CRITFC

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AGE AND LENGTH COMPOSITION OF COLUMBIA BASIN CHINOOK AND SOCKEYE SALMON AND STEELHEAD AT BONNEVILLE DAM IN 2005

John Whiteaker, Jeffrey K. Fryer, and Jeremiah Doyle

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ABSTRACT

In continuation of the Stock Assessment Project, the Columbia River Inter-Tribal Fish Commission (CRITFC) conducted a field study at Bonneville Dam in 2005 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 2006 Chinook salmon run. Adult spring, summer and fall Chinook salmon (*Oncorhynchus tshawytscha*), sockeye salmon (*O. nerka*) and summer-run steelhead (*O. mykiss*) were randomly 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 populations. Based on scale pattern analysis four-year-olds (from the 2001 brood year [BY]) were the most abundant age group for all three races of Chinook salmon, comprising 74.2% of the spring Chinook migration, 57.6% of the summer Chinook migration, and 55.4% of the fall Chinook migration. Five-year-old fish (2000 BY) were second most abundant, comprising 15.7% of the spring Chinook, 31.7% of the summer Chinook, and 36.3% of the fall Chinook. Three-year-old fish (2002 BY) were third most abundant, comprising 5.6% of the spring Chinook migration, 7.7% of the summer Chinook migration, and 5.7% of the fall Chinook migration. The largest proportion of the sockeye salmon migration through Bonneville Dam was four-year-old fish 89.9%. The steelhead migration consisted of 33.4% four-year-old fish and 25.9% three-year-old fish. Based on fin marks for classification, the steelhead migration consisted of 86.9% hatchery- and 13.1% natural-origin steelhead. A-run steelhead, less than 78cm in length, comprised 70.1% of the steelhead run. B-run fish, equal to or greater than 78cm, comprised 29.9% of the run. A year-class regression over the past 17 years of data was used to predict spring, summer, and bright fall Chinook salmon population sizes for 2006. Based on three-year-old returns, the relationship predicts four-year-old returns of 75,700 (± 63,700, 90% predictive interval [PI]) spring Chinook, 13,200 (± 32,600, 90% PI) summer, and 80,700 (± 126,400, 90% PI) bright fall Chinook salmon for the 2006 runs. Based on four-year-old returns, the relationship predicts five-year-old returns of 23,900 (± 42,700, 90% PI) spring, 31,000 (± 8,500, 90% PI) summer, and 105,700 (± 48,500, 90% PI) bright fall Chinook salmon for the 2006 runs.

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INTRODUCTION

In 1985, the US-Canada Pacific Salmon Treaty was formed between the governments of the United States and Canada 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 since 1985, spring Chinook salmon since 1987, summer Chinook salmon since 1990, and up-river bright fall Chinook salmon since 1998.

At the request of the NOAA Fisheries Northwest Fisheries Science Center, summer steelhead 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. 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 to determine stock composition if specific scale pattern 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 2004). However, this method was found to be less successful with Chinook salmon where numerous populations can exhibit similar early life histories. Currently a coast wide genetic database is being developed to create baseline 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 2005 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 2006 run size for Chinook salmon using the age composition data, 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 then migrate back 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. Chinook salmon passing Bonneville from March 15 through June 15 are classified as spring Chinook, from June 16 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 xxx for B-run).

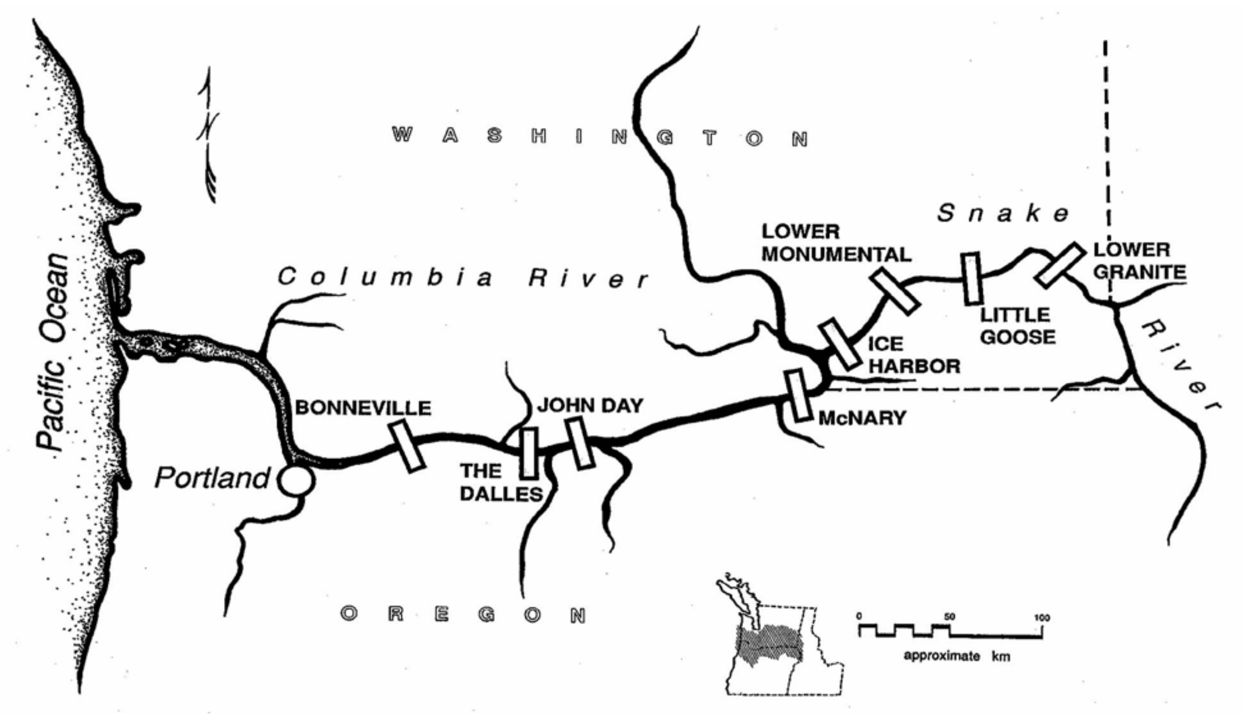

Figure 1. Map of the Columbia River displaying federal dams. Bonneville Dam (rkm 235)

Sample Design

Adult fish were sampled one or two 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, α=0.10 for age composition estimates. Additional samples were collected to buffer for unreadable scales. 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 (2005) and the Fish Passage Center (2005).

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 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. 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 was 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 2005, for example, Statistical Week 16 began on April 10 and ended on April 16.
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 the adipose fin. Some hatchery-origin steelhead are released unmarked and to identify these individuals we used scale pattern analysis methods 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.

Hatchery and wild determinations were also aided by the observation of fin clips or worn fins (typically the dorsal). Steelhead with a fin clip and/or a stubby dorsal fin are typically considered hatchery, although some wild fish may have worn fins and some hatchery fish may have neither fin clips nor worn fins. The combination of scale analysis and fin mark assessment leads to a relatively accurate determination of hatchery/wild.

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 be determined by snout shape 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 kelt 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 that a kelt is likely older than would be indicated by adding up 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 2006, based on the number of three-year-old fish estimated to have returned in 2005. A similar relationship was used to predict abundance of five-year-old fish in 2006, from the estimated number four-year-old fish that returned in 2005.

RESULTS

Sampling

Chinook salmon (spring, summer and fall) were sampled for 22 weeks (April through October) during their migration. A total of 857 spring Chinook were sampled, 456 summer Chinook and 553 fall Chinook (Tables 1, 2 and 3 respectively). A total of 613 sockeye salmon were sampled (Table 4) over 8 weeks (June through July), and 579 steelhead were sampled (Tables 5 and 6) over 9 weeks (July through October). Summer Chinook were not sampled during Statistical Week 31 and Fall Chinook were not sampled during Statistical Weeks 32 through 36 due to river water temperatures exceeding 20°C, which is approaching the lethal temperature for migrating adult Chinook salmon (McCullough 1999). Due to contracting problems along with high river water temperatures, we were also unable to sample prior to Week 35 of the summer steelhead run.

Age Composition

Based on scale pattern analysis four-year-olds were the most abundant age group for all three races of Chinook salmon, comprising 74.2% of the spring Chinook migration (Table 1, Figure 2), 57.6% of the summer Chinook migration (Table 2), and 57.6% of the fall Chinook migration (Table 3). Five-year-old fish were second most abundant, and three-year-old fish third most abundant for all three races.

Scale patterns indicated a steady increase in the percentage of ocean-type Chinook salmon from 0% in Statistical Week 20 to about 90% after Statistical Week 38, with a corresponding decrease in the percentage of stream-type Chinook salmon (Figure 3).

The Sockeye salmon run also was composed primarily of four-year-olds (88.8%), with five- and three-years-olds being less abundant (Table 4).

Due to contracting problems in 2005 we did not start sampling steelhead until Week 35, and we estimated that over half of the run had already passed Bonneville. Age composition estimates from the portion of the run that we did sample are provided in Table 5. Age composition for hatchery and wild steelhead based on fin marks are presented in Appendix A.

Table 1. Weekly and cumulative age composition of Columbia Basin spring Chinook at Bonneville Dam in 2005.

Statistical Week	Sampling Date	Number Sampled	Number Ageable	Weekly Run size	Weekly Run size	2002		2001		2000		1999	
						0.2	1.1	0.3	1.2	0.4	1.3	0.5	1.4
17[a]	4/14,20,22	117	105	7,943	7,943	0.000	0.010	0.000	0.867	0.000	0.124	0.000	0.000
18	4/25,4/29	160	149	23,590	23,590	0.000	0.013	0.000	0.886	0.000	0.101	0.000	0.000
19	5/2,5/4	150	132	18,804	18,804	0.000	0.015	0.000	0.917	0.000	0.068	0.000	0.000
20	5/9,5/11	80	65	6,381	6,381	0.000	0.123	0.000	0.815	0.000	0.062	0.000	0.000
21	5/16,5/18	90	78	8,511	8,511	0.013	0.256	0.000	0.667	0.000	0.064	0.000	0.000
22[b]	5/27	60	53	8,561	13,097	0.019	0.094	0.038	0.792	0.000	0.057	0.000	0.000
23	6/1	50	44	9,668		0.000	0.023	0.023	0.659	0.023	0.250	0.000	0.023
24	6/7, 6/9	100	78	10,785		0.013	0.038	0.115	0.462	0.000	0.295	0.013	0.064
25[c]	6/14	50	36	8,483		0.000	0.028	0.222	0.250	0.000	0.500	0.000	0.000
Through June 15		**857**	**704**	**102,726**		**0.004**	**0.052**	**0.036**	**0.741**	**0.002**	**0.155**	**0.001**	**0.009**
Through May 31[d]		**657**	**582**		**78,326**	**0.005**	**0.062**	**0.006**	**0.846**	**0.000**	**0.081**	**0.000**	**0.000**

Notes:

a The official spring Chinook salmon run begins on March 15 (Week 12). Sampling began in Week 16 but only six fish were sampled and were combined with Week 17. The weekly run size includes Chinook salmon passing Bonneville Dam in Weeks 12-17.

b. For the May 31 estimates, the spring Chinook run size for Week 22 includes fish passing Bonneville Dam for during the early part of Week 23 (May 29-31)

c. The weekly run size only includes those fish passing through June 15.

d. May 31 estimates are presented for a better comparison to previous years when the spring Chinook run at Bonneville Dam ended on May 31.

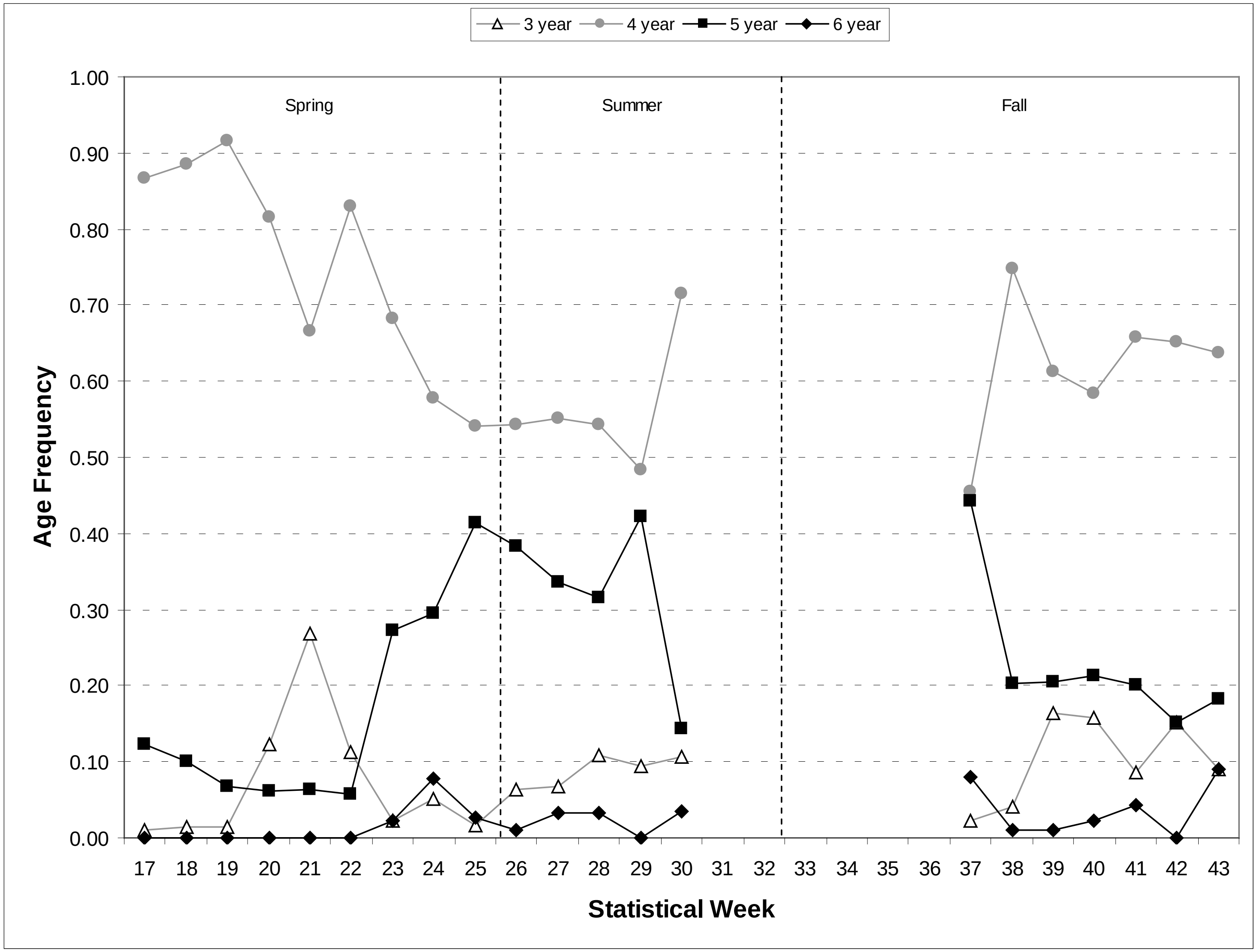

Figure 2. : Weekly age composition estimates for age groups of Columbia Basin Chinook salmon sampled at Bonneville Dam in 2005.

Table 2. Weekly and cumulative age composition of Columbia Basin summer Chinook salmon sampled at Bonneville Dam in 2005.

Statistical Week	Sampling Date	Number Sampled	Number Ageable	Weekly run size	2003	2002		2001		2000		1999		1998
					0.1	0.2	1.1	0.3	1.2	0.4	1.3	1.4	0.5	1.5
25	6/16	50	45	5,777	0.000	0.000	0.000	0.400	0.244	0.000	0.289	0.044	0.022	0.000
26	6/20, 6/22	100	94	14,254	0.000	0.011	0.053	0.298	0.245	0.011	0.372	0.011	0.000	0.000
27	6/27, 6/29	100	89	12,087	0.000	0.034	0.034	0.416	0.135	0.022	0.315	0.034	0.000	0.011
28	7/5, 7/8	100	92	11,241	0.000	0.033	0.076	0.272	0.272	0.011	0.304	0.033	0.000	0.000
29	7/11, 7/14	76	64	6,352	0.000	0.063	0.031	0.375	0.109	0.063	0.359	0.000	0.000	0.000
30-32	7/19	30	28	9,592	0.000	0.107	0.000	0.500	0.214	0.036	0.107	0.000	0.036	0.000
Cumulative		**456**	**412**	**59,303**	**0.000**	**0.040**	**0.037**	**0.368**	**0.208**	**0.022**	**0.295**	**0.020**	**0.008**	**0.002**

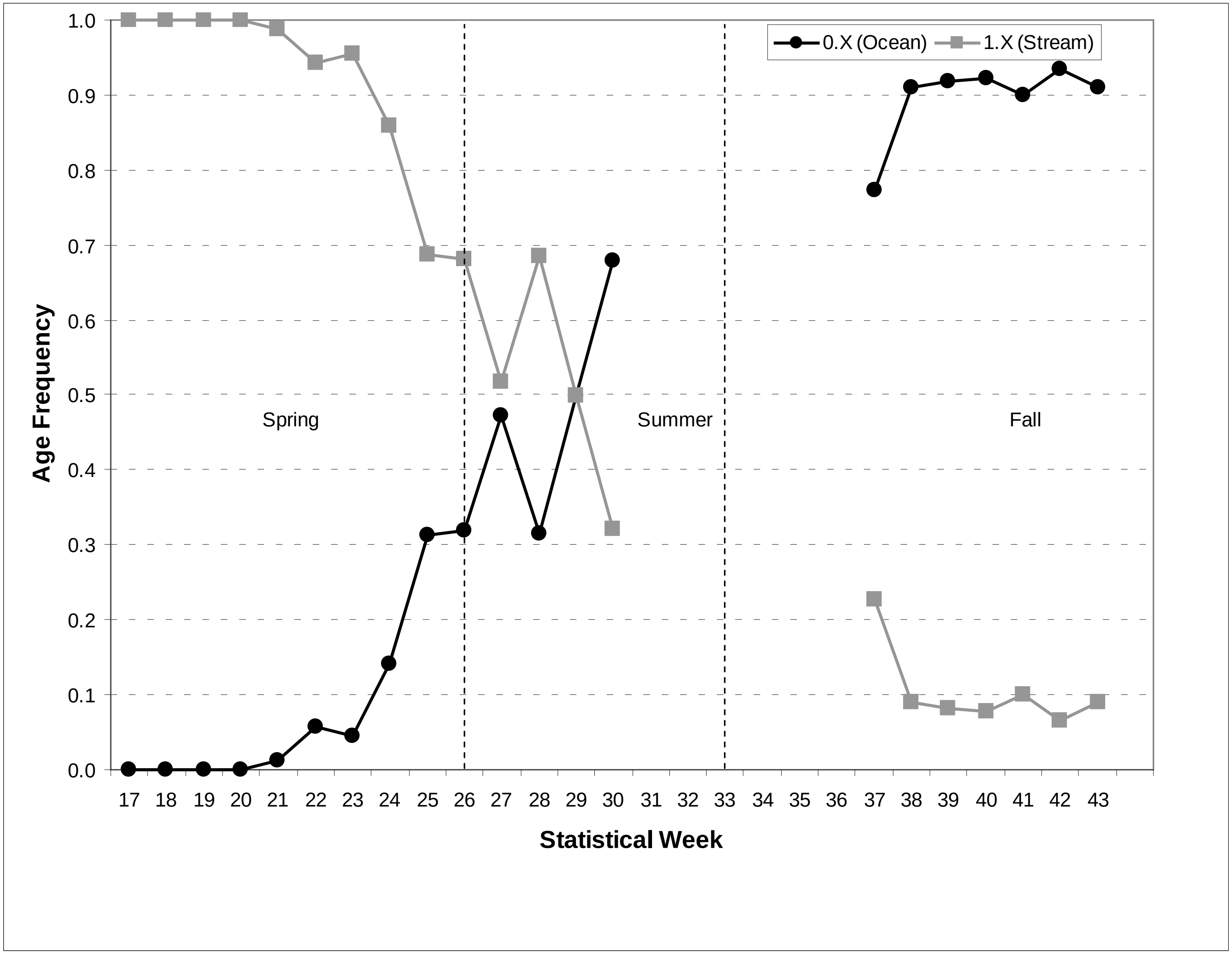

Figure 3. Weekly freshwater age composition estimates of Columbia Basin Chinook salmon sampled at Bonneville Dam in 2005.

Table 3. Weekly and cumulative age composition of Columbia Basin bright fall Chinook salmon sampled at Bonneville Dam in 2005.

Statistical Week	Sampling Date	Number Sampled	Number Ageable	Weekly run size	2003	2002		2001		2000		1999	
					0.1	0.2	1.1	0.3	1.2	0.4	1.3	0.5	1.4
37[a]	9/9	100	88	183,405	0.000	0.023	0.000	0.409	0.045	0.273	0.170	0.068	0.011
38	9/12, 9/15	110	99	68,254	0.000	0.040	0.000	0.717	0.030	0.141	0.061	0.010	0.000
39	9/19, 9/22	108	98	36,615	0.010	0.153	0.010	0.561	0.051	0.184	0.020	0.010	0.000
40	9/26, 9/29	99	89	24,368	0.022	0.146	0.011	0.562	0.022	0.169	0.045	0.022	0.000
41	10/3, 10/6	75	70	11,067	0.014	0.086	0.000	0.629	0.029	0.143	0.057	0.029	0.014
42	10/10, 10/13	50	46	6,196	0.043	0.152	0.000	0.587	0.065	0.152	0.000	0.000	0.000
43[b]	10/20	11	11	6,986	0.000	0.091	0.000	0.636	0.000	0.091	0.091	0.091	0.000
Cumulative		**553**	**501**	**336,891**	**0.004**	**0.055**	**0.002**	**0.514**	**0.040**	**0.219**	**0.114**	**0.045**	**0.007**

Notes:

a The fall Chinook run began on Week 32, however high temperatures prevented sampling prior to Week 37. The weekly run size for Week 37 includes 88,908 Chinook which passed during Weeks 30-36.

b. The weekly run size includes Chinook salmon passing from Weeks 44 through 47.

Length-at-Age Composition

Length-at-age composition estimates are presented in Figure 4 and Appendix A.

Steelhead Hatchery/Wild Determination

When classifying hatchery and wild steelhead based on fin marks, the run after Week 34 consisted of 86.9% hatchery and 13.1% wild steelhead (Table 6, Appendix A)

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 (70.1%) passing Bonneville Dam after Week 34 are A-run, and the remaining 29.9% are B-run. Though A-run steelhead dominate the run, the percentage of B-run fish does generally increase as the run progresses (Table 6). Hatchery and wild A/B compositions are presented in Appendix A.

Steelhead Gender Determination

The 2005 steelhead run after Week 34 consisted of 52.6% females and 47.4% males (Table 6). Gender compositions for hatchery and wild steelhead are presented in Appendix A.

Table 4. Weekly and cumulative age composition of Columbia Basin sockeye salmon sampled at Bonneville Dam in 2005.

Statistical Week	Sampling Date	Number Sampled	Number Ageable	Weekly Run Size	Age Composition by Brood Year and Age Class: 2002	2001		2000			1999	
					1.1	1.2	2.1	1.3	2.2	3.1	3.2	4.1
24[a]	6/1. 6/7, 6/9	27	27	2081	0.000	0.926	0.000	0.074	0.000	0.000	0.000	0.000
25	6/14,6/16	54	51	9872	0.020	0.902	0.020	0.059	0.000	0.000	0.000	0.000
26	6/20,6/22	160	157	18766	0.006	0.866	0.000	0.121	0.006	0.000	0.000	0.000
27	6/27,6/29	160	154	22559	0.013	0.883	0.013	0.071	0.006	0.000	0.006	0.006
28	7/5,7/8	140	135	12800	0.015	0.896	0.007	0.052	0.007	0.022	0.000	0.000
29	7/11,7/14	53	52	3978	0.000	0.962	0.019	0.019	0.000	0.000	0.000	0.000
30[b]	7/19	20	20	2946	0.000	0.850	0.050	0.000	0.050	0.000	0.050	0.000
Cumulative		**614**	**596**	**73002**	**0.011**	**0.888**	**0.011**	**0.073**	**0.007**	**0.004**	**0.004**	**0.002**

a Weekly run size includes sockeye passing Bonneville Dam between Weeks 20 and 23. Sampling began in Week 23 but only one fish was sampled, thus it was combined with Week 24.

b. Weekly run size includes sockeye salmon passing Bonneville Dam between Weeks 31 and 43. Sampling ended in Week 30.

Table 5. Weekly and cumulative age composition of Columbia Basin steelhead sampled at Bonneville Dam in 2005.

Statistical	Sampling	Number	Number	Weekly	2002	2001		2000			1999		1998	1-Fresh Wild			Kelt	Unageable			
Week	Date	Sampled	Ageable	Run Size	1.1	1.2	2.1	1.3	2.2	3.1	2.3	3.2	4.2	W1.1	W1.2	W1.3	2.1S	R	R.1	R.2	R.3
35	8/26	59	47	26,094	0.322	0.254	0.068	0.000	0.068	0.017	0.000	0.000	0.000	0.034	0.034	0.000	0.000	0.000	0.068	0.136	0.000
36	8/29, 9/1	92	72	15,789	0.391	0.217	0.033	0.011	0.043	0.000	0.000	0.000	0.011	0.043	0.033	0.000	0.000	0.011	0.109	0.098	0.000
37	9/5, 9/8	53	40	23,093	0.151	0.358	0.000	0.057	0.075	0.000	0.000	0.057	0.000	0.019	0.038	0.000	0.000	0.000	0.113	0.132	0.000
38	9/12, 9/15	80	62	20,809	0.150	0.413	0.000	0.125	0.038	0.013	0.013	0.000	0.000	0.000	0.013	0.000	0.000	0.038	0.050	0.138	0.013
39	9/19, 9/22	90	75	18,550	0.233	0.333	0.000	0.111	0.067	0.000	0.011	0.011	0.000	0.011	0.033	0.022	0.000	0.000	0.056	0.100	0.011
40	9/26, 9/29	80	66	16,484	0.163	0.375	0.013	0.138	0.050	0.000	0.000	0.038	0.000	0.000	0.038	0.000	0.013	0.038	0.088	0.038	0.013
41	10/3, 10/6	80	66	10,545	0.400	0.213	0.025	0.050	0.050	0.000	0.000	0.013	0.000	0.075	0.000	0.000	0.000	0.000	0.138	0.038	0.000
42[a]	10/10, 13, 20	45	35	11,586	0.400	0.222	0.067	0.044	0.022	0.000	0.000	0.000	0.000	0.022	0.000	0.000	0.000	0.000	0.156	0.044	0.022
Cumulative[b]		**579**	**463**	**142,950**	**0.259**	**0.309**	**0.025**	**0.066**	**0.055**	**0.005**	**0.003**	**0.016**	**0.001**	**0.023**	**0.026**	**0.003**	**0.001**	**0.011**	**0.090**	**0.101**	**0.007**

a. Five fish included in Week 42 were sampled in Week 43. The weekly run size includes steelhead passing from Weeks 43 through 51.

b. Cumulative age composition estimates are only for Statistical Weeks 35 through 51. An additional 171,731 steelhead passed between Statistical Weeks 16 and 34 and when no sampling occurred due to contracting and temperature problems.

Table 6. Weekly and cumulative fin mark, gender, length and hatchery/wild composition of Columbia Basin steelhead sampled at Bonneville Dam in 2005.

Statistical Week	Sampling Date	Number Sampled	Number Ageable	Weekly Run Size	Fin Clips		Stubby Dorsal	Sex		Length		Hatchery/Wild	
					Adipose	Other		Female	Male	< 78cm	≥ 78cm	H	W
35	8/26	59	47	26094	0.576	0.119	0.695	0.561	0.439	0.932	0.068	0.807	0.193
36	8/29, 9/1	92	72	15789	0.641	0.141	0.576	0.551	0.449	0.957	0.043	0.898	0.102
37	9/5, 9/8	53	40	23093	0.698	0.019	0.396	0.585	0.415	0.679	0.321	0.857	0.143
38	9/12, 9/15	80	62	20809	0.788	0.075	0.375	0.300	0.700	0.475	0.525	0.935	0.065
39	9/19, 9/22	90	75	18550	0.733	0.056	0.444	0.556	0.444	0.600	0.400	0.906	0.094
40	9/26, 9/29	80	66	16484	0.650	0.100	0.338	0.700	0.300	0.425	0.575	0.821	0.179
41	10/3, 10/6	80	66	10545	0.750	0.050	0.638	0.388	0.613	0.850	0.150	0.886	0.114
42[a]	10/10, 13, 20	45	35	11586	0.756	0.133	0.711	0.578	0.422	0.867	0.133	0.911	0.089
Cumulative[b]		**579**	**463**	**142950**	**0.684**	**0.080**	**0.493**	**0.526**	**0.474**	**0.701**	**0.299**	**0.869**	**0.131**

a. Five fish included in Week 42 were sampled in Week 43. The weekly run size includes steelhead passing from Weeks 43 through 51.

b. Cumulative age composition estimates are only for Statistical Weeks 35 through 51. An additional 171,731 steelhead passed between Statistical Weeks 16 and 34 and when no sampling occurred due to contracting and temperature problems.

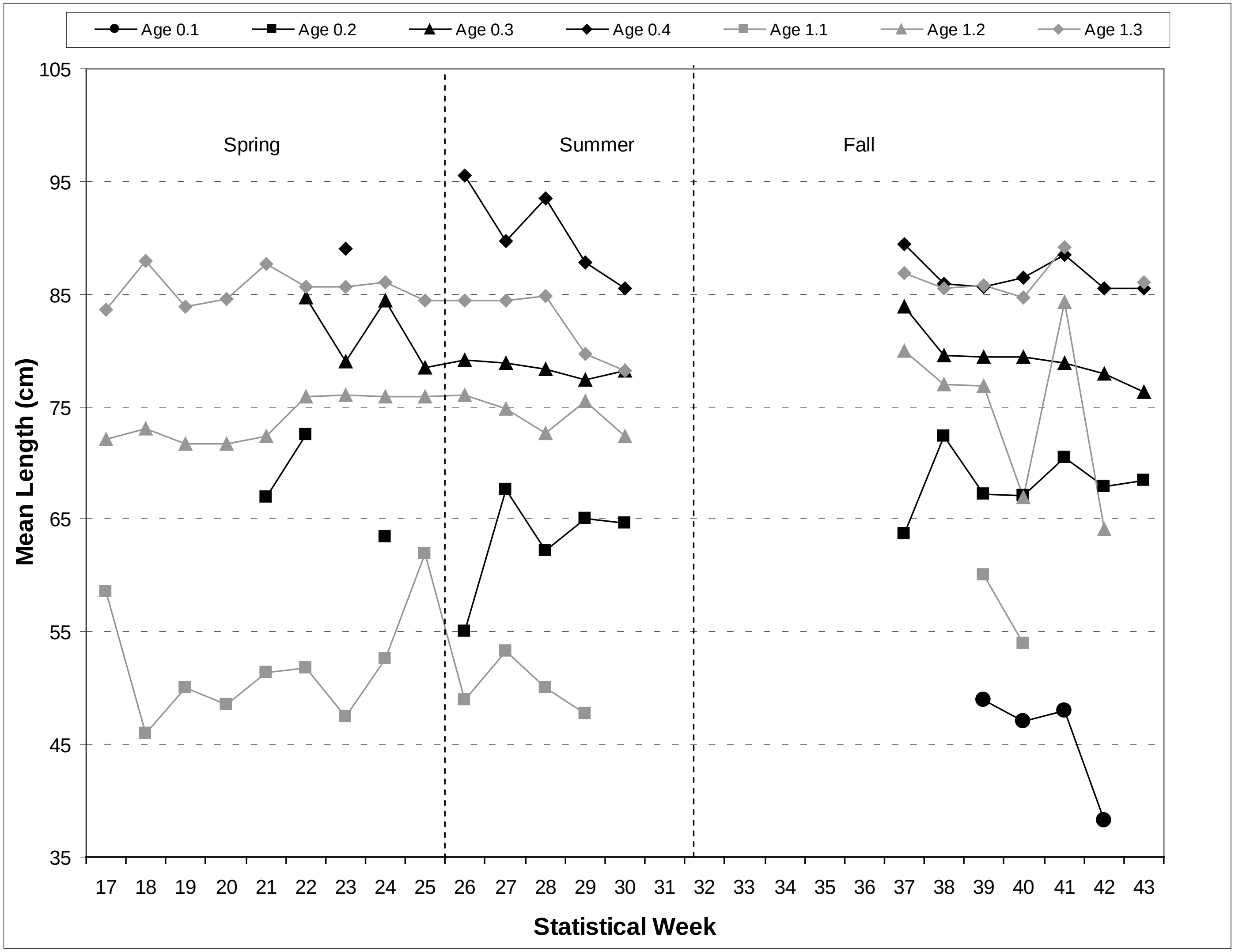

Figure 4. Weekly mean length estimates of common Columbia Basin Chinook salmon age classes (showing ocean- and stream-type) sampled at Bonneville Dam in 2005. Sampling did not occur during Weeks 31 through 36.

Fish Coloration and Condition

Bright coloration was observed in the majority of each species, 97.5% of spring Chinook, 97.1% of summer Chinook, 69.8% of fall Chinook, 99.0% of sockeye and 83.9% of steelhead. The highest condition rating of 5 was given to 87.0% of spring Chinook, 89.9% of summer Chinook, 91.2% of fall Chinook, 93.0% of sockeye and 87.0% 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 2005.

Species	Spring	Summer	Fall	Sockeye	Steelhead
Color					
B	97.5	97.1	69.8	99.0	83.9
I	2.5	2.4	20.0	0.0	14.7
D	0.0	0.0	10.3	0.3	1.4
Condition					
5	87.0	89.9	91.2	93.0	87.0
4	7.0	6.1	5.0	3.6	9.7
3	5.1	3.3	0.4	2.6	3.3
2	0.6	0.2	0.2	0.2	0.0
1	0.0	0.0	0.0	0.0	0.0

Chinook Salmon Run-Size Prediction for 2006

Using a linear relationship between the 2005 three- and four-year-old adult returns (Figure 5), the estimated number of four-year-old spring Chinook salmon returning to Bonneville Dam in 2006 is 75,700 (± 63,100, 90% prediction interval [PI]). Using the relationship between four- and five-year-olds to construct the model (Figure 6), albeit poorer than that existing between three-year-olds and four-year-olds, we predict that the 2006 five-year-old adult abundance at Bonneville Dam will be 23,900 (± 42,700, 90% PI).

For the 2005 summer Chinook salmon run at Bonneville Dam, the relationship between three- and four-year-olds (Figure 7) results in a prediction of 13,200 (± 32,600, 90% PI) four-year-olds. The relationship between four- and five-year-olds (Figure 8), the model predicts a return of 31,000 (± 8,500, 90% PI) five-year-olds.

Based on the relationship between three- and four-year-olds (Figure 9), the model results in a prediction of 80,700 (± 126,400, 90% PI) four-year-old Upriver Bright fall Chinook salmon returns for 2006. Using the relationship between four- and five-year-olds (Figure 10), the model results in a prediction of 105,700 (± 48,500, 90% PI) returning five-year-olds.

Based on the 2004 report, we made run size predictions for four- and five-year-old spring, summer, and bright fall Chinook salmon returning to Bonneville Dam in 2005 (Miranda et al. 2005) using the methods discussed in this report. For the two principle age groups (four-year-old and five-year-old), we predicted 157,000 spring, 89,600 summer, and 203,900 bright fall Chinook versus DART (2005) and the Fish Passage Center (2005) estimated returns of 95,600 spring, 53,600 summer and 295,500 bright fall Chinook salmon. Five of the six age groups predicted for 2005 were within the 90% prediction interval (Table 8) and the one that was outside was that with by far the smallest prediction intervals. Overall, we predict the 2006 return of four- and five-year old spring Chinook salmon will be similar to that which returned in 2005, while summer and Upriver Bright fall Chinook will be less than the 2005 return (Table 8).

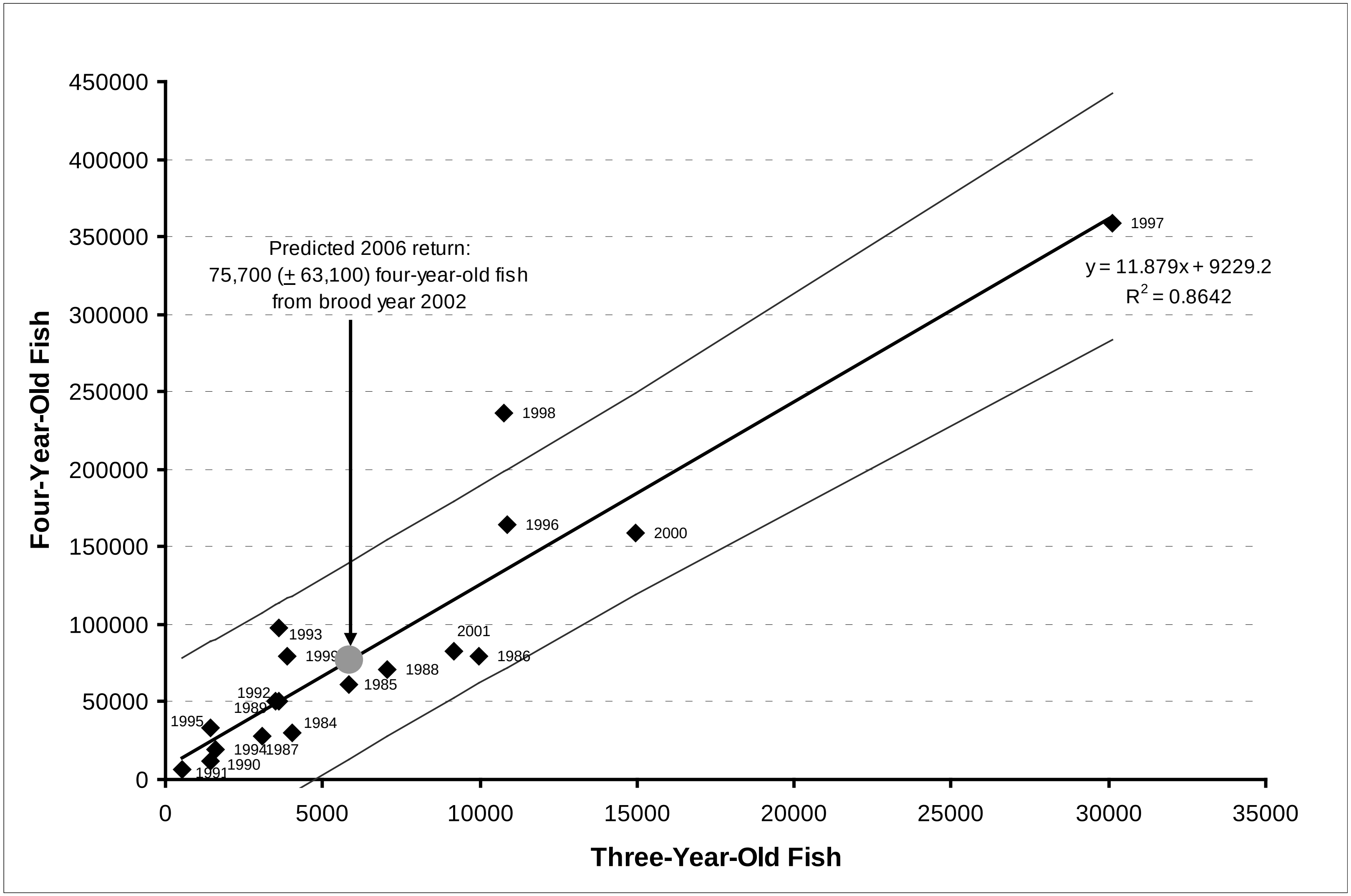

Figure 5. Predicted 2006 four-year-old Columbia Basin spring Chinook salmon abundance (at Bonneville Dam) based on a linear relationship between four-year-old and three-year-old fish abundance during brood years 1984 through 2001. Prediction intervals (90%) are also graphed.

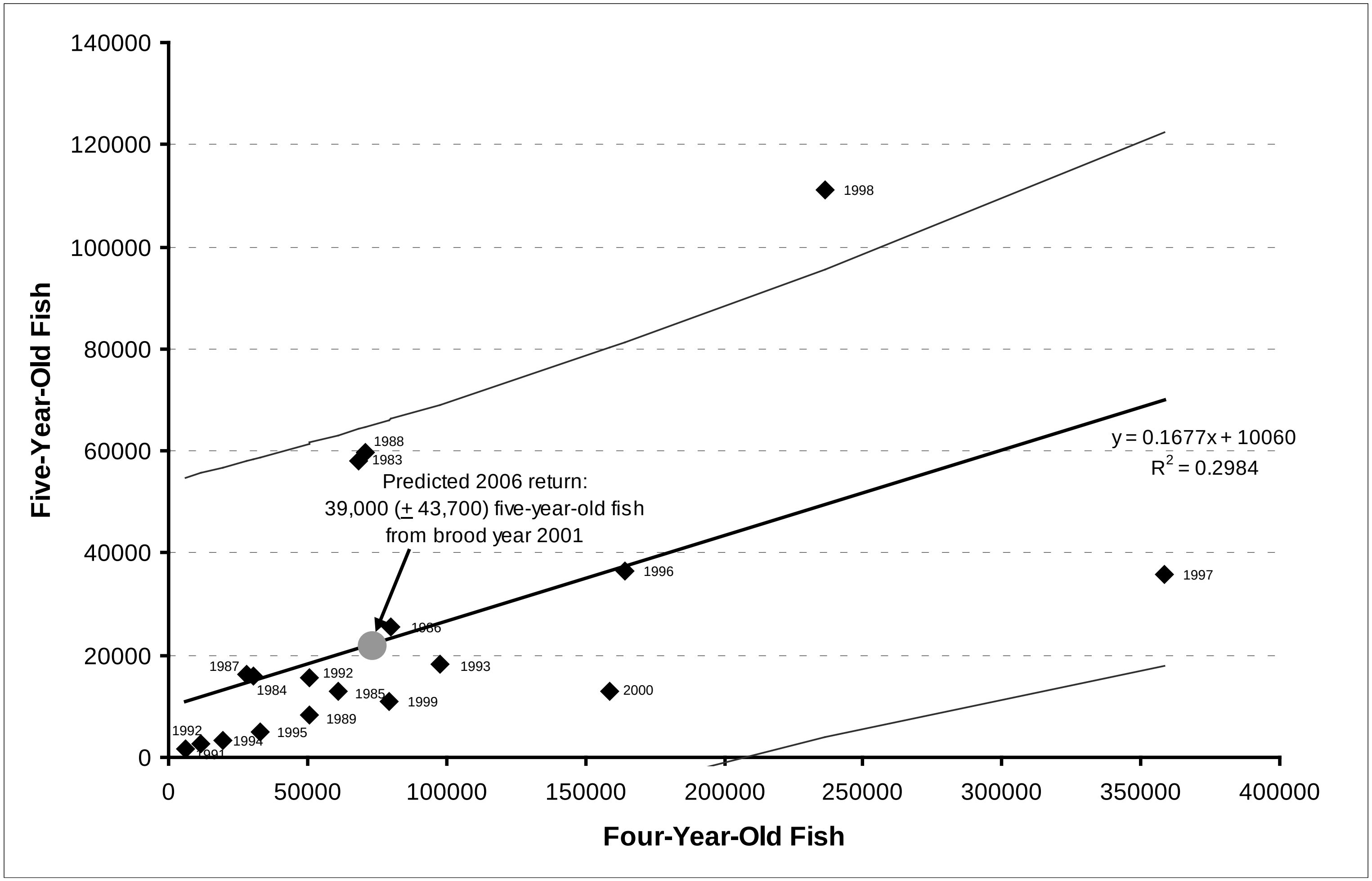

Figure 6. Predicted 2006 five-year-old Columbia Basin spring Chinook salmon abundance (at Bonneville Dam) based on a linear relationship between five-year-old and four-year-old fish abundance during brood years 1983 through 2000. Prediction intervals (90%) are also graphed.

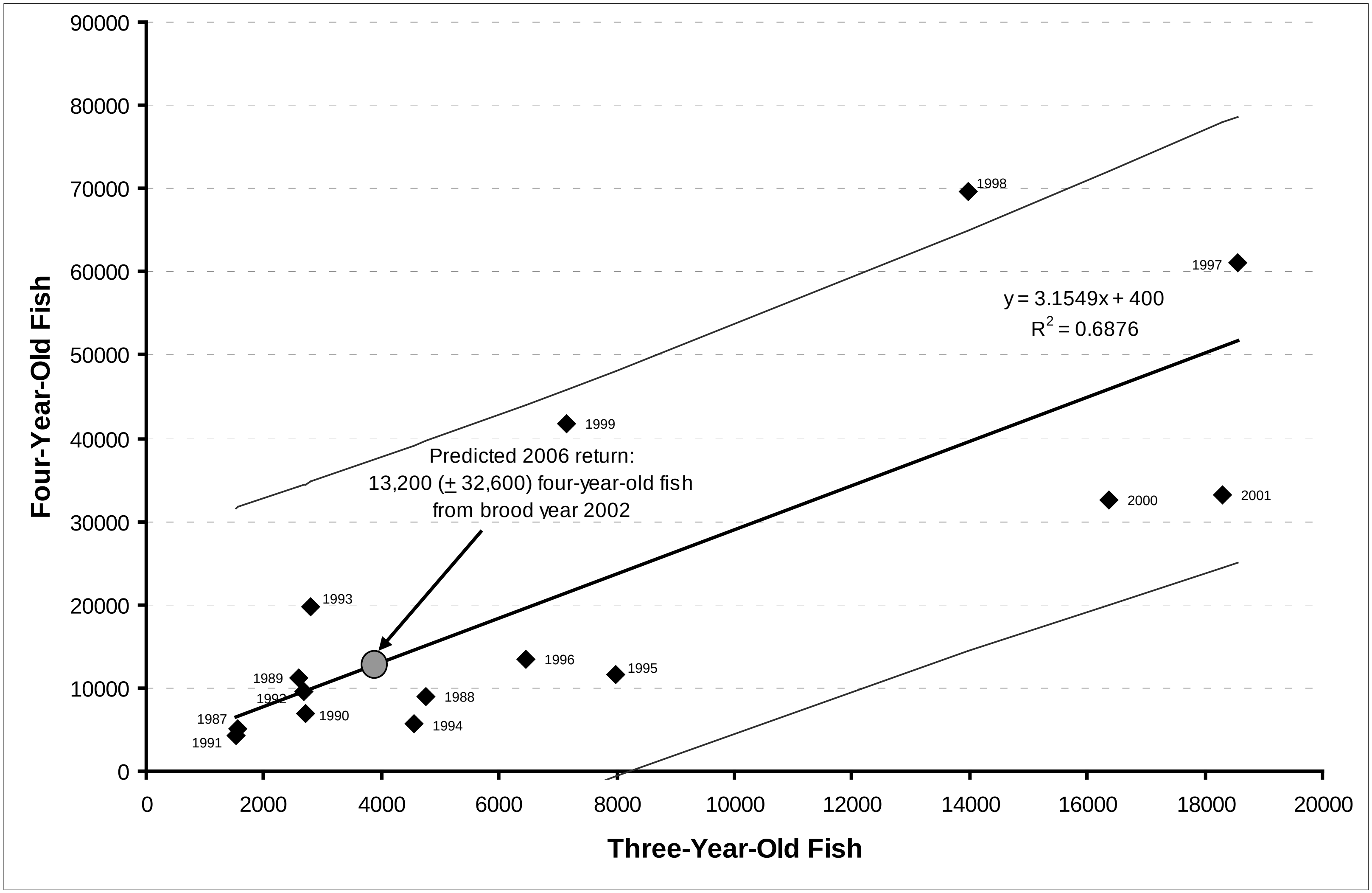

Figure 7. Predicted 2006 four-year-old Columbia Basin summer Chinook salmon abundance (at Bonneville Dam) based on a linear relationship between four-year-old and three-year-old fish abundance during brood years 1987 through 2001. Prediction intervals (90%) are also graphed.

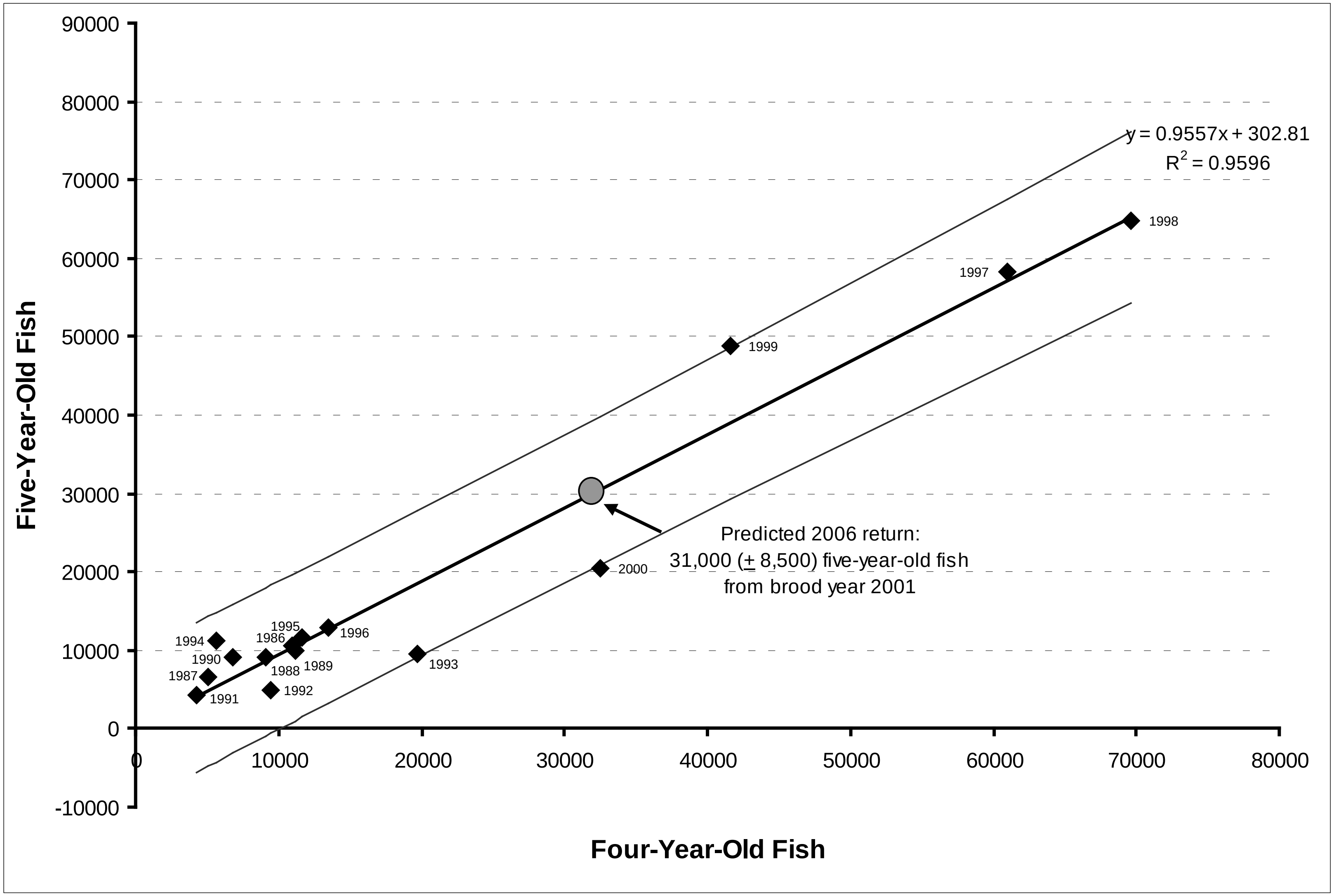

Figure 8. Predicted 2006 five-year-old Columbia Basin summer Chinook salmon abundance (at Bonneville Dam) based on a linear relationship between five-year-old and four-year-old fish abundance during brood years 1986 through 2000. Prediction intervals (90%) are also graphed.

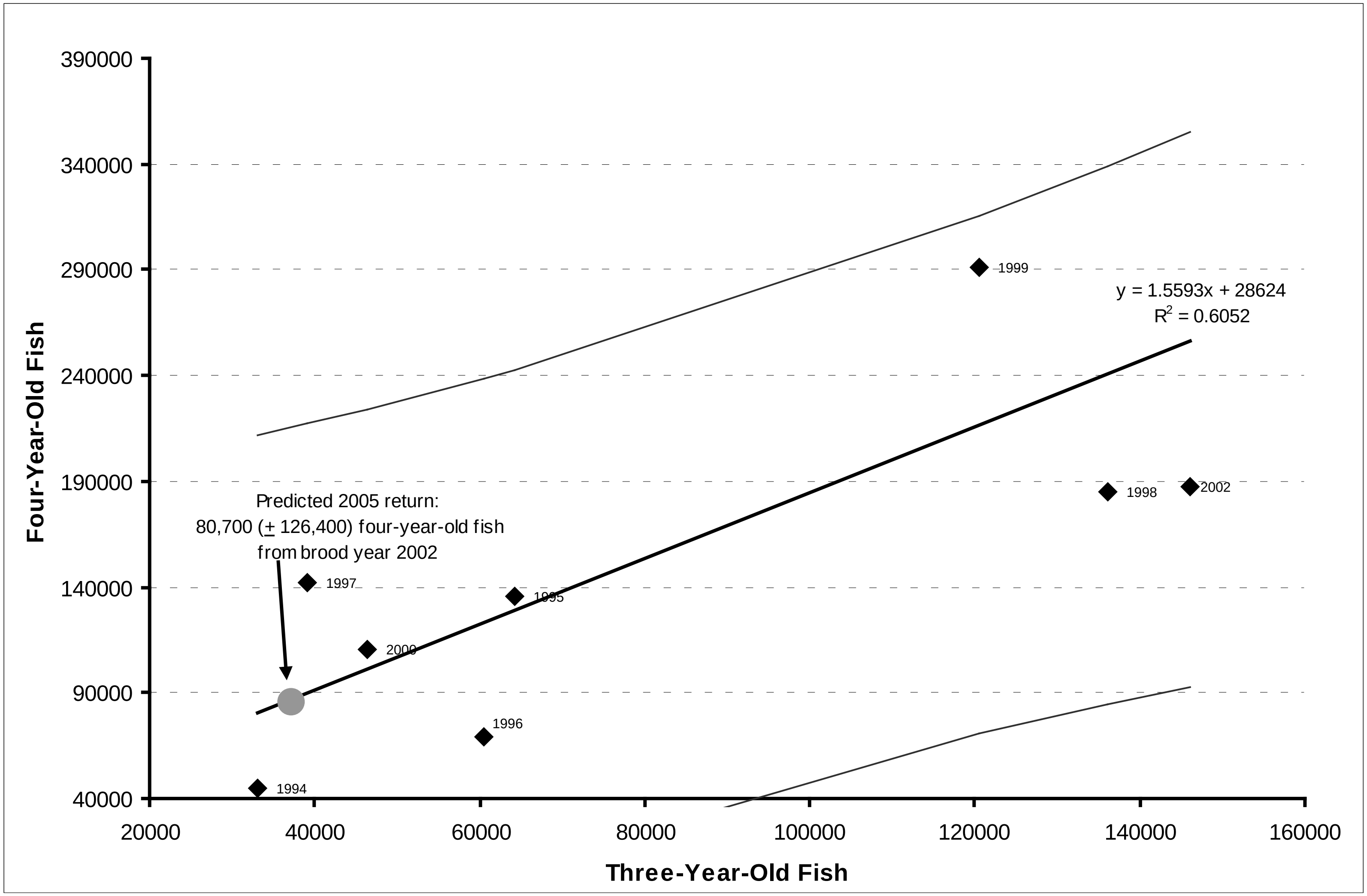

Figure 9. Predicted 2006 five-year-old Columbia Basin summer Chinook salmon abundance (at Bonneville Dam) based on a linear relationship between five-year-old and four-year-old fish abundance during brood years 1986 through 2000. Prediction intervals (90%) are also graphed.

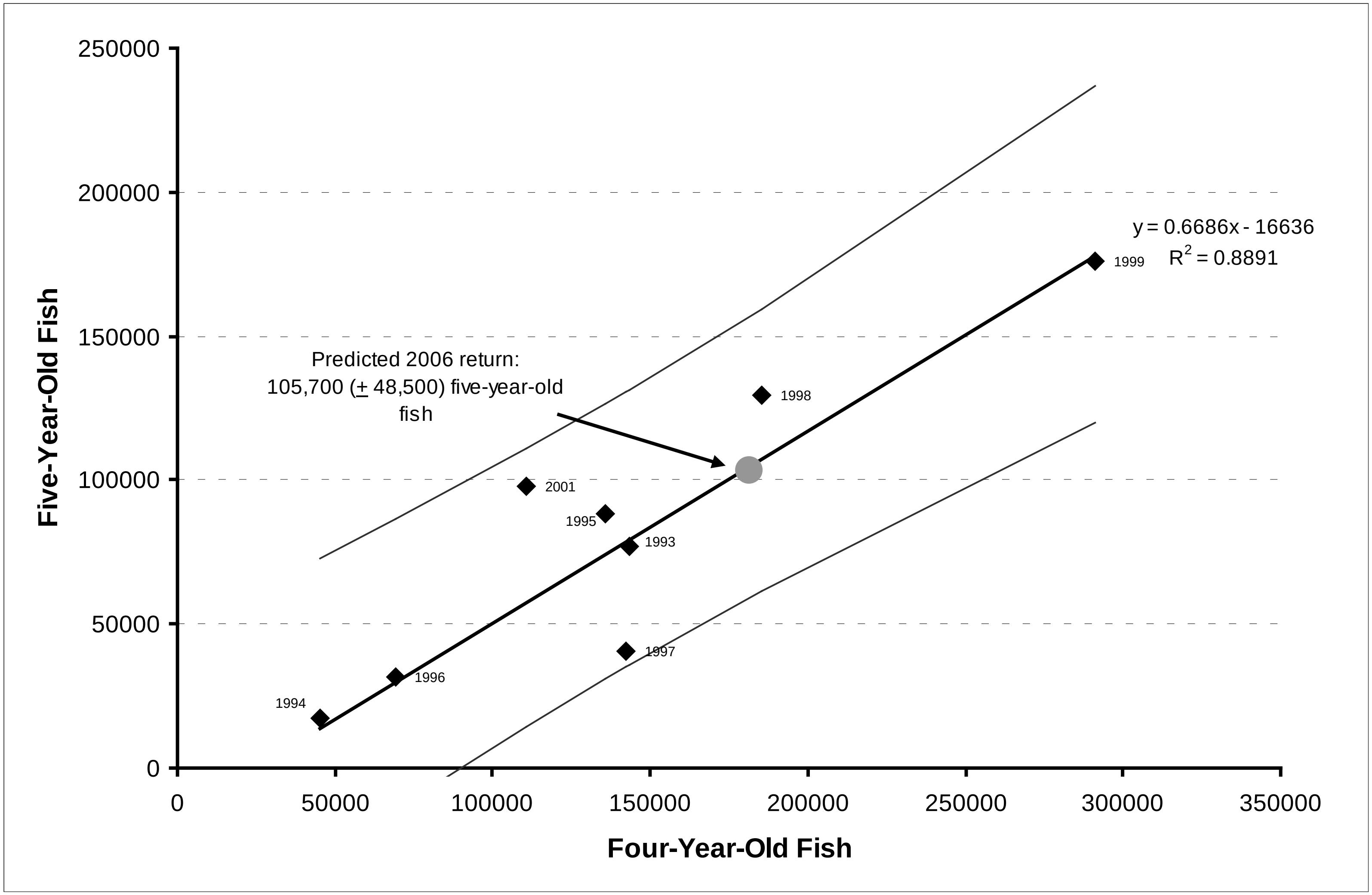

Figure 10. Predicted 2006 five-year-old Columbia Basin bright fall Chinook salmon abundance (at Bonneville Dam) based on a linear relationship between five-year-old and four-year-old fish abundance during brood years 1993 through 2000. Prediction intervals (90%) are also graphed.

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

Species and age class	Predicted in 2004 report for 2005 (±90%)	2005 Estimate	2006 Prediction (±90%)
Spring Chinook 4-year-olds	118,000 (± 63,700)	82,600	75,700 (±63,100)
Spring Chinook 5-year-olds	39,000 (± 43,700)	13,000	23,900 (±42,700)
Summer Chinook 4-year-olds	58,200 (± 26,200)	33,200	13,200 (±32,600)
Summer Chinook 5-year-olds	31,400 (±8,200)	20,400	31,000 (±8,500)
Bright Fall Chinook 4-year-olds	256,500 (± 147,600)	187,700	80,700 (±126,400)
Bright Fall Chinook 5-year-olds	57,400 (± 45,400)	97,800	105,700 (±48,500)

DISCUSSION

River Water Temperature

High river water temperature has constrained our sampling efforts during most summer sampling seasons. Our section 10 permit allows sampling of Chinook salmon at temperatures up to 20ºC. The ACOE also has modified sampling protocols for temperatures between 20 and 23.3ºC with no sampling allowed at temperatures above 23.3ºC. Therefore, during the 2005 sampling season, fall Chinook were not sampled during Statistical Weeks 32 through 36. Unlike 2004, we would not have had to curtail steelhead sampling due to high temperatures in 2005. (Rather, steelhead sampling was curtailed due to contracting problems.) McCullough (1999) asserts that temperatures exceeding 21ºC may establish a migratory barrier for Chinook salmon and Figure (11) appears to support that notion. Temperatures in this range don't appear to be as much of a factor in the steelhead migration.

Genetic Sampling

In 2005, 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 third full year for Chinook genetic collection and the second year that we collected samples from steelhead. In previous years steelhead genetic samples were collected by ODFW and WDFW. Currently 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 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.

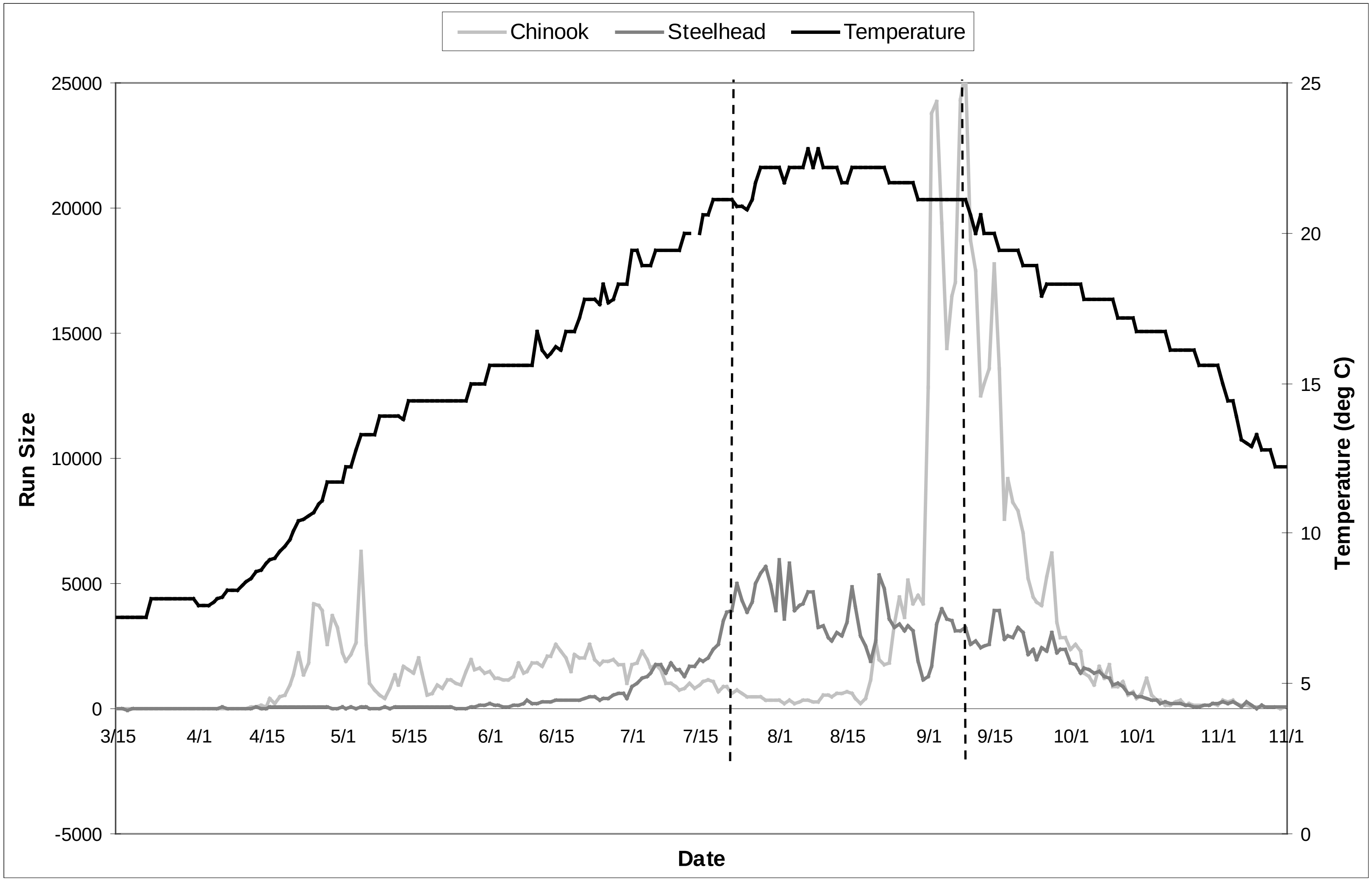

Figure 11. Chinook and steelhead daily run size and daily river temperature at Bonneville Dam from March 15 through November 1, 2005. The dashed lines represent the date range that we did not sample due to high river water temperatures (Weeks 32 through 35 for Chinook and Weeks 32 and 33 for steelhead.

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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 2005.

Statistical Week	Spring Chinook	Summer Chinook	Fall Chinook	Sockeye	Steelhead
12	X				X
13	X				X
14	X				X
15	X				X
16	X				X
17	63.2				X
18	64.4				X
19	62.7				X
20	58.8			X	X
21	61.1				X
22	42.4			X	X
23	58.0			X	X
24	51.0			0.0	X
25	52.0	32.0		0.0	X
26		39.0		0.0	X
27		44.0		1.9	X
28		53.0		1.4	X
29		43.4		0.0	X
30		30.0		0.0	X
31		X		X	X
32		X	X	X	X
33			X	X	X
34			X	X	X
35			X	X	69.5
36			X	X	78.3
37			12.0	X	71.7
38			0.9		86.3
39			6.5	X	78.9
40			4.0	X	75.0
41			4.0		80.0
42			2.0		88.9
43			0.0	X	X
44					X
45					X
46					X
47					X
Total	61.5	41.0	**7.9**		77.5

X Represents a week that a species was present, but sampling did not occur or sample sizes were small enough that data was pooled with the previous or subsequent week. Therefore, the percent in a Statistical Week before or after an X is assumed to represent the weeks during which sampling did not occur. For example, spring Chinook were first sampled in Week 15 and this week is assumed to represent Weeks 12 through 14 as well.

Table A2: Composition (%) of observed injuries of Columbia Basin Chinook salmon sampled at Bonneville Dam in 2005.

Injury Category	Spring	Summer	Fall
Marine Mammal			
Bite	2.3	0.2	0.5
Scrape	21.2	7.2	4.1
Total[a]	22.1	7.5	4.7
Descaling			
<3%[b]			
Left side	0.0	0.0	0.0
Right side	0.0	0.0	0.0
Total	0.0	0.0	0.0
3-19%			
Left side	6.4	6.4	2.9
Right side	4.6	6.6	2.7
Total[c]	11.1	10.1	4.1
≥20%			
Left side	0.6	2.9	0.7
Right side	1.2	2.0	0.5
Total[c]	1.6	3.7	0.9
Other Injuries			
Bruise	0.5	0.9	0.0
Cut	0.1	0.2	0.0
Head Injury	8.3	9.4	11.3
Head Burn	0.2	0.0	0.0
Fin	19.1	11.4	20.7
Fungus	3.0	0.4	1.4
Gash	1.6	3.1	1.8
Gas Bubble Trauma	0.0	0.0	0.0
Gill Net	2.0	1.3	6.7
Fish Hook	2.3	1.5	1.6
Lamprey	0.4	0.0	0.0
Parasite	3.0	3.1	2.3
Total[a]	30.6	26.3	37.7

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: Composition (%) of observed injuries of Columbia Basin sockeye and steelhead sampled at Bonneville Dam in 2005.

Injury Category	Sockeye	Steelhead
Marine Mammal		
Bite	0.5	0.5
Scrape	3.7	15.5
Total[a]	4.6	16.1
Descaling		
<3%[b]		
Left side	0.0	0.0
Right side	0.0	0.0
Total	0.0	0.0
3-19%		
Left side	10.7	5.0
Right side	10.9	3.1
Total[c]	19.4	5.3
≥20%		
Left side	3.1	2.4
Right side	3.6	3.1
Total[c]	5.0	3.8
Other Injuries		
Bruise	0.8	0.2
Cut	0.0	0.0
Head Injury	1.3	4.5
Head Burn	0.0	0.0
Fin	3.7	18.3
Fungus	0.0	0.3
Gash	1.5	2.6
Gas Bubble Trauma	0.0	0.0
Gill Net	0.3	5.7
Fish Hook	0.0	0.2
Lamprey	0.0	0.0
Parasite	0.7	0.9
Total[a]	7.8	28.3

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 A4: Length-at-age estimates for Columbia Basin spring Chinook salmon sampled at Bonneville Dam in 2005. Composite estimates of age classes are weighted by weekly run size.

Brood Year and	2001	2000	1999		1998
Age Class	1.1	1.2	0.4	1.3	1.4
Statistical Week 15					
Mean Fork Length (cm)		73.57		87.00	
Maximum		78.0		87.0	
Minimum		65.0		87.0	
Standard Deviation		3.97		-	
Sample Size		14		1	
Statistical Week 16					
Mean Fork Length (cm)	53.50	72.64		88.72	
Maximum	53.5	84.0		102.5	
Minimum	53.5	60.5		80.0	
Standard Deviation	-	3.85		7.38	
Sample Size	1	101		9	
Statistical Week 17					
Mean Fork Length (cm)		71.81		84.57	
Maximum		83.5		94.0	
Minimum		55.5		72.5	
Standard Deviation		4.66		6.96	
Sample Size		195		7	
Statistical Week 18					
Mean Fork Length (cm)	48.10	70.77		83.25	
Maximum	50.0	88.5		83.5	
Minimum	45.0	49.0		83.0	
Standard Deviation	2.22	6.33		0.35	
Sample Size	5	73		2	
Statistical Week 19					
Mean Fork Length (cm)	50.50	71.62		89.40	
Maximum	59.0	81.0		96.0	
Minimum	44.0	53.5		81.0	
Standard Deviation	5.55	4.35		5.55	
Sample Size	5	69		5	
Statistical Week 20					
Mean Fork Length (cm)	48.00	73.57		99.00	
Maximum	56.5	83.0		99.0	
Minimum	42.0	61.5		99.0	
Standard Deviation	4.40	4.95		-	
Sample Size	7	30		1	
Statistical Week 21					
Mean Fork Length (cm)	48.93	69.90		80.83	105.00
Maximum	51.5	82.5		85.5	105.0
Minimum	44.0	52.5		78.0	105.0
Standard Deviation	2.44	5.95		4.07	-
Sample Size	7	36		3	1
Statistical Week 22					
Mean Fork Length (cm)	53.25	73.64	89.50	89.07	
Maximum	55.5	80.0	95.0	98.0	
Minimum	49.5	63.0	84.0	75.0	
Standard Deviation	2.60	3.77	7.78	9.29	
Sample Size	4	28	2	7	
2004 Composite					
Mean Fork Length (cm)	49.59	71.91	89.50	87.31	105.00
Maximum	59.0	88.5	95.0	102.5	105.0
Minimum	42.0	49.0	84.0	72.5	105.0
Standard Deviation	3.87	4.87	7.78	7.30	-
Sample Size	29	546	2	35	1

Table A5: Length-at-age estimates for Columbia Basin summer Chinook salmon sampled at Bonneville Dam in 2005. Composite estimates of age classes are weighted by weekly run size.

Brood Year and	2002		2001		2000		1999		1998
Age Class	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)			78.4	76.7		83.5	93.0	97.5	
Maximum			91.0	86.0		94.0	93.0	104.0	
Minimum			60.0	67.0		70.0	93.0	91.0	
Standard Deviation			8.4	5.4		6.2		9.2	
Sample Size			18	11		13	1	2	
Statistical Week 26									
Mean Fork Length (cm)	55.0	49.0	79.1	76.0	95.5	84.5		90.0	
Maximum	55.0	54.0	92.5	84.0	95.5	92.5		90.0	
Minimum	55.0	43.5	65.0	65.0	95.5	76.5		90.0	
Standard Deviation		4.2	5.5	5.3		4.0			
Sample Size	1	5	28	23	1	35		1	
Statistical Week 27									
Mean Fork Length (cm)	67.7	53.3	78.9	74.8	89.8	84.4		95.3	98.5
Maximum	69.5	58.0	88.0	80.0	90.0	97.5		97.0	98.5
Minimum	65.5	47.0	63.0	62.0	89.5	71.5		94.0	98.5
Standard Deviation	2.0	5.7	5.3	5.0	0.4	5.8		1.5	
Sample Size	3	3	37	12	2	28		3	1
Statistical Week 28									
Mean Fork Length (cm)	62.2	50.0	78.4	72.7	93.5	84.9		97.5	
Maximum	63.0	58.5	92.0	85.5	93.5	95.0		105.0	
Minimum	60.5	41.5	63.5	56.0	93.5	66.0		93.0	
Standard Deviation	1.4	5.6	6.4	6.4		6.2		6.5	
Sample Size	3	7	25	25	1	28		3	
Statistical Week 29									
Mean Fork Length (cm)	65.0	47.8	77.4	75.4	87.9	79.7			
Maximum	74.0	49.5	97.0	85.5	94.5	90.0			
Minimum	55.5	46.0	61.5	64.5	85.0	68.5			
Standard Deviation	7.7	2.5	8.8	6.7	4.5	6.7			
Sample Size	4	2	24	7	4	23			
Statistical Week 30									
Mean Fork Length (cm)	64.7		78.2	72.4	85.5	78.2	92.0		
Maximum	66.5		89.0	85.0	85.5	85.5	92.0		
Minimum	62.5		66.5	61.0	85.5	74.0	92.0		
Standard Deviation	3.0		7.0	7.8		6.4			
Sample Size			14	6	1	3	1		
2005 Composite									
Mean Fork Length (cm)	64.2	50.0	78.5	74.6	89.5	83.4	92.5	95.9	98.5
Maximum	74.0	58.5	97.0	86.0	95.5	97.5	93.0	105.0	98.5
Minimum	55.0	41.5	60.0	56.0	85.0	66.0	92.0	90.0	98.5
Standard Deviation	5.1	4.9	6.7	6.0	4.2	5.9	0.7	5.3	
Sample Size	14	17	146	84	9	130	2	9	1

Table A6: Length-at-age estimates for Columbia Basin bright fall Chinook salmon sampled at Bonneville Dam in 2005. Composite estimates of age classes are weighted by weekly run size.

Brood Year and	2002	2001		2000		1999		1998	
Age Class	0.1	0.2	1.1	0.3	1.2	0.4	1.3	0.5	1.4
Statistical Week 36									
Mean Fork Length (cm)	49.25	64.55	55.25	81.56	75.42	89.10	87.64	77.50	88.00
Maximum	54.0	73.0	58.0	91.0	83.0	109.5	101.0	77.5	88.0
Minimum	44.5	53.5	49.0	76.0	70.0	79.5	78.5	77.5	88.0
Standard Deviation	6.72	6.14	4.19	4.31	5.30	5.42	6.97	-	-
Sample Size	2	10	4	18	6	43	7	1	1
Statistical Week 37									
Mean Fork Length (cm)	46.00	64.20	60.29	82.63	76.43	89.22	83.33		
Maximum	47.0	78.5	64.0	96.0	86.0	103.0	90.5		
Minimum	45.0	57.0	55.0	71.0	65.0	77.0	73.0		
Standard Deviation	1.41	4.59	3.16	5.57	6.89	4.67	6.37		
Sample Size	2	32	7	20	7	44	6		
Statistical Week 38									
Mean Fork Length (cm)	42.50	68.31	54.63	79.59	75.46	88.06	85.06	105.00	
Maximum	43.0	82.0	55.5	91.0	88.0	105.0	90.5	105.0	
Minimum	42.0	49.5	54.0	72.0	66.5	75.0	77.5	105.0	
Standard Deviation	0.71	6.44	0.75	4.18	5.90	6.68	4.24	-	
Sample Size	2	35	4	17	12	31	8	1	
Statistical Week 39									
Mean Fork Length (cm)	49.20	67.26	58.38	78.26	77.31	87.48	87.63	91.17	
Maximum	55.0	77.0	62.0	88.0	83.0	100.0	94.0	96.0	
Minimum	45.0	59.0	51.5	67.0	68.0	77.0	77.5	83.0	
Standard Deviation	3.78	4.53	4.96	4.80	4.73	5.48	7.18	7.11	
Sample Size	5	54	4	17	8	26	4	3	
Statistical Week 40									
Mean Fork Length (cm)	52.25	66.56	53.50	79.41	70.10	86.75	82.83	88.00	91.50
Maximum	58.0	74.0	53.5	91.0	74.5	97.5	96.0	88.0	93.0
Minimum	44.0	52.0	53.5	72.5	67.0	78.5	73.5	88.0	90.0
Standard Deviation	6.24	4.26	-	4.56	2.99	4.35	9.09	-	2.12
Sample Size	4	75	1	27	5	24	6	1	2
Statistical Week 41									
Mean Fork Length (cm)	47.00	68.56	59.00	81.95	79.08	86.59	88.43	92.50	
Maximum	47.5	76.5	59.0	91.5	86.0	102.0	99.5	92.5	
Minimum	46.5	56.5	59.0	68.5	71.5	73.5	83.5	92.5	
Standard Deviation	0.71	4.18	-	5.13	5.58	5.89	5.40	-	
Sample Size	2	58	1	31	6	39	7	1	
Statistical Week 42									
Mean Fork Length (cm)	47.50	66.12	58.00	79.50	74.75	87.04	81.75	90.50	
Maximum	58.0	72.0	63.5	86.5	82.5	105.5	86.5	90.5	
Minimum	39.5	56.5	51.5	65.0	71.0	78.0	77.0	90.5	
Standard Deviation	6.79	3.91	6.06	5.57	5.24	5.25	6.72	-	
Sample Size	5	29	3	20	4	27	2	1	
Statistical Week 43									
Mean Fork Length (cm)		68.01		82.00	77.00	88.50	83.20	92.00	92.00
Maximum		75.0		88.5	82.0	102.0	89.0	92.0	92.0
Minimum		60.0		76.5	70.5	68.0	77.5	92.0	92.0
Standard Deviation		3.68		4.58	5.89	7.86	4.44	-	-
Sample Size		36		13	3	15	5	1	1
Statistical Week 44									
Mean Fork Length (cm)		65.17		82.89	77.00	82.75			
Maximum		71.0		88.0	79.0	88.0			
Minimum		54.5		76.0	75.0	77.5			
Standard Deviation		9.25		4.68	2.00	7.42			
Sample Size		3		9	3	2			
2004 Composite									
Mean Fork Length (cm)	48.27	67.03	57.56	80.76	75.88	87.90	85.33	91.00	90.75
Maximum	58.0	82.0	64.0	96.0	88.0	109.5	101.0	105.0	93.0
Minimum	39.5	49.5	49.0	65.0	65.0	68.0	73.0	77.5	88.0
Standard Deviation	5.16	4.76	4.12	5.01	5.46	5.65	6.26	7.84	2.22
Sample Size	22	332	24	172	54	251	45	9	4

Table A7: Length-at-age estimates for Columbia Basin sockeye salmon sampled at Bonneville Dam in 2005. Composite estimates of age classes are weighted by weekly run size.

Brood Year and	2002	2001		2000			1999
Age Class	1.1	1.2	1.3	2.2	3.1	3.2	4.1
Statistical Week 24							
Mean Fork Length (cm)	0.00	49.04	57.00				
Maximum	0.00	53.00	57.00				
Minimum	0.00	45.00	57.00				
Standard Deviation	0.00	2.34	-				
Sample Size	0	25	1				
Statistical Week 25							
Mean Fork Length (cm)	37.50	48.91	55.50				
Maximum	37.50	53.00	56.00				
Minimum	37.50	44.50	55.00				
Standard Deviation	-	2.05	0.50				
Sample Size	1	46	3				
Statistical Week 26							
Mean Fork Length (cm)	42.00	49.50	55.00	48.00			
Maximum	42.00	57.00	63.00	48.00			
Minimum	42.00	44.00	49.00	48.00			
Standard Deviation	-	2.40	3.12	-			
Sample Size	1	136	18	1			
Statistical Week 27							
Mean Fork Length (cm)	38.25	49.19	55.86	51.50		51.00	50.00
Maximum	39.50	55.00	60.50	51.50		51.00	50.00
Minimum	37.00	42.00	49.50	51.50		51.00	50.00
Standard Deviation	1.77	2.14	2.90	-		-	-
Sample Size	2	136	11	1		1	1
Statistical Week 28							
Mean Fork Length (cm)	39.00	49.13	54.71	50.50	49.00		
Maximum	39.50	55.00	57.00	50.50	53.00		
Minimum	38.50	44.50	51.00	50.50	46.00		
Standard Deviation	0.71	2.13	1.89	-	3.61		
Sample Size	2	121	7	1	3		
Statistical Week 29							
Mean Fork Length (cm)	0.00	49.44	54.50	0.00			
Maximum	0.00	55.00	54.50	0.00			
Minimum	0.00	45.00	54.50	0.00			
Standard Deviation	0.00	2.02	-	0.00			
Sample Size	0	50	1	0			
Statistical Week 30							
Mean Fork Length (cm)	0.00	49.44	0.00	49.00		47.00	
Maximum	0.00	54.00	0.00	49.00		47.00	
Minimum	0.00	41.00	0.00	49.00		47.00	
Standard Deviation	0.00	3.07	0.00	-		-	
Sample Size	0	17	0	1		1	
2005 Composite							
Mean Fork Length (cm)	39.00	49.26	55.25	49.75	49.00	49.00	50.00
Maximum	42.00	57.00	63.00	51.50	53.00	51.00	50.00
Minimum	37.00	41.00	49.00	48.00	46.00	47.00	50.00
Standard Deviation	1.79	2.23	2.63	1.55	3.61	2.83	-
Sample Size	6	531	42	4	3	2	1

Table A8: Length-at-age estimates for Columbia Basin steelhead sampled at Bonneville Dam in 2005. Composite estimates of age classes are weighted by weekly run size.

Brood Year and	2002	2001		2000			1999		1998	1-Fresh Wild			Kelt
Age Class	1.1	1.2	2.1	1.3	2.2	3.1	2.3	3.2	4.2	W1.1	W1.2	W1.3	2.1S1
Statistical Week 35													
Mean Fork Length (cm)	58.5	72.1	61.1		73.3	55.0				60.0	67.3		
Maximum	63.5	85.0	69.0		86.5	55.0				62.0	71.0		
Minimum	54.0	62.5	52.5		64.5	55.0				58.0	63.5		
Standard Deviation	2.9	6.5	6.8		9.5					2.8	5.3		
Sample Size	18	15	4		4	1				2	2		
Statistical Week 36													
Mean Fork Length (cm)	58.0	69.5	58.5	69.0	71.0				79.0	57.4	73.3		
Maximum	67.0	83.5	61.0	69.0	72.0				79.0	60.0	79.0		
Minimum	50.0	64.0	56.0	69.0	70.0				79.0	55.5	67.0		
Standard Deviation	3.2	4.9	2.5		0.9					1.9	6.0		
Sample Size	36	20	3	1	4				1	4	3		
Statistical Week 37													
Mean Fork Length (cm)	61.6	77.9		86.7	81.4			75.5		61.5	72.5		
Maximum	71.0	91.0		89.0	90.0			84.0		61.5	82.0		
Minimum	55.5	68.5		82.5	76.5			69.0		61.5	63.0		
Standard Deviation	5.6	6.3		3.6	6.3			7.7			13.4		
Sample Size	8	19		3	4			3		1	2		
Statistical Week 38													
Mean Fork Length (cm)	59.3	78.8		84.6	76.5	69.5	91.0				84.0		
Maximum	64.0	86.0		94.0	79.0	69.5	91.0				84.0		
Minimum	52.0	62.5		78.0	74.5	69.5	91.0				84.0		
Standard Deviation	3.5	5.4		4.9	2.3								
Sample Size	12	33		10	3	1	1				1		
Statistical Week 39													
Mean Fork Length (cm)	58.4	75.6		85.6	76.8		90.0	77.0		55.5	71.7	81.3	
Maximum	67.0	86.0		91.5	83.0		90.0	77.0		55.5	78.5	83.5	
Minimum	53.0	64.0		83.0	64.0		90.0	77.0		55.5	65.0	79.0	
Standard Deviation	3.1	5.7		2.5	7.0						6.8	3.2	
Sample Size	21	30		10	6		1	1		1	3	2	
Statistical Week 40													
Mean Fork Length (cm)	61.4	80.4	63.0	86.9	82.0			80.7			81.7		71.5
Maximum	72.5	88.5	63.0	91.0	88.5			87.5			85.5		71.5
Minimum	56.5	63.5	63.0	82.5	79.0			75.0			76.5		71.5
Standard Deviation	4.4	5.7		2.4	4.4			6.3			4.6		
Sample Size	13	30	1	11	4			3			3		1
Statistical Week 41													
Mean Fork Length (cm)	58.6	75.2	59.0	92.1	72.6			66.5		61.3			
Maximum	65.0	85.0	61.0	102.5	78.5			66.5		66.5			
Minimum	55.0	68.5	57.0	86.0	65.5			66.5		56.0			
Standard Deviation	3.1	5.3	2.8	7.2	6.4					3.4			
Sample Size	32	17	2	4	4			1		6			
Statistical Week 42													
Mean Fork Length (cm)	58.3	74.2	60.2	93.5	75.5					55.5			
Maximum	66.5	86.5	62.5	93.5	75.5					55.5			
Minimum	53.5	58.5	58.5	93.5	75.5					55.5			
Standard Deviation	3.3	7.6	2.1										
Sample Size	15	10	3	1	1					1			
Statistical Week 43													
Mean Fork Length (cm)	57.2			79.0									
Maximum	59.0			79.0									
Minimum	54.5			79.0									
Standard Deviation	2.4												
Sample Size	3			1									
2005 Composite													
Mean Fork Length (cm)	58.8	76.2	60.1	86.0	76.2	62.3	90.5	76.5	79.0	59.3	74.5	81.3	71.5
Maximum	72.5	91.0	69.0	102.5	90.0	69.5	91.0	87.5	79.0	66.5	85.5	83.5	71.5
Minimum	50.0	58.5	52.5	69.0	64.0	55.0	90.0	66.5	79.0	55.5	63.0	79.0	71.5
Standard Deviation	3.5	6.6	4.0	5.2	6.6	10.3	0.7	7.1		3.3	7.9	3.2	
Sample Size	158	174	13	41	30	2	2	8	1	15	14	2	1

Table A9: Weekly and cumulative age, fin mark, gender and length composition of Columbia Basin hatchery and wild steelhead sampled at Bonneville Dam in 2005.

Hatchery

Statistical	Sampling	Number	Hatchery	Weekly	2002	2001	2000	1999	Unageable				Fin Clips		Stubby	Sex		Length	
Week	Date	Sampled	Ageable	Run Size	1.1	1.2	1.3	3.2	R	R.1	R.2	R.3	Adipose	Other	Dorsal	Female	Male	< 78cm	≥ 78cm
35	8/26	59	41	26094	0.415	0.366	0.000	0.000	0.000	0.098	0.122	0.000	0.829	0.171	0.878	0.512	0.463	0.927	0.073
36	8/29, 9/1	92	72	15789	0.486	0.278	0.014	0.000	0.014	0.139	0.069	0.000	0.806	0.167	0.694	0.542	0.431	0.972	0.028
37	9/5, 9/8	53	39	23093	0.205	0.487	0.077	0.026	0.000	0.103	0.103	0.000	0.949	0.026	0.487	0.538	0.462	0.667	0.333
38	9/12, 9/15	80	70	20809	0.171	0.471	0.143	0.000	0.029	0.057	0.114	0.014	0.900	0.086	0.414	0.286	0.714	0.457	0.543
39	9/19, 9/22	90	71	18550	0.296	0.423	0.141	0.000	0.000	0.042	0.099	0.000	0.930	0.070	0.507	0.549	0.451	0.634	0.366
40	9/26, 9/29	80	60	16484	0.183	0.450	0.183	0.000	0.033	0.100	0.033	0.017	0.867	0.133	0.417	0.700	0.300	0.417	0.583
41	10/3, 10/6	80	64	10545	0.484	0.250	0.063	0.000	0.000	0.156	0.047	0.000	0.938	0.063	0.734	0.406	0.594	0.828	0.172
42	10/10,13,20	45	40	11586	0.450	0.250	0.050	0.000	0.000	0.175	0.050	0.025	0.850	0.150	0.775	0.600	0.400	0.850	0.150
Cumulative		**579**	**457**	**142950**	**0.319**	**0.390**	**0.083**	**0.004**	**0.010**	**0.101**	**0.087**	**0.006**	**0.883**	**0.107**	**0.607**	**0.512**	**0.480**	**0.711**	**0.289**

Comments: Hatchery steelhead are determined by the presence of fin clips.

Wild

Statistical	Wild	2002	2001		2000		1999		1998	1-Fresh Wild			Kelts	Unageable				Stubby	Sex		Length	
Week	Ageable	1.1	1.2	2.1	2.2	3.1	2.3	3.2	4.2	W1.1	W1.2	W1.3	2.1S	R	R.1	R.2	R.3	Dorsal	Female	Male	< 78cm	≥ 78cm
35	18	0.111	0.000	0.222	0.222	0.056	0.000	0.000	0.000	0.111	0.111	0.000	0.000	0.000	0.000	0.167	0.000	0.278	0.611	0.333	0.944	0.056
36	20	0.050	0.000	0.150	0.200	0.000	0.000	0.000	0.050	0.200	0.150	0.000	0.000	0.000	0.000	0.200	0.000	0.150	0.500	0.450	0.900	0.100
37	14	0.000	0.000	0.000	0.286	0.000	0.000	0.143	0.000	0.071	0.143	0.000	0.000	0.000	0.143	0.214	0.000	0.143	0.714	0.286	0.714	0.286
38	10	0.000	0.000	0.000	0.300	0.100	0.100	0.000	0.000	0.000	0.100	0.000	0.000	0.100	0.000	0.300	0.000	0.100	0.400	0.600	0.600	0.400
39	19	0.000	0.000	0.000	0.316	0.000	0.053	0.053	0.000	0.053	0.158	0.105	0.000	0.000	0.105	0.105	0.053	0.211	0.579	0.421	0.474	0.526
40	20	0.100	0.150	0.050	0.200	0.000	0.000	0.150	0.000	0.000	0.150	0.000	0.050	0.050	0.050	0.050	0.000	0.100	0.700	0.300	0.450	0.550
41	16	0.063	0.063	0.125	0.250	0.000	0.000	0.063	0.000	0.375	0.000	0.000	0.000	0.000	0.063	0.000	0.000	0.250	0.313	0.688	0.938	0.063
42	5	0.000	0.000	0.600	0.200	0.000	0.000	0.000	0.000	0.200	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.200	0.400	0.600	1.000	0.000
Cumulative	**122**	**0.042**	**0.022**	**0.121**	**0.251**	**0.025**	**0.021**	**0.052**	**0.006**	**0.105**	**0.112**	**0.014**	**0.006**	**0.020**	**0.047**	**0.150**	**0.007**	**0.178**	**0.552**	**0.433**	**0.738**	**0.262**

Comments: Wild steelhead are determined by the absence of fin clips.