Chinook Salmon
Stock Separation Report #1

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DETERMINATION OF STOCK ORIGINS OF CHINOOK SALMON INCIDENTALLY CAUGHT IN FOREIGN TRAWLS IN THE ALASKA FCZ

by

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INTRODUCTION

The purpose of this project is to determine the feasibility of scale pattern and age analyses to determine the origins of chinook salmon caught by foreign trawl fisheries in the Bering Sea and Gulf of Alaska. Our initial objectives were to: 1) sort, mount, and age scales from 1978-1979 trawl samples; 2) compile chinook salmon abundance and age statistics; and 3) begin the collection of scale samples from inshore areas (standards).

Our work began on October 1, 1981 with funds provided by the Alaska Department of Fish and Game (ADF&G) to determine the origins of chinook salmon caught by the Japanese mothership fishery. Similar scale standards and biological data are required for both investigations. This report summarizes our progress through December 1981.

TRAWL SCALE SAMPLES

Chinook scale samples, data forms, and sample and biological data stored on magnetic tape were obtained from the National Marine Fisheries Service (NMFS, Northwest and Alaska Fisheries Center) during mid-October. These materials included the entire collection of chinook scales and data from the Bering Sea/Aleutian Islands, Gulf of Alaska, and coastal (Washington-Oregon-California) foreign trawl fisheries from 1976 through 1980.

The scale samples consisted of a scraping of scales taken from each fish and smeared on the inside of a small manila envelope. The outside of the envelope was marked with some identification, usually a scale number, haul/set number, date, species, and scale zone. The scale zone refers to the area of the fish where the scale sample was taken. This information is of particular importance to our study, as a valid scale pattern analysis may require the use of only those scales taken from the preferred area of the fish. Observers are provided by NMFS with a diagram showing the location of preferred scale sampling (Fig. 1). When observers did not collect scales from zones A or B (Fig. 1), they usually wrote on the scale envolope the area of the fish from which scales were collected.

After initial sorting to identify regional area and year of sampling, sorting and mounting of the 1978-1979 samples from the Bering Sea/Aleutian Islands and Gulf of Alaska began during the last week in October. Lab technicians were instructed to select the largest non-

regenerated scale they could find with no damage or flaws along the measurement axis. Non-regenerated scales are identified as those having a small, regular- (circular) shaped focus. Because there is a large number of regenerated scales, each scale sample must be sorted under a binocular microscope. One scale was selected per fish, and if all of the scales in a sample were regenerated, a scale showing the least amount of regeneration was selected. Each scale was then soaked and cleaned (using a detergent and scrubbing the scale with a soft-bristle toothbrush) until all of the skin and dirt was removed. The scale was then mounted on a gummed card. Scales from different cruises were mounted on separate cards, and up to thirty scales were mounted on each card. Scale cards were labeled by year, region, cruise number, and vessel number. A plastic impression of the labeled gum card was made by a heated (approximately 100°C) hydraulic press at 5,000 psi for 3 minutes. The scale card number, scale number, and scale zone (A or B) are coded on the data forms accompanying each sample of scales from a particular cruise. If the scale was not taken from zone A or B, the zone was coded as "0" and the area from where the scale was taken (if noted by the observer) was written on the data sheet. If we find that a large number of the scales has been taken from other areas of the fish, we may later revise our coding system to reflect predominant areas. This information, as well as information on the age of the fish in the samples, will be coded to existing data files stored on magnetic tape.

Computer tabulations of data files provided by NMFS for the number of chinook salmon sampled for scales in the Bering Sea and Gulf of

Alaska by area and month from 1977 to 1980 are shown in Tables 1 and 2, respectively. The areas shown in Tables 1 and 2 correspond to the statistical areas shown in Fig. 2. If the data on the NMFS tapes accurately reflect the number of scale samples available, the total number of scale samples for the Bering Sea and Gulf of Alaska in 1978 and 1979 is 4,326 (Tables 1 and 2). Therefore, we will be processing over 1,000 more scale samples than originally requested (3,268) in the North Pacific Fishery Management Council Solicitation for Proposal (RFP 81-2). To date, the scales of approximately 2,000 chinook salmon in the 1978 and 1979 samples from the Bering Sea and Gulf of Alaska have been processed. Depending primarily upon the number of scales that must be sorted to find one that is non-regenerated or otherwise damaged and the difficulty of cleaning, lab technicians are able to process approximately 10 to 30 scale samples per hour. The number of scales per sample has ranged from 0 to 150.

Aging of scales in the trawl fishery samples is being delayed until we have standardized our criteria for interpreting chinook scale growth zones. Criteria are currently being established by several techniques, including: 1) examination of scale samples of chinook salmon of known age; 2) a survey of the literature on aging chinook salmon by scale characters; and 3) discussion with individuals experienced in aging chinook from different regions.

In addition to scale sample processing, we have started some preliminary analyses of the biological data accompanying the scale samples. Length frequency distributions of chinook sampled by U.S.

observers for scales in the Bering Sea and Gulf of Alaska foreign trawl fisheries from 1977 through 1980 are shown in Figs. 3 and 4, respectively. Because the majority of the fish in the Bering Sea fisheries was caught during winter months (Table 1), length frequencies of Bering Sea chinook were plotted for samples taken from June of one year through May of the following year (Fig. 3). Data on samples collected after December 1980 are not yet available. In contrast to the Bering Sea samples, very few samples of chinook were taken in the Gulf of Alaska fisheries from January through March of each year (Table 2), so length frequencies for each year were plotted separately (Fig. 4). Mean lengths of chinook in the Bering Sea samples were less consistent from period to period than mean lengths of chinook in the Gulf of Alaska samples (Figs. 3 and 4). Modes in the length frequency distributions, presumably representing different age classes in the samples, are variable from period to period in both areas. Much of this variability probably can be attributed to spatial and temporal variability in sample composition (Tables 1 and 2). The differences in peak modes in the distributions plotted for chinook samples taken in 1978-1979 and 1979-1980 in the Bering Sea (Fig. 3) suggest a shift in the predominant age category, perhaps representing the presence of a dominant year class. A detailed analysis of length and other biological data will be made after the scale samples have been aged.

CHINOOK SALMON ABUNDANCE

The regional and temporal distributions of chinook salmon abundance are important considerations in constructing scale standards since the probability that a fish from a particular stock is caught by the trawl fishery is likely to depend on the abundance, location, and migratory behavior of the stock. The annual abundance of a stock (salmon run to a river system) is the sum of the catch and escapement. Unfortunately a high proportion of the world chinook salmon catch is not made near coastal spawning areas and consists of immature fish; in addition, the numbers of fish in escapements are either unknown or imprecisely known over much of the chinook salmon's range.[1]

Based on coastal catches of pink, chum, and sockeye salmon, these species are more abundant along the northern rim of the North Pacific than they are along the western coast of North America (Fig. 5). In contrast, coho and chinook salmon are more abundant in the southern region (Fig. 6). However, rates of exploitation on coho and chinook salmon historically have been much lower in the northern region because other species are so much more abundant there.

There have been exceptionally large catches of all species of salmon in western and central Alaska in recent years (since 1978), and

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[1]Data sources: Fredin (1980), INPFC (1979), Major et al. (1978), INPFC Statistical Yearbooks, PFMC proposed management plan for 1981, and personal communication with fisheries agencies (1978-1980 data).

the catches in 1981 were historical records; whereas, catches in the southern region either have declined or remained relatively level in recent years.

Commercial catches of chinook salmon recently have declined in Oregon, southeastern Alaska, and central Alaska. (In the latter area the decline is caused largely by severe restrictions on the Cook Inlet fishery since the 1960's.) Catches in California and Washington have changed little since 1921; however, catches in British Columbia have increased dramatically (Fig. 7). Based on commercial catches, it appears that British Columbia now produces the largest abundance of chinook salmon around the North Pacific, but this is unlikely because most of the British Columbia catch comes from troll fisheries that catch predominantly immature and maturing fish (Fig. 8).

Chinook salmon from southern regions tend to migrate north in their seaward migration and are distributed as far north and westward as the central Aleutians during their ocean residence.[2] Then, while maturing, they tend to migrate south along the North American coast and are thus vulnerable to several offshore and some coastal fisheries (Major et al. 1978). The center of chinook salmon production in the southern region is in the Oregon-Washington area (to include the Columbia River) based on estimated escapements and the locations of catches (Table 3). For

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[2]Of the four inshore recoveries of chinook salmon tagged near Adak, one each was recovered from Kamchatka, Bristol Bay, southeastern Alaska, and the Columbia River.

the entire region the annual abundance in recent years was about 5 million and the rate of exploitation was nearly 80%.

Chinook salmon from western Alaska and Kamchatka probably reside primarily in the Bering Sea and western Gulf of Alaska during their ocean residence, and are unlikely to occur in the eastern Gulf of Alaska. The 1976-1980 average catch of chinook salmon in the northern region (including high seas catches, 38%) was about 1.3 million and, assuming a rate of exploitation of 65%, the average annual abundance was about 2 million.

The annual fluctuations in the catches of chinook salmon generally have been much less than the fluctuations in the catches of other species of salmon; however, the high seas catch of chinook salmon in 1980 (primarily immature fish) coupled with the western Alaska catch in 1981 (USSR catch in 1981 is presently unknown) provide a major exception. The annual commercial catches since 1960 are shown by area and gear in Fig. 9. The 1981 catches are unavailable except for Alaska, and the 1979-1980 catches in British Columbia are not yet available. Catches in 1973 were exceptionally high in the southern region but exceptionally low in the northern region, and there is some indication of an inverse relationship between the abundances in the two regions. The 1980 catch on the high seas (including the trawl catch) was nearly 1 million and was thus higher than any recent catch of any inshore fishery with the exception of the British Columbia troll fishery.

In our next report we will present statistics on the age and abundance of chinook salmon stocks (rivers) within major areas. These data will be used to construct scale sample standards for the areas.

SCALE STANDARDS

We have begun collecting chinook salmon scales which will be used to construct standards for the stock separation projects. In most river systems, 200 samples (fish) will have sufficient numbers of useful scales to construct a particular standard. We are requesting samples of this quantity per major chinook river system per year from 1975 to the present. Often, less than the desired sample size is available and, in these situations, we have asked for all available samples.

We have collected or received samples from Washington, British Columbia, Yukon Territory, and Alaska (Table 4). This table represents only the acetate impressions or scale samples presently at Fisheries Research Institute and not the expected final number of samples from any area.

The biologists working on the stock separation problem met with John Sneva (the biologist in charge of scale work for the Washington State Department of Fisheries) to discuss problems encountered in aging and interpreting Washington's wild and hatchery chinook runs. We collected scales from known aged (coded-wire tagged) fish for later reference to familiarize our staff with reading chinook scales from Washington State, and we hope to obtain similar samples from Oregon, British Columbia, and Alaska. Also, we spent 3 days with personnel of the ADF&G stock

separation laboratory in Anchorage to coordinate scale analysis and data processing techniques.

LITERATURE CITED

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International North Pacific Fisheries Commission Secretariat. 1979. Historical catch statistics for salmon of the North Pacific Ocean. INPFC Bull. 39:1-166.

Major, R. L., J. Ito, S. Ito, and H. Godfrey. 1978. Distribution and origin of chinook salmon (Oncorhynchus tshawytscha) in offshore waters of the North Pacific Ocean. INPFC Bull. 38:1-54.

Table 1. The number of chinook salmon sampled for scales in the foreign trawl fisheries in the Bering Sea by area and month, 1977-1980.

	AREA AND YEAR											
	BERING 1				BERING 2				BERING 3			
Month	1977	1978	1979	1980	1977	1978	1979	1980	1977	1978	1979	1980
Jan	0	0	0	1	0	239	228	27	0	0	0	0
Feb	0	0	2	9	26	20	1706	40	0	0	0	1
Mar	0	0	1	6	9	22	257	6	0	0	0	0
Apr	0	1	0	9	2	13	220	22	0	0	0	0
May	0	2	5	8	0	9	87	2	0	0	1	0
Jun	0	18	16	0	0	0	2	0	0	0	0	0
Jul	0	4	20	0	1	0	0	0	0	1	0	0
Aug	0	12	44	7	2	0	0	0	0	0	0	0
Sep	3	9	71	10	2	2	0	0	0	0	0	0
Oct	42	21	166	21	58	11	20	0	0	1	0	0
Nov	127	15	5	119	7	96	139	76	0	0	0	0
Dec	18	1	21	17	13	10	114	44	0	0	1	0
TOTAL	190	83	351	207	120	422	2773	217	0	2	2	1

Table 2. The number of chinook salmon samples for scales in the foreign trawl fisheries in the Gulf of Alaska by area and month, 1977-1980.

	AREA AND YEAR																			
	SHUMAGIN				CHIRIKOF				KODIAK				YAKUTAT				SOUTHEASTERN			
Month	1977	1978	1979	1980	1977	1978	1979	1980	1977	1978	1979	1980	1977	1978	1979	1980	1977	1978	1979	1980
Jan	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Feb	0	0	0	0	0	0	0	0	0	0	0	0	23	0	0	0	7	0	0	0
Mar	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apr	1	0	0	0	0	12	0	5	0	0	0	0	0	1	0	0	0	0	0	0
May	0	29	0	4	0	46	0	0	0	0	49	0	0	2	4	0	2	4	0	0
Jun	3	0	15	2	0	1	8	0	3	23	34	13	2	0	0	1	0	0	2	0
Jul	0	5	4	3	0	1	4	0	45	2	13	1	0	0	1	0	0	0	0	0
Aug	0	0	10	0	2	0	2	0	25	1	19	2	0	0	0	0	0	0	0	0
Sep	0	5	66	3	2	0	0	0	6	5	5	4	0	0	1	2	0	0	0	0
Oct	0	59	19	16	0	0	0	1	6	5	32	50	0	0	2	3	0	0	8	0
Nov	0	75	21	2	1	5	0	13	7	34	16	2	1	0	1	0	0	0	0	0
Dec	0	0	44	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	4	173	179	35	5	65	14	19	92	70	168	72	26	3	9	6	9	4	8	0

Table 3. Estimates of chinook salmon escapements (wild and hatchery), 1976-1980. (Fish in thousands.)

Year	California	Oregon-Washington	British Columbia	Southeast Alaska	Total
1976	258*	593	164	18	1,033
1977	258*	660	224	30	1,172
1978	290	702	196	20	1,208
1979	269	581	177	25	1,052
1980	216	643	190*	39	1,088
Average 1976-80	258	636	190	26	1,111
Average catch (all gear)	671	1,361	1,719**	339	4,090

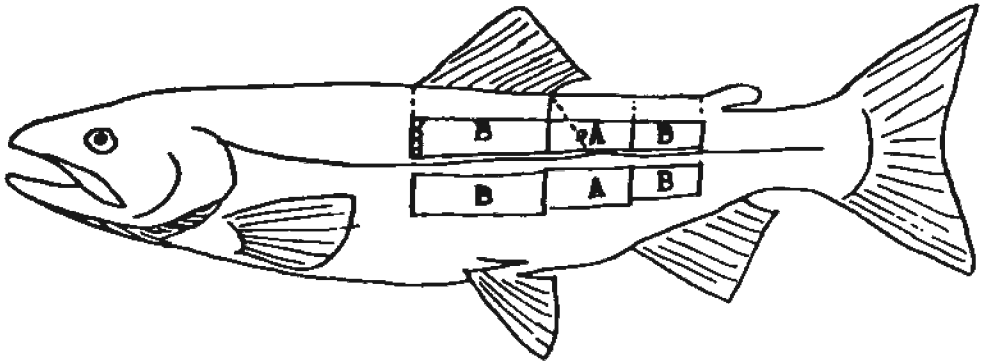
*Estimate from average of other years.
**1976-1978 average only.

Table 4. Numbers of chinook salmon scale samples collected.

River system	1975	1976	1977	1978	1979	1980	1981
Western Alaska							
Togiak	--	--	--	--	--	--	200
Nushagak	--	--	--	--	--	--	1,120
Yukon							
lower*	--	--	--	--	--	840	--
E. fork Andreafsky	--	--	--	--	--	--	230
W. fork Andreafsky	--	--	--	--	--	--	120
Anvik	--	--	--	--	--	--	300
middle							
Salcha	--	--	--	--	--	--	230
Chena	--	--	--	--	--	--	100
upper*	230	--	--	--	--	115	75
Whitehorse	--	--	--	--	--	--	280
SE Alaska-B.C.							
Taku*	--	--	--	--	--	30	--
Stikine*	35	--	10	--	30	140	20
Klukshu*	--	65	90	--	--	60	45
Washington							
Quilleute	--	--	179	219	--	--	--
USSR							
Kamchatka	200	200	--	200	150	200	--
Bolshaya	200	189	--	150	200	200	--

*Numbers are readable scales. All other samples contain some regenerated, resorbed or unreadable scales.

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.

Fig. 1. National Marine Fisheries Service instructions to U.S. observers on location of preferred scale sampling zones.

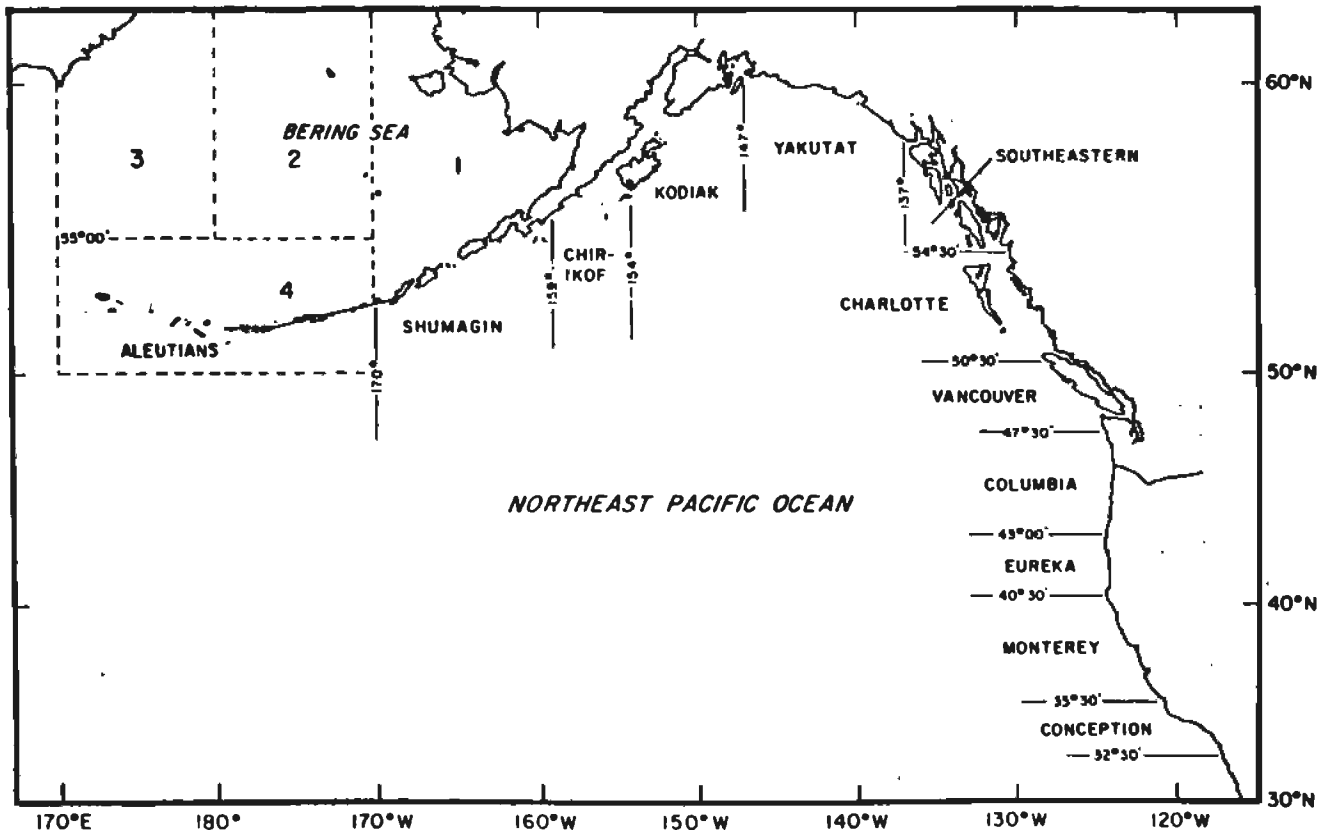


Fig. 2. Map showing the major statistical areas for the Bering Sea and Gulf of Alaska regions.

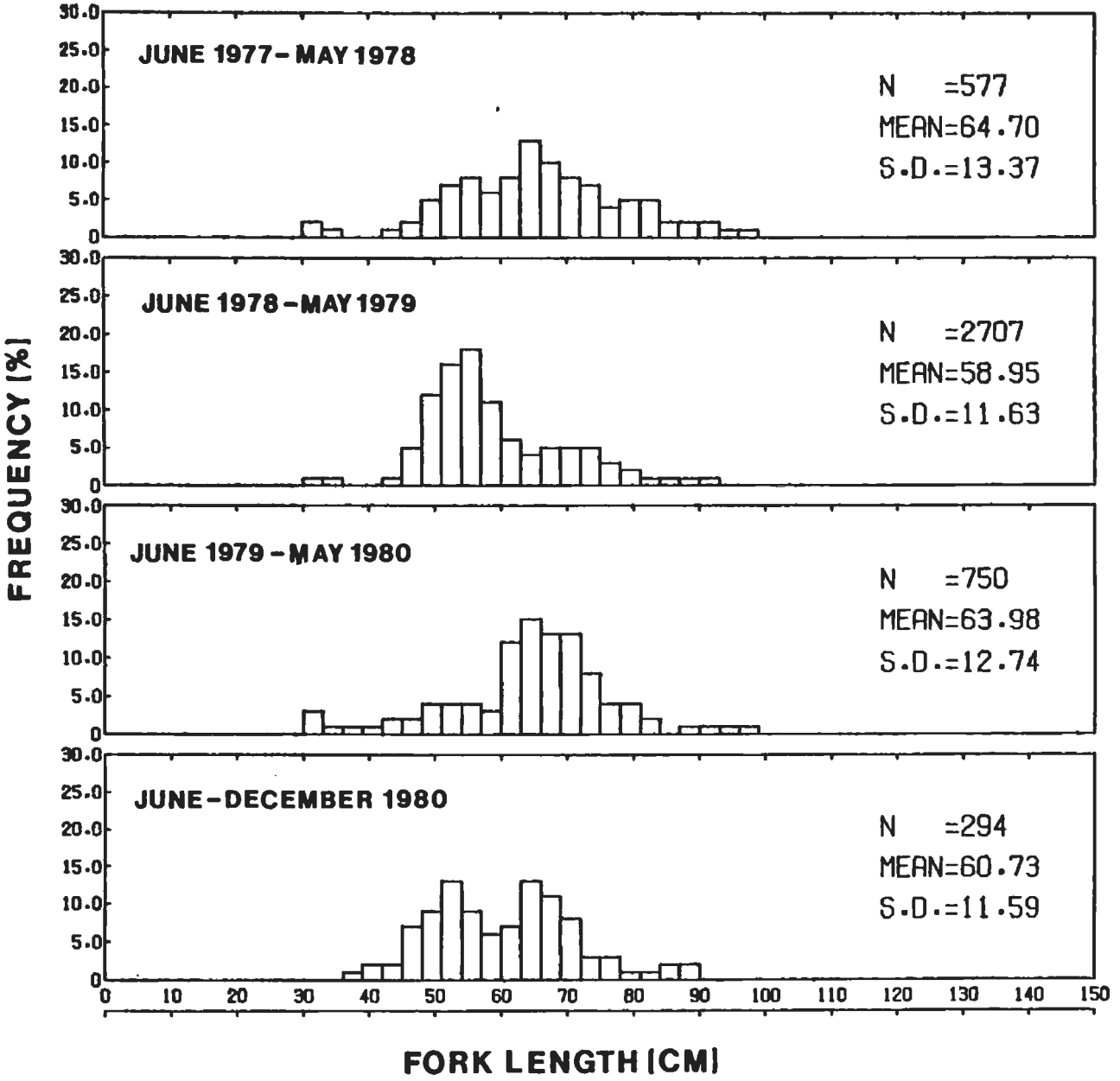


Fig. 3. Fork length frequencies (3 cm intervals) of chinook salmon sampled for scales in the foreign trawl fisheries in the Bering Sea, 1977-1980.

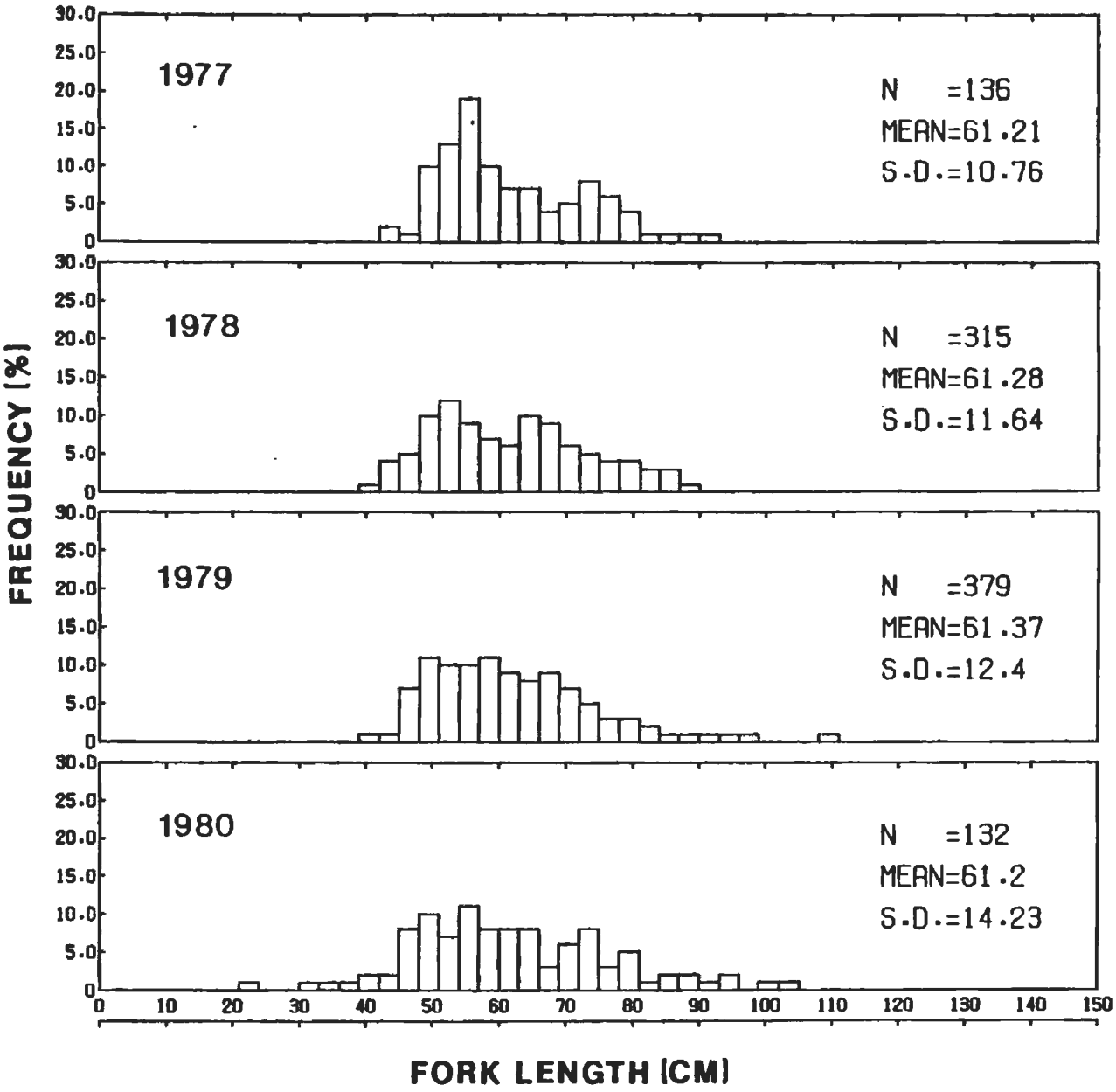


Fig. 4. Fork length frequencies (3 cm intervals) of chinook salmon sampled for scales in the foreign trawl fisheries in the Gulf of Alaska, 1977-1980.

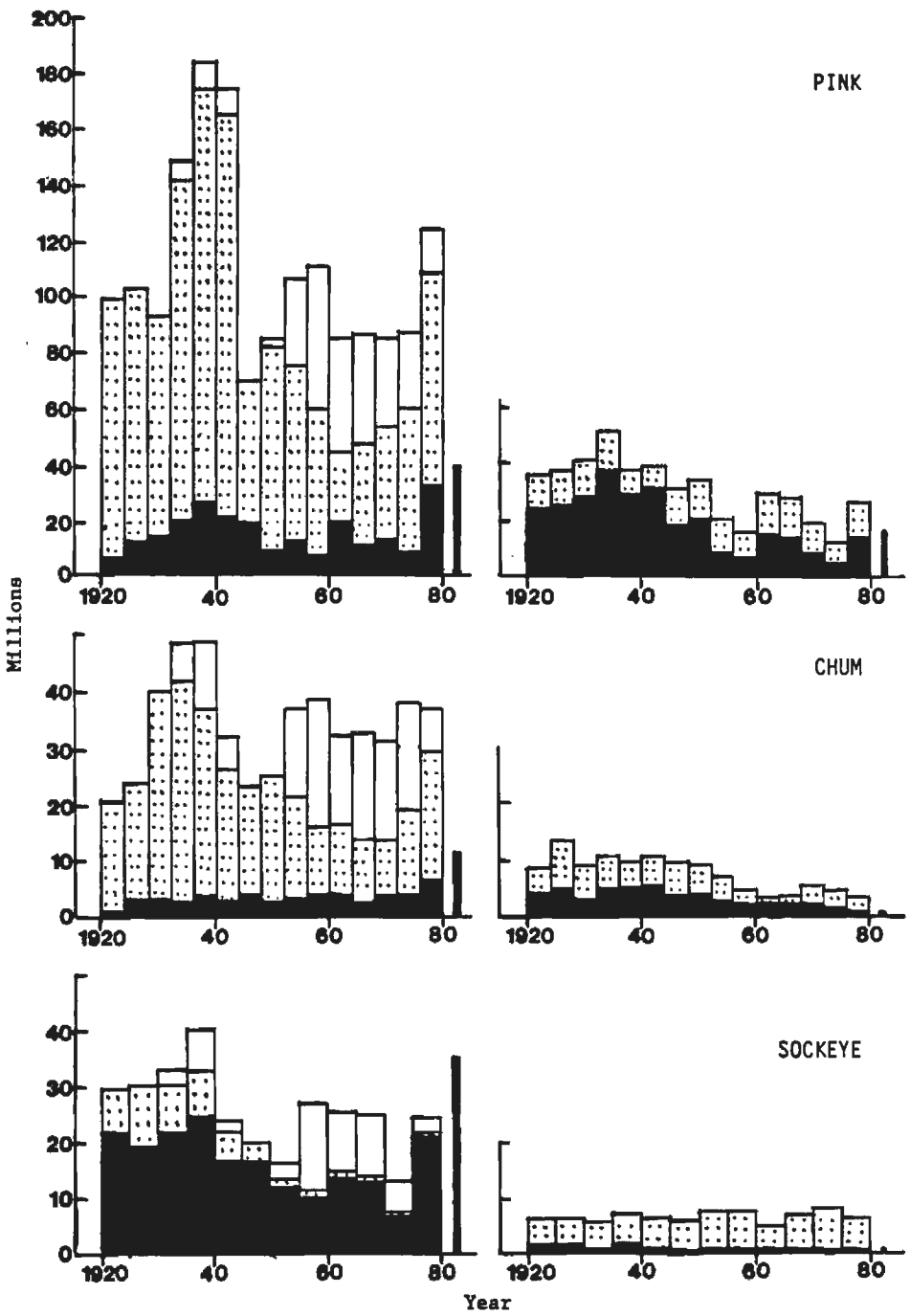


Fig 5. Annual commercial catches of salmon, 1920-1980 by 4-year averages for pink and chum salmon and 5-year averages for sockeye salmon. A) Northern region: western and central Alaska (black), Asian coastal (stippled), and high seas (open). B) Southern region: Southeastern Alaska (black) and California to British Columiba (stippled). Alaskan catches in 1981 indicated by narrow bar.

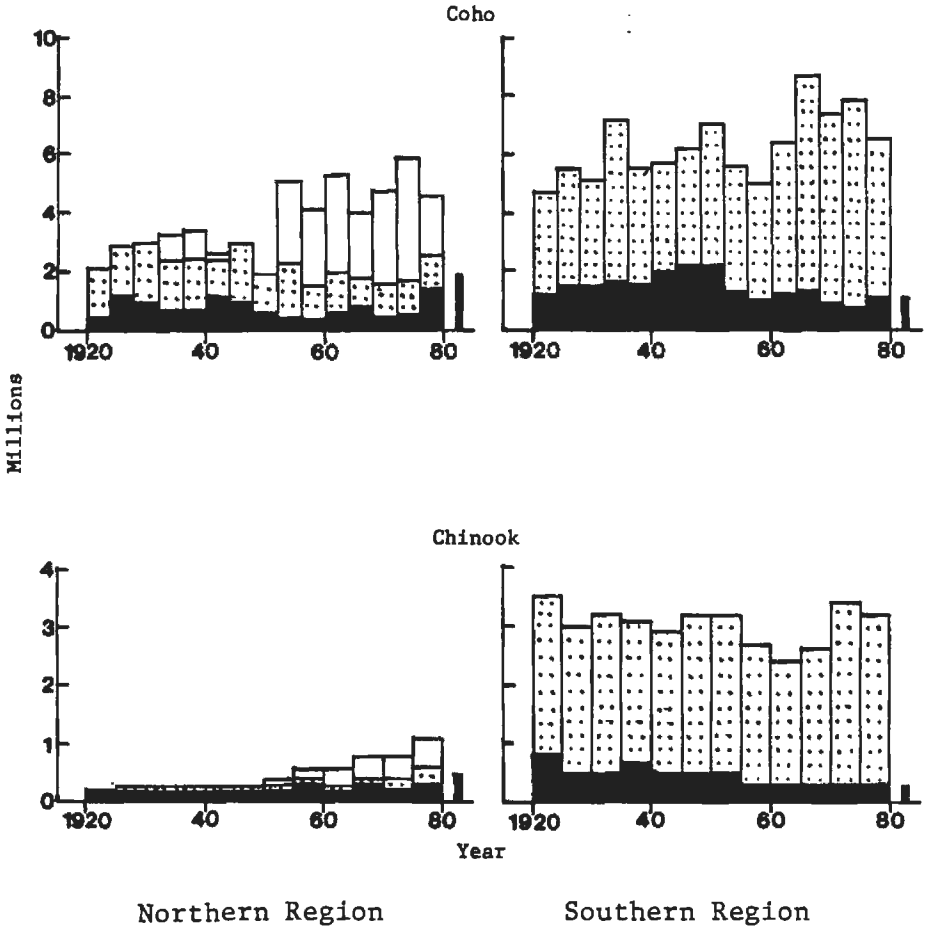


Fig. 6. Annual commercial catches of coho salmon (4-year averages) and chinook salmon (5-year averages), 1920-1980. A) Northern region: western and central Alaska (black), Asian coastal (stippled), and high seas (open). B) Southern region: Southeastern Alaska (black) and California to British Columbia (stippled). Alaskan catches in 1981 indicated by narrow bar.

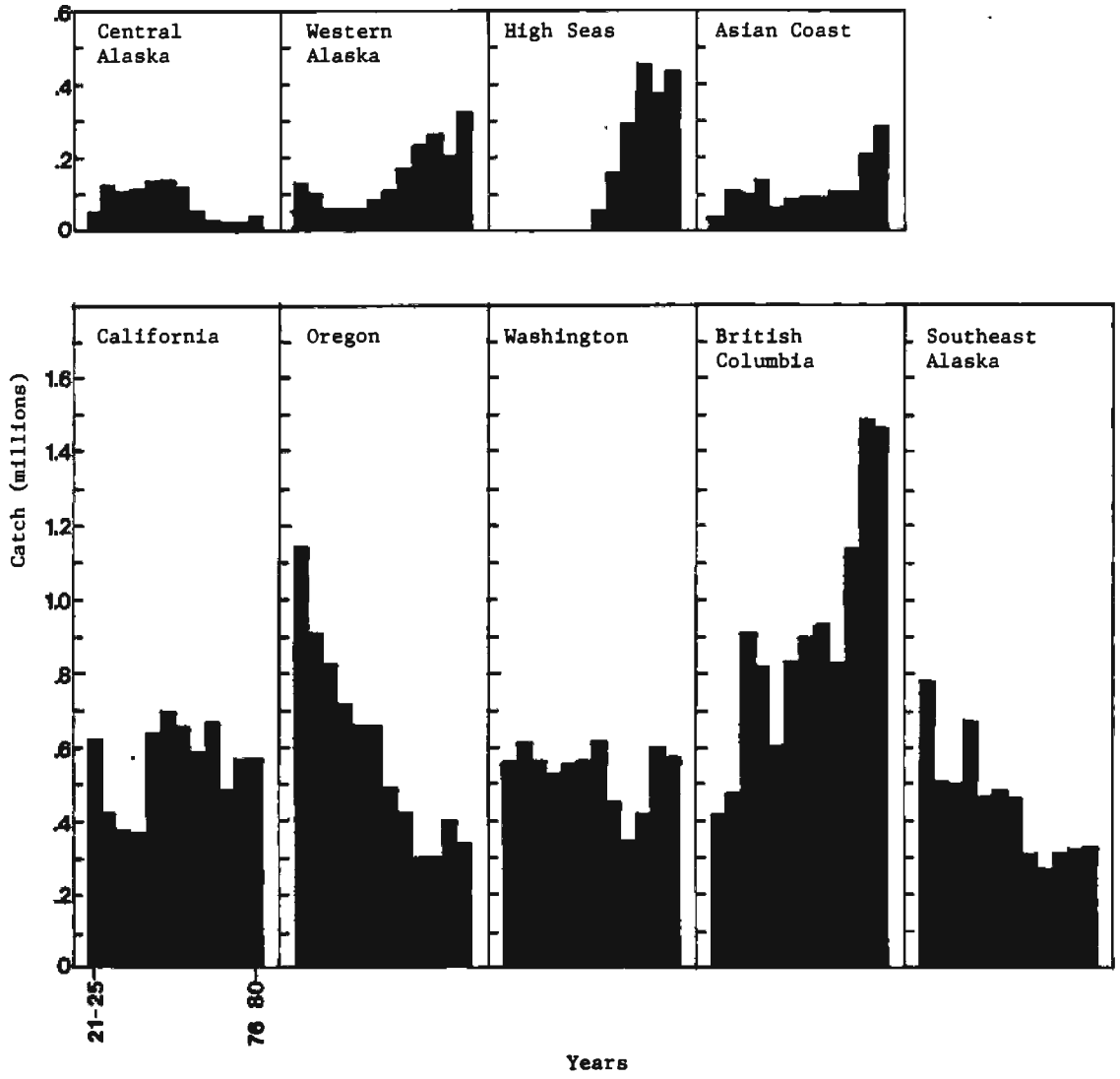


Fig. 7. Annual commercial catches of chinook salmon by 5-year periods beginning 1921-1925 and ending 1976-1980.

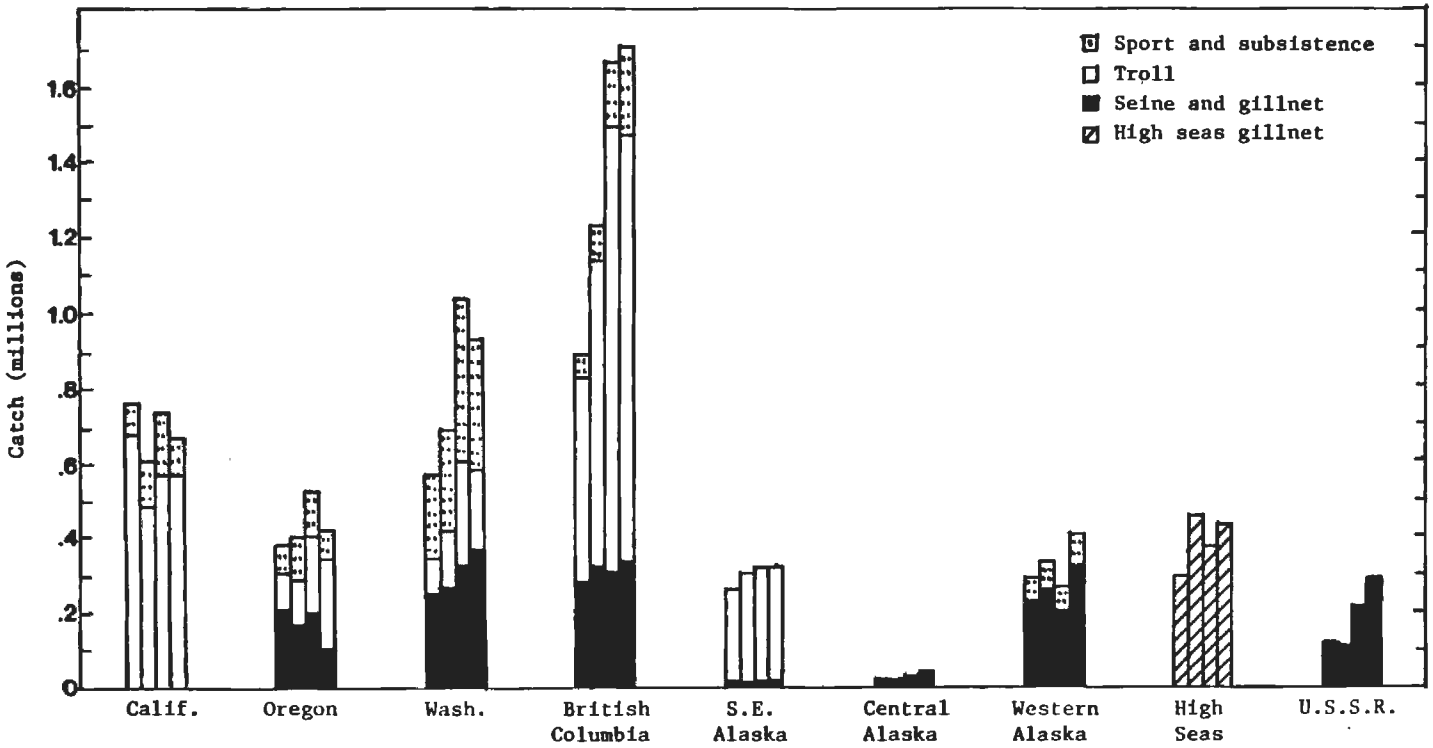


Fig. 8. Catches of chinook salmon by 5-year periods beginning 1961-1965 and ending 1976-1980.

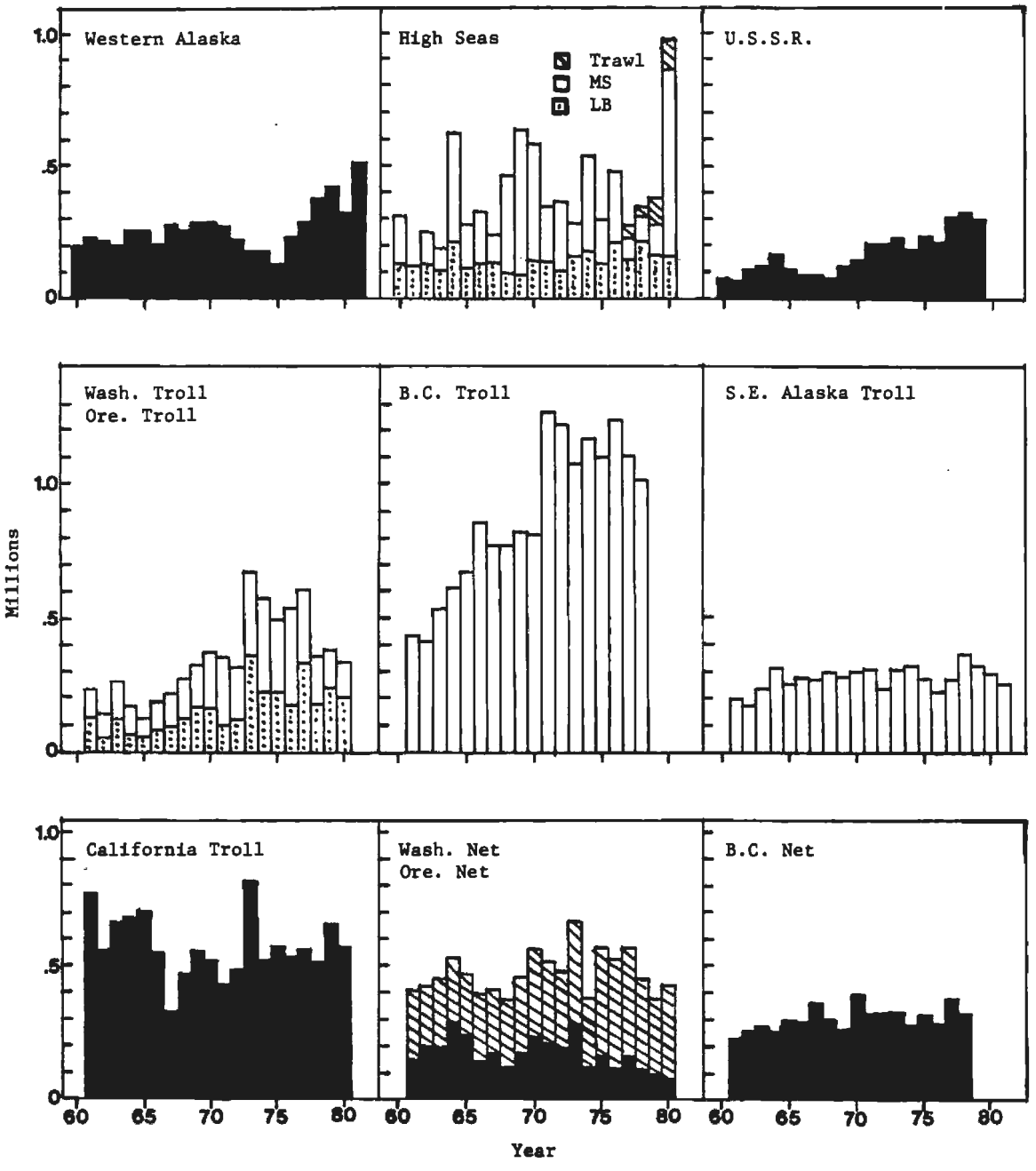


Fig. 9. Annual commercial catches of chinook salmon by area and gear, 1960-1981.