AGE AND LENGTH COMPOSITION OF COLUMBIA BASIN SPRING AND SUMMER CHINOOK SALMON AT BONNEVILLE DAM IN 1993

Technical Report 94-1

Jeffrey K. Fryer
Matthew Schwartzberg

February 21, 1994

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ABSTRACT

Representative samples of the 1993 Columbia Basin spring and summer chinook salmon populations were collected at Bonneville Dam. This year was the seventh year spring chinook and fourth year summer chinook salmon were sampled. Fish were trapped, anesthetized, sampled for scales and biological data, allowed to revive, and then released. The scales were examined to estimate age composition. Five-year-old fish were estimated to comprise 53% of the spring chinook and 39% of the summer chinook population. Four-year-old fish were estimated to comprise 45% of the spring chinook and 47% of the summer chinook population. Two-, three-, and six-year-old fish were estimated to comprise the remaining 2% of the spring chinook and 14% of the summer chinook population. Differences in age class returns were used to predict spring chinook population sizes for 1994.

Concerns over a possible increase in marine mammal predation led to the development of criteria to evaluate the physical condition of returning fish in 1992. Twenty-three percent of spring chinook and 9% of summer chinook salmon sampled were injured by marine mammals in 1993. Eleven percent of both spring and summer chinook salmon had cuts, gill net wounds, parasites, or other miscellaneous injuries. Two percent of spring chinook salmon and 4% of summer chinook salmon were more than 5% descaled on at least one side.

ACKNOWLEDGMENTS

We sincerely thank the following individuals for their assistance in this project: Stacy Hagan, Doug Hatch, Dave Pederson, and Phil Mundy of the Columbia River Inter-Tribal Fish Commission; Lyle Gilbreath of the National Marine Fisheries Service; Kevleen Fennell of the Oregon Department of Fish and Wildlife; Gary Johnson, Jim Kuskie, Dennis Schwartz, and Mary Todd Uhler of the U.S. Army Corps of Engineers; Curt Knudsen and John Sneva of the Washington Department of Fisheries; and Roger Dick, Preston Harrison, Lynn Hatcher, and Steve Parker of the Yakima Indian Nation.

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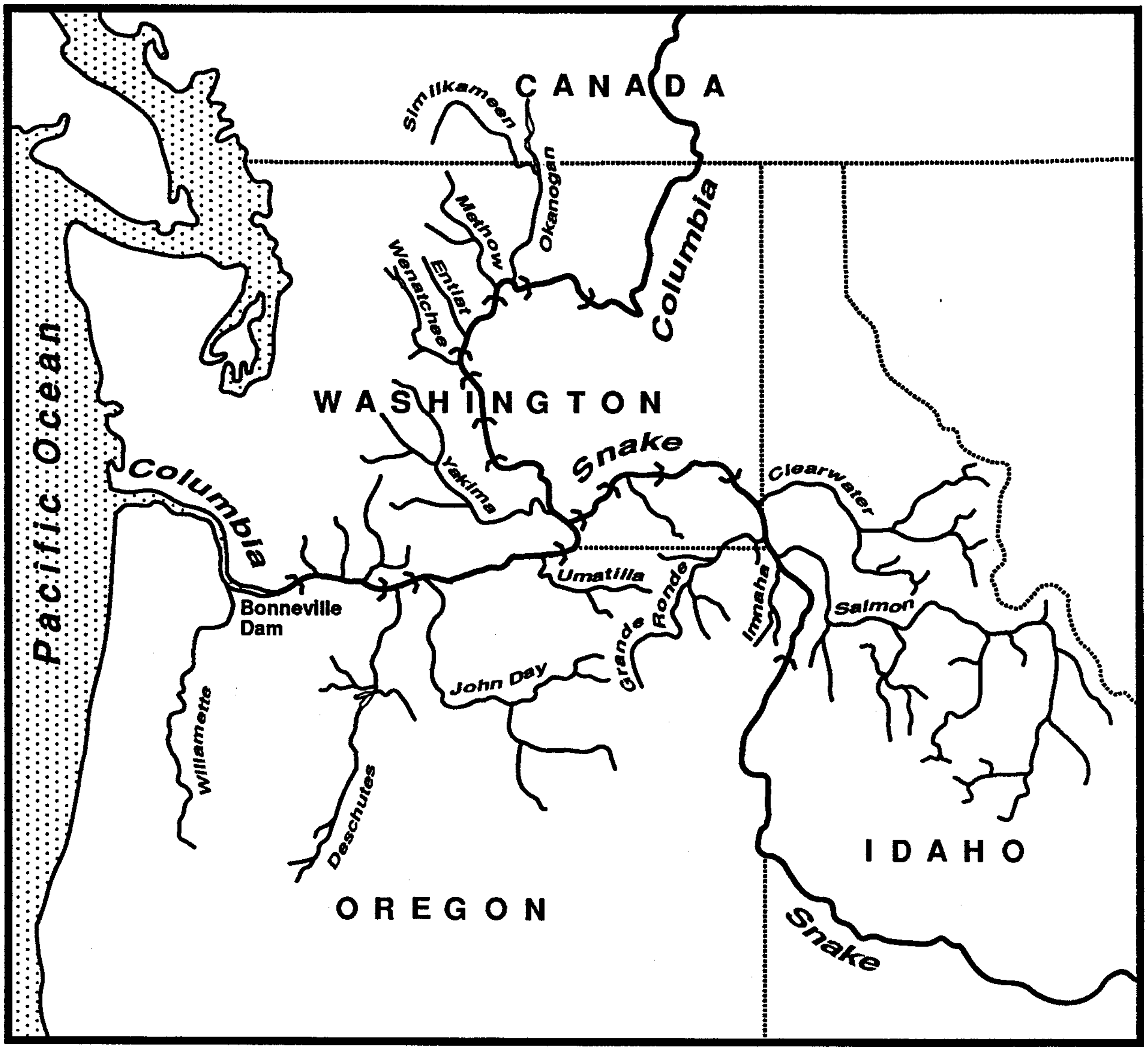
INTRODUCTION

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 1993 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). 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, Fryer and Schwartzberg 1993). Data from these studies was used to develop a linear relationship among age classes that was used to predict the 1994 population size of the predominant spring chinook salmon age class.

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

A representative sample of the Columbia River spring and summer chinook salmon populations was collected 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 statistical week[2] during the spring chinook salmon migration and two days per statistical week during most of the summer chinook migration. The desired sample size for spring and summer chinook salmon was a minimum of 500 fish each, 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 1993 migratory timing was determined from post-season analysis of 1993 Bonneville Dam fish ladder counts (CRITFC 1993). To further improve accuracy, composite age and length-at-age estimates were adjusted post-season for actual 1993 migration timing using a stratified sampling method that weighted weekly estimates proportionally.

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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 1993, for example, Statistical Week 15 began on April 4 and ended on April 10.

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 (Gilbert 1913, Borodin 1924, 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 1993 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 made with estimates obtained from a test fishery, called the Corbett test fishery, conducted annually by the Washington Department of Fisheries (Dammers, 1993). 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 multiwalled gillnets. The age distribution estimated by the Corbett test fishery and this study were compared (α=0.10) using a test of equality of two multinomial distributions (Mood et al. 1974).

Spring Chinook Salmon Run-Size Prediction

The progeny of a salmon population from a given year will return to freshwater as adult spawners during several different years. All progeny of a given year's spawning population are known collectively as a *brood.* Many salmon population-size prediction techniques are based on patterns in age composition from successive broods. Estimates of the progeny for each brood year were made by combining age composition estimates from previous studies (Schwartzberg 1988; Schwartzberg and Fryer 1989, 1990, 1993; Fryer and Schwartzberg 1991a; Fryer et al. 1992) with visual count data (CRITFC 1993). 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 1993, using linear regression techniques, 32,300 (±31,000, 90% bound) four-year-old fish had been predicted to return (Fryer and Schwartzberg 1993). A similar prediction technique is used herein to forecast returning four-year-old fish in 1994.

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. The mean lengths of spring chinook salmon sampled in this study were compared with mean lengths of fish captured in the Corbett test fishery using a two-sample t-test. Differences in the distribution of lengths of four- and five-year-old spring chinook between the two studies were tested using a Kolmogorov-Smirnov test (Hays 1988).

Fish Condition

Criteria were developed in 1992 to allow precise classification of the condition of sampled fish (Fryer and Schwartzberg 1993). These criteria were slightly modified and again applied in 1993. Each specimen was inspected for marine mammal injuries, descaling, gill net damage, cuts, bruises and other assorted injuries (Appendix A). These observations were quantified and compared with 1992 results using a test for differences between two proportions (Zar 1984).

RESULTS

Sample Design

Of the 679 spring chinook salmon collected in this study, 7% of the total sample was rejected and not classified by age because of unreadable scales. The total sample size used for the spring chinook salmon age and length-at-age composition estimates was 629 fish.

Of the 399 summer chinook salmon collected in this study, 10% of the total sample was rejected and not classified by age because of unreadable scales. Six additional fish appeared to have spent no time in saltwater. (These fish are generally under 30 cm in length and are known locally as *minijacks.* 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 summer chinook salmon age and length-at-age composition estimates was 355 fish.

Age Composition Estimates

Spring Chinook Salmon

Five-year-old fish (Age 1.3 fish from the 1988 brood-year group), comprising 53% of the population, were estimated to be the predominant age class for spring chinook salmon (Table 1). Five-year-old fish were the predominant age class in all sample periods but in Statistical Week 16 (Figure 2).

Summer Chinook Salmon

Four-year-old fish (Ages 1.2 and 0.3 fish from the 1989 brood year) were estimated to be the predominant age class for summer chinook salmon, comprising 47% of the population (Table 2).

Table 1. Age composition estimates of Columbia Basin spring chinook salmon sampled at Bonneville Dam in 1993.

Statistical Week	Sampling Dates	Sample Size	Brood Year and Age Class (Percentage) 1990 1.1	1989 1.2	1988 1.3	1987 1.4
15-16	4/08,16	146		51	49	
17	4/22	126		48	52	
18	4/28	104		45	55	
19	5/5	69		42	55	3
20	5/12	79	6	44	46	4
21	5/19	64	6	39	55	
22	5/26	41	12	17	71	
Population Estimate		629	1	45	53	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 1993.

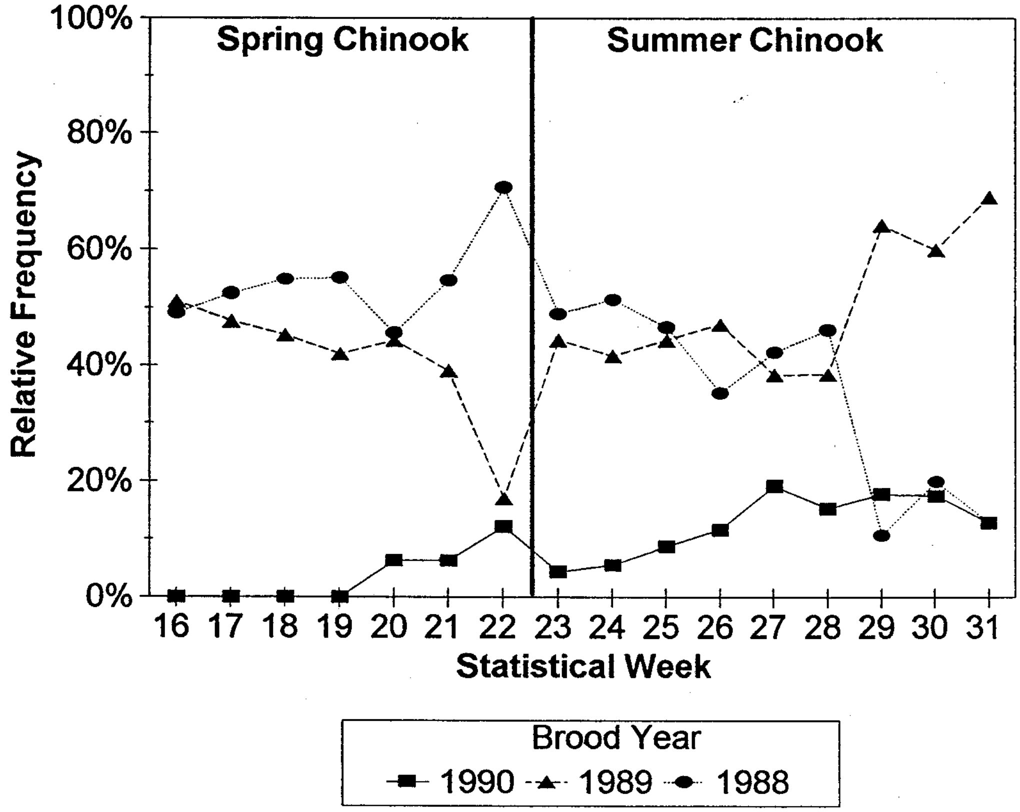


Table 2. **Age composition estimates of Columbia Basin summer chinook salmon sampled at Bonneville Dam in 1993.**

			Brood Year and Age Class (Percentage)							
Statistical Week	**Sampling Dates**	**Sample Size**	**1991 0.1**	**1990 0.2**	**1990 1.1**	**1989 0.3**	**1989 1.2**	**1988 0.4**	**1988 1.3**	**1986 1.4**
23	6/02,04	45		7	2	4	40	2	47	2
24	6/09,11	72		6		11	31	10	42	1
25	6/16,18	45		4	4	22	22	13	33	
26	6/23,25	34		3	9	26	21	9	26	6
27	6/30,7/02	26		19		12	27	4	38	
28	7/07,08	26		12	4	23	15	19	27	
29	7/14,16	28	4	11	7	32	32	4	7	4
30	7/21,23	40		2	15	18	43	12	8	2
31	7/28,30	39		10	3	36	33	10	3	5
Population Estimate		355	<1	7	4	19	28	9	30	2

Thirty-five percent of the summer chinook salmon population was estimated to represent subyearling outmigrants of Ages 0.1, 0.2, 0.3, and 0.4 (collectively called herein *Age 0-plus*). The percentage of chinook salmon of Age 0-plus steadily increased as the migration progressed, though only in Statistical weeks 28, 29, and 31 did this group form the majority of the run (Figure 3).

Spring Chinook Salmon Run Size Prediction

In 1994, we predict that four-year-old adult spring chinook salmon abundance at Bonneville Dam will be 23,400 (±33,500, 90% bound [Figure 4]). If correct, this would be the lowest number of four-year-old returns in at least the past 7 years.

Comparison of Age Composition Estimates

Inter-Annual Age Composition Estimates

For only the second year in the seven years of this study, the majority of the spring chinook salmon population returning in 1993 were five-year-old fish (Figure 5). Four-year-old summer chinook salmon were the largest age class for the second time in four 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. These data are therefore slightly different from those previously reported (Schwartzberg 1988, 1989).

Figure 3. Weekly freshwater age composition estimates of Columbia Basin spring and summer chinook salmon sampled at Bonneville Dam in 1993.

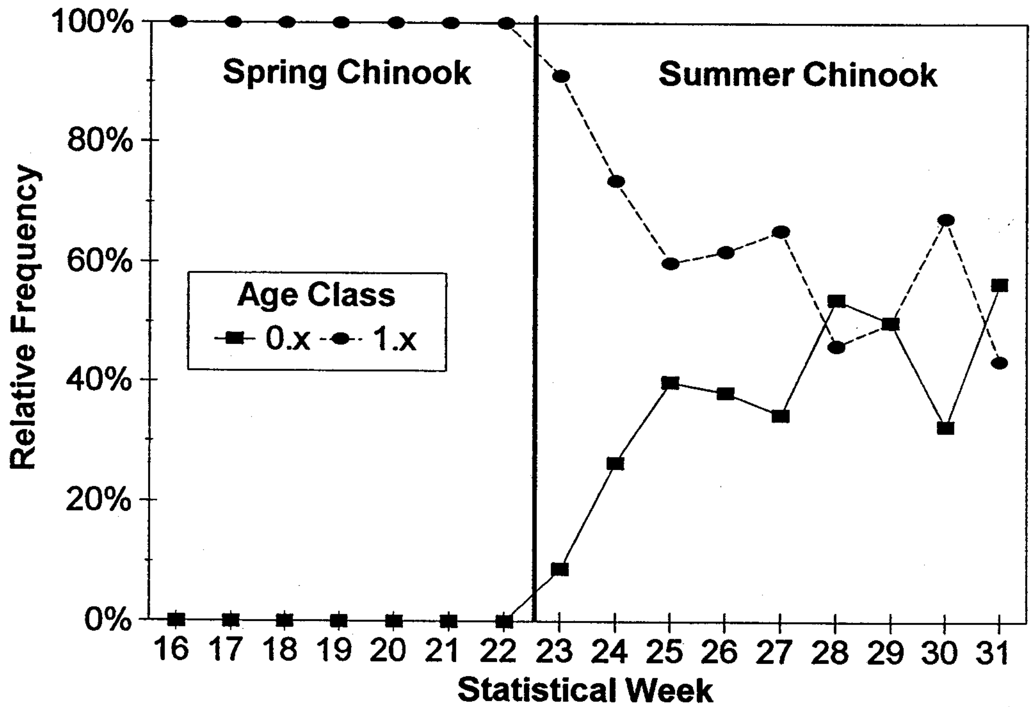


Figure 4. **Predicted 1994 four-year-old Columbia Basin spring chinook salmon abundance (at Bonneville Dam) based on a linear relationship between four-year-old and three-year-old fish bundance during brood years 1983 through 1989.**

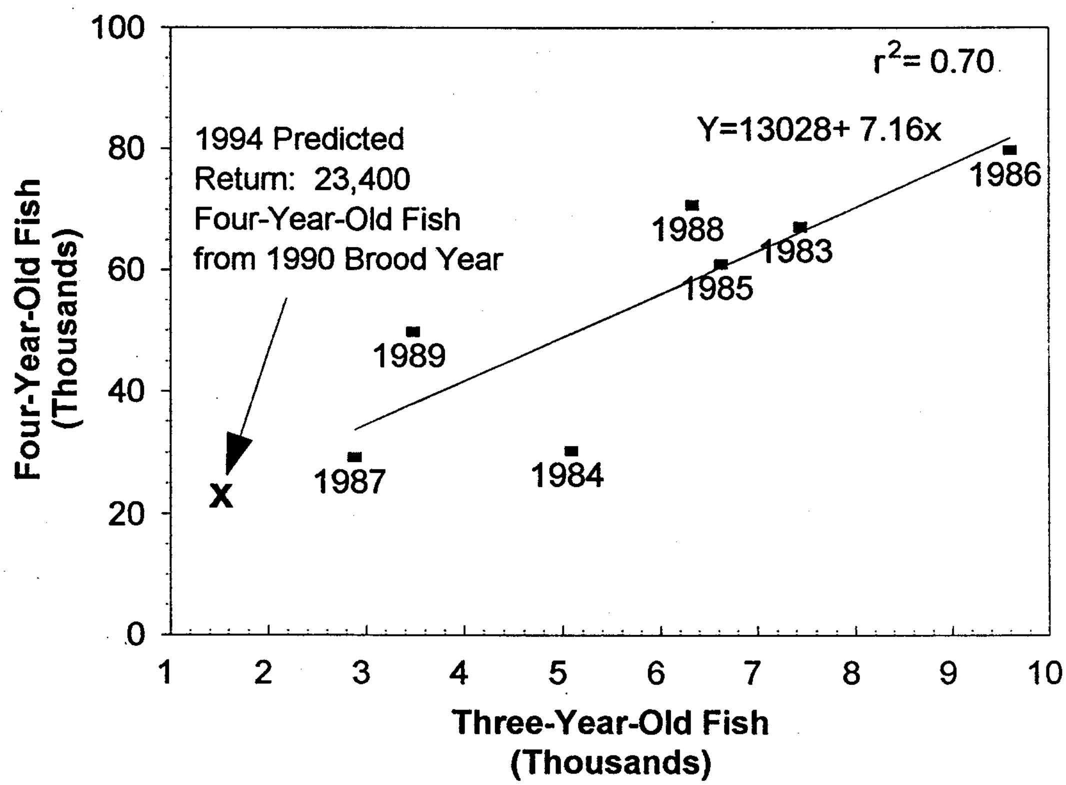


Figure 5. **Age composition estimates (%) by age class and brood year for Columbia Basin spring chinook salmon at Bonneville Dam from 1987 through 1993.**

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
1993	0	0	1	0	45	0	53	<1

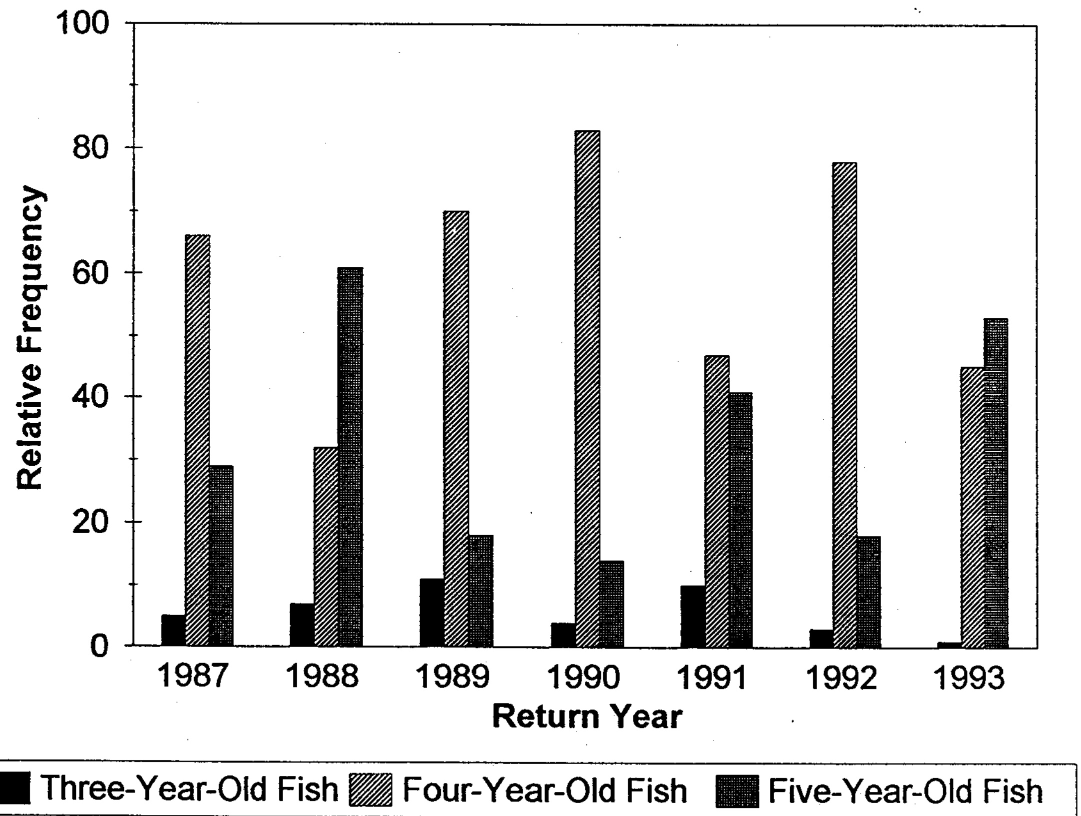
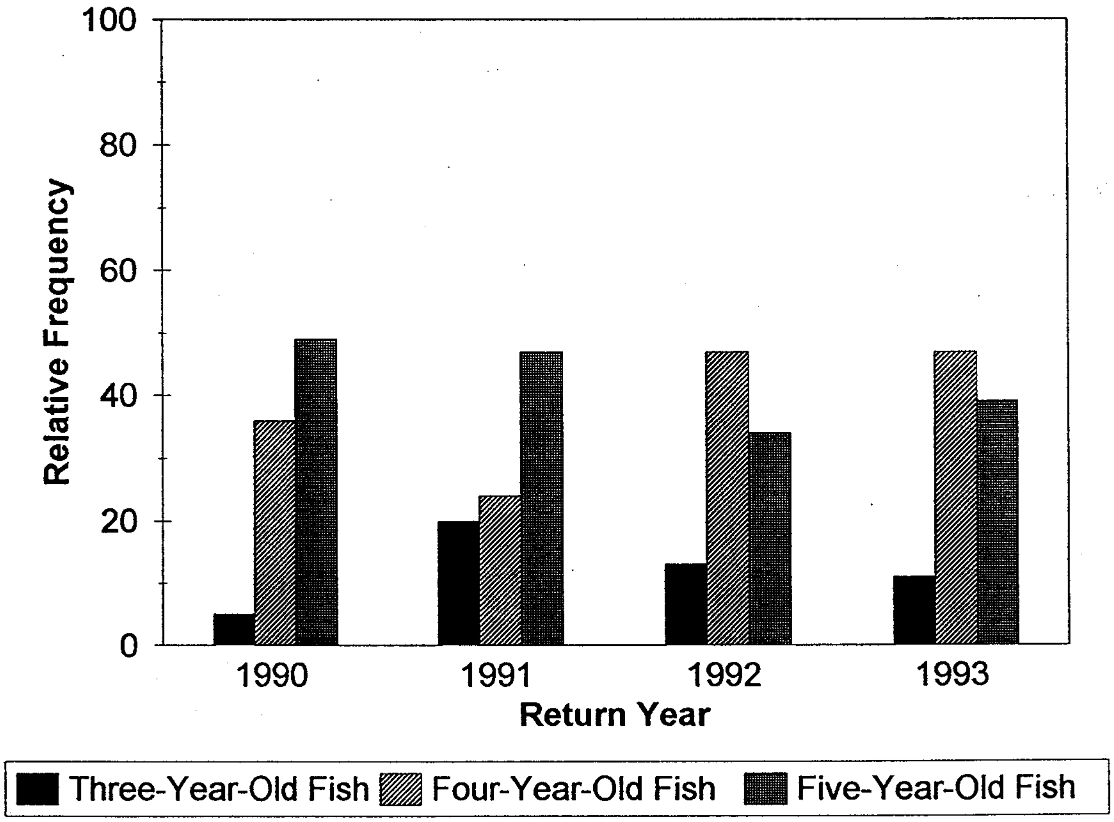


Figure 6. Age composition estimates (%) by age class and brood year for Columbia Basin summer chinook salmon at Bonneville Dam from 1990 through 1993.

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
1993	<1	7	4	19	28	9	30	0	2



Intra-Annual Age Composition Estimates

Age 1.1 fish were estimated to comprise 1% of the composite 1993 spring chinook salmon sample. Visual fish ladder counts at Bonneville Dam also estimated Age 1.1 fish to comprise 1% of the spring chinook salmon run (CRITFC 1993).

Ages 0.1 and 1.1 fish were estimated to comprise 5% of the composite 1993 summer chinook salmon sample, compared to 7% based on fish ladder counts made at Bonneville Dam (CRITFC 1993).

The Corbett test fishery estimated that the 1993 spring chinook salmon population included 61% five-year-old fish, 38% four-year-old fish, and less than 1% six-year-old fish (n=459). Since the Corbett test fishery gear does not effectively capture smaller fish (W. Dammers, Washington Department of Fisheries, personal communication), no three-year-old fish were captured. The difference between the 1993 Corbett fishery spring chinook salmon age composition estimates and those presented in this study is significant ($p<0.001$). If three-year-old fish are excluded from consideration, the difference between the two studies is still significant ($p=0.05$).

Length-at-Age Composition

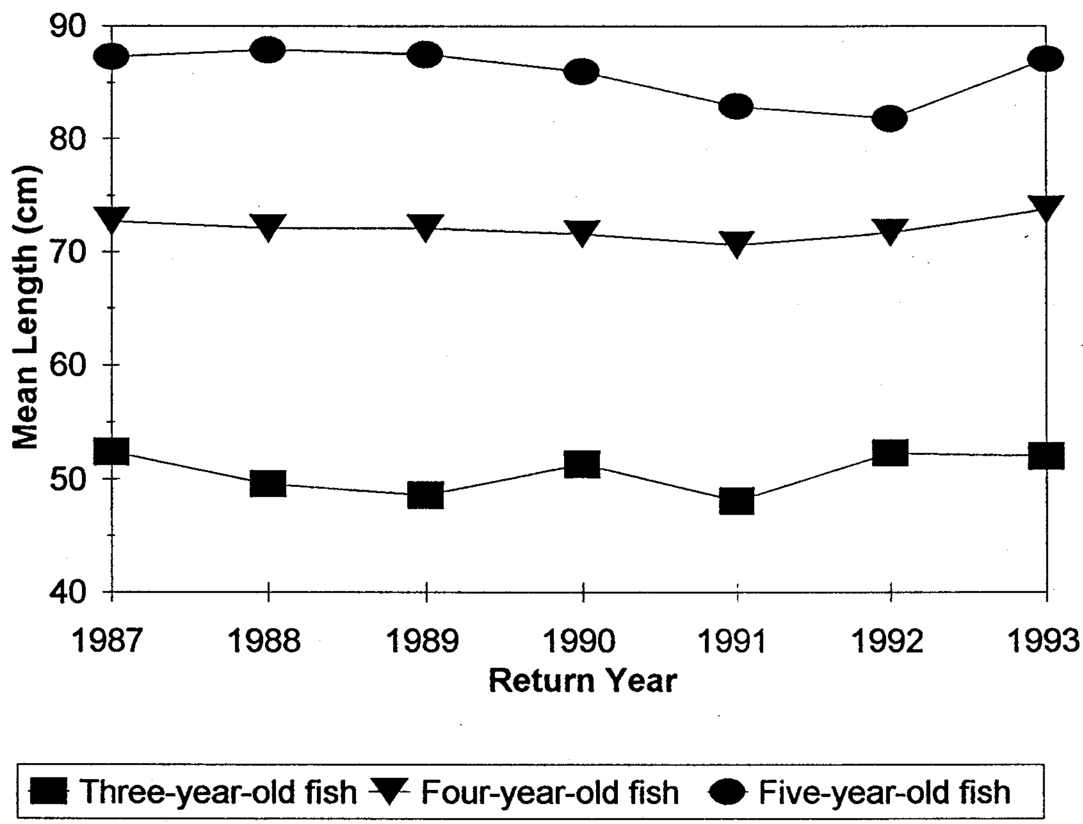
Mean fork-lengths of spring chinook salmon sampled at Bonneville Dam ranged from 52.0 cm for Age 1.1 fish to 91.3 cm for Age 1.4 fish (Table 3). The largest fish sampled was a 101.0 cm Age 1.4 fish sampled in Statistical Week 17 while the smallest (excluding minijacks) was a 44.0 cm Age 1.1 fish sampled in Statistical Week 21. Mean fork-lengths by age class have displayed only small inter-annual variation since 1987 (Figure 7).

The mean fork-length of spring chinook salmon sampled in the Corbett test fishery was 73.7 cm for four-year-old fish, 87.3 cm for five-year-old fish, and 93.0 cm for six-year-old fish. There is no significant difference between mean lengths for the Corbett test fishery and those reported in our study for any of the three age classes tested ($p>0.47$ for all tests). No significant differences were

Table 3. Length-at-age estimates for Columbia Basin spring chinook salmon sampled at Bonneville Dam in 1993.

	Brood Year and Age Class					
	1990		1989		1988	1987
	0.2	1.1	0.3	1.2	1.3	1.4
Statistical Weeks 15-16						
Mean Fork Length (cm)	62.0			73.4	87.3	
Minimum	62.0			63.5	75.0	
Maximum	62.0			86.0	96.0	
Standard Deviation	—			3.8	4.1	
Sample Size	1			74	72	
Statistical Week 17						
Mean Fork Length (cm)				73.6	88.1	
Minimum				54.0	74.5	
Maximum				82.0	101.0	
Standard Deviation				4.7	5.4	
Sample Size				60	66	
Statistical Week 18						
Mean Fork Length (cm)				73.9	86.9	
Minimum				65.5	75.5	
Maximum				80.5	97.0	
Standard Deviation				4.2	4.9	
Sample Size				47	57	
Statistical Week 19						
Mean Fork Length (cm)				73.9	84.2	93.8
Minimum				61.5	73.0	92.0
Maximum				84.0	96.5	96.0
Standard Deviation				4.8	5.7	2.3
Sample Size				29	38	2
Statistical Week 20						
Mean Fork Length (cm)		53.0		72.2	86.3	89.0
Minimum		49.5		55.5	73.0	81.0
Maximum		58.5		86.5	98.0	98.5
Standard Deviation		3.6		6.4	5.5	7.2
Sample Size		5		35	36	3
Statistical Week 21						
Mean Fork Length (cm)		51.0		74.7	85.8	
Minimum		44.0		63.0	64.5	
Maximum		56.5		85.5	99.5	
Standard Deviation		2.7		5.6	7.3	
Sample Size		4		25	35	
Statistical Week 22						
Mean Fork Length (cm)		54.3		68.4	86.9	
Minimum		49.0		61.0	69.5	
Maximum		61.0		76.0	100.0	
Standard Deviation		4.2		5.2	5.1	
Sample Size		5		7	333	
1993 Composite						
Mean Fork Length (cm)		52.0		73.8	87.0	91.3
Minimum		44.0		54.0	64.5	81.0
Maximum		61.0		86.5	101.0	98.5
Standard Deviation		4.2		4.5	5.1	5.4
Sample Size		14		277	333	5

Figure 7. **Mean fork-lengths of spring chinook salmon sampled at Bonneville Dam from 1987 through 1993.**



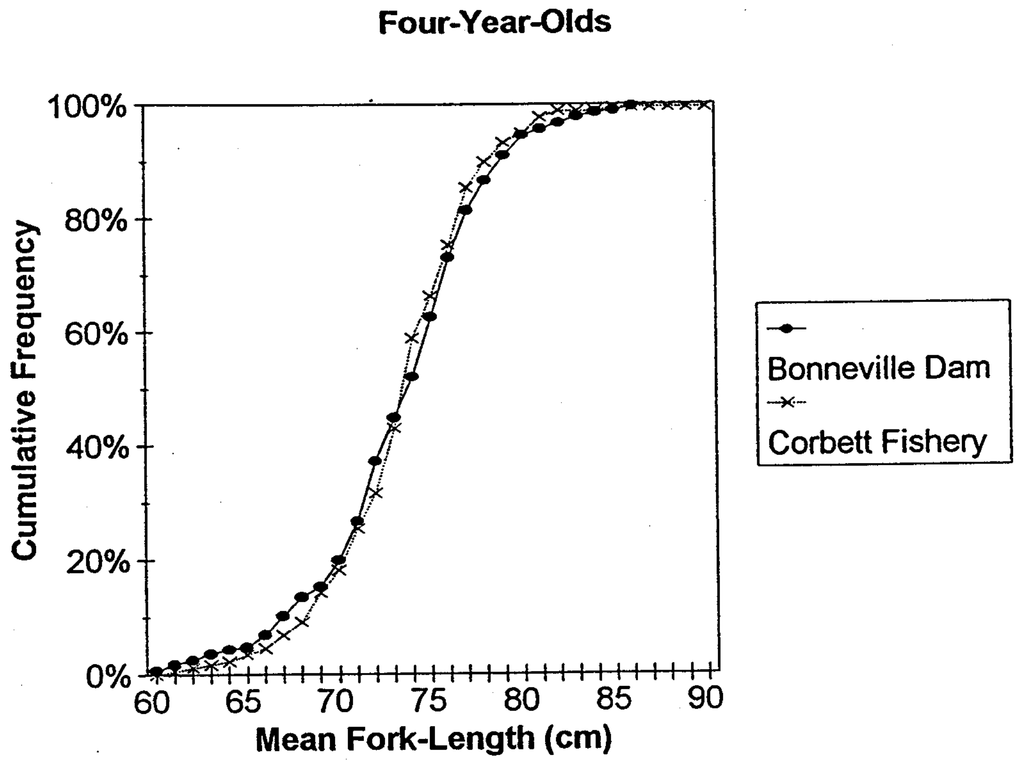
apparent between the length frequency distribution of each study (Figure 8) for either four-year-old fish (p=0.31) or five-year old fish (p=0.47).

Mean fork-lengths of summer chinook salmon sampled at Bonneville Dam ranged from 39.5 cm for Age 0.1 fish to 96.2 cm for Age 0.4 fish (Table 4). The largest fish sampled were four 102.0 cm fish; two of Age 0.4, one of Age 1.3, and one of Age 0.3, while the smallest (excluding minijacks) was a 39.5 cm Age 1.1 fish sampled in Statistical Week 29.

Fish Condition

Spring and summer chinook salmon sampled in 1993 were generally in poorer condition than those sampled in 1992 (Table 5). Of the sixteen categories of fish condition noted in both 1992 and 1993, fish were estimated to be in significantly poorer condition ($\alpha=0.10$) in 1993 in seven categories for spring chinook and four categories for summer chinook. A significant improvement in fish condition from 1992 to 1993 was noted only for parasite injury among spring chinook salmon.

Figure 8. **Cumulative length distribution for four-year-old and five-year-old spring chinook salmon sampled at Bonneville Dam and in the Corbett test fishery in 1993.**



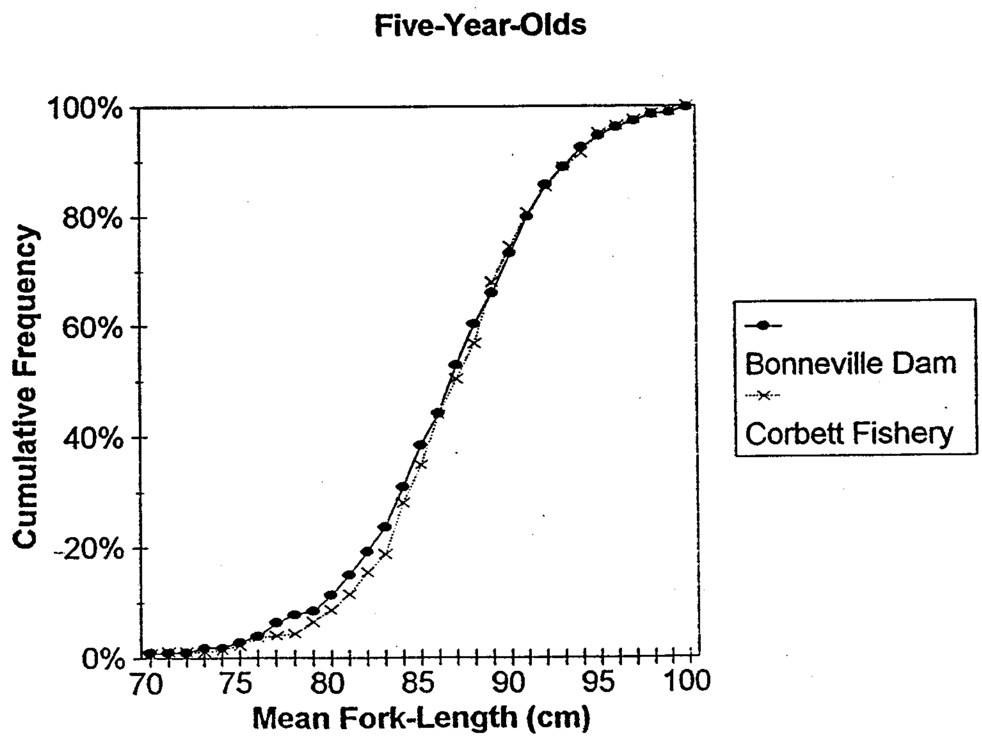


Table 4. Length-at-age estimates for Columbia Basin summer chinook salmon sampled at Bonneville Dam in 1993.

	Brood Year and Age Class								
	1991	1990		1989		1988		1987	
	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)		70.0	61.0	75.5	76.2	99.0	87.7		99.0
Minimum		70.0	61.0	74.0	64.0	99.0	76.5		99.0
Maximum		70.0	61.0	77.0	85.0	99.0	102.0		99.0
Standard Deviation		—	—	1.5	5.4	—	5.3		—
Sample Size		1	1	2	18	1	21		1
Statistical Week 24									
Mean Fork Length (cm)		65.6		84.3	76.1	95.1	89.2		96.5
Minimum		53.5		79.0	64.0	83.0	75.0		96.5
Maximum		76.5		91.5	86.0	101.0	98.0		96.5
Standard Deviation		9.4		4.3	5.8	5.8	5.2		—
Sample Size		4		8	22	7	30		1
Statistical Week 25									
Mean Fork Length (cm)		70.0	47.2	81.7	77.8	97.4	92.2		
Minimum		67.0	37.5	72.5	69.0	93.0	84.0		
Maximum		73.0	57.0	93.5	87.5	102.0	99.5		
Standard Deviation		3.0	9.8	7.6	5.8	3.1	4.9		
Sample Size		2	2	10	10	6	15		
Statistical Week 26									
Mean Fork Length (cm)		72.5	56.5	85.2	75.5	96.5	89.6		94.8
Minimum		72.5	54.5	62.0	68.0	93.0	83.5		92.0
Maximum		72.5	59.5	102.0	82.0	99.0	96.0		97.5
Standard Deviation		—	2.2	10.8	5.0	2.6	3.6		2.8
Sample Size		1	3	9	7	3	9		2
Statistical Week 27									
Mean Fork Length (cm)		67.1		72.5	74.2	102.0	91.2		
Minimum		63.5		69.0	60.0	102.0	86.0		
Maximum		70.5		79.0	84.0	102.0	98.0		
Standard Deviation		2.7		4.6	9.4	—	3.7		
Sample Size		5		3	7	1	10		
Statistical Week 28									
Mean Fork Length (cm)		63.8	52.5	82.2	76.1	97.5	85.4		
Minimum		57.5	52.5	71.0	73.0	92.5	77.5		
Maximum		73.0	52.5	89.0	81.0	100.0	96.0		
Standard Deviation		6.6	—	6.5	3.0	2.6	5.3		
Sample Size		3	1	6	4	5	7		
Statistical Week 29									
Mean Fork Length (cm)	39.5	62.5	44.5	81.6	72.2	91.5	86.2		93.0
Minimum	39.5	60.0	44.0	70.0	58.5	91.5	78.0		93.0
Maximum	39.5	65.5	45.0	94.0	84.0	91.5	94.5		93.0
Standard Deviation	—	2.3	0.5	6.7	7.2	—	8.2		—
Sample Size	1	3	2	9	9	1	2		1
Statistical Week 30									
Mean Fork Length (cm)		76.5	44.8	75.9	70.8	91.0	91.3		88.0
Minimum		76.5	33.5	58.0	56.5	84.0	89.5		88.0
Maximum		76.5	60.0	94.0	81.0	96.0	95.0		88.0
Standard Deviation		—	9.1	11.0	7.2	4.2	6.7		—
Sample Size		1	6	7	17	5	3		1
Statistical Week 31									
Mean Fork Length (cm)		70.5	45.0	80.3	68.0	95.4	84.0		99.0
Minimum		69.5	45.0	67.5	57.5	93.5	84.0		97.0
Maximum		73.0	45.0	93.0	87.0	97.5	84.0		101.0
Standard Deviation		1.5	—	6.5	2.2	1.5	—		2.0
Sample Size		4	1	14	13	4	1		2
1993 Composite									
Mean Fork Length (cm)	39.5	66.9	50.4	81.5	75.3	96.2	89.3		95.0
Minimum	39.5	53.5	33.5	58.0	56.5	83.0	75.0		88.0
Maximum	39.5	76.5	61.0	102.0	87.5	102.0	102.0		101.0
Standard Deviation	—	5.7	7.0	7.7	6.2	4.0	5.0		2.8
Sample Size	1	24	16	68	107	33	98		8

Table 5. Condition of Columbia Basin spring and summer chinook salmon sampled at Bonneville Dam in both 1992 and 1993.

	Spring Chinook				Summer Chinook			
	1993		1992	p	1993		1992	p
Category	#	%	%	value[a]	#	%	%	value[b]
<u>Marine Mammal Injuries</u>								
Bite	9	1	2	0.35	10	3	1	0.18
Claw Rake	62	9	5	<0.01	12	3	1	0.04
Twin Arches	90	13	8	<0.01	15	4	2	0.23
Total Marine Mammal[b]	156	23	14	<0.01	37	9	4	0.01
<u>Descaling</u>								
Right Side >5%	4	1	0	0.07	2	1	1	0.78
Left Side >5%	6	1	<1	0.11	10	3	1	0.03
<u>General Injuries</u>								
Bruises[c]	7	1			0	0		
Cuts	9	1	<1	0.08	4	1	2	0.38
~~Eye~~	0	0	0	1.00	5	1	0	0.06
Fin	6	1	<1	0.11	2	1	0	0.23
Fungus	4	1	<1	0.58	4	1	0	0.09
Gash[c]	11	2			2	1		
Gill Net	2	<1	1	0.28	0	0	<1	0.23
Fishing Hook	2	<1	<1	0.69	14	4	<1	0.01
Lamprey	2	<1	<1	0.69	2	1	0	0.23
Parasite	1	<1	2	<0.01	0	0	0	1.00
~~Tail~~	28	4	1	<0.01	6	2	1	0.62
Total General Injuries[b]	72	11	5	<0.01	44	11	4	<0.01

a. P values were computed for a test for differences between two proportions (Zar 1984).

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

c. Injuries of this type were not noted in 1992.

DISCUSSION

Spring Chinook Salmon

In the study described herein, in which spring chinook salmon are sampled at Bonneville Dam to obtain age composition estimates, results differed significantly from those obtained in another study (the Corbett test fishery). The Corbett fishery does not capture three-year-old fish in proportion to their abundance. However, results of the two studies still differed even after adjustments were made to attempt to standardize results (we eliminated three-year-old-fish from our Bonneville Dam estimate and then compared results). In three of the past five years (1989, 1990, and 1992), while no statistical tests of the two age composition estimates were conducted, only very small differences were noted between the Corbett fishery estimates and those of our study. However, the multinomial test used in 1993 to compare the two estimates assumed that both studies collect a random sample of Columbia Basin spring chinook salmon. It is likely though that random samples were obtained in neither study. In the Corbett fishery, fish were captured over a relatively short period using selective gear, and in the Bonneville Dam study, samples were obtained over a longer, but still limited period at only one of four fish ladders at Bonneville Dam. The multinomial comparison test used to compare the results of the two studies assumed both samples were collected randomly. Therefore variances for both studies were likely underestimated, making a significant result more possible. Implications of the differences between the results of the two studies may have been overestimated by these tests.

Nevertheless, we believe our study offers several potential and important advantages over the Corbett test fishery for spring chinook salmon age composition estimates. These include the ability to sample smaller (three-year-old) fish, the opportunity to obtain accurate weekly age composition estimates throughout the migratory period, and to obtain all data without killing fish.

The results of this study applied to visual fish ladder counts made at Bonneville Dam (CRITFC 1993), estimates 49,800 four-year-old spring chinook salmon in 1993. This estimate was greater than our 1993 prediction of 32,300 fish (Fryer and Schwartzberg 1993), but was within the 90% confidence interval of this prediction (1,300 to 63,300). Using the same techniques this year, we predict that 23,400 (±33,500) four-year-old fish will return to Bonneville Dam in 1994. Using linear regression techniques to make a prediction beyond the range 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 second consecutive year, four-year-old fish were the predominant age class (Figure 6). No explanation is apparent for these changes in age composition. For the fourth consecutive year, there appears to be a trend in the percentage of subyearling fish to steadily increase throughout the migratory period. This trend likely continues into the fall chinook migration, which has been found to consist almost entirely of subyearling fish (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 populations. 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 broods 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.

Borodin, N. 1924. Age of shad *Alosa sapidissima* (Wilson) as determined by the scales. Transactions of the American Fisheries Society 54:178-184.

CRITFC (Columbia River Inter-Tribal Fish Commission). 1993. FISHCOUNT, Columbia River Basin computerized fish count database maintained by the Columbia River Inter-Tribal Fish Commission, Portland, Oregon.

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

Dammers, W. 1993. Columbia River Corbett area spring chinook test fishery 1993. 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, Oregon.

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, Oregon.

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, Oregon.

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, Oregon.

Fryer, J.K. and M. Schwartzberg. 1993. Age and length composition of Columbia Basin spring and summer chinook salmon at Bonneville Dam in 1992. Columbia River Inter-Tribal Fish Commission Technical Report 93-3. Portland, Oregon.

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.

Hays, W.L. 1988. Statistics, fourth edition. Holt, Rinehart, and Winston, Inc. New York.

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

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.

Mood, A. M., F.A. Graybill, and D.C. Boes. 1974. Introduction to the theory of statistics. McGraw-Hill, Inc. New York.

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, Oregon.

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, Oregon.

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, Oregon.

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.

Zar, J.H.. 1984. Biostatistical Analysis. Prentice-Hall, Inc. Englewood Cliffs, New Jersey.

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 and sample forms were developed for the 1992 sampling season (Fryer and Schwartzberg 1993). Slightly modified criteria (Figure A1) and sample forms were used in 1993 (Figure A2).

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 damage
    - **C**: Cut
    - **F**: Fungus
    - **B**: Bruise
    - **G**: Gash or lesion

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.

CRITFC STOCK IDENTIFICATION PROJECT SAMPLING FORM

LOCATION:________________ SPECIES:____________________ PAGE:______OF_______

DATE:______________________ WEEK:______________________ SAMPLERS:___________

Scale Card #	Position	Fork Length	Mid-Eye Length	Gender	Gill Net Damage	Descaling Left	Descaling Right	Marine Mammal	General Injuries	Fin Clip	Comments	Scale Card #	Position	Fork Length	Mid-Eye Length	Gender	Gill Net Damage	Descaling Left	Descaling Right	Marine Mammal	General Injuries	Fin Clip	Comments
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	2												2										
	3												3										
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