AGE AND LENGTH COMPOSITION OF COLUMBIA BASIN CHINOOK AND SOCKEYE SALMON AND STEELHEAD AT BONNEVILLE DAM IN 2007

Technical Report 08-04

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April 3, 2008

ABSTRACT

The Columbia River Inter-Tribal Fish Commission (CRITFC) conducted a field study at Bonneville Dam in 2007 to assess the age, length-at-age and stock composition of adult Pacific salmon migrating up the Columbia River. These data were then used to predict the 2008 Chinook salmon run. Adult spring, summer and fall Chinook salmon (Oncorhynchus tshawytscha), sockeye salmon (O. nerka) and summer-run steelhead (O. mykiss) were collected, sampled for scales and additional biological data, revived and released. Caudal fin clips were also taken from Chinook salmon and steelhead for later genetic analysis. Scales were examined to estimate age composition; the results contributed to an ongoing database for age structure of Columbia Basin salmon runs. Based on scale pattern analysis four-year-olds were the most abundant age group for both spring and fall Chinook salmon comprising 52.4% and 46.2% of their respective runs. Three-year-olds were the most abundant age class for summer Chinook making up 37.4% of the run. Three--year-olds were also the most abundant age group for sockeye salmon and steelhead comprising 39.9% and 59% of their respective runs. Based on fin marks for classification, the steelhead migration consisted of 81.9% hatchery- and 18.1% natural-origin steelhead. A-run steelhead, less than 78cm in length, comprised 88.9% of the steelhead run. B-run fish, equal to or greater than 78cm, comprised 11.1% of the run.

A year-class regression based on up to 20 years of data was used to predict spring, summer, and bright fall Chinook salmon population sizes for 2008. Based on three-year-old returns, the relationship predicts four-year-old returns of 251,100 (± 65,700, 90% predictive interval [PI]) spring Chinook, 58,300 (± 26,300, 90% PI) summer, and 90,000 (± 98,800, 90% PI) bright fall Chinook salmon for the 2008 runs. Based on four-year-old returns, the relationship predicts five-year-old returns of 16,300 (± 41,000, 90% PI) spring, 11,600 (± 9,000, 90% PI) summer, and 52,500 (± 41,300, 90% PI) bright fall Chinook salmon for the 2008 runs.

ACKNOWLEDGMENTS

We sincerely thank the following individuals for their assistance in this project: Bobby Begay, Ryan Branstetter, Denise Kelsey, Doug Hatch, Richard McConville, Jack McCormack, Winfred Perez, Rishi Sharma, Stuart Ellis, Marianne McClure, and Phil Roger of the Columbia River Inter-Tribal Fish Commission; Ben Hausman, Tammy Mackey, and Jon Rerecich of the US Army Corps of Engineers; Steven Lee of the University of Idaho; and John Sneva of the Washington Department of Fish and Wildlife.

This report is the result of research funded by US Government (Bureau of Indian Affairs, Department of Interior) Contract No. GTP00X90107 for implementation of the US-Canada Pacific Salmon Treaty and The Northwest Fisheries Science Center (NWFSC), of the National Oceanic and Atmospheric Administration Fisheries (NOAA-Fisheries).

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INTRODUCTION

In 1985, the US-Canada Pacific Salmon Treaty was formed to manage research and enhance Pacific salmon (PSC 2000). The treaty established the Spawning Escapement-Monitoring program to assess indicator stocks within the Columbia River Basin and improve methods for providing population estimates, escapement monitoring, establishing spawner-recruit relationships and developing harvest management approaches (PST 1985). As part of this program, the Columbia River Inter-Tribal Fish Commission (CRITFC) has developed a comprehensive research strategy to monitor the age and stock composition of adult Pacific salmon returning to the Columbia River. This project has monitored the above Bonneville Dam adult migration of sockeye salmon (*Oncorhynchus nerka*) since 1985, spring Chinook salmon (*O. tshawytscha*) since 1987, summer Chinook salmon since 1990, and up-river bright fall Chinook salmon since 1998. Data on these runs are provided in near real time at www.critfc.org.

At the request of the NOAA Fisheries Northwest Fisheries Science Center, summer steelhead (*O. mykiss*) were added to our sampling regime in 2004. The Conservation Biology Division (NOAA Fisheries) formed the Mathematical Biology and Systems Monitoring Program to develop, in collaboration with the existing Salmon Science Programs and Salmon Recovery Planning Teams, quantitative tools for assessing population and habitat status and recovery potential and progress. Monitoring the age structure, hatchery fraction and stock composition of the adult Columbia River summer steelhead provides valuable information for this program.

Scale pattern analysis, the analysis of concentric rings or circuli to provide records of previous life history, is a common method for age determination in Pacific salmon (Nielsen and Johnson 1983). Fast summer growth widens the distances between circuli on the scale and slow winter growth shortens the distance between circuli. Typically, age can be determined by counting the number of winters observed on the scale (Gilbert 1913, Rich and Holmes 1929). This method is valuable in Pacific salmon management because scales can be collected without sacrificing the fish and scale samples can be collected, processed, and aged promptly. Problems with this method may include variability in scale growth, scale resorption, and difficulties in age validation (Knudsen 1990, Beamish and McFarlane 1983).

Scale pattern analysis can also be used for stock identification if distinctive patterns can be linked to specific stocks. This method has generally been successful in discriminating Columbia River sockeye partly because there are only two major runs of sockeye in the system, which experience dramatically different early rearing environments (Fryer 1995). However, this method was found to be less successful with Chinook salmon where numerous populations can exhibit similar scale growth patterns. Currently a coast wide genetic database is being developed to create baseline microsatellite and SNP (Single Nucleotide Polymorphim) genetic data for individual Chinook populations throughout the region. This baseline genetic stock information can be utilized in mixed stock sampling to distinguish individual stocks and will be useful for the Chinook sampling program at Bonneville Dam.

The primary objectives for the 2007 sampling year were to estimate the age composition and length-at-age composition of Chinook, sockeye and steelhead using scale pattern analysis, to forecast the 2008 run size for Chinook salmon using the age composition data, to PIT tag summer Chinook and sockeye salmon, and to collect tissue samples for use in the development of a genetic stock monitoring and identification program for Chinook salmon and steelhead.

METHODS

Study Area

Research was conducted at the Adult Fish Facility (AFF) located adjacent to the Second Powerhouse at Bonneville Dam (river km 235) on the north side of the Columbia River (Figure 1). This facility uses a picket weir to divert migrating fish, ascending the Washington shore fish ladder, into the adult sampling facility collection pool. An attraction flow is used to draw fish through a false weir where they can be selected for sampling. Fish not selected and fish that have recovered from sampling are returned to the Washington Shore Fish ladder above the picket weir.

Chinook salmon generally migrate between March and November and are typically categorized into three races based on migration timing past Bonneville Dam. Since 2005, June 15 has been used by Columbia River Basin fish managers as the division between spring and summer Chinook salmon. Since this project has a 20 plus year data time series, the traditional race divisions were used in this report to maintain consistency for comparisons to past reports. Chinook salmon passing Bonneville from March 15 through May 31 are classified as spring Chinook, from June 1 through July 31 are classified as summer Chinook and August 1 through November 15 are classified as fall Chinook. The fall Chinook run consists of lower river Tules and the Upriver Bright fall Chinook. Based on the needs of the Pacific Salmon Commission, this study only collects information on Upriver Bright fall Chinook. Sockeye salmon typically migrate between May 15 and August 1 and summer-run steelhead between April 1 and October 31. The steelhead run is further divided into A- and B-run components based on length (greater than 78 cm for B-run).

Figure 1. Map of the Columbia River displaying federal dams. Bonneville Dam (rkm 235) is the lowest in the system.

Sample Design

Adult fish were sampled up to five days per Statistical Week[1] from March through October. A desired minimum sample size of 610 fish each was set for spring, summer, and fall Chinook, steelhead and sockeye salmon. This sample size was derived from simulations we conducted based on the work of Thompson (1987) and assumes that the sample is distributed approximately proportional to the weekly run size. It also assumes that our weekly sample represents a random sample of the run passing over Bonneville Dam that week. These sample sizes achieved precision and accuracy levels of $d=0.05$, $\alpha=0.10$ for age composition estimates. Additional samples were collected to buffer for unreadable scales as well as to provide more precision in weekly age composition estimates. The composite age and length-at-age estimates were calculated from weekly estimates weighted by the number of each species migrating past Bonneville Dam during the sample week (Fryer 1995). Weekly and annual fish passage[2] counts were obtained from DART (2007) and the Fish Passage Center (2007).

Fish Collection

Fish of each species were trapped at the AFF and anesthetized. Chinook salmon under 35 cm in length were not sampled to exclude precocious juveniles (known as *minijacks*). All sizes of sockeye and steelhead were sampled. Each fish was measured for fork length to the nearest 0.5 cm, checked for identifying fin marks, tags, coloration and condition. Scale samples were collected from all fish for aging and caudal fin tissue was collected from all Chinook salmon for genetic stock composition analysis. These genetic samples will be used in the development of a genetic stock identification program for Columbia River Chinook salmon. Beginning approximately May 15, all fish sampled were scanned for PIT tags and any PIT tag codes recorded. Summer Chinook and sockeye salmon sampled on or after June 1, 2007 were PIT tagged. All fish were revived in a freshwater tank or pool and returned to a fishway leading to the Washington shore fish ladder.

Fish Coloration and Condition

Fish coloration and condition were recorded for all species at the time of sampling. Coloration was based on qualitative observations with the categories of Bright, Intermediate and Dark. Overall fish condition was also qualitatively assessed and classified on a scale of 1 to 5. Fish classified as a 5 had no major injuries that break the skin, 4 had injuries that broke the skin, 3 had injuries that penetrate the muscle tissue, 2 had injuries that penetrate a body cavity and 1 are fish missing large sections of the body. In addition to the fish condition classification, specific recognizable injuries or afflictions were recorded. These included percentage of descaling, marine mammal injuries, net damage, parasites, fungus, headburn[3], gas bubble trauma, deformities, and various other injuries.

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1. Statistical Weeks are sequentially numbered calendar-year weeks starting with the week that includes January 1 (Week 1). Excepting the first and last weeks of most years, weeks are seven days long, beginning on Sunday and ending on Saturday. In 2006, for example, Statistical Week 15 began on April 9 and ended on April 15.
2. Tule fall Chinook counts are subtracted from the total fall Chinook counts to estimate the upriver bright fall Chinook.
3. Headburn, the exfoliation of skin and tissues of the jaw and cranial region, has been identified as a possible stress indicator of high river flow conditions or spillway discharge from dams (Elston 1996, Groberg 1996).

Age Determination

To minimize the scale sample rejection rate, six scales (three per side) were collected for each Chinook and steelhead sampled (Knudsen 1990) and four scales (two per side) were collected from each sockeye salmon sampled. Scales were mounted and pressed according to methods described by Clutter and Whitesel (1956) and the International North Pacific Fisheries Commission (1963). Individual samples were visually examined and categorized using well-established scale age-estimation methods (Gilbert 1913, Rich and Holmes 1929). A sub-sample of scales were independently reviewed by John Sneva of the Washington Department of Fish and Wildlife for corroboration of age estimates. Direct age validation (Beamish and McFarlane 1983) was not performed, as there were no marked fish whose age was known.

The European method for fish age description (Koo 1962) is used in this report. The number of winters a fish spent in freshwater (not including the winter of egg incubation) is described by an Arabic numeral followed by a period. The number following the period indicates the number of winters a fish spent in saltwater. Total age, therefore, is equal to one plus the sum of both numerals.

Age and Length-at-Age Composition

Age composition was determined by weighing the proportion of each age class sampled by the total counts of each species passing Bonneville dam during each Statistical Week. The length-at-age composition for each species sampled was determined by calculating the mean length for each age class present during each Statistical Week.

Steelhead Hatchery/Wild Determination

Most hatchery reared steelhead in the Columbia River Basin are marked by removing a fin, typically the adipose fin. Some hatchery-origin steelhead are released unmarked and to identify these individuals scale pattern analysis methods were developed by Oregon Department of Fish and Wildlife (ODFW) to determine hatchery versus wild origin. Hatchery steelhead typically experience faster freshwater growth which results in relatively wide spaces between circuli, whereas natural origin fish typically show much slower fresh water growth narrowing the distance between circuli. In addition, hatchery origin fish are reared to smolt in a single year whereas the natural origin fish tend to remain in fresh water for two to three years.

Due to the wide variety of requests for hatchery and wild determinations by various agencies using different methods, we decided in 2006 to allow the managing agencies to make their own determinations based on the raw age, scale pattern, and fin mark data. For this report hatchery and wild determinations are based on fin clips alone.

Steelhead A/B Run Determination

A-run steelhead occur throughout the Columbia and Snake river basins and rarely exceed the length of 78 cm, whereas B-run steelhead are thought to be produced only in the Clearwater, Middle Fork Salmon, and South Fork Salmon rivers and typically exceed 78cm (Busby et al. 1996). Determination of A-run or B-run was based on length measurement.

Steelhead Gender Determination

Methods developed by ODFW were used in gender determination. Gender was determined by snout and/or body shape. Male steelhead tend to have a more protruding snout and may have beak development. Female steelhead tend to have a more rounded, short snout and a wider body near the anus indicating they contain roe.

Steelhead Kelts

Unlike other species of Pacific salmon *(Oncorhynchus spp.),* anadromous steelhead naturally exhibit varying degrees of iteroparity (repeat spawning). Successful steelhead iteroparity involves downstream migration of kelts (post-spawned steelhead) to the estuary or ocean environments (Hatch et al. 2003). During scale pattern analysis we found a few steelhead scales to have a iteroparous scale pattern. A kelt scale age is indicated through the use of the letter "S" to indicate spawning. For instance, a steelhead of Age 1.2S1 would have one freshwater annulus, two saltwater annuli, a spawning check, followed by one saltwater annulus. Note that scale resorption often occurs in kelts which can eliminate saltwater annuli marks so a kelt is likely older than would be indicated by summing the annuli. .

Chinook Salmon Run-Size Prediction

Salmon mature and return to spawn between two and seven years of age. Age composition, life history and total age vary among species. For this analysis a brood year (BY) is defined as the year in which the eggs are fertilized and a brood is defined as all the returning progeny of a given BY. This run-size prediction model is based on the relationship between the survivors within a single brood returning at different ages in successive years.

Fryer and Schwartzberg (1994) determined that adult returns of Columbia basin Chinook are comprised almost entirely of 3, 4 and 5 year old fish, with the proportions of each age class being relatively constant across years. As such, the number of three-year-old fish for a given BY is a relatively good predictor of the number of four-year-old fish from the same BY that would return in the subsequent year. This relationship and a regression analysis (Neter et al. 1985, Weisberg 1985) were used to predict the abundance of four-year-old fish for 2008, based on the number of three-year-old fish estimated to have returned in 2007. A similar relationship was used to predict abundance of five-year-old fish in 2008, from the estimated number four-year-old fish that returned in 2007.

RESULTS

Sampling

Chinook salmon (spring, summer and fall) were sampled for 20 weeks (April through October) during their migration. A total of 966 spring Chinook were sampled, 1,122 summer Chinook and 1,074 fall Chinook (Tables 1, 2 and 3 respectively). A total of 550 sockeye salmon were sampled (Table 4) over 7 weeks (May through July), and 1,973 steelhead were sampled (Tables 5 and 6) over 28 weeks (April through October). Summer Chinook were not sampled between Statistical Weeks 29 and 31, and Fall Chinook were not sampled during Statistical Weeks 31 through 36 due to river water temperatures exceeding 21.1°C, which is approaching the lethal temperature for migrating adult Chinook salmon (McCullough 1999). At temperatures above 21.1°C, the sampling protocols for the Adult Fish Facility only allow sampling of steelhead one day per week between 6am and 10am and Chinook salmon cannot be sampled.

Age Composition

Based on scale pattern analysis four-year-olds were the most abundant age group for spring Chinook salmon comprising 52.4% of the run[4]. The second most abundant age group were three-year-old at 24.5% followed by five-year-olds at 22.6% (Table 1). Yearling migrants dominated the summer Chinook migration with the three-year-old 1.1 age class being the most abundant at 32.8% followed by the 1.3 (22.0%) and 1.2 (19.1%) (Table 2). Typically the proportion of sub-yearling migrants increase during the summer Chinook run but our sampling may not have picked up that trend due to sampling ending three weeks early due to the high water temperatures (Figure 2). Four-year-old fall Chinook were the most abundant age group at 46.2% followed by five-year-olds at 22.5% (Table 3).

The Sockeye salmon run was composed primarily of three-year-olds (39.9%) followed by 35.7% four-year-olds and 21.8% five-year-olds (Table 4). Three-year-old hatchery steelhead were the most abundant at 59% followed by four-year-olds at 24% (Table 5). As in past years the vast majority of the steelhead run are A-run (88.9%) and hatchery origin (81.9% based on fin clips). Of the unmarked presumably wild fish only 13.3% were B-run (Table 6).

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4 Age composition estimates for spring and summer Chinook using June 15th as the partition date can be found at http://www.critfc.org/

Table 1. Weekly and cumulative age composition of Columbia Basin spring Chinook at Bonneville Dam in 2007.

Statistical Week	Sampling Date	Number Sampled	Number Ageable	Weekly Run Size	2005	2004		2003		2002		2001		2000	Fin Clips	
					0.1	0.2	1.1	0.3	1.2	0.4	1.3	0.5	1.4	1.5	Adipose	Other
15[a]	4/13	14	13	1851					0.462		0.538				0.786	
16	4/16,4/19	64	47	7590					0.532		0.468				0.750	
17	4/14,21,24,26,28	69	150	17199			0.060		0.667		0.273				0.734	0.012
18	5/1,5/3,5/5	180	154	17034			0.214		0.584		0.195	0.006			0.756	0.011
19	5/7,8,9,10,11	200	170	17543			0.324		0.535	0.006	0.135				0.700	
20	5/14,15,16,17,18	200	174	10991			0.489		0.368		0.144				0.725	
21	5/21,22,24,25	133	120	6317		0.008	0.483		0.325		0.175	0.008			0.677	
22[b]	5/29,30,31	106	98	5787			0.316		0.408	0.010	0.214	0.010	0.041		0.610	
Through May 31		**966**	**926**	**84312**		**0.001**	**0.244**	**0.000**	**0.524**	**0.002**	**0.224**	**0.003**	**0.003**	**0.000**	**0.720**	**0.005**

Notes:

a The official spring Chinook salmon run begins on March 15, but sampling didn't begin until Week 15 when a sufficient sample could be collected. The weekly run size for Week 15 includes Chinook salmon passing Bonneville Dam from Week 11-15.

b. For comparison to past annual reports, data and adult return forecasting, spring Chinook are defined as the Chinook passing Bonneville dam between March 15 and May 31 for the weekly and cumulative age composition estimates. The age composition for spring Chinook through June 15 can be found on our web page (http://www.critfc.org/)

Table 2. Weekly and cumulative age composition of Columbia Basin summer Chinook salmon sampled at Bonneville Dam in 2007.

Statistical Week	Sampling Date	Number Sampled	Number Ageable	Weekly Run Size	2005	2004		2003		2002		2001		2000	Fin Clips	
					0.1	0.2	1.1	0.3	1.2	0.4	1.3	1.4	0.5	1.5	Adipose	Other
22[a]	6/1	40	31	2134	0.000	0.000	0.355	0.000	0.290	0.097	0.258	0.000	0.000	0.000	22	0
23	6/4,5,6,7,8	197	182	8022	0.000	0.000	0.302	0.016	0.368	0.071	0.209	0.022	0.005	0.005	125	0
24	6/11,12,13,14,15	160	141	8897	0.007	0.021	0.397	0.021	0.177	0.078	0.262	0.021	0.007	0.007	107	1
25	6/18,19,20,21,22	181	165	10471	0.006	0.036	0.358	0.036	0.176	0.133	0.212	0.018	0.012	0.012	107	0
26	6/25,26,27,28,29	200	182	10095	0.016	0.077	0.275	0.033	0.143	0.104	0.269	0.055	0.027	0.000	133	0
27	7/2,3,4,5,6	200	186	8116	0.059	0.070	0.290	0.038	0.167	0.161	0.140	0.059	0.011	0.000	108	0
28[b]	7/9,10,11,13	144	138	8565	0.051	0.080	0.333	0.029	0.116	0.138	0.203	0.022	0.029	0.000	86	0
Cumulative		**1122**	**1025**	**56300**	**0.021**	**0.046**	**0.328**	**0.028**	**0.191**	**0.114**	**0.220**	**0.032**	**0.015**	**0.004**	**688**	**1**

Notes:

a For comparison to past annual reports, data and adult return forecasting, summer Chinook are defined as the Chinook passing Bonneville dam between June 1 and July31 for the weekly and cumulative age composition estimates. The age composition for summer Chinook between June 15 and July 31 can be found on our web page (http://www.critfc.org/)

b. Sampling ended week 28 due the water temperatures exceeding 70 F which limits our sampling protocols at the Adult Fish Facility.

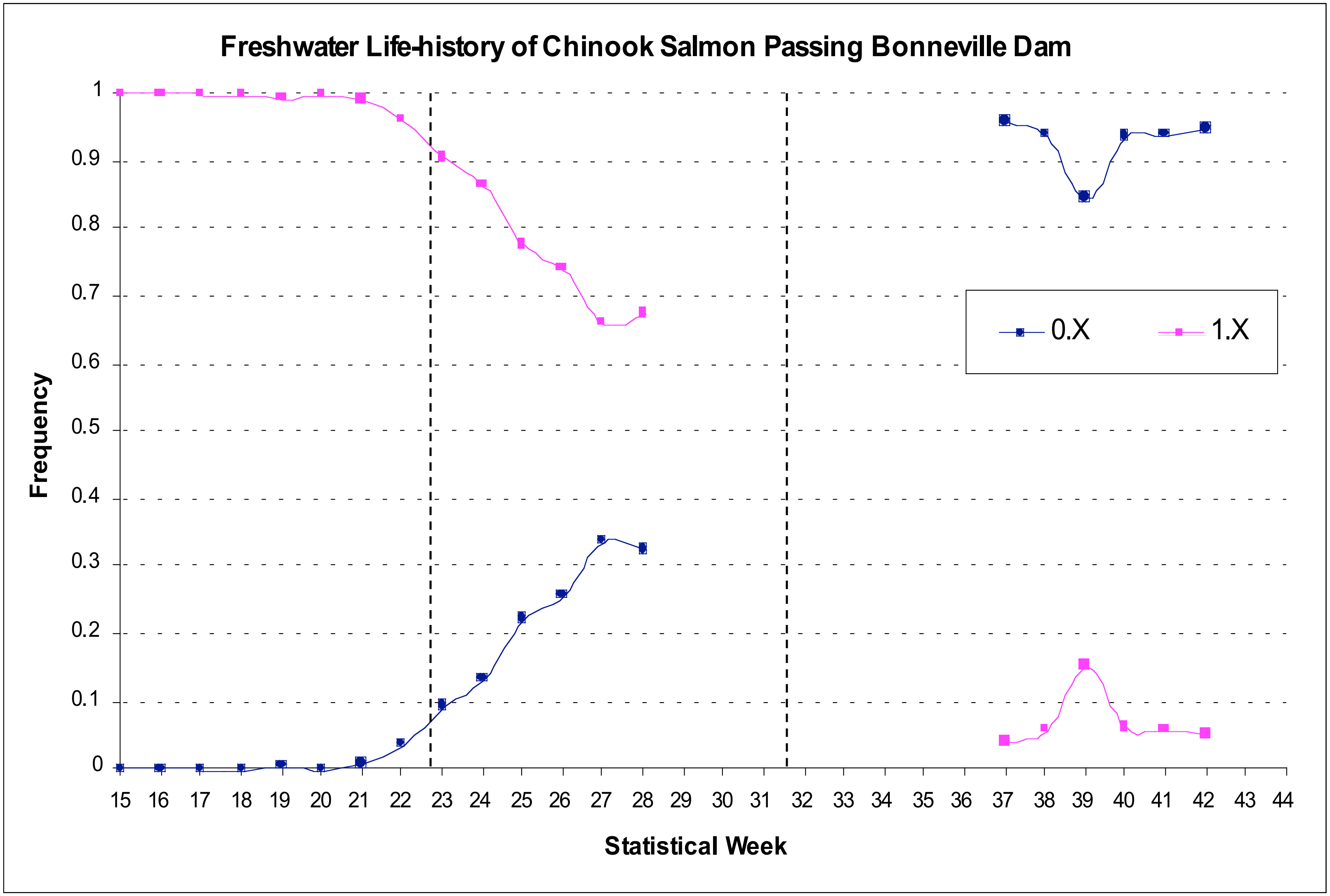

Figure 2. Weekly freshwater age composition estimates of Columbia Basin Chinook salmon sampled at Bonneville Dam in 2007. The 0.X represents juvenile Chinook that migrate as sub-yearlings and the 1.X represents juveniles that migrate as yearlings. The vertical lines represent the different life-histories of spring, summer and fall Chinook.

Table 3. Weekly and cumulative age composition of Columbia Basin bright fall Chinook salmon sampled at Bonneville Dam in 2007.

Statistical Week	Sampling Date	Number Sampled	Number Ageable	Weekly Run Size	2005	2004		2003		2002		2001		Fin Clips	
					0.1	0.2	1.1	0.3	1.2	0.4	1.3	1.4	0.5	Adipose	Other
37[a]	9/11,12,13,14	191	177	135530	0.011	0.141	0.006	0.497	0.017	0.277	0.017	0.000	0.034	11	1
38	9/16,17,19,20,21	200	184	36178	0.246	0.169	0.049	0.404	0.005	0.109	0.000	0.000	0.016	27	0
39	9/23, 24,25,26,27	200	184	17500	0.412	0.169	0.090	0.226	0.028	0.068	0.000	0.000	0.006	31	0
40	9/30,10/1,2,3,4,5	240	222	6684	0.343	0.190	0.028	0.338	0.005	0.074	0.005	0.000	0.019	21	1
41	10/8, 9,10,11,12	160	153	7463	0.263	0.211	0.026	0.349	0.026	0.125	0.000	0.000	0.000	12	1
42	10/15,17,19	83	78	4037	0.115	0.256	0.038	0.410	0.013	0.077	0.000	0.000	0.090	5	0
Cumulative		**1074**	**998**	**207392**	**0.108**	**0.155**	**0.023**	**0.446**	**0.016**	**0.214**	**0.011**	**0.000**	**0.028**	**107**	**3**

Notes:

a The fall Chinook run began on August 1, however high temperatures prevented sampling prior to Week 37. The weekly run size for Week 37 includes Chinook which passed during Weeks 31-37.

Length-at-Age Composition

Length-at-age composition estimates for all species are presented in Appendix A.

Steelhead Hatchery/Wild Determination

When classifying hatchery and wild steelhead based on fin marks alone, the run consisted of 81.9% hatchery and 11.1% wild steelhead (Table 6).

Steelhead A/B Determination

Assuming that A-run (less than 78 cm) and B-run (greater than 78 cm) steelhead can be differentiated by length alone, the majority of the steelhead run (88.9%) passing Bonneville Dam were A-run, and the remaining 11.1% were B-run. Though A-run steelhead dominate the run, the percentage of B-run fish does generally increase as the run progresses (Table 6).

Steelhead Gender Determination

The 2007 steelhead consisted of 53.2% females and 46.8% males (Table 6).

Table 4. Weekly and cumulative age composition of Columbia Basin sockeye salmon sampled at Bonneville Dam in 2007.

Statistical Week	Sampling Date	Number Sampled	Number Ageable	Weekly Run Size	2003	2002		2001			2000			Fin Clips	
					1.1	1.2	2.1	1.3	2.2	3.1	2.3	3.2	4.1	Adipose	Other
22	5/29, 5/30, 5/31, 6/1	4	4	88	0.000	0.250	0.000	0.250	0.250	0.000	0.250	0.000	0.000	2	0
23	6/4, 6/5, 6/6, 6/7, 6/8	28	26	651	0.115	0.615	0.038	0.115	0.077	0.000	0.038	0.000	0.000	4	0
24	6/11, 6/12, 6/13, 6/14, 6/15	104	99	3390	0.101	0.444	0.030	0.222	0.131	0.000	0.071	0.000	0.000	4	0
25	6/18, 6/19, 6/20, 6/21, 6/22	156	148	8079	0.318	0.324	0.074	0.122	0.135	0.000	0.027	0.000	0.000	4	0
26	6/25, 6/26, 6/27, 6/28, 6/29	151	148	6569	0.574	0.223	0.054	0.068	0.074	0.000	0.007	0.000	0.000	6	1
27	7/2, 7/3, 7/4, 7/5, 7/6	92	87	3317	0.552	0.195	0.103	0.057	0.080	0.000	0.011	0.000	0.000	5	2
28	7/10, 7/11, 7/13, 7/9	15	14	1376	0.571	0.214	0.000	0.071	0.143	0.000	0.000	0.000	0.000	0	0
Cumulative		**550**	**526**	**23470**	**0.399**	**0.296**	**0.061**	**0.109**	**0.109**	**0.000**	**0.025**	**0.000**	**0.000**	**25**	**3**

Table 5. Weekly and cumulative age composition of Columbia Basin steelhead sampled at Bonneville Dam in 2007.

Stat	Sampling	Num	Num	Weekly	2004	2003		2002			2001				2000		Repeat
Week	Date	Sampled	Aged	Run Size	1.1	1.2	2.1	1.3	2.2	3.1	1.4	2.3	3.2	4.1	3.3	4.2	Spawner
16	4/16, 4/19	2	2	204	0	0.5	0	0	0.5	0	0	0	0	0	0	0	0
17	4/23, 4/24,4/25,4/26, 4/27	4	3	164	0	1	0	0	0	0	0	0	0	0	0	0	0
18	4/30, 5/1, 5/2,5/3, 5/4	2	1	212	0	1	0	0	0	0	0	0	0	0	0	0	0
19	5/10, 5/11,5/7, 5/8, 5/9	6	5	272	0	1	0	0	0	0	0	0	0	0	0	0	0
20	5/14, 5/15,5/16, 5/17, 5/18	24	20	331	0.1	0.7	0	0.05	0.15	0	0	0	0	0	0	0	0
21	5/21, 5/22,5/24, 5/25	18	12	417	0.167	0.667	0	0	0.167	0	0	0	0	0	0	0	0
22	5/29, 5/30,5/31, 6/1	27	25	683	0.08	0.68	0.04	0.08	0.04	0	0	0	0.08	0	0	0	0
23	6/4, 6/5, 6/6,6/7, 6/8	35	29	632	0.276	0.552	0	0.03	0.103	0	0	0.034	0	0	0	0	0
24	6/11, 6/12,6/13, 6/14, 6/15	42	34	1065	0.441	0.471	0.029	0.03	0.029	0	0	0	0	0	0	0	0
25	6/18, 6/19,6/20, 6/21, 6/22	28	21	1536	0.714	0.238	0	0.05	0	0	0	0	0	0	0	0	0
26	6/25, 6/26,6/27, 6/28, 6/29	58	48	3365	0.583	0.313	0.021	0	0.063	0.021	0	0	0	0	0	0	0
27	7/2, 7/3, 7/4,7/5, 7/6	154	122	5426	0.607	0.131	0.066	0	0.172	0.016	0	0	0.008	0	0	0	0
28	7/10, 7/11,7/13, 7/9	145	126	9093	0.556	0.143	0.135	0.01	0.063	0.04	0	0	0.056	0	0	0	0
29	7/17	44	32	14929	0.625	0.031	0.063	0	0.063	0.094	0	0	0.125	0	0	0	0
30	7/24	70	54	20218	0.704	0.111	0.093	0	0.056	0	0	0	0.037	0	0	0	0.019
31	7/30	56	45	36010	0.578	0.156	0.022	0	0.089	0.067	0	0	0.067	0	0	0	0.022
32	8/7	46	35	36072	0.829	0.086	0	0	0.029	0.029	0	0	0	0	0	0	0.029
33	8/14	73	53	52628	0.698	0.094	0.094	0	0.038	0.038	0	0	0.019	0.019	0	0	0
34	8/21	59	44	46233	0.75	0.091	0.023	0	0	0.045	0	0	0.023	0	0	0	0.068
35	8/28	44	35	26560	0.486	0.286	0.057	0	0.086	0.029	0	0	0.057	0	0	0	0.029
36	9/4	50	43	16006	0.372	0.442	0.023	0	0.023	0.023	0	0	0.047	0	0	0.023	0.047
37	9/11, 9/12,9/13, 9/14	111	91	13004	0.187	0.484	0	0.19	0.077	0.011	0	0.033	0.011	0	0	0	0.022
38	9/16, 9/17,9/19, 9/20, 9/21	240	196	13578	0.173	0.526	0.005	0.23	0.036	0	0	0.01	0.01	0	0	0.005	0
39	9/23, 9/24,9/25, 9/26, 9/27	212	179	7831	0.201	0.52	0	0.22	0.022	0	0	0	0.022	0	0.006	0	0.006
40	10/1, 10/2,10/3, 10/4,	210	174	4023	0.322	0.345	0.04	0.2	0.04	0.006	0	0.029	0.006	0	0.011	0	0
41	10/10, 10/11,10/12, 10/8,	150	128	3748	0.305	0.406	0.047	0.21	0.016	0	0	0.008	0.008	0	0	0	0
42	10/15, 10/17,	63	50	1684	0.5	0.3	0.02	0.16	0.02	0	0	0	0	0	0	0	0
Cumulative		1973	1607	315924	0.59	0.197	0.043	0.03	0.047	0.034	0	0.002	0.033	0.003	0	0.001	0.023

a. Sampling was limited to 4 hours per day (6am – 10 am) from week 29 through week 36 due to high water temperatures.

Table 6. Weekly and cumulative proportions of gender, A (less than 78cm) and B (greater or equal to 78cm) run composition, and number of fin clips of Columbia Basin steelhead sampled at Bonneville Dam in 2007.

Stat	Sampling	Num	Total Run		Unmarked Run		Sex		Fin Clips	
Week	Date	Sampled	A run	B run	A run	B run	Male	Female	Adipos	Other
16	4/16, 4/19	2	1	0	1.000	0.000	0.500	0.500	1	0
17	4/23, 4/24,4/25,4/26, 4/27	4	1	0	0.000	0.000	0.750	0.250	4	0
18	4/30, 5/1, 5/2,5/3, 5/4	2	1	0	0.000	0.000	0.500	0.500	2	0
19	5/10, 5/11,5/7, 5/8, 5/9	6	0.833	0.167	0.000	0.000	0.667	0.333	6	1
20	5/14, 5/15,5/16, 5/17, 5/18	24	1	0	1.000	0.000	0.417	0.583	18	1
21	5/21, 5/22,5/24, 5/25	18	1	0	1.000	0.000	0.167	0.833	15	1
22	5/29, 5/30,5/31, 6/1	27	0.852	0.148	0.833	0.167	0.556	0.444	20	0
23	6/4, 6/5, 6/6,6/7, 6/8	35	0.943	0.057	0.778	0.222	0.457	0.543	23	0
24	6/11, 6/12,6/13, 6/14, 6/15	42	0.976	0.024	1.000	0.000	0.366	0.634	39	0
25	6/18, 6/19,6/20, 6/21, 6/22	28	0.929	0.071	0.667	0.333	0.259	0.741	24	1
26	6/25, 6/26,6/27, 6/28, 6/29	58	1	0	1.000	0.000	0.224	0.776	45	5
27	7/2, 7/3, 7/4,7/5, 7/6	154	0.981	0.019	0.946	0.054	0.362	0.638	95	6
28	7/10, 7/11,7/13, 7/9	145	1	0	1.000	0.000	0.357	0.643	82	4
29	7/17	44	1	0	1.000	0.000	0.455	0.545	21	4
30	7/24	70	0.986	0.014	0.950	0.050	0.647	0.353	49	5
31	7/30	56	1	0	1.000	0.000	0.429	0.571	36	3
32	8/7	46	1	0	1.000	0.000	0.370	0.630	38	6
33	8/14	73	1	0	1.000	0.000	0.681	0.319	51	9
34	8/21	59	0.983	0.017	1.000	0.000	0.542	0.458	45	7
35	8/28	44	0.932	0.068	0.818	0.182	0.452	0.548	26	3
36	9/4	50	0.7	0.3	0.556	0.444	0.347	0.653	41	2
37	9/11, 9/12,9/13, 9/14	111	0.315	0.685	0.167	0.833	0.486	0.514	86	4
38	9/16, 9/17,9/19, 9/20, 9/21	240	0.363	0.637	0.400	0.600	0.447	0.553	199	22
39	9/23, 9/24,9/25, 9/26, 9/27	212	0.368	0.632	0.348	0.652	0.481	0.519	174	20
40	10/1, 10/2,10/3, 10/4,	210	0.533	0.467	0.529	0.471	0.551	0.449	168	18
41	10/10, 10/11,10/12, 10/8,	150	0.487	0.513	0.722	0.278	0.537	0.463	118	14
42	10/15, 10/17,	63	0.571	0.429	0.429	0.571	0.667	0.333	50	3
Cumulative		1973	0.889	0.111	0.867	0.133	0.468	0.532	1476	139

Fish Coloration and Condition

Bright coloration was observed in the majority of each species, 95.6% of spring Chinook, 92.2% of summer Chinook, 91.1% of fall Chinook, 99.8% of sockeye and 94.9% of steelhead. The highest condition rating of 5 was given to 94.1% of spring Chinook, 97.3% of summer Chinook, 92.2% of fall Chinook, 98.2% of sockeye and 92.9% of steelhead (Table 7). Additional fish condition data can be found in Appendix A.

Table 7. Composition (%) of observed coloration and condition of Columbia Basin salmon and steelhead at Bonneville Dam in 2007.

Species	Spring	Summer	Fall	Sockeye	Steelhead
Color					
Bright	95.6	92.2	91.1	99.8	94.9
Intermediate	3.9	7.4	6.7	0	4.7
Dark	0.5	0.4	2.2	0.2	0.4
Condition					
5	94.1	97.3	92.2	98.2	92.9
4	3.6	2.3	5	1.3	4.9
3	2.2	0.4	2.8	0.5	2.2
2	0.1	0	0	0	0
1	0	0	0	0	0

Chinook Salmon Run-Size Prediction for 2007

Using a linear relationship between the 2007 three- and four-year-old adult returns (Figure 3), the estimated number of four-year-old spring Chinook salmon returning to Bonneville Dam in 2008 is 251,100 (± 65,700, 90% prediction interval [PI]). Using the relationship between four- and five-year-olds to construct the model (Figure 4), albeit poorer than that existing between three-year-olds and four-year-olds, we predict that the 2008 five-year-old adult abundance at Bonneville Dam will be 16,300 (± 41,000, 90% PI).

For the 2008 summer Chinook salmon run at Bonneville Dam, the relationship between three- and four-year-olds (Figure 5) results in a prediction of 58,300 (± 26,300, 90% PI) four-year-olds. The relationship between four- and five-year-olds (Figure 6), the model predicts a return of 11,600 (± 9,000, 90% PI) five-year-olds.

Based on the relationship between three- and four-year-olds (Figure 7), the model results in a prediction of 90,000 (± 98,800, 90% PI) four-year-old Upriver Bright fall Chinook salmon returns for 2008. Using the relationship between four- and five-year-olds (Figure 8), the model results in a prediction of 52,500 (± 41,300, 90% PI) returning five-year-olds.

Based on the 2006 report (Whiteaker et al. 2007), we made run size predictions for four- and five-year-old spring, summer, and bright fall Chinook salmon returning to Bonneville Dam in 2007 using the methods discussed in this report. For the two principle age groups (four-year-old and five-year-old), we predicted 69,100 spring, 35,300 summer, and 166,900 bright fall Chinook versus DART (2007) and the Fish Passage Center (2007) estimated actual returns of 63,300 spring, 31,300 summer and 142,500 bright fall Chinook salmon. All age groups predicted for 2007 were within the 90% prediction interval (Table 8). Overall, we predict the 2008 return of four- and five-year old spring and summer Chinook salmon runs to be greater than they were in 2007 but the fall Chinook salmon will be less than the 2007 return (Table 8).

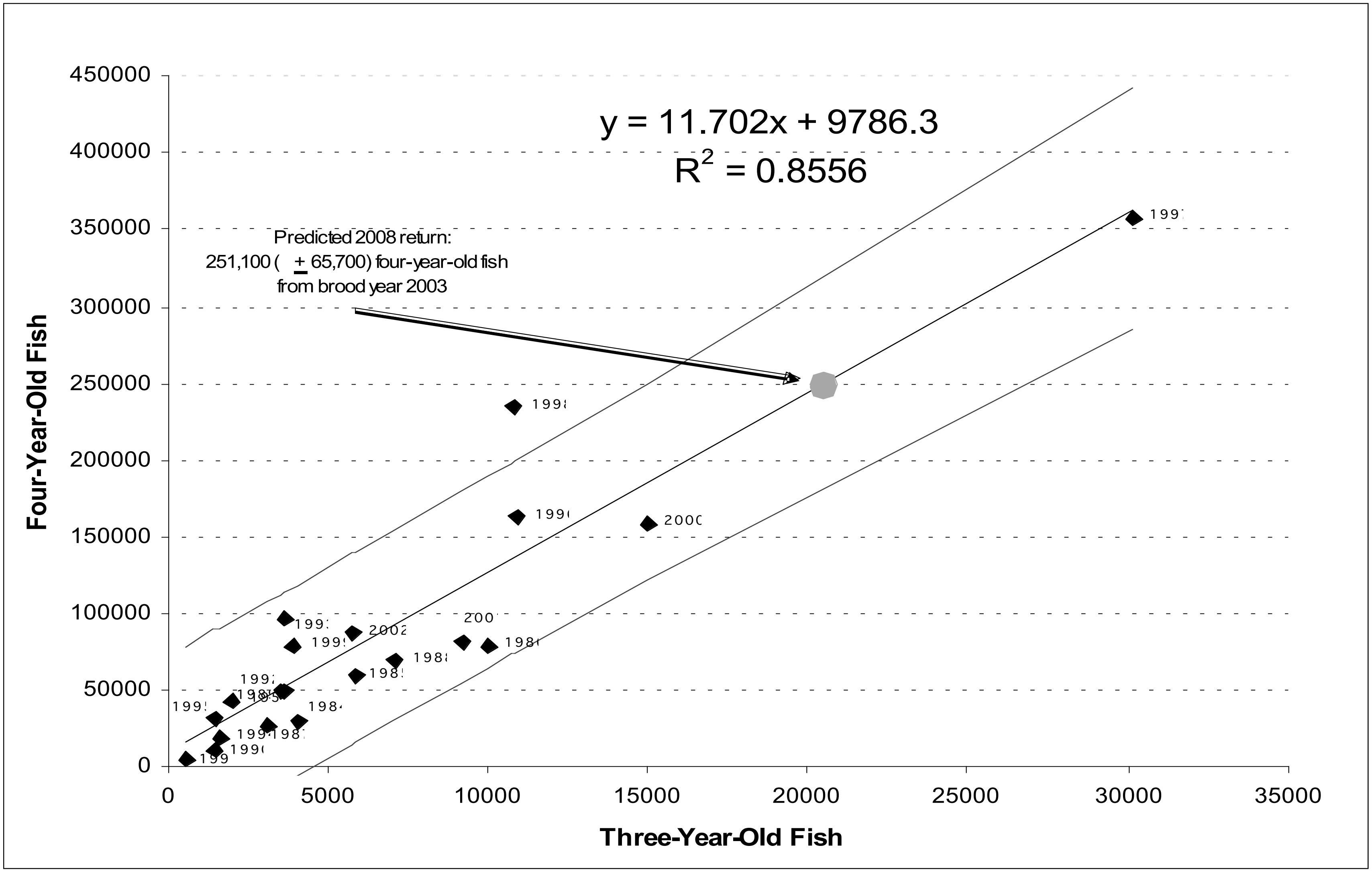

Figure 3. Predicted 2008 four-year-old Columbia Basin spring Chinook salmon abundance (at Bonneville Dam) based on a linear relationship between four-year-old and three-year-old fish abundance during brood years 1984 through 2002. Prediction intervals (90%) are also graphed.

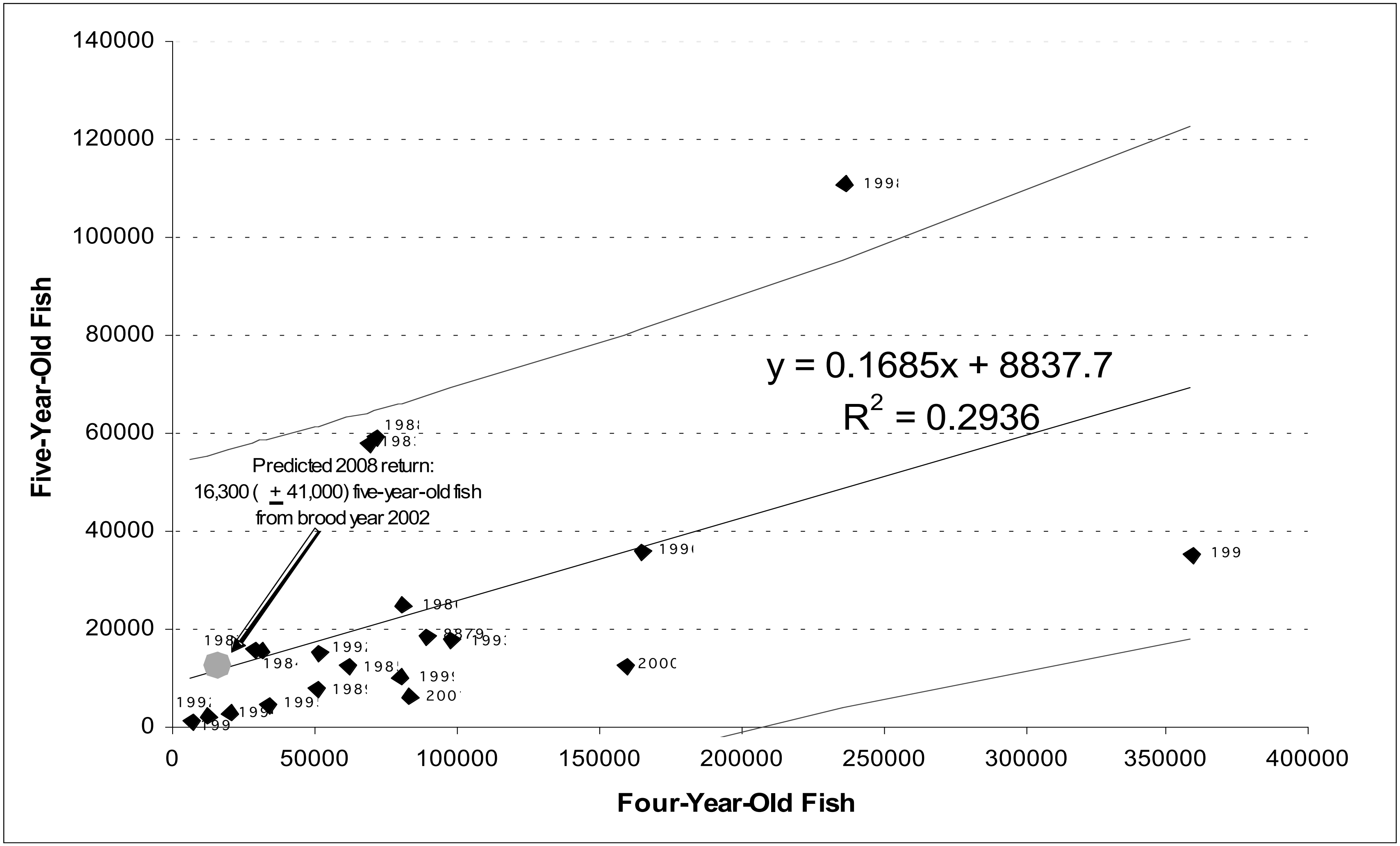

Figure 4. Predicted 2008 five-year-old Columbia Basin spring Chinook salmon abundance (at Bonneville Dam) based on a linear relationship between five-year-old and four-year-old fish abundance during brood years 1983 through 2001. Prediction intervals (90%) are also graphed.

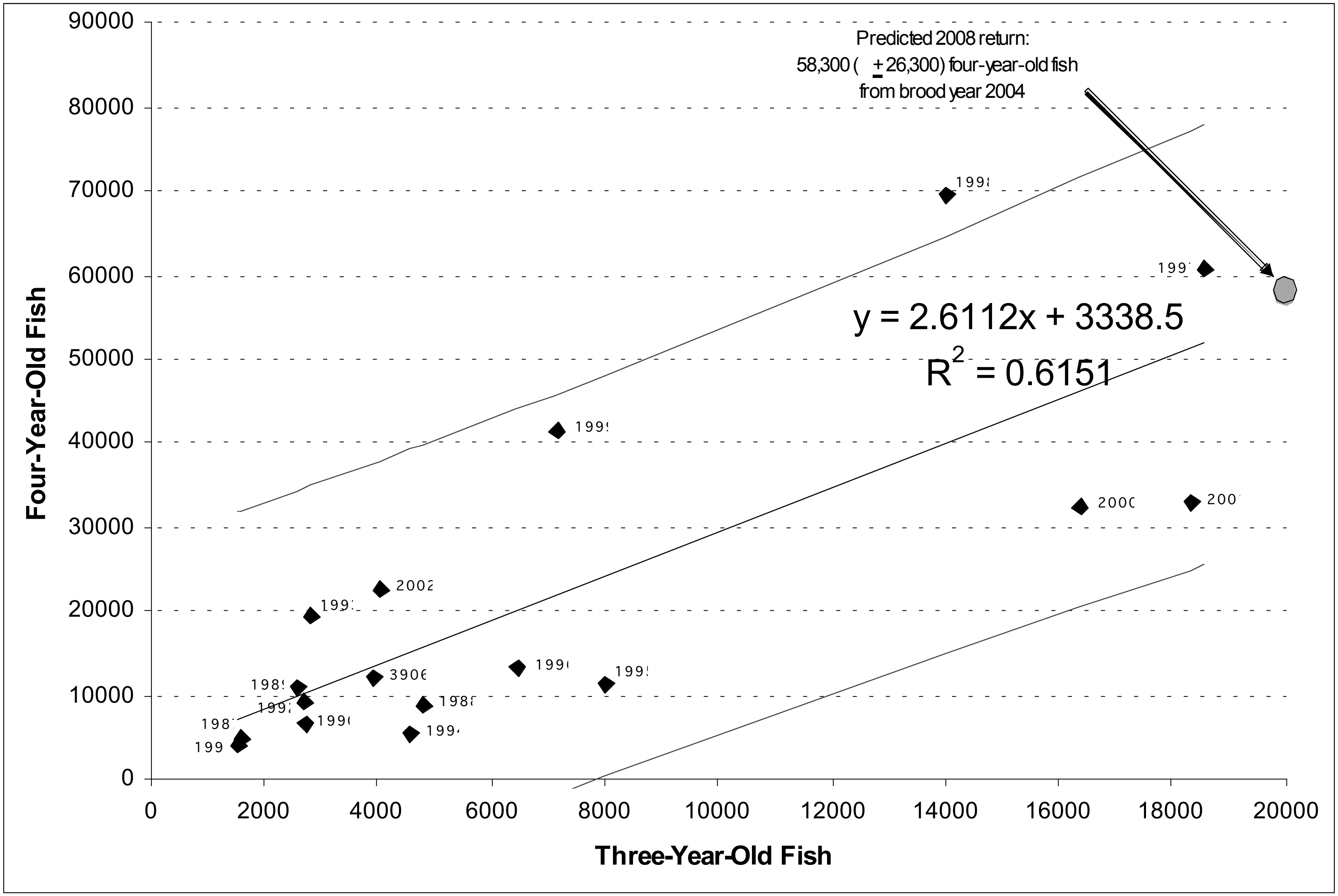

Figure 5. Predicted 2008 four-year-old Columbia Basin summer Chinook salmon abundance (at Bonneville Dam) based on a linear relationship between four-year-old and three-year-old fish abundance during brood years 1987 through 2002. Prediction intervals (90%) are also graphed.

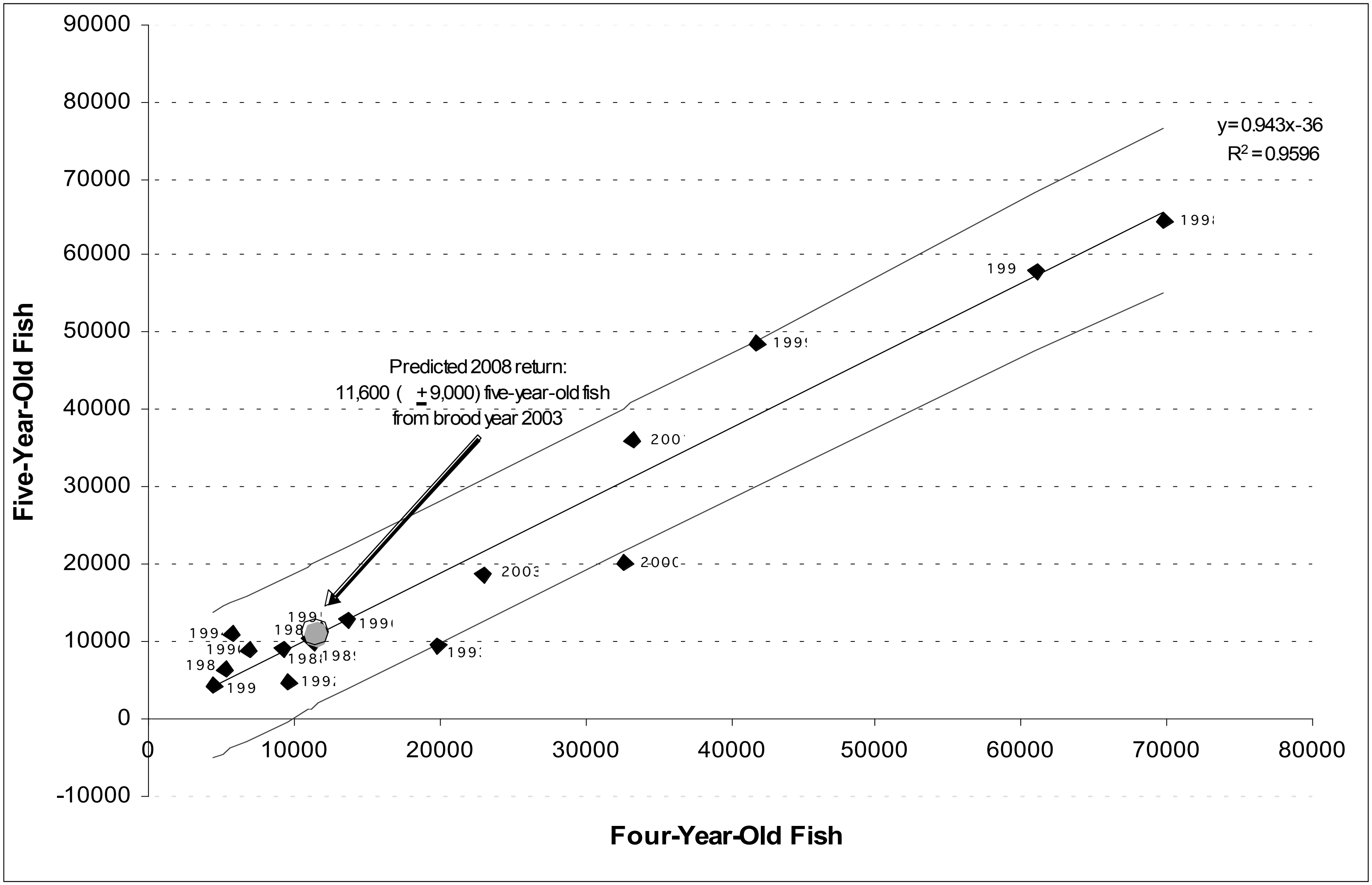

Figure 6. Predicted 2008 five-year-old Columbia Basin summer Chinook salmon abundance (at Bonneville Dam) based on a linear relationship between five-year-old and four-year-old fish abundance during brood years 1986 through 2001. Prediction intervals (90%) are also graphed.

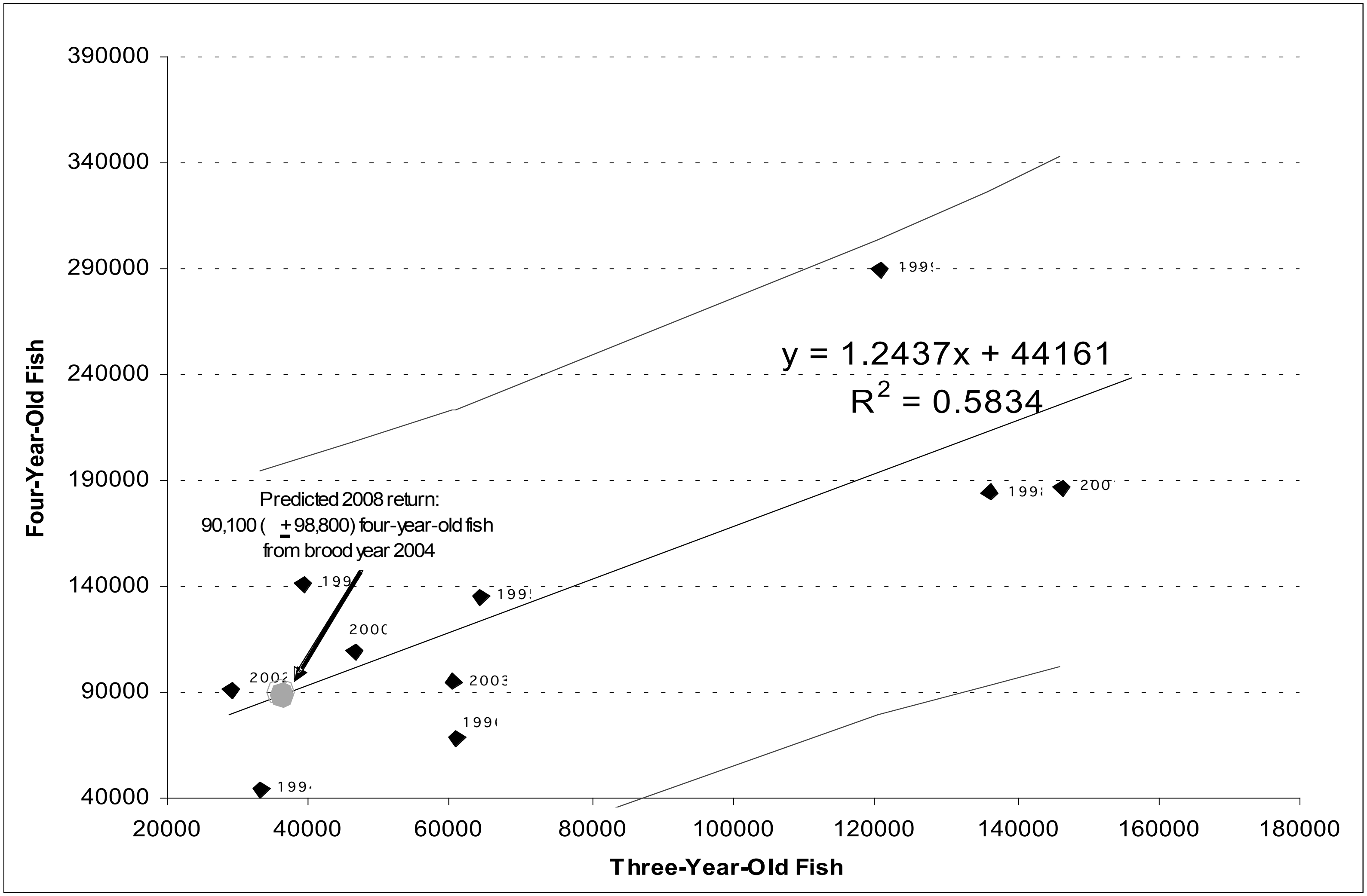

Figure 7. Predicted 2008 four-year-old Columbia Basin fall Chinook salmon abundance (at Bonneville Dam) based on a linear relationship between four-year-old and three-year-old fish abundance during brood years 1986 through 2002. Prediction intervals (90%) are also graphed.

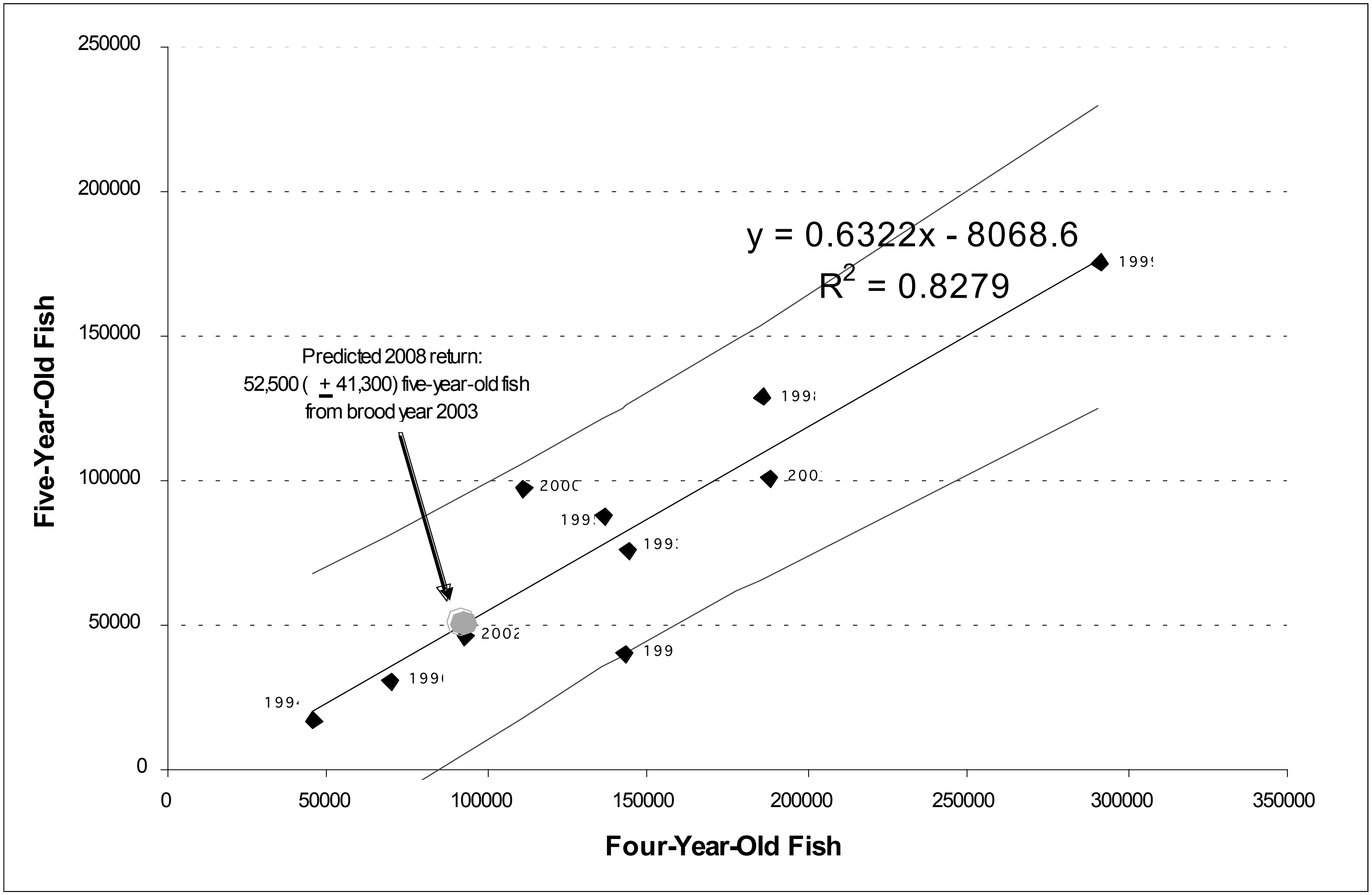

Figure 8. Predicted 2008 five-year-old Columbia Basin bright fall Chinook salmon abundance (at Bonneville Dam) based on a linear relationship between five-year-old and four-year-old fish abundance during brood years 1993 through 2001. Prediction intervals (90%) are also graphed.

Table 8. Predicted and estimated abundance of Chinook salmon returning to Bonneville Dam.

Species	2007 Forecast (±90%) From 2006 Report	Year 2007 Estimate	2008 Forecast (+ 90%)
Spring Chinook 4-year-old	55,400 (±62,100)	44,200	251,100 (±65,700)
Spring Chinook 5-year-old	13,700 (±49,800)	19,100	16,300 (±41,000)
Summer Chinook 4-year-old	13,600 (±24,000)	12,300	58,300 (±26,300)
Summer Chinook 5-year-old	21,700 (±9,200)	19,000	11,600 (±9,000)
Bright Fall Chinook 4-year-old	116,200 (±124,700)	95,800	90,000 (±98,800)
Bright Fall Chinook 5-year-old	50,700 (±44,200)	46,700	52,500 (±41,300)

2007 estimate is calculated using the proportion of X-year-old returning in 2007 multiplied by the count of spring, summer and fall Chinook at Bonneville Dam.

DISCUSSION

River Water Temperature

High river water temperature has constrained our sampling efforts during most summer sampling seasons. The ACOE and FPOM sampling protocols for temperatures between 21.1 and 23.3^{o}C does not allow sampling of Chinook and limits steelhead sampling to one day per week from 6am to 10am with no sampling allowed at temperatures above 23.3^{o}C. Therefore, during the 2007 sampling season, summer Chinook salmon were not sampled from statistical weeks 29-31 and fall Chinook salmon were not sampled weeks 31-36. Unlike past years, we were not required to stop steelhead sampling due to high temperatures but we did follow the ACOE sampling restriction for temperatures over 21.1 C in 2007. McCullough (1999) asserts that temperatures exceeding 21^{o}C may delay the migration of Chinook salmon and past sampling seasons typically follow that pattern, but in 2007 the fall Chinook migration started two weeks prior to the temperature dropping below 21^{o}C (Figure 11). Temperatures in this range do not appear to be as restrictive to the steelhead migration.

Genetic Sampling

In 2007, tissue samples (for DNA analysis) were collected from the majority of Chinook and steelhead that were sampled at the Adult Fish Facility at Bonneville Dam. This was the fifth full year for Chinook genetic collection and the fourth year that we collected samples from steelhead. In previous years steelhead genetic samples were collected by ODFW and WDFW. Significant progress has been made through the coast wide Chinook genetic database to assemble baseline genetic stock identification information for all Columbia River Chinook populations. The development of baseline genetic stock information for steelhead is still in its infancy. Once this baseline stock information is readily available, mixed stock sampling at Bonneville Dam will be a valuable tool for fisheries and ESA management within the Columbia River Basin.

Project Continuation

It is expected that this stock assessment study will continue to develop an accurate age composition and length-at-age database for Columbia Basin upriver salmon populations, and work towards improving the forecasting of terminal runs, which is important for the calibration of the PSC Chinook Technical Committee's Chinook model. These data will also aid fisheries managers in formulating spawner-return relationships and analyzing productivity. Continued data collection on age composition and length-at-age will allow managers to more accurately monitor the effects of ocean harvest restrictions agreed upon by the Pacific Salmon Treaty. The addition of steelhead to our normal sampling regime provides valuable information for NOAA-Fisheries and TAC for use in steelhead assessments, fisheries forecasting and harvest management. This study will work to improve accurate age determination, hatchery fraction, and stock identification and assessment.

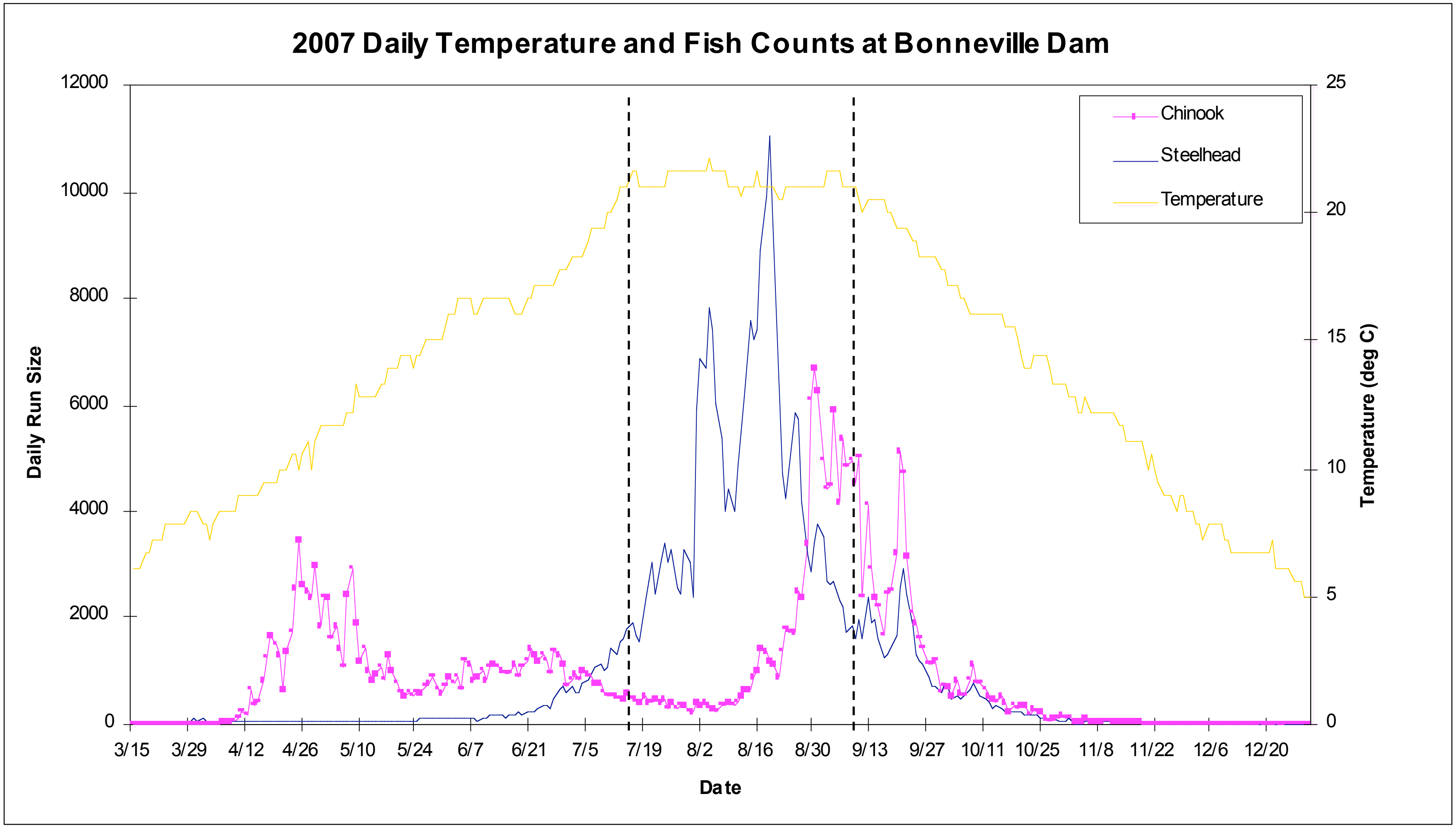

Figure 9. Chinook and steelhead daily run size and daily river temperature at Bonneville Dam from March 15 through December 31, 2007. The vertical dash lines indicate sampling limitations at the Adult Fish Facility due to river temperatures. The limitations include no Chinook sampling and steelhead sampling only one day per week (6am-10am).

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APPENDIX A

LIST OF TABLES

Table A1: Percent of sampled Chinook, sockeye and steelhead at Bonneville Dam having identifying clips by Statistical Week and total sampled in 2007.

Week	Spring	Summer	Fall	Sockeye	Steelhead
15	78.6				
16	75				50
17	74.6				100
18	75.6				100
19	70				100
20	72.5				75
21	67.7				83.3
22	61			50	74.1
23	63.5			14.3	65.7
24	67.9	60		3.8	92.9
25		59.1		2.6	85.7
26		66.5		4.6	77.6
27		54		7.6	61.7
28		59.7			56.6
29					50
30					70
31					64.3
32					82.6
33					72.6
34					76.3
35					61.4
36					82
37			6.3		77.5
38			13.5		83.3
39			15.4		82.5
40			9.2		81
41			8.1		80
42			6		79.4
Grand Total	69.6	59.9	10.2	5.1	75.3

Table A2: Composition (%) of observed injuries of Columbia Basin Chinook and sockeye salmon and steelhead sampled at Bonneville Dam in 2007.

Injury Category	Spring	Summer	Fall	Sockeye	Steelhead
Marine Mammal					
Bite	2.2%	0.0%	0.8%	0.5%	0.3%
Scrape	22.3%	8.3%	9.4%	2.5%	16.2%
Total[a]	24.5%	8.3%	10.2%	3.1%	16.5%
Descaling					
<3%[b]					
Left side	0.6%	0.0%	0.0%	0.5%	0.1%
Right side	0.8%	0.0%	0.0%	0.5%	0.0%
Total[c]	0.0%	0.0%	0.0%	0.6%	0.0%
3-19%					
Left side	12.7%	7.8%	11.5%	12.7%	11.6%
Right side	14.6%	8.1%	9.7%	13.5%	10.6%
Total[c]	17.5%	11.0%	13.2%	15.3%	13.1%
≥20%					
Left side	1.9%	1.3%	2.9%	4.2%	5.1%
Right side	1.7%	3.0%	3.7%	3.5%	6.1%
Total[c]	2.8%	3.2%	5.0%	5.5%	7.6%
Other Injuries					
Bruise	0.1%	0.1%	0.1%	0.0%	0.3%
Head Injury	4.0%	6.8%	7.3%	1.8%	3.5%
Head Burn	0.0%	0.0%	0.0%	0.0%	0.0%
Fin	11.6%	8.2%	11.0%	1.5%	12.5%
Fungus	1.5%	0.5%	0.4%	0.9%	0.8%
Gash	0.2%	0.4%	0.7%	0.2%	1.6%
Gas Bubble Trauma	0.1%	0.0%	0.0%	0.2%	0.0%
Gill Net	0.0%	0.4%	3.2%	0.2%	5.5%
Fish Hook	0.6%	1.4%	0.9%	0.9%	0.3%
Lamprey	2.1%	0.1%	0.1%	0.0%	0.1%
Parasite	0.8%	0.8%	3.2%	0.5%	1.8%
Total[a]	17.5%	15.0%	21.7%	4.9%	21.4%

a Totals do not represent the sum of subcategories, they are the number of fish with at least one injury. Fish can display more than one type of marine mammal or general injury. Occasionally injuries are recorded but not described.

b Data not collected in 2005.

c This total represents the percentage of fish with descaling on either side. Fish are recorded in the category of maximum descaling. For example, a fish 3-19% descaled on one side, and ≥20% descaled on the other, would be recorded as ≥20% descaled.

Table A3: Length-at-age estimates for Columbia Basin spring Chinook salmon sampled at Bonneville Dam in 2007. Composite estimates of age classes are weighted by weekly run size.

Brood Year and	2005	2004		2003		2002		2001		2000
Age Class	0.1	0.2	1.1	0.3	1.2	0.4	1.3	0.5	1.4	1.5
Statistical Week 15										
Mean Fork Length (cm)					74.00		86.43			
Maximum					81.00		93.00			
Minimum					68.00		83.00			
Standard Deviation					4.98		3.21			
Sample Size					6		7			
Statistical Week 16										
Mean Fork Length (cm)					71.12		86.45			
Maximum					83.00		97.00			
Minimum					59.00		76.00			
Standard Deviation					5.16		5.33			
Sample Size					25		22			
Statistical Week 17										
Mean Fork Length (cm)			47.72		71.73		85.63			
Maximum			56.00		84.50		99.00			
Minimum			44.50		56.50		73.50			
Standard Deviation			3.36		4.77		5.30			
Sample Size			9		100		41			
Statistical Week 18										
Mean Fork Length (cm)			49.86		71.47		86.78		101.50	
Maximum			59.00		83.00		95.50		101.50	
Minimum			44.50		56.00		72.00		101.50	
Standard Deviation			3.38		4.54		5.54		0.00	
Sample Size			33		90		30		1	
Statistical Week 19										
Mean Fork Length (cm)			50.08		72.02	88.00	87.17			
Maximum			60.50		79.50	88.00	97.00			
Minimum			39.00		57.50	88.00	74.00			
Standard Deviation			4.06		4.14	0.00	5.66			
Sample Size			55		91	1	23			
Statistical Week 20										
Mean Fork Length (cm)			51.37		72.43		88.80			
Maximum			62.00		82.50		100.00			
Minimum			44.00		53.00		80.00			
Standard Deviation			3.80		4.68		5.58			
Sample Size			85		63		25			
Statistical Week 21										
Mean Fork Length (cm)		69.00	51.50		72.88		87.15		98.00	
Maximum		69.00	66.00		82.00		95.50		98.00	
Minimum		69.00	44.50		53.00		73.00		98.00	
Standard Deviation		0.00	3.71		6.07		5.62		0.00	
Sample Size		1	58		39		20		1	
Statistical Week 22										
Mean Fork Length (cm)			53.08		74.88	92.75	90.12	99.00	96.25	
Maximum			66.50		88.00	95.00	100.50	99.00	104.00	
Minimum			46.00		63.50	90.00	82.00	99.00	85.00	
Standard Deviation			4.76		5.17	2.22	4.28	0.00	8.38	
Sample Size			42		49	4	29	1	4	
Statistical Week 23										
Mean Fork Length (cm)			53.27	82.67	74.31	91.62	89.16	96.00	91.75	103.00
Maximum			64.50	85.50	90.00	101.00	100.00	96.00	104.00	103.00
Minimum			46.00	79.50	56.00	71.00	76.00	96.00	79.00	103.00
Standard Deviation			3.86	3.01	5.87	8.07	5.13	0.00	10.24	0.00
Sample Size			55	3	67	13	38	1	4	1
Statistical Week 24										
Mean Fork Length (cm)	44.5	62.17	54.38	92.33	76.82	94.32	87.55	87.00	100.17	94.50
Maximum	44.5	67.00	61.50	95.00	86.50	103.00	97.00	87.00	104.00	94.50
Minimum	44.5	54.50	45.00	89.50	66.00	86.00	71.00	87.00	95.50	94.50
Standard Deviation	0	6.71	4.16	2.75	4.79	5.41	5.73	0.00	4.31	0.00
Sample Size	1	3	56	3	25	11	37	1	3	1
2007 Composite										
Mean Fork Length (cm)	44.5	64.23	51.05	87.27	72.11	92.18	87.04	94.38	97.17	98.96
Maximum	44.5	69.00	66.50	95.00	90.00	103.00	100.50	99.00	104.00	103.00
Minimum	44.5	54.50	39.00	79.50	53.00	71.00	71.00	87.00	79.00	94.50
Standard Deviation	0	4.68	3.85	2.89	4.69	5.39	5.39	0.00	5.56	0.00
Sample Size	1	4	393	6	555	29	272	3	13	2

Table A4: Length-at-age estimates for Columbia Basin summer Chinook salmon sampled at Bonneville Dam in 2007. Composite estimates of age classes are weighted by weekly run size.

Brood Year and	2005	2004		2003		2002		2001		2000
Age Class	0.1	0.2	1.1	0.3	1.2	0.4	1.3	0.5	1.4	1.5
Statistical Week 25										
Mean Fork Length (cm)	40	62.50	55.01	85.50	74.22	94.36	88.89	100.50	93.50	97.50
Maximum	40	77.00	64.00	93.00	85.50	106.00	100.50	105.00	98.00	110.00
Minimum	40	47.00	46.00	76.50	52.00	82.50	78.00	96.00	90.00	85.00
Standard Deviation	0	10.35	4.45	6.89	6.99	5.06	5.49	6.36	4.09	17.68
Sample Size	1	6	59	6	29	22	35	2	3	2
Statistical Week 26										
Mean Fork Length (cm)	43.83	63.25	53.97	82.33	75.02	93.82	85.71	94.10	90.70	
Maximum	47	69.00	63.00	91.50	86.00	105.00	95.00	96.00	107.00	
Minimum	38	57.50	44.00	76.00	58.00	87.00	56.50	90.00	68.50	
Standard Deviation	5.06	3.67	4.21	5.04	6.67	5.30	7.62	2.51	10.97	
Sample Size	3	14	50	6	26	19	49	5	10	
Statistical Week 27										
Mean Fork Length (cm)	43.09	60.96	53.83	82.14	73.15	91.07	87.10	85.50	89.18	
Maximum	53.5	69.00	63.00	89.50	83.00	106.00	101.00	95.50	94.50	
Minimum	35.5	52.00	45.50	77.00	61.00	75.00	65.00	75.50	82.00	
Standard Deviation	4.69	5.36	4.33	4.87	5.60	6.59	8.01	14.14	4.27	
Sample Size	11	13	54	7	31	30	26	2	11	
Statistical Week 28										
Mean Fork Length (cm)	48.29	66.09	54.01	79.50	71.53	93.47	86.25	91.50	96.83	
Maximum	58	87.00	65.00	86.50	81.50	102.00	105.00	97.50	104.00	
Minimum	44.5	51.50	43.50	69.00	60.50	86.50	72.00	88.00	90.00	
Standard Deviation	4.64	11.36	4.95	7.65	5.98	4.19	5.44	4.38	7.01	
Sample Size	7	11	46	4	16	19	28	4	3	
2007 Composite										
Mean Fork Length (cm)	44.2606	62.97	54.29	82.92	73.91	93.09	86.91	93.53	90.94	97.50
Maximum	58	87.00	65.00	93.00	86.00	106.00	105.00	105.00	107.00	110.00
Minimum	35.5	47.00	43.50	69.00	52.00	75.00	56.50	75.50	68.50	85.00
Standard Deviation	4.46959	6.48	4.42	5.84	6.42	5.47	6.80	5.21	7.43	17.68
Sample Size	22	44	209	23	102	90	138	13	27	2

Table A5: Length-at-age estimates for Columbia Basin bright fall Chinook salmon sampled at Bonneville Dam in 2007. Composite estimates of age classes are weighted by weekly run size.

Brood Year and	2005	2004		2003		2002		2001		2000
Age Class	0.1	0.2	1.1	0.3	1.2	0.4	1.3	0.5	1.4	1.5
Statistical Week 37	**0-1**	0-2	1-1	0-3	1-2	0-4	1-3	0-5		
Mean Fork Length (cm)	55.25	68.56	67.00	82.95	74.50	90.03	86.17	93.83		
Maximum	59.5	76.50	67.00	103.00	81.00	104.00	91.50	98.50		
Minimum	51	62.50	67.00	71.00	68.00	77.00	81.00	90.50		
Standard Deviation	6.01	3.39	0.00	6.04	6.50	5.60	5.25	3.03		
Sample Size	2	25	1	88	3	49	3	6		
Statistical Week 38										
Mean Fork Length (cm)	48.49	66.94	57.72	81.68	82.00	91.78		88.67		
Maximum	55.5	88.50	62.00	95.50	82.00	104.00		93.50		
Minimum	38.5	54.50	53.00	70.50	82.00	83.50		83.00		
Standard Deviation	3.67	7.03	3.19	5.42	0.00	5.41		5.30		
Sample Size	45	31	9	74	1	20		3		
Statistical Week 39										
Mean Fork Length (cm)	47.23	62.22	56.53	81.94	71.90	90.21		92.50		
Maximum	63	71.50	64.50	95.00	83.00	95.50		92.50		
Minimum	35	54.00	51.00	63.50	58.00	83.50		92.50		
Standard Deviation	5.12	4.80	4.28	6.20	9.03	3.66		0.00		
Sample Size	73	30	16	40	5	12		1		
Statistical Week 40										
Mean Fork Length (cm)	46.07	65.24	64.17	80.60	72.00	87.56	84.50	92.88		
Maximum	59.5	77.50	86.50	95.00	72.00	101.00	84.50	94.50		
Minimum	36.5	46.50	54.00	64.00	72.00	76.00	84.50	92.00		
Standard Deviation	4.36	6.02	12.22	6.10	0.00	5.74	0.00	1.18		
Sample Size	74	41	6	73	1	16	1	4		
Statistical Week 41										
Mean Fork Length (cm)	45.92	64.31	54.88	80.03	75.00	89.00				
Maximum	53.5	76.50	57.50	95.50	87.50	99.00				
Minimum	38.5	52.50	48.00	65.50	63.00	71.00				
Standard Deviation	3.47	5.90	4.61	5.47	11.63	6.23				
Sample Size	40	32	4	53	4	19				
Statistical Week 42										
Mean Fork Length (cm)	46.22	64.42	54.17	79.09	71.00	87.58		89.50		
Maximum	52	78.50	58.00	95.00	71.00	91.50		92.50		
Minimum	36.5	55.00	50.00	62.50	71.00	81.50		81.50		
Standard Deviation	4.56	5.63	4.01	6.34	0.00	3.51		4.14		
Sample Size	9	20	3	32	1	6		6		
2007 Composite										
Mean Fork Length (cm)	47.6524	66.16	57.83	82.02	74.62	90.32	86.07	91.96		
Maximum	63	88.50	86.50	103.00	87.50	104.00	91.50	98.50		
Minimum	35	46.50	48.00	62.50	58.00	71.00	81.00	81.50		
Standard Deviation	4.27082	5.44	4.00	5.80	6.85	5.43	4.96	3.49		
Sample Size	243	179	39	360	15	122	4	20		

Table A6: Length-at-age estimates for Columbia Basin sockeye salmon sampled at Bonneville Dam in 2007. Composite estimates of age classes are weighted by weekly run size.

Brood Year and	2004	2003		2002		2001
Age Class	1.1	1.2	2.1	1.3	2.2	2.3
Statistical Week 22	1-1	1-2	2-1	1-3	2-2	2-3
Mean Fork Length (cm)		55.50		60.00	51.50	56.50
Maximum		55.50		60.00	51.50	56.50
Minimum		55.50		60.00	51.50	56.50
Standard Deviation		0.00		0.00	0.00	0.00
Sample Size		1		1	1	1
Statistical Week 23						
Mean Fork Length (cm)	40.67	51.97	40.00	57.83	52.50	61.00
Maximum	42.00	56.00	40.00	59.00	54.00	61.00
Minimum	40.00	46.00	40.00	56.50	51.00	61.00
Standard Deviation	1.15	2.74	0.00	1.26	2.12	0.00
Sample Size	3	16	1	3	2	1
Statistical Week 24						
Mean Fork Length (cm)	39.30	50.98	41.83	57.32	53.96	57.57
Maximum	43.50	56.50	43.50	63.50	59.00	60.00
Minimum	36.50	45.00	40.00	52.50	50.00	56.00
Standard Deviation	1.87	2.34	1.76	2.75	2.95	1.54
Sample Size	10	44	3	22	13	7
Statistical Week 25						
Mean Fork Length (cm)	40.27	51.67	41.95	58.53	51.75	59.38
Maximum	47.00	57.00	45.50	62.00	58.00	63.50
Minimum	35.50	44.00	39.50	55.50	45.00	57.00
Standard Deviation	2.37	3.19	2.03	1.81	3.70	2.87
Sample Size	47	48	11	18	20	4
Statistical Week 26						
Mean Fork Length (cm)	39.23	49.97	43.50	56.15	51.14	56.00
Maximum	50.00	56.50	46.00	64.00	53.00	56.00
Minimum	34.50	44.00	41.00	50.50	48.50	56.00
Standard Deviation	2.27	3.07	1.83	3.93	1.47	0.00
Sample Size	85	33	8	10	11	1
Statistical Week 27						
Mean Fork Length (cm)	39.49	50.06	41.94	55.00	52.93	54.00
Maximum	44.00	54.50	45.00	59.00	57.00	54.00
Minimum	34.50	44.00	39.00	51.00	47.50	54.00
Standard Deviation	1.76	3.03	1.94	2.98	3.23	0.00
Sample Size	47	17	9	5	7	1
Statistical Week 28						
Mean Fork Length (cm)	37.62	50.17		60.00	50.75	
Maximum	40.50	54.00		60.00	52.50	
Minimum	34.00	46.50		60.00	49.00	
Standard Deviation	2.15	3.75		0.00	2.47	
Sample Size	8	3		1	2	
2007 Composite						
Mean Fork Length (cm)	39.58	50.98	42.39	57.54	52.00	58.14
Maximum	50.00	57.00	46.00	64.00	59.00	63.50
Minimum	34.00	44.00	39.00	50.50	45.00	54.00
Standard Deviation	2.21	2.99	1.94	2.54	3.00	1.94
Sample Size	200	162	32	60	56	15

Table A7: Length-at-age estimates for Columbia Basin steelhead sampled at Bonneville Dam in 2007.

Brood Year and	2004	2003		2002			2001			2000		1999
Age Class	1.1	1.2	2.1	1.3	2.2	3.1	2.3	3.2	4.1	3.3	4.2	4.3
Statistical Week 16												
Mean Fork Length (cm)		76.00			77.00							
Maximum		76.00			77.00							
Minimum		76.00			77.00							
Standard Deviation		0.00			0.00							
Sample Size		1			1							
Statistical Week 17												
Mean Fork Length (cm)		63.83										
Maximum		69.50										
Minimum		52.50										
Standard Deviation		9.81										
Sample Size		3										
Statistical Week 18												
Mean Fork Length (cm)		69.00										
Maximum		69.00										
Minimum		69.00										
Standard Deviation		0.00										
Sample Size		1										
Statistical Week 19												
Mean Fork Length (cm)		71.70										
Maximum		79.00										
Minimum		66.00										
Standard Deviation		5.33										
Sample Size		5										
Statistical Week 20												
Mean Fork Length (cm)	61.00	68.71		77.50	72.50							
Maximum	63.50	77.50		77.50	76.00							
Minimum	58.50	60.00		77.50	69.50							
Standard Deviation	3.54	4.73		0.00	3.28							
Sample Size	2	14		1	3							
Statistical Week 21												
Mean Fork Length (cm)	51.50	68.88			69.00							
Maximum	52.00	74.00			70.00							
Minimum	51.00	65.00			68.00							
Standard Deviation	0.71	3.14			1.41							
Sample Size	2	8			2							
Statistical Week 22												
Mean Fork Length (cm)	59.25	72.03	65.00	81.75	70.00			74.00				
Maximum	66.50	85.00	65.00	82.50	70.00			75.00				
Minimum	52.00	65.00	65.00	81.00	70.00			73.00				
Standard Deviation	10.25	4.67	0.00	1.06	0.00			1.41				
Sample Size	2	17	1	2	1			2				
Statistical Week 23												
Mean Fork Length (cm)	57.94	69.53		78.00	71.67		81.00					
Maximum	71.00	77.50		78.00	81.00		81.00					
Minimum	52.00	65.00		78.00	66.00		81.00					
Standard Deviation	7.70	3.89		0.00	8.14		0.00					
Sample Size	8	16		1	3		1					

Brood Year and	2004	2003		2002			2001			2000		1999
Age Class	**1.1**	**1.2**	**2.1**	**1.3**	**2.2**	**3.1**	**2.3**	**3.2**	**4.1**	**3.3**	**4.2**	**4.3**
Statistical Week 24												
Mean Fork Length (cm)	53.80	69.44	71.00	84.00	67.00							
Maximum	66.50	75.50	71.00	84.00	67.00							
Minimum	48.00	60.50	71.00	84.00	67.00							
Standard Deviation	4.41	4.83	0.00	0.00	0.00							
Sample Size	15	16	1	1	1							
Statistical Week 25												
Mean Fork Length (cm)	57.20	69.60		82.00								
Maximum	73.00	70.00		82.00								
Minimum	49.50	68.50		82.00								
Standard Deviation	6.24	0.65		0.00								
Sample Size	15	5		1								
Statistical Week 26												
Mean Fork Length (cm)	58.21	70.50	60.00		68.00	61.00						
Maximum	66.50	75.50	60.00		72.00	61.00						
Minimum	51.50	64.50	60.00		65.00	61.00						
Standard Deviation	4.25	3.37	0.00		3.61	0.00						
Sample Size	28	15	1		3	1						
Statistical Week 27												
Mean Fork Length (cm)	57.47	68.16	56.12		73.38	60.25		72.50				
Maximum	69.00	73.00	60.00		102.50	62.00		72.50				
Minimum	42.00	60.00	53.50		63.00	58.50		72.50				
Standard Deviation	3.88	3.19	2.05		8.58	2.47		0.00				
Sample Size	74	16	8		21	2		1				
Statistical Week 28												
Mean Fork Length (cm)	57.45	67.81	58.88	78.00	69.62	57.20		66.93				
Maximum	70.50	77.00	70.00	78.00	78.00	60.00		75.00				
Minimum	48.00	60.50	53.00	78.00	65.00	54.00		59.00				
Standard Deviation	3.27	4.55	4.34	0.00	3.93	2.39		4.76				
Sample Size	70	18	17	1	8	5		7				
Statistical Week 29												
Mean Fork Length (cm)	58.25	72.50	59.75		67.75	57.67		67.25				
Maximum	63.50	72.50	60.50		69.50	59.50		75.00				
Minimum	53.00	72.50	59.00		66.00	56.00		61.00				
Standard Deviation	2.63	0.00	1.06		2.47	1.76		5.80				
Sample Size	20	1	2		2	3		4				
Statistical Week 30												
Mean Fork Length (cm)	57.33	68.33	58.10		69.67			66.00				
Maximum	63.50	81.00	59.50		72.00			69.00				
Minimum	53.50	63.00	56.50		68.00			63.00				
Standard Deviation	2.37	6.43	1.39		2.08			4.24				
Sample Size	38	6	5		3			2				
Statistical Week 31												
Mean Fork Length (cm)	58.96	70.14	58.00		70.50	58.67		66.83				
Maximum	67.50	75.00	58.00		73.00	60.00		70.50				
Minimum	54.50	61.00	58.00		68.00	58.00		65.00				
Standard Deviation	3.32	4.85	0.00		2.08	1.15		3.18				
Sample Size	26	7	1		4	3		3				

Brood Year and	2004	2003		2002			2001			2000		1999
Age Class	1.1	1.2	2.1	1.3	2.2	3.1	2.3	3.2	4.1	3.3	4.2	4.3
Statistical Week 32												
Mean Fork Length (cm)	58.83	67.67			77.00	58.50						
Maximum	64.50	70.00			77.00	58.50						
Minimum	53.00	64.00			77.00	58.50						
Standard Deviation	3.03	3.21			0.00	0.00						
Sample Size	29	3			1	1						
Statistical Week 33												
Mean Fork Length (cm)	58.27	70.40	58.50		72.25	60.25		74.00	62.50			
Maximum	66.50	73.50	60.50		75.50	61.00		74.00	62.50			
Minimum	54.00	66.50	55.50		69.00	59.50		74.00	62.50			
Standard Deviation	2.52	3.61	1.97		4.60	1.06		0.00	0.00			
Sample Size	37	5	5		2	2		1	1			
Statistical Week 34												
Mean Fork Length (cm)	58.98	73.62	54.50			63.00		75.50				
Maximum	67.50	84.00	54.50			64.00		75.50				
Minimum	53.50	66.00	54.50			62.00		75.50				
Standard Deviation	3.26	8.12	0.00			1.41		0.00				
Sample Size	33	4	1			2		1				
Statistical Week 35												
Mean Fork Length (cm)	58.38	69.70	61.00		71.67	62.00		79.75				
Maximum	64.50	78.50	63.00		75.00	62.00		80.50				
Minimum	55.00	60.00	59.00		68.50	62.00		79.00				
Standard Deviation	2.57	5.47	2.83		3.25	0.00		1.06				
Sample Size	17	10	2		3	1		2				
Statistical Week 36												
Mean Fork Length (cm)	60.16	76.00	61.50		79.00	57.00		76.75			74.00	
Maximum	63.50	89.00	61.50		79.00	57.00		80.00			74.00	
Minimum	56.50	59.00	61.50		79.00	57.00		73.50			74.00	
Standard Deviation	2.14	8.01	0.00		0.00	0.00		4.60			0.00	
Sample Size	16	19	1		1	1		2			1	
Statistical Week 37												
Mean Fork Length (cm)	63.56	81.68		84.29	80.86	64.00	87.33	75.00				
Maximum	69.00	91.00		92.50	85.50	64.00	94.00	75.00				
Minimum	56.50	68.50		78.50	77.50	64.00	82.00	75.00				
Standard Deviation	4.21	4.40		3.86	2.78	0.00	6.11	0.00				
Sample Size	17	44		17	7	1	3	1				
Statistical Week 38												
Mean Fork Length (cm)	62.65	80.38	62.50	85.88	78.50		86.25	74.75			84.50	83.50
Maximum	69.00	92.00	62.50	93.50	89.00		89.50	75.00			84.50	83.50
Minimum	53.00	70.00	62.50	77.50	72.00		83.00	74.50			84.50	83.50
Standard Deviation	3.91	3.91	0.00	3.19	6.32		4.60	0.35			0.00	0.00
Sample Size	34	103	1	45	7		2	2			1	1
Statistical Week 39												
Mean Fork Length (cm)	64.54	80.69		86.02	77.88			82.62		88.00		
Maximum	70.00	87.50		90.50	83.00			86.00		88.00		
Minimum	53.00	70.00		76.50	72.00			79.00		88.00		
Standard Deviation	3.77	3.56		2.65	4.52			3.20		0.00		
Sample Size	36	93		40	4			4		1		

Brood Year and	2004	2003		2002			2001			2000		1999
Age Class	1.1	1.2	2.1	1.3	2.2	3.1	2.3	3.2	4.1	3.3	4.2	4.3
Statistical Week 40												
Mean Fork Length (cm)	62.20	79.63	62.71	84.44	79.21	61.50	86.40	87.50		84.00		
Maximum	71.00	89.00	68.50	91.00	88.00	61.50	88.50	87.50		84.00		
Minimum	56.00	69.00	56.50	77.00	74.00	61.50	84.00	87.50		84.00		
Standard Deviation	4.17	3.94	4.39	3.44	4.48	0.00	2.22	0.00		0.00		
Sample Size	56	60	7	35	7	1	5	1		2		
Statistical Week 41												
Mean Fork Length (cm)	62.44	80.16	61.58	85.88	78.75		87.50	65.50				
Maximum	76.50	88.00	67.00	90.00	81.00		87.50	65.50				
Minimum	52.00	60.50	57.00	80.00	76.50		87.50	65.50				
Standard Deviation	4.78	4.62	4.02	3.46	3.18		0.00	0.00				
Sample Size	39	52	6	26	2		1	1				
Statistical Week 42												
Mean Fork Length (cm)	60.92	79.67	59.00	87.38	82.00							
Maximum	68.50	86.00	59.00	98.00	82.00							
Minimum	53.50	72.50	59.00	84.00	82.00							
Standard Deviation	4.02	4.57	0.00	4.60	0.00							
Sample Size	25	15	1	8	1							
2007 Composite												
Mean Fork Length (cm)	58.86	76.05	58.68	85.44	73.11	59.65	86.75	71.10	62.50	86.14	78.29	83.50
Maximum	76.50	92.00	71.00	98.00	102.50	64.00	94.00	87.50	62.50	88.00	84.50	83.50
Minimum	42.00	52.50	53.00	76.50	63.00	54.00	81.00	59.00	62.50	84.00	74.00	83.50
Standard Deviation	3.08	4.53	2.26	3.17	3.89	1.17	4.43	3.00	0.00	0.00	0.00	0.00
Sample Size	639	557	60	178	87	23	12	34	1	3	2	1