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Age and Length Composition of Columbia Basin Chinook, Sockeye, and Coho Salmon at Bonneville Dam in 2001

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January 31, 2002

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ABSTRACT

In 2001, representative samples of adult Columbia Basin chinook (*Oncorhynchus tshawytscha*), sockeye (*O. nerka*), and coho salmon (*O. kisutch*) populations at Bonneville Dam were collected. Fish were trapped, anesthetized, sampled for scales and biological data, revived, and then released adult migrating salmonids. Scales were examined to estimate age composition; the results contributed to an ongoing database for age class structure of Columbia Basin salmon populations. Based on scale analysis of chinook salmon, four-year-old fish (from brood year [BY] 1997) comprised 88% of the spring chinook, 67% of the summer chinook, and 42% of the Bright fall chinook salmon population. Five-year-old fish (BY 1996) comprised 9% of the spring chinook, 14% of the summer chinook, and 9% of the fall chinook salmon population. The sockeye salmon population at Bonneville was predominantly four-year-old fish (81%), with 18% returning as five-year-olds in 2001. The coho salmon population was 96% three-year-old fish (Age 1.1). Length analysis of the 2001 returns indicated that chinook salmon with a stream-type life history are larger (mean length) than the chinook salmon with an ocean-type life history. Trends in mean length over the sampling period for returning 2001 chinook salmon were analyzed. Chinook salmon of age classes 0.2 and 1.3 show a significant increase in mean length over time. Age classes 0.1, 0.3, 0.4, 1.1, 1.2, and 1.4 show no significant change over time. A year class regression over the past 12 years of data was used to predict spring, summer, and Bright fall chinook salmon population sizes for 2002. Based on three-year-old returns, the relationship predicts four-year-old returns of 132,600 (± 46,300, 90% predictive interval [PI]) spring chinook and 44,200 (± 11,700, 90% PI) summer chinook salmon for the 2002 runs. Based on four-year-old returns, the relationship predicts five-year-old returns of 87,800 (± 54,500, 90% PI) spring, 33,500 (± 11,500, 90% PI) summer, and 77,100 (± 25,800, 90% PI) Bright fall chinook salmon for the 2002 runs. The 2002 run size predictions should be used with caution; some of these predictions are well beyond the range of previously observed data.

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INTRODUCTION

The Stock Assessment Project of the Columbia River Inter-Tribal Fish Commission (CRITFC) is a part of the US-Canada Pacific Salmon Treaty spawning escapement-monitoring program (PST 1985). An objective of the project is the monitoring of the age and length-at-age composition of Columbia Basin salmonids, as well as the design and development of salmon stock identification techniques.

We use scale-pattern analysis to estimate the age and length-at-age composition for populations of chinook[1] (*Oncorhynchus tshawytscha*), sockeye (*O. nerka*), and coho salmon (*O. kisutch*). This study has been conducted since 1985 for sockeye, 1987 for spring chinook, and 1990 for summer chinook salmon (Schwartzberg 1988, 1989; Schwartzberg and Fryer 1990; Fryer and Schwartzberg 1991a, 1991b, 1992, 1993, 1994; Fryer et al. 1992; Hooff et al. 1999a; Hooff et al. 1999b; Kelsey and Fryer 2001). Bright fall chinook and coho salmon were added in 1998 (Hooff et al. 1999a; Hooff et al. 1999b; Kelsey and Fryer 2001)[2]. Over the course of these studies, we have developed procedures to monitor symptoms of gas bubble trauma, marine mammal predation, and headburn (for description and identification protocols of these symptoms, refer to the Methods section and Appendix B).

Data that are not reported in the results, but are part of the data collected for this project, are in Appendix A and B. These include clips (fin and jaw) observed, length-at-age composition, and assessments of fish condition, coloration, and injuries.

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1. Columbia Basin upriver spring chinook salmon are defined as those migrating past Bonneville Dam before June 1. Columbia Basin summer chinook salmon are defined as those migrating past Bonneville Dam between June 1 and July 31, while later migrating chinook salmon are defined as fall chinook salmon.
2. Columbia Basin fall chinook salmon are divided into Tules and Brights. Tules typically spawn downstream of The Dalles, while Brights spawn upstream of The Dalles.

METHODS

Sample Design

Fish were sampled one or two days per statistical week[3] from April through October. The sample size goal was 500 fish each for spring, summer, and fall chinook salmon, and for coho and sockeye salmon. In past study years, this sample size has resulted in desired levels of precision and accuracy (d=0.05, α=0.10) for age composition estimates. The composite age and length-at-age estimates are calculated from weekly estimates weighted by the number of each species migrating past Bonneville Dam during the week of the sample (Fryer 1995). Year-to-date dam counts of fish passage were obtained from DART (2001).

Sampling Methods

Representative samples of each species and population were collected at the Adult Fish Facility located adjacent to the Second Powerhouse of Bonneville Dam (river km 235). Fish were trapped and anesthetized. Each fish was sampled for scales, measured for fork length, inspected for markings and/or tag information, and noted for other pertinent biological information (Appendix B). All fish were revived in freshwater and returned to the exit fishway leading to the Washington shore fish ladder. No fish were sacrificed. To minimize the scale sample rejection rate, six scales were collected per coho and chinook salmon sampled (Knudsen 1990). Four scales were collected from each sockeye salmon sampled. Tule, a dark-colored fall chinook salmon (when observed at Bonneville Dam), are not sampled in our study with the Bright fall chinook. Bright fall chinook salmon, that migrate over Bonneville Dam, consist of Upriver Brights and Mid-Columbia Brights. Upriver Brights spawn in the Columbia Basin upstream of McNary Dam and Mid-Columbia Brights spawn in the section of the Columbia Basin between Bonneville and McNary Dams.

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3. 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 2001, for example, Statistical Week 14 began on April 1 and ended on April 7.

Length Measurements

Fork lengths were measured to the nearest 0.5 cm. Mean lengths and measurements of variability were calculated for each age class, by weekly sampling period, and for the composite sample (Appendix A). Composite samples were weighted by weekly run size, if more than one fish represents the age class sample for a statistical week, in which sample(s) were caught. Possible changes in weekly mean length over the sampling period were analyzed by simple linear regression for each age class.

Fish Condition

Criteria were developed in 1992 to classify the condition of sampled fish (Fryer and Schwartzberg 1993). These criteria have been expanded and refined in subsequent years so that, in 2001, each specimen was inspected for: coloration (a sign of maturation), marine mammal injuries, headburn, descaling, gill net abrasion, gas bubble trauma (Fryer 1994), cuts, bruises, and other assorted new and old injuries (Appendix B). New injuries were rated regarding their penetration into the flesh and body of the fish.

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). Assessment and classification protocols for headburn were added to our study in 1997, after reports of increased incidence and awareness of headburn throughout the basin (Elston 1996, Groberg 1996).

Notation was also taken on clips (fins and jaw) and other tag types found on the fish.

Age Determination

Scales were selected, mounted, and pressed according to methods described in 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 sample of scales was sent to John Sneva of the Washington Department of Fish and Wildlife for corroboration of age estimates. Validation of the ages estimated from scale patterns (Beamish and McFarlane 1983) was not possible because fish of a known age were not sacrificed.

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.

Chinook Salmon Run-Size Prediction

Salmon mature and return to spawn between ages 2 and 7. The year when the parents spawned is referred to as the brood year (BY). All of the progeny returning from a spawning population is collectively called a brood. Many chinook salmon prediction or forecast models are based on the relationship between the survivors within a single brood returning in successive years at different ages. In the early years of this project, it was noted that the number of three-year-old fish for a given BY appeared to be a relatively good predictor of the number of subsequently returning four-year-old fish of the same BY (Fryer and Schwartzberg 1994). This relationship and a regression analysis (Neter et al. 1985, Weisberg 1985) are used herein to predict the abundance (four-year-old fish in 2002) and the predictive interval ([PI] range), from a known value (the three-year-old fish that returned in 2001). A similar relationship is used to predict returning five-year-old fish in 2002 from four-year-old fish of 2001. Since 1998, CRITFC staff has collected data on Bright fall chinook. Therefore, for the first time Bright fall chinook salmon run-size prediction returns for 2002 are included in this annual report. Our Bright fall chinook predictions and data do not include Tule chinook salmon. Estimated abundances of Tule chinook (Fish Passage Center 2001) that migrated over Bonneville Dam were removed from the Bonneville Dam fall chinook salmon counts for an estimate of the Bright fall chinook abundance over Bonneville Dam.

RESULTS

Sample Design

This report does not include information on mini-jacks (fish generally under 35 cm in length which show a scale pattern that indicates they have not spent any winters in saltwater) because of their different life history and because collection protocol is not conducive for random sampling of mini-jacks. During the fall chinook salmon run, Tules are not sampled; only Bright fall chinook salmon data and abundance are used in this report.

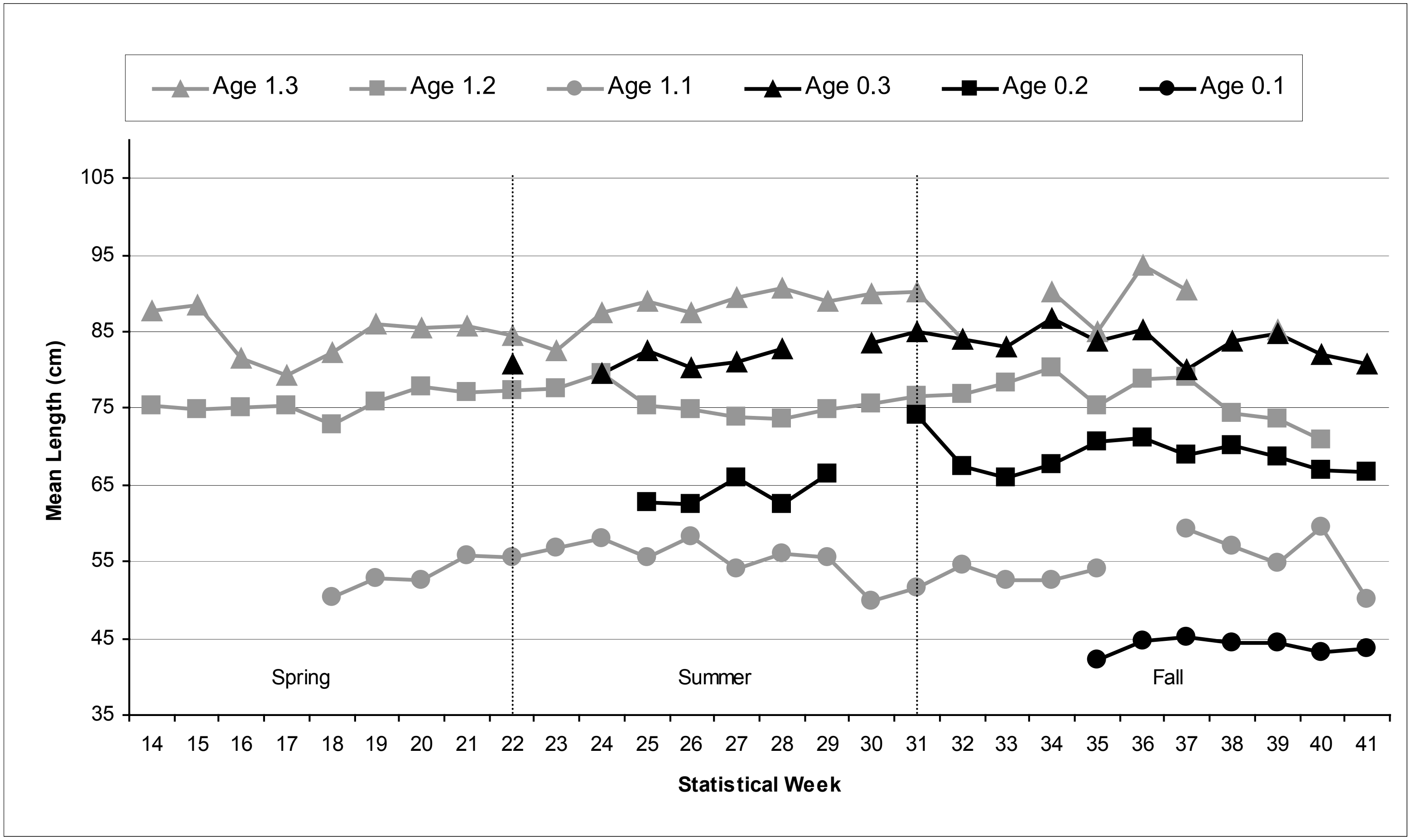
Fish were removed from age composition and length analyses because of damaged and/or unreadable scales (spring chinook 7.9%, summer chinook 7.8%, fall chinook 6.6%, sockeye 2.7%, and coho 3.0%) these fish were used in analyses of other types of data collected during sampling.

Length Analysis

Chinook salmon that have a stream-type (Age 1.X) life history maintain consistently have a greater mean length than ocean-type (Age 0.X) chinook salmon with the same ocean age (Figure 1). As age increases so does the mean length. The mean length of chinook salmon for age classes of 0.2 and 1.3, when analyzed using a linear regression technique, showed a significant increase over the sampling period ($P < 0.05$). The mean length of age classes 0.1, 0.3, 0.4, 1.1, 1.2, and 1.4 (Age 0.4 and 1.4 were not graphed in Figure 1) did not change significantly over time (P = 0.94, 0.14, 0.59, 0.64, 0.94, and 0.38, respectively).

One age class for coho salmon and three age classes for sockeye salmon were analyzed for a change in mean length over the sampling period. Age classes for both coho and sockeye did not change significantly over time (P = 0.76 for coho; P = 0.75, 0.83, and 0.21 for sockeye age classes 1.2, 1.3, and 2.2, respectively).

Figure 1. Weekly mean length estimates of Columbia Basin chinook salmon by age class (showing stream- and ocean-type) sampled at Bonneville Dam in 2001. Note: Not all age classes were present each week of sampling.



Fish Condition

Data analysis on clips and fish condition can be found in Appendix A and B. Most clips consist of fin clips, with the adipose fin as the usual fin clipped for identification. However, the clip data also includes ventral and pelvic fins and the maxilla (rare). Some fish display more than one clip. Gender of collected specimens, most in early stages of sexual maturation, could not be determined with certainty and are not included in this report.

In 2001, a very large proportion of coho salmon (32.5%, Appendix B) were observed with one or more round red sore/rash (most were 1 cm in diameter) located on the belly or sides (most sores were below the lateral line) of the fish. Some of these sores/rash were observed on chinook and sockeye salmon, but not near the number seen in coho salmon. It is suspected, but not confirmed, that this condition may be a sign of bacterial kidney disease (Carl Schreck, Oregon State University, personal communication).

Age Composition Estimates

Sampling periods, sample sizes, number of fish from the sample with ageable scales used in the age composition estimates, and run sizes for species and populations are tabulated in the age composition tables (Tables 1-5).

Spring chinook salmon returns were estimated to be predominately four-year-olds (88%, Table 1, Figure 2) with a small proportion of five-year-old fish (9%). The life history scale pattern (Table 1, Figure 3) for spring chinook salmon sampled was 99.7% stream-type.

Summer chinook salmon were a mix of age classes, and in 2001, four-year-olds (67%) were the most abundant. Proportions of three- (15%) and five-year-old fish (14%) were nearly evenly split with 3% returning as six-year in 2001 (Table 2, Figure 2). Twelve percent of the run had scale patterns indicating an ocean-type life history and 88% of the run had a stream-type life history (Table 2, Figure 3).

Bright fall chinook salmon were mostly three- (40%) and four-year-olds (42%), with smaller proportions of five- (9%) and six-year-old (1%) age classes (Table 3, Figure 2). Twenty-one percent of the fall chinook salmon sampled had a stream-type life history (Table 3, Figure 3).

Sockeye salmon were estimated to be mostly four-year-old fish (81%), with virtually all of the remainder returning as five-year-old-fish (18%). Over 90% of the sockeye salmon spent one year in fresh water (Table 4), while the remaining proportion spent two years in fresh water.

The 2001 coho salmon run passing Bonneville Dam was estimated as 99.5% three-year-old fish (Age 1.1) from the 1998 BY (Table 5). A very small proportion of the run (0.5%) was two-year-old fish (Age 1.0) from the BY 1999.

Table 1. Weekly and cumulative age composition of Columbia Basin spring chinook salmon sampled at Bonneville Dam in 2001.

Statistical Week	Sampling Date	Number Sampled	Number Ageable	Weekly run size	1998 1.1	1997 0.3	1997 1.2	1996 1.3	1995 1.4
					Age Composition by Brood Year and Age Class				
14[a]	4/3, 5, 6	125	117	62879			0.880	0.111	0.009
15	4/10, 12	150	140	87824			0.957	0.043	
16	4/17, 19	130	125	104822			0.912	0.088	
17	4/24, 27	120	101	48112		0.010	0.861	0.129	
18	5/1, 3	100	95	30210	0.063		0.853	0.084	
19	5/10, 11	100	93	26314	0.118		0.785	0.097	
20	5/17	61	53	16483	0.151		0.774	0.075	
21	5/24, 25	50	45	18627	0.089		0.778	0.133	
22[b]	5/29	50	47	10719	0.149	0.064	0.659	0.128	
Cumulative		886	816	405990	0.027	0.003	0.879	0.090	0.001

a Weekly run size includes fish numbers from Weeks 9 – 13. Sampling started in Week 14.

b Weekly run size includes only a portion of the fish numbers from Week 22. Spring chinook salmon run at Bonneville Dam official ends on May 31st.

Figure 2. Weekly age composition estimates for the three major Columbia Basin spring, summer, and Bright fall chinook salmon age classes sampled at Bonneville Dam in 2001.

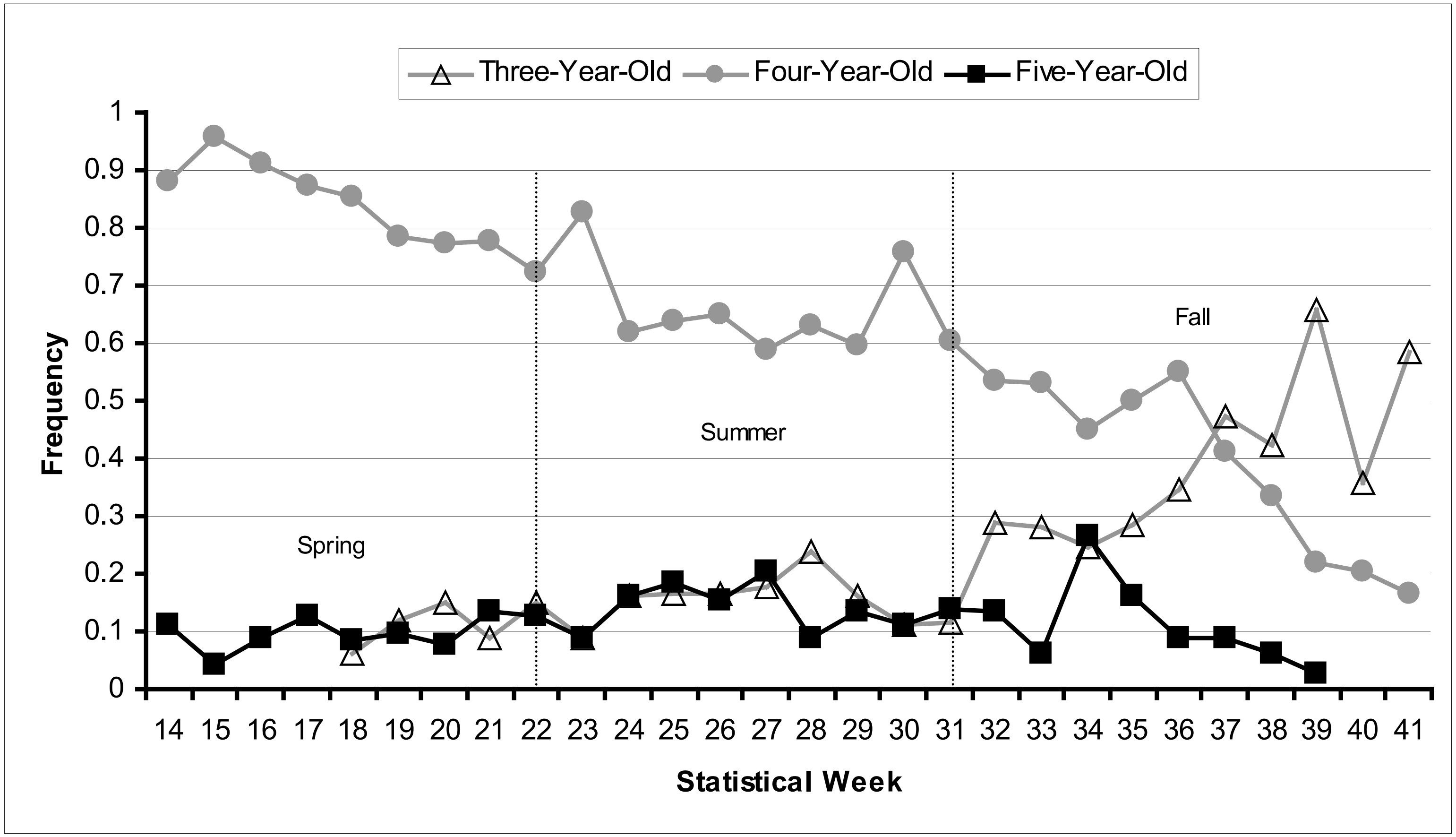


Figure 3. Weekly freshwater age composition estimates of Columbia Basin spring, summer, and Bright fall chinook salmon sampled at Bonneville Dam in 2001.

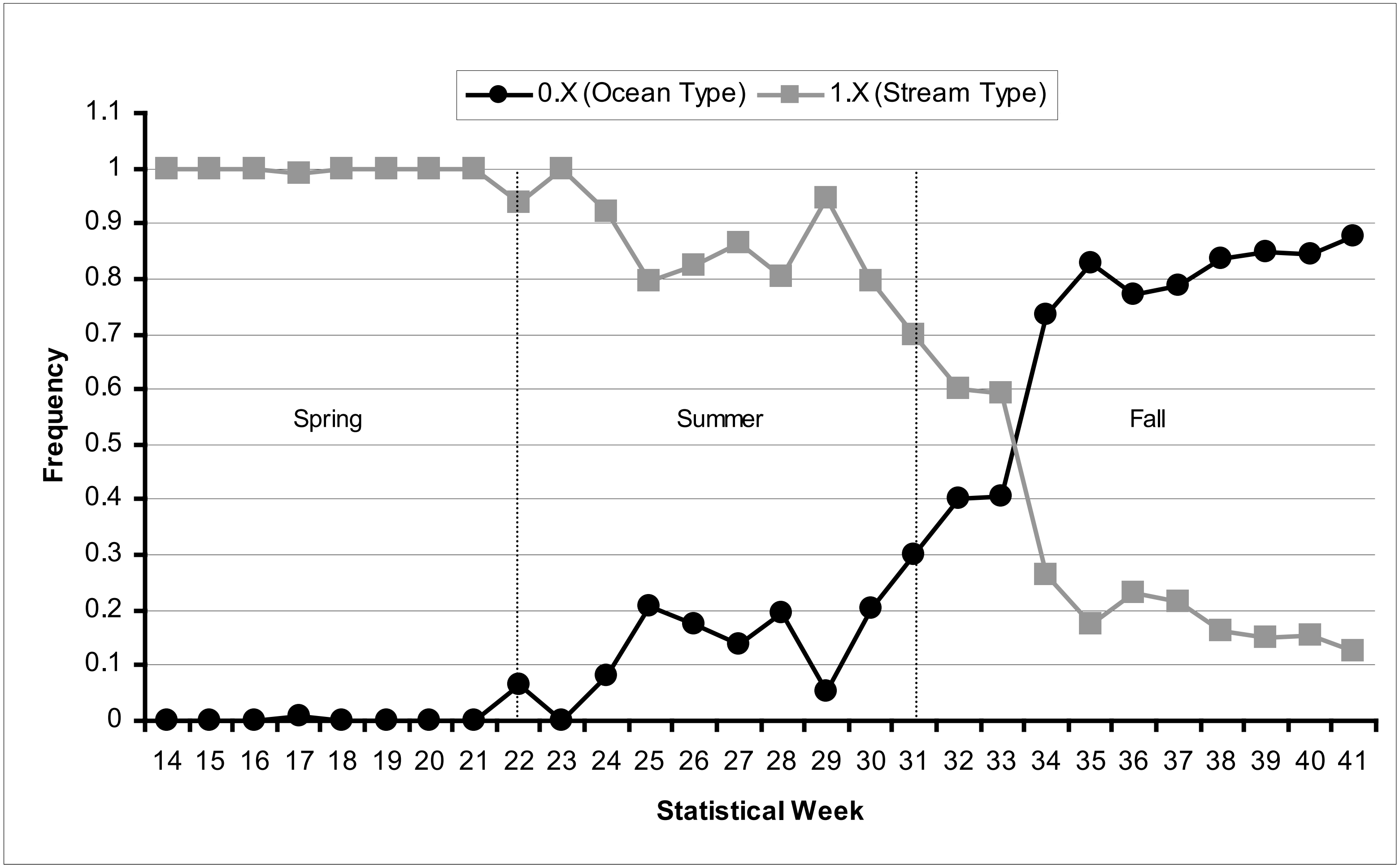


Table 2. Weekly and cumulative age composition of Columbia Basin summer chinook salmon sampled at Bonneville Dam in 2001.

					Age Composition by Brood Year and Age Class								
Statistical	Sampling	Number	Number	Weekly	1999	1998		1997		1996		1995	
Week	Date	Sampled	Ageable	run size	0.1	0.2	1.1	0.3	1.2	0.4	1.3	0.5	1.4
23[a]	6/5	49	46	16266			0.087		0.826		0.087		
24	6/12	50	50	12032			0.160	0.080	0.540		0.160		0.060
25	6/19, 21	110	102	13338		0.020	0.147	0.137	0.500	0.039	0.147	0.010	
26	6/26, 29	109	97	10285	0.010	0.031	0.134	0.113	0.536	0.021	0.134		0.021
27	7/3	80	73	13035		0.027	0.151	0.110	0.480		0.205		0.027
28	7/10 13	50	46	8677	0.022	0.043	0.196	0.130	0.500		0.087		0.022
29	7/17	40	37	7953		0.054	0.108		0.595		0.135		0.108
30[b]	7/25	60	54	9243	0.018		0.111	0.130	0.630	0.056	0.056		
Cumulative		548	505	90829	0.005	0.019	0.135	0.085	0.586	0.014	0.129	0.001	0.026

a Weekly run size includes a portion of the fish numbers from Week 22. Summer chinook salmon run at Bonneville Dam official starts on June 1st.

b Weekly run size includes a portion of the fish numbers from Week 31. Summer chinook salmon run at Bonneville Dam official ends on July 31st.

Table 3. Weekly and cumulative age composition of Columbia Basin Bright fall chinook salmon sampled at Bonneville Dam in 2001.

Statistical Week	Sampling Date	Number Sampled	Number Ageable	Weekly run size	Age Composition by Brood Year and Age Class: 1999	1998		1997		1996		1995	
					0.1	0.2	1.1	0.3	1.2	0.4	1.3	0.5	1.4
31[a]	8/1	50	43	3046	0.023	0.070	0.047	0.186	0.418		0.140	0.023	0.093
32	8/8	50	45	6223	0.022	0.089	0.200	0.222	0.311	0.067	0.067		0.022
33	8/15	34	32	5253	0.031	0.156	0.125	0.188	0.344	0.031	0.031		0.094
34	8/22	50	49	14735		0.184	0.061	0.367	0.082	0.184	0.082		0.041
35	8/29, 31	108	98	50135	0.031	0.255	0.031	0.439	0.061	0.102	0.061		0.020
36	9/5	120	113	78234	0.018	0.336	0.009	0.363	0.186	0.053	0.035		
37	9/12, 14	118	112	87256	0.027	0.420	0.053	0.286	0.125	0.053	0.036		
38	9/17, 20	117	111	41343	0.135	0.378	0.045	0.234	0.099	0.054	0.009	0.036	0.009
39	9/24, 26	74	73	22397	0.096	0.589	0.069	0.164	0.055		0.027		
40	10/3	45	39	13038	0.436	0.308	0.051	0.103	0.103				
41[b]	10/10	25	24	15867	0.250	0.500	0.083	0.125	0.042				
Cumulative		791	739	337527	0.068	0.358	0.045	0.297	0.125	0.058	0.036	0.005	0.009

a Fall chinook run at Bonneville Dam officially starts on August 1st. Therefore, the weekly run size is only those fish passing Bonneville Dam after the 31st of July.

b Weekly run size includes fish numbers from Weeks 42 - 46. Sampling ended in Week 41.

Table 4. Weekly and cumulative age composition of Columbia Basin sockeye salmon sampled at Bonneville Dam in 2001.

Statistical Week	Sampling Date	Number Sampled	Number Ageable	Weekly run size	Age Composition by Brood Year and Age Class: 1998				
					1998	1997		1996	
					1.1	1.2	2.1	1.3	2.2
24[a]	5/29, 6/5, 6/12	57	56	16986		0.786		0.161	0.054
25	6/19, 21	180	177	55204		0.814		0.124	0.062
26	6/26, 29	180	175	25686	0.006	0.800	0.006	0.074	0.114
27	7/3	80	78	11684	0.013	0.808	0.013	0.064	0.102
28	7/10, 13	50	47	3377	0.064	0.745	0.064	0.042	0.085
29[b]	7/17, 25	10	9	1996	0.222	0.778			
Cumulative		557	542	114933	0.008	0.803	0.005	0.108	0.076

a Weekly run size includes fish numbers from Week 21 - 24. Sampling began in Week 22. Due to small sample sizes in Weeks 22 and 23, Weeks 22 - 24 were combined.

b Weekly run size includes fish numbers from Weeks 30 - 37. Sampling ended in Week 30. Due to small sample size (n=2) in Week 30, Weeks 29 and 30 were combined.

Table 5. Weekly and cumulative age composition of Columbia Basin coho salmon sampled at Bonneville Dam in 2001.

Statistical Week	Sampling Date	Number Sampled	Number Ageable	Weekly run size	Age Composition by Brood Year and Age Class 1999 1.0	1998 1.1
34[a]	8/22	9	8	5352		1.000
35	8/29, 31	39	39	29354		1.000
36	9/5	40	40	55199		1.000
37	9/12, 14	65	63	74894		1.000
38	9/17, 20	53	51	52487	0.020	0.980
39	9/24, 26	30	28	12552		1.000
40	10/3	50	49	8366		1.000
41	10/10	26	26	5923	0.038	0.962
42[b]	10/17	20	18	21815		1.000
Cumulative		332	322	265942	0.005	0.995

a Weekly run size includes fish numbers from Weeks 25 – 33. Sampling started in Week 34.

b Weekly run size includes fish numbers from Weeks 43 - 46. Sampling ended in Week 42.

Chinook Salmon Run-Size Prediction For 2002

Based on a linear relationship between three-year-old and four-year-old returns (Figure 4) the estimated 2002 four-year-old adult spring chinook salmon count at Bonneville Dam will be 132,600 (± 46,300, 90% PI). A relationship between four-year-olds and five-year-olds (Figure 5), albeit poorer than that existing between three-year-olds and four-year-olds, predicts that the 2002 five-year-old adult count at Bonneville Dam will be 87,800 (± 54,500, 90% PI).

For the 2002 summer chinook salmon run at Bonneville Dam, the relationship between three- and four-year-olds (Figure 6) resulted in a prediction of 44,200 four-year-olds (±11,700, 90% PI). The relationship between four- and five-year-olds (Figure 7) results in a prediction for summer chinook salmon run of 33,500 (± 11,500, 90% PI) five-year-olds for 2002.

For the 2002 Bright fall chinook salmon run at Bonneville Dam, the relationship between three- and four-year-olds based on four points results in a run prediction that has a poor relationship (R^2 = 0.06). Therefore, the run prediction for 2002 four-year-old fish is not part of this report. The relationship between four- and five-year-olds (Figure 8) results in a prediction for Bright fall chinook salmon run of 77,100 (± 25,800, 90% PI) five-year-olds for 2002.

The predicted 2002 five-year-old adult spring and summer chinook salmon returning number is beyond existing data. These abundance estimates should be used with caution for we can not be sure that the regression function that fits the past data is appropriate over a wider range (Neter et al. 1985).

Figure 4. Predicted 2002 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 1998.

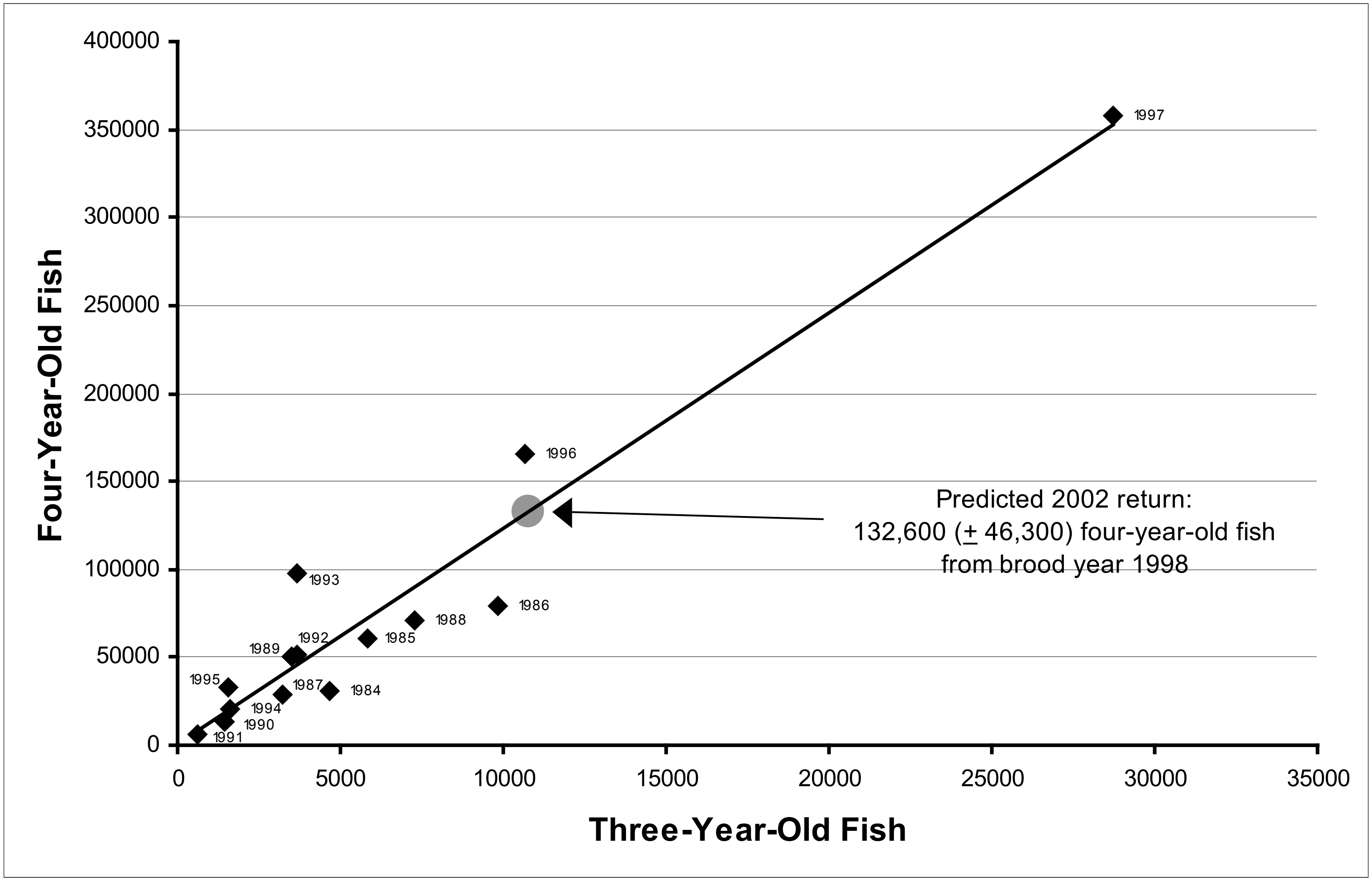


Figure 5. Predicted 2002 five-year-old Columbia Basin spring chinook salmon abundance (at Bonneville Dam) based on a linear relationship between five-year-old and four-year-old fish abundance during brood years 1984 through 1997.

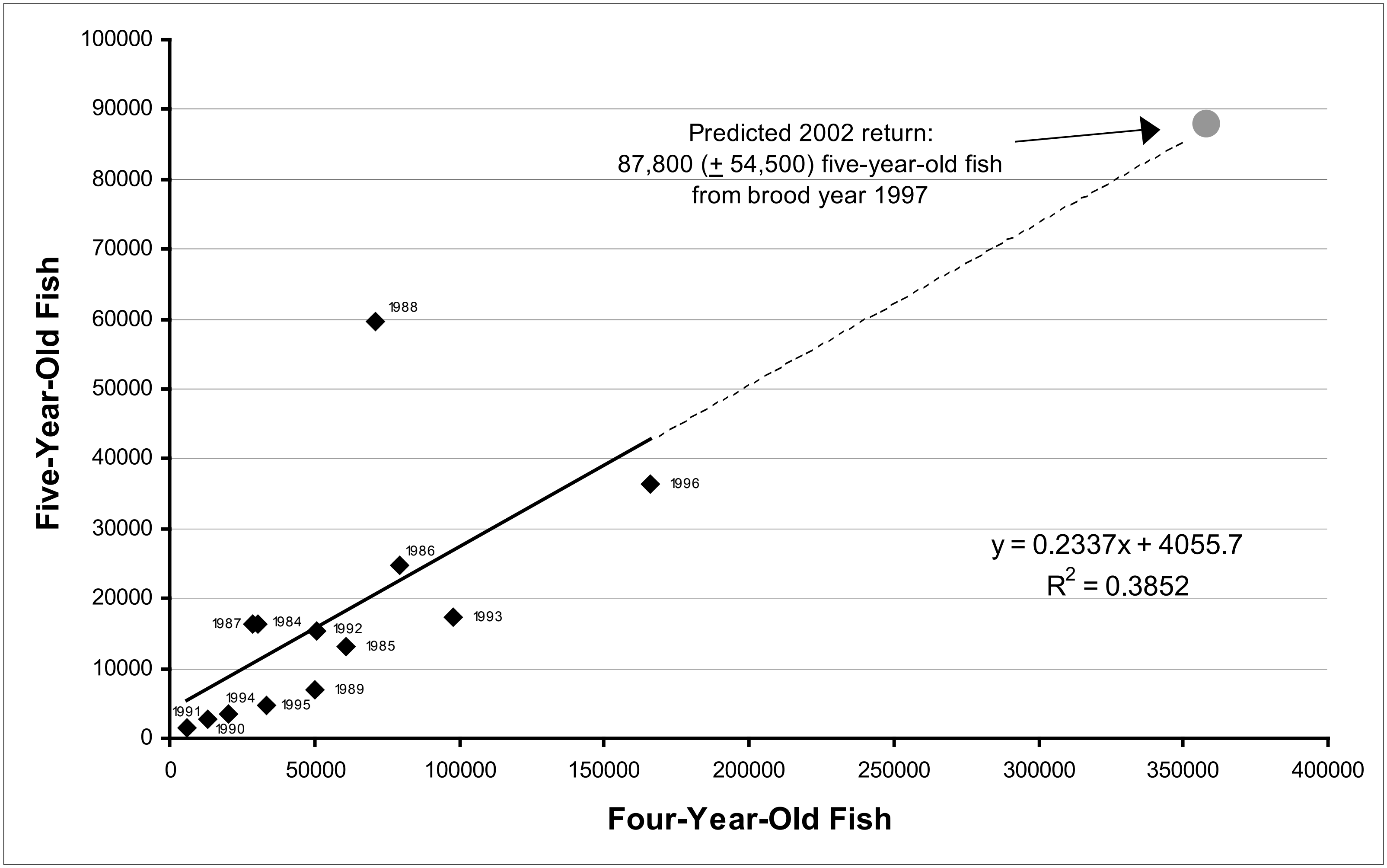


Figure 6. Predicted 2002 four-year-old Columbia Basin summer chinook salmon abundance (at Bonneville Dam) based on a linear relationship between four-year-old and three-year-old fish abundance during brood years 1987 through 1998.

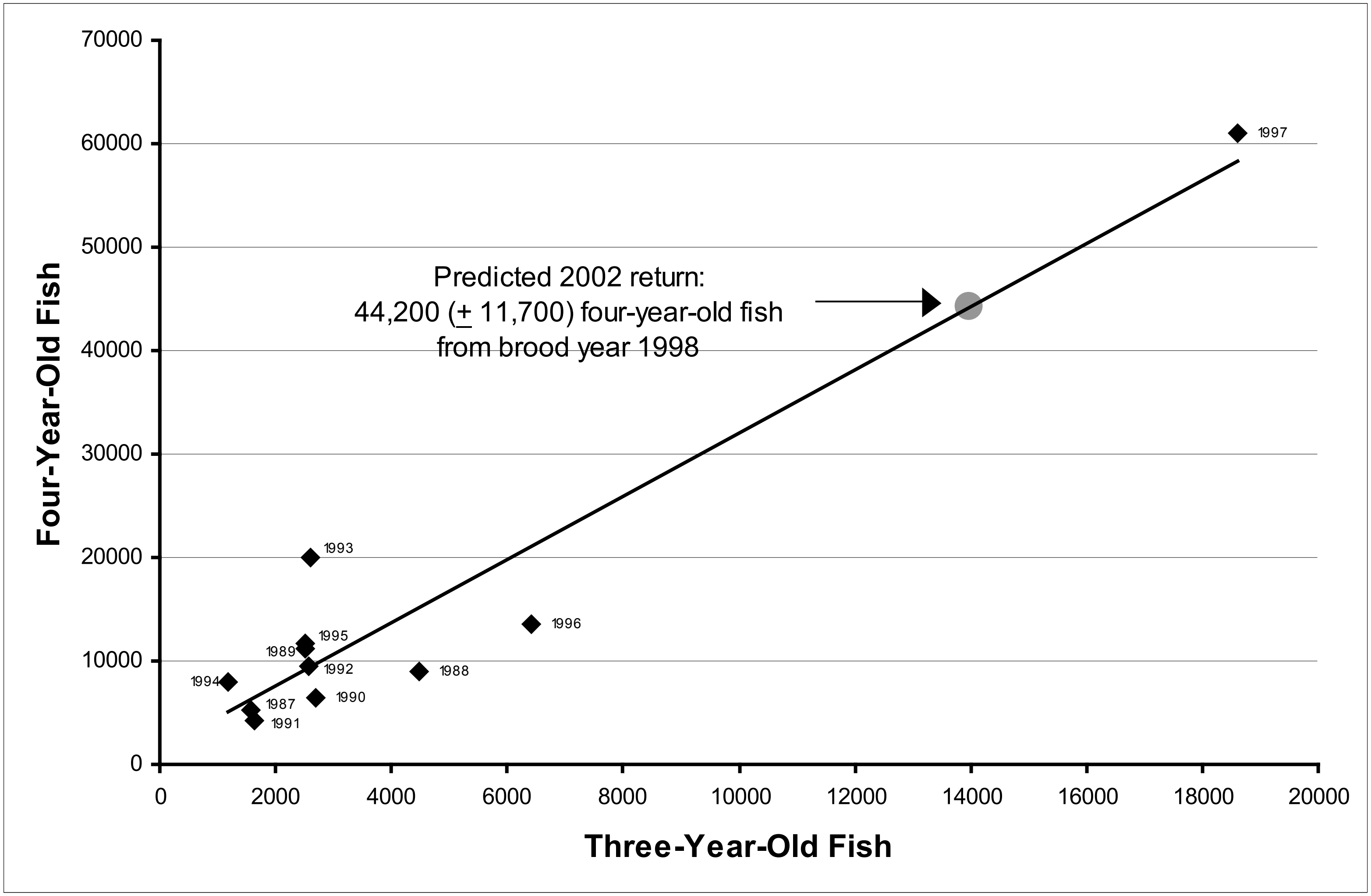


Figure 7. Predicted 2002 five-year-old Columbia Basin summer chinook salmon abundance (at Bonneville Dam) based on a linear relationship between five-year-old and four-year-old fish abundance during brood years 1986 through 1997.

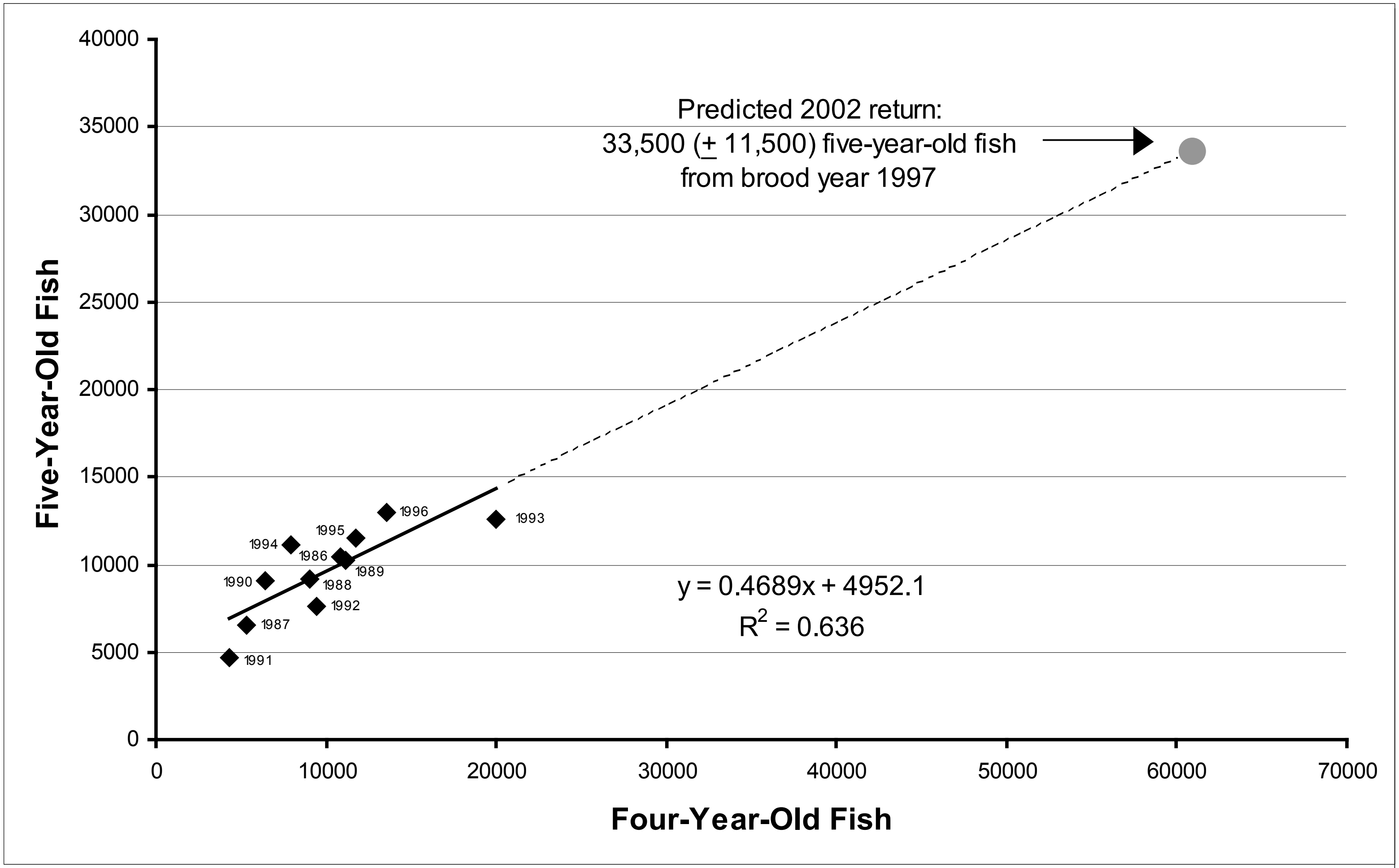
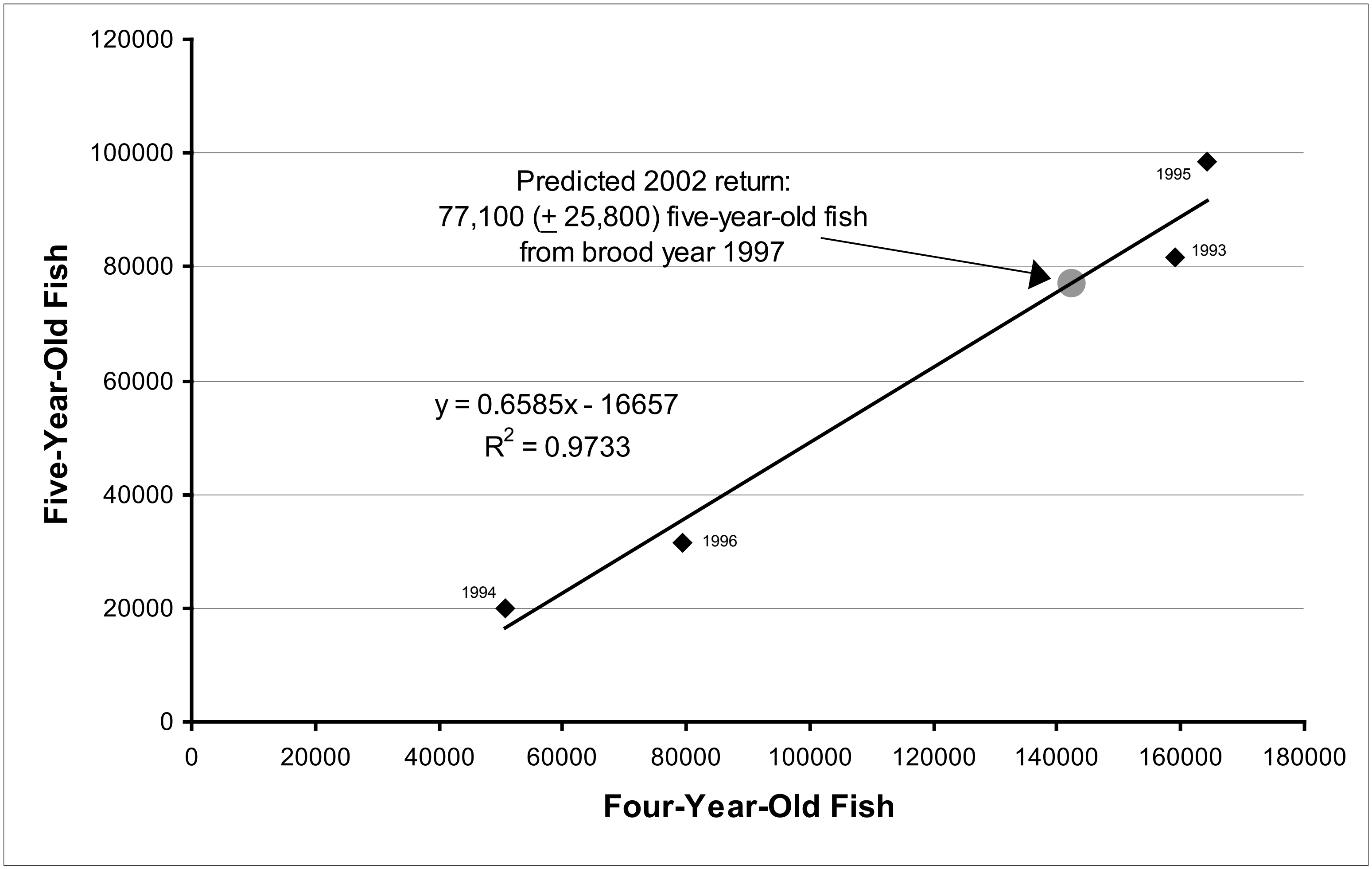


Figure 8. Predicted 2002 five-year-old Columbia Basin Bright fall chinook salmon abundance (at Bonneville Dam) based on a linear relationship between five-year-old and four-year-old fish abundance during brood years 1993 through 1997.



DISCUSSION

This study offers a unique opportunity to obtain representative samples of multiple species from a large river over the entire period of their run. Sockeye salmon were sampled over the entirety of their run, while 98% of the chinook salmon runs (spring, summer, and fall) were sampled over 28 weeks (April into October) during their migration. Ninety-five percent of the coho salmon run was sampled over 9 weeks (August into October) during their migration. Coho were overwhelmingly of a single age class (1.1) throughout the run. Similar to previous years, the 1.2 age class predominated the sockeye salmon run, although the percentage of five-year-olds was higher than in most years. Chinook salmon showed considerable variation in age structure (Figure 2). The majority of spring and summer chinook salmon returned as four-year-old fish, while Bright fall chinook salmon returned in relatively equal proportions as three- and four-year-olds.

With the exception of two chinook salmon age classes (0.2 and 1.3), none of the salmon age classes sampled show any significant change in mean lengths over the sampling period. Age 0.2 chinook had a significant increase of 0.33 cm per week and age 1.3 chinook had a significant increase of 0.23 cm per week. Last year, most salmon stocks did show a significant increase in mean length over the sampling period (Kelsey and Fryer 2001).

Based on 2000 results, we made run size predictions for four- and five-year-old spring and summer chinook returning to Bonneville Dam in 2001 in Kelsey and Fryer (2001) using the methods discussed in this report. Three of the four predictions were within the 90% prediction interval (Table 6), while one prediction (summer chinook four-year-olds) fell just outside this interval. Our prediction was within 10% of the estimated return of four-year-old spring chinook and 18% of the estimated return of five-year-old summer chinook. However, the estimated number of returning chinook five-year-old spring chinook were 33% below our prediction, while the four-year-old summer chinook were 119% above our prediction. As we stated in Kelsey and Fryer (2001), "we are predicting returns considerably higher than the range of previous data. Using a regression to predict beyond the range of past data should be done with extreme caution because one cannot be sure that the regression function that fits the past data is appropriate over a wider range (Neter et al. 1985)". Given how far beyond the past data range we were predicting, it was surprising how close our predictions were in 2001, particularly for the returning four-year-old spring chinook.

In 2002, we are once again predicting far beyond the range of previous data in our predictions for five-year-old spring and summer chinook. Our four-year-old summer chinook prediction is also beyond the range of previous data, with the exception of the 1997 data point.

Our prediction for five-year-old Bright fall chinook returning in 2002 should also be treated with caution, as this is the first year we are making a prediction and the prediction is based on only four data points. The relationship between three- and four-year-old fall chinook is too poor to attempt a prediction in 2002; it is hoped that such predictions may be possible with the addition of more years of data.

Table 6. Predicted and estimated abundance of chinook salmon returning to Bonneville Dam.

Species	2000 Report's Predicted (± 90%) for Year 2001	Year 2001 Estimate	Predicted (± 90%) for Year 2002
Spring Chinook 4-year-old	325,000 (± 111,600)	358,338	132,600 (± 46,300)
Spring Chinook 5-year-old	54,300 (± 40,600)	36,354	87,800 (± 54,500)
Summer Chinook 4-year-old	27,800 (± 29,750)	60,971	44,200 (± 11,700)
Summer Chinook 5-year-old	11,000 (± 3,250)	12,949	33,500 (± 11,500)
Bright Fall Chinook 5-year-old	--	31,613	77,100 (± 25,800)

2001 estimate is calculated using the proportion of X-year-old returning in 2001 multiplied by the count of spring, summer, and fall chinook at Bonneville Dam.

This study is expected to continue to develop an accurate age composition and length-at-age database for Columbia Basin upriver salmon populations. This information provides unbiased estimates of the age composition of the terminal run, and improves predicting or forecasting of terminal runs, which are both important in improving the calibration of the Chinook Technical Committee's chinook model. The 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 imposed by the Pacific Salmon Treaty.

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APPENDIX A

Data Tables

Table A1. Total age composition (%) for clipped and non-clipped chinook, sockeye, and coho salmon sampled at Bonneville Dam in 2001. Note: Age 1.0 chinook salmon ("mini-jacks") were omitted.

			Age Composition (%) by Brood Year and Age Class												
	Sample Size (n)	Ageable (n)	1999		1998		1997			1996			1995		
			0.1	1.0	0.2	1.1	0.3	1.2	2.1	0.4	1.3	2.2	0.5	1.4	2.3
Spring Chinook															
Fin - Clipped	525	497				4.4		90.8			4.8				
No Fin - Clips	361	319				4.4	1.3	77.7			16.3			0.3	
Summer Chinook															
Fin - Clipped	319	288			0.7	18.4	1.7	64.2		0.4	11.5			3.1	
No Fin - Clips	229	217	1.4		4.1	7.8	20.7	44.7		3.7	15.7		0.5	1.4	
Fall Chinook															
Fin - Clipped	140	127			17.3	18.9	9.5	39.4		3.9	5.5		0.8	4.7	
No Fin - Clips	651	612	9.2		35.6	2.9	31.2	9.5		5.9	3.9		0.7	1.1	
Coho															
Fin - Clipped	189	184				100.0									
No Fin - Clips	143	138		1.4		98.6									
Sockeye															
Fin - Clipped	13	12						66.7			25.0	8.3			
No Fin - Clips	544	530				1.3		80.2	0.9		9.1	8.5			

Table A2. Percent of sampled chinook, coho, and sockeye salmon at Bonneville Dam having clips by statistical week and total sampled in 2001.

Statistical Week	Spring Chinook	Summer Chinook	Fall Chinook	Coho	Sockeye
11	x				
12	x				
13	x				
14	65.6				
15	51.3				
16	60.8				
17	51.7				
18	58.0				
19	68.0				
20	63.9				
21	62.0				x
22	58.0				a
23		44.9			a
24		58.0			0.0
25		46.4		x	3.3
26		61.5		x	2.2
27		63.8		x	0.0
28		62.0		x	6.0
29		62.5		x	0.0
30		71.7		x	a
31			42.0	x	x
32			44.0	x	x
33			32.4	x	x
34			20.0	66.7	x
35			20.4	61.5	x
36			9.2	75.0	x
37			13.6	49.2	x
38			11.1	34.0	
39			6.8	43.3	
40			13.3	61.2	
41			16.0	80.8	
42			x	75.0	
43			x	x	
44			x	x	
45			x	x	
46			x	x	
47			x	x	
48			x	x	
% of Total Sampled	**59.3**	**58.2**	**17.7**	**57.1**	**2.3**

x Represents that a species was present, but sampling did not occur or a sample of the species was not caught. Therefore, the percent in a sampled statistical week, before or after an x, is assumed to represent the weeks not sampled. For example, spring chinook were first sampled in Week 14, this week is assumed to represent Weeks 11-13 as well.

a Week combined with next or previous week due to low sample size.

Table A3. Length-at-age estimates for Columbia Basin spring chinook salmon sampled at Bonneville Dam in 2001. Composite estimates are weighted by weekly run size.

	Brood Year and Age Class				
	1998	1997		1996	1995
	1.1	0.3	1.2	1.3	1.4
Statistical Week 14					
Mean Fork Length (cm)			75.36	87.65	100.00
Maximum			86.0	98.0	100.0
Minimum			63.5	77.0	100.0
Standard Deviation			3.58	6.35	0.00
Sample Size			103	13	1
Statistical Week 15					
Mean Fork Length (cm)			74.95	88.42	
Maximum			85.0	93.0	
Minimum			65.0	83.0	
Standard Deviation			3.82	3.98	
Sample Size			134	6	
Statistical Week 16					
Mean Fork Length (cm)			75.17	81.64	
Maximum			87.5	94.5	
Minimum			62.0	69.0	
Standard Deviation			4.14	7.29	
Sample Size			114	11	
Statistical Week 17					
Mean Fork Length (cm)		78.00	75.32	79.38	
Maximum		78.0	82.5	89.0	
Minimum		78.0	65.0	70.5	
Standard Deviation		0.00	3.47	5.59	
Sample Size		1	87	13	
Statistical Week 18					
Mean Fork Length (cm)	50.33		72.80	82.25	
Maximum	55.0		82.5	89.0	
Minimum	45.0		57.5	76.0	
Standard Deviation	3.91		4.43	4.58	
Sample Size	6		81	8	
Statistical Week 19					
Mean Fork Length (cm)	52.91		75.83	85.94	
Maximum	63.5		85.0	94.5	
Minimum	46.0		61.0	78.0	
Standard Deviation	4.93		4.32	5.18	
Sample Size	11		73	9	
Statistical Week 20					
Mean Fork Length (cm)	52.50		77.73	85.38	
Maximum	58.0		84.5	86.0	
Minimum	46.0		67.0	85.0	
Standard Deviation	3.87		3.65	0.48	
Sample Size	8		41	4	
Statistical Week 21					
Mean Fork Length (cm)	55.88		77.06	85.75	
Maximum	56.5		85	94	
Minimum	55.0		67	79	
Standard Deviation	0.63		3.83	6.18	
Sample Size	4		35	6	
Statistical Week 22					
Mean Fork Length (cm)	55.57	80.83	77.27	84.50	
Maximum	64.0	88.5	85.5	94.5	
Minimum	50.5	75.0	70.0	77.5	
Standard Deviation	4.24	6.93	3.58	5.68	
Sample Size	7	3	31	6	
2001 Composite					
Mean Fork Length (cm)	53.21	80.13	75.24	83.97	100.00
Maximum	64.0	88.5	87.5	98.0	100.0
Minimum	45.0	75.0	57.5	69.0	100.0
Standard Deviation	3.98	5.84	3.92	6.03	0.00
Sample Size	36	4	699	76	1

Table A4. **Length-at-age estimates for Columbia Basin summer chinook salmon sampled at Bonneville Dam in 2001. Composite estimates are weighted by weekly run size.**

	Brood Year and Age Class								
	1999	1998		1997		1996		1995	
	0.1	0.2	1.1	0.3	1.2	0.4	1.3	0.5	1.4
Statistical Week 23									
Mean Fork Length (cm)			56.75		77.63		82.63		
Maximum			58.0		88.0		89.0		
Minimum			56.0		68.0		76.0		
Standard Deviation			0.87		4.77		5.62		
Sample Size			4		38		4		
Statistical Week 24									
Mean Fork Length (cm)			58.06	79.50	79.56		87.56		99.17
Maximum			63.5	88.5	91.0		93.0		107.0
Minimum			46.5	72.0	69.5		83.0		85.0
Standard Deviation			5.42	6.82	4.77		3.76		12.29
Sample Size			8	4	27		8		3
Statistical Week 25									
Mean Fork Length (cm)		62.75	55.60	82.50	75.45	92.75	88.97	87.00	
Maximum		71.5	64.0	92.0	84.0	101.0	99.0	87.0	
Minimum		54.0	46.0	71.5	65.0	84.5	76.0	87.0	
Standard Deviation		12.37	5.85	6.10	4.86	6.74	5.76	0.00	
Sample Size		2	15	14	51	4	15	1	
Statistical Week 26									
Mean Fork Length (cm)	42.00	62.50	58.35	80.41	74.77	90.50	87.42		95.00
Maximum	42.0	65.0	63.5	96.0	88.0	93.0	94.5		103.0
Minimum	42.0	59.0	53.0	64.5	54.5	88.0	76.0		87.0
Standard Deviation	0.00	3.12	3.56	8.72	6.90	3.54	5.43		11.31
Sample Size	1	3	13	11	52	2	13		2
Statistical Week 27									
Mean Fork Length (cm)		66.00	54.14	80.94	73.89		89.43		98.50
Maximum		67.0	65.0	93.0	86.0		98.0		99.0
Minimum		65.0	44.5	66.0	55.5		81.0		98.0
Standard Deviation		1.41	5.96	9.17	7.08		4.93		0.71
Sample Size		2	11	8	35		15		2
Statistical Week 28									
Mean Fork Length (cm)	47.00	62.50	56.00	82.83	73.72		90.75		92.50
Maximum	47.0	63.0	62.0	90.5	85.0		96.0		92.5
Minimum	47.0	62.0	47.0	74.0	52.0		88.0		92.5
Standard Deviation	0.00	0.71	5.01	5.34	7.17		3.57		0.00
Sample Size	1	2	9	6	23		4		1
Statistical Week 29									
Mean Fork Length (cm)		66.50	55.50		74.75		88.90		96.13
Maximum		68.0	62.0		87.0		102.0		107.0
Minimum		65.0	51.0		63.5		78.0		86.0
Standard Deviation		2.12	4.65		6.06		8.58		8.87
Sample Size		2	4		22		5		4
Statistical Week 30									
Mean Fork Length (cm)	47.00		49.92	83.43	75.63	96.83	89.83		
Maximum	47.0		54.5	90.5	85.0	102.0	93.0		
Minimum	47.0		44.0	73.0	62.0	92.0	87.0		
Standard Deviation	0.00		4.03	6.75	6.00	5.01	3.01		
Sample Size	1		6	7	34	3	3		
2001 Composite									
Mean Fork Length (cm)	45.33	63.91	55.77	81.71	76.06	93.61	88.04	87.00	96.79
Maximum	47.0	71.5	65.0	96.0	91.0	102.0	102.0	87.0	107.0
Minimum	42.0	54.0	44.0	64.5	52.0	84.5	76.0	87.0	85.0
Standard Deviation	2.89	4.63	4.56	7.41	5.78	5.62	5.25	0.00	8.07
Sample Size	3	11	70	50	282	9	67	1	12

Table A5. Length-at-age estimates for Columbia Basin Bright fall chinook salmon sampled at Bonneville Dam in 2001. Composite estimates are weighted by weekly run size.

	Brood Year and Age Class								
	1999	1998		1997		1996		1995	
	0.1	0.2	1.1	0.3	1.2	0.4	1.3	0.5	1.4
Statistical Week 31									
Mean Fork Length (cm)	37.00	74.00	51.50	85.06	76.47		90.25	95.00	88.75
Maximum	37.0	80.0	57.0	93.5	87.5		97.0	95.0	94.5
Minimum	37.0	68.0	46.0	81.5	59.5		82.0	95.0	81.0
Standard Deviation	0.00	6.00	7.78	4.08	7.67		6.13	0.00	5.81
Sample Size	1	3	2	8	18		6	1	4
Statistical Week 32									
Mean Fork Length (cm)	46.00	67.38	54.50	83.90	76.86	93.50	84.00		93.50
Maximum	46.0	70.5	64.0	91.0	86.5	97.5	86.0		93.5
Minimum	46.0	59.5	47.0	77.0	56.5	89.5	82.0		93.5
Standard Deviation	0.00	5.27	6.09	4.22	7.78	4.00	2.00		0.00
Sample Size	1	4	9	10	14	3	3		1
Statistical Week 33									
Mean Fork Length (cm)	54.00	65.90	52.63	82.90	78.23	100.00	89.00		96.17
Maximum	54.0	73.0	59.5	90.0	88.0	100.0	89.0		103.0
Minimum	54.0	60.5	41.5	76.5	67.0	100.0	89.0		83.5
Standard Deviation	0.00	4.52	7.88	5.87	6.87	0.00	0.00		10.98
Sample Size	1	5	4	6	11	1	1		3
Statistical Week 34									
Mean Fork Length (cm)		67.61	52.67	86.81	80.25	92.17	90.13		100.00
Maximum		72.0	54.5	96.5	97.5	102.0	103.0		105.0
Minimum		63.0	49.5	80.0	61.5	78.5	81.5		95.0
Standard Deviation		2.42	2.75	4.88	15.17	7.72	9.44		7.07
Sample Size		9	3	18	4	9	4		2
Statistical Week 35									
Mean Fork Length (cm)	42.17	70.70	54.00	83.75	75.33	93.35	85.00		90.50
Maximum	42.5	85.0	56.5	101.0	79.5	102.5	89.0		92.0
Minimum	42.0	53.5	51.0	70.0	72.0	82.0	80.5		89.0
Standard Deviation	0.29	7.25	2.78	5.70	2.60	6.02	3.16		2.12
Sample Size	3	25	3	43	6	10	6		2
Statistical Week 36									
Mean Fork Length (cm)	44.75	71.25	46.50	85.15	78.79	93.92	93.75		
Maximum	49.0	86.0	46.5	95.5	95.5	100.5	104.5		
Minimum	40.5	62.0	46.5	72.5	65.0	84.5	83.5		
Standard Deviation	6.01	5.98	0.00	4.44	7.90	5.76	8.82		
Sample Size	2	38	1	41	21	6	4		
Statistical Week 37									
Mean Fork Length (cm)	45.17	68.97	59.25	80.13	79.11	88.83	90.50		
Maximum	50.5	80.5	67.5	92.0	91.5	98.5	98.0		
Minimum	41.0	59.5	56.0	70.5	66.0	77.0	83.5		
Standard Deviation	4.86	4.32	4.27	5.18	7.42	7.08	7.56		
Sample Size	3	47	6	32	14	6	4		
Statistical Week 38									
Mean Fork Length (cm)	44.30	70.23	57.00	83.85	74.32	91.08	98.00	96.00	94.00
Maximum	50.5	81.5	65.0	97.0	87.5	94.5	98.0	105.0	94.0
Minimum	38.5	49.5	51.5	72.0	64.0	88.0	98.0	90.5	94.0
Standard Deviation	3.36	5.87	5.70	5.68	7.33	2.71	0.00	6.42	0.00
Sample Size	15	42	5	26	11	6	1	4	1
Statistical Week 39									
Mean Fork Length (cm)	44.36	68.67	54.70	84.83	73.50		85.25		
Maximum	48.5	79.5	59.5	94.0	83.0		87.0		
Minimum	41.0	54.5	49.5	78.5	61.0		83.5		
Standard Deviation	2.63	5.38	4.48	4.92	9.29		2.47		
Sample Size	7	43	5	12	4		2		
Statistical Week 40									
Mean Fork Length (cm)	43.26	66.83	59.50	82.13	70.88				
Maximum	50.0	77.0	61.5	85.5	82.5				
Minimum	39.0	42.0	57.5	78.5	55.5				
Standard Deviation	3.04	8.92	2.83	3.04	11.25				
Sample Size	17	12	2	4	4				
Statistical Week 41									
Mean Fork Length (cm)	43.58	66.75	50.00	80.83	72.50				
Maximum	47.5	79.0	58.0	85.5	72.5				
Minimum	40.0	54.5	42.0	75.0	72.5				
Standard Deviation	2.40	5.91	11.31	5.35	0.00				
Sample Size	6	12	2	3	1				
2001 Composite									
Mean Fork Length (cm)	43.94	69.51	54.79	83.38	77.62	92.35	88.98	95.80	93.23
Maximum	54.0	86.0	67.5	101.0	97.5	102.5	104.5	105.0	105.0
Minimum	37.0	42.0	41.5	70.0	55.5	77.0	80.5	90.5	81.0
Standard Deviation	3.41	5.56	5.77	5.05	7.37	6.04	6.63	5.57	7.13
Sample Size	56	240	42	203	108	41	31	5	13

Table A6. **Length-at-age estimates for Columbia Basin sockeye salmon sampled at Bonneville Dam in 2001. Composite estimates are weighted by weekly run size. Note: Due to small sample size, Weeks 22 and 23 were combined with Week 24 and Week 30 was combined with Week 29.**

Brood Year and Age Class

	1998	1997		1996	
	1.1	1.2	2.1	1.3	2.2
Statistical Week 24					
Mean Fork Length (cm)		51.26		57.72	53.67
Maximum		55.0		60.5	54.0
Minimum		40.0		54.5	53.0
Standard Deviation		2.69		2.15	0.58
Sample Size		44		9	3
Statistical Week 25					
Mean Fork Length (cm)		51.44		57.73	53.14
Maximum		59.5		61.0	56.5
Minimum		46.0		52.5	50.5
Standard Deviation		2.33		2.26	1.78
Sample Size		144		22	11
Statistical Week 26					
Mean Fork Length (cm)	37.00	51.75	43.00	58.35	52.48
Maximum	37.0	59.0	43.0	66.5	56.0
Minimum	37.0	46.0	43.0	54.0	45.0
Standard Deviation	0.00	2.36	0.00	3.26	2.51
Sample Size	1	139	1	13	20
Statistical Week 27					
Mean Fork Length (cm)	42.00	51.49	45.00	56.60	53.56
Maximum	42.0	56.5	45.0	58.5	56.0
Minimum	42.0	47.5	45.0	54.5	51.5
Standard Deviation	0.00	2.04	0.00	1.60	1.74
Sample Size	1	63	1	5	8
Statistical Week 28					
Mean Fork Length (cm)	41.17	50.30	45.00	58.00	51.75
Maximum	42.0	55.5	47.5	58.0	55.0
Minimum	39.5	42.5	42.0	58.0	49.0
Standard Deviation	1.44	2.87	2.78	0.00	2.50
Sample Size	3	35	3	2	4
Statistical Week 29					
Mean Fork Length (cm)	43.50	52.43			
Maximum	47.0	56.0			
Minimum	40.0	49.0			
Standard Deviation	4.95	2.52			
Sample Size	2	7			
2001 Composite					
Mean Fork Length (cm)	41.36	51.47	44.60	57.76	52.99
Maximum	47.0	59.5	47.5	66.5	56.5
Minimum	37.0	40.0	42.0	52.5	45.0
Standard Deviation	3.09	2.35	2.16	2.42	1.86
Sample Size	7	432	5	51	46

Table A7. Length-at-age estimates for Columbia Basin coho salmon sampled at Bonneville Dam in 2001. Composite estimates are weighted by weekly run size.

	Brood Year and Age Class	
	1999 1.0	1998 1.1
Statistical Week 34		
Mean Fork Length (cm)		57.81
Maximum		70.0
Minimum		51.0
Standard Deviation		7.07
Sample Size		8
Statistical Week 35		
Mean Fork Length (cm)		65.01
Maximum		77.5
Minimum		52.5
Standard Deviation		6.68
Sample Size		39
Statistical Week 36		
Mean Fork Length (cm)		68.18
Maximum		85.5
Minimum		51.0
Standard Deviation		6.30
Sample Size		40
Statistical Week 37		
Mean Fork Length (cm)		64.07
Maximum		81.0
Minimum		51.0
Standard Deviation		5.75
Sample Size		63
Statistical Week 38		
Mean Fork Length (cm)	36.50	67.21
Maximum	36.5	85.5
Minimum	36.5	56.0
Standard Deviation	0.00	6.33
Sample Size	1	50
Statistical Week 39		
Mean Fork Length (cm)		65.13
Maximum		77.5
Minimum		53.5
Standard Deviation		6.03
Sample Size		28
Statistical Week 40		
Mean Fork Length (cm)		64.03
Maximum		77.5
Minimum		47.0
Standard Deviation		8.62
Sample Size		49
Statistical Week 41		
Mean Fork Length (cm)	35.00	62.22
Maximum	35.0	79.5
Minimum	35.0	45.5
Standard Deviation	0.00	9.99
Sample Size	1	25
Statistical Week 42		
Mean Fork Length (cm)		63.67
Maximum		77.0
Minimum		47.0
Standard Deviation		8.27
Sample Size		18
2001 Composite		
Mean Fork Length (cm)	35.75	65.49
Maximum	36.5	85.5
Minimum	35.0	45.5
Standard Deviation	1.06	6.21
Sample Size	2	320

Table A8. Composition (%) of observed injuries of Columbia Basin chinook salmon sampled at Bonneville Dam in 2001.

Injury Category	Spring	Summer	Fall
Marine Mammal			
Bite	2.1	0.7	0.8
Claw Rake	11.2	3.3	3.9
Twin Arches	6.9	1.1	1.0
Total[a]	**19.0**	**4.7**	**5.3**
Descaling			
< 3%			
Right side	5.4	5.8	8.3
Left side	5.5	5.7	8.7
Total[b]	**7.1**	**8.2**	**7.1**
3-19%			
Right side	8.9	11.5	9.9
Left side	7.2	7.7	9.1
Total[c]	**10.6**	**14.4**	**10.0**
≥20%			
Right side	0.9	1.3	0.8
Left side	1.5	0.9	0.4
Total[d]	**2.1**	**1.3**	**1.1**
Other Injuries			
Bruises	0.2	0.2	1.8
Cuts	0.7	0.5	0.5
Head Injury	1.8	2.2	5.8
Head Burn	0.1	0.0	0.0
Fin	5.5	2.7	8.1
Fungus	1.4	0.2	0.0
Gash	1.1	2.0	1.0
Gas Bubble Trauma	0.0	0.0	0.0
Gill Net	0.3	0.2	3.2
Fishing Hook	0.7	0.7	1.8
Lamprey	0.5	0.2	0.0
Parasite	0.5	0.0	0.4
Total[a]	**11.5**	**8.6**	**19.7**

a Totals, as percentages, 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.

b This total represents, as a percentage, the number of fish with descaling on either side, which is less than 3% descaled. If either side is ≥ 3%, the fish moves into another category.

c This total represents, as a percentage, the number of fish with descaling on either side, which is 3 – 19% descaled. If either side is > 19% the fish moves into another category.

d This total represents, as a percentage, the number of fish with descaling on at least one side that is ≥ 20% descaled.

Table A9. Composition (%) of observed injuries of Columbia Basin sockeye and coho salmon sampled at Bonneville Dam in 2001.

Injury Category	Sockeye	Coho
Marine Mammal		
Bite	0.2	0.6
Claw Rake	1.8	11.1
Twin Arches	0.4	3.3
Total[a]	**2.3**	**13.9**
Descaling		
< 3%		
Right side	20.8	15.4
Left side	23.5	17.2
Total[b]	**25.7**	**13.0**
3-19%		
Right side	20.6	14.2
Left side	21.5	14.5
Total[c]	**28.2**	**18.4**
≥20%		
Right side	1.3	0.9
Left side	0.9	0.6
Total[d]	**1.6**	**0.9**
Other Injuries		
Bruises	0.7	0.6
Cuts	0.7	0.9
Head Injury	0.7	17.2
Head Burn	0.0	0.0
Fin	1.3	10.2
Fungus	0.0	1.2
Gash	0.7	1.8
Gas Bubble Trauma	0.0	0.0
Gill Net	0.2	10.5
Fishing Hook	0.0	1.8
Lamprey	0.0	0.0
Parasite	0.0	0.6
Total[a]	**4.1**	**33.4**

a Totals, as percentages, 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.

b This total represents, as a percentage, the number of fish with descaling on either side, which is less than 3% descaled. If either side is > 3%, the fish moves into another category.

c This total represents, as a percentage, the number of fish with descaling on either side, which is 3 – 19% descaled. If either side is > 19% the fish moves into another category.

d This total represents, as a percentage, the number of fish with descaling on at least one side that is > 20% descaled.

APPENDIX B

Description of fish condition assessment notation

Prior to 1992, sampling personnel had the option of noting fish condition in the comments section of the sampling form. This resulted in an assessment of fish condition, which varied with sampling personnel, sampling site, and sampling date. To standardize this information and allow meaningful comparisons of relative fish condition by date and/or site, new criteria and sample forms were developed for the 1992-sampling season (Fryer and Schwartzberg 1993). Slightly modified criteria have been used for sampling since 1997 to standardize assessment of gas bubble trauma (GBT) and headburn (Figure B1). In 2001 GBT and headburn were not a priority and the sampling forms were changed to reflect this (Figure B2).

In 2000, new condition and coloration criteria were developed to reduce subjectivity in data (Figure B1). Condition codes the penetration of the mark or injury instead of judging the condition of a fish in a range of 5 for perfect fish to a 1 for extremely poor condition fish. For the year 2001 sampling period Table B1 displays the results from collection of condition and coloration data. Also in 2001 we noted old healed wounds, deformities (either resulting from a fish's genetic make up or an injury), and any new types of unexplained phenomena (Table B2).

Figure B1. Fish condition assessment notation.

1. Condition classification:
   - **5**: no marks or injuries, or marks and injuries do not break the skin
   - **4**: mark or injury breaks the skin
   - **3**: injury penetrates the muscle
   - **2**: injury penetrates a body cavity
   - **1**: missing large sections of body or appendages needed for locomotion

2. Coloration:
   - **B**: Bright
   - **I**: Intermediate
   - **D**: Dark

3. Descaling, left side; estimate actual percentage descaled

4. Descaling, right side; estimate actual percentage descaled

5. Gill net marks

6. Fin Injuries
   - **R**: Right
   - **L**: Left
   - **P**: Pectoral
   - **V**: Ventral
   - **D**: Dorsal
   - **AD**: Adipose
   - **AN**: Anal
   - **T**: Tail

7. Other Injuries
   - **P**: Parasite
   - **L**: Lamprey (circular wound)
   - **C**: Cut
   - **F**: Fungus
   - **B**: Bruise
   - **G**: Gash or lesion
   - **H**: Fishing hook
   - **D**: Daggertooth

8. Head Injuries
    - **E**: Eye
    - **N**: Nose
    - **M**: Mouth
    - **J**: Jaw
    - **O**: Opercula/gill

9. Marine mammal injuries as follows:
    - **C**: Claw rake (2-3 or more parallel scratches on flanks of fish)
    - **G**: Golden arches (2-3 or more curved scratches on flanks of fish)
    - **B**: Bite (ragged wounds, often in caudal area)
    - **N/O**: New or old

10. Gas Bubble Trauma monitoring
    - **0**: 0 % area affected
    - **1**: 1 to 5 % area affected
    - **2**: 6 to 25 % area affected
    - **3**: 26 to 50 % area affected
    - **4**: > 50 % area affected

11. Headburn

    Location:
    - **1**: Left dorsal
    - **2**: Right dorsal
    - **3**: Left lateral
    - **4**: Right lateral

    Severity:
    - **A**: Abrasion
    - **L**: Lesion
    - **B**: Blister

    Coverage:
    - **1**: 1 to 25 %
    - **2**: 26 to 50 %
    - **3**: > 50 %

CRITFC

Stock Identification Project

Updated 2/01

LOCATION:__________________ SPECIES:______COHO_____________ PAGE:______OF______

DATE:______________________ WEEK:_____________ Start WEATHER:______________________ Stop WEATHER:__________________

MARINE MAMMAL C G B N O FINS T AD D RV LV RP LP AN OTHER H C B G F P L D HEAD E N M J O

Age	Age Comment	Card #	Position	Fork Length	Fin Clip	Condition (1-5)	Coloration (B,I,D)	Descaling left(%)	Descaling right(%)	Gill Net Damage	Marine M. (C,G,B)	N or O	Fin Injuires	Other Inj. H,C,B,G,F,P,L,D	Head Inj. E,N,M,J,O	Headburn Location (1-4)	Headburn Severity (A,L,B)	Headburn Coverage (1-3)	GBT	Time	Comments
			1																	:	
			2																	:	
			3																	:	
			4																	:	
			5																	:	
			6																	:	
			7																	:	
			8																	:	
			9																	:	
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			3																	:	
			4																	:	
			5																	:	
			6																	:	
			7																	:	
			8																	:	
			9																	:	
			10																	:	

START TIME:

STOP TIME:

SAMPLERS:

SAMPLE #

Coho ___________

Chinook ________

Sockeye________

Water T. °C

A Tank___________

R Tank___________

SPILL:

YES NO

Lead Time:

DAM COUNT:

Chinook__________

Coho___________

Sockeye_________

DATA ENTRY:

Computer__________

Check___________

Other__________

CODES

CONDITION

5 = marks? Do not break skin

4 = mark or injury breaks skin

3 = injury penetrates muscle

2 = injury penetrates body cavity

1 = missing large portion of body

COLORATION

Bright

Intermediate

Dark

HEADBURN

Location

1 = L dorsal

2 = R dorsal

3 = L lateral

4 = R lateral

Severity

A = abrasion

L = lesion

B = blister

Coverage

1 = 1 - 25 %

2 = 26 - 50%

3 = > 50 %

Figure B2. Sampling form used in adult salmonid sampling at Bonneville Dam in 2001.

Table B1. Composition (%) of observed condition and coloration categories of Columbia Basin salmon sampled at Bonneville Dam in 2001 .

	Chinook Spring	Chinook Summer	Chinook Fall	Sockeye	Coho
Condition					
5	91.8	96.2	94.7	97.1	85.9
4	5.0	2.9	3.9	1.8	11.1
3	2.4	0.7	1.4	0.9	2.7
2	0.8	0.2	0	0.2	0.3
1	0	0	0	0	0
Color					
B	95.1	89.1	89.9	99.8	85.8
I	4.9	9.8	9.0	0.2	13.3
D	0	1.1	1.1	0	0.9

Table B2. Composition (%) of observed old wounds, deformities, or new phenomenon of Columbia Basin salmon sampled at Bonneville Dam in 2001 .

New Data	Chinook Spring	Chinook Summer	Chinook Fall	Sockeye	Coho
Old Wound	2.3	2.7	5.6	6.1	5.7
Deformity	0.8	0.4	0.5	0.5	2.1
Sore / Rash	0	0	1.6	1.3	32.5
Wart / Bumps	0	0	0.6	0	4.8