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EVALUATION OF U.S. OBSERVER BIOLOGICAL DATA AND SCALE SAMPLES FROM CHUM SALMON IN THE BYCATCH OF THE 1993 POLLOCK B-SEASON FISHERY IN THE BERING SEA

by

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ABSTRACT

Chum salmon (*Oncorhynchus keta*) scale samples and biological data collected by U.S. National Marine Fisheries Service (NMFS) scientific observers during the 1993 B-season pollock (*Theragra chalcogramma*) fishery in the Bering Sea (August 15-September 25) were evaluated to determine if the samples are adequate for stock identification studies and to provide additional information on the biological composition of the chum salmon bycatch. In the NMFS sampling program, the primary purpose for collecting scales is to confirm species identification, and observers are instructed to take scale samples only from the first 20 salmon of each species that they identify. Sampling from 897 fish, there were only 13 fish with unreadable or missing scales, and the species of only two fish were identified incorrectly (one steelhead and one sockeye). Only 3.4% of the scales were collected from body areas of the fish that cannot be used for stock identification studies. The samples were composed of ages 0.2 (22%), 0.3 (65%), 0.4 (12%), and 0.5 (1%) fish from eight NMFS statistical areas. A minimum sample of 100 fish per age group in each time and area stratum is required for stock identification by scale pattern analysis because variance of stock proportion estimates is high when the samples are small. Samples from only one statistical area and age group met the minimum requirement of 100 or more fish. Samples were significantly different ($\alpha = .05$) in mean age of fish by area and month, and in mean size of fish by area. In the statistical area where most samples were collected, mean age did not vary significantly with time, but mean size varied significantly by time and sex. These differences indicate that the population structure of chum salmon in the fishery bycatch is complex. Historical data indicate that chum salmon in the eastern Bering Sea in August and September are likely a mixture of immature and maturing fish of Asian and North American origin. In the 1993 observer samples, patterns of initial ocean growth on chum salmon scales appeared to be extremely variable, which may indicate the presence of stocks originating from many different coastal areas. Fish with a reduced amount of growth in the third ocean year, a character that has been observed on the scales of Japanese and Russian chum salmon after 1970, were also present in the observer samples. Regardless of the stock identification technique used, the collection of a sufficient number of biological samples from all time and area strata of the fishery is necessary, and the samples should also be representative of the various size, age, maturity, and stock groups of fish in the bycatch.

INTRODUCTION

The eastern Bering Sea groundfish fisheries in the U.S. exclusive economic zone (EEZ) are managed under the Fishery Management Plan of the groundfish fisheries in the Bering Sea/Aleutian Islands (BS/AI) Area. Incidental catches (bycatch) of Pacific salmon (*Oncorhynchus* spp.) are taken mainly by trawl gear, as a byproduct of the groundfish catch. In 1993 the estimated bycatch of all species of salmon in the BS/AI groundfish fisheries was 291,564 fish (Berger and Low 1994), and most of the 1993 bycatch was chum salmon (*O. keta*) taken during the pollock (*Theragra chalcogramma*) B-season fishery (August-September). With the exception of a few recoveries of coded-wire tagged fish, stock origins of chum salmon in the BS/AI groundfish fishery bycatch are not known, and there is also no published information on age, size, and maturity of chum salmon in the bycatch.

In this document, we evaluate chum salmon scale samples and biological data collected by U.S. National Marine Fisheries Service (NMFS) scientific observers during the 1993 B-season fishery. Our objectives were to determine if the 1993 scale samples are adequate for stock identification studies, and to provide additional information on the biological composition of the chum salmon bycatch. The results are discussed with respect to historical information on stock origins and migration patterns of chum salmon in the Bering Sea.

METHODS

Chum salmon scale samples and accompanying biological data from the 1993 pollock B-season fishery were provided to the Fisheries Research Institute (FRI), School of Fisheries, University of Washington, by the NMFS Scientific Observer Program, Alaska Fisheries Science Center. The materials provided by NMFS included labeled coin envelopes, which contained scrape samples of scales from individual fish, and original biological data forms (Appendix Fig. 1). The samples and data obtained from NMFS came from only those fish identified by observers as chum salmon and caught in the BS/AI from August 15 through September 25.

Age determinations and verification of observer species identifications were made by visual examination of scales. For each fish, the scales were temporarily removed from the coin envelope, visually examined under magnification (40-60X) to confirm species identification and determine age, and then replaced in the original coin envelope. Age determinations were entered on the original data forms, and were denoted by the European formula (for example: 0.2), whereby the first number is the number of freshwater annuli, and the second number is the number of ocean annuli. An 'x' was entered if the number of annuli could not be determined. If the observer recorded body area of scale collection (A=preferred body area, B=adjacent to preferred body area, C=other body areas, Appendix Fig. 1), this was also coded on the original data forms. All data on the original forms (statistical area, month, day, year, length, weight, sex, age, and body area of scale collection) were entered onto a computer file.

Scale quality and the potential number of scales that could be used for stock identification studies were evaluated by summarizing data on body area of scale collection for samples stratified by month, age, and NMFS statistical area (Fig. 1). For stock identification analyses, only scales from body zones A or B can be used (Appendix Fig. 1a; Knudsen 1985). A minimum sample of 100 fish per age group in each time and area stratum is required for stock identification by scale pattern analysis because variance of stock proportion estimates is high when the samples are less than this minimum (INPFC 1987), and we used this minimum sample size as our criterion to decide if the observer samples were adequate.

Descriptive statistics of length and weight were calculated for samples stratified by age, area, time, and sex. Factorial analysis of variance (ANOVA; $\alpha = .05$) was used to examine variability in mean age, length, and weight of chum salmon in observer samples stratified by time, area, and sex. Because the cells had unequal sample sizes, an unbalanced model was used. Records for individual fish and strata with missing values were not used in the ANOVAs. The statistical software used (StatView II, Feldman et al. 1987) calculates the sum of squares by the reduction technique (Searle 1971, pp. 246-248); the reduction sum of squares are calculated using a method described by Hocking (1985, pp. 146-148); and a sweep operator (Goodnight 1979) is used to calculate the residual sum of squares for the full model and for each effect. For factorial models with no missing cells, this technique produces sums of squares that generally agree with such programs as

BMDP4V or SAS GLM (Type III SS), even for models with unequal cell sizes (Feldman et al. 1987).

RESULTS AND DISCUSSION

Sampling from 897 fish during the August 15 to September 25 period, there were only 13 fish with unreadable or missing scales and only two fish were identified by observers incorrectly to species (one steelhead and one sockeye). Data from these 15 fish were excluded from all calculations. Samples from only 33 fish were missing data on body area of scale collection. In the remaining sample of 849 fish, observers collected 73.4% of the scales from body area A (preferred area), 23.2% from body area B (adjacent to preferred area), and 3.4% from body area C. Although most of the observer scales were from body areas A and B, the only strata with 100 or more fish were those for age 0.3 chum salmon in area 517 in August (n=203 fish) and September (n=212 fish) (Table 1). In the U.S. observer biological sampling program, the primary purpose for collecting scales is to confirm species identification, and observers are instructed to take scale samples only from the first 20 salmon of each species identified (Appendix Table 1). Tabulation of the 1993 observer samples indicates that this sampling strategy is inadequate for obtaining a sufficient number of scale samples for stock identification in most time and area strata.

The age composition of 882 chum salmon with readable scales was 22% age 0.2, 65% age 0.3, 12% age 0.4, and 1% age 0.5 (Table 2). The predominance of age 0.3 fish is typical of most offshore samples and also of stocks of maturing chum salmon in coastal waters (for example, Bakkala 1970, Neave et al. 1976, Rogers 1994). Percentages of younger, age 0.2 fish were substantially higher in samples from areas west of 170°W longitude (statistical areas 521 and 523) than in samples from areas east of 170°W (Table 2). Detailed age compositions by NMFS statistical area, month, and sex, and length and weight statistics by age, sex, area, and month are presented in Appendix Tables 2 and 3. Because age is a discrete variable, the significance levels of the F tests for the ANOVAs on age are approximate (Tables 3 and 4). ANOVAs of samples from areas 509 and 517 showed statistically significant differences ($\alpha = .05$) in mean age by area and month, and in mean size of fish by area (Table 3). In the ANOVA on age, there were significant interactions between area and month (Table 3a). An examination of mean values shows that in area 509, the mean age of fish was greater in August than in September (Table 3d). The mean ages of fish in area 517 in August, area 517 in September, and area 509 in September were similar. Within statistical area 517, mean age did not vary significantly with time, but mean size varied significantly by time and sex (Table 4). In the ANOVA on age, there were also significant interactions between period and sex (Table 4a). Males predominated in the samples from area 517 in Period 1 (8/15-8/24) and Period 3 (9/4-9/13), and the mean age of males was less than the mean age of females in the first two periods, and greater than the mean age of females in the last two periods (Table 4d). The mean age of females in area 517 tended to decrease over the entire sample period (Table 4d). The differences in mean age and size by time, area, and sex indicate that the population structure of chum salmon in the fishery bycatch is complex.

Although not quantified in this paper, patterns of initial ocean growth on chum salmon scales appeared to be extremely variable, which may indicate the presence of stocks originating from many different coastal areas. We also noted the presence of fish with a reduced amount of growth in the third ocean year, a character that has been observed on the scales of Japanese and Russian chum salmon after 1970 (Ishida et al. 1993). We do not know, however, if similar changes in ocean growth in the third year have also occurred in Alaska salmon.

In the Bering Sea, research sampling with gillnets and purse seines indicates that juvenile (age .0) chum salmon are distributed to more than 55 km from shore in August and September, along the north side of the Alaska Peninsula, and tend to remain east of 165° W until at least the end of August (Neave et al. 1976). From directional purse seine sets, Hartt et al. (1970) concluded that juvenile chum in this area probably move back and forth with the tides, with a net movement seaward to the southwest. In August, immature age .1 and older chum salmon are intermixed in high seas research gillnet and purse seine catches. There were no age .0 and .1 chum salmon in the 1993 observer samples, indicating that these younger, smaller fish are not retained by the gear used in the B-season fishery.

High-seas tagging experiments have shown that immature chum salmon (age .1 and older) make strong seasonal north-south migrations (Shepard et al. 1968; Neave et al. 1976). Distribution studies summarized by Neave et al. (1976) show that there are two main concentrations of immature chum salmon in July-September; the larger, composed of Asian fish, moves into the Bering Sea in summer, and the second, composed primarily of North American fish is located in the northeastern Pacific throughout the summer and does not enter the Bering Sea. The results from high-seas tagging experiments indicate that most immature chum salmon in the Bering Sea are of Asian origin. However, the maturity of chum salmon in the observer samples is not known.

The results of high-seas tagging studies in the eastern Bering Sea indicate that maturing Asian and North American chum salmon intermingle in this region (Shepard et al. 1968; Neave et al. 1976), however, very little historical data is available for the August-September period. In their last spring, most maturing chum salmon are distributed south of the Aleutians, and research and fishery data show that active migrations of maturing chum salmon into the Bering Sea occur in June (Neave et al. 1976). By July, maturing chum salmon are apparently more abundant in the Bering Sea than in the North Pacific. In August, they are widely distributed in the Bering Sea, but abundance in offshore areas has declined, and by September most maturing chum salmon have returned to coastal areas.

There have been six reported recoveries of coded-wire tagged chum salmon in foreign and domestic commercial trawl fisheries in the eastern Bering Sea in August and September (Dahlberg and Fowler 1985; Dahlberg et al. 1986, 1987, 1991, 1994). The fish were caught in the area 164° 25' W -165° 54' W longitude, between 54° 45'N-55° 22'N latitude (NMFS statistical areas 509, 517, and 519, Fig. 1). The fish were ages 0.2 (3 fish), 0.3 (2 fish), and 0.4 (1 fish), and originated in Alaska (1 fish), British Columbia (4 fish), and Washington (1 fish). The Washington fish was a male with a gonad weight of 70 g, which indicates that it was a maturing fish (Godfrey 1961, Takagi 1961). Gonad weights were not recorded for the other fish. There is one additional recovery of a coded-wire tagged chum salmon caught by a commercial trawler in the eastern Bering Sea (Dahlberg et al. 1986). This fish, an immature male (gonad weight: 1 g.) caught at 166°02'W, 54°33'N in January 1985, was released from Kasnyku Bay in southeastern Alaska in May, 1982. This recovery indicates that at least some immature Alaskan chum salmon overwinter in the Bering Sea.

Neave et al. (1976) concluded that most distribution studies have failed to show specific routes and timing of inshore migrations of maturing chum salmon because of their broad geographical range, numerous individual populations, and extended spawning periods. These same factors make the identification of stocks of chum salmon in ocean fisheries difficult. If the number of contributing stocks is large, separation between contributing stocks is low, and discriminating traits are few, maximum-likelihood procedures, which are commonly used for stock identification analysis, are very sensitive to the effect of sampling error, even with unknown sample sizes of 50 or more fish per contributing stock (Wood et al. 1987). Regardless of the stock identification technique used, the collection of a sufficient number of biological samples from all time and area strata of the fishery is necessary, and the samples should also be representative of all size, age, maturity, and stock groups of fish in the bycatch.

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LITERATURE CITED

Bakkala, R.G. 1970. Synopsis of biological data on the chum salmon, *Oncorhynchus keta* (Walbaum). 1972. U.S. Fish. Wildl. Serv. Circ. 315 (FAO Fisheries Synopsis No. 41):89 p.

Berger, J.D., and L. Low. 1994. Incidental catches of salmonids in U.S. groundfish fisheries in the Bering Sea/Aleutians, Gulf of Alaska and Pacific Coast Areas, 1990-1994. 4 p. (NPAFC Doc. 59.) Resource Ecology and Fisheries Management Div., Alaska Fish. Sci. Cent., NMFS, NOAA, U.S. Dep. Commerce, 7600 Sand Point Way NE, Seattle, WA 982115-0070.

Dahlberg, M.S., and S. Fowler. 1985. Report of the incidence of coded-wire-tagged salmonids in catches of foreign commercial and research vessels operating in the North Pacific Ocean and Bering Sea during 1984-1985. (INPFC Doc., Rev. 1) Auke Bay Laboratory, Alaska Fisheries Science Center, NMFS, NOAA, 11305 Glacier Highway, Juneau, AK 99801-8626. 16 pp.

Dahlberg, M.S., S. Fowler, N. Maloney, and R. Heintz. 1991. Incidence of coded-wire tagged salmonids in commercial and research catches in the North Pacific Ocean and Bering Sea, 1990-1991. (NPAFC Doc. 68.) Auke Bay Laboratory, Alaska Fisheries Science Center, NMFS, NOAA, 11305 Glacier Highway, Juneau, AK 99801-8626. 17 pp.

Dahlberg, M.S., S. Fowler, N. Maloney, and R. Heintz. 1994. Incidence of coded-wire tagged salmonids in commercial and research catches in the North Pacific Ocean and Bering Sea, 1993-1994. (NPAFC Doc. 68.) Auke Bay Laboratory, Alaska Fisheries Science Center, NMFS, NOAA, 11305 Glacier Highway, Juneau, AK 99801-8626. 16 pp.

Dahlberg, M.S., F.P. Thrower, and S. Fowler. 1986. Incidence of coded-wire-tagged salmonids in catches of foreign commercial and research vessels operating in the North Pacific Ocean and Bering Sea during 1985-1986. (INPFC Doc.) Auke Bay Laboratory, Alaska Fisheries Science Center, NMFS, NOAA, 11305 Glacier Highway, Juneau, AK 99801-8626. 26 pp.

Dahlberg, M.S., F.P. Thrower, and S. Fowler. 1987. Incidence of coded-wire-tagged salmonids in catches of foreign commercial and research vessels operating in the North Pacific Ocean and Bering Sea during 1986-1987. (INPFC Doc.) Auke Bay Laboratory, Alaska Fisheries Science Center, NMFS, NOAA, 11305 Glacier Highway, Juneau, AK 99801-8626. 50 pp.

Feldman, D.S., J. Gagnon, R. Hofmann, and J. Simpson. 1987. Abacus Concepts, StatView II. Abacus Concepts, Inc., Berkeley, CA. 234 pp.

Godfrey, H. 1961. Method used to distinguish between immature and maturing sockeye and chum salmon taken by Canadian exploratory fishing vessels in the Gulf of Alaska. Int. N. Pac. Fish. Comm. Bull. 5:17-25.

Goodnight, J.H. 1979. A tutorial on the SWEEP Operator. The American Statistician, 33:149-158.

Hartt, A.C., M.B. Dell, and L.S. Smith. 1970. Investigations by the U.S. for the INPFC - 1968: Tagging and sampling. 1970. Int. N. Pac. Fish. Comm. Annu. Rep. 1968:68-79.

Hocking, R.R. 1985. The analysis of linear models. Brooks/Cole, Monterey, California.

International North Pacific Fisheries Commission. 1987. Report of the scale pattern working group. Int. N. Pac. Fish. Comm. Doc., Vancouver, Canada. 8 pp. + appendices.

Ishida, Y., S. Ito, M. Kaeriyama, S. McKinnell, and K. Nagasawa. 1993. Recent changes in age and size of chum salmon (*Oncorhynchus keta*) in the North Pacific Ocean and possible causes. Can. J. Fish. Aquat. Sci. 50:290-295.

Knudsen, C.M. 1985. Chinook salmon scale character variability due to body area sampled and possible effects on stock separation studies. M.S. Thesis. Univ. Washington, Seattle. 141 pp.

Neave, F., T. Yonemori, and R.G. Bakkala. 1976. Distribution and origin of chum salmon in offshore waters of the North Pacific Ocean. Int. N. Pac. Fish. Comm. Bull. 35. 79 pp.

Rogers, D.E. 1994. False Pass chum salmon, 1993. FRI-UW-9404. Fish. Res. Inst., School of Fish., Univ. Washington, Seattle. 55 pp.

Searle, S.R. 1971. Linear models. John Wiley & Sons, New York.

Shepard, M.P., A.C. Hartt, and T. Yonemori. 1968. Salmon of the North Pacific Ocean, Part VIII. Chum salmon in offshore waters. Int. N. Pac. Fish. Comm. Bull. 25. 69 pp.

Takagi, K. 1961. The seasonal change of gonad weight of sockeye and chum salmon in the North Pacific Ocean, especially with reference to mature and immature fish. Bull. Hokkaido Reg. Fish. Res. Lab. 23:17-34.

Wood, C.C., S. McKinnell, T.J. Mulligan, and D.A. Fournier. 1987. Stock identification with the maximum-likelihood mixture model: sensitivity analysis and application to complex problems. Can. J. Fish. Aquat. Sci. 44:866-881.

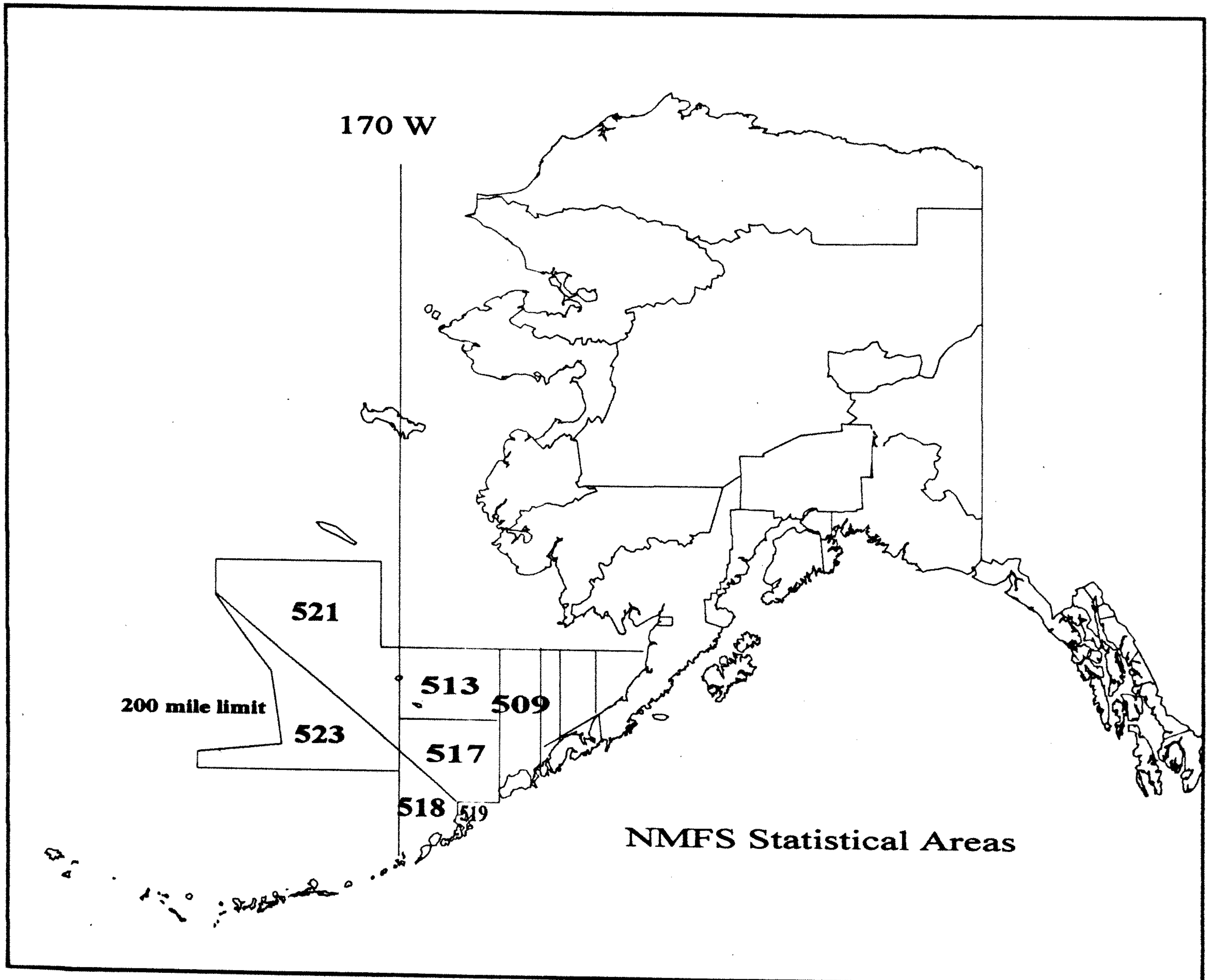


Fig. 1. NMFS statistical areas in the eastern Bering Sea.

Table 1. Number of chum salmon by age group, body area of scale collection (areas A + B and area C, Appendix Fig. 1a), NMFS statistical area (Fig. 1), and month for U.S. observer samples from the 1993 B-season pollock fishery in the Bering Sea.

		Age 0.2			Age 0.3			Age 0.4			Age 0.5			Grand
Area	Month	A + B	C	Total	A + B	C	Total	A + B	C	Total	A + B	C	Total	Total
507	9	0	0	0	0	0	0	1	0	1	0	0	0	1
507 Sum		0	0		0	0		1	0		0	0		1
509	8	2	0	2	16	0	16	8	0	8	2	0	2	28
	9	14	0	14	19	0	19	8	0	8	0	0	0	41
509 Sum		16	0		35	0		16	0		2	0		69
513	8	1	0	1	2	0	2	0	0	0	0	0	0	3
513 Sum		1	0		2	0		0	0		0	0		3
517	8	49	3	52	203	11	214	24	2	26	2	0	2	294
	9	60	0	60	212	1	213	35	1	36	1	0	1	310
517 Sum		109	3		415	12		59	3		3	0		604
518	8	0	0	0	1	0	1	0	0	0	0	0	0	1
518 Sum		0	0		1	0		0	0		0	0		1
519	8	0	0	0	0	1	1	0	0	0	0	0	0	1
	9	6	0	6	25	0	25	7	0	7	0	0	0	38
519 Sum		6	0		25	1		7	0		0	0		39
521	8	47	4	51	54	5	59	12	1	13	2	0	2	125
521 Sum		47	4		54	5		12	1		2	0		125
523	8	3	0	3	4	0	4	0	0	0	0	0	0	7
523 Sum		3	0		4	0		0	0		0	0		7
Grand total		182	7	189	536	18	554	95	4	99	7	0	7	849

Table 2. Age composition of chum salmon in U.S. observer samples collected during the 1993 Bering Sea Pollock B-season fishery (August 15 to September 25). n = sample size.

NMFS Stat. Area		Ocean Age Group 0.2	0.3	0.4	0.5	Total
507	n	0	0	1	0	1
				100%		
509	n	18	43	17	2	80
		22%	54%	21%	3%	
513	n	1	3	0	0	4
		25%	75%			
517	n	119	434	65	3	621
		19%	70%	10%	1%	
518	n	0	1	0	0	1
			100%			
519	n	6	26	7	0	39
		15%	67%	18%		
521	n	52	61	14	2	129
		40%	47%	11%	2%	
523	n	3	4	0	0	7
		43%	57%			
Total	n	199	572	104	7	882
		22%	65%	12%	1%	

Table 3. Two-factor (area and month) analysis of variance (ANOVA) on (a) age, (b) length, and (c) weight for chum salmon samples from NMFS statistical areas 509 and 517 in August and September 1993.

(a) Age

Source:	df:	Sum of Squares:	Mean Square:	F-test	P value:
Area (A)	1	2.163	2.163	6.53	0.0108
Month (B)	1	3.913	3.913	11.813	0.0006
AB	1	3.764	3.764	11.363	0.0008
Error	697	230.877	.331		

(b) Length

Source:	df:	Sum of Squares:	Mean Square:	F-test	P value:
Area (A)	1	540.002	540.002	9.989	0.0016
Month (B)	1	112.399	112.399	2.079	0.1498
AB	1	74.934	74.934	1.386	0.2395
Error	697	37678.582	54.058		

(c) Weight

Source:	df:	Sum of Squares:	Mean Square:	F-test	P value:
Area (A)	1	27.77	27.77	19.006	0.0001
Month (B)	1	1.334	1.334	0.913	0.3396
AB	1	2.529	2.529	1.731	0.1887
Error	697	1018.394	1.461		

(d) Means

Variable	Area	August	September	Total
Age	509	3.34	2.86	3.04
	517	2.92	2.92	2.92
Length	509	58.17	58.41	58.32
	517	54.25	56.62	55.50
Weight	509	2.93	2.87	2.89
	517	2.08	2.42	2.26
(e) Sample sizes	509	29	51	80
	517	294	327	621

Table 4. Two-factor (period and sex) analysis of variance (ANOVA) on (a) age, (b) length, and (c) weight for chum salmon samples from NMFS statistical area 517.

(a) Age

Source:	df:	Sum of Squares:	Mean Square:	F-test	P value:
Period (A)	3	0.365	0.122	0.402	0.7514
Sex (B)	1	0.633	0.633	2.095	0.1483
AB	3	2.470	0.823	2.723	0.0436
Error	597	180.451	0.302		

(b) Length

Source:	df:	Sum of Squares:	Mean Square:	F-test	P value:
Period (A)	3	1373.779	457.926	9.003	0.0001
Sex (B)	1	210.237	210.237	4.133	0.0425
AB	3	223.430	74.477	1.464	0.2232
Error	597	30367.117	50.866		

(c) Weight

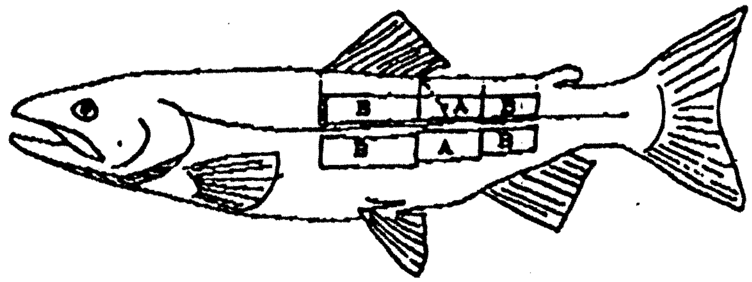
Source:	df:	Sum of Squares:	Mean Square:	F-test	P value:
Period (A)	3	25.741	8.560	6.583	0.0002
Sex (B)	1	5.755	5.755	4.415	0.0360
AB	3	3.470	1.157	0.887	0.4473
Error	597	778.173	1.303		

(d) Means

	Sex	Sample size	Mean age	Mean length	Mean weight
Period 1	Male	124	2.919	54.363	2.127
8/15-8/24	Female	88	2.977	54.989	2.121
Period 2	Male	66	2.879	53.909	2.071
8/25-9/3	Female	68	2.941	52.706	1.936
Period 3	Male	113	3.018	58.115	2.635
9/4-9/13	Female	77	2.818	56.468	2.426
Period 4	Male	35	2.971	57.514	2.511
9/14-9/25	Female	34	2.765	54.529	2.146

LOCATION OF PREFERRED SCALE SAMPLING ZONES

(Do not take lateral line scales)



SALMON - Follow the diagonal scale row from the posterior insertion of the dorsal fin to the lateral line of either side. Two scale rows up from the lateral line (on the diagonal) are the preferred scales

Scale Envelope:

SPECIES COMMON NAME______________________

SCALE/OTOLITH NO.______________________

SCALE ZONE__________ SEX________

LENGTH________(CM) WT____________(KG)

DATE____________ HAUL/SET NO.__________

ADIPOSE FIN YES__ NO__

Appendix Fig. 1a. Body area of scale collection and coin envelope for collection of salmon scales.

AREA ______ **FORM 9US - BIOLOGICAL SAMPLING FORM** Page ____ of ____

Cruise no.	Vessel code	Date			Species name	Species code	Speci-men type	Sampling system
		Year	Mo	Day				
1 2 3 4 5	6 7 8 9	10 11	12 13	14 15		16 -18	20 - 21	22 - 23

Total no. of specimens ______

Catalogue date ______

	Set/haul number	Specimen number	Sex	Length (cm)	Weight (kg)	Form 7	Maturity stage	Notes	Age	REMARKS
	25 26 27	28 29 30	31	32 33 34	35 36 37 38 39	41	42 43	44 45	47 48 49	
1					.					
2					.					
3					.					
4					.					
5					.					
6					.					
7					.					
8					.					
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19					.					
20					.					
21					.					
22					.					
23					.					
24					.					
25					.					
26					.					
27					.					
28					.					
29					.					
30					.					
31					.					
32					.					
33					.					
34					.					
35					.					
36					.					
37					.					

Appendix Fig. 1b. NMFS biological data form.

Appendix Table 1. NMFS instructions to U.S. observers for collection of biological samples from salmon.

Collecting Data From Salmon and Steelhead

The following information should be collected from the salmon and steelhead obtained in the prohibited species incidence samples:

(a) Species identification--the six species which may be encountered are -- king, chum, sockeye, pink, coho, or steelhead.

(b) Sex--determine the sex of each salmon; only live salmon that have minimal scale loss should not be sexed, but listed as "unknown" sex. When the observer is not sure of the sex of a salmon or does not have enough time to sex it, the sex should also be listed as "unknown."

(c) Numbers of salmon/steelhead--determine numbers by species and sex groups.

(d) Weight--record the individual weights if scale samples are to be taken; if scale samples are not taken of all fish, obtain the total weight by species and sex group for those fish whose scales were not sampled.

(e) Length--the fork length of each salmon found in the sample is recorded to the nearest whole centimeter on Form 7US, (see "Length Frequencies" in a following section). Length measurements are grouped by species and by sex, and are recorded in ascending order.

(f) Scale samples--the purpose of taking scale sample is primarily for confirming the observer's identity of the salmon, therefore, observers should take scale samples of the first 20 salmon of each species identified during the deployment period (regardless of the number of vessels the observer was on). The scale samples and data forms will also be used for ageing. Follow the collecting instructions in "Scale Samples and Random Stratified Otolith Samples" in a following section. Do not collect scales from salmon that are not part of your prohibited species sample unless they were tagged salmon.

(g) Check for missing adipose fin, fins that are clipped, brands, and tags. Salmon with these types of marks may also have been tagged with a coded wire in the snout. Follow the directions in the section on "Tagged Fish."

The observer should seldom have to subsample salmon. If time does not allow the observer to gather all of the above information from each fish, get at least numbers and weights by species from your random sample, (failing this, reduce your sample size!). Then take a random subsample for sexed lengths (and watch for tags). Take scale samples from each species identified, as needed.

Appendix Table 2. Age composition by NMFS statistical area, month, and sex for chum salmon in observer samples from the 1993 B-season fishery.

		Age Group				
Area/month	Sex	0.2	0.3	0.4	0.5	Total
507/9	Male	0	0	1	0	1
	Percent	0.0%	0.0%	100.0%	0.0%	100.0%
	Female	0	0	0	0	0
	Percent	0.0%	0.0%	0.0%	0.0%	0.0%
	Both Sexes	0	0	1	0	1
	Percent	0.0%	0.0%	100.0%	0.0%	100.0%
509/8	Male	2	10	4	0	16
	Percent	6.9%	34.5%	13.8%	0.0%	55.2%
	Female	0	7	4	2	13
	Percent	0.0%	24.1%	13.8%	6.9%	44.8%
	Both Sexes	2	17	8	2	29
	Percent	6.9%	58.6%	27.6%	6.9%	100.0%
509/9	Male	9	18	8	0	35
	Percent	17.6%	35.3%	15.7%	0.0%	68.6%
	Female	7	8	1	0	16
	Percent	13.7%	15.7%	2.0%	0.0%	31.4%
	Both Sexes	16	26	9	0	51
	Percent	31.4%	51.0%	17.6%	0.0%	100.0%
513/8	Male	0	1	0	0	1
	Percent	0.0%	25.0%	0.0%	0.0%	25.0%
	Female	1	2	0	0	3
	Percent	25.0%	50.0%	0.0%	0.0%	75.0%
	Both Sexes	1	3	0	0	4
	Percent	25.0%	75.0%	0.0%	0.0%	100.0%
517/8	Male	34	117	14	2	167
	Percent	11.7%	40.2%	4.8%	0.7%	57.4%
	Female	16	96	12	0	124
	Percent	5.5%	33.0%	4.1%	0.0%	42.6%
	Both Sexes	50	213	26	2	291
	Percent	17.2%	73.2%	8.9%	0.7%	100.0%

continued

Appendix Table 2. continued.

Area/month	Sex	Age Group 0.2	0.3	0.4	0.5	Total
517/9	Male	26	120	25	0	171
	Percent	8.3%	38.2%	8.0%	0.0%	54.5%
	Female	37	94	11	1	143
	Percent	11.8%	29.9%	3.5%	0.3%	45.5%
	Both Sexes	63	214	36	1	314
	Percent	20.1%	68.2%	11.5%	0.3%	100.0%
518/8	Male	0	1	0	0	1
	Percent	0.0%	100.0%	0.0%	0.0%	100.0%
	Female	0	0	0	0	0
	Percent	0.0%	0.0%	0.0%	0.0%	0.0%
	Both Sexes	0	1	0	0	1
	Percent	0.0%	100.0%	0.0%	0.0%	100.0%
519/8	Male	0	1	0	0	1
	Percent	0.0%	100.0%	0.0%	0.0%	100.0%
	Female	0	0	0	0	0
	Percent	0.0%	0.0%	0.0%	0.0%	0.0%
	Both Sexes	0	1	0	0	1
	Percent	0.0%	100.0%	0.0%	0.0%	100.0%
519/9	Male	2	14	4	0	20
	Percent	5.3%	36.8%	10.5%	0.0%	52.6%
	Female	4	11	3	0	18
	Percent	10.5%	28.9%	7.9%	0.0%	47.4%
	Both Sexes	6	25	7	0	38
	Percent	15.8%	65.8%	18.4%	0.0%	100.0%
521/8	Male	22	20	8	1	51
	Percent	19.1%	17.4%	7.0%	0.9%	44.3%
	Female	27	30	6	1	64
	Percent	23.5%	26.1%	5.2%	0.9%	55.7%
	Both Sexes	49	50	14	2	115
	Percent	42.6%	43.5%	12.2%	1.7%	100.0%

continued

Appendix Table 2. continued.

Area/month	Sex	Age Group 0.2	0.3	0.4	0.5	Total
523/8	Male	2	0	0	0	2
	Percent	28.6%	0.0%	0.0%	0.0%	28.6%
	Female	1	4	0	0	5
	Percent	14.3%	57.1%	0.0%	0.0%	71.4%
	Both Sexes	3	4	0	0	7
	Percent	42.9%	57.1%	0.0%	0.0%	100.0%
Total/8	Male	60	150	26	3	239
	Percent	13.4%	33.4%	6.0%	0.7%	53.3%
	Female	45	139	22	3	209
	Percent	10.0%	31.0%	4.9%	0.7%	46.7%
	Both Sexes	105	289	48	6	448
	Percent	23.4%	64.5%	10.8%	1.3%	100.0%
Total/9	Male	37	152	38	0	227
	Percent	9.2%	37.7%	9.4%	0.0%	56.3%
	Female	48	113	15	1	177
	Percent	11.9%	28.0%	3.7%	0.2%	43.8%
	Both Sexes	85	265	53	1	404
	Percent	21.0%	65.6%	13.1%	0.3%	100.0%
Total	Male	97	302	64	3	466
	Percent	11.4%	35.4%	7.5%	0.4%	54.7%
	Female	93	252	37	4	386
	Percent	10.9%	29.6%	4.3%	0.5%	45.3%
	Both Sexes	190	554	101	7	852
	Percent	22.3%	65.0%	11.9%	0.8%	100.0%

Appendix Table 3. Length and weight statistics for chum salmon in U.S. observer samples of the bycatch of the 1993 B-season fishery.

	Age Group							
	Age 0.2		Age 0.3		Age 0.4		Age 0.5	
Area/month	Male	Female	Male	Female	Male	Female	Male	Female
507/9								
Sample size					1			
Mean length					80.0			
Standard dev.								
Mean weight					7.0			
Standard dev.								
Sample size					1			
509/8								
Sample size	2		10	7	4	4		2
Mean length	51.5		55.3	54.3	68.0	60.5		68.5
Standard dev.	2.1		4.8	5.4	5.4	7.0		0.7
Mean weight	2.0		2.5	2.1	4.7	3.2		4.8
Standard dev.	0.4		0.9	0.8	0.9	1.6		0.7
Sample size	2		10	7	4	4		2
509/9								
Sample size	9	7	18	8	8	1		
Mean length	53.6	49.0	59.9	59.5	68.2	53.0		
Standard dev.	5.1	4.0	6.4	5.3	9.6			
Mean weight	1.9	1.8	3.0	2.9	4.7	1.8		
Standard dev.	0.5	0.3	1.3	1.2	2.2			
Sample size	9	7	18	8	8	1		
513/8								
Sample size		1	1	2				
Mean length		44.0	59.0	51.5				
Standard dev.				3.5				
Mean weight		1.2	3.1	1.9				
Standard dev.				0.8				
Sample size		1	1	2				
517/8								
Sample size	34	16	117	96	14	12	2	
Mean length	50.0	51.2	54.3	54.4	61.7	58.4	65.5	
Standard dev.	4.5	3.6	5.9	6.0	6.8	5.1	2.1	
Mean weight	1.5	1.5	2.1	2.1	3.2	2.6	4.0	
Standard dev.	0.5	0.4	0.9	1.2	1.3	0.7	0.4	
Sample size	34	16	117	96	14	12	2	
517/9								
Sample size	26	37	120	94	25	11		1
Mean length	52.1	50.1	57.3	55.8	63.9	63.1		85.0
Standard dev.	5.0	5.0	7.6	7.0	9.0	8.1		
Mean weight	1.8	1.6	2.5	2.2	3.7	3.6		7.5
Standard dev.	0.6	0.6	1.1	1.0	1.7	1.7		
Sample size	26	37	120	94	25	11		1

continued

Appendix Table 3. continued.

	Age Group							
	Age 0.2		Age 0.3		Age 0.4		Age 0.5	
Area/month	Male	Female	Male	Female	Male	Female	Male	Female
518/8								
Sample size				1				
Mean length				58.0				
Standard dev.								
Mean weight				2.7				
Standard dev.								
Sample size				1				
519/8								
Sample size			1					
Mean length			52.0					
Standard dev.								
Mean weight			1.7					
Standard dev.								
Sample size			1					
519/9								
Sample size	2	4	14	11	4	3		
Mean length	52.5	50.8	58.8	59.1	68.0	62.7		
Standard dev.	0.7	3.9	4.6	6.8	5.2	2.3		
Mean weight	1.7	1.5	2.7	3.5	5.0	3.0		
Standard dev.	0.0	0.4	0.6	1.5	1.7	0.3		
Sample size	2	3	5	4	4	2		
521/8								
Sample size	22	27	20	30	8	6	1	1
Mean length	49.9	47.9	53.7	53.6	58.4	64.8	59.0	73.0
Standard dev.	3.3	4.1	5.0	6.7	5.4	6.0		
Mean weight	1.4	1.32	2.0	2.0	2.5	4.0	2.5	5.6
Standard dev.	0.3	0.4	0.8	1.2	0.8	1.5		
Sample size	22	27	20	30	8	6	1	1
523/8								
Sample size	2	1		4				
Mean length	45.0	47.0		51.5				
Standard dev.	4.2			2.6				
Mean weight	1.0	1.1		1.3				
Standard dev.	0.3			0.2				
Sample size	2	1		4				