AGE AND LENGTH COMPOSITION OF COLUMBIA BASIN SPRING AND SUMMER CHINOOK SALMON AT BONNEVILLE DAM IN 1992

Technical Report 93-3

Jeffrey K. Fryer
Matthew Schwartzberg

February 22, 1993

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ABSTRACT

Representative samples of the 1992 Columbia Basin spring and summer chinook populations were obtained at Bonneville Dam. 1992 marked the sixth year spring chinook, and third year summer chinook salmon were so sampled. Fish were trapped, anesthetized, sampled for scales and biological data, allowed to revive, and released. The scales were examined to estimate the age of the fish. Four-year-old fish were estimated to comprise 78% of the spring chinook and 47% of the summer chinook population. Five-year-old fish were estimated to comprise 18% of the spring chinook and 34% of the summer chinook population. Two-, three-, and six-year-old fish were estimated to comprise the remaining 4% of the spring chinook, and 19% of the summer chinook population. Differences in age class returns were used to predict spring chinook population sizes for 1993.

Concerns over possible increasing marine mammal predation led to the development of criteria to evaluate the condition of returning fish. Fourteen percent of spring chinook, and four percent of summer chinook salmon sampled were injured by marine mammals. Less than one percent of spring and summer chinook salmon were more than five percent descaled on either side. Five percent of spring chinook, and four percent of summer chinook salmon had cuts, gill net wounds, parasites, or other miscellaneous injuries.

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INTRODUCTION

The Stock Assessment Project of the Columbia River Inter-Tribal Fish Commission (CRITFC) is a part of the U.S.-Canada Pacific Salmon Treaty spawning escapement monitoring program (PST 1985). A principal aim 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.

This report uses scale pattern interpretation techniques to estimate the 1992 age and length-at-age compositions for upriver spring and summer chinook salmon[1] *Oncorhynchus tshawytscha* (Walbaum). Bonneville Dam, located at Columbia River kilometer 235, was the sampling site for this project (Figure 1). In 1992, new criteria were developed to evaluate the condition of fish sampled at this site. The spring chinook study began in 1987 and the summer chinook study began in 1990. Reports of previous results are available (Schwartzberg 1988, 1989; Schwartzberg and Fryer 1990; Fryer and Schwartzberg 1991a, 1991b, 1992; Fryer et al. 1992). Data from these studies was used to predict the 1993 population size of the predominant age class.

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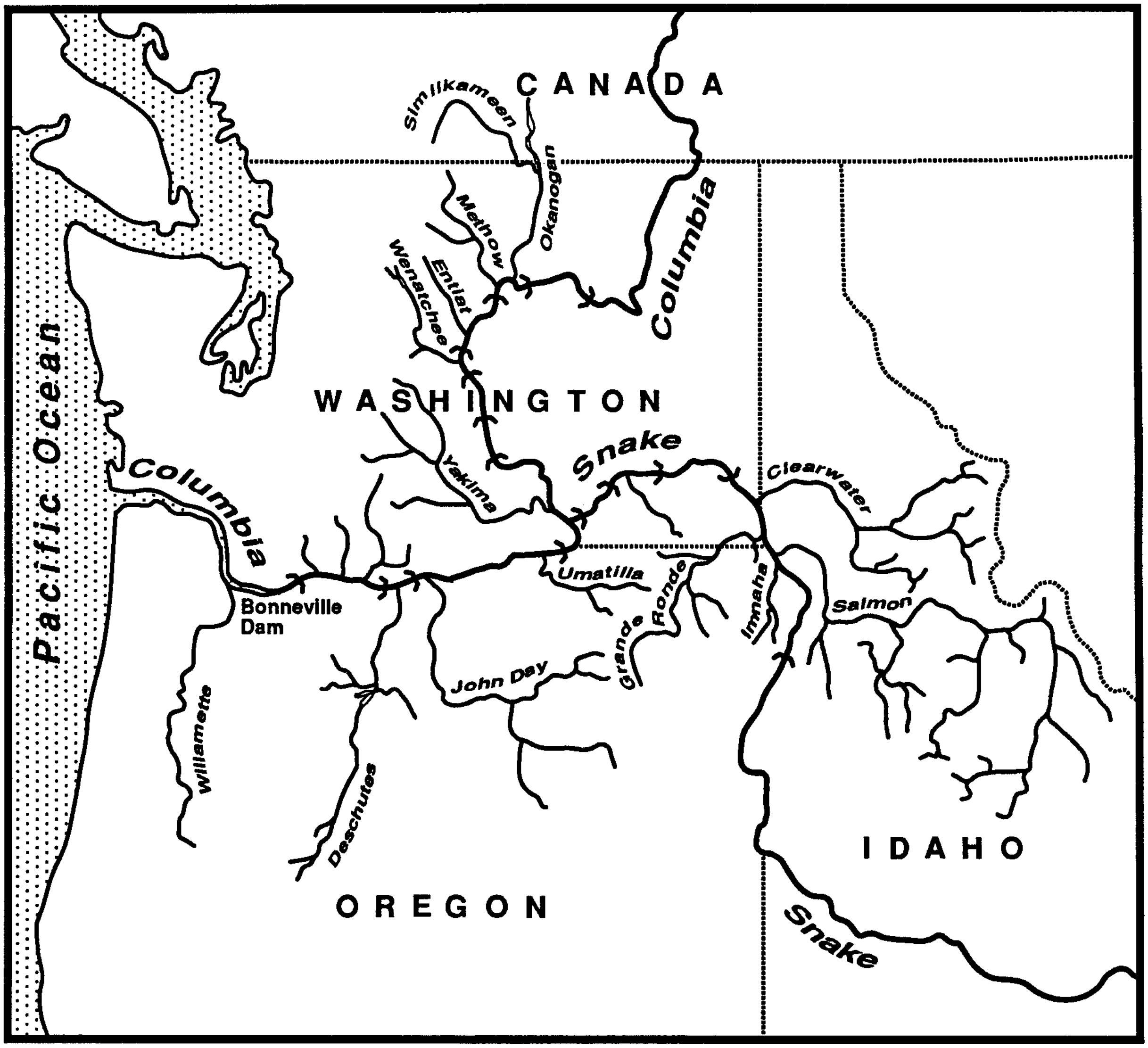
1. Columbia Basin upriver spring chinook salmon are defined as those chinook salmon migrating past Bonneville Dam before June 1. Columbia Basin summer chinook salmon are defined as those chinook salmon migrating past Bonneville Dam between June 1 and July 31 while later migrating chinook salmon are defined as fall chinook salmon.

Figure 1. Map of the Columbia Basin showing spring and summer chinook salmon spawning areas and Bonneville Dam.



METHODS

Sampling Methods

In order to collect a representative sample of the Columbia River spring and summer chinook salmon populations, fish were sampled at the Fisheries Engineering and Research Laboratory located adjacent to the Second Powerhouse of Bonneville Dam. Fish were trapped, anesthetized, sampled for scales and biological data, allowed to revive, and then returned to the exit fishway leading to one of the Bonneville Dam fish ladders. To minimize the sample rejection rate, six scales were collected per fish (Knudsen 1990). Fork length measurements were recorded along with observed mark and/or tag information. No fish were sacrificed in the study. Gender of collected specimens, all in early stages of sexual maturation, could not be determined.

Sample Design

Sampling was conducted one day per week during the spring chinook salmon migration and two days per week during most of the summer chinook migration. The desired total sample size for both spring and summer chinook salmon was a minimum of 500 fish which, in past study years, has resulted in age composition estimates within preferred levels of precision and accuracy ($d=0.05$, $\alpha=0.10$). Actual 1992 migratory timing was determined from post-season analysis of 1992 Bonneville Dam fish ladder counts (CRITFC 1992). To further improve accuracy, composite age and length-at-age estimates were adjusted post-season for actual 1992 migration timing using a stratified sampling method that weighted weekly estimates proportionally.

Age Determination

Scales were prepared and mounted 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 (Johnston 1905, Gilbert 1913, Van Oosten 1929). Age estimates were corroborated by personnel at the Harvest Management Division of the Washington Department of Fisheries. Validation of ages (Beamish and McFarlane 1983) was not possible because no known-age fish were present in the sample.

The method used for fish age description was that recommended by Koo (1955). 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.

Comparison of Age Composition Estimates

Inter-Annual Age Composition Estimates

Age composition estimates obtained during earlier years of this study, beginning in 1987 for spring chinook salmon and 1990 for summer chinook salmon, were compiled and compared with results from this year's work to explore inter-annual variation in age composition estimates.

Intra-Annual Age Composition Estimates

Age composition estimates obtained in 1992 from Bonneville Dam scale samples were compared to estimates from two independent sources to explore differences in intra-annual age composition estimates. The first comparison was with the percentage of chinook salmon estimated in visual Bonneville Dam fish ladder counts to be less than approximately 56 cm (22 in) in overall length (USACE 1992). These fish, called *jacks*, are typically of age 0.1 or 1.1.

The second comparison was with estimates obtained from a test fishery, called the Corbett test fishery, conducted annually by the Washington Department of Fisheries (Dammers, in preparation). This fishery is conducted approximately 32 km downstream of Bonneville Dam from April 2 through April 30 and uses 18.42 cm (7.25 in)-mesh gillnets.

Spring Chinook Run Size Prediction

The progeny of a salmon population in a given year will return to freshwater in the future as adult spawners in several different years. All progeny of a given year's spawning population are known as a *brood*. Many salmon population size prediction techniques are based on patterns in age composition from successive broods. By combining age composition estimates from previous studies (Schwartzberg 1988; Schwartzberg and Fryer 1989, 1990; Fryer and Schwartzberg 1991a; Fryer et al. 1992) with visual count data (CRITFC 1992), estimates of the progeny for each brood year were made from analysis of historic data. It was noted that the number of three-year-old fish for a given brood year appeared to be a relatively good predictor of the number of subsequently returning four-year-old fish of the same brood year. For example in 1992, using linear regression techniques, 53,200 (±25,500, 90% bound) four-year-old fish were predicted to return (Fryer et al. 1992). A similar prediction technique is used to forecast returning four-year-old fish in 1993.

Length Measurements

Fork lengths were measured to the nearest 0.5 cm. Mean lengths and measurements of variability were calculated for each age class and brood year, by weekly sampling period, and for the composite sample.

Fish Condition

The percentage of spring chinook salmon injured by marine mammals has been perceived by personnel conducting the sampling to have increased in

recent years. However, year-to-year comparisons of marine mammal, or other types of, injuries are difficult without a standardized methodology for describing these injuries. Therefore in 1992, new criteria were developed to allow more precise classification of the condition of sampled fish (Appendix A).

RESULTS

Sample Design

Of the 547 spring chinook salmon collected in this study, eight percent of the total sample was rejected and not classified by age because of unreadable scales. One additional fish, sampled in week 21, was under 30 cm in length (known locally as a *minijack*) and appeared to have spent no time in saltwater. We excluded information on minijacks from this report because of their different life history and because sampling of minijacks was conducted in a non-random manner. The total sample size used for the age and length-at-age composition estimates was 504 fish.

Of the 281 summer chinook salmon collected in this study, seven percent of the total sample was rejected and not classified by age because of unreadable scales. Ten additional minijacks were excluded from the analysis. The total sample size used for the age and length-at-age composition estimates was 252 fish. Due to the small sample size collected in statistical week 31 (5 fish), Statistical weeks[2] 30 and 31 were combined for analysis.

Age Composition Estimates

Spring Chinook Salmon

Four-year-old fish (from the 1988 brood-year group, including Age 0.3 and 1.2 fish), comprising 78% of the population, were estimated to be the predominant age class for spring chinook salmon (Table 1) Four-year-old fish were the predominant age class in all statistical weeks (Figure 2). Five fish, or 1% of the spring chinook salmon population, were estimated to be Age 0-plus (two of age 0.2 and three of age 0.3).

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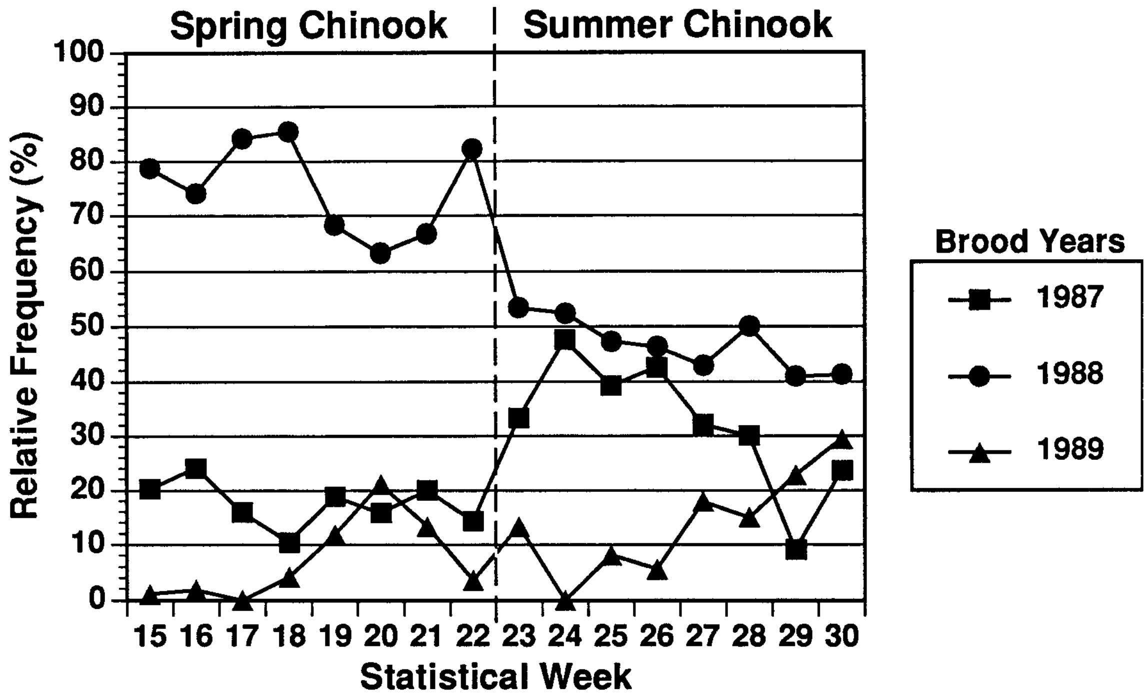
2. Statistical weeks are sequentially numbered calendar-year weeks. Excepting the first and last weeks of most years, weeks are seven days long, beginning on Sunday and ending on Saturday. In 1992, for example, Statistical Week 15 began on April 5 and ended on April 11.

Table 1. Age composition estimates of Columbia Basin spring chinook salmon sampled at Bonneville Dam in 1992.

Statistical Week	Sampling Dates	Sample Size	1989 0.2	1989 1.1	1988 0.3	1988 1.2	1987 0.4	1987 1.3	1986 1.4
			Brood Year and Age Class (Percentage)						
15	4/08	94		1	1	78		20	
16	4/15	108	1	1		74		24	
17	4/22	44				84		16	
18	4/29	96		4		85		10	
19	5/6	85		12	1	67		19	1
20	5/13	19		21		63		16	
21	5/19	30		13	3	63		20	
22	5/27	28	4			82		14	
Population Estimate		504	<1	3	<1	78		18	<1

Figure 2. **Weekly age composition estimates for the three major Columbia Basin spring and summer chinook salmon brood years sampled at Bonneville Dam in 1992.**



Summer Chinook Salmon

Four-year-old fish were also estimated to be the predominant age class for summer chinook salmon, comprising 47% of the population (Table 2). As with spring chinook, four-year-old fish were the predominant age class in all statistical weeks (Figure 2).

Thirty percent of the summer chinook salmon population was estimated to be age 0-plus. The percentage of chinook salmon of age 0-plus steadily increased as the migration progressed, though only in Statistical Week 29 did this group form the majority of the run (Figure 3).

Spring Chinook Salmon Run Size Prediction

In 1993, we predict four-year-old adult spring chinook abundance at Bonneville Dam will be 32,300 (±31,000, 90% bound [Figure 4]). If correct, this would be the second lowest number of four-year-old returns in (at least) the past 6 years.

Comparison of Age Composition Estimates

Inter-Annual Age Composition Estimates

The estimated age composition of the 1992 spring chinook population is similar to that of 1987, 1989, and 1990 in that four-year-old fish formed the majority of the population (Figure 5). Four-year-old summer chinook salmon were the largest age class for the first time in three years (Figure 6). Data presented for years 1987 and 1988 are adjusted for actual migration timing in those years using a stratified sampling method that weighted weekly age composition estimates and therefore are slightly different from those previously reported (Schwartzberg 1988, 1989).

Table 2. Age composition estimates of Columbia Basin summer chinook salmon sampled at Bonneville Dam in 1992.

Statistical Week	Sampling Dates	Sample Size	Brood Year and Age Class (Percentage) 1990	1989		1988		1987		1986
			0.1	0.2	1.1	0.3	1.2	0.4	1.3	1.4
23	6/03	15		7	7	7	47		33	
24	6/10	21				24	29	5	43	5
25	6/17,19	74	3	1	7	11	36	5	34	5
26	6/24,26	54		4	2	17	30	4	39	6
27	7/01,02	28		7	11	11	32	7	25	7
28	7/08,10	20			15	25	25	5	25	5
29	7/15,17	22	27	4	18	23	18		9	
30-31	7/22,24,29	17	6	6	24	24	18		18	6
Population Estimate		251	4	4	9	17	30	5	29	3

Figure 3. **Weekly freshwater age composition estimates for Columbia Basin spring chinook salmon sampled at Bonneville Dam in 1992.**

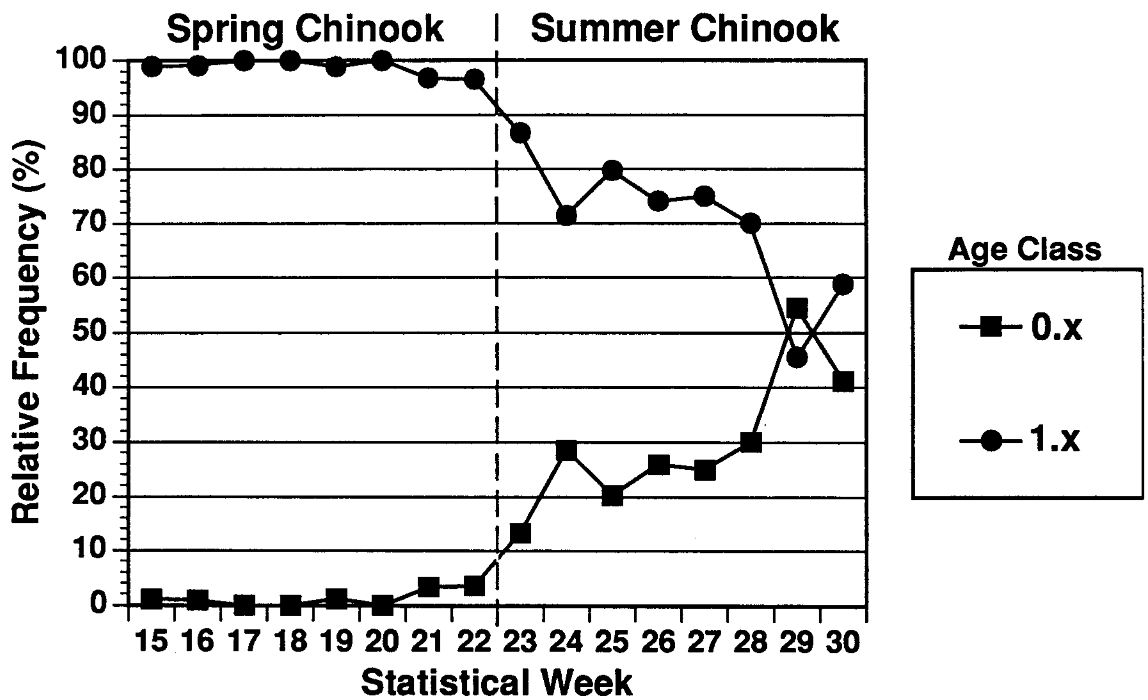


Figure 4. Predicted 1993 four-year-old Columbia Basin spring chinook abundance (at Bonneville Dam) based on a linear relationship between four-year-old and three-year-old returns from brood years 1983 through 1988.

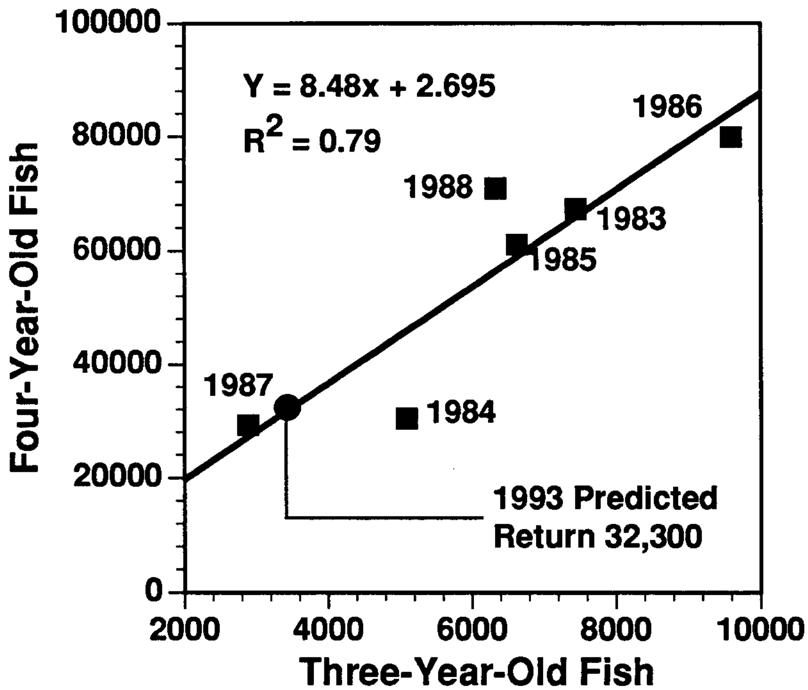


Figure 5. **Age composition estimates by age class and brood year of Columbia Basin spring chinook at Bonneville Dam from 1987 through 1992.**

Return Year	Age Class (%) 0.1	0.2	1.1	0.3	1.2	0.4	1.3	1.4
1987	0	1	4	0	67	0	29	<1
1988	<1	1	6	1	31	<1	61	0
1989	0	<1	11	1	69	<1	18	<1
1990	0	1	3	<1	83	0	14	<1
1991	<1	<1	10	<1	48	0	40	<1
1992	0	<1	3	<1	78	0	18	<1

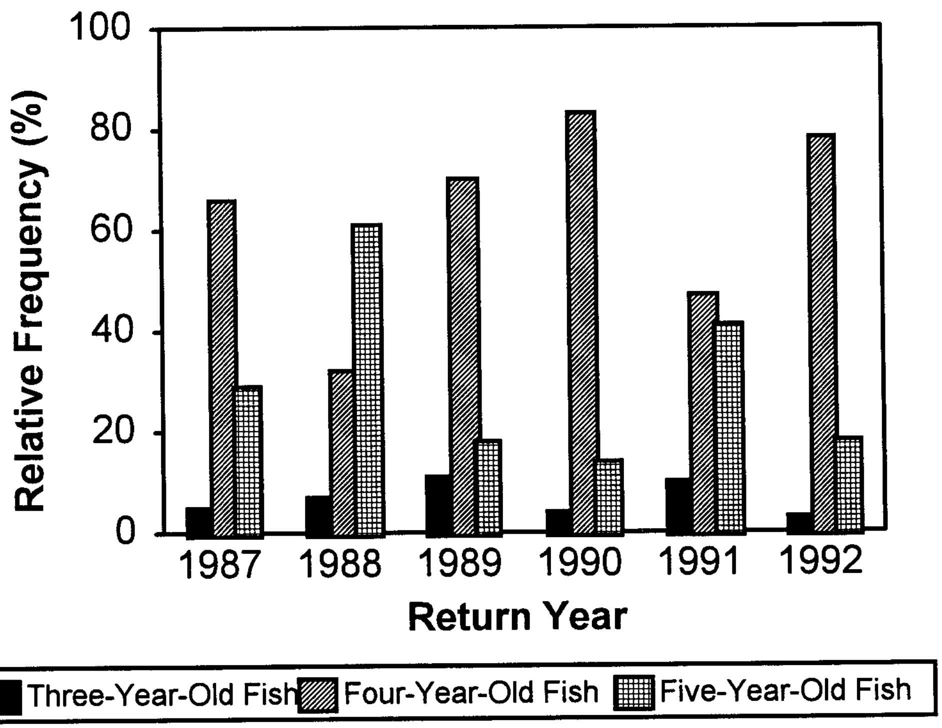
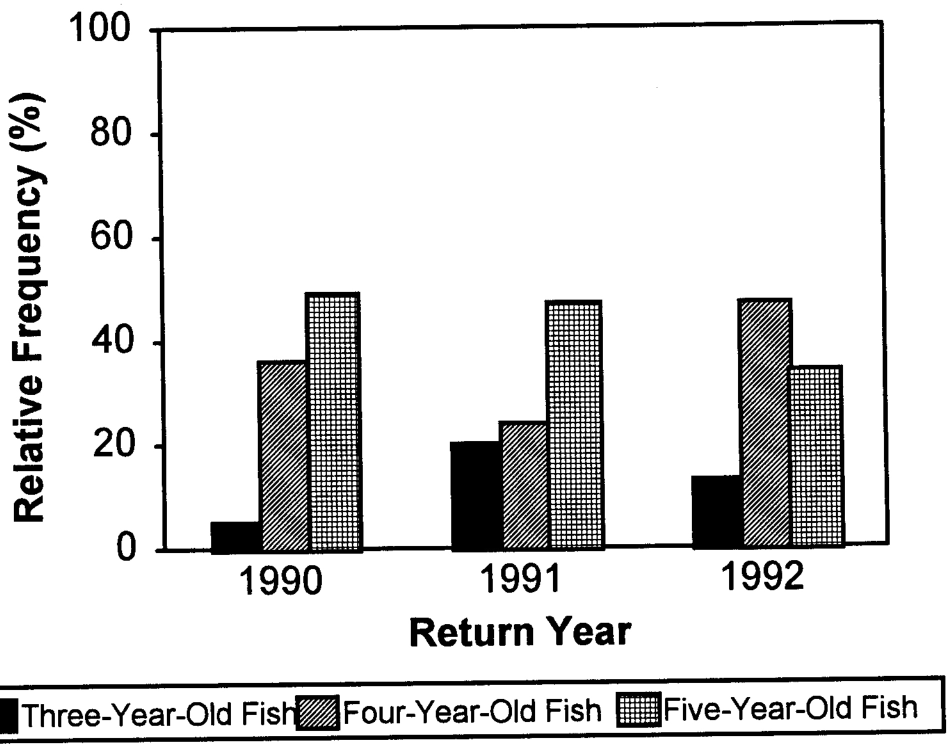


Figure 6. **Age composition estimates by age class and brood year of Columbia Basin summer chinook at Bonneville Dam from 1990 through 1992.**

Return Year	Age Class (%) 0.1	0.2	1.1	0.3	1.2	0.4	1.3	0.5	1.4
1990	1	1	4	12	24	23	26	1	7
1991	5	3	17	7	17	16	31	1	2
1992	4	4	9	17	30	5	29	0	3



Intra-Annual Age Composition Estimates

Age 1.1 fish were estimated to comprise 3% of the composite 1992 spring chinook sample compared to 2% based on visual fish ladder counts made at Bonneville Dam (CRITFC 1992). By comparison, 1987 through 1991 adjusted results from our studies estimated that three-year-old abundance was 4, 6, 11, 3, and 10%, respectively. Visual fish counts estimated abundances during these years of 3, 4, 7, 2, and 6%; respectively.

Age 0.1 and 1.1 fish were estimated to comprise 13% of the composite 1992 summer chinook sample compared to 22% based on visual fish ladder counts made at Bonneville Dam (CRITFC 1992). By comparison, 1990 and 1991 results from our studies estimated that Age 0.1 and 1.1 fish abundance was 5% and 22%; respectively. Visual fish counts estimated abundances during these years of 11 and 14%; respectively.

Length-at-Age Composition

Mean fork-lengths of spring chinook salmon sampled at Bonneville Dam ranged from 51.8 cm for Age 1.1 fish to 97.5 cm for Age 1.4 fish (Table 3). The largest fish sampled was a 97.5 cm Age 1.4 fish sampled in Statistical Week 19 while the smallest (excluding minijacks) was a 42.0 cm Age 1.1 fish sampled in Statistical Week 18. The mean fork-length of five-year-old fish was the smallest in the past 6 years (Figure 7).

Mean fork-lengths of summer chinook salmon sampled at Bonneville Dam ranged from 49.6 cm for Age 1.1 fish to 100.6 cm for Age 1.4 fish (Table 4). The largest fish sampled was an 110.0 cm Age 1.4 fish sampled in Statistical Week 27 while the smallest (excluding minijacks) was a 42.5 cm Age 1.1 fish sampled in Statistical Week 29.

Table 3. Length-at-age estimates for Columbia Basin spring chinook sampled at Bonneville Dam in 1992.

	Brood Year and Age Class					
	1989		1988		1987	1986
	0.2	1.1	0.3	1.2	1.3	1.4
Statistical Week 15						
Mean Fork Length (cm)		60.5	71.0	71.0	83.4	
Minimum		60.5	71.0	61.0	70.0	
Maximum		60.5	71.0	77.0	93.0	
Standard Deviation		—	—	3.6	5.9	
Sample Size		1	1	73	19	
Statistical Week 16						
Mean Fork Length (cm)	62.0	53.0		71.3	81.6	
Minimum	62.0	53.0		57.0	72.0	
Maximum	62.0	53.0		79.0	91.0	
Standard Deviation	—	—		4.0	4.6	
Sample Size	1	1		80	26	
Statistical Week 17						
Mean Fork Length (cm)				72.2	80.5	
Minimum				62.0	67.5	
Maximum				79.0	91.0	
Standard Deviation				4.1	7.0	
Sample Size				37	7	
Statistical Week 18						
Mean Fork Length (cm)		46.2		71.6	81.8	
Minimum		42.0		51.0	71.0	
Maximum		48.0		79.0	91.0	
Standard Deviation		2.5		4.9	5.6	
Sample Size		4		82	10	
Statistical Week 19						
Mean Fork Length (cm)		49.8	69.0	72.8	78.7	97.5
Minimum		43.5	69.0	63.0	74.0	97.5
Maximum		57.0	69.0	80.0	86.5	97.5
Standard Deviation		4.6	—	57	3.5	—
Sample Size		10	1	35	16	1
Statistical Week 20						
Mean Fork Length (cm)		52.6		73.4	80.7	
Minimum		50.5		65.0	76.5	
Maximum		57.5		81.0	85.5	
Standard Deviation		2.8		4.9	3.7	
Sample Size		4		12	3	
Statistical Week 21						
Mean Fork Length (cm)		51.2	80.0	73.0	81.8	
Minimum		47.5	80.0	63.5	77.0	
Maximum		53.5	80.0	82.5	86.0	
Standard Deviation		2.3	—	4.7	2.8	
Sample Size		4	1	19	6	
Statistical Week 22						
Mean Fork Length (cm)	71.0			72.5	79.1	
Minimum	71.0			61.0	76.0	
Maximum	71.0			81.5	80.5	
Standard Deviation	—			5.5	1.8	
Sample Size	1			23	4	
1992 Composite						
Mean Fork Length (cm)	66.5	51.8	73.3	71.7	81.8	97.5
Minimum	62.0	42.0	69.0	51.0	67.5	97.5
Maximum	71.0	60.5	80.0	81.5	93.0	97.5
Standard Deviation	4.5	3.2	4.8	4.0	5.6	—
Sample Size	2	24	3	383	91	1

Figure 7. **Mean fork lengths of spring chinook salmon sampled at Bonneville Dam from 1987 through 1992 by age class.**

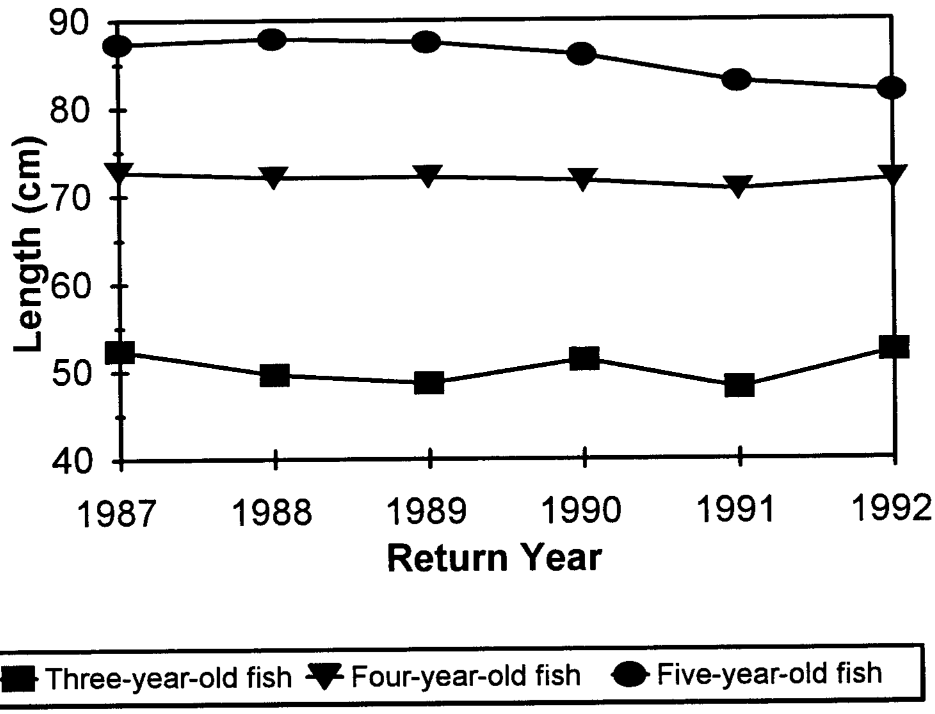


Table 4. Length-at-age estimates for Columbia Basin summer chinook sampled at Bonneville Dam in 1992.

	Brood Year and Age Class								
	1990	1989		1988		1987		1986	
	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)		59.5	53.0	83.0	74.0		78.4		
Minimum		59.5	53.0	83.0	68.0		65.0		
Maximum		59.5	53.0	83.0	79.5		84.0		
Standard Deviation		—	—	—	4.1		6.8		
Sample Size		1	1	1	7		5		
Statistical Week 24									
Mean Fork Length (cm)				81.8	75.9	94.0	86.4		
Minimum				73.0	63.0	84.0	80.0		
Maximum				91.0	84.0	84.0	92.0		
Standard Deviation				6.0	7.1	—	4.5		
Sample Size				5	6	1	9		
Statistical Week 25									
Mean Fork Length (cm)	41.5	59.0	51.1	81.2	75.2	99.6	86.4		98.8
Minimum	37.0	59.0	44.0	73.0	58.5	93.0	80.0		97.5
Maximum	46.0	59.0	56.0	88.0	86.5	109.0	92.0		100.0
Standard Deviation	4.5	—	4.2	4.4	5.9	5.8	5.4		1.2
Sample Size	2	1	5	8	27	4	25		2
Statistical Week 26									
Mean Fork Length (cm)		66.3	56.0	85.7	75.0	95.0	87.6		97.7
Minimum		64.0	56.0	80.0	63.0	82.0	71.0		94.0
Maximum		68.5	56.0	93.0	86.0	107.0	95.0		102.0
Standard Deviation		2.2	—	4.3	6.1	10.2	5.3		3.3
Sample Size		2	1	9	16	3	20		3
Statistical Week 27									
Mean Fork Length (cm)		60.2	53.0	84.3	76.9	94.5	87.7		105.0
Minimum		59.5	46.0	80.5	67.0	94.0	85.0		100.0
Maximum		61.0	61.0	86.5	87.0	95.0	92.0		110.0
Standard Deviation		0.8	6.2	2.7	6.0	0.5	2.9		5.0
Sample Size		2	3	3	9	2	7		2
Statistical Week 28									
Mean Fork Length (cm)			53.2	81.4	74.3	88.0	91.5		100.0
Minimum			52.0	77.0	64.5	88.0	82.0		100.0
Maximum			55.0	88.0	84.0	88.0	100.0		100.0
Standard Deviation			1.3	3.9	6.5	—	7.0		—
Sample Size			3	5	5	1	5		1
Statistical Week 29									
Mean Fork Length (cm)	43.8	69.0	47.8	87.8	77.5		90.8		
Minimum	41.0	69.0	52.0	82.5	76.0		84.5		
Maximum	50.0	69.0	55.0	99.0	80.0		97.0		
Standard Deviation	3.3	—	2.8	6.1	1.7		6.2		
Sample Size	6	1	4	5	4		2		
Statistical Week 30-31									
Mean Fork Length (cm)	45.5	71.0	49.6	83.1	83.7	93.0	83.2		
Minimum	45.5	71.0	46.5	79.0	80.0	93.0	75.5		
Maximum	45.5	71.0	53.0	86.0	86.0	93.0	96.0		
Standard Deviation	—	—	2.7	3.0	2.6	—	9.1		
Sample Size	1	1	4	4	3	1	3		
1992 Composite									
Mean Fork Length (cm)	43.4	63.9	51.2	83.6	75.3	92.3	86.2		100.6
Minimum	37.0	59.0	42.5	73.0	58.5	82.0	71.0		94.0
Maximum	50.0	71.0	61.0	99.0	86.5	109.0	100.0		110.0
Standard Deviation	3.5	4.6	4.8	5.1	5.6	6.6	5.5		3.7
Sample Size	9	8	21	40	77	12	76		8

Fish Condition

Fourteen percent of the spring chinook salmon and four percent of the summer chinook salmon sampled showed signs of injury by marine mammals (Table 5). The percentage of the sample with more than five percent descaling on either side of the body was one percent or less for both spring and summer chinook.

Table 5. **Condition of 1992 Columbia Basin spring and summer chinook salmon sampled at Bonneville Dam with marine mammal, gill net, descaling, and other injuries.**

Category	Spring Chinook Number	Spring Chinook %	Summer Chinook Number	Summer Chinook %
Marine Mammal Injuries				
Bite	11	2	3	1
Claw Rake	28	5	2	1
Twin Arches	45	8	6	2
Total Marine Mammal[a]	78	14	11	4
Descaling				
Right Side >5%	0	0	1	<1
Left Side >5%	1	<1	1	<1
General Injuries				
Cuts	2	<1	5	2
Eye	0	0	0	0
Fin	1	<1	0	0
Fungus	2	<1	0	0
Gill Net	4	1	1	<1
Head	1	<1	1	<1
Lamprey	1	<1	0	0
Parasite	12	2	0	0
Tail	3	1	3	1
Total General Injuries[a]	25	5	9	4

a Fish often displayed more than one type of marine mammal or general damage. Therefore, totals for these damage categories are not equal to the sum of the subcategories.

DISCUSSION

Spring Chinook Salmon

Comparison of the 1992 spring chinook study results to those obtained in study years 1987 through 1991 shows variability with no trends discernible in age composition estimates (Figure 5). Results for 1992 were similar to those of three of the previous five years (1987, 1989, and 1990) in that four-year-old fish made up a majority of the run, with lesser proportions of five- and three-year-old fish.

In the 1992 Corbett test fishery (Dammers, in preparation), 82% of the sample was estimated to be Age 1.2 or 0.3 while the remaining 18% was estimated to be Age 1.3 or 0.4. After standardizing results to account for the fact Corbett gear does not effectively catch smaller fish, these estimates are very close to those reported by this study. Age composition estimates of the two studies were also similar in both 1989 and 1990. Sampling fish at Bonneville Dam to obtain age and length-at-age composition estimates offers several advantages over the Corbett test fishery including the ability to sample smaller fish, obtain accurate weekly age composition estimates throughout the migratory period, and obtain these data without killing the fish.

The estimated number of four-year-old spring chinook salmon counting at Bonneville in 1992 (70,803) was greater than our 1992 prediction of 53,500 fish (Fryer et al. 1992), but was within the 90% prediction interval of 27,000 to 79,000. Using the same techniques this year, we predict that 32,300 (±31,000) four-year-old fish will return to Bonneville Dam in 1993. This estimate approaches the smallest return of four-year-old fish in the past six years. Using linear regression techniques to make a prediction so near the extremes of existing data decreases the accuracy of the prediction (Neter et al. 1985). This is the primary reason for the wide bounds in the confidence interval for the prediction presented.

Summer Chinook Salmon

For the first time since our summer chinook study began in 1990, four-year-old fish were the predominant age class in 1992 (Figure 6). The percentage of five-year-old fish, which predominated in 1990 and 1991, dropped to 34% in 1992. No explanation is apparent for these changes in age composition.

As in 1991, the total number of summer chinook sampled was relatively small (251). Small sample sizes and uncertainties in differentiating yearling and subyearling summer chinook scale samples make the accuracy and precision of summer chinook age composition estimates relatively low. Nevertheless, even after taking into account these possible errors, for the third consecutive year there appears to be a strong trend for the percentage of subyearlings to steadily increase through the migration. This trend should continue into the fall chinook migration, which has been found to consist almost entirely of subyearlings (U.S. v. Oregon 1991, Fryer and Schwartzberg 1991b).

This program will be continued in future years to develop an accurate age- and length-at-age composition database for the Columbia Basin upriver spring and summer chinook salmon population. This information will aid fisheries managers in detecting and possibly explaining changes in the age composition of stocks. Patterns detectable in age and length-at-age composition of successive brood groups may allow managers to more accurately monitor the effects of ocean harvest restrictions imposed by the Pacific Salmon Treaty. As this study progresses, the database being created may also provide a basis for more accurate population size prediction models.

REFERENCES

Beamish, R.J., and G.A. McFarlane. 1983. The forgotten requirement for age validation in fisheries biology. Transactions of the American Fisheries Society 112:735-743.

CRITFC (Columbia River Inter-Tribal Fish Commission). 1992. FISHCOUNT, Columbia River Basin computerized fish count database maintained by the Columbia River Inter-Tribal Fish Commission, Portland.

Clutter, R., and L. Whitesel. 1956. Collection and interpretation of sockeye salmon scales. International Pacific Salmon Fisheries Commission Bulletin 9.

Dammers, W. (in preparation). Columbia River Corbett area spring chinook test fishery 1992. Washington Department of Fisheries Progress Report. Battle Ground.

Fryer, J.K., C.E. Pearson, and M. Schwartzberg. 1992. Age and length composition of Columbia Basin spring chinook salmon at Bonneville Dam in 1991. Columbia River Inter-Tribal Fish Commission Technical Report 92-1. Portland.

Fryer, J.K., and M. Schwartzberg. 1991a. Age and length composition of Columbia Basin spring chinook salmon sampled at Bonneville Dam in 1990. Columbia River Inter-Tribal Fish Commission Technical Report 91-1. Portland.

Fryer, J.K., and M. Schwartzberg. 1991b. Age and length composition of Columbia Basin summer chinook salmon sampled at Bonneville Dam in 1990. Columbia River Inter-Tribal Fish Commission Technical Report 91-4. Portland.

Fryer, J.K. and M. Schwartzberg. 1992. Age and length composition of Columbia Basin summer chinook salmon at Bonneville Dam in 1991. Columbia River Inter-Tribal Fish Commission Technical Report 92-4. Portland.

Gilbert, C.H. 1913. Age at maturity of the Pacific coast salmon of the genus *Oncorhynchus.* United States Bureau of Fisheries Bulletin 32:1-22.

International North Pacific Fisheries Commission. 1963. Annual report — 1961.

Johnston, H.W. 1905. The scales of Tay salmon as indicative of age, growth, and spawning habitat. Scotland Fishery Board Annual Report 23(2):63-79.

Knudsen, C.M. 1990. Bias and variation in stock composition analyses due to scale regeneration. American Fisheries Society Symposium 7:127-133.

Koo, T.S.Y. 1955. Biology of the red salmon, *Oncorhynchus nerka* (Walbaum), of Bristol Bay, Alaska, as revealed by a study of their scales. Ph.D. thesis, University of Washington, Seattle.

Neter, J., W. Wasserman, and M.H. Kutner. 1985. Applied linear statistical models. Richard D. Irwin, Inc. Homewood, Illinois.

PST (Pacific Salmon Treaty). 1985. Treaty between the United States of America and the government of Canada concerning Pacific salmon. Treaty Document Number 99-2, (entered into force March 18, 1985), 16 USC§§3631-3644 (1988).

Schwartzberg, M. 1988. Age and length composition of Columbia Basin spring chinook salmon sampled at Bonneville Dam in 1987. Columbia River Inter-Tribal Fish Commission Technical Report 88-1. Portland.

Schwartzberg, M. 1989. Age and length composition of Columbia Basin spring chinook salmon sampled at Bonneville Dam in 1988. Columbia River Inter-Tribal Fish Commission Technical Report 89-1. Portland.

Schwartzberg, M., and J.K. Fryer. 1990. Age and length composition of Columbia Basin spring chinook salmon sampled at Bonneville Dam in 1989. Columbia River Inter-Tribal Fish Commission Technical Report 90-1. Portland.

USACE (U.S. Army Corps of Engineers). 1992. Annual fish passage report — 1992, Columbia and Snake river projects, Oregon and Washington. North Pacific Division, U.S. Army Engineer District, Portland.

U.S. v. Oregon Technical Advisory Committee. 1991. 1991 all species review, Columbia River fish management plan. Oregon Department of Fisheries and Wildlife, Columbia Regional Office, Clackamas.

Van Oosten, J. 1929. Life history of the lake herring *Leucichthys artedi* (Le Sueur) of Lake Huron as revealed by its scales, with a critique of the scale method. United States Bureau of Fisheries Bulletin 44:265-428.

Appendix A. 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 (Figure A1) and sample forms were developed (Figure A2). Similar criteria will be used as part of 1993 sampling procedures.

Figure A1. Fish condition assessment notation.

Injuries to be noted:

1. Gill Net
2. Descaling, left side; estimate actual percentage descaled
3. Descaling, right side; estimate actual percentage descaled
4. Marine mammal injuries as follows:
   - **C:** Claw Rake (2-3 or more parallel scratches on flanks of fish)
   - **G**: Twin Arches (2-3 or more curved scratches on flanks of fish)
   - **B**: Bite (Ragged wounds, often in caudal area)
5. General injuries as follows
   - **E:** Eye
   - **N**: Nose
   - **H:** Fishing hook
   - **P**: Parasite
   - **L**: Lamprey, circular wound
   - **RP, LP, LV, RV, D, A,T** (Tail or Caudal Fin): Fin
   - **C:** Cut
   - **F:** Fungus

For all injuries, a plus (+) indicates the injury is judged severe (extensive scarring or blood/flesh visible). A check (√) indicates that the injury is judged to have recently occurred (i.e. on the upstream migration).

Figure A2. Sampling form used in spring and summer chinook salmon sampling.

LOCATION:________________ SPECIES:_____________ PAGE:_______ OF ______

DATE:____________________ WEEK: _____________ SAMPLERS: ___________

Scale Card #	Position	Fork Length	Mid-Eye Length	Gender	Gill Net Injuries	Descaling Right	Descaling Left	Marine Mammal	General Injuries	Fin Clip	Comments	Scale Card #	Position	Fork Length	Mid-Eye Length	Gender	Gill Net Injuries	Descaling Right	Descaling Left	Marine Mammal	General Injuries	Fin Clip	Comments
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	3												3										
	4												4										
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