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INTERCEPTIONS OF YUKON SALMON BY HIGH SEAS FISHERIES

by

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INTRODUCTION

The interception of migratory salmon in distant-water fisheries may cause an economic loss to coastal or in-river fisheries and a problem for management of those fisheries if the numbers intercepted are unknown but sufficiently large and variable from year to year to alter the perceived abundances of local stocks. Management of coastal salmon fisheries (regulation of fishing to achieve optimum or sufficient spawning escapement) is based on the historical escapements (or indices) and the subsequent adult returns. If the returns do not include distant-water catches, then the management strategy may be in error. If we can estimate the annual numbers intercepted, the only problems with distant-water fisheries are social economic, because where or when salmon are caught (prior to spawning) has little impact on the population dynamics of a stock.

In the mid-1950s, Japan embarked on high seas salmon fishing in the North Pacific and Bering Sea west of 175°W (Fig. 1). These fisheries, which targeted on sockeye, chum, and pink salmon, soon became the largest salmon fisheries around the North Pacific rim. This created great concern from coastal nations, especially the U.S.S.R. and the United States when by the 1970s it was evident from tagging experiments that the Japanese catches came largely from U.S.S.R. and western Alaska stocks (Fredin et al. 1977). The U.S. concerns, which were primarily with the interceptions of Bristol Bay sockeye, were expressed through the International North Pacific Fisheries Commission (INPFC) and culminated in the elimination of high seas fishing between 175°W and 175°E (except in the central Bering Sea) after 1977. Coincidentally, the U.S.S.R. has restricted high seas fishing to the westward and further imposed decreasing catch quotas so that in 1986 the Japanese salmon catch was the lowest since the inception of the fisheries in the 1950s. Nevertheless, high seas fishing is still a concern for the United States and Canada in regard to Yukon chinook salmon (Eggers 1986) and, to some extent, chum salmon stocks that are fished by both nations.

In spite of the restrictions imposed on the Japanese fisheries after 1977, the catches of chinook salmon remained relatively high with the largest catch in the history of the fisheries in 1980. This prompted a study by Rogers et al. (1983) that provided estimates of chinook salmon interceptions according to region of origin: Asia, western Alaska, central Alaska, and southeastern Alaska/British Columbia.

The main purpose of this report is to estimate the Yukon River component of the western Alaskan interceptions by the Japanese mothership and landbased fisheries; however, Yukon chinook salmon may also be caught incidentally in foreign and domestic trawl fisheries (Myers and Rogers 1985) and in the domestic salmon fisheries south of Unimak Island and in the Shumagin Islands (False Pass; Rogers 1986). I will estimate Yukon chinook salmon interceptions in these fisheries and also review the status of knowledge on possible interceptions of Yukon chum salmon by distant-water fisheries.

METHODS

Several types of information can be used to estimate the relative contributions of individual stocks of salmon to a mixed-stock fishery, e.g., external tagging experiments, biological tags (parasites, electrophoresis, scale patterns), and relative abundances of contributing stocks (if their time/space distributions are known). Scale pattern analysis, which depends on environmentally or genetically caused differences in growth among various stocks or stock complexes, is presently the best method available for high seas fisheries. This method has been used to estimate regional stock contributions of sockeye, coho, and chinook salmon to the Japanese fisheries. Detailed methods, results, and sources of error for chinook salmon are presented in Rogers et al. (1984), Myers (1985), and Myers and Rogers (1985), and will not be repeated here.

Chinook Salmon

Estimates of the regional stock compositions of chinook salmon in the Japanese mothership fishery were made from scale pattern analyses by year (1975-1981) age (1.2 and 1.3), month (June-July), and sub-area (Appendix Table F in Rogers et al. 1984). Stock compositions were then calculated on an annual basis for the Bering Sea and North Pacific areas of the fishery by weighting the age/month/sub-area estimates by the catches (Appendix Table A in Rogers et al. 1984). The annual catches of western Alaskan chinook salmon were calculated from the proportion of western Alaskan stocks and the total catch including unaged and mature fish.

The proportions of Yukon stocks were calculated in a similar manner from stock compositions estimated by six-region analyses (Asia, Yukon, Kuskokwim, Bristol Bay, central Alaska, and southeastern Alaska/British Columbia; Appendix Table G in Rogers et al. 1984). The proportions of Yukon, Kuskokwim, and Bristol Bay stocks were recalculated to total one, and then the proportions of Yukon stocks were applied to the western Alaskan components of the Japanese mothership catches to estimate the interception of Yukon origin chinook salmon.

Throughout the analyses, missing observations were estimated by the nearest appropriate mean, e.g., age/sub-area averaged over years or age averaged over Bering Sea or North Pacific sub-areas and years. To estimate interceptions prior to 1975, the unweighted annual means of the stock compositions in the Bering Sea and North Pacific areas were calculated for 1975-1977 and to estimate interceptions after 1981, the unweighted annual means for 1978-1981 were used to reflect the change in the fisheries after 1977. In addition, stock composition estimates for the mothership North Pacific area were used to estimate interceptions in the landbased fishery. This may have resulted in some overestimation of Alaskan stocks (primarily central Alaska) and underestimation of Asian stocks (Ito et al. 1985). However, the effect on estimates of Yukon chinook was probably negligible. Unfortunately, it has not been feasible to calculate confidence intervals on estimates of interceptions in the high seas fisheries. All we can say is that the estimates are the best available. However, we can judge their appropriateness based on the relative abundances of the contributing stocks even though our knowledge of the oceanic distribution of chinook salmon is comparatively poor (Major et al. 1978).

Catch statistics used here are from INPFC Statistical Yearbooks through 1983, and INPFC and ADF&G preliminary reports after 1983. Escapement estimates and some subsistence catches in Alaska were taken from ADF&G reports (e.g., ADF&G 1986) and Rogers (1985), whereas escapement estimates for Kamchatkan chinook salmon were obtained from unofficial sources (U.S.S.R. via Japan).

Chum Salmon

In contrast to chinook salmon, we have a relatively good description of the geographical limits of the oceanic distributions of major chum salmon stock assemblages in the North Pacific. These distributions, which were described largely from INPFC-related tagging experiments in the 1960s, are reported in Neave et al. (1976). However, the discrete distributions of western Alaskan stocks (e.g., Yukon summer and fall stocks) were not shown, and thus will be presented here from the INPFC tagging statistics on file at the Fisheries Research Institute, University of Washington.

Scale pattern analyses have been utilized only to a very limited extent for chum salmon in the Japanese fisheries (Ishida et al. 1985) and the False Pass fisheries (Conrad 1984) and presently do not provide useful estimates of the interceptions of Yukon chum salmon. Therefore, the results of the INPFC tagging experiments were used to determine the relative vulnerability of Yukon chum salmon to interception fisheries by examining the tag returns with information on run timing and the approximate abundances of contributing stocks. It was not possible, however, to estimate numbers of Yukon chum salmon intercepted by these fisheries for several reasons (e.g., see Brannian 1984).

The same sources given for statistics on chinook salmon were used for chum salmon, except that there were no estimates of chum salmon escapements for Asian stocks nor western Alaskan stocks other than Bristol Bay. Therefore, tag returns to western Alaskan stocks were examined relative to catches (commercial and subsistence) as an estimate of tag recovery effort. Buklis and Barton (1984) was used to identify summer and fall stocks in the Yukon River.

RESULTS

Chinook Salmon

Because chinook salmon are the least abundant of the Pacific salmon on the high seas, there have been comparatively few fish tagged and only eight tag recoveries from the Bering Sea (four to the Yukon) and eight tag recoveries from the North Pacific, excluding coastal tagging off southeastern Alaska-Washington (Table 1). Although there have been no tag returns to the Yukon River from the North Pacific, it seems quite reasonable to assume Yukon chinook salmon are distributed well south of the Aleutian Islands and perhaps into the Gulf of Alaska.

From the inception of the Japanese high seas fisheries in the 1950s until just recently, their annual catches of chinook salmon have usually exceeded the commercial catches in any one of the Alaskan or U.S.S.R. coastal fisheries (Table 2). During the 1960s, the Yukon commercial fisheries were the most productive of the northern coastal chinook fisheries, excluding the largely interception fishery in southeastern Alaska. Catches in the Alaskan fisheries declined during the early 1970s, but then increased substantially in the late 1970s, especially in Bristol Bay (mainly the Nushagak River stocks). In contrast, Kamchatkan catches increased in the early 1970s but declined in 1980 when there was a record catch of immatures by the Japanese.

Based on estimates of the annual coastal runs (catches and escapements) during 1976-1983 (excluding southeastern Alaska), the Yukon River chinook salmon constituted 17% of the coastal runs, whereas central Alaskan stocks (mostly Cook Inlet; Rogers 1985) constituted 25% of the coastal runs and were most numerous (Table 3). The Yukon stocks constituted 31% of the western Alaskan runs during 1976-1983 and about the same percentage (32%) for earlier years (1965-1975). However, the scale pattern analyses of samples of immature chinook salmon in the Japanese mothership fishery yielded consistently higher estimates of Yukon origin fish within the western Alaskan component.

Classifications of Yukon chinook within western Alaskan chinook (age 1.2) generally exceeded 50% and often was 100% in the sub-area/year/month strata (Table 4). For the annual estimates of western Alaskan stock composition (ages combined, 1976-1981), Yukon chinook constituted 62% to 99% of the fish in the North Pacific area and 28% to 76% of the fish in the Bering Sea area (Table 5). Yukon chinook salmon averaged 36% in the mothership catches in the Bering Sea during 1975-1977 and 42% during 1978-1981 (Table 6). They were thus the major contributor of chinook salmon in the Bering Sea fishery. In the North Pacific fishery, they averaged 14% and 20% for the two periods and were the third largest contributing stock to the mothership fishery.

The annual catches in the Japanese fisheries and the apportioned catches (interceptions) by region are given in Table 7. Note that in many years, the catch in the landbased fishery was greater than the catch in the mothership fishery (particularly recent years). This is a special source of error in the estimates of Yukon interceptions because we had to assume that the stock composition estimates for the mothership area applied to the more southerly landbased area. Since the proportion of Yukon chinook declined between the Bering Sea and the North Pacific areas of the mothership fishery, it may also have declined in the landbased area.

The approximate exploitation rates of the Japanese fisheries on the coastal stocks were estimated from the average catches (interceptions) for 1975-1981 (Table 7) and the average coastal runs for 1976-1983 (Table 3). The exploitation rate (catch divided by catch plus run) for the Yukon stocks was 26% compared to 18% for the Kuskokwim stocks and only 4% for the Bristol Bay stocks. Of course, these estimates of exploitation assume that the fish caught in the high seas fisheries would have returned over the following 1-3 years with no natural mortality.

The annual estimates of interceptions of Yukon origin chinook salmon were assigned to year of inshore run based on an average maturity schedule for Yukon chinook salmon older than age .2. The high seas catches were then compared to the domestic catches (including the small Norton Sound fishery) to measure the relative impact of the Japanese fisheries on the coastal or in-river fisheries (Table 8). The high seas interceptions often nearly equaled or exceeded the domestic catch during the 1970s and even in 1986, after considerable curtailment of the Japanese fisheries, the interception amounted to over 20% of the domestic catch. However, the recent decline in the interceptions should provide an increase in the domestic catch in the future and lower the overall exploitation rate on the Yukon River chinook salmon stocks (Fig. 2).

The interceptions of Yukon-origin chinook salmon in other distant-water fisheries has probably been negligible. The relatively large incidental catches of chinook salmon in the trawl fisheries in 1979-1980 preceded the large coastal runs in 1980-1981, so the impact of the interceptions was not great. Approximately 20,000 to 30,000 fish were removed from those large runs to the Yukon (Table 10). Since 1982, the interceptions of Yukon chinook salmon in trawl fisheries has probably numbered less than 5,000 fish. Catches of chinook salmon in the June False Pass fisheries (South Unimak-Shumagin Islands) have generally numbered well under 10,000 each year and the interceptions of Yukon-origin chinook salmon have probably been only a few hundred annually.

Chum Salmon

There are three distant-water fisheries that could impact the chum salmon runs to the Yukon River: the Japanese mothership fishery, the Japanese landbased fishery, and the U.S. False Pass fishery. After their inception and until 1977, the Japanese chum salmon catches generally exceeded the combined coastal catches of Asia, western Alaska, and central Alaska, whereas the chum salmon catches in the False Pass fishery were relatively small during this period (Table 11). After 1977, the Japanese high seas catches declined to about one-fourth of their former level, the Asian coastal catches about doubled, mainly from increased Japanese hatchery production, and the False Pass catches increased along with an increase in the runs of Bristol Bay sockeye salmon (the target species) and chum salmon (Table 12).

Estimates of annual escapements of chum salmon to the Yukon River are not available; however, based on the catches since the 1970s (Table 13), it is apparent that the Yukon summer run is the largest run in western Alaska (about 2 million fish annually). It is followed in magnitude by the Nushagak run and then the North Peninsula, Kuskokwim, and Yukon fall runs, which are probably of comparable magnitude and typically number about 1 million per year. The Kotzebue run has probably averaged about a half million fish annually as have the Togiak run and the other Bristol Bay runs combined since 1977.

Based on the results of high seas tagging (Figs. 3-5 and Table 14), it is evident that all of the western Alaskan stocks of chum salmon have probably contributed fish to both the Japanese and False Pass fisheries; however, the extent to which the various stocks have been impacted by the interception fisheries is largely unknown.

The Japanese fisheries have undoubtedly taken a much greater proportion of Asian stocks than western Alaskan stocks. Fredin et al. (1977) estimated that through 1975, only about 1-2% of the Japanese catches came from western Alaskan stocks. The estimated interceptions were only about 7% of the western Alaskan catches during those years. However, they assumed that all chum salmon west of 175°E and south of 48°N (landbased area) were of Asian origin. Since 1978, the Japanese fishery in the Bering Sea has been concentrated east of 175°E (Fig. 1) and there was one tag recovery in western Alaska from the Bering Sea west of 175°E and one tag recovery from the landbased area. Both of the fish were Yukon fall chums (Fig. 3). Thus, it seems quite likely that the interceptions of western Alaskan chum salmon have been underestimated. Even with the reduced catches by Japanese fisheries since 1977, the interceptions of Yukon chum salmon (especially the fall chums, which would be available through July) may be considerable, i.e., greater than 100,000 annually.

Most of the western Alaskan chum salmon stocks appear quite healthy; however, the recent Yukon fall runs (mid-July through August), which are probably the most heavily exploited runs in western Alaska, may be declining from under-escapement (ADF&G 1986). Concern has centered on the June False Pass fishery to the extent that this fishery was greatly curtailed in 1986 in an effort to protect the Yukon fall run; however, there are two sources of evidence that suggest that Yukon fall chum salmon are much less vulnerable to this interception fishery than the other western Alaskan stocks.

The False Pass fishery exploits western Alaskan chum salmon that are on their homeward migration from areas in the central and eastern Gulf of Alaska. Chum salmon were tagged in the Gulf of Alaska during 1961-1967. Yukon fall chum salmon appeared to be distributed farther to the south and west than the other western Alaskan stocks in the early spring (Figs. 3-6). The average coastal catches during 1961-1967 (a relative measure of the number examined for tags) were compared to the numbers of tags recovered from tagging in the Gulf of Alaska (same areas where there were recoveries in the False Pass fishery). The percentage of tags recovered from Yukon fall chums was low relative to the percentage of the western Alaskan catch and low relative to the tag recoveries and catches of Yukon summer chums (Fig. 7).

Yukon chum salmon required about 30 days to migrate from the Gulf of Alaska to the Yukon River[1] and western Alaskan chum salmon required about 10 days to migrate from the Gulf of Alaska to Unimak-Shumagin fisheries (Fig. 8 and Table 15). The time required to migrate from the False Pass fishery to the Yukon was probably about 20 days or similar to the time required for Yukon chums to migrate from the eastern Aleutians, which is a comparable distance from the Yukon River (Fig. 9). Since the Yukon fall run does not begin in the lower river until mid-July, it seems very unlikely that a significant number would migrate through the False Pass fishery in June.

It seems more likely that the Japanese fisheries, rather than the False Pass fishery, impact the Yukon fall chums. Estimates of interceptions in these fisheries will require tagging and a scale pattern analyses directly in the fishery areas. This is planned for the False Pass area but is also needed in the Japanese fisheries, especially during July in the central Bering Sea.

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[1]An exception was one chum tagged just south of Kodiak and recovered in the Yukon River two weeks later.

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Table 1. Coastal tag recoveries of chinook salmon that were tagged in the North Pacific west of 140°W and in the Bering Sea.

Tagged				Recovered		
Area	Date (mo/yr)	Length (TS-TF)	Ocean age[1]	Location	Date (mo/yr)	Ocean age
Bering Sea (north of 56°)	7/59	558	2	Yukon	6/60	3
	7/65	500	(2)	"	6/67	(4)
	7/72	700	3	"	6/74	5
	6/75	560	(2)	"	6/77	(4)
	7/66	530	2	Kuskokwim	6/68	4
	6/75	530	(2)	"	6/77	(4)
	7/65	480	2	Nushagak	6/67	4
	6/75	630	3	"	6/77	5
South of Aleutians (170°W-180°)	6/64	745	3	Togiak	7/64	3
	7/68	465	2	S.E. troll[2]	7/69	3
	8/56	480	(2)	Columbia	7/57	(3)
	8/78	580	2	Kamchatka	7/79	3
Gulf of Alaska (off Yakutat)	7/61	610	2	S.E. Alaska	8/61	2
	6/61	560	2	"	7/61	2
	7/61	395	2	British Columbia	7/61	2
	6/61	555	2	"	7/62	3

[1]Number of winters spent at sea. Ages estimated from length in parenthesis.

[2]Fish caught in northern southeast troll fishery. Origin unknown.

Table 2. Commercial catches of chinook salmon in high seas and coastal fisheries in thousands of fish, 1957-1986.

Year	High seas	U.S.S.R.	Western Alaska: Yukon[1]	Western Alaska: Kuskokwim	Western Alaska: Bristol Bay[2]	Central Alaska	S.E. Alaska
1957	80	90	64	0	91	60	300
58	99	70	67	0	103	45	325
59	147	97	81	4	84	47	367
60	311	69	72	6	112	41	310
61	116	64	129	23	89	31	230
62	251	100	106	21	84	42	206
63	192	124	126	19	62	35	258
64	618	160	99	21	140	22	357
65	287	107	121	24	113	31	287
66	326	93	96	26	77	24	308
67	243	91	133	30	117	26	301
68	459	83	110	43	104	20	332
69	642	122	95	65	125	38	314
70	585	141	83	65	141	33	322
71	345	183	116	45	123	45	334
72	368	197	98	57	70	42	287
73	284	210	79	51	44	30	344
74	549	172	103	31	46	29	347
75	299	223	69	28	30	28	301
76	486	196	94	50	96	49	242
77	239	310	106	59	136	40	285
78	315	314	112	63	206	55	401
79	286	279	145	54	230	40	367
80	864	126	170	49	112	30	323
81	278	157	174	79	256	49	272
82	272	178	138	78	284	86	300
83[3]	265	219	123	81	228	111	293
84[3]	174	205	138	74	127	60	270
85[3]	167	--	178	74	151	78	244
86[3]	137	--	117	45	106	79	232

[1] Includes Norton Sound and Canadian Yukon.
[2] Includes north side of Alaska Peninsula.
[3] Preliminary statistics for Alaskan catches.

Table 3. Estimates of annual runs of chinook salmon in thousands of fish, 1965-1985.

Year	Region				
	Kamchatka	Yukon	Kuskokwim	Bristol Bay	Central Alaska
1965	170	170	140	235	--
66	160	210	200	158	--
67	160	170	230	215	--
68	200	230	180	22	--
69	240	190	240	200	--
70	290	160	270	239	--
71	340	150	200	192	--
72	380	200	200	121	--
73	330	170	180	110	--
74	280	160	120	155	--
75	360	120	100	135	--
76	320	146	144	235	340
77	430	193	176	245	460
78	410	247	191	416	380
79	390	294	206	374	370
80	200	380	197	334	360
81	260	410	272	491	400
82	270	223	245	524	340
83	280	258	237	465	510
84	--	--	--	282	430
85	--	--	--	304	--
Means (1976-83)	320	269	208	385	395

Table 4. Catches (in hundreds) and stock compositions (%) of immature 2-ocean chinook salmon in the mothership fishery by sub-area, year, and month.

				Stock percentages							
Sub-		Catch		West. Alaska		Yukon		Kuskokwim		Bristol Bay	
area	Year	June	July	June	July	June	July	June	July	June	July
3	75	14	27	22	18	60	0	0	67	40	33
	76	64	134	-	22	-	100	-	0	-	0
	77	1	23	-	14	-	100	-	0	-	0
	78	6	19	-	43	-	100	-	0	-	0
	79	2	1	-	46	-	100	-	0	-	0
	80	7	67	-	11	-	100	-	0	-	0
	81	1	4	-	-	-	-	-	-	-	-
5	75	45	15	8	0	70	0	0	0	30	0
	76	17	49	32	15	100	100	0	0	0	0
	77	18	73	21	19	69	88	3	0	28	12
	78	9	685	40	27	80	100	20	0	0	0
	79	94	305	51	19	67	74	33	26	0	0
	80	140	2295	30	11	100	100	0	0	0	0
	81	39	539	36	27	73	60	26	23	1	17
7	75	44	63	41	6	71	67	0	33	29	0
	76	70	425	13	30	100	100	0	0	0	0
	77	31	77	37	19	72	35	0	58	28	7
9	75	49	1	32	5	79	100	17	0	4	0
	76	66	174	8	21	100	100	0	0	0	0
	77	18	+	16	10	92	100	0	0	8	0
6	75	2	317	63	79	100	41	0	18	0	41
	76	55	149	63	46	100	93	0	0	0	7
	77	0	15	-	-	-	-	-	-	-	-
	78	21	2	-	-	-	-	-	-	-	-
	79	+	34	-	-	-	-	-	-	-	-
	80	9	127	-	83	-	44	-	56	-	0
	81	+	4	-	-	-	-	-	-	-	-
8	75	18	123	47	82	49	82	0	0	51	18
	76	48	152	60	45	52	77	48	0	0	23
	77	13	95	92	40	49	33	27	0	24	67
	78	58	6	-	-	-	-	-	-	-	-
	79	+	341	-	70	-	57	-	27	-	16
	80	97	1679	-	89	-	68	-	32	-	0
	81	+	92	-	59	-	70	-	17	-	13

Table 4. Catches (in hundreds) and stock compositions (%) of immature 2-ocean chinook salmon in the mothership fishery by sub-area, year, and month - cont'd.

				Stock percentages							
Sub-		Catch		West. Alaska		Yukon		Kuskokwim		Bristol Bay	
area	Year	June	July	June	July	June	July	June	July	June	July
10	75	30	429	48	94	84	70	0	0	16	30
	76	171	336	76	69	39	23	20	77	41	0
	77	77	254	94	81	24	24	48	32	28	44
	78	1	15	-	83	-	86	-	0	-	14
	79	1	312	-	81	-	36	-	38	-	26
	80	19	2017	-	91	-	34	-	61	-	5
	81	0	79	-	44	-	73	-	8	-	19

Table 5. Estimates of western Alaskan stock compositions (%) by region, year, and ocean age.

Region	Year	Age	Yukon	Kuskokwim	Bristol Bay	Catch (100s)
Bering Sea (6,8,10)	75	.2	65.4	6.0	28.6	780
		.3	--	--	--	43
		Comb.	65.4	6.0	28.6	
	76	.2	49.9	36.3	13.7	562
		.3	45.6	54.0	0.4	55
		Comb.	49.5	37.9	12.5	
	77	.2	26.1	31.3	42.6	393
		.3	42.6	54.5	2.9	49
		Comb.	27.9	33.9	38.2	
	78	.2	56.9	22.7	20.4	74
		.3	58.3	39.8	1.9	3
		Comb.	57.0	23.4	19.7	
	79	.2	46.2	32.7	21.1	517
		.3	41.5	58.5	0	9
		Comb.	46.1	33.1	20.7	
	80	.2	49.2	47.4	3.4	3525
		.3	6.6	93.3	.1	247
		Comb.	46.4	50.4	3.2	
	81	.2	71.4	13.4	15.2	92
		.3	99.9	.1	0	17
		Comb.	75.8	11.3	13.9	
North Pacific (3,5,7,9)	75	.2	65.6	14.7	19.7	49
		.3	47.2	46.3	6.5	6
		Comb.	63.6	18.1	18.3	
	76	.2	98.8	.6	.6	234
		.3	48.8	43.9	7.3	+
		Comb.	98.8	.6	.6	
	77	.2	68.5	17.0	14.5	50
		.3	39.4	35.0	25.6	10
		Comb.	63.6	20.0	16.4	
	78	.2	96.8	3.2	0	235
		.3	47.0	46.3	6.7	22
		Comb.	92.5	6.9	.6	
	79	.2	70.8	29.2	0	107
		.3	47.3	46.2	6.5	17
		Comb.	67.6	31.5	.1	

Table 5. Estimates of western Alaskan stock compositions (%) by region, year, and ocean age - cont'd.

Region	Year	Age	Yukon	Kuskokwim	Bristol Bay	Catch (100s)
	80	.2	99.8	.1	.1	330
		.3	41.3	56.3	2.4	39
		Comb.	93.6	6.0	.3	
	81	.2	61.6	23.2	15.2	160
		.3	72.7	24.0	3.3	13
		Comb.	62.4	23.3	14.3	

Table 6. Average regional stock composition (%) in the mothership fishery for the Bering Sea and North Pacific areas, 1975-77 and 1978-81.

Region of Origin	1975-77 Bering	1975-77 Pacific	1978-81 Bering	1978-81 Pacific
Asia	17	16	12	25
Yukon	36	14	42	20
Kuskokwim	19	3	22	4
Bristol Bay	20	2	11	1
Central Alaska	7	62	13	42
Southeastern-British Columbia	1	3	0	8

Table 7. High seas catches of chinook salmon (MS = mothership, LBDN = landbased driftnet) and the apportioned catches to coastal regions, 1958-1986. Numbers of fish in thousands.

	High seas catches			Regional estimates					
	Bering	North Pacific							
Year	Sea MS	MS	LBDN	USSR	Yukon	Kusk.	B.B.	C.AK	SE BC
1958	0	58	41	17	14	2	2	61	3
59	30	38	79	24	27	9	9	75	3
60	141	39	131	51	75	32	31	115	7
61	10	21	85	20	18	5	4	66	3
62	+	122	129	40	35	8	5	155	8
63	41	46	105	31	36	12	11	96	6
64	204	206	208	101	131	51	49	271	15
65	116	69	102	47	66	27	33	109	5
66	123	85	118	54	73	29	29	134	7
67	71	57	115	40	50	18	17	112	6
68	294	68	97	77	129	61	62	122	8
69	448	106	88	108	188	91	94	151	10
70	404	33	148	98	170	83	85	140	9
71	161	45	139	56	84	37	36	125	7
72	223	38	1097	61	101	46	48	106	6
73	36	83	165	46	48	14	12	157	7
74	241	120	188	90	131	55	54	208	11
75	114	48	137	40	83	11	34	120	11
76	125	160	201	58	116	32	11	264	5
77	55	38	146	55	39	23	24	97	1
78	12	93	210	69	88	8	3	105	42
79	71	55	160	74	65	37	12	98	+
80	432	272	160	96	229	196	13	275	55
81	21	67	190	86	55	18	12	94	13
82	39	68	165	63	63	18	6	103	19
83	22	65	178	64	58	15	4	105	19
84	32	50	92	40	41	13	5	64	11
85	16	50	101	40	37	10	3	65	12
86	19	41	77	32	32	9	3	52	9

Table 8. Yukon region catches of chinook salmon and estimated interceptions from high seas fishing, 1961-1986 (number of fish in thousands).

	In-river catch		Norton Sd.		High seas catch[1]	
Year	Commercial	Subsistence	catch	Total	Number	% of inshore
1961	124	21	5	150	39	26
62	99	11	7	117	53	45
63	119	25	7	151	28	19
64	97	16	2	115	34	30
65	120	17	1	138	66	48
66	94	12	2	108	103	95
67	131	16	2	149	75	50
68	109	12	1	122	66	54
69	93	14	2	109	76	70
70	81	14	2	97	138	142
71	113	26	3	142	177	125
72	95	20	3	118	146	124
73	77	24	2	103	97	94
74	100	20	3	123	83	67
75	67	13	2	82	78	95
76	92	18	2	112	109	97
77	102	18	4	124	98	79
78	102	30	10	142	90	63
79	134	31	11	176	61	35
80	164	43	6	213	77	36
81	166	30	8	204	117	57
82[2]	132	28	6	166	160	96
83[3]	113	49	10	172	75	44
84[3]	130	42	8	180	61	34
85[3]	159	40	19	218	53	24
86[3]	111	40	6	157	42	27
87					36	
88					23+	

[1] Prorated to year of inshore run assuming 30% age .3, 60% age .4, and 10% age .5.

[2] INPFC Yearbook for in-river catch, ADF&G Yukon Area salmon report gives a catch of 148,000+.

[3] Preliminary from ADF&G.

Table 9. Estimates of interceptions of Yukon chinook salmon in foreign and joint-venture (J/V) trawl fisheries in the Bering Sea/ Aleutian Islands region of the U.S. FCZ, 1977-1985 (numbers of fish in hundreds).

Year	Foreign-J/V catch[1]	W.A. %[1]	W.A. catch	Yukon %[2]	Yukon catch
1977	435	(50)	217	27.9	61
78	391	(50)	195	57.0	111
79	1004	50.3	505	46.1	233
80	1150	(50)	575	46.4	267
81	362	46.3	168	75.8	127
82	157	53.0	83	(53)	44
83	103	(50)	51	(53)	27
84	113	(50)	56	(53)	30
85	96	(50)	48	(53)	25

[1] Source: Myers and Rogers (1983). Percentages in parenthesis from mean of 1979, 1981-82 estimates.

[2] Source: Table 6, Bering Sea estimates. Percentages in parenthesis are the mean from 1975-81 estimates.

Table 10. Commercial catches of chum salmon in high seas and coastal fisheries in millions of fish, 1957-1986.

Year	High seas	Asia	Western Alaska: Yukon[1]	Western Alaska: Kuskokwim	Western Alaska: Bristol Bay[2]	Central Alaska: False Pass[3]	Central Alaska: Other
1957	16.5	12.1	0	0	.53	.30	4.32
58	29.3	11.2	0	0	.61	.20	3.04
59	23.4	12.5	0	0	.88	.10	1.81
60	20.7	13.6	0	0	1.93	.10	3.58
61	13.5	13.4	.09	.02	.88	.19	1.89
62	15.4	13.4	.36	.05	.71	.28	3.74
63	15.2	14.4	.21	0	.43	.12	2.23
64	19.3	11.8	.23	+	.94	.23	3.93
65	15.6	15.2	.10	+	.43	.17	1.47
66	22.3	13.5	.18	+	.42	.23	2.34
67	19.1	11.5	.12	.01	.52	.12	1.08
68	17.3	7.8	.14	.02	.44	.17	2.67
69	12.9	7.1	.33	.05	.36	.27	1.37
70	17.2	10.3	.61	.06	.77	.45	3.16
71	16.7	13.7	.58	.10	.74	.67	3.65
72	22.4	10.0	.56	.10	.74	.58	2.15
73	15.7	13.0	1.02	.18	.84	.21	1.93
74	21.8	14.9	1.67	.19	.32	0	.86
75	19.1	21.9	1.76	.22	.33	.10	1.22
76	22.4	15.1	1.01	.23	1.40	.40	1.85
77	12.2	19.1	1.18	.30	1.73	.12	3.26
78	7.3	21.5	1.62	.25	1.32	.12	2.50
79	6.1	32.4	1.51	.30	.97	.10	2.13
80	5.8	29.5	1.77	.56	2.00	.53	3.10
81	5.0	39.9	2.32	.48	2.21	.57	6.18
82	5.5	36	1.29	.32	1.09	1.09	5.80
83	6.1	35	1.46	.30	1.98	.78	4.52
84[4]	5.5	--	1.22	.50	2.62	.34	3.99
85[4]	4.3	--	1.43	.22	1.56	.48	3.26
86[4]	2.9	--	1.27	.35	1.24	.34	5.36

[1] Includes Norton Sound and Kotzebue.
[2] Includes north side of Alaska Peninsula.
[3] June catches only.
[4] Preliminary.

Table 11. Estimates of chum salmon runs (R): catch (C) + escapement (E) in thousands of fish, 1956-1986.

	Nushagak			Togiak			Other B.B.			No. Peninsula			Total
Year	C	E	R[1]	C	E	R[1]	C	E	R[1]	C	E	R[2]	run
1956	173		304	25		83	118		292	427		806	1485
57	143		255	44		72	72		120	275		519	966
58	194		380	20		63	144		272	255		481	1196
59	187		435	45		118	250		520	405		764	1837
60	642		1032	255		567	419		707	607		1145	3454
61	267		651	190		288	271		386	153		289	1614
62	291		393	165		254	222		626	35	150	185	1458
63	167		363	77		122	126		286	49	203	252	1032
64	463		681	131		162	209		338	138	157	295	1476
65	177		432	112		165	72		99	69	50	119	815
66	129	80	209	95		156	118		242	83	150	233	840
67	338	200	538	63	179	242	75		191	40	122	162	1133
68	179	100	279	108	348	456	77		193	74	250	324	1252
69	214	130	344	66	85	151	53		120	30	147	177	792
70	435	273	675	101	241	342	182		300	44	170	214	1531
71	360	226	590	124	229	353	193		300	64	109	173	1416
72	310	195	530	179	170	349	168		407	84	124	208	1494
73	336	200	536	195	163	358	153		643	156	123	279	1816
74	158	100	258	81	161	242	47		438	31	105	136	1074
75	153	80	233	87	114	201	85		379	9	110	119	932
76	801	500	1301	154	392	546	374		751	74	293	367	2965
77	900	609	1509	271	496	767	427		703	128	682	810	3789
78	652	293	945	275	396	671	231		408	164	311	475	2499
79	440	166	606	220	293	513	246		361	66	305	371	1851
80	681	969	1651	300	415	715	301		635	702	769	1471	4472
81	795	177	972	230	331	561	480		635	707	541	1248	3416
82	435	256	691	151	86	237	172		266	331	458	504	1698
83	725	164	889	339	165	504	584		679	349	393	742	2814
84	680	362	1042	339	204	543	820		1061	796	870	1666	4312
85	253	288	541	206	212	418	405		569	671	344	1015	2543
86	462			270			399		639	284			

[1]For missing escapement estimates, the run was estimated from catch and rate of exploitation on male 3-ocean sockeye.

[2]1956-61 runs estimated from catch and rate of exploitation of .53.

Table 12. Catches of chum salmon in Yukon River fisheries, 1961-86 (numbers in thousands).

	Summer chum			Fall chum[1]				
Year	Commer-cial	Sub-sistence	Total	Commer-cial	Sub-sistence	Total	Total	Percent Fall
1961	0	305	305	46	107	153	458	33
62	0	262	262	54	96	150	412	36
63	0	297	297	2	125	127	424	30
64	0	361	361	10	130	140	501	28
65	0	337	337	25	122	147	484	30
66	0	155	155	74	62	136	291	47
67	11	206	217	42	83	125	342	37
68	14	134	148	53	56	109	257	42
69	62	156	218	196	57	253	471	54
70	137	167	304	208	56	264	568	46
71	100	171	271	291	72	363	634	57
72	136	108	244	155	41	196	440	45
73	286	161	447	235	61	296	743	40
74	590	278	868	292	103	395	1263	31
75	710	212	922	277	104	381	1303	29
76	601	187	788	154	76	230	1018	23
77	535	160	695	262	91	353	1048	34
78	1078	197	1275	250	101	351	1626	22
79	820	196	1016	387	246	633	1649	38
80	1068	272	1340	307	186	493	1833	27
81	1196	208	1404	493	196	689	2093	33
82	614	261	875	236	138	374	1249	30
83	895	240	1135	334	197	531	1666	32
84	756	231	987	234	181	415	1402	30
85	766	265	1031	306	211	517	1548	33
86	993	166	1159	1515	131	282	1441	20

[1]Includes Canadian catches.

Table 13. Numbers of tagged mature and immature (in parenthesis) chum salmon returned to coastal areas from tagging in the North Pacific east of 175°E.

Recovery area	Tagging regions: 175°E-175°W	175°W-165°W	165W°-155°W	155°W-145°W	East of 145°W
Kotzebue	1 (2)	19 (1)	2	3 (1)	1 (1)
Norton Sound	1	10 (1)	1	10	2
Yukon fall	3 (2)	23	3 (1)	10	2 (1)
summer	3 (2)	26 (1)	14 (1)	43(10)	18 (2)
Romanzof	0	2	0	2	1
Kuskokwim	1 (1)	18 (2)	8	18 (1)	11
Togiak	0	9	0 (1)	7 (1)	4 (1)
Nushagak	0 (2)	15	5 (2)	12	10
Naknek-Kvichak	1 (1)	18	0	4 (1)	1
Other Bristol Bay	0 (1)	9	0	2	1
No. Peninsula	0	6	3	2	0
So. Peninsula	0	0	0	18 (1)	9
Central Alaska	0	0	0	52 (6)	37
SE Alaska	1 (4)	0 (1)	0 (1)	35 (1)	145 (3)
British Columbia	0	1	1	8 (2)	98 (3)
Washington	0	1	0 (1)	1	12
Asia					
Anadyr	3 (1)	14 (1)	7	6	0
Kamchatka	5 (5)	9 (1)	5	2	1
Other	193(72)	94 (7)	9 (3)	10 (1)	4
Total	212(93)	274(15)	58(10)	245(25)	357(11)
Number Tagged					
April	0	0	356	1043	1423
May	1465	787	626	1480	2664
June	11713	5428	706	1881	1913
July	16065	3851	379	2862	2705
August	3736	369	378	671	1358

Table 14. Recoveries of tagged chum salmon in South Peninsula fisheries from 1961-1967 tagging in the Gulf of Alaska.

Tagged			Recovery					
	Date		Date				Days	Ocean
Location	Mo.	Day	Mo.	Day	Yr.	Location	out	age
4046	4	19	7	23	62	Shumagin	95	1
4050	5	18	6	21	65		34	3
4552	4	7	6	18	65		75	3
5054	5	29	6	17	64		19	3
5554	5	29	6	10	64		12	3
5556	6	29	7	4	62		5	2
5550*	7	25	6	29	67		339	3
4554	4	23	6	17	66	South Unimak	55	3
4556	5	19	6	15	62		27	4
5050	5	15	6	12	63		28	3
5050	6	4	7	3	62		29	3
5054	5	17	6	16	67		30	3
5054	5	26	6	17	66		22	4
5054	5	28	6	29	66		32	3
5550	6	8	6	27	62		19	2
5556	4	23	6	12	62		50	4
4556	5	24	7	25	63	Stepovak	62	2
5556	6	18	7	10	61	SE District	22	3
4554	5	31	8	3	62	SW District	64	2
4556	7	9	8	10	64		32	2
5556	7	13	8	16	64		34	3
4556**	4	30	6	--	62	Unknown	--	3
5056	6	18	7	18	62		30	3
5056	6	25	7	13	62		18	3
5058	6	12	7	26	61		44	3
5548**	5	24	6	26	62		33	3
5556**	6	21	7	4	61		13	3
5556	8	28	9	19	61		22	3

*Tagged as an immature in 1966 at age .2.
**Assumed False Pass recovery.

Table 14. Recoveries of tagged chum salmon in South Peninsula fisheries from 1961-1967 tagging in the Gulf of Alaska.

Tagged				Recovery					
	Date			Date				Days	Ocean
Location	Mo.	Day	Yr.	Mo.	Day	Yr.	Location	out	age
4046	4	19	120	7	23	62	Shumagin	95	1
4050	5	18	139	6	21	65		34	3
4552	4	7	98	6	18	65		75	3
5054	5	29	150	6	17	64		19	3
5554	5	29	150	6	10	64		12	3
5556	6	29	181	7	4	62		5	2
5550*	7	25		6	29	67		339	3
4554	4	23	114	6	17	66	South Unimak	55	3
4556	5	19	140	6	15	62		27	4
5050	5	15	136	6	12	63		28	3
5050	6	4	156	7	3	62		29	3
5054	5	17	138	6	16	67		30	3
5054	5	26	147	6	17	66		22	4
5054	5	28	149	6	29	66		32	3
5550	6	8	160	6	27	62		19	2
5556	4	23	114	6	12	62		50	4
4556	5	24	145	7	25	63	Stepovak	62	2
5556	6	18	170	7	10	61	SE District	22	3
4554	5	31	152	8	3	62	SW District	64	2
4556	7	9	191	8	10	64		32	2
5556	7	13	195	8	16	64		34	3
4556**	4	30	121	6	--	62	Unknown	--	3
5056	6	18	170	7	18	62		30	3
5056	6	25	177	7	13	62		18	3
5058	6	12	164	7	26	61		44	3
5548**	5	24	145	6	26	62		33	3
5556**	6	21	173	7	4	61		13	3
5556	8	28	241	9	19	61		22	3

*Tagged as an immature in 1966 at age .2.
**Assumed False Pass recovery.

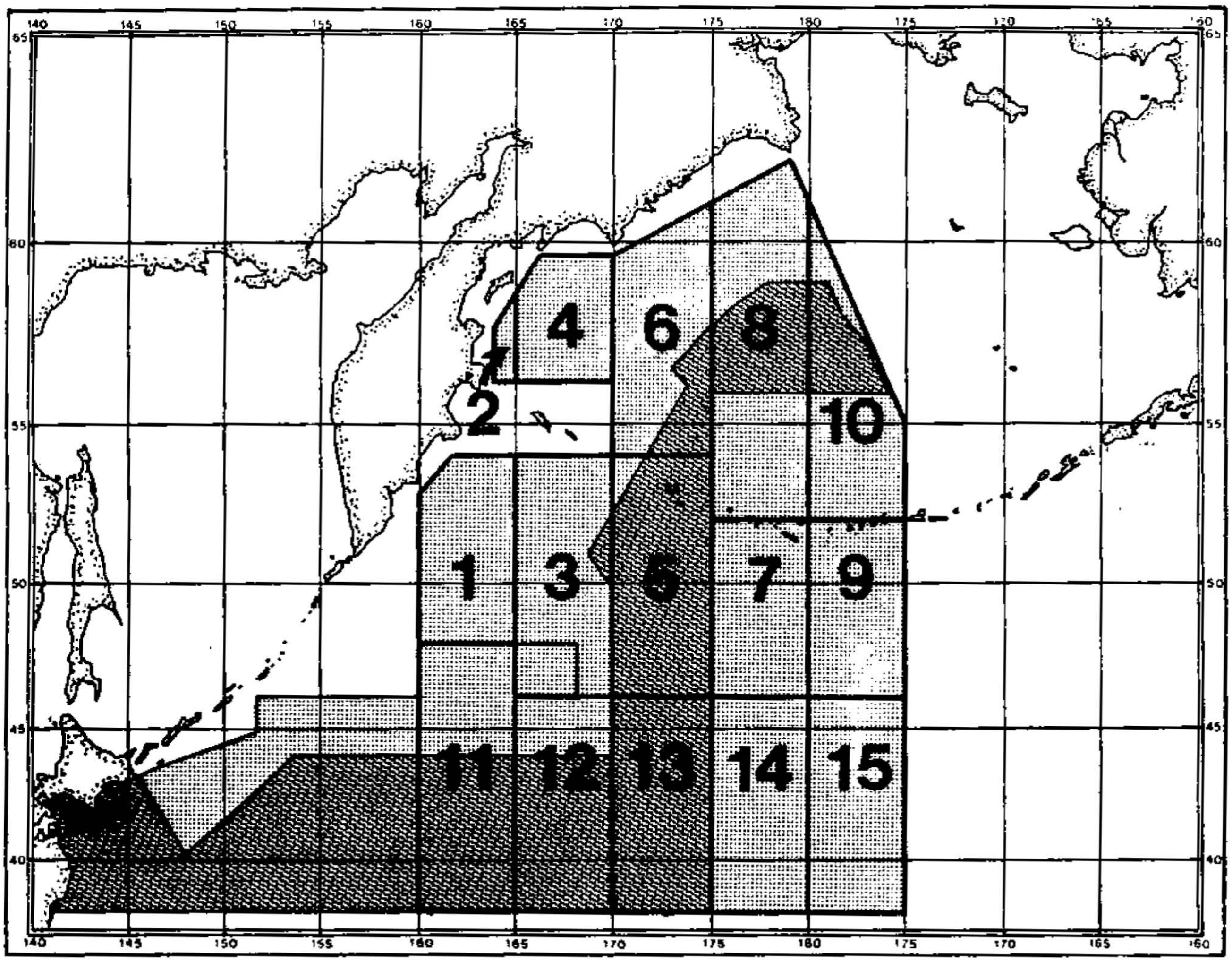

Fig. 1. Sub-areas of the Japanese salmon fisheries (Nos. 1-10) and landbased driftnet salmon fisheries (Nos. 11-15). The post-1977 fishery areas are shown by cross hatching. For the early landbased fishery, sub-area 12 extends north to 48°N.

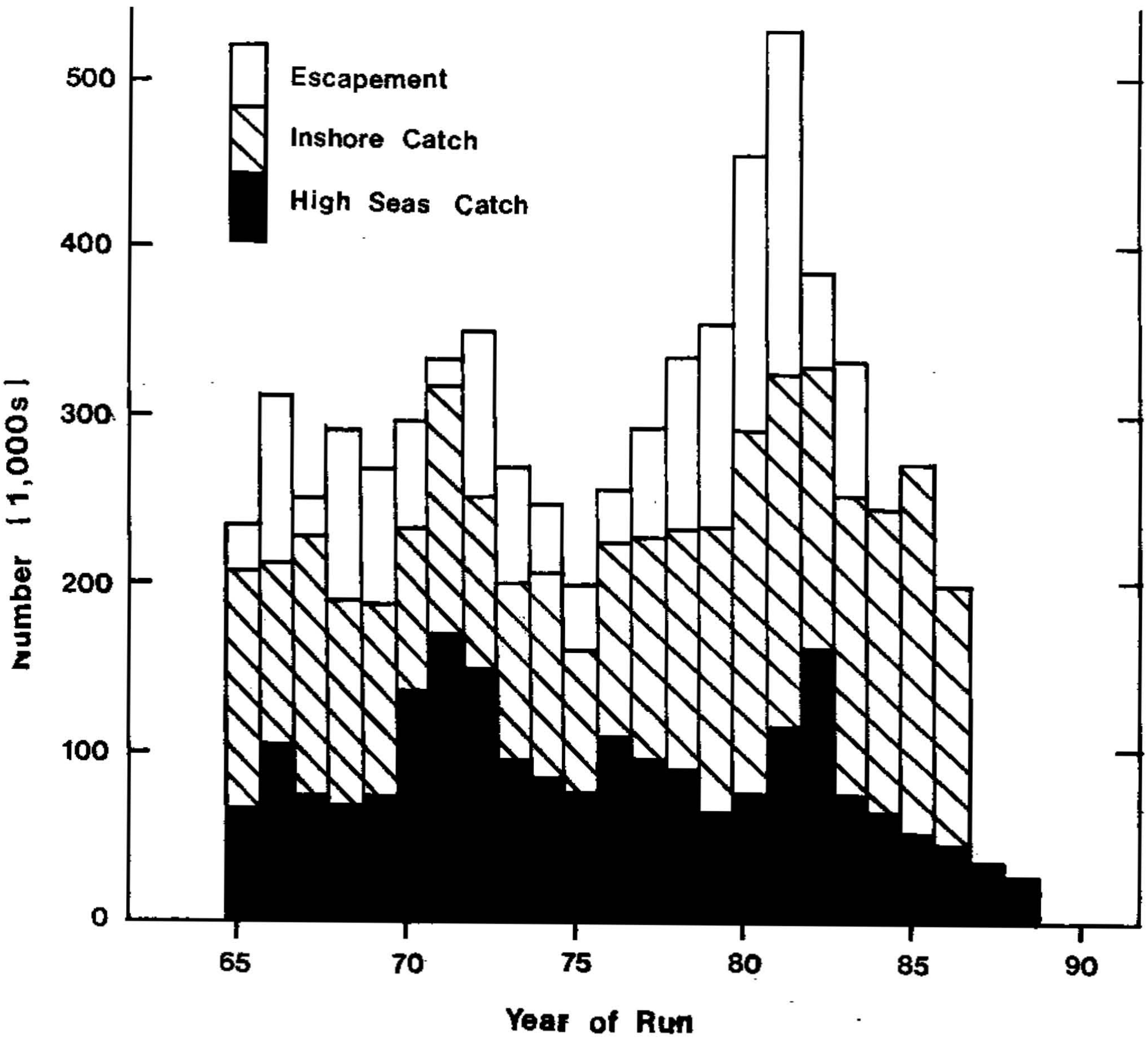

Fig. 2. Estimates of the annual Yukon chinook salmon runs including Japanese interceptions, 1965-1983, and the catches since 1983.

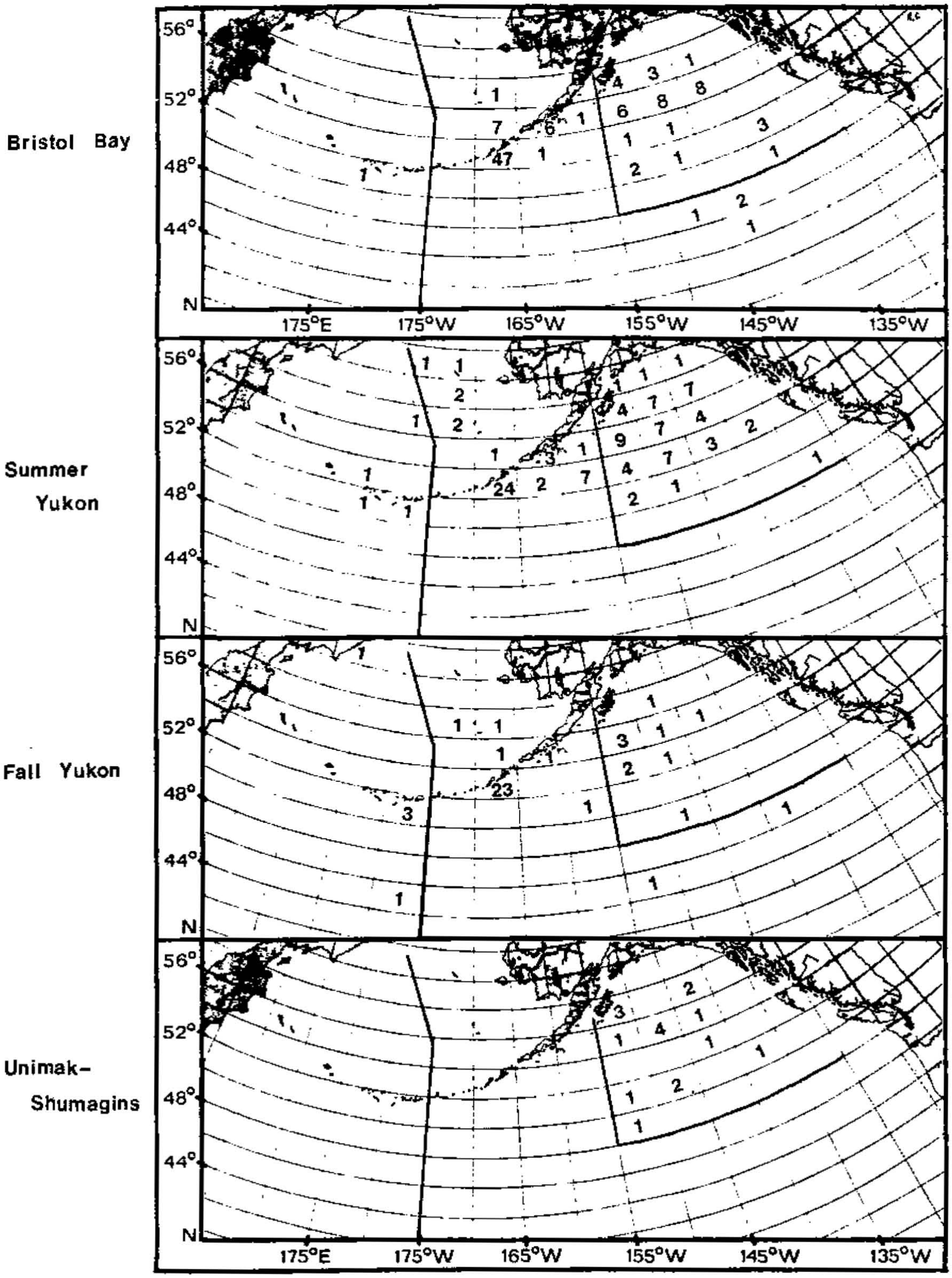

Fig. 3. Numbers of tagged mature chum salmon returned to Bristol Bay, the Yukon River, and the False Pass (Unimak-Shumagins) fisheries by 2°x5° areas of tagging.

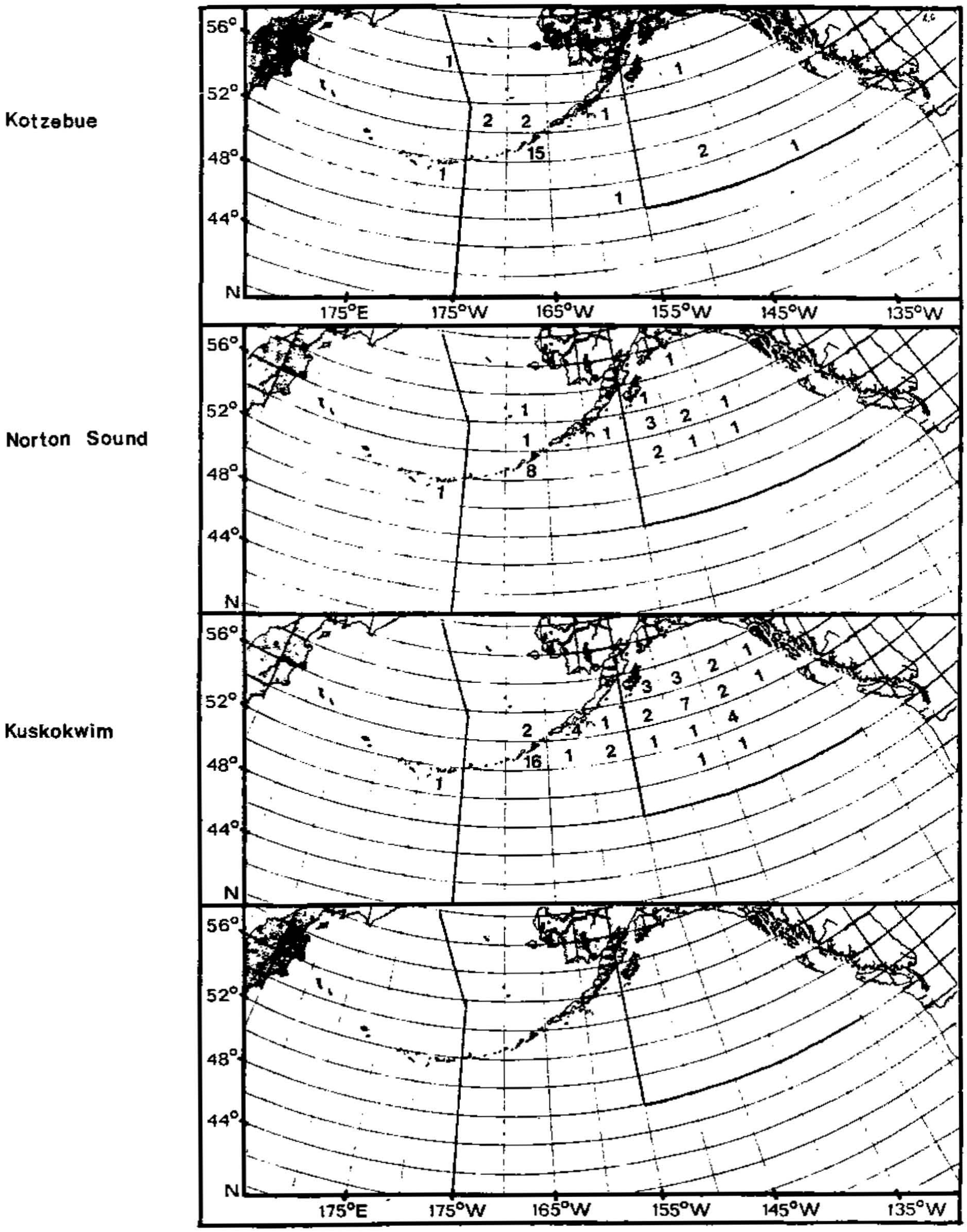

Fig. 4. Numbers of mature chum salmon returned to Kotzebue, Norton Sound, and Kuskokwim fisheries by 2°x5° areas of tagging.

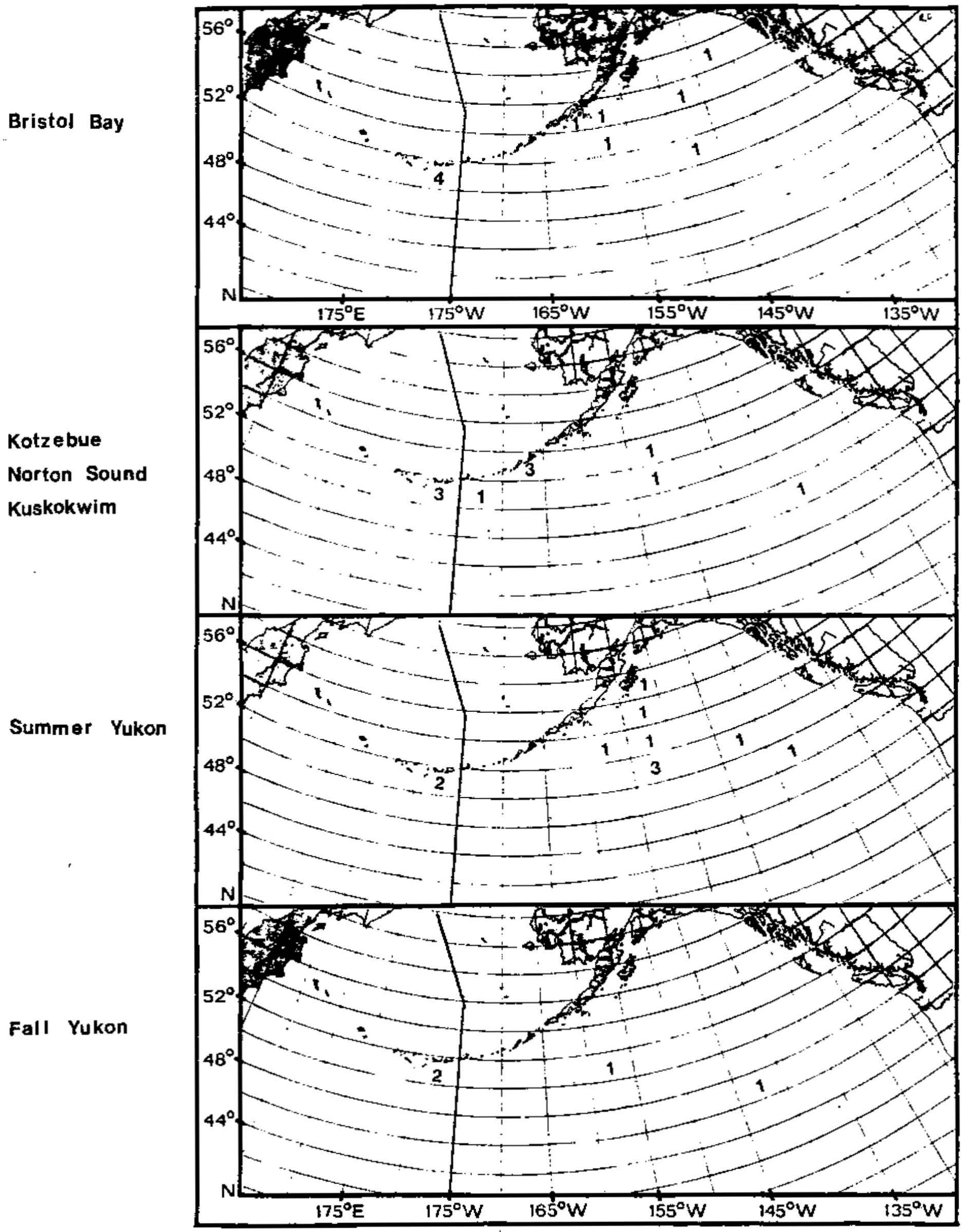

Fig. 5. Numbers of tag returns from tagged immature chum salmon to coastal fisheries in western Alaska by 2°x5° areas of tagging.

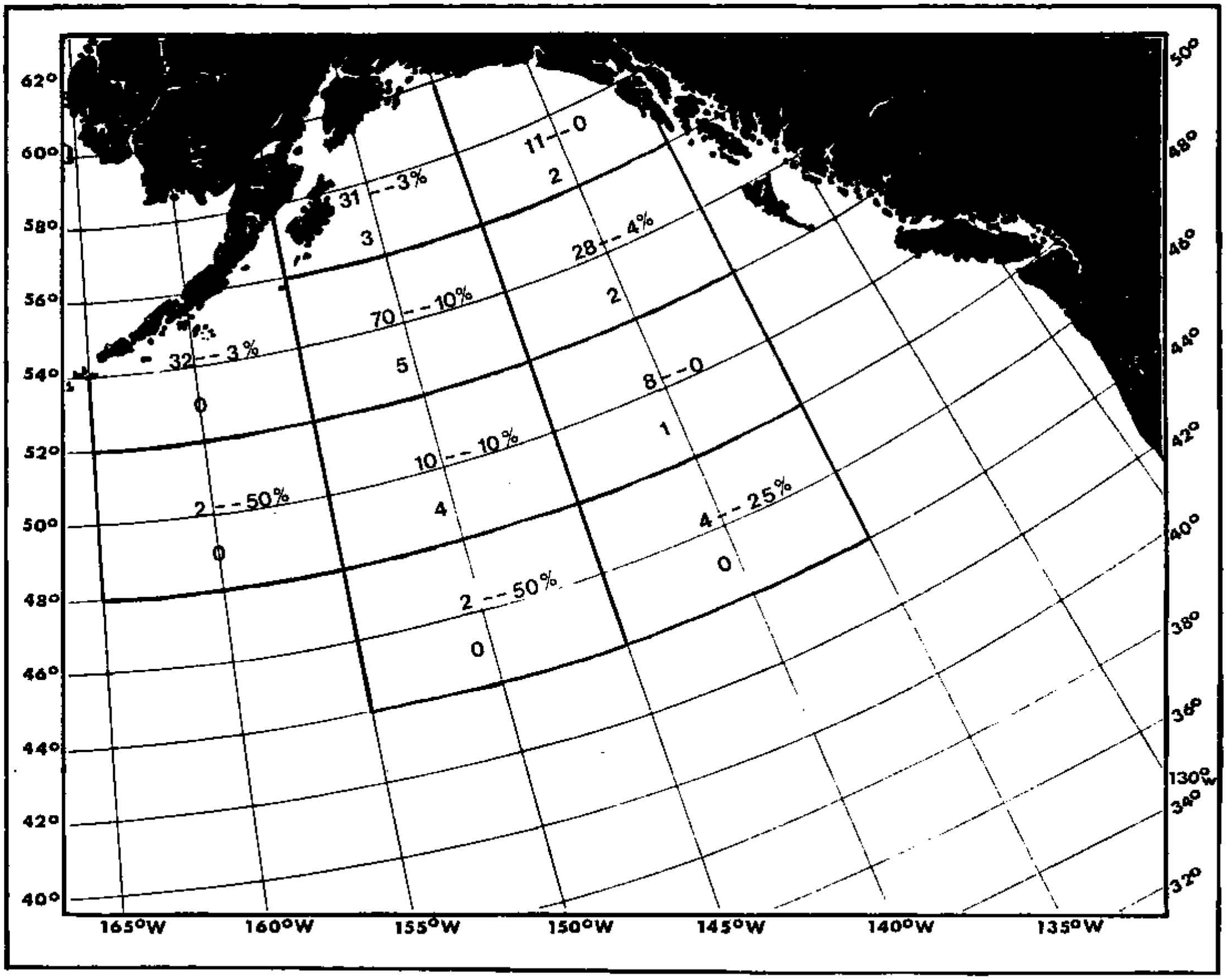

Fig. 6. Total numbers of tagged mature chum salmon returned to western Alaskan fisheries--the percentage that were Yukon fall chums and the numbers of tag returns to the False Pass fishery (below) by 4°x10° areas in the Gulf of Alaska.

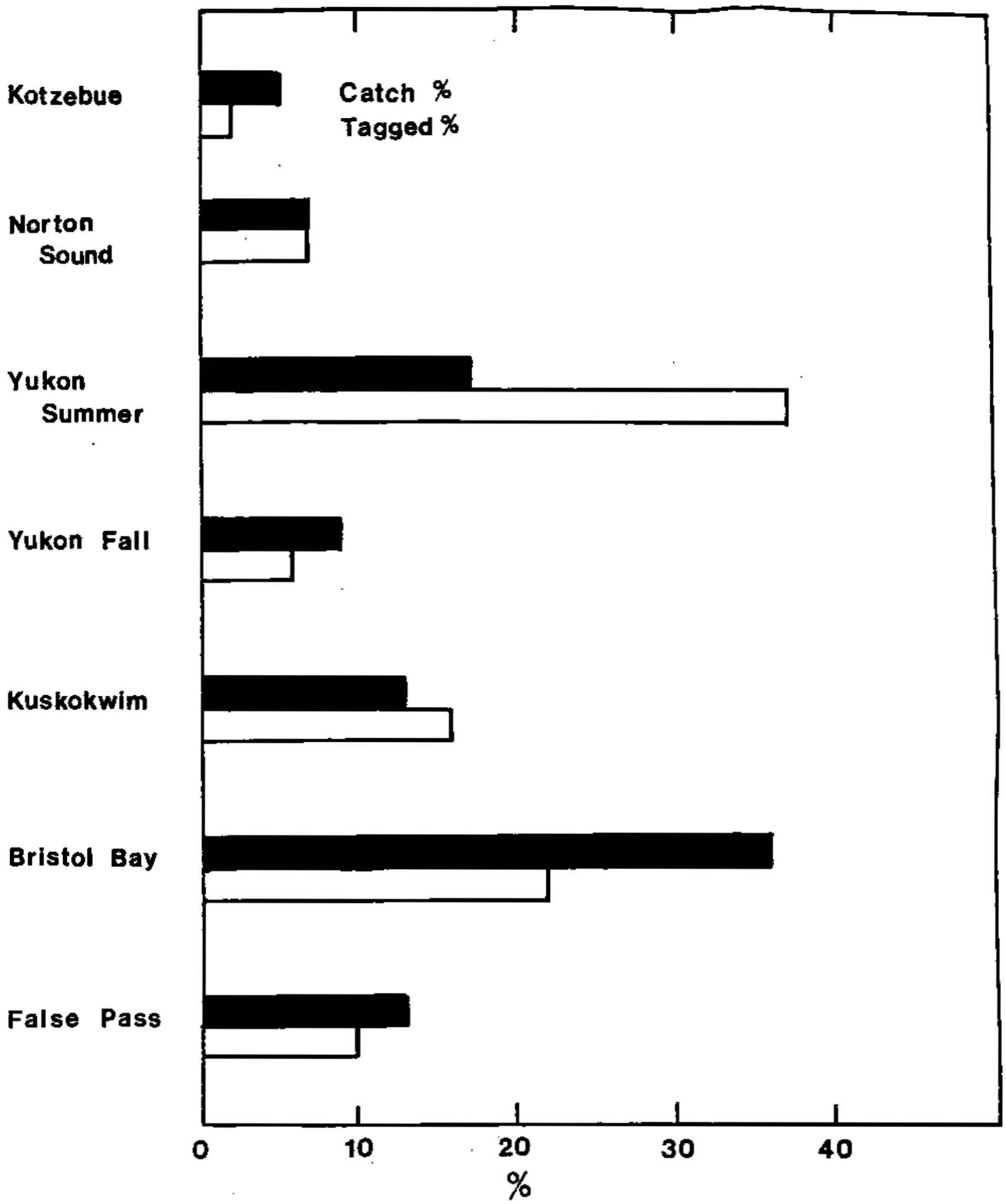

Fig. 7. Comparison of the composition of the average chum salmon catches in Western Alaskan and False Pass fisheries with the composition of tag returns from the Gulf of Alaska east of 155°W and north of 48°N.

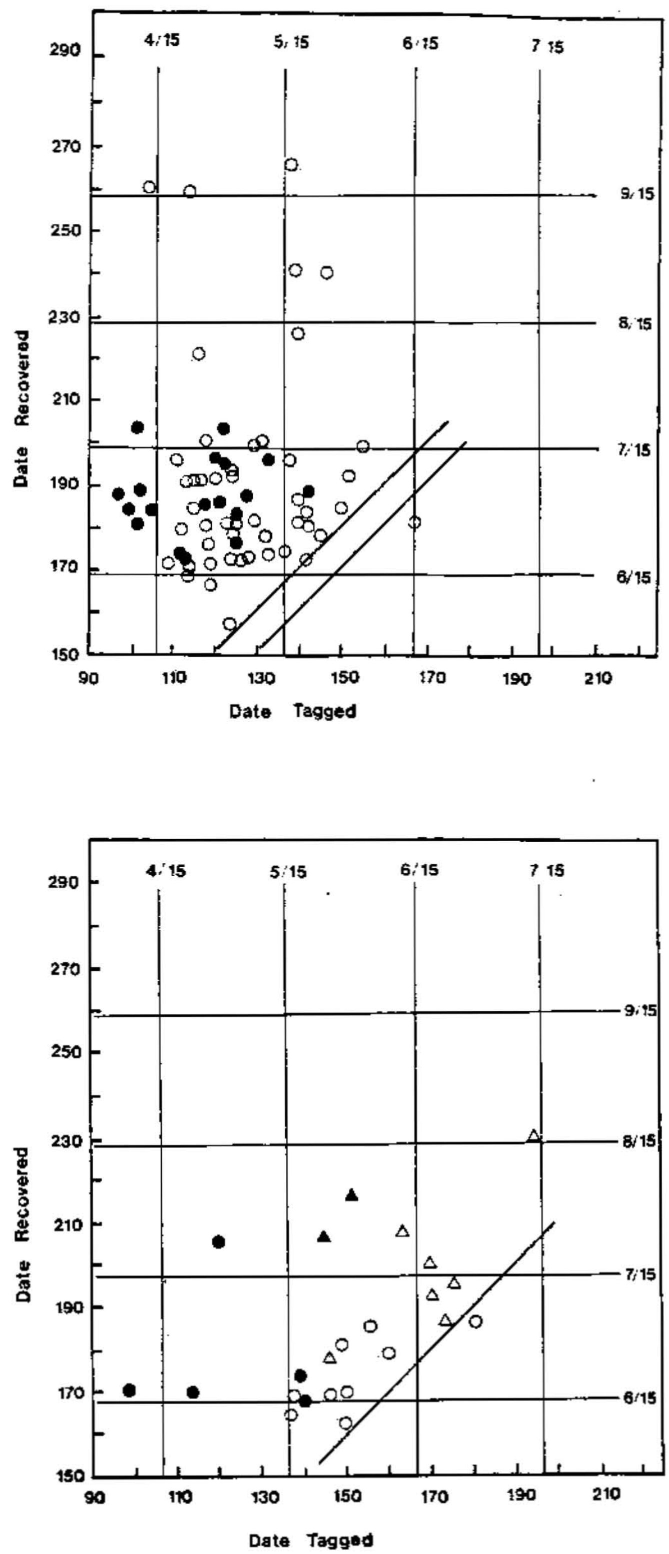

Fig. 8. Date of tag recovery plotted on date of tagging for chum salmon recovered in the Yukon River (top) and in the False Pass fishery (bottom). Solid circles for fish tagged west of 145°W, open circles for fish tagged between 155°W and 145°W, and triangles for fish recovered in local south peninsula fisheries.

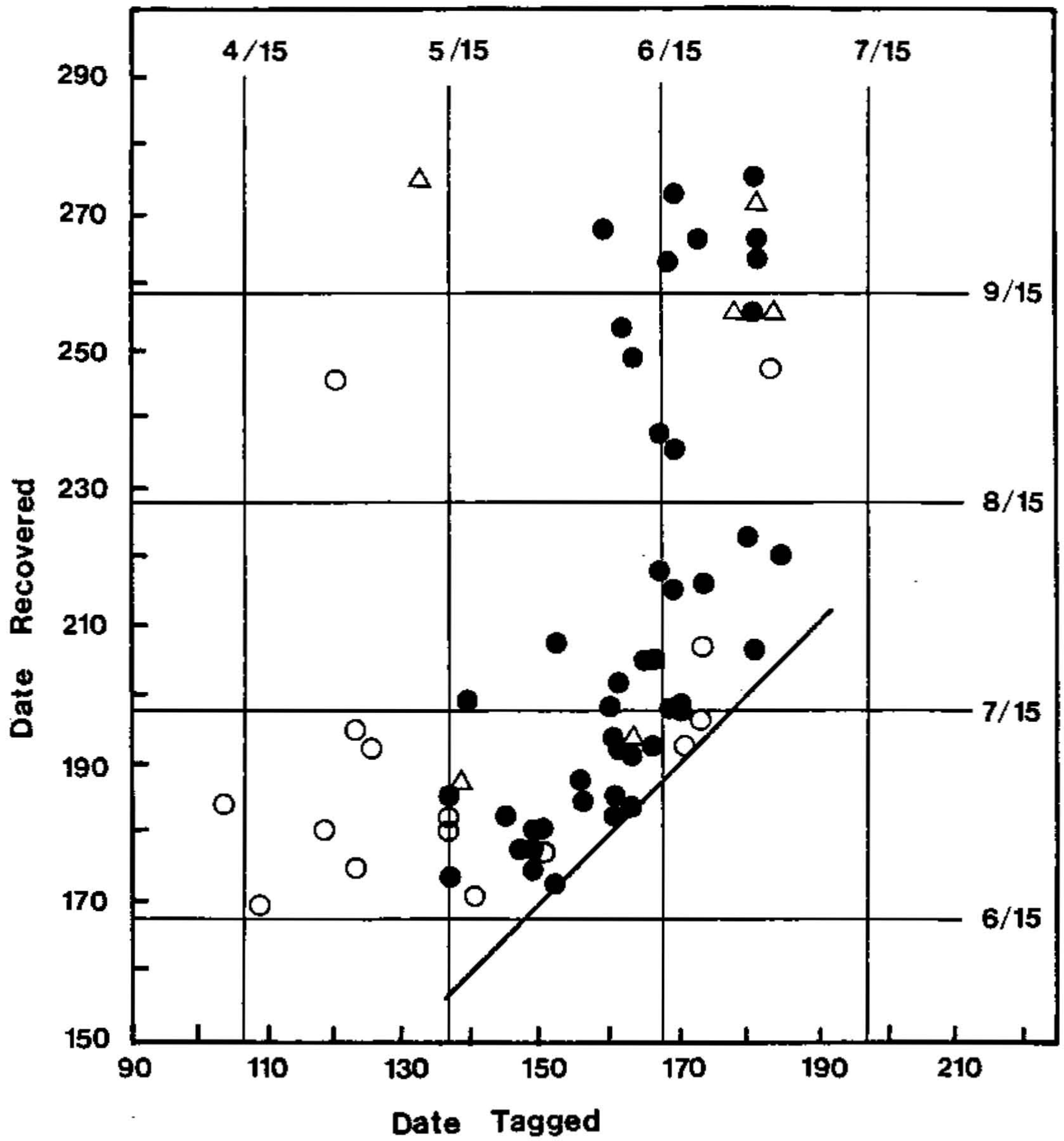

Fig. 9. Date of recovery plotted on date of tagging for chum salmon recovered in the Yukon River and tagged in the North Pacific between 155°W and 165°W (open circles), 165°W and 175°W (all north of 52°N, solid circles), and fish tagged west of 175°W (triangles).