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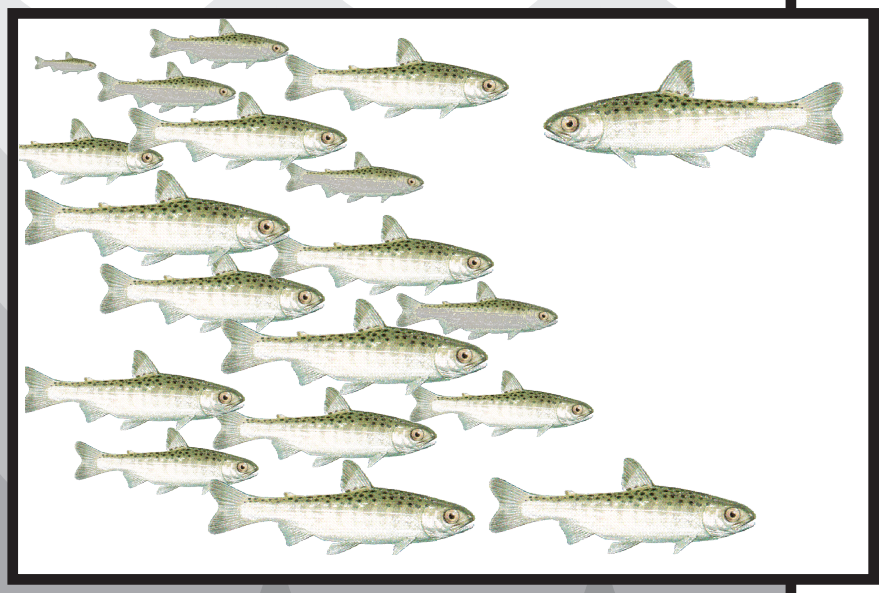
Green River Juvenile Salmonid Production Evaluation: 2008 Annual Report



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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 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, for providing logistical support and a secure staging site near the trap. Steve Foley, 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 Water in 2008.

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Executive Summary

This report provides results from the juvenile salmonid production study conducted on the Green River in 2008. The primary objective of this project was to estimate natural-origin production of Puget Sound Chinook in the Green River. Additional objectives were to evaluate environmental variables contributing to Chinook survival and to estimate the production of other Green River salmonids. Juvenile salmonids were captured in a five-foot screw trap located at river mile 34.5 (55 rkm). Production estimates were made using a time-stratified mark-recapture approach that relied on release and recapture of marked fish throughout the period of outmigration. A Petersen-Chapman estimator was used to calculate juvenile migration and its variance during each time stratum. The sum of all strata provided the total production estimate.

The trap was operated from January 23 through July 15, 2008. The trap fished 92% of the time during this period. Mark and recapture efficiency trials were conducted throughout the trapping period. Production estimates of natural-origin salmonids were derived for subyearling Chinook and pink salmon and a combined natural and hatchery-origin estimate was derived for chum salmon (Table 1). Low catches and recapture rates prohibited production estimations for other species.

TABLE 1.—Catch and production estimates for juvenile salmonids in the Green River, 2008. Data are for juveniles migrating from above the Green River screw trap, river mile 34.5.

Species	Origin	Total Catch	Production	Low 95% C.I.	High 95% C.I.	CV
Chinook 0+	Natural	14,912	373,053	338,682	407,424	4.70%
	Hatchery	0	N/A	N/A	N/A	N/A
Coho	Natural	407	N/A	N/A	N/A	N/A
	Hatchery	560	N/A	N/A	N/A	N/A
Steelhead	Natural	175	N/A	N/A	N/A	N/A
	Hatchery	437	N/A	N/A	N/A	N/A
Pink	Natural	502,597	9,312,134	7,666,917	10,957,351	6.81%
Chum	Nat & Hat	120,974	3,076,614	2,480,572	3,672,656	9.88%

Egg-to-migrant survival of the 2007 brood of Green River Chinook was estimated to be 3.40%. A basin-wide production estimate of 546,756 natural-origin sub-yearling Chinook was based on production measured above the trap and 3.40% survival applied to spawning below the trap and to spawners passed above the weir in Big Soos Creek.

Timing of the Chinook outmigration was bimodal. The earlier migration represented 63% of total abundance and peaked between March 11 and 16. The later migration represented 37% of total abundance and peaked between June 2 and 8. The first peak was composed of recently emerged juveniles (i.e., “fry”, 40-45-mm FL) whereas the second peak was mostly subyearlings that had reared in the river for several months (i.e., “parr”, 46 to 106-mm FL).

Introduction

This report contains results from the 2008 Green River juvenile salmonid production study. The Green River study was initiated in 2000 with a focus on freshwater production and survival of Chinook salmon but has also provided abundance and biological information for pink, chum, and coho salmon and steelhead trout. Results from this study serve at least two management purposes. First, juvenile abundance and life history data are relevant to the status of Puget Sound Chinook and steelhead, both listed as *threatened* under the Endangered Species Act by the National Marine Fisheries Service (NMFS). Second, migrant abundance estimates of 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, GSRO 2006; NMFS 2006). Population designations for the Puget Sound steelhead ESU are still being evaluated.

Juvenile abundance and productivity of Green River Chinook provide a direct measure of freshwater survival and allow brood-specific survival to be partitioned between the freshwater and marine environment. This information is critical to improving harvest, habitat, and hatchery influences on this stock. Monitoring juvenile production over a range of escapements assesses watershed and stock productivity through the spawner-recruit function. Under adequate escapements, inter-annual variation in juvenile production is an empirical measure of the watershed's natural production potential. Inter-annual variation in juvenile production can also be used to identify major density-independent variables affecting freshwater survival.

In addition to the broad scale issue of ESA status, results from the Green River juvenile salmonid production study provide baseline data that can be used to evaluate 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 domestic use. The final design for the project was developed between 1999 and 2001. Construction began in 2001 and is ongoing. 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.

From 2000 to present, a floating juvenile migrant 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 located on Big Soos Creek. This study has produced a long-term data set on freshwater production that can be used to evaluate of temporal trends of Green River Chinook salmon. Chinook salmon trends from the Green River, and elsewhere, should be interpreted with respect to variables that have potential to impact inter-annual production (i.e., spawner abundance, incubation flows). The Green River watershed is distinguished by a number of factors including a canyon geomorphology of the

upper watershed, dikes and development in the lower watershed, regulated flows from Howard Hanson dam, and large-scale hatchery production. Options for freshwater management of Chinook populations are influenced by these features and their impact on freshwater production and survival.

Objectives

The primary objective of this project was to estimate natural-origin production of Puget Sound Chinook in the Green River. Additional objectives were to identify variables contributing to Chinook production and survival and to estimate production of other Green River salmonids. This report includes results from the 2008 field season.

Methods

Trap Operation

A floating screw trap (5-ft or 1.5-m diameter) was used to capture downstream migrant salmonids 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). The trap was operated between January 23 and July 15, 2008 for a total of 3,825 of 4,169 possible hours (92% of the time). Trap operations were suspended four times during the season for high flows, heavy debris, and trap damage. Trap operations were also suspended during daytime hours between June 27 and the end of the trapping season (175 hours over 15 days) because recreational use of the river was high and few fish were being captured.

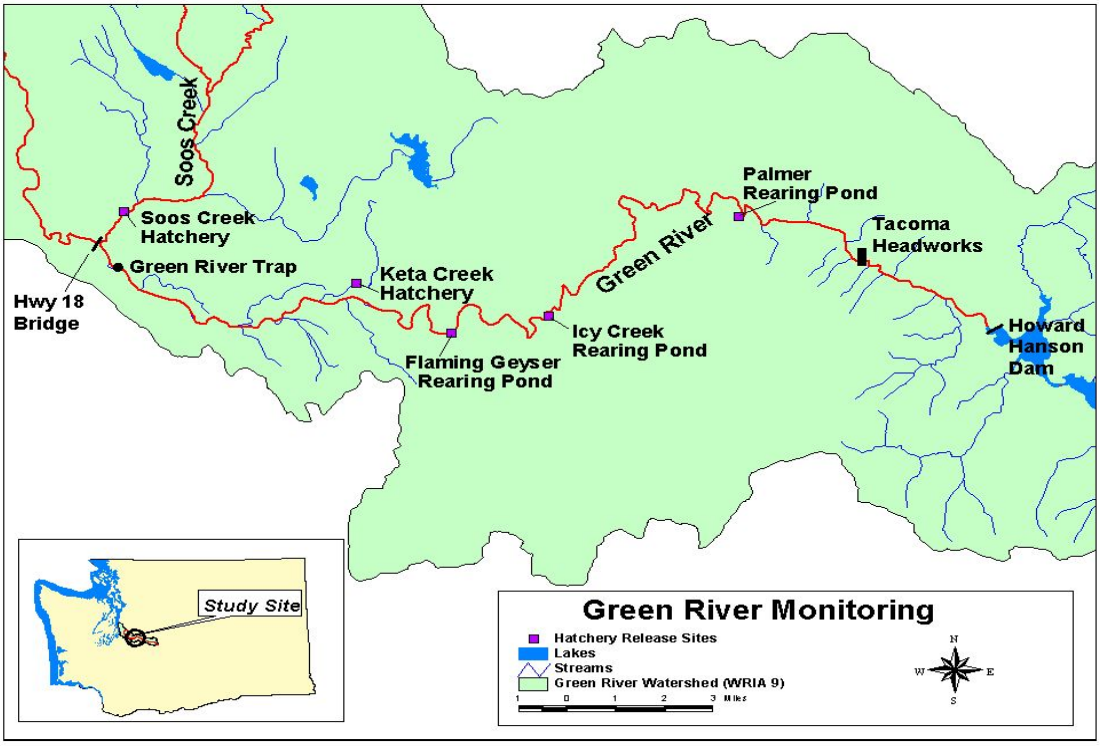

FIGURE 1.—Map of screw trap location on the Green River relative to existing hatcheries and hydrological projects.

Fish Collection

The trap was checked for fish at dawn and dusk each day and at additional times when required by debris loads or 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 subsample of natural-origin salmonid species.

Multiple efficiency trials were conducted for each natural-origin species and life stage (subyearling or yearling), permitting adequate catch. Efficiency trials were conducted throughout the season and at least once each statistical week. Captured fish were anesthetized

with tricaine methanesulfonate (MS-222) and marked with either Bismarck-brown dye or with a partial caudal fin clip. Release groups were marked with Bismarck Brown dye prior to June 24 and a partial caudal fin-clip after this date. The position of the fin clip 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 distribution of marked fish across the river prior to recapture. Dyed or clipped fish caught in the trap were recorded as recaptures. Trap efficiency trials were conducted with natural-origin fish, when possible. Early in the trapping season (prior to adequate catches of natural-origin Chinook fry), three groups of hatchery-origin Chinook from the Soos Creek Hatchery were marked and released upstream from the trap.

Hatchery Releases

Hatchery-origin salmonids were released from one of five hatcheries (Table 2). An additional release of subyearling Chinook occurred above Howard Hanson Dam in 2007 (brood year 2006) and could have contributed to the catch of hatchery yearling Chinook in 2008 if they failed to migrate from above the dam in 2007. No hatchery Chinook were released above Howard Hansen Dam in 2008 (BY 2007). Juvenile salmon caught in our traps were either natural or hatchery origin. These two groups were distinguished based on the presence (natural) or absence (hatchery) of an adipose fin (ad-mark). However, marking of hatchery fish has an associated error rate and without an ad-mark, unmarked hatchery-origin fish will be mistaken for natural-origin fish. In 2008, releases of unmarked hatchery Chinook, coho, and steelhead were low (0.7% to 5.7%) whereas all chum releases were unmarked hatchery fry (Table 2). Therefore, hatchery marking error was disregarded when estimating natural-origin production of Chinook, coho, and steelhead in 2008. Chum production in 2008 was derived as a combined estimate for natural and hatchery-origin chum.

TABLE 2.–Hatchery releases that could have contributed to catches in the Green River screw trap, 2008. Hatchery fish were marked with a coded-wide tag (CWT), ad-mark, or both[a].

Species	Release Date(s)	Release Location	Brood Year	CWT Only	CWT Ad-mark	Ad-mark Only	Unmarked	Total Release	% Unmarked
2007 Releases Above Howard Hanson Dam									
Chinook	3/30-4/11	Howard Hanson Dam	2006			333,666	19,934	353,600	5.6%
2008 Releases									
Chinook									
	5/1	Icy Creek	2006		80,238	214,323	2,864	297,425	1.0%
	5/22-6/6	Soos Creek	2007	202,635	202,671	2,734,600	90,400	3,230,306	2.8%
Coho	5/5-5/14	Keta Creek	2006	1,944	43,490	98,960	8,806	153,200	5.7%
	4/20	Soos Creek	2006	45,644	45,233	115,450	5,673	212,000	2.7%
Steelhead	5/1	Soos Creek Summer	2007			25,520	180	25,700	0.7%
	5/1	Soos Creek Winter	2007			59,977	423	60,400	0.7%
	5/1-5/4	Palmer Summer	2007			27,486	194	27,680	0.7%
	5/1-5/14	Palmer Winter	2007			183,258	1,292	184,550	0.7%
	5/5	Icy Creek Summer	2007			25,322	178	25,500	0.7%
	5/5	Flaming Geyser Smr	2007			3,200		3,200	0.0%
	5/5	Flaming Geyser Wtr	2007			4,800		4,800	0.0%
Chum	3/4-5/22	Keta Creek	2007				3,165,250	3,165,250	100.0%

[a] All release sites are upstream of the screw trap except Soos Creek. Soos Creek enters the Green River approximately 0.8 km downstream of our trap; however a few individuals from these releases have contributed to our catches in previous years (Source: Regional Mark Information System, www.rmpc.org).

Production Estimate

Production is measured as the abundance of juvenile downstream migrants. Abundance was estimated using a single-trap, time-stratified mark-recapture approach and based on released marked fish (n_1), maiden catch (n_2), and recaptured marked fish (m_2). The general approach was to (1) calculate total catch, (2) group efficiency trials into strata (3) calculate abundance for each stratum, and (4) calculate total production.

(1) Calculate total catch. Total catch of the second sample period ($\hat{n}_2$) was the actual catch (c) summed with missed catch ($\hat{c}$) during periods of trap outages. Missed catch for a given period i was estimated as:

Equation 1

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

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 $\hat{n}_2$ was equivalent to that of the estimated catch ($\hat{c}$) as actual catch had no variance. Variance of total catch was estimated as:

Equation 2

$$Var(\hat{n}_2) = Var(\hat{c}) = Var(\overline{R}) * T_i^2$$

where:

Equation 3

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

(2) Group efficiency trials into 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 (n_1), a portion are recaptured (m_2) and a portion are not seen (n_1-m_2). If the *seen:unseen* [m_2:(n_1-m_2)] ratio differs 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. 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) Calculate abundance for each stratum. Abundance for a given stratum *j* was calculated from total maiden catch ($\hat{n}_2$), marked fish released (n_1), and marked fish recaptured (m_2). Abundance was estimated with a Petersen estimator with a Chapman correction (Seber 1973).

Equation 4

$$\hat{N}_j = \frac{(\hat{n}_{2j}+1)(n_{1j}+1)}{(m_{2j}+1)}$$

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

Equation 5

$$V(\hat{N}_j) = Var(\hat{n}_{2j})\left(\frac{(n_{1j}+1)(n_{1j}*m_{2j}+3n_{1j}+2)}{(m_{2j}+1)^2(m_{2j}+2)}\right)+\left(\frac{(n_{1j}+1)(n_{1j}-m_{2j})*\hat{n}_{1j}*(\hat{n}_{1j}+m_{2j}+1)}{(m_{2j}+1)^2*(m_{2j}+2)}\right)$$

(4) Calculate total production. Total production was the sum of stratified abundance estimates:

Equation 6

$$\hat{N} = \sum_{j=1}^{j=n}\hat{N}_j$$

Total variance was the sum of abundance variances for all strata. Confidence intervals were calculated from the variance:

Equation 7

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

Coefficient of variation was:

Equation 8

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

Chinook Life History Diversity

Weekly migration estimates were partitioned between "fry" and "parr". Two approaches were taken to compare the fry and parr components of the outmigration. The first approach was based on a date selected between the two modal peaks in the outmigration. This date was selected when the outmigration had decreased to minimal levels following an initial peak and preceding the second peak. The second approach was based on a size threshold. "Fry" were Chinook less than or equal to 45-mm FL and "parr" were Chinook longer than 45-cm FL. For a given statistical week, the proportion of Chinook with each size class was applied to the migration estimate for that week. The length cutoff was selected based on the observation that Chinook migrants during the first seven weeks of trapping were consistently less than 45-mm FL and were presumed to have begun their outmigration soon after emergence (i.e., "fry"). In comparison, Chinook migrants caught later in the season were as long as 106-mm FL and were presumed to have reared in the river for several months prior to beginning their outmigration (i.e., "parr").

Chinook Survival

Egg-to-migrant survival was estimated for subyearling Chinook. Egg-to-migrant survival was the number of migrants divided by potential egg deposition (P.E.D.). Chinook migrants were the production estimates 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. Spawning escapement data were based on redd count methodology and assumed 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).

Results

Subyearling Chinook

A total of 14,912 natural-origin Chinook were captured (Appendix B). Missed catch was estimated to be 526 Chinook, resulting in a total estimated catch of 15,438 natural-origin Chinook. Ninety-one efficiency trials, ranging from 8 to 678 fish, were conducted. A total of 598 hatchery-origin Chinook were used in the first three trials; the remaining trials used natural-origin Chinook only. These trials were pooled to form seven strata with trap efficiencies between 2.44% and 15.20% (Table 3). A total migration of 373,053 ± 34,371 (95% C.I.) natural-origin subyearling Chinook are estimated to have migrated past the screw trap between January 23 and July 15, 2007. Coefficient of variation for this estimate was 4.7%.

TABLE 3.─Catch, efficiency, and production estimates of juvenile Chinook at the Green River screw trap in 2008. Release groups were pooled to form seven strata. Catch variance was calculated for periods that the trap did not fish.

Strata	Dates	TotalCatch					Migration	
		Number	Variance	Rate	Marked	Recaptured	Number	Variance
1	1/23-2/6	869	7.64E+01	4.03%	1,041	42	21,081	1.02E+07
2	2/7-2/19	1,053	9.09E+03	5.32%	639	34	19,272	1.32E+07
3	2/20-2/25	293		2.44%	246	6	10,373	1.33E+07
4	2/26-2/27	151		8.18%	110	9	1,686	2.48E+05
5	2/28-3/27	4,223		2.83%	4,099	116	148,020	1.85E+08
6	28-Mar	169		15.20%	125	19	1,070	5.08E+04
7	3/29-7/19	8,680	3.60E+02	5.05%	6,718	339	171,551	8.53E+07
Season Total		15,438	9.52E+03	6.15%	12,978	565	373,053	3.08E+08

The trapping season included the majority of the migration; however, some fish were already migrating on January 23 (average catch of 12 fish per day) and some are assumed to have migrated after the trap was removed from the water on July 15 (average catch of 26 fish per day). Timing of the outmigration was bimodal (Figure 2). The first peak occurred during statistical week 11 (March 11-16). The second peak occurred during statistical week 23 (June 2-8).

From statistical week 4 to 16, lengths of natural-origin Chinook consistently averaged between 40 and 43-mm FL (Figure 2). This period encompassed the first peak in the outmigration. Around statistical week 17 (last week in April), natural-origin 0+ Chinook were caught at larger sizes each week (average increase of 3.5-mm FL per week). By the peak of the second outmigration (statistical week 23), average natural-origin 0+ Chinook were longer than 65-mm FL (Figure 2).

Using April 20 as the transition between the fry and parr components of the Chinook outmigration, 63% migrated as fry and 37% migrated as parr. The same percentage of fry and parr migrants was estimated from the length-threshold approach.

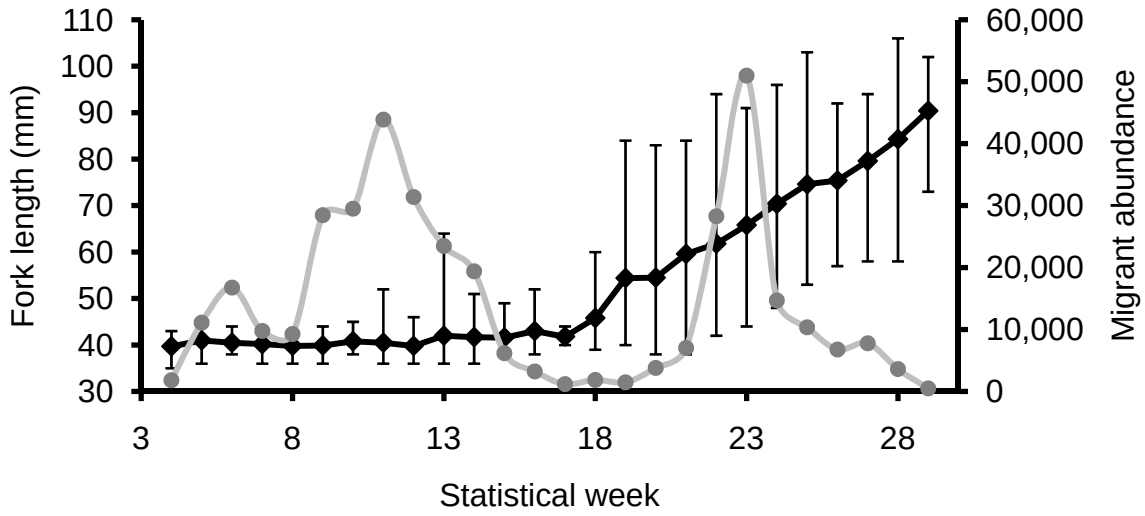

FIGURE 2.—Length (black) and abundance (gray) of natural-origin 0+ Chinook by statistical week at the Green River screw trap in 2008. Length data are mean, minimum, and maximum fork lengths. Abundance data are migration estimate for each statistical week.

Egg-to-migrant survival of natural-origin Chinook (brood year 2007) was estimated to be 3.40%. This calculation was based on the estimated natural-origin Chinook migration passing the trap (373,053 natural-origin 0+ Chinook migrants) divided by the P.E.D above the trap site of 10,957,500 eggs. The P.E.D. above the trap site was based on an estimated 2,435 redds (female spawners) in fall of 2007 (personal communication, Steve Foley, WDFW Region 4).

Coho

A total of 407 natural-origin coho smolts were captured between January 23 and July 11, 2008 (Appendix D). Missed catch was estimated to be 70 smolts, resulting in a total estimated catch of 477 natural-origin coho smolts, an increase of 15.0% over the actual catch. Trap efficiency trials were conducted in January and February and yielded recapture rates between 13% and 75%. Coho used for these early efficiency tests were not fully smolted. Between March 4 through the end of the season, 26 efficiency trials were conducted with a total of 130 individuals. None of these marked coho were recaptured. Due to the absence of reliable trap efficiency information, no production estimate was made for coho in 2008.

Lengths of natural-origin coho ranged from 60 to 132-mm FL (average = 112-mm FL) with no apparent seasonal trend (Figure 3, Appendix E)

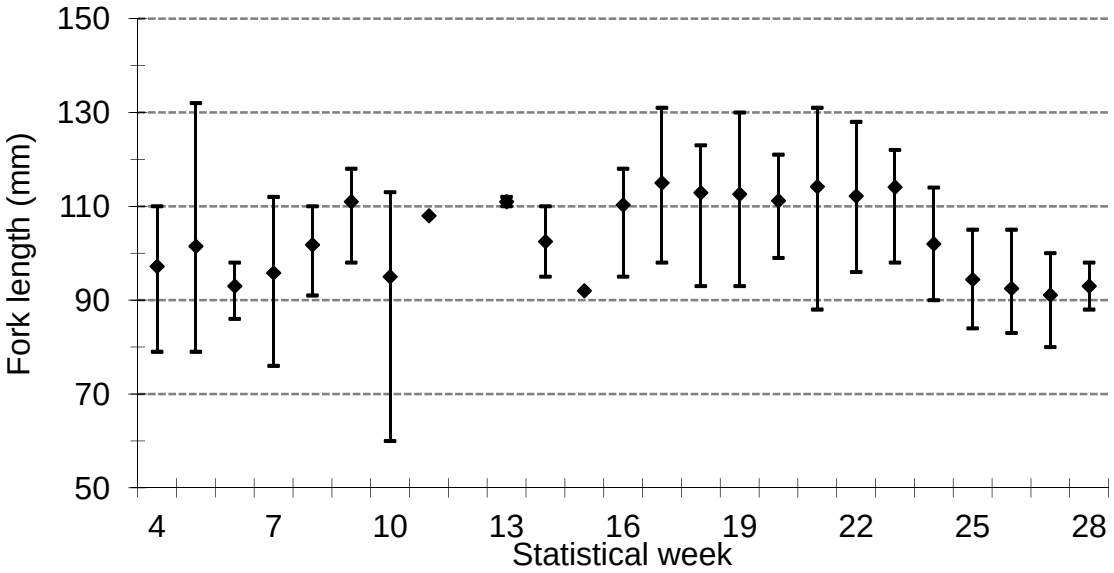

FIGURE 3.—Fork lengths (mm) of natural-origin coho by statistical week at the Green River screw trap in 2008. Data are mean, minimum, and maximum values.

Coho catch remained low through the third week of April, increased slightly in late April and early May, and peaked on May 14 (36 smolts/day). Increased catch in mid-May corresponded to an increase in flow. Catches declined quickly and averaged less than a fish a day by May 22. The last natural-origin coho was captured on July 11.

Steelhead

A total of 175 natural-origin juvenile steelhead were captured between January 23 and July 1, 2008 (Appendix D). Missed catch was estimated to be 43 fish, resulting in a total estimated catch of 218 natural-origin steelhead, an increase of 20.0% over the actual catch. Efficiency trials for were not conducted for natural-origin steelhead smolts because catches were low. In previous years, trap efficiency for steelhead has been estimated using a steelhead:coho capture ratio of 60% applied to the natural-origin coho efficiency data. However, with no reliable coho data, a steelhead production estimate was not possible in 2008.

Natural-origin steelhead smolt lengths ranged from 130 to 250-mm FL and averaged 167.7-mm FL (Figure 4).

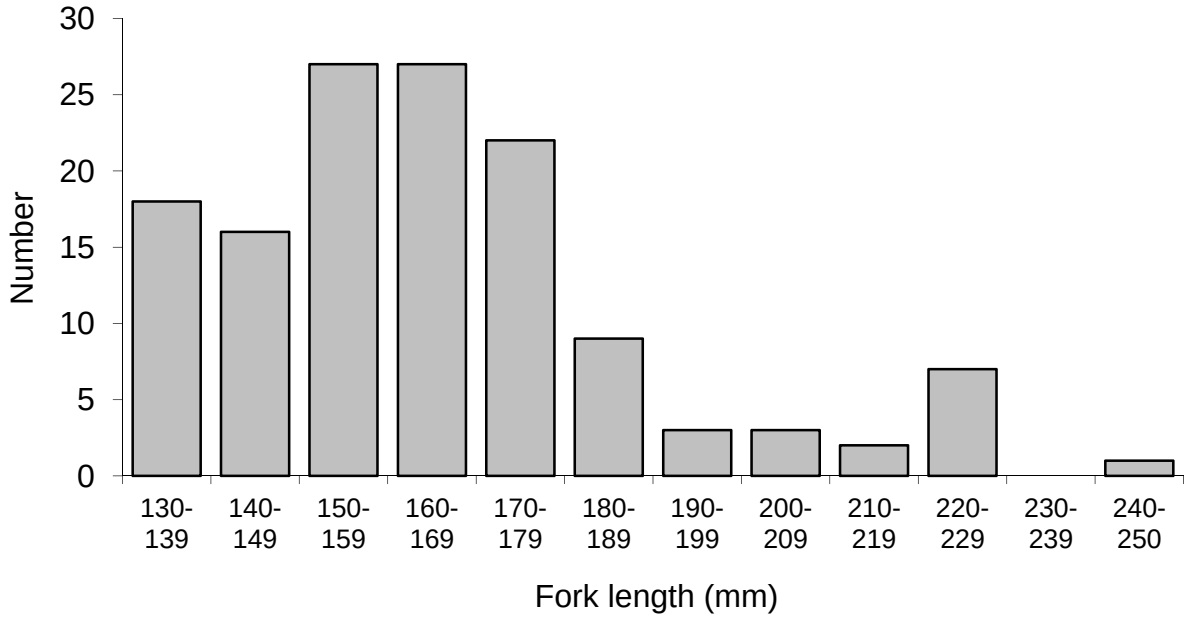

FIGURE 4.—Fork lengths (mm) of unmarked steelhead juvenile caught in the Green River screw trap in 2008.

Steelhead catches were inconsistent with no clear modality throughout the season. Thirty-seven smolts were captured in the first three weeks of trapping. However, only 9 smolts were captured between mid-February and the beginning of May. Peak daily catch of natural-origin smolts occurred on May 14 (15 smolts), corresponding with an increase in flow.

Chum

A total of 120,384 chum migrants were captured between February 4 and June 30, 2008 (Appendix D). Missed catch was estimated to be 410 chum, resulting in a total estimated catch of 120,974 fry. A total of 34 trap efficiency trials were conducted over the season and used a total of 3,327 chum fry. Individual trials were pooled to form 5 strata. Strata efficiency rates ranged from 1.39% to 15.0% and averaged 3.82% (TABLE 4). A total of 3,076,614 ±596,042 (95% C.I.) chum fry were estimated to have migrated past the Green River screw trap. Coefficient of variation for this estimate was 9.88%. This production estimate includes both natural-origin production above the trap site and releases from Keta Creek hatchery.

TABLE 4. ─Catch, efficiency, and migration estimates of chum fry at the Green River screw trap in 2008. Data are stratified by pooled release groups. Catch variance was calculated for periods that the trap did not fish.

Strata	Dates	Catch					Migration	
		Estimated	Variance	Effciency	Marked	Recaptured	Number	Variance
1	1/23-4/4	36,440	2.05E+00	3.51%	1,568	55	1,020,998	1.77E+10
2	4/5-4/12	23,212	0.00E+00	5.82%	395	23	383,014	5.52E+09
3	4/13-4/16	5,226	0.00E+00	15.00%	100	15	32,994	5.40E+07
4	4/17-5/4	50,472	0.00E+00	3.77%	690	26	1,291,734	5.73E+10
5	5/5-7/14	5,444	5.68E+03	1.39%	574	8	347,874	1.20E+10
	Season total	120,794	5.69E+03	3.82%	3,327	127	3,076,614	9.25E+10

Daily catches of chum were low until March 4, the first release date for Keta Creek hatchery chum. Catch remained consistent averaging well over 1,000 fry per day until early May when the daily catch quickly declined. Peak catch occurred on the night of April 10 with a single day's catch of 11,700 chum fry.

Pinks

A total of 502,597 pink fry were captured between January 25 and June 26, 2008 (Appendix D). Missed catch was estimated to be 571 fry, resulting in a total estimated catch of catch was 503,168 fry. Total catch was just 0.1% greater than actual catch. Thirty-three efficiency trials were conducted with a total of 3,256 pink fry (Table 5). Efficiency trials were pooled to form 7 strata with efficiencies between 0.76% and 16.0%. A total migration of 9,312,134 ±1,645,217 (95% C.I.) pink fry was estimated to have passed the Green River screw trap (Table 5). Coefficient of variation for this estimate was 6.81%.

TABLE 5.─Catch, efficiency, and migration estimates of pink fry at the Green River screw trap in 2008. Data are stratified by pooled release groups. Catch variance was calculated for periods that the trap did not fish.

Strata	Dates	Catch					Migration	
		Estimated	Variance	Efficiency	Marked	Recaptured	Number	Variance
1	1/23-3/15	23,698	4.35E+04	9.37%	395	37	246,968	1.421E+09
2	3/16-3/30	85,331		4.45%	989	44	1,877,303	7.317E+10
3	3/31	10,490		16.00%	100	16	62,328	179756471
4	4/1-4/8	101,587		6.35%	394	25	1,543,355	8.243E+10
5	4/9-4/10	37,170		14.43%	97	14	242,850	3.123E+09
6	4/11-5/4	239,841		4.85%	887	43	4,840,447	4.95E+11
7	5/5-7/14	5,051	1.32E+03	0.76%	394	3	498,884	4.931E+10
	Season total	503,168	4.48E+04	5.59%	3256	182	9,312,134	7.046E+11

During first full week of trapping, 261 pinks were estimated to have migrated past the trap (Figure 5). By the end of February, daily migration increased to an average of 4,000 fry. After this date, daily migration increased steadily and reached an average of 30,000 fry by mid March. Between mid-March and the end of April, daily migration of pinks averaged 180,000 fry. Peak migration occurred on April 10 and 11 with over 1.1 million fry estimated for these two days. The daily migration quickly declined to near zero by the third week of May.

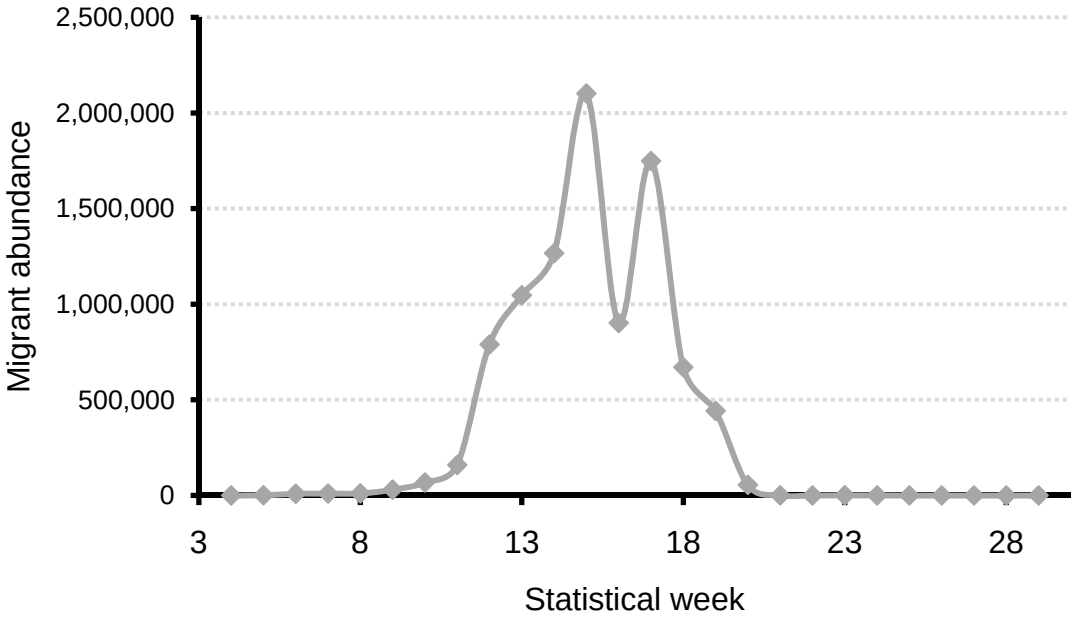

FIGURE 5. ─Juvenile migrant abundance of pink salmon by statistical week in the Green River, 2008.

Hatchery Releases

The data collected on all hatchery fish released above the trap site was limited to actual and estimated catches for missed fishing periods. No hatchery Chinook fry were captured. Yearling hatchery releases were captured for Chinook, coho, and steelhead. However, migration and survival estimates for hatchery coho, steelhead and yearling Chinook could not be calculated because no efficiency data were available for their natural-origin counterparts in 2008.

A total of 914 hatchery Chinook (677 ad-marked, 237 ad-marked/CWT) were captured between April 7 and May 10, 2008. The largest catch occurred on April 15, with 750 hatchery yearlings (82% of the total catch). No additional catch was estimated for periods of suspended trapping.

A total of 560 hatchery coho (410 ad-marked, 150 ad-marked/CWT) were captured between January 26 and June 6, 2008 (Appendix D). An additional 23 smolts (16 ad-marked, 7 ad-marked/CWT) were estimated for periods of suspended trapping. Peak catch occurred on May 6, with 362 smolts captured. An additional 23 smolts (16 ad-marked and 7 ad-marked/CWT) were estimated for periods of suspended trapping.

A total of 437 hatchery steelhead smolts were captured between April 15 and June 27, 2008 (Appendix D). Peak catch occurred on May 14, with 83 smolts captured, corresponding with an increase in flow. An additional 105 smolts were estimated for periods of suspended trapping.

Other Species

In addition to species and age classes described above, catch during the trapping season included 831 coho fry, 104 steelhead parr, 4 cutthroat smolts, 4 cutthroat parr, and 2 cutthroat adults. 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.

Discussion

The Green River produces a diversity of salmonid species, with variable life history strategies. Herein, we have provided production estimates of natural-origin Chinook sub-yearlings, pink fry, and a combined production estimate for natural and hatchery-origin chum during the 2008 outmigration period.

Assumptions

The mark-recapture approach used to derive juvenile production estimates was based on six assumptions (Hayes et al. 2007). Violation of an assumption has potential to bias estimates derived from the mark-recapture study. Consideration of assumptions and the accuracy of abundance and survival estimates are discussed below.

Assumption 1. Population is geographically closed and no immigration or emigration has occurred. This assumption is technically violated because the trap catches downstream migrants that are emigrating from the river. This issue is addressed with a time-stratified study design that provides multiple, more instantaneous measures of juvenile abundance. The time-stratified study design does assume that all captured juveniles are leaving the system. This assumption would be violated if some individuals are caught while redistributing in the river. Redistribution is likely for coho and steelhead caught in January and February, as these are not typical migration months for these species. Recapture rates of coho caught during these months were unusually high and may be explained if the fish were lingering near the trap rather than moving downstream. This assumption would also be violated if some individuals in the population are not anadromous. Residency is unlikely for juvenile Chinook, chum, or pink, or coho but possible for cutthroat and steelhead.

Assumption 2. Population is demographically closed with no births or deaths. This assumption would be violated if new juveniles recruited into the cohort or if deaths occurred between the period of mark and recapture. With one exception, this assumption was met. Trapping occurred outside the spawning season (i.e., no births). Deaths between the mark and recapture period were unlikely given the short time interval. A possible source of mortality was predation on juvenile fry in the live box of the trap. This bias is most likely to impact catch and recapture of Chinook, chum, and pink fry (due to their small size) even though traps were checked regularly and every effort was made to minimize predation. If substantial predation occurred on maiden captures in the live box, catch and migration would be underestimated for this time period. If substantial predation occurred on recaptured fish in the live box, efficiency would be underestimated and migration overestimated for this time period.

Assumption 3. No marks are lost or missed. This assumption would be violated if dye or fin clips were not recognized on recaptured fish. This assumption was likely met. None of the marks used (clips, dye) were likely to be "lost" over 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. 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 4. Marking does not change fish behavior or vulnerability to capture. This assumption would be violated if marked fish either avoided the trap or were more prone to

capture than they were during the maiden capture event. Trap avoidance of marked fish would overestimate migrant abundance whereas trap attraction of marked fish would underestimate migrant abundance. Behavioral differences between maiden captures and recaptured fish are unknown. However, the ability to behaviorally avoid the trap under in-stream flows is more likely for coho or steelhead than the smaller subyearling Chinook, chum or pink salmon.

Assumption 5. 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). Marked fish were released at an upstream location selected to maximize mixing of marked and unmarked fish. Between the release and recapture sites, the river bend and fast flowing water was expected to maximize dispersal of marked fish. For this reason, we expect that random mixing did occur between marked and unmarked fish.

Assumption 6. All animals have an equal probability of capture that does not change over time. This assumption would be violated if trap efficiency changes over time or if some fish are not moving in a unidirectional 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. Equal probability of capture would also be violated if a portion of the juvenile fish were caught because they were redistributing in the creek rather than in process of a downstream migration. Lack of unidirectional 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 subyearling fish (Chinook, chum, and pink) were likely to be in process of a downstream migration. Marked subyearling 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, a trap site low in the river system is typically the preferred location for a juvenile salmon trap. However, trap site selection is also influenced by channel configurations, river flow velocities, and hatchery releases. In the Green River, the selected trap site 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.

In addition to estimator assumptions, the accuracy of Chinook production estimates from the Green River was partially dependent on accuracy of estimated catches during periods when the trap was not operating. As Chinook have the most extended migration of any species in our study, nonoperational trap periods need to be examined at the beginning, middle, and end of the trapping season. A minimal number of Chinook were caught on the first and last day of trapping, indicating that total migration may be underestimated. As the onset and termination of the Chinook migration is unknown, a more complete migration estimate would only be possible by increasing the scope of the project and 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 estimate provided herein. Mid-season trapping operations were suspended on three occasions. Based on consistent catches before and after the outages, we assume that no major migration occurred during the mid-season trap outages and that the

estimates of missed catch are realistic. During the final two weeks of the season, trapping operations were suspended 15 times for a total of 175 hours during day time periods to avoid interactions with the public. We estimated 81 Chinook fry would have been captured had we not suspended trapping.

Subyearling Chinook

Total watershed production of subyearling Chinook was 546,756 in 2008. This estimate is based on Chinook production and egg-to-migrant survival above the Green River trap applied to spawning below the trap. Spawning below the trap was the number of redds on the main stem and the number of females released above the Big Soos Creek hatchery weir. Total watershed production included 67,478 juvenile Chinook produced from 438 females below the trap and 104,144 juvenile Chinook produced from 676 females released above the weir on Big Soos Creek. Soos Creek production is likely underestimated with this method because flow velocities are lower in this tributary than in the main-stem Green River. Low velocities during the incubation period should lessen egg mortality due to scour and sediment movement.

Chinook production above the Green River trap has ranged between 102,728 and 728,216 over the eight years of this study. The 2008 production was slightly below the average production of 393,830 subyearling Chinook. Over this time period, the number of female spawners has not been a good predictor of juvenile production (Figure 6).

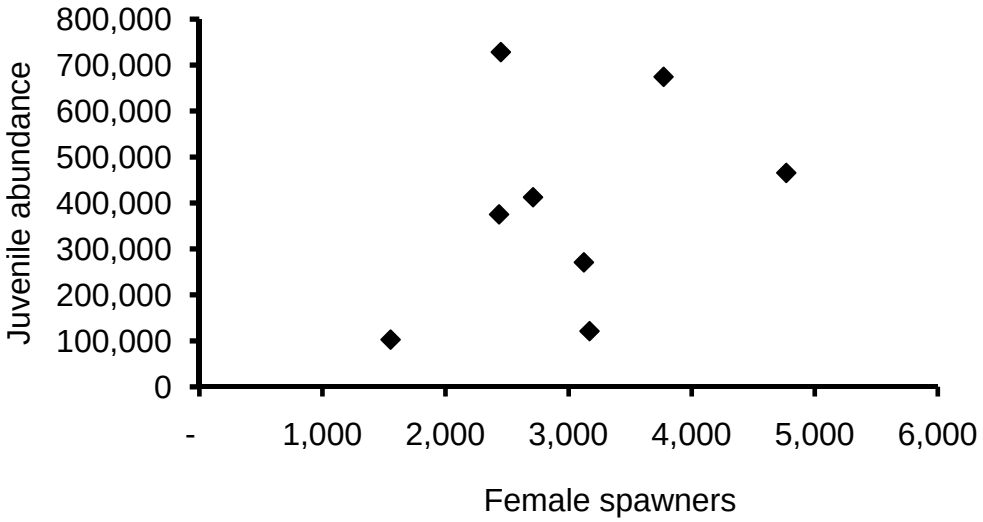

FIGURE 6.—Subyearling Chinook production as a function of female spawners in the Green River, brood year 2000-2007. Data are estimates above the Green River screw trap for each brood year.

Egg-to-migrant survival has ranged from 0.85% to 6.6% over the eight years of study (Table 6). The 3.40% survival for the 2007 brood year was slightly higher than the average of 2.9%. During the study period, egg-to-migrant survival has been negatively correlated with peak flows during the incubation period (Figure 7). Peak incubation flows for this analysis were the maximum of mean daily flows at USGS gage# 12106700 (near Palmer, Washington) between November 1 and February 28. This relationship, combined with the lack of a relationship between spawners and production, suggests that the effects of incubation flow may be over-riding potential effects of spawner abundance on Chinook production in the Green River.

TABLE 6.—Egg-to-migrant survival rates correlated with flow (USGS gage# 12106700, near Palmer WA) in the Green River for brood years 2000-2007. Flow statistic represents maximum of mean daily flows between November 1 and February 28 of each year

Brood Year	Trap Year	# Redds Female	Estimated Egg deposition	Estimated Migration	Survival	Peak Winter Flow (cfs)
2000	2001	2,449	11,020,500	728,216	6.61%	1,632
2001	2002	2,711	12,199,500	412,460	3.38%	5,400
2002	2003	3,772	16,974,000	674,397	3.97%	6,099
2003	2004	3,124	14,058,000	270,877	1.93%	4,962
2004	2005	4,769	21,460,500	465,531	2.17%	5,972
2005	2006	1,553	6,988,500	102,728	1.47%	6,321
2006	2007	3,170	14,200,000	121,295	0.85%	7,992
2007	2008	2,435	10,957,500	373,053	3.40%	3,789

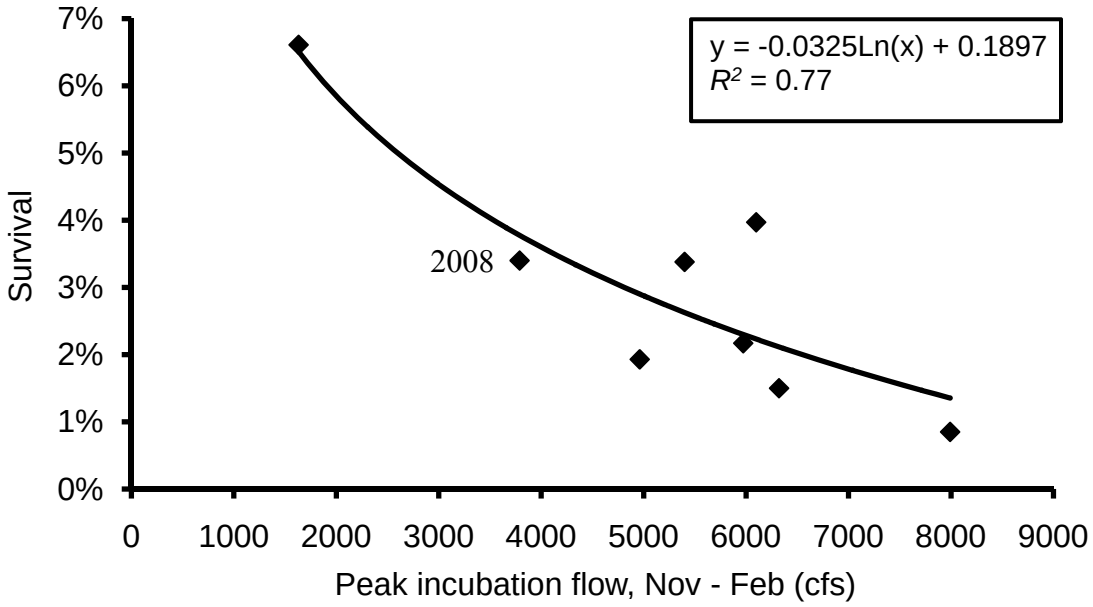

FIGURE 7.—Natural-origin sub-yearling Chinook egg-to-migrant survival in the Green River as a function of peak winter flow (USGS gage#12106700 near Palmer) between 2001-2008 (migration years).

Timing of the 2008 outmigration was bimodal, a pattern that has been observed in previous years on the Green River and for Chinook outmigrations in other Puget Sound watersheds. The two approaches used to estimate the fry and parr components yielded similar abundance estimates each components of the migration. Because the size threshold should be more sensitive than date selection to inter-annual changes in emergence timing, the size threshold will be used to describe the fry and parr components in future analyses.

The proportion of parr migrants has ranged from 2% to 69% between 2001 and 2008 (Table 7). Over this period, fry abundance was positively related with total juvenile production (Figure 8). In comparison, parr abundance was not a function of total juvenile production. One explanation for these results is that the fry component of the outmigration is composed of juvenile Chinook that either volitionally move downstream soon after emergence or are displaced downstream during flow events. Under this explanation, the parr component of the outmigration are juveniles that maintain position in the river during flow events, rear to larger

sizes before emigrating, and emigrate later in the season (i.e., during June rather than March). Therefore, the parr component of the outmigration may represent the rearing capacity of the river for the subyearling life history stage of Chinook. The fate of small fry versus larger parr migrants is unknown; however, survival upon saltwater entry is hypothesized to increase with size.

The exception to the observed pattern was the 2001 outmigration (BY 2000) where the parr component of the outmigration was 342,000 Chinook, nearly three times the abundance of parr migrants in any other year. This year was also exceptional in that flows remained minimal throughout the incubation and emergence period for the BY 2000 Chinook (i.e., "winter without rain", Seiler et al. 2004). Future analysis will focus on the interaction between outmigrant abundance, incubation flows, and rearing flows as related to fry and parr components of outmigrant abundance.

TABLE 7.—Production estimates for natural-origin Chinook above the Green River trap site (BY 2000 to 2007). Production is represented as the total migration and as the fry and parr components of the migration.

Trap Year	Total		Fry			Parr		
	Migration Interval	Estimated Migration	Migration Interval	Estimated Migration	% of Total	Migration Interval	Estimated Migration	% of Total
2001	1/1-7/13	728,216	1/1-4/15	386,315	53.0%	4/16-7/13	341,901	47.0%
2002	2/7-7/11	412,460	2/7-5/1	358,313	87.0%	5/2-7/11	54,147	13.0%
2003	1/1-7/13	674,397	1/1-4/15	659,568	98.0%	4/16-7/13	14,829	2.0%
2004	1/1-7/14	270,877	1/1-4/15	171,181	63.0%	4/16-7/14	99,696	37.0%
2005	1/1-7/13	465,531	1/1-4/15	425,585	91.4%	4/16-7/13	39,946	8.6%
2006	1/24-7/16	102,728	1/24-4/23	32,195	31.3%	4/24-7/16	70,533	69.1%
2007	1/23-7/31	121,295	1/23-4/18	84,687	69.8%	4/19-7/31	36,607	30.2%
2008	1/23-7/14	373,053	1/23-4/20	234,449	62.8%	4/21-7/31	138,604	37.2%

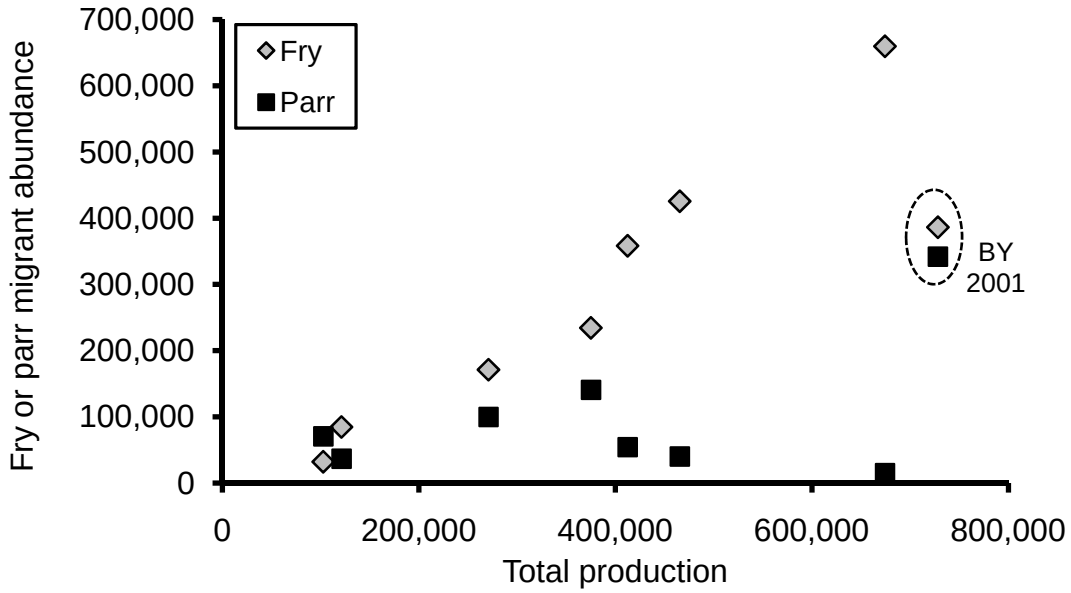

FIGURE 8.—Abundance of fry (gray diamonds) and parr (black squares) migrants as a function of total Chinook production above the Green River screw trap, brood year 2000-2007.

Pinks

Freshwater production of pink salmon has steadily increased over the course of this study from a production estimate of 35,000 pink fry in 2000 (BY 1999) to a production of 9.3 million in 2006 (BY 2005) and 2008 (BY 2007) (Figure 9). Although WDFW does not estimate pink escapement in the Green River, pink salmon in neighboring Puget Sound rivers, such as the Puyallup, have experienced a dramatic increase in escapement between the 1999 to 2007 brood years. Increased juvenile production in the Green River likely reflects increasing returns of pink spawners to the Green River.

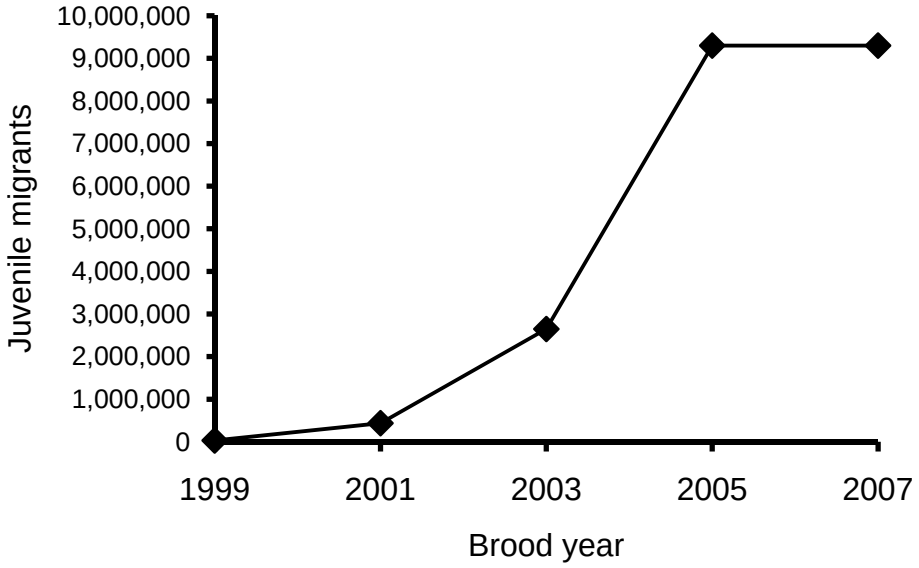

FIGURE 9.—Freshwater production of pink salmon above the Green River screw trap, brood year 1999-2007.

Yearling Migrants

Due to low catches of yearling Chinook and steelhead, production estimates of these species are typically based on coho efficiency trials. In 2008, river velocities at our trapping location were low and resulted in no recaptures of any of the marked natural-origin coho during the peak migration period (March through July). Coho caught in January and February were not fully smolted and were recaptured at an exceptionally high rate (13-75%), a result that was likely due to dispersal around the trap location rather than active downstream migration. The Green River trap is located far enough up river that dispersal during the months of January and February would be expected for coho yearlings. Without coho efficiency data, no 2008 estimates of production, migration, or survival rates were calculated for natural-origin or hatchery-origin coho, steelhead, and yearling Chinook.

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.

NOTE: This derivation was written using a different notation than this report. Variable conversions are as follows:

Derivation = Report

$$\hat{U}_i = \hat{N}_j$$

$$\hat{u}_i = n_{2j}$$

$$M_i = n_{1j}$$

$$m_i = m_{2j}$$

****

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,

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

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

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

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

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

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

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

Note that,

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

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

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

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

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

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

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

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

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

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

Appendix B

Daily catch and migration estimate for natural-origin, subyearling Chinook in the Green River, 2008.

APPENDIX B. —Actual and estimated daily catches and migration for natural-origin sub-yearling Chinook migrants in the Green River, 2008. 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	
1/23/08	18.25		9		9	218
1/24/08	22.50		14		14	340
1/25/08	24.00		20		20	485
1/26/08	24.00		4		4	97
1/27/08	25.50		28		28	679
1/28/08	22.50		22		22	534
1/29/08	24.00		35		35	849
1/30/08	24.00		59		59	1,431
1/31/08	24.00		126		126	3,057
2/1/08	23.75		81		81	1,965
2/2/08	15.75	8.25	50	32	82	1,989
2/3/08	20.25	3.75	49	5	54	1,310
2/4/08	24.00		33		33	801
2/5/08	24.00		174		174	4,221
2/6/08	24.00		128		128	3,105
2/7/08	24.00		125		125	2,288
2/8/08	23.75		26		26	476
2/9/08	10.00	14.00	122	63	185	3,386
2/10/08		24.00		137	137	2,507
2/11/08	14.00	10.00	110	74	184	3,368
2/12/08	24.00		115		115	2,105
2/13/08	24.00		69		69	1,263
2/14/08	24.00		48		48	879
2/15/08	24.33		36		36	659
2/16/08	24.17		35		35	641
2/17/08	24.00		47		47	860
2/18/08	24.00		33		33	604
2/19/08	24.00		13		13	238
2/20/08	22.50		29		29	1,027
2/21/08	25.50		53		53	1,876
2/22/08	23.50		61		61	2,160
2/23/08	24.00		55		55	1,947
2/24/08	24.00		41		41	1,452
2/25/08	24.00		54		54	1,912
2/26/08	24.00		65		65	726
2/27/08	24.00		86		86	960
2/28/08	24.00		95		95	3,330
2/29/08	24.00		90		90	3,155

Table continued next page

APPENDIX B.—Actual and estimated daily catches and migration for natural-origin sub-yearling Chinook migrants in the Green River, 2008. 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	
3/1/08	24.00		352		352	12,338
3/2/08	24.00		173		173	6,064
3/3/08	24.00		95		95	3,330
3/4/08	24.00		166		166	5,818
3/5/08	24.00		144		144	5,047
3/6/08	24.00		108		108	3,785
3/7/08	24.00		101		101	3,540
3/8/08	24.25		160		160	5,608
3/9/08	24.25		68		68	2,383
3/10/08	24.00		202		202	7,080
3/11/08	24.00		438		438	15,352
3/12/08	24.00		161		161	5,643
3/13/08	24.00		93		93	3,260
3/14/08	21.50		93		93	3,260
3/15/08	26.50		129		129	4,522
3/16/08	24.00		136		136	4,767
3/17/08	24.00		120		120	4,206
3/18/08	24.00		114		114	3,996
3/19/08	24.00		74		74	2,594
3/20/08	23.50		118		118	4,136
3/21/08	24.00		208		208	7,291
3/22/08	24.00		60		60	2,103
3/23/08	24.00		202		202	7,080
3/24/08	24.00		159		159	5,573
3/25/08	24.00		70		70	2,454
3/26/08	24.00		158		158	5,538
3/27/08	24.00		136		136	4,767
3/28/08	24.00		169		169	1,070
3/29/08	24.00		99		99	1,957
3/30/08	24.00		108		108	2,135
3/31/08	24.00		102		102	2,016
4/1/08	24.00		184		184	3,637
4/2/08	24.00		160		160	3,162
4/3/08	24.00		30		30	593
4/4/08	24.00		226		226	4,467
4/5/08	24.00		70		70	1,383
4/6/08	24.00		210		210	4,150
4/7/08	24.00		54		54	1,067
4/8/08	24.00		55		55	1,087
4/9/08	24.00		22		22	435
4/10/08	24.00		62		62	1,225
4/11/08	24.00		45		45	889
4/12/08	24.00		42		42	830
4/13/08	24.00		34		34	672

Table continued next page

APPENDIX B.—Actual and estimated daily catches and migration for natural-origin sub-yearling Chinook migrants in the Green River, 2008. 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	
4/16/08	25.00		31		31	613
4/17/08	24.00		8		8	158
4/18/08	23.00		9		9	178
4/19/08	24.50		5		5	99
4/20/08	24.00		2		2	40
4/21/08	24.00		8		8	158
4/22/08	23.50		8		8	158
4/23/08	24.00		2		2	40
4/24/08	24.00		10		10	198
4/25/08	24.00		17		17	336
4/26/08	24.00		7		7	138
4/27/08	24.00		9		9	178
4/28/08	24.00		23		23	455
4/29/08	24.00		27		27	534
4/30/08	24.00		10		10	198
5/1/08	24.00		10		10	198
5/2/08	24.00		6		6	119
5/3/08	24.00		6		6	119
5/4/08	24.00		13		13	257
5/5/08	24.00		7		7	138
5/6/08	24.00		10		10	198
5/7/08	24.00		20		20	395
5/8/08	24.00		8		8	158
5/9/08	24.00		13		13	257
5/10/08	24.00		13		13	257
5/11/08	24.00		5		5	99
5/12/08	24.00		23		23	455
5/13/08	24.00		36		36	712
5/14/08	24.00		19		19	376
5/15/08		24.00		28	28	553
5/16/08		24.00		16	16	316
5/17/08		24.00		34	34	672
5/18/08		24.00		37	37	731
5/19/08	11.00	13.00	12	19	31	613
5/20/08	24.00		43		43	850
5/21/08	24.00		42		42	830
5/22/08	24.00		63		63	1,245
5/23/08	24.00		38		38	751
5/24/08	24.00		71		71	1,403
5/25/08	24.00		69		69	1,364
5/26/08	24.00		64		64	1,265
5/27/08	24.00		49		49	968
5/28/08	24.00		22		22	435
5/29/08	24.00		34		34	672
5/30/08	24.00		197		197	3,893
5/31/08	24.00		505		505	9,981

Table continued next page

APPENDIX B.—Actual and estimated daily catches and migration for natural-origin sub-yearling Chinook migrants in the Green River, 2008. Migration estimate is based on daily catch adjusted by the trap efficiency for each pooled time stratum.

Date	Time Fished Hours		Unmakred Chinook Catch			Migration
	In	Out	Actual	Estimated	Total	
6/1/08	24.00		561		561	11,088
6/2/08	24.00		609		609	12,036
6/3/08	24.00		375		375	7,411
6/4/08	24.00		190		190	3,755
6/5/08	24.00		157		157	3,103
6/6/08	24.00		720		720	14,230
6/7/08	24.00		395		395	7,807
6/8/08	24.00		134		134	2,648
6/9/08	24.00		97		97	1,917
6/10/08	24.00		82		82	1,621
6/11/08	24.00		49		49	968
6/12/08	24.00		70		70	1,383
6/13/08	24.00		122		122	2,411
6/14/08	24.00		183		183	3,617
6/15/08	24.00		142		142	2,806
6/16/08	24.00		136		136	2,688
6/17/08	24.00		106		106	2,095
6/18/08	24.00		136		136	2,688
6/19/08	25.50		53		53	1,047
6/20/08	25.00		22		22	435
6/21/08	24.00		40		40	791
6/22/08	21.50		32		32	632
6/23/08	24.00		89		89	1,759
6/24/08	24.00		58		58	1,146
6/25/08	24.00		44		44	870
6/26/08	25.50		62		62	1,225
6/27/08	12.00	12.50	31	9	40	791
6/28/08	12.50	12.00	21	9	30	593
6/29/08	12.00	11.50	12	9	21	415
6/30/08	12.00	12.00	24	9	33	652
7/1/08	24.00		48		48	949
7/2/08	12.00	12.00	28	6	34	672
7/3/08	24.00		65		65	1,285
7/4/08	12.50	12.00	69	6	75	1,482
7/5/08	13.00	11.50	72	6	78	1,542
7/6/08	12.00	11.00	56	6	62	1,225
7/7/08	12.00	12.00	31	3	34	672
7/8/08	12.00	12.00	24	3	27	534
7/9/08	12.00	12.00	23	3	26	514
7/10/08	25.50		37		37	731
7/11/08	13.00	10.50	27	3	30	593
7/12/08	13.00	11.00	14	3	17	336
7/13/08	12.00	11.00	10	3	13	257
7/14/08	11.67	12.00	23	3	26	514
Total	3,824.92	344.00	14,912	526	15,438	373,053

Appendix C

Fork lengths of natural-origin, subyearling Chinook in the Green River, 2008

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 2008.

Statistical Week			Average	St.Dev.	Range		Number	Percent Sampled	
Number	Begin	End			Min	Max	Sampled	Caught	%
4	01/21/08	01/27/08	39.7	2.00	35	43	23	75	30.7%
5	01/28/08	02/03/08	41.0	2.20	36	45	35	422	8.3%
6	02/04/08	02/10/08	40.5	1.70	38	44	31	608	5.1%
7	02/11/08	02/17/08	40.2	1.60	36	43	38	460	8.3%
8	02/18/08	02/24/08	39.8	1.80	36	43	21	285	7.4%
9	02/25/08	03/02/08	39.9	2.20	36	44	38	915	4.2%
10	03/03/08	03/09/08	40.8	1.70	38	45	38	842	4.5%
11	03/10/08	03/16/08	40.5	2.50	36	52	61	1,252	4.9%
12	03/17/08	03/23/08	39.8	2.40	36	46	55	896	6.1%
13	03/24/08	03/30/08	42.0	4.70	36	64	55	899	6.1%
14	03/31/08	04/06/08	41.7	3.20	36	51	39	982	4.0%
15	04/07/08	04/13/08	41.6	2.60	38	49	29	314	9.2%
16	04/14/08	04/20/08	43.0	3.80	38	52	19	164	11.6%
17	04/21/08	04/27/08	41.8	1.60	40	44	6	61	9.8%
18	04/28/08	05/04/08	45.8	6.80	39	60	16	95	16.8%
19	05/05/08	05/11/08	54.4	11.70	40	84	27	76	35.5%
20	05/12/08	05/18/08	54.5	14.40	38	83	12	78	15.4%
21	05/19/08	05/25/08	59.6	9.90	38	84	54	338	16.0%
22	05/26/08	06/01/08	61.8	12.30	42	94	100	1,432	7.0%
23	06/02/08	06/08/08	65.8	12.90	44	91	81	2,580	3.1%
24	06/09/08	06/15/08	70.4	12.30	48	96	35	745	4.7%
25	06/16/08	06/22/08	74.6	9.70	53	103	53	525	10.1%
26	06/23/08	06/29/08	75.4	9.40	57	92	30	317	9.5%
27	06/30/08	07/06/08	79.6	8.10	58	94	32	362	8.8%
28	07/07/08	07/13/08	84.3	11.70	58	106	23	166	13.9%
29	07/14/08	07/20/08	90.4	8.10	73	102	23	23	100.0%
Season Total			53.4	6.20	35	106	974	14,912	6.5%

Appendix D

Daily catch of coho, chum and pink salmon and cteelhead and cutthroat trout in the Green River, 2008

APPENDIX D.–Daily catches of coho, chum, and pink salmon, steelhead and cutthroat trout caught in the Green River screw trap in 2008. 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	Pink Fry	Steelhead Smolts		Steelhead Parr	Cutthroat Smolt	Cutthroat Parr	Cutthroat Adult
	In	Out	Nat	Hat	Total	Nat	Nat	Hat	Nat	Nat	Nat	Nat
01/23/08	18.3	0.0	5	0	0	0	2	0	3	0	0	0
01/24/08	22.5	0.0	7	0	0	0	3	0	1	0	0	0
01/25/08	24.0	0.0	11	1	0	2	2	0	2	0	0	0
01/26/08	24.0	0.0	4	0	0	0	2	0	4	0	0	0
01/27/08	25.5	0.0	9	0	0	4	4	0	5	0	0	0
01/28/08	22.5	0.0	8	0	0	7	0	0	2	0	0	0
01/29/08	24.0	0.0	14	0	0	12	4	0	7	0	0	0
01/30/08	24.0	0.0	16	0	0	15	0	0	2	0	0	0
01/31/08	24.0	0.0	11	0	0	28	0	0	4	0	0	0
02/01/08	23.8	0.0	8	0	0	25	0	0	3	0	0	0
02/02/08	15.8	8.3	5	0	0	16	0	0	2	0	0	0
02/03/08	20.3	3.8	3	0	0	17	1	0	0	0	0	0
02/04/08	24.0	0.0	4	0	1	22	0	0	0	0	0	0
02/05/08	24.0	0.0	6	0	0	79	0	0	3	0	0	0
02/06/08	24.0	0.0	2	0	0	80	1	0	1	0	0	0
02/07/08	24.0	0.0	3	0	0	111	0	0	4	0	0	0
02/08/08	23.8	0.0	2	0	0	29	7	0	3	0	0	0
02/09/08	10.0	14.0	2	0	3	300	4	0	2	0	0	0
02/10/08	0.0	24.0	2	0	2	230	4	0	2	0	0	0
02/11/08	14.0	10.0	1	0	2	360	0	0	1	0	0	0
02/12/08	24.0	0.0	5	0	2	52	0	0	1	0	1	0
02/13/08	24.0	0.0	2	0	5	87	1	0	2	0	0	0
02/14/08	24.0	0.0	0	0	2	112	1	0	3	0	0	0
02/15/08	24.3	0.0	3	0	0	131	1	0	3	0	0	0
02/16/08	24.2	0.0	3	0	3	111	0	0	0	0	0	0
02/17/08	24.0	0.0	0	0	6	115	0	0	0	0	0	0
02/18/08	24.0	0.0	2	0	4	52	0	0	1	0	0	0
02/19/08	24.0	0.0	0	0	4	58	0	0	0	0	0	0
02/20/08	22.5	0.0	0	0	13	60	0	0	0	0	0	0
02/21/08	25.5	0.0	0	0	9	208	0	0	1	0	0	0
02/22/08	23.5	0.0	3	0	2	5	0	0	0	0	1	0
02/23/08	24.0	0.0	0	0	14	385	0	0	0	0	0	0
02/24/08	24.0	0.0	0	0	7	288	0	0	1	0	0	0
02/25/08	24.0	0.0	0	0	67	331	0	0	0	0	0	0
02/26/08	24.0	0.0	0	0	49	362	0	0	0	0	0	0
02/27/08	24.0	0.0	0	0	35	449	0	0	1	0	0	0
02/28/08	24.0	0.0	0	0	11	467	1	0	1	0	0	0
02/29/08	24.0	0.0	0	0	14	156	0	0	0	0	0	0

Table continued next page

APPENDIX D.–Daily catches of coho, chum, and pink salmon, steelhead and cutthroat trout caught in the Green River screw trap in 2008. 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	Pink Fry	Steelhead Smolts		Steelhead Parr	Cutthroat Smolt	Cutthroat Parr	Cutthroat Adult
	In	Out	Nat	Hat	Total	Nat	Nat	Hat	Nat	Nat	Nat	Nat
03/01/08	24.0	0.0	1	0	56	820	0	0	5	0	0	1
03/02/08	24.0	0.0	7	0	16	314	0	0	3	1	0	0
03/03/08	24.0	0.0	2	0	31	239	0	0	0	0	0	1
03/04/08	24.0	0.0	0	0	2,258	862	1	0	0	0	0	0
03/05/08	24.0	0.0	1	0	2,048	751	0	0	1	0	0	0
03/06/08	24.0	0.0	1	0	584	782	0	0	1	0	0	0
03/07/08	24.0	0.0	0	0	246	993	0	0	1	0	0	0
03/08/08	24.3	0.0	1	0	415	1,365	0	0	1	0	0	0
03/09/08	24.3	0.0	2	0	118	1,494	0	0	1	0	0	0
03/10/08	24.0	0.0	0	0	272	2,641	0	0	0	0	0	0
03/11/08	24.0	0.0	1	0	329	1,642	0	0	0	0	0	0
03/12/08	24.0	0.0	0	0	62	1,717	0	0	0	0	0	0
03/13/08	24.0	0.0	0	0	115	1,205	1	0	0	0	0	0
03/14/08	21.5	0.0	0	0	122	1,605	0	0	0	0	0	0
03/15/08	26.5	0.0	0	0	133	2,502	0	0	1	0	0	0
03/16/08	24.0	0.0	0	0	98	1,890	0	0	1	0	0	0
03/17/08	24.0	0.0	0	0	115	1,770	0	0	0	0	0	0
03/18/08	24.0	0.0	0	0	233	2,838	0	0	0	0	0	0
03/19/08	24.0	0.0	0	0	357	4,592	0	0	0	0	0	0
03/20/08	23.5	0.0	0	0	306	5,162	0	0	0	0	0	0
03/21/08	24.0	0.0	0	0	461	6,551	0	0	0	0	0	0
03/22/08	24.0	0.0	0	1	306	5,460	0	0	1	0	0	0
03/23/08	24.0	0.0	0	0	802	9,500	0	0	0	0	0	0
03/24/08	24.0	0.0	0	1	341	7,193	0	0	1	0	0	0
03/25/08	24.0	0.0	0	0	203	5,399	0	0	0	0	0	0
03/26/08	24.0	0.0	0	0	520	5,520	0	0	1	0	0	0
03/27/08	24.0	0.0	2	0	314	5,663	0	0	0	0	0	0
03/28/08	24.0	0.0	0	0	477	5,853	0	0	0	0	0	0
03/29/08	24.0	0.0	0	0	368	7,870	1	0	1	0	0	0
03/30/08	24.0	0.0	0	2	746	10,070	0	0	1	0	0	0
03/31/08	24.0	0.0	1	1	793	10,490	0	0	0	0	0	0
04/01/08	24.0	0.0	1	0	16,148	10,370	0	0	0	0	0	0
04/02/08	24.0	0.0	4	1	4,523	13,156	0	0	2	0	0	0
04/03/08	24.0	0.0	2	0	877	13,900	0	0	0	0	0	0
04/04/08	24.0	0.0	0	0	1,392	14,207	0	0	0	0	0	0
04/05/08	24.0	0.0	0	0	1,147	14,860	0	0	0	0	0	0
04/06/08	24.0	0.0	0	0	1,377	12,781	0	0	1	0	0	0
04/07/08	24.0	0.0	0	2	775	9,904	0	0	0	0	0	0
04/08/08	24.0	0.0	0	2	1,354	12,409	0	0	0	0	0	0
04/09/08	24.0	0.0	0	1	1,254	13,170	0	0	0	0	0	0
04/10/08	24.0	0.0	0	0	11,700	24,000	0	0	0	0	0	0
04/11/08	24.0	0.0	0	1	3,844	29,300	0	0	0	0	0	0
04/12/08	24.0	0.0	1	1	1,761	28,244	0	0	0	0	0	0
04/13/08	24.0	0.0	0	0	1,782	17,750	2	0	0	0	0	0
04/14/08	24.0	0.0	4	4	975	3,258	0	0	0	0	0	0
04/15/08	23.0	0.0	2	1	1,609	9,720	0	1	1	0	0	0

Table continued next page

APPENDIX D.–Daily catches of coho, chum, and pink salmon, steelhead and cutthroat trout caught in the Green River screw trap in 2008. 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	Pink Fry	Steelhead Smolts		Steelhead Parr	Cutthroat Smolt	Cutthroat Parr	Cutthroat Adult
	In	Out	Nat	Hat	Total	Nat	Nat	Hat	Nat	Nat	Nat	Nat
04/16/08	25.0	0.0	1	0	860	7,875	1	0	0	0	0	0
04/17/08	24.0	0.0	1	0	747	6,537	0	0	0	0	0	0
04/18/08	23.0	0.0	0	4	624	5,898	0	1	1	0	0	0
04/19/08	24.5	0.0	0	2	1,069	5,987	0	0	0	0	0	0
04/20/08	24.0	0.0	0	1	745	5,410	0	0	0	0	0	0
04/21/08	24.0	0.0	0	0	2,401	8,900	0	0	1	0	0	0
04/22/08	23.5	0.0	0	0	2,138	11,170	0	0	0	0	0	0
04/23/08	24.0	0.0	1	0	3,335	15,269	0	0	0	0	0	0
04/24/08	24.0	0.0	1	0	6,539	12,722	0	0	0	0	0	0
04/25/08	24.0	0.0	1	0	6,960	12,623	1	1	1	0	0	0
04/26/08	24.0	0.0	4	0	3,171	13,800	0	2	0	0	0	0
04/27/08	24.0	0.0	5	1	5,392	12,160	0	1	1	0	0	0
04/28/08	24.0	0.0	0	1	4,709	12,663	0	1	1	0	0	0
04/29/08	24.0	0.0	6	3	3,436	5,178	1	1	0	0	0	0
04/30/08	24.0	0.0	5	0	3,576	3,818	0	8	0	0	0	0
05/01/08	24.0	0.0	4	1	1,354	3,149	0	6	0	0	0	0
05/02/08	24.0	0.0	4	0	2,057	3,700	0	6	1	0	0	0
05/03/08	24.0	0.0	0	0	833	1,900	0	6	0	0	0	0
05/04/08	24.0	0.0	4	0	1,386	2,810	0	8	0	0	0	0
05/05/08	24.0	0.0	4	24	722	1,650	1	10	0	0	0	0
05/06/08	24.0	0.0	12	362	292	1,205	9	15	0	0	1	0
05/07/08	24.0	0.0	8	48	255	326	5	7	0	0	0	0
05/08/08	24.0	0.0	2	20	255	250	2	5	1	0	0	0
05/09/08	24.0	0.0	11	30	455	276	3	2	0	0	0	0
05/10/08	24.0	0.0	6	6	1,216	366	2	9	0	0	0	0
05/11/08	24.0	0.0	5	4	747	400	3	6	0	0	0	0
05/12/08	24.0	0.0	18	6	491	338	4	17	1	0	0	0
05/13/08	24.0	0.0	22	6	235	104	8	4	0	0	0	0
05/14/08	24.0	0.0	36	17	64	17	15	68	0	0	0	0
05/15/08	0.0	24.0	30	12	150	61	12	36	0	0	0	0
05/16/08	0.0	24.0	21	9	86	31	8	35	0	0	0	0
05/17/08	0.0	24.0	6	1	78	8	4	14	0	0	0	0
05/18/08	0.0	24.0	5	1	65	0	7	16	0	0	0	0
05/19/08	11.0	13.0	7	0	53	0	5	6	0	0	0	0
05/20/08	24.0	0.0	3	0	91	0	8	25	0	0	0	0
05/21/08	24.0	0.0	4	1	55	1	9	11	0	0	0	0
05/22/08	24.0	0.0	0	0	16	1	3	13	0	0	0	0
05/23/08	24.0	0.0	0	0	4	0	2	3	0	0	0	0
05/24/08	24.0	0.0	2	0	8	3	3	9	0	0	0	0
05/25/08	24.0	0.0	2	0	6	1	0	6	0	0	0	0
05/26/08	24.0	0.0	1	0	10	0	0	3	0	0	0	0
05/27/08	24.0	0.0	1	0	7	0	0	0	0	0	0	0
05/28/08	24.0	0.0	0	0	6	0	0	0	0	0	0	0
05/29/08	24.0	0.0	1	0	3	0	0	0	0	0	0	0
05/30/08	24.0	0.0	3	1	3	0	4	13	0	0	0	0
05/31/08	24.0	0.0	4	1	11	0	8	14	1	0	1	0

Table continued next page

APPENDIX D.–Daily catches of coho, chum, and pink salmon, steelhead and cutthroat trout caught in the Green River screw trap in 2008. 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	Pink Fry	Steelhead Smolts		Steelhead Parr	Cutthroat Smolt	Cutthroat Parr	Cutthroat Adult
	In	Out	Nat	Hat	Total	Nat	Nat	Hat	Nat	Nat	Nat	Nat
06/01/08	24.0	0.0	4	0	8	0	7	17	3	0	0	0
06/02/08	24.0	0.0	5	0	11	6	5	31	2	0	0	0
06/03/08	24.0	0.0	2	1	5	0	6	20	2	0	0	0
06/04/08	24.0	0.0	0	0	7	0	3	10	1	0	0	0
06/05/08	24.0	0.0	1	0	3	0	0	6	0	0	0	0
06/06/08	24.0	0.0	2	1	4	0	15	36	1	0	0	0
06/07/08	24.0	0.0	0	0	4	3	5	10	0	0	0	0
06/08/08	24.0	0.0	0	0	1	0	0	1	0	1	0	0
06/09/08	24.0	0.0	0	0	2	0	2	1	0	0	0	0
06/10/08	24.0	0.0	2	0	1	0	0	3	0	0	0	0
06/11/08	24.0	0.0	0	0	2	0	0	0	0	0	0	0
06/12/08	24.0	0.0	2	0	2	0	0	1	0	0	0	0
06/13/08	24.0	0.0	0	0	3	0	0	1	0	0	0	0
06/14/08	24.0	0.0	0	0	1	2	1	4	0	0	0	0
06/15/08	24.0	0.0	0	0	1	1	0	3	0	0	0	0
06/16/08	24.0	0.0	3	0	1	0	0	3	0	0	0	0
06/17/08	24.0	0.0	0	0	0	0	0	1	2	0	0	0
06/18/08	24.0	0.0	5	0	0	0	0	3	0	0	0	0
06/19/08	25.5	0.0	2	0	0	0	0	0	0	0	0	0
06/20/08	25.0	0.0	1	0	1	0	1	0	0	0	0	0
06/21/08	24.0	0.0	2	0	0	0	0	0	0	1	0	0
06/22/08	21.5	0.0	0	0	1	0	0	0	0	0	0	0
06/23/08	24.0	0.0	2	0	0	0	1	0	0	0	0	0
06/24/08	24.0	0.0	1	0	0	0	0	0	0	0	0	0
06/25/08	24.0	0.0	0	0	0	1	0	0	0	1	0	0
06/26/08	25.5	0.0	2	0	1	0	0	1	0	0	0	0
06/27/08	12.0	12.5	0	0	0	0	0	1	0	0	0	0
06/28/08	12.5	12.0	2	0	0	0	0	0	0	0	0	0
06/29/08	12.0	11.5	1	0	0	0	0	0	0	0	0	0
06/30/08	12.0	12.0	2	0	1	0	0	0	0	0	0	0
07/01/08	24.0	0.0	0	0	0	0	1	0	0	0	0	0
07/02/08	12.0	12.0	0	0	0	0	0	0	0	0	0	0
07/03/08	24.0	0.0	4	0	0	0	0	0	0	0	0	0
07/04/08	12.5	12.0	0	0	0	0	0	0	0	0	0	0
07/05/08	13.0	11.5	3	0	0	0	0	0	0	0	0	0
07/06/08	12.0	11.0	0	0	0	0	0	0	0	0	0	0
07/07/08	12.0	12.0	0	0	0	0	0	0	0	0	0	0
07/08/08	12.0	12.0	2	0	0	0	0	0	0	0	0	0
07/09/08	12.0	12.0	0	0	0	0	0	0	0	0	0	0
07/10/08	25.5	0.0	0	0	0	0	0	0	0	0	0	0
07/11/08	13.0	10.5	2	0	0	0	0	0	0	0	0	0
07/12/08	13.0	11.0	0	0	0	0	0	0	0	0	0	0
07/13/08	12.0	11.0	0	0	0	0	0	0	0	0	0	0
07/14/08	11.7	12.0	0	0	0	0	0	0	0	0	0	0
Total	3824.9	344.0	477	583	120,794	503,168	218	542	109	4	4	2

Appendix E

Fork lengths of natural-origin coho in the Green River, 2008

APPENDIX E.─Mean fork length (mm), standard deviation (St.Dev.), range, and sample size of natural-origin coho smolts in the Green River in 2008.

Statistical Week			Average	St.Dev.	Range		Number
No	Begin	End			Min	Max	Sampled
4	01/21/08	01/27/08	97.2	8.62	79	110	29
5	01/28/08	02/03/08	101.5	9.86	79	132	60
6	02/04/08	02/10/08	93.0	4.73	86	98	7
7	02/11/08	02/17/08	95.8	9.73	76	112	12
8	02/18/08	02/24/08	101.8	8.35	91	110	5
9	02/25/08	03/02/08	111.0	6.32	98	118	8
10	03/03/08	03/09/08	95.0	18.88	60	113	7
11	03/10/08	03/16/08	108.0	n/a	108	108	1
12	03/17/08	03/23/08	----	----	----	----	0
13	03/24/08	03/30/08	111.0	1.41	110	112	2
14	03/31/08	04/06/08	102.5	6.37	95	110	8
15	04/07/08	04/13/08	92.0	n/a	92	92	1
16	04/14/08	04/20/08	110.3	7.40	95	118	8
17	04/21/08	04/27/08	115.0	11.80	98	131	12
18	04/28/08	05/04/08	112.9	7.73	93	123	17
19	05/05/08	05/11/08	112.6	9.93	93	130	49
20	05/12/08	05/18/08	111.2	6.71	99	121	18
21	05/19/08	05/25/08	114.2	11.37	88	131	13
22	05/26/08	06/01/08	112.2	11.10	96	128	14
23	06/02/08	06/08/08	114.1	7.49	98	122	9
24	06/09/08	06/15/08	102.0	16.97	90	114	2
25	06/16/08	06/22/08	94.4	6.83	84	105	10
26	06/23/08	06/29/08	92.5	7.45	83	105	8
27	06/30/08	07/06/08	91.1	5.80	80	100	9
28	07/07/08	07/13/08	93.0	7.07	88	98	2
29	07/14/08	07/20/08	----	----	----	----	0
Season Total			105.1	11.95	60	132	311

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