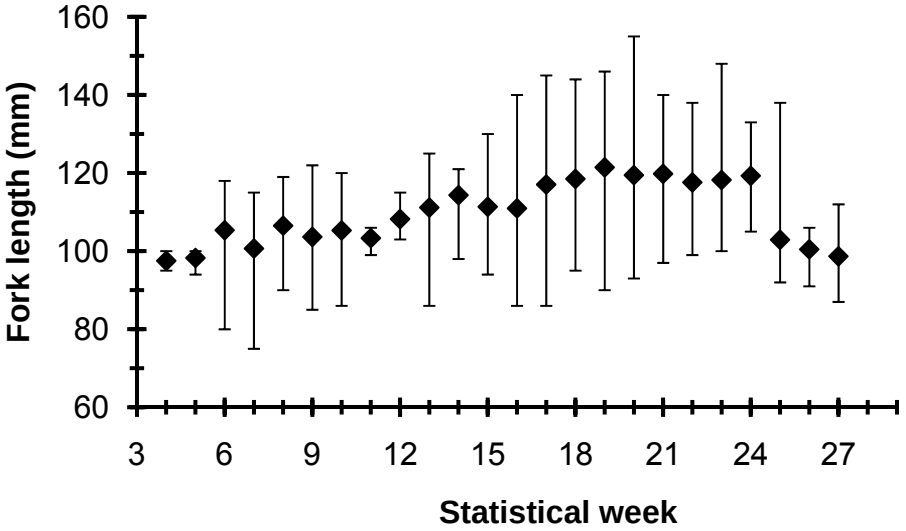

FIGURE 11.—Fork lengths (mm) of natural-origin coho captured in the Green River screw trap in 2010. Data are mean, minimum, and maximum values by statistical week.

Steelhead

The total estimated catch of natural-origin steelhead ($\hat{u}$ = 2,026) included 1,898 captures in the trap and 128 missed catch estimated for trap outage periods (Table 7, Appendix I). Trap efficiency trials (36 in total) were conducted between April 25 and June 13. Prior to stratification, individual trials were summed by statistical week or until a group had a minimum of 5 recoveries. *G*-test comparisons of these efficiency groups resulted in a single strata for the season, with an efficiency of 2.75% (Table 7).

A total of 71,710 ± 22,393 (95% C.I.) natural-origin steelhead smolts were estimated to have reared above the screw trap (Table 7). Coefficient of variation for this estimate was 15.93%. No estimate was made for migration before or after the trapping period or for production originating below the screw trap site.

TABLE 7.─Catch, marked and recaptured fish, and abundance estimates of steelhead smolts rearing above the Green River screw trap in 2010. Release groups were pooled to form one strata. Missed catch and associated variance were calculated for periods that the trap did not fish.

		Catch					Abundance	
Strata	Date	Actual	Estimated	Variance	Marked	Recaptured	Estimated	Variance
1	1/20-7/14	1,898	128	2.37E+03	1,344	37	71,710	1.31E+08

The first steelhead was captured on February 8, 2010. Daily migration of steelhead was minimal to none, average of less than 21 fish per day between February 8 and May 18 (Figure 12). Two peaks in daily migration were observed. The first peak occurred on April 22 when 6,796 steelhead smolts were estimated to have passed the trap in a single night. The second peak occurred on May 17 when 5,274 steelhead smolts were estimated to have passed the trap. Steelhead migration declined to minimal levels by mid June and the last steelhead was captured on June 25, 2010.

Natural-origin steelhead smolt lengths ranged from 116-mm to 350-mm FL and averaged 178.7-mm FL (Figure 13, Appendix K).

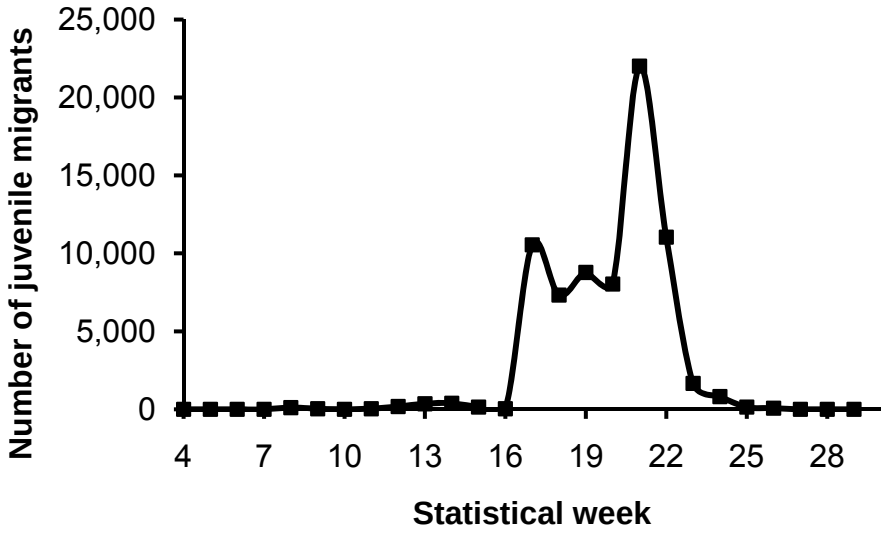

FIGURE 12.─ Weekly migration of natural-origin steelhead smolts rearing above the Green River screw trap in 2010. Data are number of juvenile migrants by statistical week.

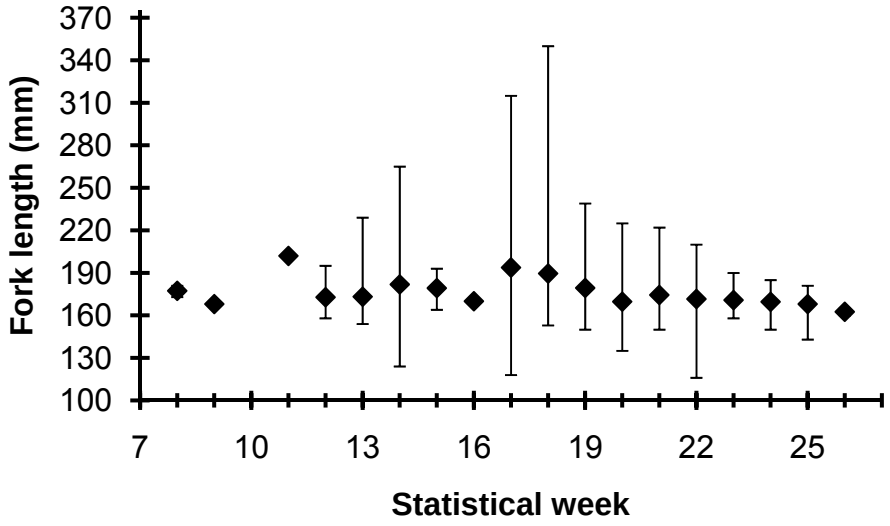

FIGURE 13.─Fork lengths (mm) of unmarked steelhead juvenile caught in the Green River screw trap in 2010. Data are mean, minimum, and maximum values by statistical week.

Chum

The total estimated catch of chum fry ($\hat{u}$ = 142,498) included 141,863 captures in the trap and 635 missed catch estimated for trap outage periods (Appendix I). Chum migrants were captured between February 8 and July 6, 2010. A portion of this catch is unmarked hatchery fish released from Keta Creek hatchery.

Pinks

The total estimated catch of pink fry ($\hat{u}$ = 1,787,184) included 1,773,610 captures in the trap and 13,574 missed catch estimated for trap outage periods (Table 8, Appendix I). Eight efficiency trials were conducted and ranged in size from 100 to 412 pink fry. The *G*-test pooled these trials into five strata, with trap efficiencies ranging between 9.5% and 51.4%. No estimate was made for migration before or after the trapping season or for production originating below the trap site.

A total migration of 9,670,461 ± 2,576,111 (95% C.I.) natural-origin pink fry was estimated to have migrated past the screw trap between January 20 and July 14, 2010. Coefficient of variation for this estimate was 13.6%.

Daily catches of pink fry in the first week of trap operation were small indicating the migration was just getting started. During the first full week of trapping, 87 pinks were estimated to have migrated past the trap (Figure 14). By the end of February, daily migration increased to an average of 1,200 fry. After this date, daily migration increased quickly and reached an average of 40,000 fry per day by mid March and 187,000 fry per day by the end of April. Peak migration occurred on April 21 with over 1.1 million fry estimated to have passed the trap site. Daily migration quickly declined by the final week of May (less than 100 fry per day). The last pink captured for the season was on June 8.

TABLE 8.—Catch, marked and recaptured fish, and abundance of pink fry migrants at the Green River screw trap in 2010. Data were pooled into five time strata. Missed catch and associated variance was calculated for periods that the trap did not fish.

Strata	Date	Catch			Abundance			
		Actual	Missed	Variance	Marked	Recaptured	Estimated	Variance
1	1/19-3/3	19,743	2	4.82E-01	107	55	38,080	1.23E+07
2	3/4-3/7	18,604	0	0.00E+00	105	37	51,895	4.44E+07
3	3/8-3/10	11,734	0	0.00E+00	105	10	113,073	9.56E+08
4	3/11-4/16	1,007,218	0	0.00E+00	412	98	4,201,829	1.34E+11
5	4/17-7/14	716,311	13,572	3.09E+07	100	13	5,265,585	1.59E+12
	Season Total	1,773,610	13,574	3.09E+07	829	213	9,670,461	1.73E+12

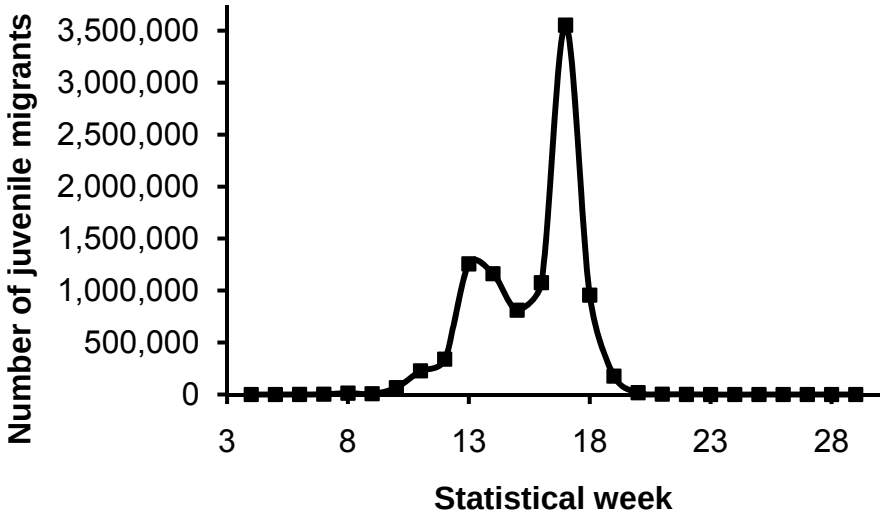

FIGURE 14. ─Weekly migration of juvenile pink salmon past the Green River screw trap in 2010.

Other Species

In addition to species and age classes described above, catch during the trapping season included 301 coho fry, 821 trout parr, 32 cutthroat smolts, and 1 cutthroat adults. Non-salmonid species captured included sculpin (*Cottus* spp.), three-spine sticklebacks (*Gasterosteus aculeatus*), longnose dace (*Rhynichthys cataractae*), and lamprey ammocoetes.

Discussion and Synthesis

This report provides the abundance and life history characteristics of juvenile migrant salmonids in the Green River in both 2009 and 2010. In 2009, this information is provided for Chinook, coho, and steelhead. A fourth species, pink salmon, were included in the 2010 results. Pink salmon are primarily an odd-year return to the Green River and were not caught during the 2009 trapping season. Although we report the actual and missed catch for chum salmon, we were not able to make an estimate of juvenile migrants of natural origin due to large releases of unmarked hatchery chum from Keta Creek hatchery.

Assumptions for Mark-Recapture Estimates

The mark-recapture approach used to derive juvenile abundance estimates was based on five assumptions (Seber 1973, Hayes et al. 2007). Abundance estimates derived from the collected data are potentially biased when any of these assumptions are violated. Therefore, the Green River juvenile monitoring study was designed to minimize any violation of these assumptions. Consideration of mark-recapture assumptions with respect to the Green River monitoring study are discussed below.

Assumption 1. Population is closed with no immigration or emigration and no births or deaths. The emigration assumption is technically violated because the trap catches downstream migrants that are emigrating from the river. However, we assume that the entire cohort is leaving the system within a defined period and that the abundance of juveniles can be estimated at a fixed station during this migration. This assumption is supported by the modality of downstream movement and the condition of the yearling fish (visibly undergoing a process of smoltification). The mark-recapture approach does not account for the proportion of offspring that remain in the river as resident fish (possible for both cutthroat and steelhead).

Two potential sources of deaths due to the trapping operations are mark-related mortality and in-river predation. Evaluating these types of mortality are particularly relevant to marked fish. Unknown deaths of marked fish will lower the estimated trap efficiency and bias high the abundance estimate for that period. Death between release and recapture in response to handling or marking appears to be minimal based on fish held for 24-hour periods after the marking process. The stress associated with handling or marking is minimized by gentle handling and dying by trained staff. Death between release and recapture due to in-river predation or live box predation is expected to be an important issue for the small fry migrants (Chinook, chum, pink). The release site above the trap was selected to be close enough to the trap to minimize in-river predation but far enough from the trap to maximize mixing of marked and unmarked fish (assumption #4 below). Predation in the live box is an addition source of mortality of marked fish which is monitored when cutthroat and steelhead catches increase.

Assumption 2. All animals have the same probability of being caught. This assumption would be violated if trap efficiency changes over time, if small fish are caught at a different rate than large fish of the same species, or if some fish are not moving in a downstream direction. Changes in trap efficiency are most likely to bias migration estimates if they occur during peak migration periods. Changes in trap efficiency are accommodated by stratifying the migration estimate into different time periods that incorporate time-specific mark and recapture data.

The potential for size biased capture is greater for yearling smolts (coho or steelhead) than for the sub yearling migrants. 2010 was the first year that we have measured both released and recaptured fish in order to estimate the change in capture rates with increasing size. Preliminary results indicate that length frequencies of released and recaptured fish were not equal for either species (Figure 15 and 16). The interpretation of these results and their application to the abundance estimate is a current area of research for WDFW.

Equal probability of capture would also be violated if a portion of the juvenile fish were caught because they were redistributing in the river rather than in process of a downstream migration. Lack of directional movement will result in an overestimate of migration because catch is overestimated and recaptures are underestimated. In this study, most if not all of the captured sub yearling fish (Chinook, chum, and pink) were likely to be in process of a downstream migration. Marked sub yearling fish were typically recaptured within a one day time frame. Redistribution of yearling fish is more likely as rearing habitat does occur below the trap site location. For this reason, the preferred location for a juvenile salmon trap is as low as possible in the river system. However, trap site selection is also influenced by channel configurations, river flow velocities, and hatchery releases. In the Green River, the selected site was not low in the river but was the first good location above the Soos Creek hatchery. Soos Creek hatchery annually releases over 3 million Chinook fry, ten times the average natural-origin production. Hatchery releases of this magnitude require the trap to be pulled for long blocks of time, an activity that would add uncertainty to the natural-origin estimate.

Assumption 3. Marking does not affect catchability. This assumption would be violated if marked fish were better able to avoid the trap or were more prone to capture than maiden caught fish. Trap avoidance would over estimate abundance whereas trap attraction would under estimate abundance. Trap avoidance of marked fish is more likely for coho or steelhead than the smaller sub-yearling Chinook, chum or pink salmon. However, behavioral differences between maiden captures and recaptured fish are currently unknown. Handling and marking the fish may also make them more prone to capture if the stress of handling compromises fish health. To minimize this effect, fish held for release are monitored for the 10+ hours between initial capture and release. During this period, fish are held in a perforated bucket that allows water to be exchanged between the bucket and stream. Fish that do not appear to be swimming naturally are removed prior to release.

Assumption 4. Marked fish mix at random with unmarked fish. This assumption would be violated if marked and unmarked fish were spatially or temporally distinct in their downstream movements. Spatial or temporal segregation could increase likelihood of recapture (underestimate migrant abundance) or decrease likelihood of capture (overestimate migrant abundance). The location of the Green River release site was selected to minimize both possibilities. In 2009 and 2010, marked fish were released at the same location that has been used since 2000. Below this location, the river bends and fast flowing water was expected to maximize dispersal of marked fish. In particular, this release site was selected in order to maximize mixing of marked and unmarked sub yearlings while minimizing in-river predation. In comparison to sub yearling migrants, yearling migrants are not assumed to be as vulnerable to in-river predation and are assumed to migrate with intermittent periods of holding and feeding. Multiple release locations for yearling migrants have not been tested in previous years due to low catches. If catches allow in 2011, at least one additional upstream release site will be paired with the current release site in order to compare efficiencies and variation in trap efficiencies between locations.

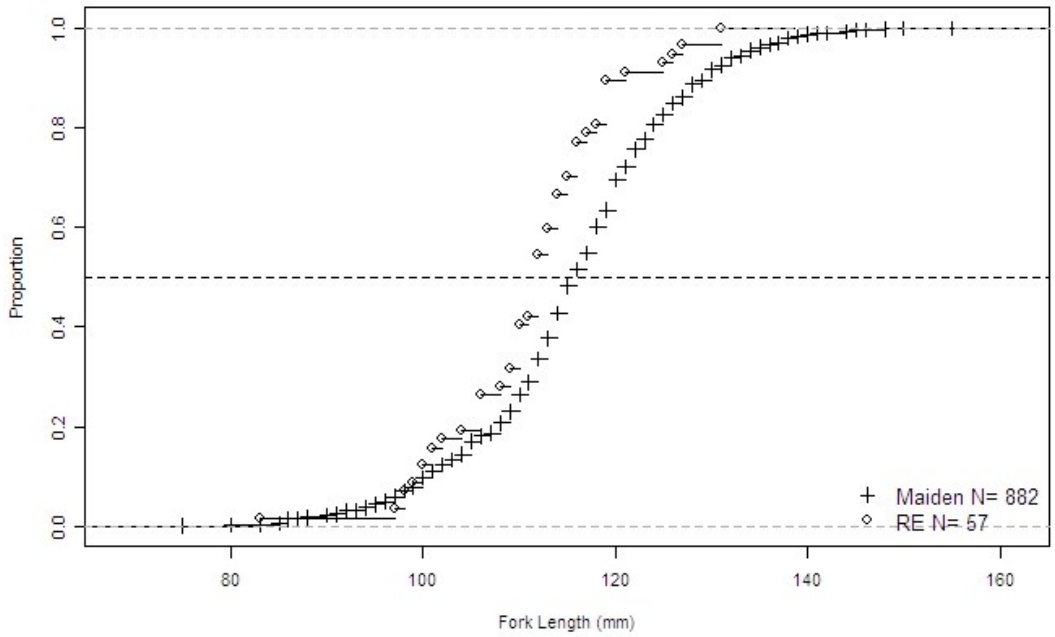

FIGURE 15.—Length frequency distribution of maiden and recaptured coho smolts at the Green River juvenile trap, 2010. Maiden lengths are individual lengths of maiden captures throughout the trapping season. Recapture lengths (RE) are the average length of recaptures from a specific release group.

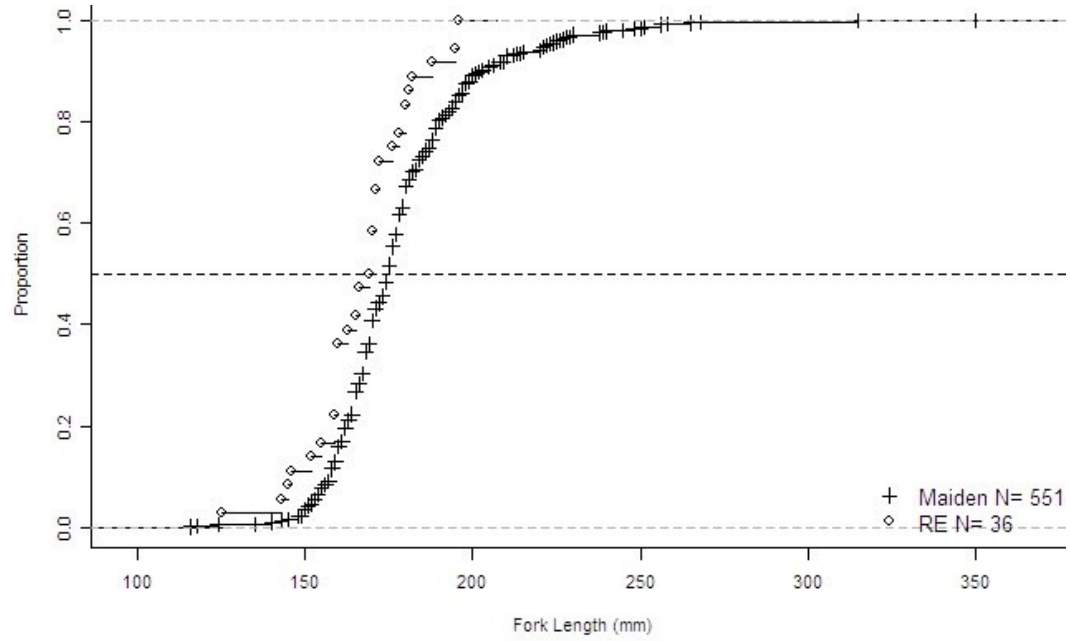

FIGURE 16.—Length frequency distribution of maiden and recaptured steelhead smolts at the Green River juvenile trap, 2010. Maiden lengths are individual lengths of maiden captures throughout the trapping season. Recapture lengths (RE) are the average length of recaptures from a specific release group.

Assumption 5. No marks are lost and all marks are detected. This assumption would be violated if dye or fin clips were not retained or recognized on recaptured fish. This assumption was likely met. Bismarck Brown dye is known to stain fish for up to two weeks and fin regeneration takes much longer than the one to two day time frame between release and recapture. The frequency of undetected marks should also have been low given the highly trained staff performing both the marking procedure and collecting the recapture data. However, in order to test this assumption, we plan to measure mark detection rates with blind counts of a known number of marked and unmarked fish in 2011. If marks were lost or undetected, catch data would be inflated (individuals would be recorded as maiden capture) and the recapture rate decreased. In combination, these errors would result in an underestimate of trap efficiency and an overestimate of migrant abundance.

Assumption for Missed Catch

The accuracy of abundance estimates for all species depends, in part, on accurate estimates of missed catch during periods that the trap did not fish. One type of missed catch occurred in season. The linear interpolation method used to estimate in season missed catch assumed that no major changes occurred in fish migration during the outage period. Drops or spikes in migration rates during high flows would violate this assumption but are nearly impossible to verify. A second type of missed catch occurred prior to or after the trapping season. Chinook salmon have the most extended migration of any species in the Green River juvenile monitoring study and low levels of catch still occur at the beginning and end of the trapping season. As the onset and termination of the Chinook migration is unknown, a more complete abundance estimate would only be possible by increasing the length of the trapping season. Available information from other Puget Sound Chinook trapping projects indicates that the majority of the outmigration occurs between January and July and that a longer trapping season is unlikely to dramatically change the results.

Assumptions for Basin-Wide Chinook Estimate

Expansion of abundance above the trap location to other portions of the watershed relies on two assumptions. The first assumption is that the Green River Chinook spawner abundance estimates above and below the trap sites are accurate. Chinook spawners passed above the Soos Creek hatchery rack are a census count and therefore assumed to be accurate. However, the accuracy of spawner abundances on the lower main stem Green River have been brought into question by a series of mark-recapture studies conducted by WDFW. The mark-recapture study resulted in very different estimates than those derived from peak redd count methodology. Until this discrepancy is resolved, juvenile data will be interpreted with respect to results from the peak redd count methodology provided by WDFW Region 4 staff. However, the basin-wide estimates provided in this report are expected to change as WDFW continues to study and improve Chinook spawner estimates for the Green River. The second assumption is that egg-to-migrant survival is comparable above and below the juvenile trap. Differences in watershed geomorphology, land use, spawner distribution, as well as differing reproductive success of natural versus hatchery origin spawners, add uncertainty to this assumption. However, a single survival rate was applied because no additional information is currently available to justify applying different survival rates to the lower main stem or Soos Creek.

Sub Yearling Chinook

Abundance estimates for juvenile migrant Chinook generated over the eleven years of study have been derived using several different stratification methods, estimator equations, and approaches for partitioning fry and parr components of the outmigration. Changes in methodology over time reflect the challenges of estimating migrant abundance for this species which emigrates from large watersheds over a seven month period with temporally changing river conditions. These methods have been described in detail in annual reports produced for this monitoring study (Seiler et al. 2002, Volkhardt et al. 2006, Topping et al. 2009). In order to make juvenile abundance estimates consistent from year to year, we have reanalyzed previous data using the approach described in the Methods section of this report (Tables 9 and 10). We anticipate that the approach described in the Methods section of this report will be adopted in the future with minimal modification. This section describes the updated sub yearling Chinook estimates as well as the abundance and life history trends observed.

Original and revised estimates of juvenile migrant abundances did not differ notably (Figure 17). The largest discrepancy occurred in the 2003 outmigration estimate where the revised estimate was just 67% of the originally published estimate. Deviations were equally distributed in the positive and negative direction meaning that the revised estimates were not biased in one direction.

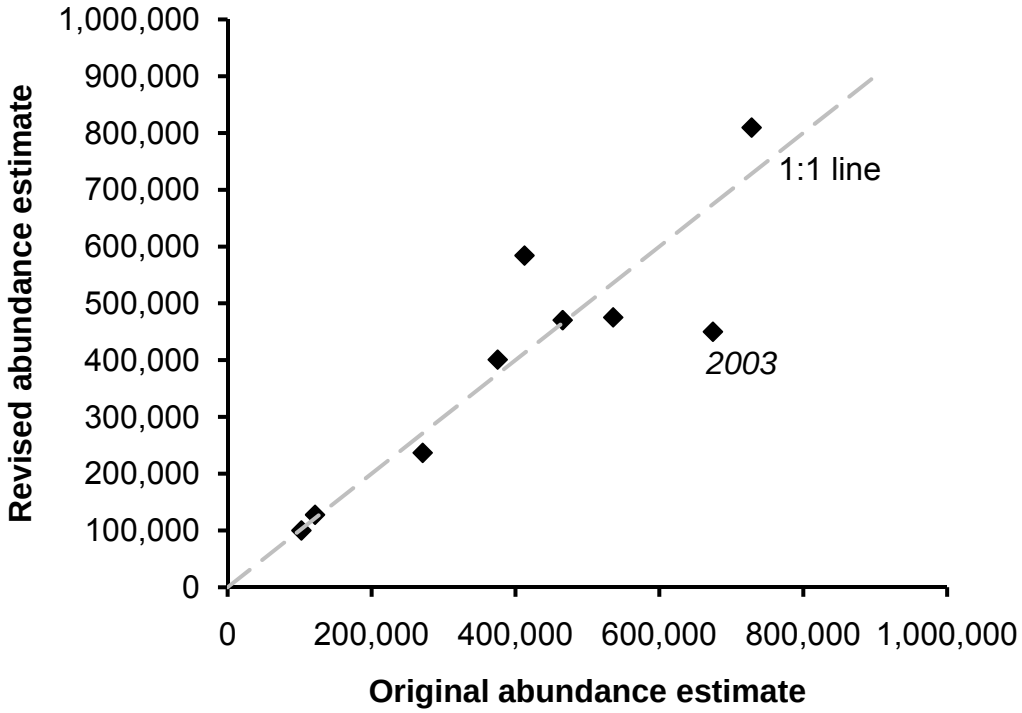

FIGURE 17.—Original and revised abundance estimates of sub yearling Chinook migrants from the Green River, migration year 2000-2008. The largest discrepancy occurred for migration year 2003 labeled in this graph.

The abundance of juvenile migrant Chinook of natural origin passing the Green River trap has ranged between 55,547 and 809,616 over the eleven years of study (Table 9). Average abundance has been 406,000 sub yearlings. Over this time period, the number of juvenile

migrants has trended downward (Figure 18). The 2010 juvenile migrant abundance was the lowest observed since 2000 and corresponded with the lowest spawner returns observed during the same time period. Just 218 females were estimated to have spawned above the trap in 2009 (personal communication, Darcy Wildermuth, WDFW Region 4).

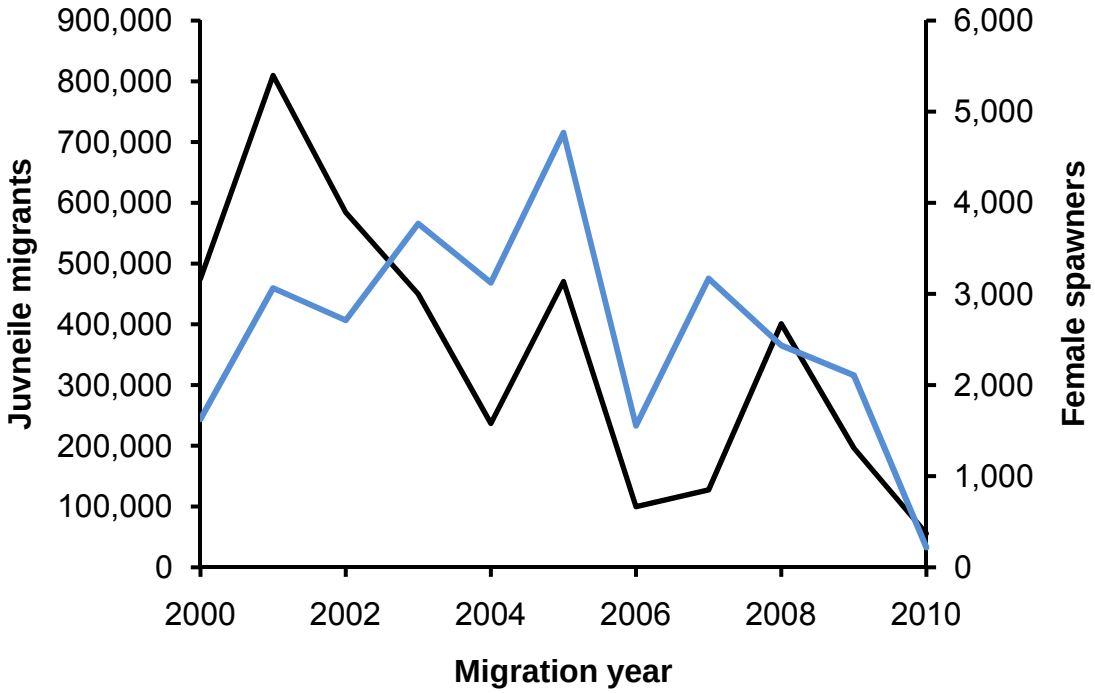

FIGURE 18.—Number of sub yearling Chinook migrants (black line) passing the Green River juvenile trap and the corresponding number of female spawners (blue line) above the juvenile trap, migration year 2000-2010.

TABLE 9.—Abundance of juvenile migrant Chinook (sub yearling) in the Green River. Abundance is partitioned into regions above the juvenile trap site, below the juvenile trap site, and above Soos Creek hatchery rack. Juvenile abundance data in this table has been re-calculated based on methods described in this report.

Brood	Trap	Above Trap				Below Trap				Soos Creek		Total Green
Year	Year	Redds	Deposition	Abundance	Survival	Redds	Deposition	Abundance	Females	Deposition	Abundance	Abundance
1999	2000	1,625	7,312,500	475,207	6.50%	826	3,717,000	241,551	1,616	7,272,000	275,125	991,883
2000	2001	3,064	13,788,000	809,616	5.87%	936	4,212,000	247,324	1,580	7,110,000	275,000	1,331,940
2001	2002	2,711	12,199,500	584,151	4.79%	480	2,160,000	103,428	995	4,477,500	275,000	962,579
2002	2003	3,772	16,974,000	449,956	2.65%	2,314	10,413,000	276,034	1,239	5,575,500	275,000	1,000,990
2003	2004	3,124	14,058,000	236,650	1.68%	1,038	4,671,000	78,631	720	3,240,000	54,542	369,822
2004	2005	4,769	21,460,500	470,334	2.19%	827	3,721,500	81,561	623	2,803,500	61,442	613,338
2005	2006	1,553	6,988,500	99,796	1.43%	82	369,000	5,269	598	2,691,000	38,428	143,493
2006	2007	3,170	14,265,000	127,491	0.89%	883	3,973,500	35,512	313	1,408,500	12,588	175,592
2007	2008	2,435	10,957,500	400,763	3.66%	438	1,971,000	72,088	676	3,042,000	111,259	584,109
2008	2009	2,107	9,481,500	196,118	2.07%	282	1,269,000	26,248	504	2,268,000	46,911	269,277
2009	2010	218	981,000	55,547	5.66%	57	256,500	14,524	759	3,415,500	193,395	263,466

In previous years, sub yearling Chinook migrants were divided into fry and parr components using a selected date when the mid season migration was at its lowest point (Topping et al. 2008). The lull in the bimodal migration typically occurs in mid April. However, in some years, larger parr migrants were observed much earlier in the season and prior to the lull in the bimodal migration. In these years, the use of a single date to assign juvenile life history types was likely producing an estimate of parr abundance that was too low. To accommodate for this issue, the 2008-2010 sub yearling Chinook data were allotted to fry or parr migrant life histories based on the relative proportion of migrants above and below a given size threshold (45-mm FL) in a given week (Topping et al. 2009 and this report). This size threshold was selected to be representative of recently emerged Chinook that had not reared in freshwater (Pflug and Mobrand 1989). In order to compare fry (and parr) migrants among years, we also applied the size-based approach to the 2000 to 2007 data (Table 10). The percent of fry and parr migrants estimated with the two approaches were correlated but that the size-base approach consistently estimated a lower proportion of fry migrants (conversely higher percentage of parr migrants, Figure 19). This discrepancy can be explained by the range in dates prior to mid April during which sub yearling migrants were large enough to be considered parr. Most of these larger migrants were classified as "fry" under the previous analysis approach. The size-based approach is preferred because it allows the fry and parr migrants to overlap and better represent the outmigration patterns observed in the field.

The expression of the fry and parr migrant life history represents two different rearing strategies for sub yearling Chinook. Fry migrants emerge from the gravel and immediately move downstream. Although we assume that many of them move straight into Puget Sound, a portion may remain in the lower Green River to rear. Parr migrants emerge from the gravel and rear in freshwater for a 3-4 month duration prior to outmigration. Few studies have been conducted on the rearing habits of parr migrants. In the Skagit River, sub yearling Chinook parr were observed to rear in off channel habitats (Hayman et al. 1996); therefore channel complexity and the availability of off channel habitat may be a important to the expression of this life history.

If the expression of juvenile life histories was a density-dependent response to total juvenile abundance (Greene and Beechie 2004), one would expect that the ratio of fry to parr would increase as a function of the total numbers of juveniles. However, the ratio of fry to parr was not correlated with total migrant abundance in the Green River data set (Figure 20). Although the proportion of parr migrants has ranged between 8.1% and 90.0% (Table 10), the years with the highest proportion of parr (>50%) represented both the minimum (2006, 2010 migration years) and maximum (2001 migration year) abundance of juvenile migrants. This does not support the hypothesis that freshwater rearing habitat is being used to capacity by juvenile Chinook. This result contrasts with juvenile migrant Chinook in the Skagit basin where disproportionately more sub yearlings emigrate as fry in years when total juvenile abundance is higher (Zimmerman et al. In prep).

The fry and parr analysis presented in this report relied on several assumptions that remain to be validated. For example, although the fry to parr ratio was not correlated with juvenile migrants, there was a positive relationship between the fry to parr ratio and number of redds. The discrepancy between these analyses may result from different incubation survival among years and will be evaluated once the validation of current redd-based estimates has been completed. In addition, the equivalence of fry and parr migrants has not been quantified. Therefore, we will

assess the consequence of this uncertainty on our analysis and on any conclusions regarding freshwater rearing capacity for Chinook in the Green River.

TABLE 10.—Relative abundance of two life history strategies for sub yearling natural-origin Chinook in the Green River. Data are abundance of fry and parr migrants above the Green River trap site, brood year 1999 to 2009.

	Fry Migrants			Parr Migrants		
Trap Year	Migration Interval	Abundance	% of Migration	Migration Interval	Abundance	% of Migration
2000	1-1-4/29	266,481	56.1%	3/11-7/31	208,726	43.9%
2001	1/1-5/20	379,174	46.8%	3/8-7/31	430,442	53.2%
2002	1/1-5/23	357,602	61.2%	3/3-7/31	226,550	38.8%
2003	1/1-5/27	413,358	91.9%	2/16-7/13	36,598	8.1%
2004	1/1-4/29	136,144	57.5%	3/21-7/31	100,506	42.5%
2005	1/1-4/26	391,274	83.2%	2/20-7/31	79,061	16.8%
2006	1/1-5/1	29,946	30.0%	2/18-7/31	69,850	70.0%
2007	1/1-5/7	88,439	69.4%	3/21-7/31	39,053	30.6%
2008	1/1-6/8	251,815	62.8%	3/15-7/31	148,948	37.2%
2009	1/1-5/13	119,406	60.9%	2/6-7/31	76,709	39.1%
2010	1/1-4/20	5,559	10.0%	2/11-7/31	49,988	90.0%

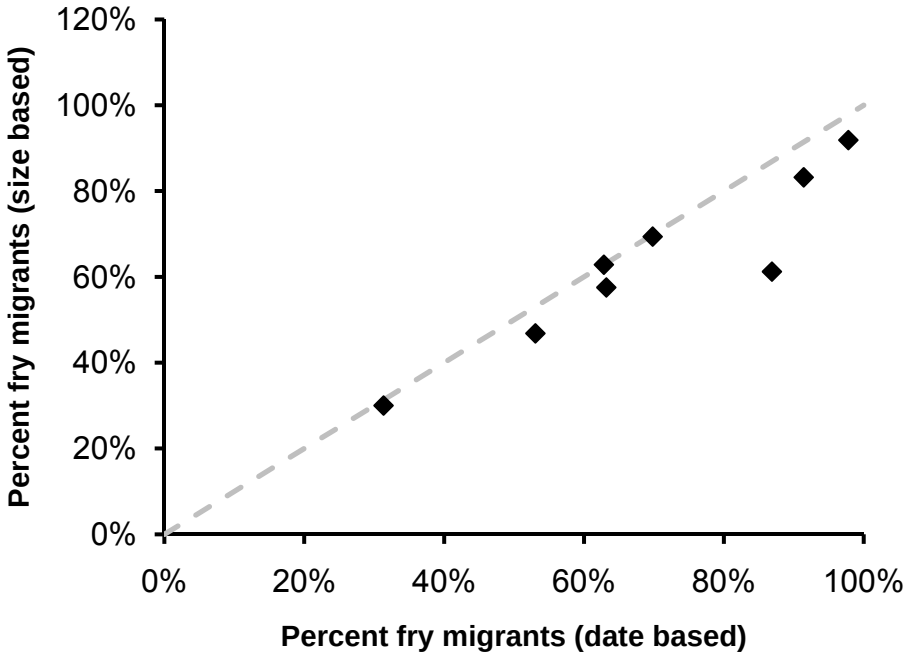

FIGURE 19.—Percent of sub yearling Chinook emigrating from the Green River at the fry life stage for the 2001 to 2008 trap years. Revised estimates assign fry and parr migrants based on a size threshold whereas the original estimates assigned fry and parr based on a date in mid April that partitioned the first and second migration peak.

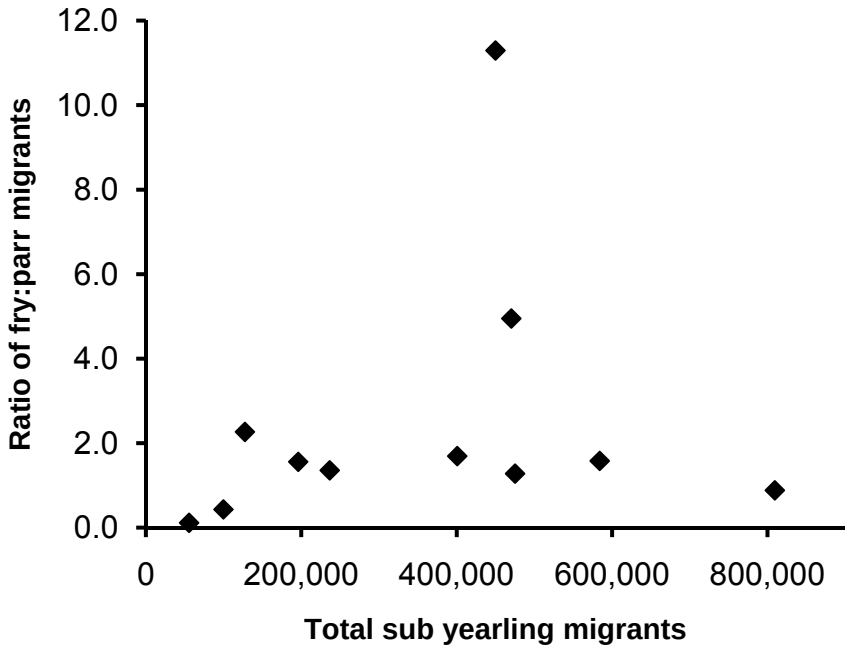

FIGURE 20. ─Percent of sub yearling Chinook that emigrate as parr (50-100 mm FL) from the Green River, migration year 2000-2010.

Pinks

In South Puget Sound, pink salmon populations from the Green River south to the Nisqually River have experienced rapid expansion from brood year 1999 to the present (Figure 21). Although WDFW does not directly estimate the abundance of pink spawners in the Green River, rough estimates have been made during surveys conducted for Chinook salmon. Based on these estimates, adult escapement has increased from 10,000 in 2001 to 2.9 million in 2009 (unpublished data, WDFW Region 4). Over this period, the number of juvenile migrant pinks increased 250-fold from an estimated 35,000 in the spring of 2000 to 9.3 million in 2008. Although the 2007 and 2009 returns of pink salmon increased from 800,000 to 2.9 million spawners, the juvenile migrants produced by these spawners were similar between years. Differences in egg-to-migrant survival were unlikely to explain this pattern as both the 2007 and 2009 broods experienced very favorable incubation flows under 4,000 cfs. This suggests that the Green River may have reached a freshwater capacity for pink salmon. Additional years of high pink returns will be necessary to evaluate the hypothesis that suitable spawning habitat above the trap site may limit freshwater production of juvenile migrants to 9 million fry.

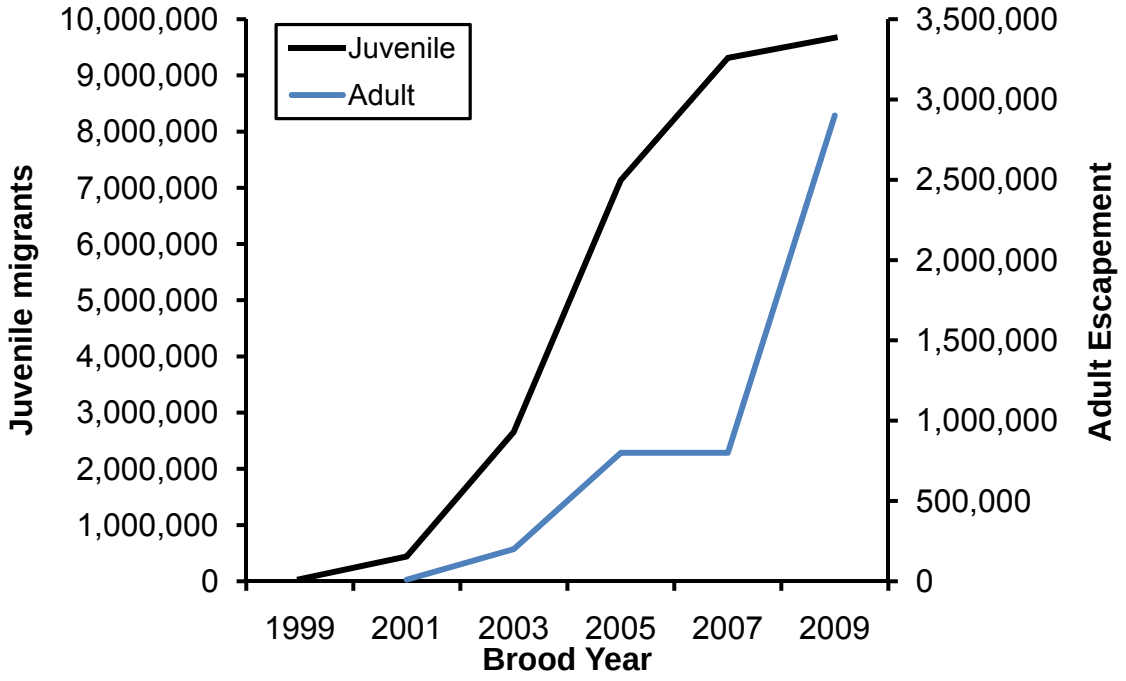

FIGURE 21.—Changes in the number of adult spawners (blue line) and resulting juvenile migrants (black line) of pink salmon on the Green River, migration year 2000-2010.

The rapid increase in Green River pink salmon may have both positive and negative effects on the other salmonid populations in the Green River. Positive effects of increases in pink spawning include gravel turning and nutrient inputs. The large biomass of pink spawners should result in turning of large areas of spawning habitat, cleaning the gravel of silt. In addition, the returning adults bring vast amounts of marine-derived nutrients back to the river to help support the entire ecosystem. Adult pink carcasses, eggs and fry all supply a direct food source to many of the fish species present in the Green River. For example, the number of steelhead smolts in 2010 was the highest observed since monitoring began in 2000. In addition, average body sizes of natural-origin steelhead (178.7-mm FL) and coho (115.9-mm FL) in 2010 were the longest estimated in the eleven years of monitoring. In the live box of the trap, we have observed predation on pink fry by coho smolts, steelhead parr and smolts, cutthroat of all age classes, yearling Chinook, and sculpin. The importance of the pink fry as a food source for steelhead smolts was supported by the apparent movement of steelhead during the pink outmigration. On the peak of the pink outmigration (April 21), catch of steelhead was 192 smolts, a 190 fish increase from the previous nights' catch. This peak catch occurred almost a month prior to the peak of the steelhead migration and is most likely the result of steelhead distributing in a downstream direction in order to feed on pink fry during their outmigration.

The rapid increase of pink salmon may also have negative impacts on Chinook salmon. Although the body size differences between Chinook and pink salmon may allow Chinook to outcompete pinks in one-on-one encounters, the total population biomass differences between Chinook and pinks have the potential to push the competitive advantage towards pink salmon. The large numbers of pink spawners are likely to compete with Chinook for spawning habitat

leading to potential superimposition of Chinook redds. Furthermore, juvenile pink salmon are known to be dominant competitors in near shore habitats (Ruggerone and Goetz 2004). Large increases in pink salmon entering Puget Sound from the Green River and elsewhere may have a negative impact on near-shore survival of other outmigrating salmonids, including Chinook and steelhead.

Yearling Migrants

The abundance of coho smolts rearing above the Green River trap has been estimated for 8 of the 11 years of this study. In the first two years of the study (2000 and 2001), coho estimates were based on just one or two trap efficiency tests with hatchery fish and no associated variance was calculated. No estimates were generated for trapping years 2004 and 2005 because a large percentage of the coho released from the Keta Creek Hatchery (above our trap site) were unmarked, making positive identification of the natural-origin coho smolts impossible. In trapping year 2008, an abundance estimate was not made because recapture rates were so low that no reliable coho efficiency data were available.

The abundance of steelhead smolts rearing above the Green River trap has been estimated for 7 of the 11 years of this study. Prior to 2009, all the abundance estimates were based on a steelhead:coho capture ratio applied to the coho efficiency data. The steelhead:coho capture ratio used was 75% for trap years 2001 to 2003 and 60% for trap years 2006 to 2008. No variance or confidence intervals were developed for those estimates. In 2009 and 2010, catch rates of steelhead improved at the trapping location and abundance estimates were derived directly from release and recaptures of natural-origin steelhead. Variance and confidence intervals were developed for the 2009 and 2010 estimates (Table 11).

TABLE 11.—Abundance estimates, 95% confidence intervals, and coefficient of variation (CV) for natural-origin coho and steelhead smolts rearing above the Green River juvenile trap, migration years 2000-2010.

Trap Year	Coho				Steelhead			
	Abundance	95% C.I.		C.V.	Abundance	95% C.I.		C.V.
		Lower	Upper			Lower	Upper	
2000	32,769							
2001	55,113				14,529			
2002	194,393	129,500	259,286	17.0%	53,077			
2003	207,442	67,404	347,480	34.4%	12,612			
2004								
2005								
2006	31,460	21,143	41,777	16.7%	16,748			
2007	22,671	14,735	30,607	17.9%	2,285			
2008								
2009	81,079	56,522	105,636	11.9%	26,174	10,151	42,198	19.4%
2010	43,763	32,663	54,864	12.9%	71,710	49,317	94,103	15.9%

Estimating the abundance of yearling migrants (i.e., coho and steelhead) has proven to be more challenging than for sub yearling fish. Several factors have contributed to these problems. The greatest problem is trap avoidance by these larger stronger swimming migrants. Slow water

velocity at the trap location has minimized the recapture rates of marked coho and steelhead smolts used in the efficiency trials. The degree to which water velocity has been a problem has varied by year depending on the channel configuration above the trap. The best years of study have been 2009 and 2010; however, size selectivity in the capture rates was evident in these years (Figure 15 and 16).

A second challenge associated with estimating abundance for steelhead and coho smolts is the releases of hatchery fish above the trap. The release timing of the hatchery fish typically coincide with the peak migration period for the natural-origin smolts of the same species. As a result, missed catch estimated during this period is high as is the corresponding uncertainty (variance) of this catch. Hatchery yearling smolts (Chinook, coho, and steelhead) have a tendency to migrate downstream in large groups resulting in large catches that can overwhelm the live box of the juvenile trap. In order to accommodate for these catches, the trap is either completely lifted from the water or is operated intermittently during the hatchery migration. In addition, the catch of natural-origin smolts increases during the hatchery fish migration, presumably because the natural-origin fish are following the hatchery fish out of the system. This results in high numbers of missed catch of coho and steelhead estimated during the outage period. In 2009, 27% of the coho and 33% of the steelhead catch were estimated missed catch during outages. Over 90 percent of this estimated missed catch for both species occurred during the outages corresponding to hatchery fish releases.

Summary

In summary, the number of juvenile migrant Chinook in 2009 and 2010 were among the lowest observed in 11 years of study. Declines in sub yearling Chinook in these years are most likely due to low spawner abundances. In comparison, juvenile pink and steelhead abundances in these years were among the highest observed during the course of study. Coho and steelhead fork lengths were also among the longest observed since 2000. The increase in pink salmon returns to the Green River provides a natural experiment with effects that will continue to be evaluated. Pink salmon provide added nutrients for yearlings rearing in freshwater, but they also are known to be dominant competitors in the early marine environment (Ruggerone and Nielsen 2004, Malick et al. 2009). Abundance of pink fry has increased in response to increased spawner abundances, and additional years of high pink returns will help to evaluate the hypothesis that nine million fry may be close to the capacity for the Green River watershed.

Appendix A

Variance of total unmarked smolt numbers, when the number of unmarked juvenile out-migrants, is estimated.

Author: Kristen Ryding, WDFW Biometrician

APPENDIX A.—Variance of total unmarked smolt numbers, when the number of unmarked juvenile out-migrants, is estimated.

The estimator for $\hat{U}_i$ is,

$$\hat{U}_i = \frac{\hat{u}_i\left(M_i+1\right)}{\left(m_i+1\right)}$$

the estimated variance of $\hat{U}_i$, $Var\left(U_i\right)$ is as follows,

$$Var\left(\hat{U}_i\right) = Var\left(\hat{u}_i\right)\left(\frac{\left(M_i+1\right)\left(M_i m_i+3M_i+2\right)}{\left(m_i+1\right)^2\left(m_i+2\right)}\right)+Var\left(\hat{U}_i\middle|E\left(\hat{u}\right)\right)$$

$$\text{where } Var\left(\hat{U}_i\middle|E\left(\hat{u}\right)\right) = \frac{\left(M_i+1\right)\left(M_i-m_i\right)E\left(\hat{u}_i\right)\left(E\left(\hat{u}_i\right)+m_i+1\right)}{\left(m_i+1\right)^2\left(m_i+2\right)},$$

$E\left(\hat{u}_i\right)$ = the expected value of $\hat{u}_i$ either in terms of the estimator (equation for $\hat{u}_i$) or just substitute in the estimated value and, $Var\left(\hat{u}_i\right)$ depends on the sampling method used to estimate $\hat{u}_i$.

Derivation:

Ignoring the subscript i for simplicity, the derivation of the variance estimator is based on the following unconditional variance expression,

$$Var\left(\hat{U}\right) = Var\left(E\left(\hat{U}\middle|u\right)\right)+E\left(Var\left(\hat{U}\middle|u\right)\right).$$

The expected value and variance $\hat{U}$ given u is as before, respectively,

$$E\left(\hat{U}_i\middle|u\right) = \frac{u_i\left(M_i+1\right)}{\left(m_i+1\right)} \text{ and,}$$

$$Var\left(\hat{U}\middle|u\right) = \frac{u\left(u+m+1\right)\left(M+1\right)\left(M-m\right)}{\left(m+1\right)^2\left(m+2\right)}.$$

Substituting in $\hat{u}$ for u gives the following,

$$Var\left(\hat{U}\right) = Var\left(\frac{\hat{u}\left(M+1\right)}{\left(m+1\right)}\right)+E\left[\frac{\left(M+1\right)\left(M-m\right)\hat{u}\left(\hat{u}+m+1\right)}{\left(m+1\right)^2\left(m+2\right)}\right]$$

$$Var\left(\hat{U}\right) = \left(\frac{\left(M+1\right)}{\left(m+1\right)}\right)^2 Var\left(\hat{u}\right)+\frac{\left(M+1\right)\left(M-m\right)}{\left(m+1\right)^2\left(m+2\right)}\left[E\left(\hat{u}^2\right)+E\left(\hat{u}\right)\left(m+1\right)\right]$$

Note that,

$$E\left(\hat{u}^2\right) = Var\left(\hat{u}\right)+\left(E\hat{u}\right)^2$$

Substituting in this value for $E\left(\hat{u}^2\right)$,

$$Var\left(\hat{U}\right)=\left(\frac{\left(M+1\right)}{\left(m+1\right)}\right)^2 Var\left(\hat{u}\right)+\frac{\left(M+1\right)\left(M-m\right)}{\left(m+1\right)^2\left(m+2\right)}\left[Var\left(\hat{u}\right)+\left(E\left(\hat{u}\right)\right)^2+E\left(\hat{u}\right)\left(m+1\right)\right]$$

$$=\left(\frac{\left(M+1\right)}{\left(m+1\right)}\right)^2 Var\left(\hat{u}\right)+\frac{\left(M+1\right)\left(M-m\right)}{\left(m+1\right)^2\left(m+2\right)}\left[Var\left(\hat{u}\right)+E\left(\hat{u}\right)\left[E\left(\hat{u}\right)+m+1\right]\right]$$

$$Var\left(\hat{U}\right)=\left(\frac{\left(M+1\right)}{\left(m+1\right)}\right)^2 Var\left(\hat{u}\right)+\frac{\left(M+1\right)\left(M-m\right)}{\left(m+1\right)^2\left(m+2\right)}Var\left(\hat{u}\right)+\frac{\left(M+1\right)\left(M-m\right)E\left(\hat{u}\right)\left[E\left(\hat{u}\right)+m+1\right]}{\left(m+1\right)^2\left(m+2\right)}$$

$$Var\left(\hat{U}\right)=Var\left(\hat{u}\right)\left(\frac{\left(M+1\right)^2}{\left(m+1\right)^2}+\frac{\left(M+1\right)\left(M-m\right)}{\left(m+1\right)^2\left(m+2\right)}\right)+\frac{\left(M+1\right)\left(M-m\right)E\left(\hat{u}\right)\left[E\left(\hat{u}\right)+m+1\right]}{\left(m+1\right)^2\left(m+2\right)}$$

$$Var\left(\hat{U}\right)=Var\left(\hat{u}\right)\left(\frac{\left(M+1\right)^2}{\left(m+1\right)^2}+\frac{\left(M+1\right)\left(M-m\right)}{\left(m+1\right)^2\left(m+2\right)}\right)+Var\left(\hat{U}\left|E\left(\hat{u}\right)\right.\right)$$

$$Var\left(\hat{U}\right)=\frac{\left(M+1\right)}{\left(m+1\right)^2}Var\left(\hat{u}\right)\left(\frac{\left(M+1\right)\left(m+2\right)}{\left(m+2\right)}+\frac{\left(M-m\right)}{\left(m+2\right)}\right)+Var\left(\hat{U}\left|E\left(\hat{u}\right)\right.\right)$$

$$Var\left(\hat{U}\right)=\frac{\left(M+1\right)}{\left(m+1\right)^2}Var\left(\hat{u}\right)\left(\frac{Mm+2M+m+2+M-m}{\left(m+2\right)}\right)+Var\left(\hat{U}\left|E\left(\hat{u}\right)\right.\right)$$

$$Var\left(\hat{U}\right)=Var\left(\hat{u}\right)\left(\frac{\left(M+1\right)\left(Mm+3M+2\right)}{\left(m+1\right)^2\left(m+2\right)}\right)+Var\left(\hat{U}\left|E\left(\hat{u}\right)\right.\right)$$

Appendix B

Daily catch and migration estimate for natural-origin, sub yearling Chinook in the Green River, 2009.

APPENDIX B. ─Actual and estimated daily catches and migration for natural-origin sub-yearling Chinook migrants in the Green River, 2009. Migration estimate is based on daily catch adjusted by the trap efficiency for each pooled time stratum.

Date	Time Fished Hours		Unmarked Chinook Catch			Migration
	In	Out	Actual	Estimated	Total	
1/1-1/26	Pre-Trapping					3,675
1/27/09	16.50	0.00	7	0	7	58
1/28/09	24.00	0.00	27	0	27	225
1/29/09	24.00	0.00	50	0	50	417
1/30/09	24.00	0.00	30	0	30	250
1/31/09	24.00	0.00	49	0	49	409
2/1/09	24.00	0.00	52	0	52	434
2/2/09	24.00	0.00	83	0	83	693
2/3/09	24.00	0.00	95	0	95	793
2/4/09	24.00	0.00	88	0	88	735
2/5/09	24.00	0.00	132	0	132	1,102
2/6/09	24.00	0.00	141	0	141	1,177
2/7/09	24.00	0.00	179	0	179	1,495
2/8/09	24.00	0.00	103	0	103	673
2/9/09	24.00	0.00	81	0	81	529
2/10/09	24.00	0.00	82	0	82	536
2/11/09	24.00	0.00	104	0	104	680
2/12/09	24.00	0.00	59	0	59	385
2/13/09	24.00	0.00	32	0	32	209
2/14/09	24.00	0.00	64	0	64	418
2/15/09	24.00	0.00	78	0	78	510
2/16/09	24.00	0.00	74	0	74	483
2/17/09	24.00	0.00	90	0	90	588
2/18/09	24.00	0.00	86	0	86	562
2/19/09	24.00	0.00	149	0	149	974
2/20/09	24.00	0.00	97	0	97	634
2/21/09	24.00	0.00	46	0	46	301
2/22/09	24.00	0.00	82	0	82	536
2/23/09	24.00	0.00	215	0	215	1,405
2/24/09	24.50	0.00	532	0	532	3,476
2/25/09	23.50	0.00	396	0	396	2,587
2/26/09	24.00	0.00	247	0	247	1,614
2/27/09	24.00	0.00	276	0	276	1,803
2/28/09	24.00	0.00	165	0	165	1,078
3/1/09	23.50	0.00	192	0	192	1,254
3/2/09	24.00	0.00	297	0	297	1,941
3/3/09	24.00	0.00	145	0	145	947
3/4/09	24.00	0.00	193	0	193	1,261
3/5/09	24.00	0.00	396	0	396	2,587
3/6/09	24.00	0.00	443	0	443	2,894
3/7/09	24.00	0.00	243	0	243	1,588
3/8/09	24.00	0.00	276	0	276	1,803
3/9/09	24.50	0.00	256	0	256	1,673

Table continued next page

APPENDIX B.–continued.

Date	Time Fished Hours		Unmarked Chinook Catch			Migration
	In	Out	Actual	Estimated	Total	
3/10/09	24.00	0.00	410	0	410	2,679
3/11/09	24.00	0.00	280	0	280	1,829
3/12/09	24.00	0.00	207	0	207	1,352
3/13/09	24.00	0.00	160	0	160	1,045
3/14/09	24.00	0.00	644	0	644	4,208
3/15/09	24.00	0.00	823	0	823	6,708
3/16/09	24.00	0.00	398	0	398	3,244
3/17/09	24.00	0.00	193	0	193	1,573
3/18/09	24.00	0.00	120	0	120	978
3/19/09	24.00	0.00	163	0	163	1,329
3/20/09	24.00	0.00	246	0	246	2,005
3/21/09	24.00	0.00	98	0	98	799
3/22/09	24.00	0.00	158	0	158	2,028
3/23/09	24.00	0.00	103	0	103	1,322
3/24/09	24.00	0.00	261	0	261	3,350
3/25/09	11.00	14.50	33	92	125	1,604
3/26/09	22.50	0.00	87	0	87	1,117
3/27/09	23.50	0.00	68	0	68	873
3/28/09	24.00	0.00	129	0	129	1,656
3/29/09	24.00	0.00	48	26	74	950
3/30/09	12.00	12.00	63	26	89	2,860
3/31/09	12.00	12.00	106	0	106	3,407
4/1/09	24.00	0.00	152	0	152	4,885
4/2/09	22.50	0.00	140	34	174	5,592
4/3/09	12.00	13.50	100	0	100	3,214
4/4/09	24.00	0.00	61	0	61	1,960
4/5/09	24.00	0.00	106	0	106	3,407
4/6/09	24.00	0.00	126	0	126	4,050
4/7/09	21.50	0.00	4	13	17	546
4/8/09	0.00	26.50	0	79	79	2,539
4/9/09	11.50	12.00	33	0	33	1,061
4/10/09	24.50	0.00	34	0	34	1,093
4/11/09	24.00	0.00	41	0	41	1,318
4/12/09	24.00	0.00	62	13	75	2,410
4/13/09	2.00	22.00	0	57	57	1,832
4/14/09	12.00	12.00	41	0	41	1,318
4/15/09	24.00	0.00	24	0	24	771
4/16/09	24.00	0.00	24	0	24	771
4/17/09	12.00	12.00	0	29	29	932
4/18/09	11.00	12.50	33	0	33	1,061
4/19/09	24.00	0.00	29	0	29	932
4/20/09	24.00	0.00	29	9	38	1,221
4/21/09	0.00	24.00	0	34	34	1,093
4/22/09	10.50	13.50	24	0	24	771

Table continued next page

APPENDIX B.–continued.

Date	Time Fished Hours		Unmarked Chinook Catch			Migration
	In	Out	Actual	Estimated	Total	
4/23/09	24.00	0.00	60	0	60	1,928
4/24/09	24.00	0.00	27	0	27	868
4/25/09	24.00	0.00	30	0	30	964
4/26/09	24.00	0.00	19	0	19	611
4/27/09	24.00	0.00	29	0	29	932
4/28/09	24.00	0.00	15	0	15	482
4/29/09	24.00	0.00	49	0	49	1,575
4/30/09	24.00	0.00	42	11	53	1,703
5/1/09	15.23	8.77	4	17	21	675
5/2/09	1.73	22.27	1	19	20	643
5/3/09	1.73	22.27	6	7	13	418
5/4/09	13.50	10.50	9	20	29	932
5/5/09	15.48	12.52	81	45	126	4,050
5/6/09	11.52	7.98	4	12	16	514
5/7/09	10.00	14.00	11	0	11	354
5/8/09	24.00	0.00	10	0	10	321
5/9/09	24.00	0.00	12	0	12	386
5/10/09	24.00	0.00	21	0	21	675
5/11/09	24.00	0.00	13	0	13	418
5/12/09	24.00	0.00	15	0	15	482
5/13/09	24.00	0.00	12	0	12	386
5/14/09	24.00	0.00	21	0	21	675
5/15/09	24.00	0.00	19	0	19	611
5/16/09	24.00	0.00	12	0	12	386
5/17/09	24.00	0.00	9	0	9	289
5/18/09	24.00	0.00	7	2	9	289
5/19/09	10.00	14.00	6	8	14	450
5/20/09	24.00	0.00	28	0	28	367
5/21/09	24.00	0.00	45	0	45	589
5/22/09	24.00	0.00	71	0	71	930
5/23/09	24.00	0.00	72	0	72	943
5/24/09	24.00	0.00	113	0	113	1,480
5/25/09	24.00	0.00	69	0	69	904
5/26/09	24.00	0.00	90	0	90	1,179
5/27/09	24.00	0.00	92	0	92	1,205
5/28/09	24.00	0.00	57	0	57	747
5/29/09	24.00	0.00	89	0	89	1,166
5/30/09	24.00	0.00	67	0	67	878
5/31/09	24.00	0.00	85	0	85	274
6/1/09	24.00	0.00	58	0	58	187
6/2/09	24.00	0.00	149	0	149	480
6/3/09	24.00	0.00	45	17	62	200
6/4/09	16.50	7.50	56	15	71	229

Table continued next page

APPENDIX B.–continued.

Date	Time Fished Hours		Unmarked Chinook Catch			Migration
	In	Out	Actual	Estimated	Total	
6/5/09	9.50	14.50	85	0	85	274
6/6/09	24.00	0.00	176	0	176	567
6/7/09	24.00	0.00	58	0	58	464
6/8/09	24.00	0.00	27	0	27	216
6/9/09	24.00	0.00	12	0	12	96
6/10/09	24.00	0.00	32	0	32	256
6/11/09	24.00	0.00	34	0	34	272
6/12/09	24.00	0.00	77	8	85	679
6/13/09	9.50	14.50	301	8	309	2,470
6/14/09	9.50	14.50	439	0	439	3,509
6/15/09	24.00	0.00	233	0	233	1,862
6/16/09	24.00	0.00	157	0	157	1,255
6/17/09	24.00	0.00	213	0	213	1,702
6/18/09	26.00	0.00	127	0	127	1,015
6/19/09	25.50	0.00	84	0	84	671
6/20/09	22.50	0.00	147	0	147	1,175
6/21/09	24.50	0.00	163	0	163	2,582
6/22/09	21.50	0.00	87	0	87	1,378
6/23/09	24.00	0.00	53	0	53	840
6/24/09	24.00	0.00	20	0	20	317
6/25/09	26.50	0.00	57	1	58	919
6/26/09	12.00	12.00	27	1	28	444
6/27/09	11.50	12.00	10	1	11	174
6/28/09	11.00	13.00	21	1	22	348
6/29/09	11.25	12.75	6	1	7	111
6/30/09	11.12	12.75	11	0	11	174
7/1/09	24.63	0.00	6	0	6	95
7/2/09	13.00	11.50	25	0	25	396
7/3/09	24.00	0.00	6	1	7	111
7/4/09	11.00	11.00	6	1	7	111
7/5/09	12.25	13.75	6	1	7	111
7/6/09	11.25	12.00	12	0	12	190
7/7/09	23.92	0.00	11	1	12	190
7/8/09	13.50	11.33	10	0	10	158
7/9/09	23.50	0.00	3	0	3	48
7/10/09	11.75	12.25	0	0	0	0
7/11/09	9.75	14.25	1	0	1	16
7/12/09	11.50	12.00	1	0	1	16
7/13/09	11.42	12.50	0	0	0	0
7/14/09	24.33	0.00	0	0	0	0
7/15-7/31	Post-Trapping				51	
Total	3,526.37	522.89	16,767	610	17,377	196,118

Appendix C

Fork length of natural-origin, sub yearling Chinook in the Green River, 2009

APPENDIX C.─Mean fork length (mm), standard deviation (St.Dev.) range, and sample size of natural-origin 0+ Chinook caught in the Green River screw trap in 2009.

Statistical Week			Average	St.Dev.	Range		Number		Percent
Number	Begin	End			Min	Max	Sampled	Caught	Sampled
5	01/26/09	02/01/09	40.2	1.54	36	44	45	195	23.08%
6	02/02/09	02/08/09	39.9	2.09	35	46	49	830	5.90%
7	02/09/09	02/15/09	40.4	1.94	36	46	37	499	7.41%
8	02/16/09	02/22/09	41.0	2.10	38	48	44	606	7.26%
9	02/23/09	03/01/09	41.4	2.14	37	51	94	1,981	4.75%
10	03/02/09	03/08/09	42.6	3.13	38	53	133	1,943	6.85%
11	03/09/09	03/15/09	42.4	3.51	36	53	140	2,806	4.99%
12	03/16/09	03/22/09	41.9	3.27	35	53	105	1,435	7.32%
13	03/23/09	03/29/09	43.3	4.56	38	62	83	766	10.84%
14	03/30/09	04/05/09	42.0	2.12	39	49	33	685	4.82%
15	04/06/09	04/12/09	44.2	3.85	38	53	27	336	8.04%
16	04/13/09	04/19/09	45.0	5.03	38	56	31	144	21.53%
17	04/20/09	04/26/09	47.1	6.60	38	62	42	193	21.76%
18	04/27/09	05/03/09	55.4	13.55	41	85	28	153	18.30%
19	05/04/09	05/10/09	61.4	11.34	42	81	33	134	24.63%
20	05/11/09	05/17/09	59.1	9.05	43	83	47	117	40.17%
21	05/18/09	05/24/09	64.4	8.74	52	84	56	304	18.42%
22	05/25/09	05/31/09	69.0	9.06	51	91	87	563	15.45%
23	06/01/09	06/07/09	71.8	8.19	56	91	47	637	7.38%
24	06/08/09	06/14/09	76.0	11.13	55	103	51	922	5.53%
25	06/15/09	06/21/09	78.9	8.99	55	101	105	1,138	9.23%
26	06/22/09	06/28/09	84.9	7.87	69	106	68	276	24.64%
27	06/29/09	07/05/09	86.6	7.77	69	99	42	66	63.64%
28	07/06/09	07/12/09	85.6	10.61	62	103	19	38	50.00%
Season Total			54.7	17.49	35	106	1,446	16,767	8.62%

Appendix D

Daily catch of coho, and chum salmon and steelhead and cutthroat trout in the Green River, 2009

APPENDIX D.–Daily catches of coho and chum salmon and steelhead and cutthroat trout caught in the Green River screw trap in 2009. Catch represents actual and estimated catch for a given day. Time in and out reflect time fished (in) and not fished (out) on a given day.

Date	Hours Fished		Coho Smolts		Chum Fry	Steelhead Smolts		Cutthroat Smolt	Cutthroat Adult	Trout Parr
	In	Out	Nat	Hat	Total	Nat	Hat	Nat	Nat	Nat
1/27/09	16.50	0.00	4	8	0	6	1	0	0	2
1/28/09	24.00	0.00	3	3	0	1	2	0	0	2
1/29/09	24.00	0.00	10	7	0	1	0	2	0	11
1/30/09	24.00	0.00	8	5	0	1	0	0	0	3
1/31/09	24.00	0.00	9	1	0	2	0	0	0	4
2/1/09	24.00	0.00	8	7	0	4	1	0	0	8
2/2/09	24.00	0.00	4	3	0	3	0	0	0	4
2/3/09	24.00	0.00	6	3	0	1	0	1	0	5
2/4/09	24.00	0.00	11	10	0	0	0	0	0	6
2/5/09	24.00	0.00	8	2	0	0	0	1	0	7
2/6/09	24.00	0.00	6	0	0	0	0	0	0	2
2/7/09	24.00	0.00	1	0	0	0	0	0	0	1
2/8/09	24.00	0.00	4	2	0	0	0	0	0	3
2/9/09	24.00	0.00	7	0	2	1	0	0	0	6
2/10/09	24.00	0.00	8	0	6	0	0	0	0	5
2/11/09	24.00	0.00	2	6	11	0	0	0	0	4
2/12/09	24.00	0.00	6	7	2	0	0	0	0	9
2/13/09	24.00	0.00	2	3	4	0	0	0	0	0
2/14/09	24.00	0.00	0	1	2	0	0	0	0	0
2/15/09	24.00	0.00	3	2	2	0	0	0	0	0
2/16/09	24.00	0.00	7	1	1	0	0	0	0	1
2/17/09	24.00	0.00	7	2	1	0	0	0	0	5
2/18/09	24.00	0.00	4	2	1	0	1	0	0	1
2/19/09	24.00	0.00	4	0	3	0	0	0	0	1
2/20/09	24.00	0.00	4	1	0	0	0	1	0	0
2/21/09	24.00	0.00	5	1	0	0	0	1	0	6
2/22/09	24.00	0.00	4	1	0	0	0	0	0	3
2/23/09	24.00	0.00	0	0	0	0	0	0	0	2
2/24/09	24.50	0.00	2	1	10	0	0	1	0	1
2/25/09	23.50	0.00	8	1	8	0	0	0	0	2
2/26/09	24.00	0.00	9	2	5	0	0	0	0	1
2/27/09	24.00	0.00	1	1	7	0	0	0	0	1
2/28/09	24.00	0.00	7	0	0	0	0	0	0	1
3/1/09	23.50	0.00	4	1	3	0	0	0	0	0
3/2/09	24.00	0.00	1	1	7	0	0	0	0	0
3/3/09	24.00	0.00	3	0	2	0	0	0	0	1
3/4/09	24.00	0.00	1	0	2	0	0	0	0	1
3/5/09	24.00	0.00	0	0	10	0	0	0	0	0
3/6/09	24.00	0.00	6	0	20	0	0	0	0	3
3/7/09	24.00	0.00	3	1	7	0	0	0	0	3
3/8/09	24.00	0.00	4	3	7	0	0	0	0	0
3/9/09	24.50	0.00	12	0	8	0	0	0	0	4

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APPENDIX D.–continued.

Date	Hours Fished		Coho Smolts		Chum Fry	Steelhead Smolts		Cutthroat Smolt	Cutthroat Adult	Trout Parr
	In	Out	Nat	Hat	Total	Nat	Hat	Nat	Nat	Nat
3/10/09	24.00	0.00	6	3	7378	0	0	0	0	4
3/11/09	24.00	0.00	8	0	4518	0	0	1	0	1
3/12/09	24.00	0.00	15	1	1523	0	0	0	0	0
3/13/09	24.00	0.00	6	1	159	0	0	0	0	0
3/14/09	24.00	0.00	2	0	156	1	0	0	0	1
3/15/09	24.00	0.00	3	0	5212	1	0	1	0	1
3/16/09	24.00	0.00	1	0	4396	0	0	0	0	1
3/17/09	24.00	0.00	3	0	2886	0	0	0	0	2
3/18/09	24.00	0.00	2	0	1898	0	0	0	0	4
3/19/09	24.00	0.00	3	18	1044	0	0	0	0	0
3/20/09	24.00	0.00	0	11	781	0	0	0	0	4
3/21/09	24.00	0.00	2	10	172	0	0	0	0	2
3/22/09	24.00	0.00	2	4	335	0	1	0	0	0
3/23/09	24.00	0.00	2	7	159	0	0	0	0	1
3/24/09	24.00	0.00	3	10	7023	0	0	0	0	2
3/25/09	11.00	14.50	4	10	5044	1	0	0	0	3
3/26/09	22.50	0.00	5	5	362	1	0	0	0	3
3/27/09	23.50	0.00	5	6	223	1	0	1	0	3
3/28/09	24.00	0.00	0	0	556	0	0	0	0	1
3/29/09	24.00	0.00	3	6	469	1	0	0	0	1
3/30/09	12.00	12.00	2	5	272	0	0	0	0	0
3/31/09	12.00	12.00	2	4	629	0	0	0	0	2
4/1/09	24.00	0.00	2	39	4650	1	0	0	0	0
4/2/09	22.50	0.00	0	0	2429	1	0	0	0	1
4/3/09	12.00	13.50	2	0	724	2	0	0	0	1
4/4/09	24.00	0.00	2	5	581	0	1	0	0	2
4/5/09	24.00	0.00	8	2	1070	0	0	0	0	7
4/6/09	24.00	0.00	24	36	1085	2	1	0	0	6
4/7/09	21.50	0.00	2	0	204	0	10	0	0	6
4/8/09	0.00	26.50	13	83	780	1	2	0	0	5
4/9/09	11.50	12.00	5	116	349	0	2	0	0	3
4/10/09	24.50	0.00	4	184	625	2	21	0	0	4
4/11/09	24.00	0.00	4	41	373	0	5	1	0	3
4/12/09	24.00	0.00	3	18	951	0	4	1	0	4
4/13/09	2.00	22.00	1	12	638	1	4	1	0	3
4/14/09	12.00	12.00	2	3	330	1	2	0	0	1
4/15/09	24.00	0.00	10	9	643	2	295	0	0	4
4/16/09	24.00	0.00	5	9	1834	1	57	0	0	3
4/17/09	12.00	12.00	10	11	2031	2	57	0	0	3
4/18/09	11.00	12.50	15	12	1218	2	54	0	0	2
4/19/09	24.00	0.00	7	2	318	2	68	0	0	4
4/20/09	24.00	0.00	8	1	144	1	16	0	0	2
4/21/09		24.00	4	1	165	1	11	0	0	1
4/22/09	10.50	13.50	0	0	195	0	6	0	0	0

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APPENDIX D.–continued.

Date	Hours Fished		Coho Smolts		Chum Fry	Steelhead Smolts		Cutthroat Smolt	Cutthroat Adult	Trout Parr
	In	Out	Nat	Hat	Total	Nat	Hat	Nat	Nat	Nat
4/23/09	24.00	0.00	0	2	142	0	12	0	0	1
4/24/09	24.00	0.00	1	1	132	5	31	0	0	1
4/25/09	24.00	0.00	5	3	166	2	64	0	0	2
4/26/09	24.00	0.00	23	6	71	1	79	0	0	6
4/27/09	24.00	0.00	31	9	305	1	47	0	0	3
4/28/09	24.00	0.00	37	5	3669	9	78	1	0	6
4/29/09	24.00	0.00	52	6	451	5	76	0	0	4
4/30/09	24.00	0.00	57	9	4883	6	69	0	0	12
5/1/09	15.23	8.77	78	21	3849	40	381	0	0	6
5/2/09	1.73	22.27	190	0	1845	70	1475	0	0	1
5/3/09	1.73	22.27	225	16	1355	48	732	0	0	1
5/4/09	13.50	10.50	191	10	717	38	718	0	0	0
5/5/09	15.48	12.52	153	3845	498	62	484	0	0	9
5/6/09	11.52	7.98	33	1558	194	20	100	0	0	6
5/7/09	10.00	14.00	71	490	136	3	41	0	0	1
5/8/09	24.00	0.00	118	436	85	5	410	0	0	0
5/9/09	24.00	0.00	97	207	136	10	263	1	0	1
5/10/09	24.00	0.00	128	164	100	9	192	2	0	2
5/11/09	24.00	0.00	84	56	125	21	173	1	0	0
5/12/09	24.00	0.00	64	71	1054	13	79	0	0	2
5/13/09	24.00	0.00	38	26	147	3	46	0	0	1
5/14/09	24.00	0.00	23	7	59	1	13	0	0	1
5/15/09	24.00	0.00	87	31	46	8	124	0	0	0
5/16/09	24.00	0.00	77	16	100	17	63	0	0	0
5/17/09	24.00	0.00	10	1	16	2	7	0	0	0
5/18/09	24.00	0.00	23	7	32	5	14	0	0	0
5/19/09	10.00	14.00	16	5	31	6	12	0	0	1
5/20/09	24.00	0.00	12	2	11	7	10	0	0	2
5/21/09	24.00	0.00	18	6	33	21	35	1	0	1
5/22/09	24.00	0.00	55	4	64	20	42	0	0	1
5/23/09	24.00	0.00	42	2	88	19	23	1	0	2
5/24/09	24.00	0.00	49	5	51	22	23	0	0	2
5/25/09	24.00	0.00	52	5	98	19	35	0	0	2
5/26/09	24.00	0.00	54	5	8	16	21	0	0	0
5/27/09	24.00	0.00	41	5	48	17	19	0	0	1
5/28/09	24.00	0.00	36	5	55	24	14	0	0	0
5/29/09	24.00	0.00	15	5	70	18	14	0	0	0
5/30/09	24.00	0.00	21	5	99	15	12	0	0	2
5/31/09	24.00	0.00	27	4	92	10	15	0	0	0
6/1/09	24.00	0.00	21	3	130	18	16	0	0	0
6/2/09	24.00	0.00	12	4	13	12	13	0	0	1
6/3/09	24.00	0.00	14	3	108	23	10	0	0	0
6/4/09	16.50	7.50	16	2	93	9	4	0	0	0

Table continued next page

APPENDIX D.–continued.

Date	Hours Fished		Coho Smolts		Chum Fry	Steelhead Smolts		Cutthroat Smolt	Cutthroat Adult	Trout Parr
	In	Out	Nat	Hat	Total	Nat	Hat	Nat	Nat	Nat
6/5/09	9.50	14.50	16	2	74	10	4	0	0	0
6/6/09	24.00	0.00	21	5	22	13	5	0	1	0
6/7/09	24.00	0.00	9	5	21	3	2	0	0	0
6/8/09	24.00	0.00	3	0	38	4	2	0	0	0
6/9/09	24.00	0.00	3	2	16	4	1	0	0	0
6/10/09	24.00	0.00	2	0	18	1	1	1	0	0
6/11/09	24.00	0.00	3	2	13	2	1	0	0	0
6/12/09	24.00	0.00	5	0	27	0	0	0	0	0
6/13/09	9.50	14.50	5	1	40	3	0	0	0	0
6/14/09	9.50	14.50	3	0	16	0	5	0	0	2
6/15/09	24.00	0.00	2	3	23	3	1	0	0	0
6/16/09	24.00	0.00	1	0	16	0	1	0	0	0
6/17/09	24.00	0.00	2	4	20	2	1	0	0	0
6/18/09	26.00	0.00	0	2	10	2	2	0	0	0
6/19/09	25.50	0.00	3	4	9	2	0	0	0	0
6/20/09	22.50	0.00	2	0	13	0	1	1	0	0
6/21/09	24.50	0.00	1	1	28	0	0	1	0	0
6/22/09	21.50	0.00	1	0	8	0	1	1	0	0
6/23/09	24.00	0.00	0	0	5	0	0	0	0	0
6/24/09	24.00	0.00	1	1	9	0	1	0	0	0
6/25/09	26.50	0.00	3	0	19	0	0	0	0	0
6/26/09	12.00	12.00	0	1	6	0	0	0	0	0
6/27/09	11.50	12.00	0	0	2	1	0	0	0	0
6/28/09	11.00	13.00	1	0	2	0	0	0	0	0
7/4/09	11.00	11.00	0	0	0	0	0	0	0	0
7/5/09	12.25	13.75	1	0	3	0	0	0	0	0
7/6/09	11.25	12.00	0	0	2	0	0	0	0	0
7/7/09	23.92	0.00	0	0	3	0	0	0	0	0
7/8/09	13.50	11.33	0	0	2	0	0	0	0	0
7/9/09	23.50	0.00	0	0	5	0	0	0	0	0
7/10/09	11.75	12.25	0	0	1	0	0	0	0	0
7/11/09	9.75	14.25	0	0	1	1	0	0	0	0
7/12/09	11.50	12.00	0	0	1	0	0	0	0	0
7/13/09	11.42	12.50	0	0	1	0	0	0	0	0
7/14/09	24.33	0.00	0	0	0	0	0	0	0	0
Total	3526.37	522.89	2,904	7,880	88,554	779	6,740	24	1	303

Appendix E

Fork lengths of natural-origin coho smolts in the Green River, 2009

APPENDIX E.─Mean fork length (mm), standard deviation (St.Dev.), range, and sample size of natural-origin coho smolts in the Green River in 2009.

Statistical Week			Average	St.Dev.	Range		Number
No	Begin	End			Min	Max	Sampled
5	01/26/09	02/01/09	100.1	11.1	78	120	25
6	02/02/09	02/08/09	96.7	10.0	67	120	43
7	02/09/09	02/15/09	99.6	9.1	87	120	27
8	02/16/09	02/22/09	97.7	9.6	84	115	31
9	02/23/09	03/01/09	97.7	9.2	84	121	29
10	03/02/09	03/08/09	94.9	8.5	77	108	17
11	03/09/09	03/15/09	95.2	7.4	79	110	53
12	03/16/09	03/22/09	89.6	12.4	65	109	13
13	03/23/09	03/29/09	99.6	7.1	85	114	17
14	03/30/09	04/05/09	100.0	10.3	85	112	9
15	04/06/09	04/12/09	96.1	13.2	61	141	37
16	04/13/09	04/19/09	99.2	8.1	85	114	29
17	04/20/09	04/26/09	106.2	10.9	85	124	18
18	04/27/09	05/03/09	109.5	8.9	87	125	71
19	05/04/09	05/10/09	107.2	7.9	95	122	41
20	05/11/09	05/17/09	107.5	8.4	85	125	73
21	05/18/09	05/24/09	107.9	9.9	91	131	36
22	05/25/09	05/31/09	107.6	8.8	87	127	61
23	06/01/09	06/07/09	111.4	8.4	91	136	52
24	06/08/09	06/14/09	107.3	10.0	90	123	12
25	06/15/09	06/21/09	108.0	12.8	90	138	13
26	06/22/09	06/28/09	97.4	5.8	91	110	9
27	06/29/09	07/05/09	100.0	4.6	96	104	4
28	07/06/09	07/12/09	----	----	----	----	0
29	07/13/09	07/19/09	----	----	----	----	0
		Season Total	103.0	10.9	61	141	720

Appendix F

Fork lengths of natural-origin steelhead smolts in the Green River, 2009

APPENDIX F.─Mean fork length (mm), standard deviation (St.Dev.), range, and sample size of natural-origin steelhead smolts in the Green River in 2009.

	Statistical Week		Average	St.	Range		Number
No	Begin	End		Dev.	Min	Max	Sampled
5	01/26/09	02/01/09	171.7	27.7	128	225	11
6	02/02/09	02/08/09	168.6	6.2	160	180	8
7	02/09/09	02/15/09	175.0	n/a	175	175	1
8	02/16/09	02/22/09	----	----	----	----	0
9	02/23/09	03/01/09	----	----	----	----	0
10	03/02/09	03/08/09	----	----	----	----	0
11	03/09/09	03/15/09	180.0	n/a	180	180	1
12	03/16/09	03/22/09	160.0	n/a	160	160	1
13	03/23/09	03/29/09	149.0	4.2	146	152	2
14	03/30/09	04/05/09	184.2	10.3	170	198	5
15	04/06/09	04/12/09	172.5	31.1	151	218	4
16	04/13/09	04/19/09	217.7	30.2	160	250	6
17	04/20/09	04/26/09	203.5	47.8	139	267	10
18	04/27/09	05/03/09	174.7	32.7	127	270	41
19	05/04/09	05/10/09	182.1	21.6	149	224	29
20	05/11/09	05/17/09	178.8	18.4	146	246	73
21	05/18/09	05/24/09	165.6	13.8	140	203	64
22	05/25/09	05/31/09	167.4	13.2	139	213	130
23	06/01/09	06/07/09	166.9	10.2	140	191	95
24	06/08/09	06/14/09	162.4	15.6	148	200	17
25	06/15/09	06/21/09	159.9	13.3	130	173	9
26	06/22/09	06/28/09	142.0	n/a	142	142	1
27	06/29/09	07/05/09	----	----	----	----	0
28	07/06/09	07/12/09	----	----	----	----	0
		Season Total	171.4	20.3	127	270	508

Appendix G

Daily catch and migration estimate for natural-origin, sub yearling Chinook in the Green River, 2010.

APPENDIX G.─Actual and estimated daily catches and migration for natural-origin sub-yearling Chinook migrants in the Green River, 2010. Migration estimate is based on daily catch adjusted by the trap efficiency for each pooled time stratum.

Date	Time Fished Hours		Unmarked Chinook Catch			Migration
	In	Out	Actual	Estimated	Total	
1/1-1/19	Pre-Trapping					11
1/20/10	27.00	0.00	0	0	0	0
1/21/10	25.00	0.00	1	0	1	6
1/22/10	24.00	0.00	0	0	0	0
1/23/10	24.00	0.00	0	0	0	0
1/24/10	24.00	0.00	0	0	0	0
1/25/10	24.00	0.00	0	0	0	0
1/26/10	24.00	0.00	0	0	0	0
1/27/10	24.00	0.00	0	0	0	0
1/28/10	24.00	0.00	0	0	0	0
1/29/10	24.00	0.00	1	0	1	6
1/30/10	24.00	0.00	1	0	1	6
1/31/10	24.00	0.00	2	0	2	12
2/1/10	11.50	12.50	0	0	0	0
2/2/10	24.00	0.00	0	0	0	0
2/3/10	24.00	0.00	3	0	3	18
2/4/10	24.00	0.00	2	0	2	12
2/5/10	24.00	0.00	2	0	2	12
2/6/10	24.00	0.00	3	0	3	18
2/7/10	24.00	0.00	5	0	5	29
2/8/10	24.00	0.00	7	0	7	41
2/9/10	24.00	0.00	16	0	16	93
2/10/10	24.00	0.00	11	0	11	64
2/11/10	24.00	0.00	1	0	1	6
2/12/10	24.00	0.00	2	0	2	12
2/13/10	24.00	0.00	10	0	10	58
2/14/10	24.50	0.00	10	0	10	58
2/15/10	24.00	0.00	14	0	14	82
2/16/10	24.00	0.00	37	0	37	216
2/17/10	24.00	0.00	32	0	32	187
2/18/10	24.00	0.00	11	0	11	64
2/19/10	24.00	0.00	9	0	9	53
2/20/10	24.00	0.00	19	0	19	111
2/21/10	24.00	0.00	15	0	15	88
2/22/10	24.00	0.00	21	0	21	123
2/23/10	24.00	0.00	16	0	16	93
2/24/10	24.00	0.00	7	0	7	41
2/25/10	24.00	0.00	5	0	5	29
2/26/10	24.00	0.00	0	0	0	0
2/27/10	24.00	0.00	4	0	4	23
2/28/10	24.00	0.00	10	0	10	58

Table continued next page

APPENDIX G.–continued.

Date	Time Fished Hours		Unmarked Chinook Catch			Migration
	In	Out	Actual	Estimated	Total	
3/1/10	24.00	0.00	2	0	2	12
3/2/10	24.00	0.00	2	0	2	12
3/3/10	24.00	0.00	18	0	18	105
3/4/10	24.00	0.00	21	0	21	123
3/5/10	24.50	0.00	18	0	18	105
3/6/10	24.00	0.00	6	0	6	35
3/7/10	24.00	0.00	8	0	8	47
3/8/10	24.00	0.00	9	0	9	53
3/9/10	24.00	0.00	27	0	27	158
3/10/10	24.00	0.00	3	0	3	18
3/11/10	24.00	0.00	6	0	6	35
3/12/10	24.00	0.00	13	0	13	76
3/13/10	24.00	0.00	17	0	17	99
3/14/10	25.00	0.00	23	0	23	134
3/15/10	24.00	0.00	2	0	2	12
3/16/10	24.00	0.00	11	0	11	64
3/17/10	24.00	0.00	50	0	50	440
3/18/10	24.00	0.00	50	0	50	440
3/19/10	24.00	0.00	10	0	10	88
3/20/10	24.00	0.00	13	0	13	114
3/21/10	24.00	0.00	7	0	7	62
3/22/10	24.00	0.00	51	0	51	448
3/23/10	24.00	0.00	17	0	17	149
3/24/10	25.00	0.00	17	0	17	149
3/25/10	24.00	0.00	6	0	6	53
3/26/10	24.00	0.00	14	0	14	123
3/27/10	24.00	0.00	21	0	21	185
3/28/10	24.00	0.00	1	0	1	9
3/29/10	24.00	0.00	21	0	21	185
3/30/10	24.00	0.00	139	0	139	1,222
3/31/10	24.00	0.00	12	0	12	106
4/1/10	24.00	0.00	14	0	14	123
4/2/10	24.00	0.00	6	0	6	53
4/3/10	24.00	0.00	17	0	17	149
4/4/10	24.00	0.00	17	0	17	149
4/5/10	24.00	0.00	11	0	11	60
4/6/10	24.00	0.00	6	0	6	33
4/7/10	24.00	0.00	5	0	5	27
4/8/10	24.00	0.00	21	0	21	114
4/9/10	24.00	0.00	6	0	6	33
4/10/10	24.00	0.00	11	0	11	60
4/11/10	24.00	0.00	20	0	20	109
4/12/10	24.00	0.00	0	0	0	0
4/13/10	24.00	0.00	1	0	1	5

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APPENDIX G.–continued.

Date	Time Fished Hours		Unmarked Chinook Catch			Migration
	In	Out	Actual	Estimated	Total	
4/14/10	24.00	0.00	1	0	1	5
4/15/10	18.00	0.00	6	0	6	33
4/16/10	30.00	0.00	2	0	2	11
4/17/10	24.00	0.00	0	0	0	0
4/18/10	24.00	0.00	1	0	1	5
4/19/10	24.00	0.00	1	0	1	5
4/20/10	24.00	0.00	7	0	7	38
4/21/10	24.00	0.00	47	0	47	256
4/22/10	24.00	0.00	44	0	44	239
4/23/10	24.00	0.00	5	0	5	27
4/24/10	24.00	0.00	8	0	8	44
4/25/10	24.00	0.00	20	0	20	109
4/26/10	24.00	0.00	0	0	0	0
4/27/10	24.00	0.00	7	0	7	38
4/28/10	24.00	0.00	5	0	5	27
4/29/10	24.00	0.00	22	0	22	120
4/30/10	24.00	0.00	4	0	4	22
5/1/10	24.00	0.00	4	0	4	22
5/2/10	23.25	0.75	7	0	7	64
5/3/10	10.50	13.50	9	13	22	200
5/4/10	0.00	24.00	0	29	29	264
5/5/10	24.00	0.00	44	0	44	401
5/6/10	24.00	0.00	40	0	40	364
5/7/10	24.00	0.00	12	0	12	109
5/8/10	24.00	0.00	10	0	10	91
5/9/10	24.00	0.00	8	0	8	73
5/10/10	24.00	0.00	2	0	2	18
5/11/10	24.00	0.00	19	0	19	173
5/12/10	24.00	0.00	25	0	25	228
5/13/10	14.75	9.25	8	6	14	127
5/14/10	14.00	10.00	17	37	54	492
5/15/10	24.00	0.00	74	0	74	674
5/16/10	24.00	0.00	15	0	15	137
5/17/10	24.00	0.00	29	0	29	104
5/18/10	24.00	0.00	9	0	9	32
5/19/10	24.00	0.00	227	0	227	816
5/20/10	24.00	0.00	46	0	46	165
5/21/10	24.00	0.00	37	0	37	133
5/22/10	24.00	0.00	35	0	35	126
5/23/10	24.00	0.00	28	0	28	101
5/24/10	24.00	0.00	30	0	30	108
5/25/10	10.00	14.00	5	0	5	18
5/26/10	24.00	0.00	5	0	5	18
5/27/10	24.00	0.00	16	0	16	58

Table continued next page

APPENDIX G.–continued

Date	Time Fished Hours		Unmarked Chinook Catch			Migration
	In	Out	Actual	Estimated	Total	
5/28/10	26.00	0.00	414	0	414	1,489
5/29/10	0.00	22.00	0	222	222	798
5/30/10	24.00	0.00	12	0	12	43
5/31/10	24.00	0.00	35	0	35	126
6/1/10	24.00	0.00	33	0	33	119
6/2/10	24.00	0.00	133	0	133	478
6/3/10	0.00	24.00	0	72	72	259
6/4/10	8.00	16.00	2	58	60	216
6/5/10	24.00	0.00	11	0	11	40
6/6/10	24.00	0.00	38	0	38	277
6/7/10	24.00	0.00	77	0	77	3,273
6/8/10	24.00	0.00	60	0	60	2,550
6/9/10	24.00	0.00	303	0	303	12,878
6/10/10	24.00	0.00	95	0	95	4,038
6/11/10	24.00	0.00	127	0	127	5,398
6/12/10	24.00	0.00	28	0	28	1,190
6/13/10	24.00	0.00	15	0	15	638
6/14/10	24.00	0.00	30	0	30	1,275
6/15/10	24.00	0.00	34	0	34	439
6/16/10	24.00	0.00	52	0	52	672
6/17/10	24.00	0.00	49	0	49	633
6/18/10	23.67	0.00	48	0	48	620
6/19/10	23.33	0.00	8	0	8	103
6/20/10	25.00	0.00	35	0	35	452
6/21/10	24.00	0.00	26	0	26	336
6/22/10	24.00	0.00	22	0	22	284
6/23/10	24.00	0.00	17	0	17	220
6/24/10	10.00	14.00	19	2	21	271
6/25/10	10.00	14.50	26	2	28	362
6/26/10	10.50	13.50	22	2	24	310
6/27/10	11.50	12.50	25	2	27	349
6/28/10	23.50	0.00	25	0	25	323
6/29/10	24.00	0.00	20	0	20	258
6/30/10	10.00	14.00	6	2	8	103
7/1/10	10.00	14.00	4	2	6	78
7/2/10	11.00	13.00	4	1	5	65
7/3/10	12.00	12.00	10	1	11	142
7/4/10	11.50	12.50	3	1	4	52
7/5/10	12.00	12.00	2	1	3	39
7/6/10	10.00	14.00	5	2	7	90
7/7/10	24.00	0.00	1	0	1	13
7/8/10	10.00	14.00	0	2	2	26

Table continued next page

APPENDIX G.–continued.

Date	Time Fished Hours		Unmarked Chinook Catch			Migration
	In	Out	Actual	Estimated	Total	
7/9/10	10.00	14.00	3	2	5	65
7/10/10	10.00	14.00	0	2	2	26
7/11/10	10.00	14.00	2	2	4	52
7/12/10	0.00	24.00	0	5	5	65
7/13/10	0.00	24.00	0	5	5	65
7/14/10	10.00	0.00	3	0	3	39
7/15-7/31	Post Trapping					417
Total	3,821.00	396.00	3,852	473	4,325	55,546

Appendix H

Fork length of natural-origin, sub yearling Chinook in the Green River, 2010

APPENDIX H.–Mean fork length (mm), standard deviation (St.Dev.) range, and sample size of natural-origin 0+ Chinook caught in the Green River screw trap in 2010.

Statistical Week					Range		Number	Percent Sampled	
Number	Begin	End	Average	St. Dev.	Min	Max	Sampled	Caught	%
4	1/18/10	1/24/10	39	n/a	39	39	1	1	100.00%
5	1/25/10	1/31/10	40.3	0.50	40	41	4	4	100.00%
6	2/1/10	2/7/10	40.2	1.25	39	43	11	15	73.33%
7	2/8/10	2/14/10	40.8	2.33	38	52	44	57	77.19%
8	2/15/10	2/21/10	41.3	1.87	34	44	59	137	43.07%
9	2/22/10	2/28/10	41.3	2.37	33	47	41	63	65.08%
10	3/1/10	3/7/10	41.3	2.75	37	51	38	75	50.67%
11	3/8/10	3/14/10	44.1	5.52	36	58	74	98	75.51%
12	3/15/10	3/21/10	42.8	5.24	35	59	46	143	32.17%
13	3/22/10	3/28/10	43.6	6.76	36	63	43	127	33.86%
14	3/29/10	4/4/10	48.1	9.16	36	70	71	226	31.42%
15	4/5/10	4/11/10	48.8	8.58	39	66	52	80	65.00%
16	4/12/10	4/18/10	45.9	6.74	40	58	7	11	63.64%
17	4/19/10	4/25/10	61.4	9.94	38	80	48	132	36.36%
18	4/26/10	5/2/10	66.4	9.15	49	82	18	49	36.73%
19	5/3/10	5/9/10	73.1	9.08	49	88	47	123	38.21%
20	5/10/10	5/16/10	75.6	8.88	52	101	95	160	59.38%
21	5/17/10	5/23/10	76.7	7.55	60	90	77	411	18.73%
22	5/24/10	5/30/10	80.7	9.05	56	97	70	482	14.52%
23	5/31/10	6/6/10	80.9	9.24	60	101	65	252	25.79%
24	6/7/10	6/13/10	85.5	8.64	60	107	121	705	17.16%
25	6/14/10	6/20/10	90.9	6.88	70	107	87	256	33.98%
26	6/21/10	6/27/10	93.0	6.83	75	112	98	157	62.42%
27	6/28/10	7/4/10	94.0	7.09	77	115	41	72	56.94%
28	7/5/10	7/11/10	101.0	12.76	86	118	9	13	69.23%
29	7/12/10	7/18/10	104.7	10.41	93	113	3	3	100.00%
		Season Total	67.3	21.43	33	118	1,270	3,852	32.97%

Appendix I

Daily catch of coho, pink, and chum salmon and steelhead and cutthroat trout in the Green River, 2010

APPENDIX I.─Daily catches of coho, chum, and pink salmon, steelhead and cutthroat trout caught in the Green River screw trap in 2010. Catch represents actual and estimated catch for a given day. Time in and out reflect time fished (in) and not fished (out) on a given day.

Date	Hours Fished		Coho			Pink	Chum	Steelhead		Cutthroat		Trout
			Smolts		Fry	Fry	Fry	Smolts		Smolts	Adult	Parr
	In	Out	Nat	Hat	Nat	Nat	Total	Nat	Hat	Nat	Nat	Nat
01/20/10	27.0	0.0	0	0	0	9	0	0	0	0	0	6
01/21/10	25.0	0.0	0	0	0	6	0	0	0	0	0	8
01/22/10	24.0	0.0	0	0	0	1	0	0	0	0	0	4
01/23/10	24.0	0.0	0	0	0	1	0	0	0	0	0	0
01/24/10	24.0	0.0	2	0	0	2	0	0	0	0	0	18
01/25/10	24.0	0.0	0	0	0	10	0	0	0	0	0	12
01/26/10	24.0	0.0	0	0	0	16	0	0	0	0	0	10
01/27/10	24.0	0.0	1	0	0	10	0	0	0	1	0	11
01/28/10	24.0	0.0	0	1	0	5	0	0	0	0	0	2
01/29/10	24.0	0.0	3	0	0	7	0	0	0	0	0	4
01/30/10	24.0	0.0	1	0	0	10	0	0	0	0	0	3
01/31/10	24.0	0.0	0	0	0	32	0	0	0	0	0	4
02/01/10	11.5	12.5	0	0	0	45	0	0	0	0	0	6
02/02/10	24.0	0.0	6	0	0	16	0	0	0	0	0	2
02/03/10	24.0	0.0	9	0	0	29	0	0	0	0	0	7
02/04/10	24.0	0.0	3	0	0	55	0	0	0	0	0	4
02/05/10	24.0	0.0	1	0	0	33	0	0	0	0	0	4
02/06/10	24.0	0.0	0	0	0	106	0	0	0	0	0	2
02/07/10	24.0	0.0	4	0	0	64	0	0	0	0	0	5
02/08/10	24.0	0.0	1	0	0	7	1	0	0	0	0	4
02/09/10	24.0	0.0	3	0	0	160	1	0	0	0	0	12
02/10/10	24.0	0.0	2	0	0	115	0	0	0	0	0	10
02/11/10	24.0	0.0	3	0	0	87	0	0	0	0	0	4
02/12/10	24.0	0.0	1	0	0	99	7	0	0	0	0	8
02/13/10	24.0	0.0	0	0	0	336	6	0	0	0	0	6
02/14/10	24.5	0.0	2	0	0	480	12	0	0	0	0	6
02/15/10	24.0	0.0	4	0	0	875	14	0	0	0	0	12
02/16/10	24.0	0.0	4	0	0	1,845	8	0	0	0	0	19
02/17/10	24.0	0.0	10	0	0	1,760	7	1	0	0	0	30
02/18/10	24.0	0.0	3	0	0	987	4	0	0	0	0	16
02/19/10	24.0	0.0	7	0	0	336	4	1	0	0	0	13
02/20/10	24.0	0.0	9	1	1	558	0	0	0	0	0	22
02/21/10	24.0	0.0	2	0	0	467	0	1	0	0	0	16
02/22/10	24.0	0.0	7	0	1	334	4	1	0	0	0	10
02/23/10	24.0	0.0	6	1	0	241	2	0	0	0	0	16
02/24/10	24.0	0.0	1	1	0	338	11	0	0	0	0	2
02/25/10	24.0	0.0	1	0	0	684	38	0	0	0	0	5
02/26/10	24.0	0.0	4	0	0	435	20	0	0	0	0	1
02/27/10	24.0	0.0	1	0	0	597	30	0	0	0	0	4
02/28/10	24.0	0.0	1	0	0	1,187	75	0	0	0	0	4
03/01/10	24.0	0.0	5	0	0	1,745	63	0	0	0	0	11
03/02/10	24.0	0.0	5	0	0	1,297	25	0	0	0	0	10
03/03/10	24.0	0.0	4	0	0	4,318	124	0	0	0	0	6

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APPENDIX I.—continued

Date	Hours Fished		Coho			Pink	Chum	Steelhead		Cutthroat		Trout
			Smolts		Fry	Fry	Fry	Smolts		Smolts	Adult	Parr
	In	Out	Nat	Hat	Nat	Nat	Total	Nat	Hat	Nat	Nat	Nat
03/04/10	24.0	0.0	0	0	0	6,279	164	0	0	0	0	6
03/05/10	24.5	0.0	0	0	0	4,140	60	0	0	0	0	10
03/06/10	24.0	0.0	2	0	1	4,366	72	0	0	0	0	1
03/07/10	24.0	0.0	1	1	1	3,819	62	0	0	0	0	5
03/08/10	24.0	0.0	0	0	0	3,999	186	0	0	0	0	3
03/09/10	24.0	0.0	0	0	0	4,810	165	0	0	0	0	2
03/10/10	24.0	0.0	1	0	0	2,925	143	0	0	0	0	3
03/11/10	24.0	0.0	0	0	0	3,034	204	0	0	0	0	1
03/12/10	24.0	0.0	1	0	0	6,863	1,098	0	0	0	0	1
03/13/10	24.0	0.0	0	0	1	13,643	356	1	0	0	0	7
03/14/10	25.0	0.0	1	0	2	3,840	145	0	0	0	0	4
03/15/10	24.0	0.0	0	0	0	3,235	125	0	0	0	0	0
03/16/10	24.0	0.0	3	0	0	7,010	57	0	0	0	0	2
03/17/10	24.0	0.0	1	0	4	14,147	466	1	0	0	0	7
03/18/10	24.0	0.0	0	0	26	17,938	287	3	0	0	0	19
03/19/10	24.0	0.0	0	0	0	8,153	97	1	0	0	0	13
03/20/10	24.0	0.0	0	0	5	16,320	183	0	0	1	0	8
03/21/10	24.0	0.0	1	0	0	14,584	256	0	0	0	0	7
03/22/10	24.0	0.0	0	0	35	70,272	367	7	0	0	0	8
03/23/10	24.0	0.0	3	2	13	30,429	300	1	0	0	0	11
03/24/10	25.0	0.0	0	0	8	36,557	445	0	0	0	0	4
03/25/10	24.0	0.0	4	0	0	23,215	234	1	0	0	0	3
03/26/10	24.0	0.0	3	0	14	66,381	807	0	0	0	0	4
03/27/10	24.0	0.0	8	0	5	46,780	18,813	1	0	1	0	14
03/28/10	24.0	0.0	2	0	2	27,571	1,555	0	0	0	0	0
03/29/10	24.0	0.0	3	0	1	40,255	1,921	0	0	0	0	2
03/30/10	24.0	0.0	5	0	23	90,744	860	7	0	2	0	13
03/31/10	24.0	0.0	0	0	3	56,708	2,942	0	0	3	1	19
04/01/10	24.0	0.0	0	0	2	30,971	9,100	0	0	2	0	8
04/02/10	24.0	0.0	3	0	0	17,579	2,177	1	0	0	0	7
04/03/10	24.0	0.0	2	0	2	29,442	2,168	1	0	1	0	6
04/04/10	24.0	0.0	5	2	0	12,778	812	2	0	1	0	7
04/05/10	24.0	0.0	1	3	0	18,565	1,333	0	0	1	0	4
04/06/10	24.0	0.0	6	1	1	19,017	1,583	0	0	0	0	4
04/07/10	24.0	0.0	2	0	0	22,003	6,548	1	0	1	0	2
04/08/10	24.0	0.0	3	2	0	27,520	12,796	1	0	0	0	3
04/09/10	24.0	0.0	1	1	0	21,128	7,960	2	0	0	0	4
04/10/10	24.0	0.0	1	0	0	19,007	4,460	0	0	0	0	6
04/11/10	24.0	0.0	0	1	1	67,242	3,609	0	0	0	0	9
04/12/10	24.0	0.0	2	0	0	24,276	377	0	0	0	0	3
04/13/10	24.0	0.0	1	2	0	34,310	673	1	0	0	0	4
04/14/10	24.0	0.0	3	2	0	25,368	2,040	0	0	0	0	6
04/15/10	18.0	0.0	0	0	0	23,426	647	0	0	0	0	3
04/16/10	30.0	0.0	5	3	1	16,907	1,503	0	0	0	0	6
04/17/10	24.0	0.0	5	0	0	34,060	1,911	0	0	0	0	3
04/18/10	24.0	0.0	3	3	0	43,270	2,211	0	2	2	0	1

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APPENDIX I.–continued

Date	Hours Fished		Coho Smolts		Coho Fry	Pink Fry	Chum Fry	Steelhead Smolts		Cutthroat Smolts	Cutthroat Adult	Trout Parr
	In	Out	Nat	Hat	Nat	Nat	Total	Nat	Hat	Nat	Nat	Nat
04/19/10	24.0	0.0	15	2	1	78,560	4,579	7	3	2	0	3
04/20/10	24.0	0.0	12	3	0	45,414	16,390	1	0	0	0	0
04/21/10	24.0	0.0	16	0	3	158,902	16,829	2	2	0	0	0
04/22/10	24.0	0.0	47	3	1	72,727	1,908	193	52	2	0	18
04/23/10	24.0	0.0	31	2	1	45,160	507	32	10	0	0	23
04/24/10	24.0	0.0	16	1	3	54,780	795	16	70	1	0	11
04/25/10	24.0	0.0	31	2	3	37,000	658	48	166	0	0	2
04/26/10	24.0	0.0	16	0	0	23,000	231	6	28	0	0	0
04/27/10	24.0	0.0	3	0	1	12,754	745	4	16	0	0	3
04/28/10	24.0	0.0	12	5	0	12,086	879	3	9	0	0	0
04/29/10	24.0	0.0	26	3	1	11,000	492	81	115	1	0	8
04/30/10	24.0	0.0	59	3	0	22,452	131	39	73	2	0	12
05/01/10	24.0	0.0	36	1	0	21,900	232	14	14	0	0	2
05/02/10	23.3	0.8	97	571	0	29,310	650	60	83	0	0	10
05/03/10	10.5	13.5	30	2,143	0	10,722	278	43	15	0	0	1
05/04/10	0.0	24.0	35	1,205	1	7,613	223	37	17	0	0	4
05/05/10	24.0	0.0	40	375	1	1,316	40	33	13	0	0	7
05/06/10	24.0	0.0	55	691	0	2,050	60	52	31	1	0	35
05/07/10	24.0	0.0	29	149	1	1,700	42	31	22	0	0	3
05/08/10	24.0	0.0	121	148	0	820	24	31	25	1	0	2
05/09/10	24.0	0.0	17	105	0	340	13	21	62	3	0	6
05/10/10	24.0	0.0	14	42	0	378	53	3	23	0	0	0
05/11/10	24.0	0.0	17	55	0	40	234	12	23	0	0	3
05/12/10	24.0	0.0	26	87	0	49	315	12	12	0	0	1
05/13/10	14.8	9.3	39	43	0	530	274	10	5	0	0	1
05/14/10	14.0	10.0	52	73	1	581	205	44	14	0	0	3
05/15/10	24.0	0.0	62	110	1	545	137	78	22	0	0	5
05/16/10	24.0	0.0	41	65	0	273	80	68	13	1	0	5
05/17/10	24.0	0.0	49	90	1	179	13	149	22	0	0	11
05/18/10	24.0	0.0	53	78	0	77	34	91	20	0	0	4
05/19/10	24.0	0.0	73	46	0	20	45	100	11	0	0	3
05/20/10	24.0	0.0	62	44	0	46	155	70	13	0	0	1
05/21/10	24.0	0.0	45	53	1	42	143	66	14	0	0	4
05/22/10	24.0	0.0	40	33	0	35	70	61	6	0	0	1
05/23/10	24.0	0.0	36	18	0	20	34	85	10	0	0	0
05/24/10	24.0	0.0	45	24	0	45	40	66	11	2	0	0
05/25/10	10.0	14.0	41	23	0	27	26	46	8	0	0	1
05/26/10	24.0	0.0	39	9	0	5	26	38	6	0	0	0
05/27/10	24.0	0.0	55	8	1	8	12	53	12	0	0	0
05/28/10	26.0	0.0	32	18	0	13	25	74	4	0	0	0
05/29/10	0.0	22.0	8	3	0	8	9	31	1	0	0	0
05/30/10	24.0	0.0	1	1	0	6	7	4	0	0	0	0
05/31/10	24.0	0.0	9	1	0	3	5	6	2	0	0	0
06/01/10	24.0	0.0	6	0	1	1	1	4	3	0	0	1

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APPENDIX I.—continued

Date	Hours Fished		Coho Smolts		Coho Fry	Pink Fry	Chum Fry	Steelhead Smolts		Cutthroat Smolts	Cutthroat Adult	Trout Parr
	In	Out	Nat	Hat	Nat	Nat	Total	Nat	Hat	Nat	Nat	Nat
06/02/10	24.0	0.0	5	1	0	1	12	15	2	0	0	0
06/03/10	0.0	24.0	4	1	0	4	12	9	1	0	0	0
06/04/10	8.0	16.0	3	1	0	5	14	8	1	0	0	0
06/05/10	24.0	0.0	3	1	0	4	11	1	0	0	0	0
06/06/10	24.0	0.0	5	1	0	1	3	4	0	0	0	1
06/07/10	24.0	0.0	1	5	0	0	0	7	2	0	0	0
06/08/10	24.0	0.0	1	3	0	1	1	7	0	0	0	1
06/09/10	24.0	0.0	4	0	0	0	6	4	2	0	0	0
06/10/10	24.0	0.0	0	0	3	0	2	2	0	0	0	1
06/11/10	24.0	0.0	2	1	0	0	3	1	0	0	0	0
06/12/10	24.0	0.0	2	1	2	0	2	0	0	0	0	0
06/13/10	24.0	0.0	0	0	0	0	3	2	0	0	0	0
06/14/10	24.0	0.0	1	1	0	0	0	1	0	0	0	1
06/15/10	24.0	0.0	0	0	0	0	2	0	0	0	0	0
06/16/10	24.0	0.0	0	0	2	0	5	0	0	0	0	0
06/17/10	24.0	0.0	0	0	2	0	1	2	0	0	0	0
06/18/10	23.7	0.0	3	0	0	0	6	1	0	0	0	0
06/19/10	23.3	0.0	1	1	4	0	0	0	0	0	0	0
06/20/10	25.0	0.0	5	0	2	0	4	0	0	0	0	0
06/21/10	24.0	0.0	0	0	4	0	1	1	0	0	0	0
06/22/10	24.0	0.0	0	0	5	0	2	0	0	0	0	0
06/23/10	24.0	0.0	0	0	3	0	1	0	0	0	0	0
06/24/10	10.0	14.0	1	0	3	0	2	0	0	0	0	0
06/25/10	10.0	14.5	0	0	5	0	0	1	0	0	0	0
06/26/10	10.5	13.5	5	0	4	0	2	0	0	0	0	0
06/27/10	11.5	12.5	3	0	7	0	0	0	0	0	0	0
06/28/10	23.5	0.0	0	0	12	0	2	0	0	0	0	0
06/29/10	24.0	0.0	0	0	10	0	2	0	0	0	0	0
06/30/10	10.0	14.0	0	0	4	0	3	0	0	0	0	0
07/01/10	10.0	14.0	0	0	5	0	1	0	0	0	0	0
07/02/10	11.0	13.0	2	0	1	0	0	0	0	0	0	0
07/03/10	12.0	12.0	4	0	5	0	1	0	0	0	0	1
07/04/10	11.5	12.5	0	0	4	0	0	0	0	0	0	0
07/05/10	12.0	12.0	0	0	3	0	0	0	0	0	0	0
07/06/10	10.0	14.0	0	0	3	0	2	0	0	0	0	0
07/07/10	24.0	0.0	0	0	3	0	0	0	0	0	0	0
07/08/10	10.0	14.0	0	0	7	0	1	0	0	0	0	0
07/09/10	10.0	14.0	0	0	1	0	1	0	0	0	0	0
07/10/10	10.0	14.0	0	0	3	0	1	0	0	0	0	0
07/11/10	10.0	14.0	0	0	4	0	1	0	0	0	0	0
07/12/10	0.0	24.0	0	0	5	0	2	0	0	0	0	0
07/13/10	0.0	24.0	0	0	5	0	2	0	0	0	0	0
07/14/10	10.0	0.0	0	0	4	0	1	0	0	0	0	0
Total	3,821.0	396.0	1,842	6,380	301	1,787,184	142,498	2,027	1,091	32	1	821

Appendix J

Fork lengths of natural-origin coho smolts in the Green River, 2010

APPENDIX J.–Mean fork length (mm), standard deviation (St.Dev.) range, and sample size of natural-origin coho smolts in the Green River screw trap in 2010.

Statistical Week					Range		Number
No	Begin	End	Average	St.Dev.	Min	Max	Sampled
4	1/18/10	1/24/10	97.50	3.54	95	100	2
5	1/25/10	1/31/10	98.25	2.87	94	100	4
6	2/1/10	2/7/10	105.35	10.33	80	118	23
7	2/8/10	2/14/10	100.67	11.02	75	115	12
8	2/15/10	2/21/10	106.51	7.62	90	119	39
9	2/22/10	2/28/10	103.64	11.19	85	122	22
10	3/1/10	3/7/10	105.29	10.72	86	120	17
11	3/8/10	3/14/10	103.33	3.79	99	106	3
12	3/15/10	3/21/10	108.20	4.66	103	115	5
13	3/22/10	3/28/10	111.16	9.83	86	125	19
14	3/29/10	4/4/10	114.33	5.97	98	121	18
15	4/5/10	4/11/10	111.36	9.38	94	130	14
16	4/12/10	4/18/10	110.95	15.44	86	140	19
17	4/19/10	4/25/10	117.06	10.18	86	145	115
18	4/26/10	5/2/10	118.50	8.86	95	144	155
19	5/3/10	5/9/10	121.45	10.28	90	146	108
20	5/10/10	5/16/10	119.46	8.91	93	155	109
21	5/17/10	5/23/10	119.80	9.09	97	140	84
22	5/24/10	5/30/10	117.61	9.29	99	138	64
23	5/31/10	6/6/10	118.22	11.10	100	148	18
24	6/7/10	6/13/10	119.29	10.90	105	133	7
25	6/14/10	6/20/10	102.90	13.35	92	138	10
26	6/21/10	6/27/10	100.44	5.75	91	106	9
27	6/28/10	7/4/10	98.67	10.27	87	112	6
28	7/5/10	7/11/10	----	----	----	----	0
29	7/12/10	7/18/10	----	----	----	----	0
		Season Total	115.85	11.21	75	155	882

Appendix K

Fork lengths of natural-origin steelhead smolts in the Green River, 2010

APPENDIX K.─ Mean fork length (mm), standard deviation (St.Dev.) range, and sample size of natural-origin steelhead smolts in the Green River screw trap in 2010.

Statistical Week					Range		Number
No	Begin	End	Average	St.Dev.	Min	Max	Sampled
4	1/18/10	1/24/10	----	----	----	----	0
5	1/25/10	1/31/10	----	----	----	----	0
6	2/1/10	2/7/10	----	----	----	----	0
7	2/8/10	2/14/10	----	----	----	----	0
8	2/15/10	2/21/10	177.3	4.04	173	181	3
9	2/22/10	2/28/10	168.0	n/a	168	168	1
10	3/1/10	3/7/10	----	----	----	----	0
11	3/8/10	3/14/10	202.0	n/a	202	202	1
12	3/15/10	3/21/10	172.8	14.13	158	195	5
13	3/22/10	3/28/10	173.2	21.78	154	229	10
14	3/29/10	4/4/10	181.8	40.85	124	265	12
15	4/5/10	4/11/10	179.3	12.84	164	193	4
16	4/12/10	4/18/10	170.0	n/a	170	170	1
17	4/19/10	4/25/10	193.8	35.27	118	315	63
18	4/26/10	5/2/10	189.6	26.35	153	350	90
19	5/3/10	5/9/10	179.4	19.55	150	239	84
20	5/10/10	5/16/10	169.7	15.23	135	225	77
21	5/17/10	5/23/10	174.4	14.43	150	222	84
22	5/24/10	5/30/10	171.6	13.36	116	210	71
23	5/31/10	6/6/10	170.8	8.93	158	190	18
24	6/7/10	6/13/10	169.6	9.37	150	185	21
25	6/14/10	6/20/10	168.0	17.47	143	181	4
26	6/21/10	6/27/10	162.5	3.54	160	165	2
27	6/28/10	7/4/10	----	----	----	----	0
28	7/5/10	7/11/10	----	----	----	----	0
29	7/12/10	7/18/10	----	----	----	----	0
		Season Total	178.65	22.87	116	350	551

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