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Condition of Groundfish Resources of the Gulf of Alaska Region as Assessed in 1983

October 1983

This report does not constitute a publication and is for information only. All data herein are to be considered provisional.

NOTICE

Condition of Groundfish Resources of the Gulf of Alaska Region as Assessed in 1983

by

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and

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Preface

The U.S. 1983 assessment of the condition of the status of the Gulf of Alaska groundfish stocks is an update of the 1982 INPFC groundfish Document No. 2575.[1/] The pollock report has been divided into two reports. The first, Section 1, is an update on the assessment of the stock condition and the second, Section 2, is a description of the fisheries. The sablefish report, Section 3, updates the condition of the resource based on results of the 1982 fisheries, 1982 Japan and U.S. cooperative longline survey, and the 1983 U.S. pot survey in Southeast Alaska. The Pacific ocean perch report, Section 6, was revised to clarify the resource is composed of 5 species of rockfish, although the status report is primarily directed at Sebastes alutus. The reports for Pacific cod (Section 4), Atka mackerel (Section 5) and flatfish (Section 7) are updated with 1982 catch statistics. Reports on the results from the U.S. pollock resource survey in Shelikof Strait in 1983 have been completed for just the bottom trawl survey (Section 8). A document for the hydroacoustic survey will be completed at a later date. The biomass estimates from this survey are given in Section 1. A summary of the 1983 and planned 1984 resource surveys for the Gulf of Alaska is given in Section 9.

1/Ito, D. and J. Balsiger (ed.). 1983. Condition of groundfish resources of the Gulf of Alaska in 1982. U. S. Dept. Commer., NOAA Tech. Memo. NMFS F/NWC-52, 204 p.

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Condition of Gulf of Alaska Pollock Resource

by

Miles S. Alton[1/] and Richard B. Deriso[2/]

This report updates the one given by Alton and Deriso (1983) in the condition of the Gulf of Alaska pollock resource by considering the results of (1) catch-at-age analysis that includes an additional year of data, 1982; and (2) NMFS research vessel surveys of 1983. An update of catch and biological information from the fisheries that includes statistics for 1982 and for the Shelikof joint venture fisheries in 1983 is provided in a separate report (See section on pollock fisheries by Alton); highlights of that report are given here.

BACKGROUND

Resource Characteristics

Pollock is a semidemersal schooling fish belonging to the same group of fish as the cod, whiting, and other gadoid forms. It is widely distributed in North Pacific temperate and subarctic waters where major fisheries on this species occurs. Individual pollock may live as long as 20 years, although most fish taken in the fisheries are less than 12 years. Most of the Gulf of Alaska pollock resource lie in the central and western regulatory areas, i.e. from the vicinity of Prince William Sound west to Unimak Pass.

The Gulf of Alaska pollock has been treated as a stock separate from that of the Bering Sea and Aleutian pollock. A major pollock spawning site occurs in the Shelikof region near Kodiak Island where it is believed that fish from various regions of the western and central Gulf mix with resident fish during the winter--spring months for reproduction. Other spawning

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areas in the Western and Central Gulf of Alaska, although appearing minor compared to the Shelikof region, have been inferred from the occurrences of eggs during ichthyoplankton surveys (Boretz 1981; Bates and Clark 1983). Information on spawning sites in the eastern Gulf of Alaska has been negligible.

Our emphasis has been placed on the pollock of the central and western Gulf of Alaska where most of the commercial harvest occurs. We have treated the pollock of these areas as a group separate from those of the eastern Gulf of Alaska. The allowable biological catch (ABC) has been allocated by the three regulatory areas (Western, Central, and eastern) based on biomass distribution estimated from research vessel surveys (Alton, Hughes, and Hirschhorn 1977).

Fisheries

Foreign nationals have been the principal harvesters of Gulf of Alaska pollock, since they began fishing there in the early 1960's. By 1981 their annual pollock catch had reached a record 130.3 thousand t. However, in that year, joint venture fisheries caught almost 17 thousand t. The joint venture pollock catch rose sharply to about 71 thousand t in 1982 and again in 1983, when some 131 thousand t were taken in the winter-spring Shelikof fisheries. The foreign nations' fisheries catch declined in 1982 to 92.6 thousand t and is expected to fall further in 1983. Pollock landed in strictly U.S. fisheries has always been negligible compared to the foreign and joint venture fisheries. U.S. fisheries landed 2.2 thousand t in 1982. The total pollock catch by all nations and fisheries in 1982 was a record 166 thousand t. This catch is expected to be exceeded in 1983.

In 1982 only two foreign nations, Japan and the Republic of Korea, had trawlers operating in the Gulf of Alaska harvesting pollock. At one time, 1979, five foreign nations (Japan, ROK, USSR, Poland, and Mexico) fished in the Gulf of Alaska. Japan has the longest history of fishing in the Gulf of Alaska (1962 to present). Korean nationals have been fishing in the Gulf of Alaska since 1974.

Regulations and Allocations

Licensing, catch and area-time restrictions were placed on foreign vessels fishing in the U.S. 200 mile fishery conservation zone when the Magnuson Fishery Conservation and Management Act was passed in 1977. Pollock and other groundfish allocations were set annually for each nation (Table 1-1). The current summary of time-area closures and gear restrictions that affect the foreign trawl fisheries is shown in Figure 1-1.

Optimum Yield (OY)

During the period, 1978-82, pollock OY was set near the low end of the maximum sustainable yield (MSY) range (166,200 - 344,000 t) and apportioned to the three regulatory areas based on resource distribution as estimated from research vessel surveys (Table 1-2). In 1983 OY for the central area was increased to the mid-point (143,000 t) of the MSY range for that area.

RESULTS OF ANALYSIS AND RESEARCH IN 1983

Catch-at-age Analysis

We applied the catch-at-age analysis that we used in last year's report (Alton and Deriso 1983) by including the 1982 catch results (foreign nation and joint venture fisheries) and the 1983 joint venture catch for January to April in the Shelikof region (Table 1-3).

Catch-at-age for 1982 and 1983 were estimated by procedures described by Alton and Deriso, 1982. We used a single set of weight at age values for all years instead of the highly variable average weight-at-age by year that was used in our last year's report. This set consists of average values for the years 1976-83 for the 2-month period, July-August (Table 1-4).[3/]

The combined nation model reported last year was used for this year's analysis. Initial attempts to obtain parameter estimates were not successful for the model with assumptions (1) age selectivity of 3-6 year olds remains invariant for all of the years 1976-1983, (2) 7-10 year olds are fully available to the gear. We are not surprised at this result in view of the apparent low availability of older fish in the 1982 fishery and the difference in catch composition of the 1983 joint venture operation from that of combined nations in earlier years. Catches of 8 through 10 year olds in 1982 were very low in comparison to catches of these ages in earlier years. This may be due in part to sampling in 1982 which may not have been representative of the catch of older fish, and in part, to low population numbers of ages 8 and 9. These age groups represent the '73 and '74 year classes which have never contributed significantly to the catch through their years of vulnerability to the fisheries. The catch of 7-year olds in the 1983 joint venture fisheries was unusually high; they represent one of the larger year classes in recent years (Figures 1-2).

Alternative assumptions were tried, including a multiple gear stratification of joint venture catches from the foreign catches with varying assumptions about the yearly changes in gear-specific age selectivity. Results were very sensitive to these changes, e.g. average ASP (exploitable annual surplus production) varying from less than 200,000 mt to more than 600,000 mt. As a consequence of the unstable results, 1983 data were not incorporated in our final analyses, but may be at a latter date after foreign catches have been tabulated and aged. Even excluding 1983 data, results of the model were unstable until additional parameters for age selectivity of the 7-10 year

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3/ Employs the non-linear repression methods of Doubleday (1976).

olds were added to the model for the 1982 data. This final model has the following assumptions: (1) selectivity of 3-6 year olds is the same for all years (1976-1982), (2) M= 0.4, (3) selectivity of 7-10 year olds is equal to 1 for years 1976-1981, but is estimated for 1982. The 8 new data points (ages 3-10 in 1982) add 2 degrees of freedom to the regression (6 new parameters are estimated for 1982). Standard deviations were attained by the bootstrap method (Efron, 1982) as explained in our last year's report.

The results of the analysis show an increase in exploitable biomass over the years 1976 through 1981 (as was the case in last year's analysis) and a continuance of this trend in 1982 (Table 1-5). The average exploitable biomass (1,430 thousand t), however, is greater for the years 1976-1982 than for the period 1976-1981, as shown in last year's report (1,040 thousand t). As for annual surplus production our new analysis indicates a sharp rise in 1978 and retention of high levels for the period 1979-1982. Average ASP for 1976-1982 was 408 thousand t with a level of precision much greater than for the average in last year's report (Table 1-5).

The increase in exploitable biomass has been due to a series of relatively strong year classes (1975-1979) (Figure 1-2).

Research Surveys

During March and April of 1983, an acoustical survey of pollock was conducted in the western and central Gulf of Alaska. The only sizeable concentrations of fish were found in the Shelikof region. Four separate surveys were made on the Shelikof fish with the initial survey in early March having the highest pollock biomass (2.5 million t), and the last survey having the minimum estimate (0.8 million t). During the acoustic surveys, a bottom trawl survey using a separate vessel was made in the Shelikof region (see

Section 8 by E. Brown) in order to assess the on-and near-bottom component of the pollock aggregations that are incapable of being acoustically assessed. The biomass of this component was estimated at 184 thousand t. A secondary purpose of the bottom trawl survey was to determine whether females were more abundant than males near the bottom than in the upper water column. In both the fisheries (See Section 2 by M. Alton) and acoustic survey males were frequently more numerous than females in the samples. The dominance of males were found to be a frequent occurrence in the bottom trawl survey catches. Individual catches, commercial or research, in the Shelikof region may at times be mostly females, but in the overall estimate of population or of the commercial catch males have been more numerous.

Discussion of Research and Analytical Findings

The extensive acoustic survey of the western and central Gulf of Alaska found only significant amounts of pollock in the Shelikof region during the spawning season in 1983. This suggests that the pollock which are normally found by the foreign nation fisheries in large quantities in the Shumagin and offshore waters of Kodiak Island during other times of the year were in the Shelikof region during the spawning period. This would support our treatment of the catch-at-age data as if the pollock of the western and central Gulf were all of one stock. We have, however, some reservations. The extreme western part of the western regulatory area (Unimak Pass to the Fox Islands) and the most eastern part of the central area (off the Kenai Peninsula and Prince William Sound) were not covered by the survey. The Unimak Pass-Fox Island region has been important in the foreign fisheries for pollock (see Section 2 by M. Alton, Figure 2-1), and there has been some evidence that the fish from this region have more rapid growth than fish from the Shumagin and Kodiak regions. We suspect that the fish from the Unimak Pass-Fox Island region may be part of either the Bering Sea or Aleutian pollock stock. The pollock off the Kenai Peninsula and Prince William Sound have never been harvested in the amounts taken in the other regions of the Western and Central Gulf (See Section 8 by M. Alton, Figure 2-1). Whether this is due to lower abundance there or to factors related to the fisheries are not known. In May of 1983, a U.S. fishing vessel reported finding intense and extensive echo sounding signs indicative of pollock south of the Kenai Peninsula which might suggest a spawning aggregation of pollock separate from those that spawn in the Shelikof region. We mention the Unimak Pass-Fox Island pollock and those off the Kenai Peninsula and Prince William Sound to emphasize the incompleteness of our knowledge of the stock structure of Gulf of Alaska pollock.

The results of acoustic surveys in the Shelikof region suggests that the pollock biomass has declined from 1981 to 1983 (no survey was made in 1982). Using the average biomass from the first two surveys of each of these years, the decline is from 3.8 million t in 1981 to 2.4 million t in 1983. Results from catch-at-age analysis has shown a continued increase in biomass in 1982. The 1981 acoustic estimate of biomass compares well with the 1981 estimate from catch-at-age analysis.

We examined whether the change in exploitable biomass as derived from catch-at-age analysis has any relationship with changes in CPUE from the Japanese fisheries. CPUE values came from a report by Yamaguchi and Okada, 1983, that was provided at this year's U.S.-Japan bilaterals. The values were for the Japanese freezer trawlers standardized to the 2,505-3,504 gross tonnage vessels. The years 1977-1982 could only be considered, since it was not until 1977 that the freezer trawlers began to place an emphasis on the harvest of pollock. We used the relationship, $CPUE_i = aB_i^b$ (B_i is the exploitable biomass for the year _i_) transformed into a linear relationship for regression analysis. Despite the low degrees of freedom (N-2=4), the correlation is marginally significant (Figure 1-3). Thus the trend in CPUE corresponds with that of exploitable biomass. The regression coefficient of 0.911 is close to 1.0 and suggests that the catchability coefficient of Japanese freezer trawlers have remained constant for the years 1977 through 1982, i.e. $CPUE_i = qB_i$, where q is the catchability coefficient.

EVALUATION OF STOCK CONDITION

The results of catch-at-age analysis suggest that four successive strong year classes (1975-79) have occurred in the Gulf of Alaska pollock stock and have brought about a substantial increase in stock biomass and fishable biomass for the years 1979-1982. Surplus production for this period ranged from 484-524 thousand t and exceeded the annual harvest by the fisheries (103.2-166.5 thousand t).

The catch-at-age analysis provides an estimate of conditions existing in the past (1976-82); for 1983 there is a biomass estimate from the combined acoustic-bottom trawl survey of 2.6 million t. This figure translates to an exploitable or fishable biomass of about 2 million t which is below the 1982 estimate (2.6 million t) from catch-at-age analysis, but greater than the average for the years 1976-82 (1.4 million t).

Although the 1983 survey estimate suggests a decline in abundance between 1981 and 1983, the stock in 1983 is still considered to be at a high abundance level, comparable to levels in 1980 and 1981. Conditions in 1984 will depend to a great degree on the abundance of the 1980 year class as 4 year olds; this age has been an important contributor to the annual catch since 1979 (Table 1-3). The poor showing of the 1980 year class as age 3 fish in both the joint venture fisheries and the survey in early 1983 may indicate that this year class is below average or was only partially present in the Shelikof region during the period of the fisheries and survey.

ONGOING AND SCHEDULED RESEARCH AND ANALYSIS

We are presently collecting and analyzing information that will clarify our understanding of the stock structure of the Gulf of Alaska pollock. Biochemical genetic studies are underway to determine if subpopulations can be recognized. The possibility that persistent regional growth differences may exist will be examined through the analysis of size-at-age data.

Vessel surveys directed towards Gulf of Alaska pollock are planned for early 1984. One survey will be in the Shelikof spawning region to update the acoustical estimate of biomass and its composition. Another survey will explore the region off the Kenai Peninsula and Prince William Sound for the presence of spawning concentrations separate from those in the Shelikof region.

An age structured computer based model will be developed for projecting stock abundance and composition given various levels of recruitment and catch. The model would allow forecasting one to two years in advance using the most recent acoustical estimate of biomass and its composition.

Fisheries stock assessment is commonly done by assuming some sort of quantity is invariant across years. For example CPUE is used as an index of abundance by assuming catchability is constant across years. In our catch-at-age analysis the assumption of time invariant age selectivities serves as an analogous constant. But its usefulness may now be limited. Both 1982 and 1983 data show unusual catch patterns that apparently violate our selectivity assumption. This year we have basically patched things together by discarding 1983 data and adding a new group of selectivity coefficients for the 1982 data. A goal now is to find another type of invariant for the changing GOA pollock fishery, possibly the mean and variance information from the acoustic survey estimates of stock biomass, or possibly the CPUE from the Japanese freezer trawlers along with variance measures for CPUE. This auxiliary information about the pollock stock will be examined in 1984 for inclusion along with catch-at-age data in a Bayesian type estimation procedure for next year's stock assessment. We are hopeful that this auxiliary information will allow us to relax the time invariant assumption about age selectivity while retaining a reasonable degree of precision in our stock assessment.

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Table 1-1.--Foreign fisheries allocations (t) of Gulf of Alaska pollock by nation and area in 1980[1/], 1982[2/] a 1982[3/].

Nation	Shumagin			Chirikof-Kodiak			Yakutat-Southeastern			All areas		
	1980	1981	1982	1980	1981	1982	1980	1981	1982	1980	1981	1982
Japan	360	24,849	36,980	40,915	36,960	43,314	5,470	7,545	10,613	46,745	69,354	90,907
ROK	16,025	none	none	24,917	none	none	none	none	none	40,942	none	none
USSR	24,878	14,235	18,325	none	15,982	19,106	3,727	3,732	5,772	28,605	33,949	43,203
Germany	none	none	420	none	none	420	none	none	none	none	none	840
Poland	12,293	13,513	none	15,172	21,842	none	none	3,542	none	27,465	38,897	none
Mexico	none	none	none	7,611	none	none	5,806	none	none	13,417	none	none
All nations	53,556	52,597	55,725	88,615	74,784	62,840	15,003	14,819	16,385	157,174	142,200	134,950

1/ Nov. 1, 1979 to Oct. 31, 1980.

2/ Nov. 1, 1980 to Dec. 31, 1981.

3/ Jan. 1, 1982 to Dec. 31, 1982.

Table 1-2.--Optimum yield and maximum sustainable yield (MSY) by regulatory area.

Regulatory Area	MSY 1/ (t)	Optimum Yield (t) 1978-1982 2/	1983
Western	57,000-114,000	57,000	57,000
Central	95,200-191,000	95,200	143,000 3/
Eastern	14,000-29,000	16,600	16,600
All areas	166,200-334,000	168,800	216,600

1/ Based on estimates of exploitable biomass from research trawl surveys during the years, 1973-1977.

2/ 1981 was a transition year in changing from a fishing year of Nov. 1 to Oct. 31 to a calendar year. Hence the 1981 fishing year was 14 months (Nov. 1, 1980 to Dec. 31, 1981) and the OY for just that year was increased to 196,933 t.

3/ Midpoint of MSY range; effective Sept. 16, 1983.

Table 1-3.--Estimates of the annual catch in numbers of pollock in the western Gulf of Alaska (INPFC areas Shumagin, Chirikof, and Kodiak) by age, 1976-81, by foreign trawlers and joint-venture fisheries. Catch, age, and size of fish converted to age information form U.S. observer data. Insufficient age information for years prior to 1976.

	Catch in 1000 Fish						
Age	1976	1977	1978	1979	1980	1981	1982
0			12				
1		50	497	262	360	543	12
2	603	13,189	47,651	1,773	65,253	6,439	10,948
3	13,562	7,676	111,332	76,305	30,514	33,106	62,435
4	94,005	18,821	13,819	55,977	54,838	75,760	102,612
5	32,137	92,616	19,338	9,669	31,910	54,959	73,869
6	8,997	24,204	34,446	7,661	11,586	16,861	50,899
7	2,515	8,990	7,684	14,473	6,787	4,630	7,631
8	2,515	1,823	2,669	4,951	7,150	3,770	1,081
9	1,561	795	1,488	1,591	2,914	3,744	736
10	1	1,105	548	708	925	687	173
11+		524	574	499	673	202	3
Total	155,896	169,843	240,058	173,869	212,910	200,701	310,399

Table 1-4.--Average weight at age of pollock used in catch-at-age analysis.

Age	3	4	5	6	7	8	9	10
Weight (kg)	.42	.56	.64	.69	.76	.84	.87	.86

Table 1-5.--Estimates of exploitable biomass and exploitable annual surplus production (ASP) from the combined nation model using the Monte Carlo bootstrap method. A standard deviation of 1 is in parenthesis and units are in thousands of metric tons.

	Exploitable biomass		Exploitable ASP1/	
Year	1982 Analysis	1983 Analysis	1982 Analysis	1983 Analysis
1976	590(220)	719(59)	177(63)	120
1977	689(243)	749(64)	70(84)	185
1978	669(260)	835(79)	429(213)	484(105)
1979	1,010(457)	1,220(163)	543(259)	598(147)
1980	1,450(697)	1,726(296)	502(306)	536(167)
1981	1,831(937)	2,176(438)		524(226)
1982		2,587(615)		
Average	1,040(448)	1,430(220)	344(164)	408(103)

1/ Exploitable annual surplus production is calculated as the exploitable biomass at the beginning of the year minus the exploitable biomass one year earlier plus the annual catch.

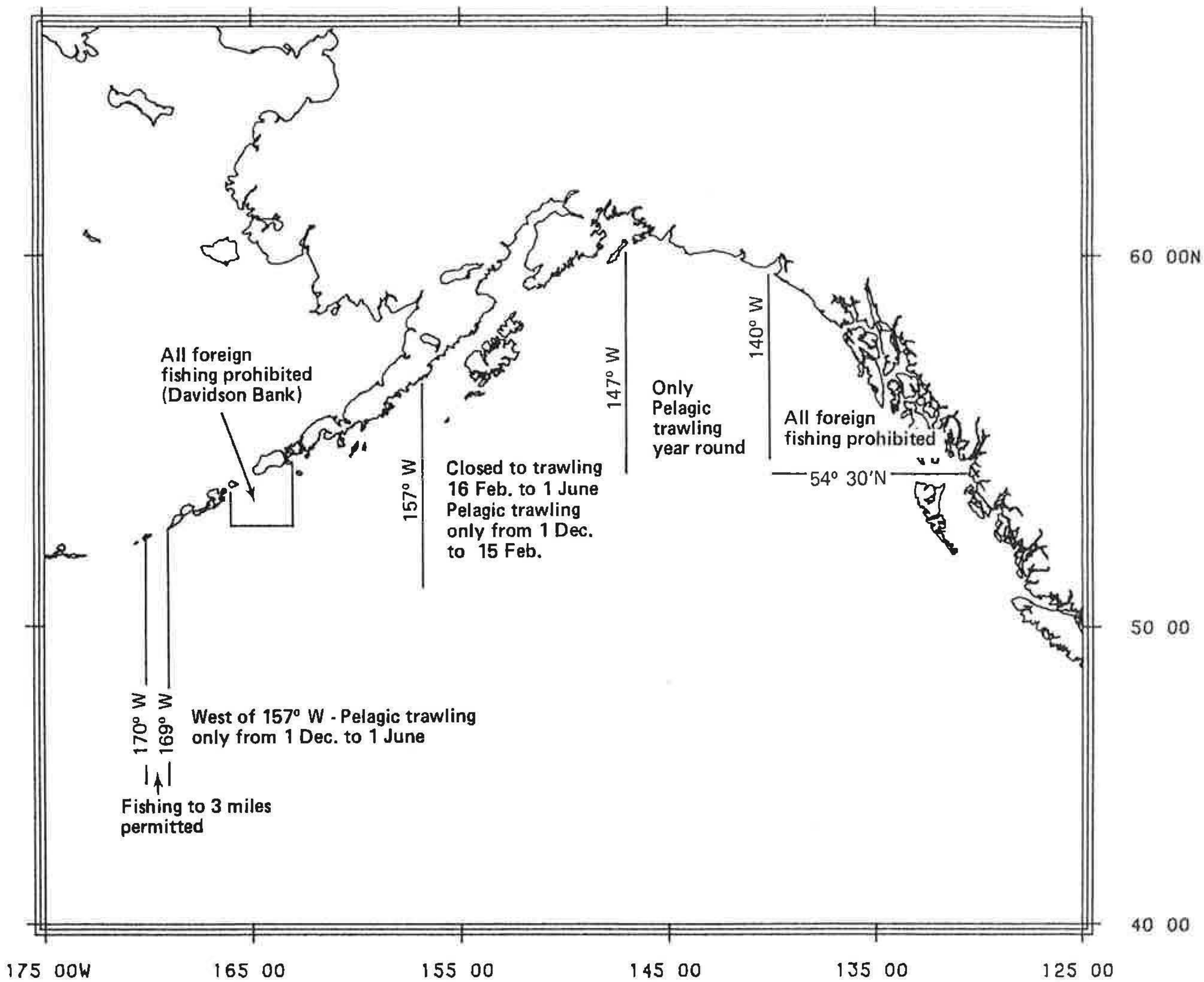

Figure 1-1.--Restrictions affecting foreign trawl fisheries for Gulf of Alaska pollock and other groundfish.

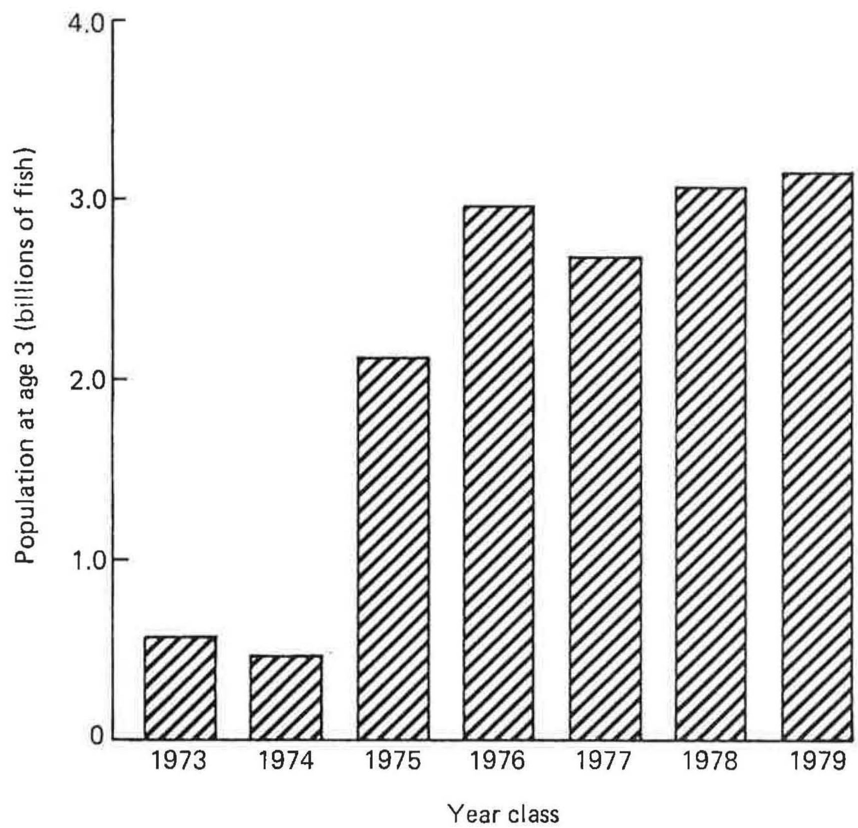

Figure 1-2.--Changes in year-class strength of Gulf of Alaska pollock from results of catch-at-age analysis. Strength is indicated by the population size at age 3.

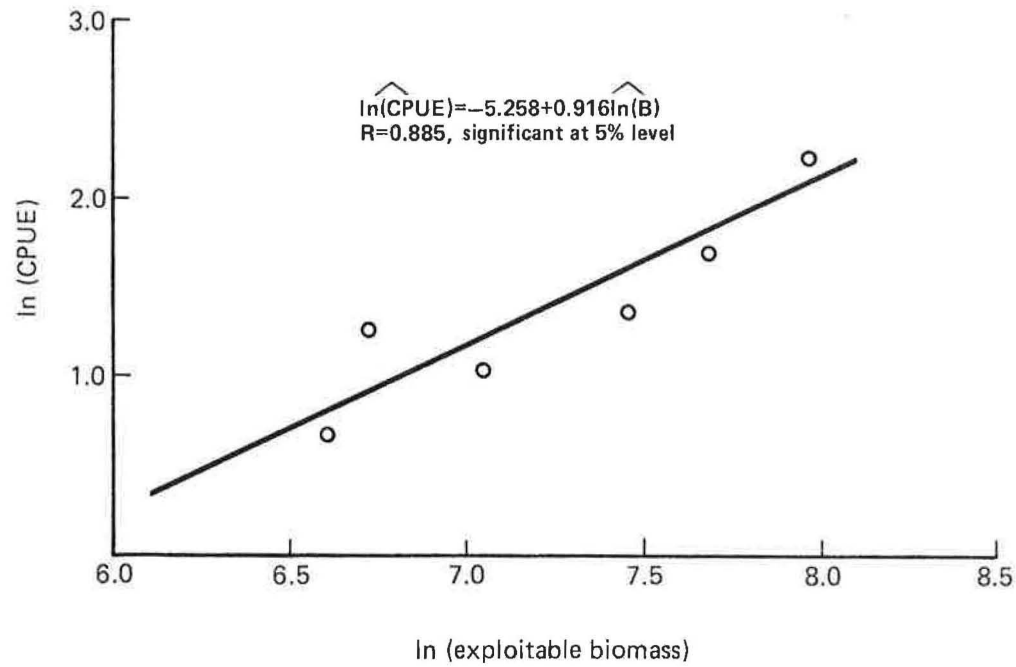

Figure 1-3.--Correspondence between exploitable biomass of pollock and pollock CPUE of Japanese freezer trawlers for the years 1977-82.

GULF OF ALASKA POLLOCK FISHERIES

Miles Alton[1/]

This report updates fisheries information for Gulf of Alaska pollock as given by Alton and Deriso (1983) by including data from all fisheries in 1982 (Foreign, joint-venture, and domestic) and joint-venture[2/] fisheries for the January to May period in 1983 for the Shelikof region. The latter fisheries target on prespawning and spawning fish that gather in this region during the winter and early spring; spawning peaks during the latter part of March and early April. The pollock that spawn in the Shelikof region are believed to come from the Central and Western regions of the Gulf of Alaska and to mix with resident fish during the early part of the year. Those fish that leave the Shelikof region after spawning are subject to the foreign trawl fisheries operating along the edge and outer part of the continental shelf during the summer and fall.

Foreign trawl fisheries have operated in the Gulf of Alaska since the early 1960's, first targetting on rockfish and then shifting their emphasis to pollock in the 1970's. Until 1973 only Japanese and USSR vessels fished in the Gulf of Alaska; after 1973 trawlers from other nations entered the fisheries. In 1982 only two foreign nations; Japan and the Republic of Korea, had fishing vessels operating in the Gulf of Alaska.

Joint venture fisheries began at a modest level of effort in the Gulf of Alaska in 1978. Small amounts of pollocks were taken in such

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2/ A joint-venture is an arrangement between U.S. and foreign interests in which U.S. vessels catch and sell fish to foreign processing vessels operating in the Fishery Conservation Zone (FCZ).

fisheries from the Shelikof region in 1980 and by 1983 the pollock catch from this region exceeded 100 thousand tons.

Domestic fisheries continue to place a low level of effort on pollock.

DATA SOURCES AND COMPILATION

Catch

Each foreign nation reports its annual catch by statistical blocks of 1° longitude and 1/2° latitude, by month, and by vessel tonnage class. The U.S. Observer Program provides an estimate of the foreign nation catch, called "best blend", from observer sampling of a portion of the total foreign fleet (Wall, French, and Nelson, Jr., 1981). Observer coverage (number of observer days/total vessel day x 100) in 1981 was 11%; in 1982 it rose to 32.2%. For joint venture fisheries the estimated pollock catch is "best blend". Observer coverage in the Shelikof region was 38%, in 1983. Domestic catch for 1982 was obtained from the Alaska Department of Fish and Game.

Length and Age Composition

Estimates of the length and age composition of both the foreign and joint venture catch come from data collected by U.S. observers aboard foreign trawlers and processors. A description of the sampling procedures used by the observers to obtain length information and age structures is given by Nelson, French, and Wall (1981). Procedures in determining the age of pollock from otoliths is described by LaLanne (1979). Estimating the age composition of the pollock catch is given by Alton and Deriso (1983).

CATCH

In 1982 168.77 thousand t of pollock were harvested in the Gulf of Alaska which nearly equaled the optimum yield for that year (Table 1). Nearly all of the catch was from foreign fisheries (92.6 thousand t) and joint venture fisheries (73.9 thousand t) The remainder (2.2 thousand t) was landed in strictly U.S. fisheries. (Table 2-1).

The pollock catch in the joint-venture fisheries of the Shelikof region in early 1983 was 131.4 thousand t which exceeded the foreign catch of pollock in 1982.

Foreign Fisheries

In 1982 the total foreign nations' catch of pollock declined from the peak year of 1981 by some 38 thousand t (Table 2.2), and was less than the annual catch of the previous five years (1977-81). Vessels from only two foreign nations fished in the Gulf in 1982, Japan and the Republic of Korea. Japanese vessels harvested an annual record of some 55 thousand t; vessels from ROK caught 37.6 thousand t which was slightly less than their previous year's catch.

The trend of increasing catch of pollock by Japanese surimi trawlers continued with that class taking some 62% of the total Japanese trawl catch of pollock in 1982 (Table 2.3). Surimi trawlers for the most part target on pollock. The importance of the Japanese large freezer trawlers in the harvest of pollock has been declining and that of the small freezer trawler increasing (Table 2.3).

Among ROK trawlers the large tonnage class vessels (1500 gt and greater) continue to harvest the greater amount of pollock (92%) compared to the other smaller tonnage class (<1500 gt).

The general area of the Shumagin Islands between longitude 156° and 162° continues to be a major pollock producing area for the foreign fisheries (Figure 1). Its importance has increased over the past several years (1980-82) so that by 1982 some 70% of the foreign pollock catch came from this area. The catch from the eastern Gulf of Alaska, i.e. the Yakutat INPFC area 2/ declined sharply in 1982 to only 26 t (Table 2.4).

JOINT VENTURE FISHERIES

Since 1981 the joint venture pollock catch has risen rapidly (Table 2.5) and has been for the most part harvested in the Shelikof region of the central Gulf of Alaska (Figure 2.2). Small U.S. trawlers use mid-water trawls to catch the pollock. Some eight separate joint ventures and 31 U.S. vessels were involved in the 1983 winter-spring Shelikof fisheries.

LENGTH AND AGE COMPOSITION

Foreign Fisheries

Pollock taken in the foreign trawl fisheries in 1982 were unimodally distributed in length with the mode and mean being almost identical (Figure 2.3). This was also the case in 1981 but with the mean and mode being slightly larger. The bimodal distribution in length of pollock in 1980 (Figure 2.3) was due to the presence in the catch that year of the usual older fish having a mode at 43 cm and a large number of 2 year olds having a mode of 25 cm. For all those years (1980-82) there has not been any marked change in the length distribution of the older fish which have had a mode falling within a narrow range of

2/ The southeastern INPFC area has been closed to foreign fisheries since 1982.

43-44 cm. The age compositions of these older fish (age 3-6) have also remained similar for the 3-year period with age 4 fish being the most numerous followed by ages 5, 3, and 6 (Figure 2.4). The contribution of fish older than 6 to the catch has varied and this is due in part to the weak showing of the 1973 and 1974 year classes as ages 8 and 7 in 1981 and as ages 9 and 8 in 1982. These year classes have been poorly represented in the fisheries during their period of vulnerability (age 3+).

Joint Venture Fisheries

For all four years (1980-83) of the fisheries in the Shelikof region there was a prominent peak in the length distribution of the pollock that shifted from 35 cm in 1980 to 38 cm in 1983 (Figure 2.5). The greater amount of fish between 25 and 35 cm in 1982 as compared to other years is due to the strong presence of 3-year olds. This age group representing the 1979 year class was the most numerous year class at age 4 in the 1983 catch (Figure 2.6). Ages 8 and 9 representing the weak 1974 and 1973 year classes were poorly represented in the catch in 1982 as was noted in the foreign trawl fisheries for that year.

SEX COMPOSITION

Males and females were equally represented in the catch by foreign trawlers in 1982 and in previous years. This was not the case in the joint venture fisheries in the Shelikof region where males have consistently been taken in greater numbers than females (Table 2.6). The dominance of males in the catch persists throughout the months of the fishery and becomes more pronounced in April after the peak of spawning (Figure 2.7).

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Table 2.1.--Catch of pollock in 1982 as compared to optimum yield (OY) in metric tons.

	Management Area.			
	Western	Central	Eastern	All Areas
Japan	21,679	33,341	26	55,046
ROK	18,550	19,016	-	37,566
Joint-Venture	145	73,772	-	73,917
Domestic	82	2,129	26	2,237
Total	40,456	128,258	52	168,766
OY	57,000	95,200	16,600	168,800

Table 2.2--Annual catch (t) of walleye pollock by foreign nation, 1964-82.

Year	Japan	USSR	ROK	Poland	Mexico	Total
	- - - - - - - - - - - - - -		t - - - - - - - - - - -			- - - - - - -
1964	1,126	Unknown				1,126
1965	2,749	"				2,749
1966	8,932	"				8,932
1967	6,276	"				6,276
1968	6,164	"				6,164
1969	17,553	"				17,553
1970	9,343	"				9,343
1971	9,018	440				9,458
1972	13,696	20,385				34,081
1973	6,706	30,130				36,836
1974	30,433	31,000	447			61,880
1975	13,032	39,949	5,900	631		59,512
1976	11,796	37,825	36,906	---		86,527
1977	41,953	41,588	35,579	1,256		120,376
1978	26,093	41,956	27,052	1,226		96,327
1979	31,920	17,300	25,739	19,551	8,677	103,187
1980	37,897	37,001	25,013	13,085	---	112,996
1981	51,885	---	38,552	39,886	---	130,323
1982	55,046	---	37,566	---	---	92,612

Table 2.3.--Annual catch of Gulf of Alaska pollock by Japanese trawler vessel category (1976-82)[1/]

Year [2/]	Surimi factory trawler (1,500-4,505 gt)	Small freezer trawler (<1,500 gt)	Large freezer trawler (1,500-4,504 gt)	Total
	------------------------------1,000 t	------------------------------		
1976	4.9	0.3	6.6	11.8
1977	19.0	7.0	15.0	41.0
1978	17.8	6.7	1.5	26.0
1979	10.6	5.5	15.7	31.8
1980	20.4	8.6	8.5	37.5
1981	30.4	12.3	8.8	51.5
1982	34.0	14.5	6.3	54.8

1/ Vessel classification used by U.S. Observer Program.

2/ Foreign reported catch for 1976 and 1977; best blend estimate for 1978-81.

Table 2.4.--Pollock catch (t) by area and foreign nation in the Gulf of Alaska (1977-82).1/

Nation	Year	Western (Shumagin)	Central (Chirikof-Kodiak)	Eastern (Yakutat-Southeastern)
		- - - - - - - - - - - - t - - - - - - - - - - - - -		
Japan	1977	8,626	25,969	7,358
	1978	3,539	19,026	3,528
	1979	1,366	27,700	2,862
	1980	378	32,975	4,544
	1981	14,125	33,604	4,156
	1982	21,679	33,341	26
Republic of Korea	1977	34,166	1,413	-
	1978	26,268	784	-
	1979	23,312	-	2,427
	1980	24,926	-	87
	1981	17,191	16,961	4,400
	1982	18,550	19,016	-
USSR	1977	13,981	27,262	345
	1978	1,494	40,462	-
	1979	170	17,087	43
	1980	15,495	21,506	-
	1981	-	-	-
	1982	-	-	-
Poland	1977	-	1,256	-
	1978	-	1,226	-
	1979	249	19,302	-
	1980	5,848	7,237	-
	1981	16,244	23,624	18
	1982	-	-	-
All nations	1977	56,773	55,900	7,703
	1978	31,301	61,498	3,528
	1979 2/	30,218	67,597	5,372
	1980	46,647	61,718	4,631
	1981	47,560	74,189	8,574
	1982	40,229	52,357	26

1/ For 1977, reported catch by foreign nations indicated; for 1978-80, a "best blend" estimate as described by Wall et al. (1981), was used.

2/ Includes catch by Mexico

Table 2.5.--Pollock catch (t) in joint venture fisheries in the Gulf of Alaska (1980-83).

Year	Western	Central	All Areas
1980	113	1,023 1/	1,136
1981	20	16,836 2/	16,856
1982	145	73,722 3/	73,917
1983		131,391 3/	131,391 4/

1/ Apr.-May

2/ Feb.-Apr.

3/ Jan.-May

4/ preliminary

Table 2.6.--Contribution of males to the catch of pollock in the Gulf of Alaska (in percentage).

Fisheries	1980	1981	1982	1983
Foreign Trawlers	50	50	50	1/
Joint Ventures 2/	60	58	62	60

1/ data unavailable

2/ Shelikof region (winter-spring)

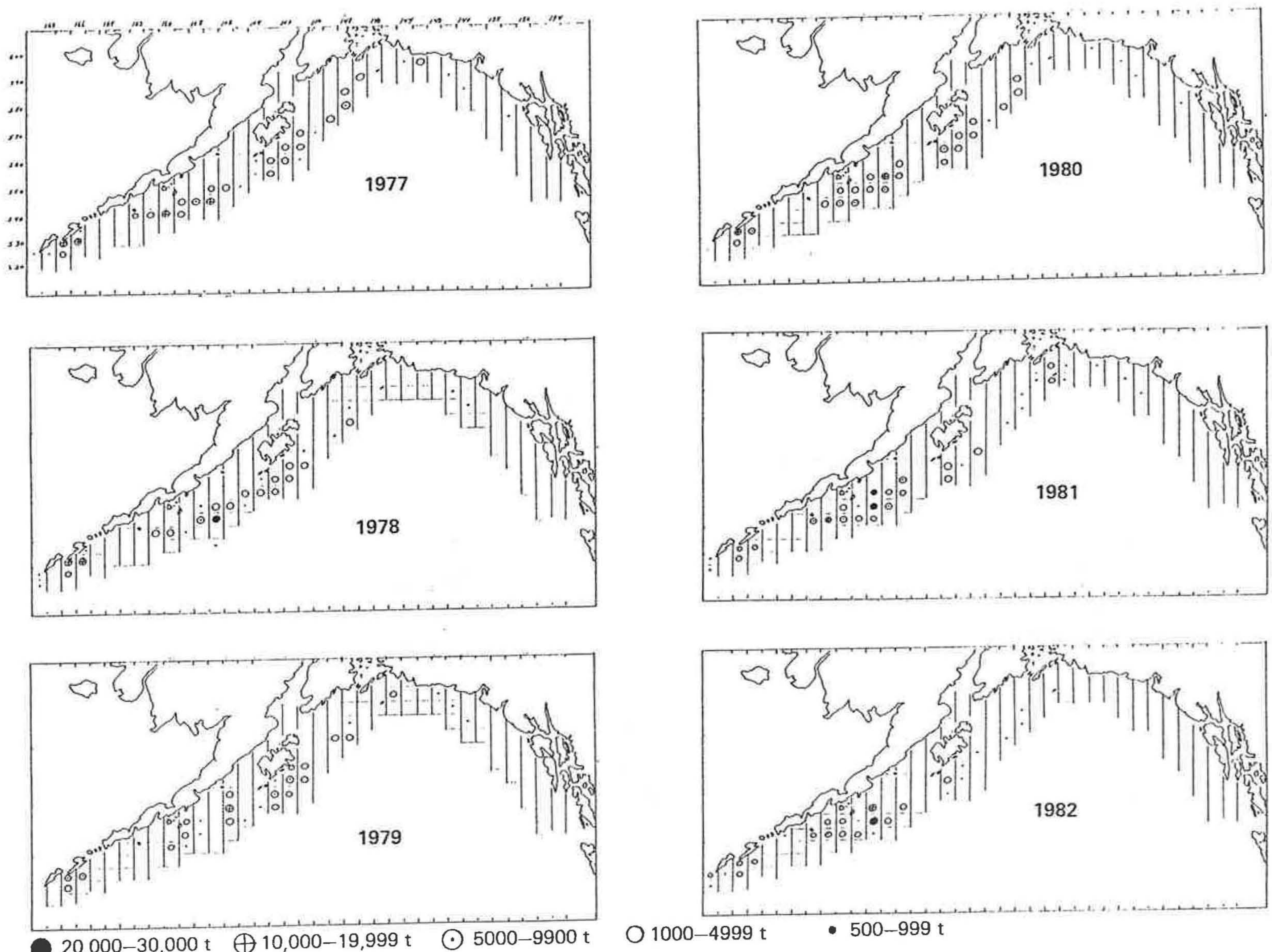
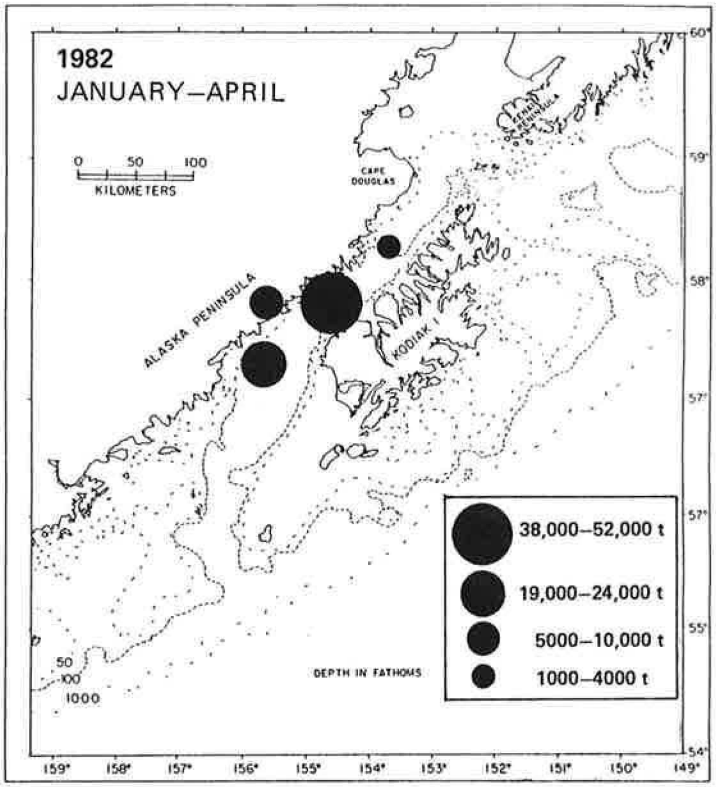


Figure 2.1.--Important pollock harvesting areas for foreign nation fisheries in the Gulf of Alaska, 1977-82.



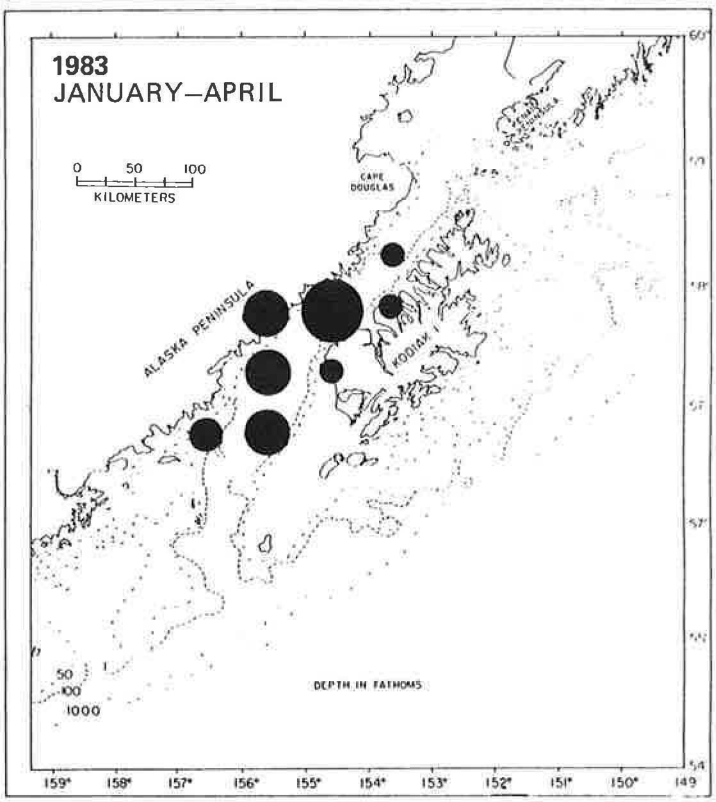


Figure 2.2--Important pollock producing areas for U.S.-foreign joint venture fisheries in the Shelikof region of the Gulf of Alaska, 1982-83.

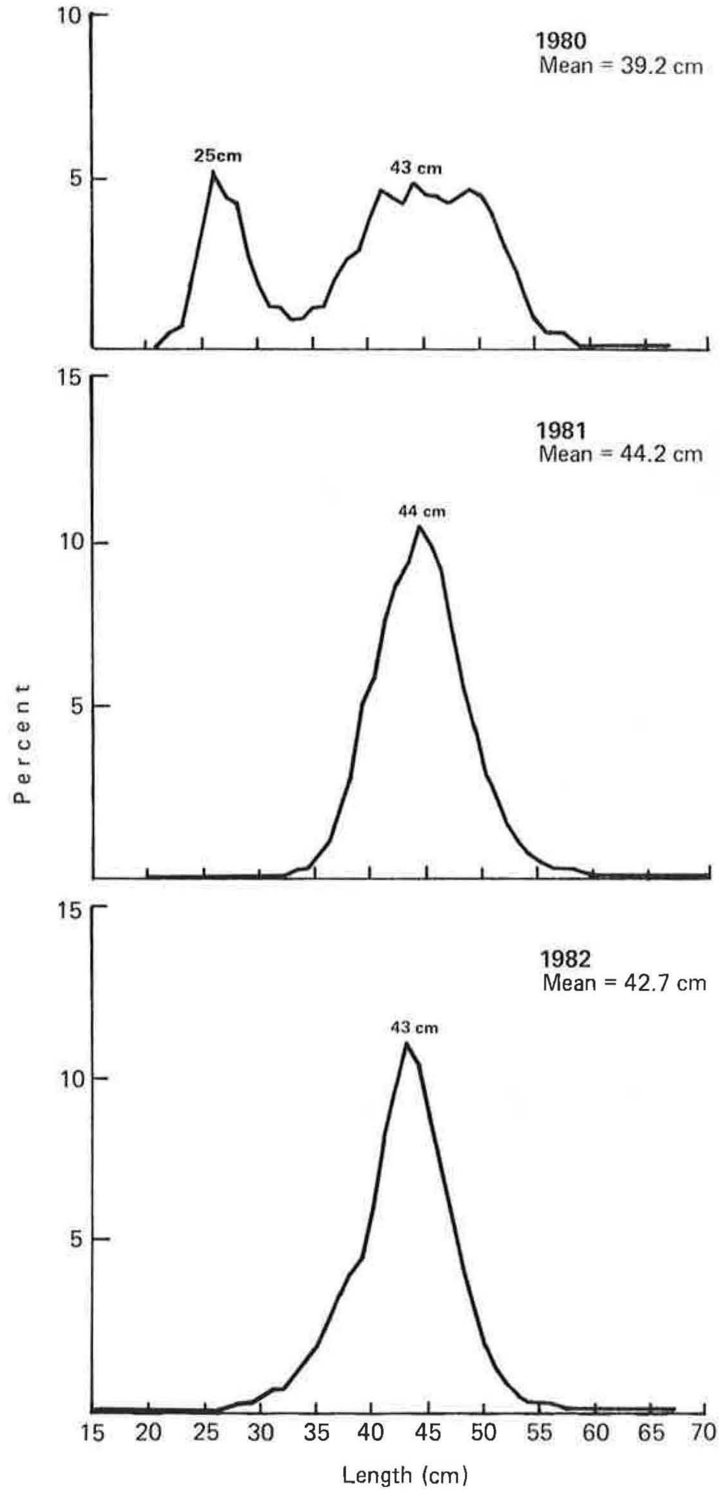


Figure 2.3--Length composition of the pollock catch taken by foreign trawl fisheries in the combined central-western regulatory areas of the Gulf of Alaska, 1980-82.

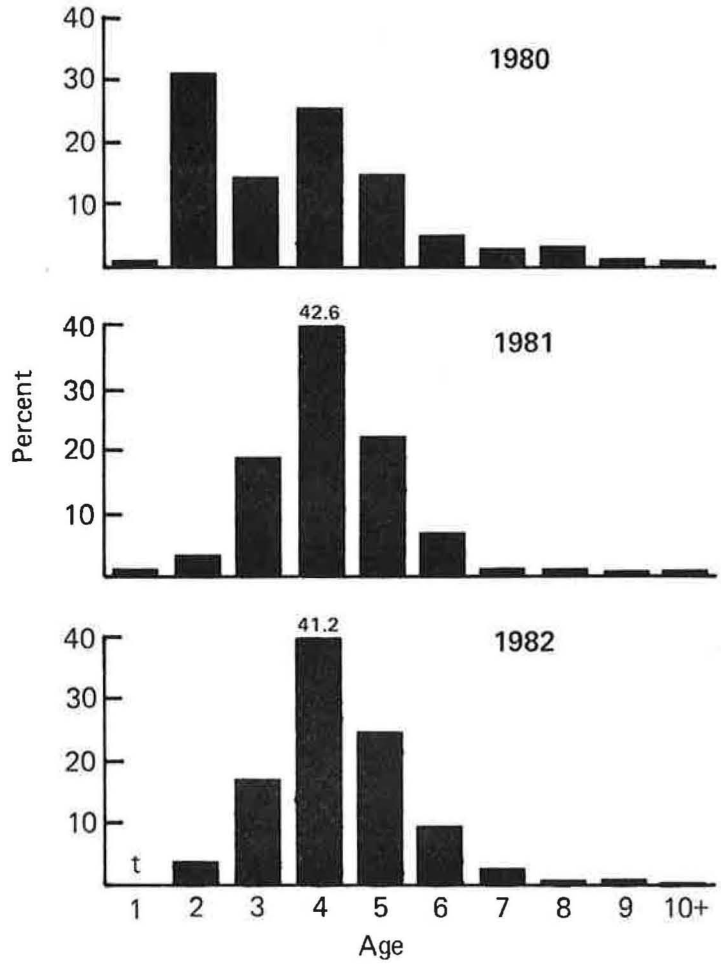


Figure 2.4--Age composition of pollock catch taken by foreign trawl fisheries in the combined central-western regulatory areas of the Gulf of Alaska, 1980-82.

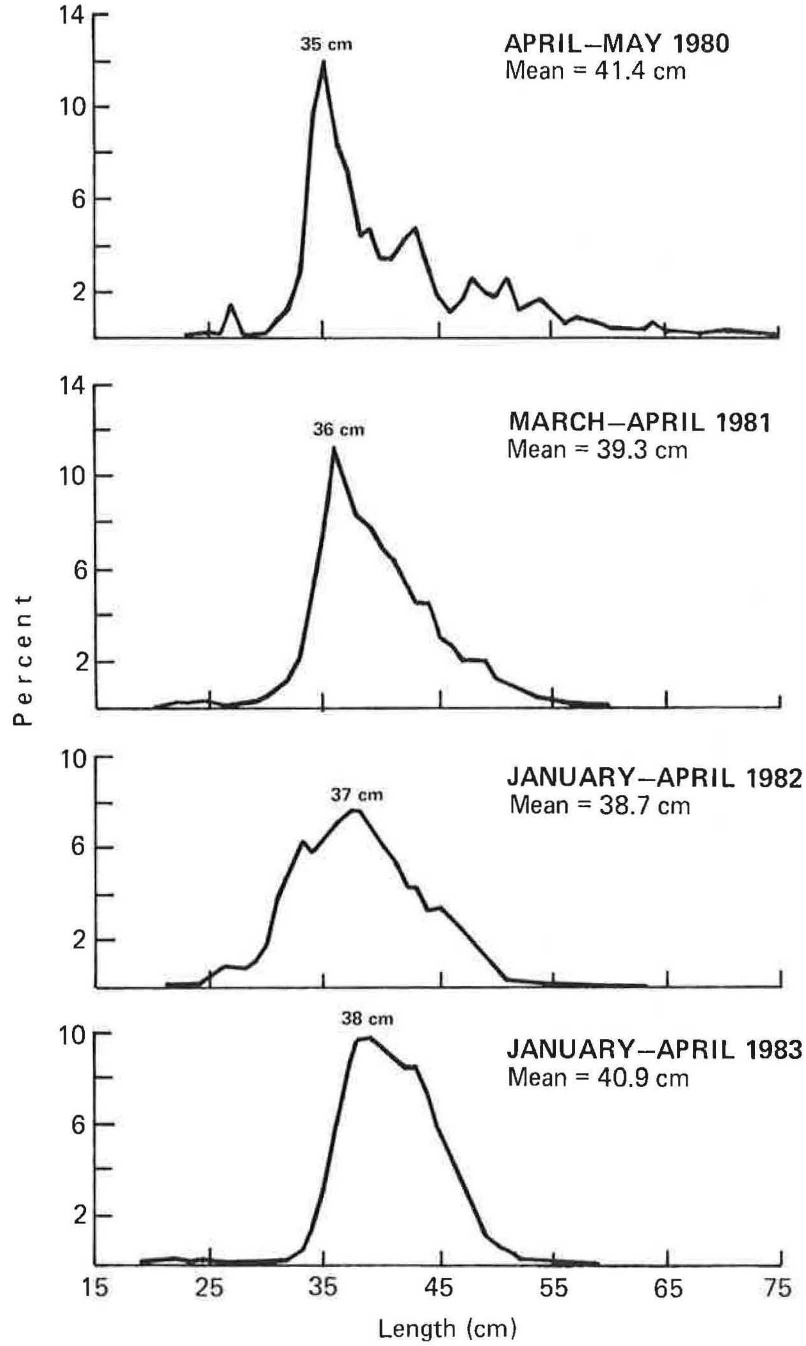


Figure 2.5--Length composition of the joint-venture fisheries catch in the Shelikof region of the Gulf of Alaska, 1980-83.

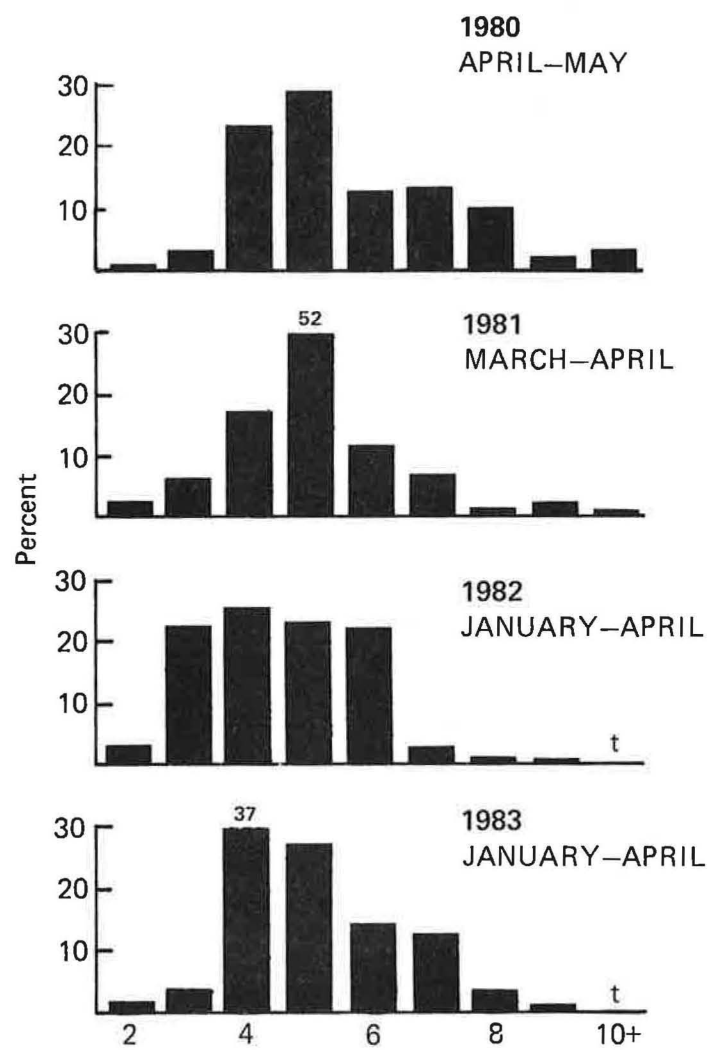


Figure 2.6--Age composition of joint-venture fisheries catch in the Shelikof region of the Gulf of Alaska, 1980-83.

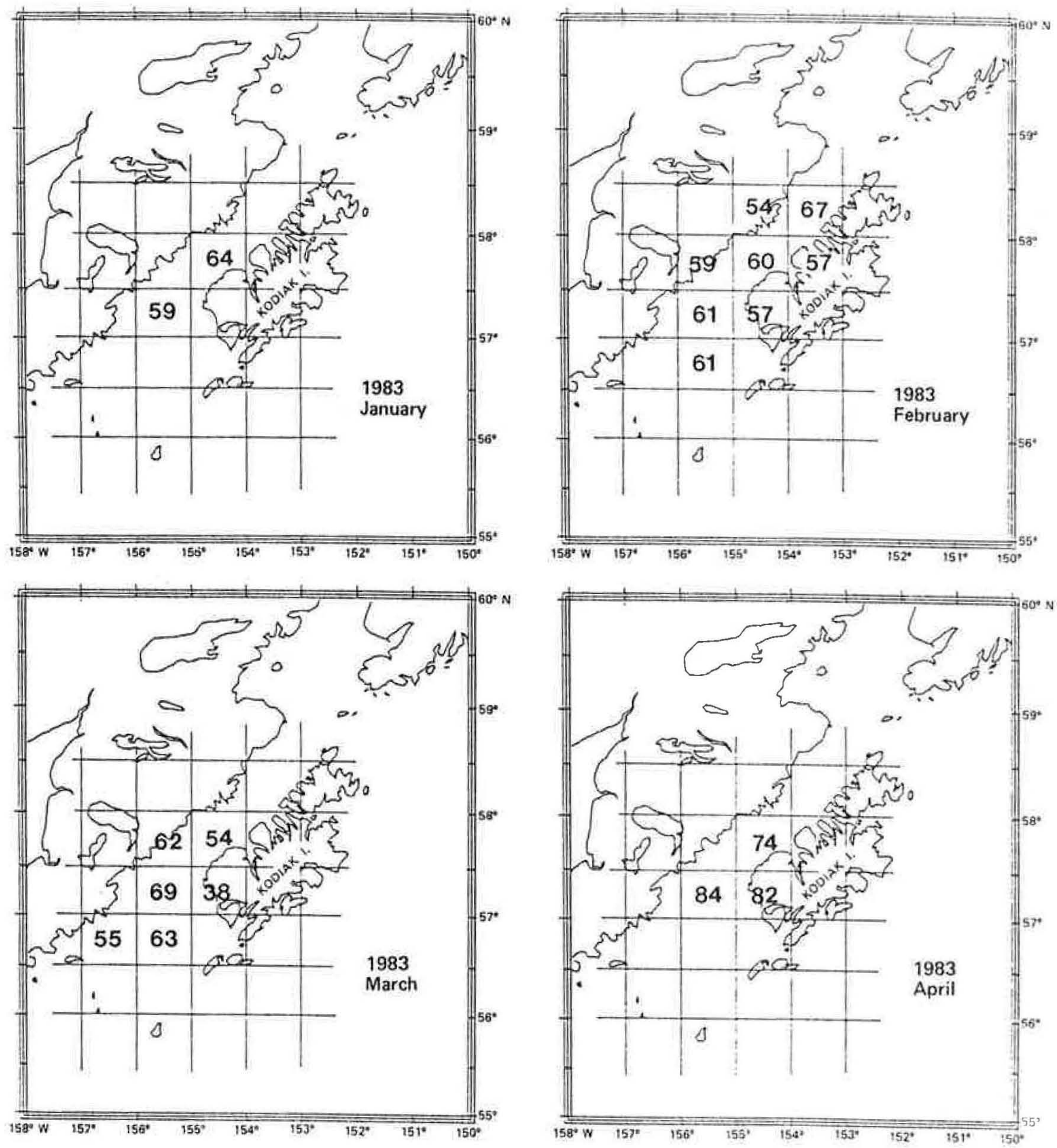


Figure 2-7.--Percent males in the Shelikof joint-venture fisheries catch in 1983 by month and statistical block (1° long. by 1/2° lat.).

SABLEFISH[1/]

by

Gary D. Stauffer[2/]

INTRODUCTION

The sablefish, Anoplopoma fimbria, resource in the northeast Pacific Ocean is found in waters off northern Mexico to the Gulf of Alaska, westward to the Aleutian Islands region, and into the Bering Sea. This resource has been harvested by U.S. and Canadian fisheries since early in this century, but catches were relatively small and generally limited to areas near fishing ports from California to southeast Alaska. Catches in the Gulf of Alaska averaged about 1,500 metric tons (t) from 1930 to 1950 and exploitation rates remained very low until Japanese longliners began operations in the Eastern Bering Sea in 1958. The Japanese fishery expanded very rapidly and took 30,000 t as early as 1962 (Narita 1983). In 1963 the Japanese longline fleet expanded to the Aleutian region and the Gulf of Alaska, and catches rapidly escalated until the record all-nation catch from the northeast Pacific reached 67,000 t in 1972. Following this peak year, northeast Pacific total catch averaged about 50,000 t from 1973 to 1976.

Evidence of declining stock abundance led to significant fisheries restrictions since 1977, and total catches have been reduced substantially. Until 1977, the majority of the sablefish harvest was taken from the Gulf of Alaska. Beginning in 1978, regulations on foreign fleets in the Gulf of Alaska, coupled with

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1/ This report is a revised update of the 1982 INPFC document; Balsiger, J. 1983. Sablefish. In Ito, D. and J. Balsiger (ed.), Conditions of groundfish resources of the Gulf of Alaska in 1982. U. S. Dept. of Commer., NOAA Tech. Memo. NMFS F/NWC-52, 204 p.

2/ Northwest and Alaska Fisheries Center, National Marine Fisheries Service, NOAA, 2725 Montlake Blvd. E., Seattle, WA 98112.

sharply increased U.S. effort off Washington-California, have reduced the proportion of total sablefish harvested in the Gulf. Sablefish catches off Washington to California from 1978 to 1982 were 10,700 t, 17,300 t, 9,500 t, 11,600 t, 18,523 t, respectively, and catches off Canada for 1978-1980 about 3,700 t (Stocker 1981). Gulf of Alaska landings averaged 9,187 t annually for the years 1978-1982.

FISHERY STATISTICS

A summary of the annual sablfish landings by nation is given in Table 3.1 for the Gulf of Alaska. The harvest of sablefish first expanded in 1963 by the Japanese trawl fisheries. The reported landings exceeded 15,000 t in 1968 with start of the Japanese longline fishery. The fishery in the Gulf of Alaska peaked in 1972 with 37,498 t landed. Annual landings average 27,310 t for 1973-1976. Following the passage of the Magnuson Fishery Conservation and Management Act in 1976, maximum catch quotas were implemented. The foreign harvest of sablefish has declined from 15,957 t in 1977 to 5,645 t in 1982. The U.S. domestic harvests since 1976 have averaged about 2,200 t and exceeded 3,000 t in 1979 and 1982. The U.S. landing in 1983 are also expected to exceed 3,000 t.

The directed foreign sablefish fishery in the Gulf of Alaska is limited by regulation to longline gear. An allowance is made for incidental catches in the trawl fisheries, and for 1979 to 1982 the foreign trawl catch of sablefish was 686 t, 1,422 t, 919 t, and 540 t, respectively; an annual average of 892 t. Domestic sablefish gear in the Gulf of Alaska has consisted almost exclusively of longline gear although occasional small catches with pot gear have been made. If Amendment 12 of the Groundfish Fishery Management Plan (FMP), is implemented the use of pots for sablefish by domestic fishermen will be prohibited off Southeast Alaska between Cape Addington (55°26'N, 133°24'W) and 140°W. Trawlers may take sablefish only incidentally to other targeted species.

In 1977, the optimum yield for sablefish throughout the Gulf of Alaska was set at 22,000 t (Table 3.2). The OY was reduced to 15,000 t in 1978, and to 13,000 t in 1979 with the implementation of the FMP. Also, the OY was prorated between the three new regulatory regions, 2,100 t to the Western region (Shumagin INPFC area), 3,800 t to the Central region (Chirikof and Kodiak INPFC areas), and 7,100 t to the Eastern region (Yakutat and Southeast INPFC areas). The 1981 OY numbers are 16.7% greater to account for a 14 month season as a result converting the reporting year to coincide with the calendar year. In 1982 the Eastern region OY was partitioned into separate numbers for the Yakutat and Southeast areas, and OY for the two areas combined was 6,400 t for a Gulfwide OY of 12,300 t. In 1983 Amendment 11 established OY at 8,230 to 9,480 t, 75% of equilibrium yield (EY).

The annual landings have averaged 68% of the OY for the 6 years following 1976. Domestic landings during this same period have averaged 45% of Domestic Annual Harvest (DAH) established each year. The foreign landings have exceeded the initial allocations of Total Allowable Level of Foreign Fishing (TALFF), but have averaged 78% of the final allocations.

CONDITION OF STOCKS

Stock Structure

Experiments designed to identify sablefish stock structure in the Gulf of Alaska continue. The National Marine Fisheries Service (NMFS), Alaska Department of Fish and Game (ADF&G), and Japanese and Canadian fisheries scientists have released tagged sablefish over the past several years. The results of these experiments indicated that sablefish throughout the northeast Pacific are of one genetic pool. There is less agreement on the degree of interchange of fish between regions. Wespestad (1981) reported that interregional migration is small in comparison to stock size within each region and agreed with previous reports (Low et al. 1976: Wespestad et al. 1978) that management of the resource is best conducted by discrete geographic regions.

Bracken (1982), however, described an analysis of Gulf-wide sablefish tagging data and suggested that sablefish move extensively throughout the Gulf of Alaska. The analysis showed fish under 60 cm tended to move westward while fish 60 cm or greater tended to migrate eastward.

Bracken (1982) also presented a conceptual model that identified south-eastern Alaska and British Columbia as a pooling area for large fish and that much of the spawning occurs in that region. Small fish inhabit the shallow nearshore areas and then enter deep water in their third or fourth year. From there a significant portion of the fish migrate to open ocean and move westward until they reach maturity. A large portion of the mature fish then migrate back into the Eastern Gulf to spawn. Bracken concluded by recommending management of sablefish as a single stock Gulf-wide with OY prorated over all management areas and suggested that lower harvest levels throughout the Gulf of Alaska would speed rebuilding of the depleted spawning population in the southeastern area.

Beamish and McFarlane (1983) concluded from their tagging studies that a large portion of juvenile sablefish reared in Queen Charlotte Sound and Hecate Strait, British Columbia, move north to Gulf of Alaska waters. On the other hand, most of the tagged adult sablefish were recovered close to the release area indicating that the adult population is composed of subpopulations or groups. Based on these results, they contend that adult sablefish in the Canadian zone should be managed separately and not as part of one large stock off the west coast of North America. In a review of U.S. tagging studies, Dark (1983) found a similar apparent northward movement of small sablefish (40-65 cm) released off Alaska and Washington and less movement of fish larger than 65 cm. Garrett (1983) re-examined electrophoretic data on sablefish. His new results suggest some geographic separation of genetically distinct stocks. He separated 8 Gulf of Alaska collections (excluding sea mount samples) into 4 groups with divisions at Kodiak Island, about 140°W in the Yakutat area, and in the vicinity of Cape Addington in the Southeast area.

Currently, management of sablefish is by five management regions in the Gulf of Alaska: West, Central, Yakutat, Southeast inside waters, and Southeast outside waters. Clearly, the questions of migration and stock structure are basic to rational management of sablefish, but are yet unresolved.

Year-Class Strength

U.S. observers on Japanese longline vessels in the Gulf of Alaska have collected data on length-frequency of sablefish taken in this fishery. Figures 3.1-3.5 depict these length frequencies for the years 1977 to 1982 by International North Pacific Fisheries Commission (INPFC) area, year, and sex for the directed Japanese longline fishery deeper than 500 m. For the years 1977-79 in all areas except Yakutat, the distribution is unimodal and similar to the mean length in the historic fishery (Table 3.3). In the Yakutat area in 1979, a group of fish of about 47-49 cm appeared; in 1980 the fishery took a large percentage of fish at a size of 49-51 cm in all areas. By 1981, the size of this first mode was approximately 55 cm. This apparent strong year-class has been noted by others and has usually been identified as the 1977 year-class (Balsiger and Alton 1981; Zenger 1981; Zenger and Hughes 1981; and Sasaki 1981). The length frequency patterns for 1982 are similar to 1981. The mean sizes are greater than or equal to the 1981 means with the greatest increase occurring in the Yakutat area where the sample size is the smallest. Unlike

1981, the length frequencies for the Yakutat area in 1982 are strongly bimodel for both sexes with intermediate lows at 55 cm for the males and 57-61 cm for the females. Recruitment of any strong year classes subsequent to 1977 is not apparent in the length-frequency data.

CPUE Data of the Japanese Longline Fishery

Until 1977, catch and effort statistics from the Japanese North Pacific longline fishery provided consistent information for assessing the condition of sablefish stocks in the Gulf of Alaska. Catch per unit of effort (CPUE) in terms of kilograms of sablefish per 10 hachi units of effort are shown in Table 3.4 for 1967 to 1977 and 1978 to 1981.

Prior to 1974, CPUE was generally greater than 200 in all INPFC areas. In 1975, CPUE dropped to as low as 154 in the Shumagin area and was generally about 185 in the other areas. In 1976, CPUE increased in all areas of the Gulf of Alaska. From 1976 to 1977, CPUE dropped in all areas with the decline ranging from 13 to 34% and averaging about 25%.

In 1978, fishing regulations in the Gulf of Alaska were changed to permit Japanese longliners to fish in depths shallower than 500 m in the Shumagin-Chirikof region for Pacific cod, *Gadus macrocephalus*. In 1979, the permission was extended to the rest of the Gulf. Also in 1978, catch limits for the Japanese longline fishery were imposed. This resulted in a shift of Japanese longline fishing effort towards Pacific cod in depths of 100-300 m, while in the past all the effort was directed at sablefish in depths generally greater than 500 m. Since target effort cannot be detected in the Japanese reported statistics, this source of information is available only through 1977. Okada et al. (1982) provided Gulf-wide CPUE's to continue this data series (Table 3.4), but it is not clear how effort directed specifically at sablefish was estimated. These latest data points show significant increases in 1980 and 1981.

U.S. Observer Data

Beginning in 1977 a new data source for evaluating sablefish stocks became available as U.S. observers were deployed on Japanese longline vessels. The observers collected a variety of information, including depth of fishing gear. Using this depth information, Japanese longline effort in the Gulf was identified as 1) directed at Pacific cod in the less than 300 m zone, or 2) directed at sablefish in the deeper than 500 m zone (Balsiger and Alton 1981).

A new data series of Japanese longline CPUE was calculated using only effort directed at sablefish as described above. These observer CPUE rates are shown in Tables 3.5 and 3.6. Comparing the combined CPUE's for the Shumagin to Yakutat area for 1977-80, it appears that a 25% decline occurred from 1977 to 1979, but that in 1980 stocks recovered to about the 1977 level. In 1981 CPUE was up sharply in the Chirikof and Kodiak areas, but decreased significantly in the Yakutat area. It should be noted that the observer coverage in the Yakutat area in 1981 was about 0.8%, considerably smaller than for any other year/area observed (Table 3.7). This raises some question as to the accuracy of this particular statistic since the Yakutat area provided a major part of the Japanese longline catch of sablefish in 1981 (Table 3.8).

The increasing trend in CPUE continued into 1982 in each INPFC area with the greatest increase in the Yakutat area, additional evidence that the low 1981 value was a poor estimate. The 1982 CPUE values by area are the highest in the 6 year time-series. The 1982 overall CPUE value is 56% greater than 1981 and approximately 75% greater than 1980 and 1977.

If these CPUE estimates in units of t/1000 hooks are converted to kg/10 hachi by assuming 45 hooks/hachi, then the CPUE data from the observer program can be compared with the CPUE records for the Japanese longline fleet from 1967 to 1977 in Table 3.4. The two time-series overlap for 1977 in which the observer CPUE of 135 kg/10 hachi is nearly equal to 139 kg/10 hachi from Japanese catch statistics. The 1982 estimate of 235 kg/10 hachi is the same as the 1969 and 1970 values. The Southeast INPFC area, though, has not been fished by the Japanese since 1977. Based on the mean fish length data for 1969 and 1970 compared to 1982 (Table 3.3), the catches in earlier years consisted of larger fish or fewer small fish. It is also likely that more than 45 hooks were fished per hachi in these earlier years. If catchability of longline gear has remained constant over the years, these data suggest that the abundance of sablefish in 1982 is similar to that in 1969 and 1970 when the fishery first expanded although the present structure of the population has a greater proportion of smaller and younger fish.

This comparison of the 1982 catch rates with the earlier years should be used cautiously because CPUE has probably not remained proportional to stock abundance over these 14 years. As discussed in the FMP, increasing experience and technological improvements in gear and vessels as a fishery develops tend to maintain high catch rates as a stock declines. In addition, longline gear with its limited catch potential is easily saturated such that stock abundance decrease for some time before the CPUE is affected. Lastly, as the catch quotas were reduced beginning in 1977, the less productivity fishing captains and vessels probably left the fishery first. These factors though are probably less of a problem since 1980.

The CPUE rates for the Japanese longline fishery were partitioned into three categories for small (<57 cm), medium (57-66 cm), and large (>66 cm) sablefish based on the length frequency data in Figures 3.1 to 3.5 with sexes combined (Figure 3.6). The CPUE for the small fish category shows a significant increase beginning in 1980 for the four INPFC areas, Shumagin to Yakutat. The 1982 CPUE values, which exceed 0.115 t/1000 hooks in all four areas, are approximately 10 times greater than the 1977-1979 values. The increasing trend in the medium fish category first occurred in Chirikof and

Kodiak in 1979. Increases in Shumagin and Yakutat did not occur until 1982. The 1982 CPUE values, which exceed 0.200 t/1000 k in each area, are approximately double the 1977 to 1979 values. These increases in CPUE are apparently the result of the recruitment of the strong 1977 year class to the Japanese longline fishery. The CPUE for the large fish category, which was probably in a depressed condition prior to 1977, has remained relatively stable over the six year time-series except for the major increase in the Yakutat area in 1982 which may be largely the result of a large sampling error in 1981.

Japanese-U.S. Cooperative Longline Survey

Japan and the U.S. have cooperatively conducted an annual longline survey since 1978 in the Gulf of Alaska which in recent years has expanded to the Aleutian and Bering Sea areas. The objective of the surveys is study the stock conditions of sablefish and other longline-caught species. The relative abundance and size structure of sablefish in the northeast Pacific and Bering Sea based on the results of these surveys have been recently updated by Sakaki (1983a & b) for the years 1979-1982 including a comparison with a 1969 Japanese survey in the Gulf of Alaska. The index of biomass referred to as relative population weight, RPW, is a summation of the CPUE in units of catch weight for the longline gear for each of several depth categories multiplied by the area of the fishing grounds which lies in those depth categories. Index values have been summarized by INPFC area, bottom depth intervals and fish size categories for the years 1979-1982 (Table 3.9). Survey results from the 1978 data were excluded from the analysis because of the fishing techniques were not standardized until 1979.

In general, the overall RPW estimates for the Gulf of Alaska have increased by 70% from 1979 to 1980. Approximately 80% of the relative biomass occurs within the 101-400 m depth category which is above the depth where the directed sablefish longline fishery occurs. Since 1980, the sablefish index for the 401-1000 m depth interval has consistently increased in all five areas. The 1982 index for this depth category is approximately 100% greater than those for 1980 in the Shumagin, Chirikof, Kodiak, and Yakutat areas, but only 43% greater in the Southeast areas. The RPW values for fish greater than 58.1 cm in length increased 73% from 1979 to 1982. In the Shumagin area, the relative biomass estimates increased annually, while in Chirikof and Kodiak the increase occurred between 1981 and 1982. In the Yakutat and Southeast areas the increases in these medium and large sablefish occurred between 1980 and 1981. From 1979 to 1982 the overall increase of 74% for fish greater than 58.1 cm in the four areas, Shumagin, Chirikof, Kodiak, and Yakutat, is consistent with the 108% increase in CPUE from the U.S. observer data for fish 57 cm and greater in length in areas west of 140°W and greater than 500 m depth. Comparable estimates of RPW have not been derived for fish larger than 66 cm (or mature females).

Sasaki (1983a) compared CPUE of sablefish from the 1979-1982 cooperative survey with the CPUE from a similar 1969 Japanese longline survey conducted as a training cruise. The comparison of CPUE in kg/hachi was for the 401-800 m depth interval within the Kodiak-Yakutat areas. Based on this comparison, he concluded that the 1980 biomass in this zone was 61% of the 1969 biomass, but that the abundance by 1982 was 19% greater than in 1969. Given that the 1969 survey was an actual training cruise at the beginning of expansion of the Japanese longline fishery, it is quite unlikely the comparison is valid due to the difficulty in standardizing effort.

Sasaka (1983a & b) noted the size composition and concluded that the sharp increase in the stock from 1979 to 1982 was caused by the entry of the very abundant 1977 year class. He predicted the numbers of sablefish in the population will decrease after 1983 but that biomass will continue to increase for a few years.

U.S. Pot Index Survey

The NMFS pot index survey conducted annually since 1978 has become an important means of assessment for sablefish stocks in the Southeast area since the foreign longline fishery no longer operates there. Based on results of surveys from 1978 to 1980, Zenger and Hughes (1981) estimated that the acceptable biological catch for the June 1980 - May 1981 should not exceed the previous seasons harvest of 2,580 t. An unknown fraction of this harvest though actually occurred in the Cape Spencer area which is technically in the Yakutat INPFC area along with the Cape Cross index sight. The population index for the 1981 pot survey (Zenger 1981) appeared to be down about 50% from the previous years (Figure 3.7). The results for the 1982 survey were slightly lower. Unfortunately, this survey encountered problems with weather and two stations, Cape Cross and Cape Ommaney, were fished with what was believed to have been inferior bait. A test comparison of baits, conducted in the spring of 1983, found no detectable differences in catch rates between the 1982 bait and fresh bait (J. Fujioka, NMFS pers. comm.).

The 1983 survey completed in June showed a slight improvement in the catch rates of marketable size sablefish ($\geq$57 cm in length) at all four index sites. The greatest increase occurred at Cape Muzon and the smallest at Cape Cross, a major domestic fishing grounds. The pattern of decreasing catch rates between 1980 and 1981 for the pot survey index (Figure 3.7) is opposite of the increases for the RPW index in the Yakutat and Southeast areas for the marketable sablefish for the same two years. The sablefish length frequencies for the 1983 pot survey are similar to 1982 with only a slight progression of the length mode (Figure 3.8). There is no indication of another strong year-class recruiting to the fishery.

POTENTIAL YIELD

Estimates of MSY

Although the sablefish resource is managed by regions, the long-term productivity in each region is assumed to be related to the overall condition of the resource. Japanese and U.S. scientists have estimated MSY of the resources as a whole and apportioned MSY to each region based on historic production trends. The Japanese estimate of MSY for the entire resource from California to the Bering Sea is 69,600 mt. Using essentially the same general production model as the Japanese, but with a different weighting of data among regions, Low and Wespestad (1979) estimated MSY for the California to Bering Sea resource at 50,300 t.

By region, historical catches were Bering Sea (25%), Aleutian region (4%), Gulf of Alaska (47%), and British Columbia-Washington region (25%). The apportioned MSY estimates were then compared to MSY estimates derived by applying general production models region by region. The resulting mean and overall estimate of MSY was 25,100 t for the Gulf of Alaska (Low and Wespestad 1979). This estimate updates the MSY range of 22,000-25,000 t in the FMP. Production models are most appropriate for relatively short-lived fish stocks in which annual recruitment is relatively stable. It is questionable whether time-series of catch and effort data are appropriate for use in general production modeling of sablefish stocks, given that the life-span of sablefish may be much longer than previously thought and that the fisheries are apparently supported by infrequent strong year classes (McFarlane and Beamish 1983).

Equilibrium yield

Determination of potential yield from a population of fish is dependent on the size at which an individual fish becomes available to the fishery.

EY for sablefish, as presented in the FMP, is based on data from the Japanese longline fishery. Hence, the implicit size at entry to the fishery for which the EY figure is appropriate is the size of entry to the Japanese longline fishery. Table 3.3 demonstrates that although there was variability by year and area, the average size did not change significantly from 1969-1979. However, in 1981 and 1982, the average size was less than 60 cm, reflecting the increased availability of the 1977 year class to the fishery. Thus, the current EY reflects yields with sablefish entering the fishery from about 42 cm (1.2 lbs dressed weight), until the fish are fully recruited at sizes of 62-65 cm (4.2-4.8 lb dressed weight). Fish of both sexes are 50% recruited at 55 cm (2.8 lb dressed) (Balsiger and Alton 1981).

The information available to evaluate EY for the Eastern region east of 140°W longitude is the Japan/U.S. cooperative longline survey, 1979-1982, and the U.S. pot index, 1978-1983. The results from the longline survey (Table 3.9) for Yakutat and Southeastern show a 100% increase in marketable sablefish (>58.1 cm in length) between 1980 and 1981 and a decrease of 16% between 1981 and 1980. The RPW values for sablefish in the 401-1000 m depth interval in the eastern region has steadily increased, although the increase has been the smallest in the Southeast area. The conflicting results have been found by the U.S. pot survey with a 50% decrease in number of sablefish per pot between 1980 to 1981 and a slight decline in 1982. The results from 1983 show slight improvement with the largest increase at the Cape Muzon site. Funk and Bracken (MS) report that results from port sampling of the domestic fishery in southeast Alaska indicates that both CPUE and average size of the landed fish have increased since 1981 for both the offshore and inshore fishery segments.

The EY value for 1982 in the Southeast area was given as 1,290 t to 2,580 t. The latter number was estimated to be ABC for the 1980-1981 season by Zenger and Hughes (1981), which was equal to the previous seasons catch. Balsiger and Alton (1981) reduced EY for the 1981 calendar year by half because of the 50% decline in the U.S. pot index value. The EY value for 1982 was given as the range, 1,290 to 2,580 t. The 1983 fishery was managed to harvest the upper limit. Because of the conflicting evidence from the two surveys, the EY for 1984 is left unchanged from 1983, i.e. 1,290 t to 2,580 t.

Little information is available for the portion of the Yakutat area east of 140°W longitude other than Japan/U.S. longline survey and the Cape Cross Station from the U.S. pot survey. The range for EY in 1982 was given by Balsiger (1983) as 1,135 t to 1,510 t based in part in 1981 EY values and the decline in the pot index in 1981. Given that there is little change in the index values for the longline survey pot between 1981 and 1982, and the Cape Cross index site between 1981 and 1983, the EY for 1983 is set equal to the 1982 values of 1,135 to 1,510 t.

Annual adjustments of EY for the areas west of 140°W longitude have been based on changes in CPUE of the Japanese longline fishery and estimates of MSY derived from surplus production models. On the basis of the decline of CPUE from 1970 to 1977 (Table 3.4), Low (1978) reduced the EY for 1980 in the Gulf of Alaska to 14,000 t based on an MSY of 23,500, the mid-point of the 22,000-25,000 t range given in the FMP. The EY for the area west of 140°W longitude would have been 8,540 t or 61% of the EY as specified by the FMP. Sasaki (1983b) proposes that 80% of the biomass (based on RPW for all sablefish or for fish >58.1 cm) is west of 140°W. The EY for the 1983 was kept at 8,540 t because of the uncertainty as to when the abundant small fish would attain marketable size. Evidence from the 1982 Japanese longline survey (Table 3.9) and CPUE recorded by U.S. observers aboard Japanese longline vessels (Table 3.5) indicate that the relative abundance of marketable sablefish has increased by at least 74% between 1979 to 1982. The magnitude of this increase is equivalent to the earlier decline. Using the same procedures for adjusting EY as in the past for this area, the current EY is 74% greater than in 1979. This is equivalent to MSY for the area west of 140°W, which is 14,335 t or 61% of 23,500 t. Using the same percentages as in the past for prorating EY by management regions, EY values would be 3,737 t for the Western region, 6,838 t for the Central region, and 3,760 t for the Yakutat rgion west of 140°W.

For all regions combined, the EY for the entire Gulf would range from 16,760 to 18,425 t. These values are within the range of average annual surplus production (ASP) projected by Funk and Bracken (MS) from an age structure simulation model. For 1984 to 1987 they projected an average ASP of 21,148 t gulf-wide based on a sablefish biomass of 155,000 t in 1979. For a biomass of 104,000 t (33% smaller), they projected an average ASP of 15,524 t. The magnitude of their projected ASP depends on the value for the 1979 biomass given to the model. Also the model is probably sensitive to the estimated age structure of the population derived from their length-at-age relationship. Their method of estimating age composition likely underestimated the size of the 1977 year class and overestimated the adjacent year classes.

Uncertainties in the appropriateness of MSY and the CPUE data, the proportionality of the relative biomass indices, the importance of longevity to recruitment and migration patterns, and the slower recovery of sablefish in the area east of 140°W longitude are arguments for conservative management of sablefish. Given these uncertainties, setting EY for 1984 equal to MSY for the area west of 140°W longitude based observed increases in fishing conditions would be optimistic. The risk of overfishing though is reduced by Amendment 11 of the FMP which sets OY equal to 75% of EY in 1982 or 6,410 t in the area west of 140°W longitude. This is approximately 48% of the average catch for these western areas from 1968 to 1977 and 30% of the peak catch in 1972. If indeed the abundance of the resource in the western areas is similar to that in the early 1970's, then the harvest of the OY should allow the stock to continue rebuilding. Because of the above uncertainties in the biomass and production of the sablefish stock in the Gulf of Alaska, the EY values for 1984 will be kept at 1983 levels of 2,225 t for the western region, 4,075 t for the central region, 2,240 t for Yakatut west of 140° W, 1,135-1,510 t for Yakatut east of 140° W and 1,290-2,580 t for southeast area.

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Table 3.1.--Reported historical landings of sablefish in metric tons by area and nation in the Gulf of Alaska, 1958-1982.

	Gulf of Alaska (Shumagin-Southeastern)					
Year	U.S.	Canada	Japan	USSR	ROK	Total
1958	698	98	--	--	--	796
1959	1,048	52	--	--	--	1,100
1960	1,925	17	--	--	--	1,942
1961	866	31	--	--	--	897
1962	684	47	--	--	--	731
1963	881	109	1,819	--	--	2,809
1964	1,172	238	1,047	--	--	2,457
1965	1,047	194	2,217	--	--	3,458
1966	1,067	335	3,778	--	--	5,180
1967	946	199	5,030	--	--	6,175
1968	161	128	14,767	--	--	15,056
1969	301	72	19,051	--	--	19,424
1970	527	68	24,530	--	--	25,125
1971	386	15	25,228	--	--	25,629
1972	1,081	16	35,558	535	308[a/]	37,498
1973	1,217	16	27,264	109	58[a/]	28,664
1974	1,114	10	24,176	38	2,431[a/]	27,769
1975	1,556	16	22,072	33	3,000[a/]	26,677
1976	1,145	23	21,924	41	3,700[a/]	26,833
1977	1,173	3	14,356	4	1,594	17,130
1978	1,777	0	6,458	4	665	8,904
1979	3,382	0	5,901	152	759	10,194[b/]
1980	2,270	0	4,831	416	891	8,408
1981	1,801	0	6,911	0	1,062	9,774[c/]
1982	3,008	0	4,921	0	724	8,653

a/ Includes catches from other areas in the northeastern Pacific.
b/ Includes 55 mt by Mexico.
c/ Includes 7 mt by Poland.

Source: Revised and updated U.S. landing from ADFG; Canadian data 1971-76 from PMFC data series, groundfish section; 1958-70 from Sasaki (1982); Japanese, USSR, ROK data from INPFC document 1883, pers. comm. T. Sasaka, Far Sea Fishery Lab., Shimizu, Japan; and Sasaki (1982); U.S. Foreign Fisheries Observer Program.

Table 3.2.--Year-end sablefish optimum yield (OY), domestic annual harvest (DAH) and total allowable level of foreign fishing (TALFF) for the Gulf of Alaska regulatory regions, 1977-1983.

		Western	Central	Eastern		All regions
1977	OY					22,000
	DAH					2,500
	TALFF					19,500
1978	OY					15,000
	DAH					4,000
	TALFF					10,200
1979	OY	2,100	3,800	7,100		13,000
	DAH	100	100	3,800		4,000
	TALFF	1,965	3,570	3,270		8,805
1980	OY	2,100	3,800	7,100		13,000
	DAH	25	171	4,812		5,008
	TALFF	2,075	3,629	2,288		7,992
1981[1]	OY	2,450	4,433	7,466		14,349
	DAH	115	423	3,805		4,343
	TALFF	2,335	4,101	3,661		10,006
				YK	SE	
1982	OY	2,100	3,800	3,400	3,700	13,000
	DAH	270	750	1,380	2,910	5,310
	TALFF	1,830	3,050	2,020	90	6,990
Initial				West 140°W	East 140°W 2/	
1983	OY	1,670	3,060	1,680	1,820-3,070	8,230-9,480
	DAH	270	1,220	530	1,820-3,070	3,840-5,090
	TALFF & Reserve	1,400	1,840	1,140	0	4,390

1/ Values for 1981 are for 14 months or 16.7% greater than 1980

2/ OY range is 850-1135 t for east Yakutat, 470-1435 for the outer coast of Southeast and 500 t for the inside waters of Southeast.

Table 3.3.--Average size (cm) of sablefish taken by the Japanese longline fleet in the Gulf of Alaska from 1969-1982. (Data from foreign reported fishery statistics for 1969-1978, and from U.S. observer data for 1979-1982 for depths >500 m).

Year	All areas	Shumagin	Chirikof	Kodiak	Yakutat	Southeast
1969	67.2	--	65.2	--	68.7	--
1970	66.2	--	--	60.5	67.8	68.6
1971	65.4	61.4	60.6	63.6	66.3	66.0
1972	62.3	62.4	60.8	60.8	63.9	63.5
1973	62.8	63.2	61.2	63.7	63.7	64.4
1974	--	--	--	--	--	--
1975	67.1	66.4	--	--	--	67.9
1976	66.2	66.3	65.5	64.1	65.9	68.4
1977	64.7	--	60.9	--	64.6	65.0
1978	67.4	65.8	67.0	67.0	69.9	--
1979	--	66.3	64.7	63.5	63.5	--
1980	--	60.4	60.9	61.8	59.1	--
1981	--	58.9	56.1	59.7	55.8	--
1982	--	58.9	58.4	60.3	59.3	
Average (1969-1978)	64.6	64.5	62.0	63.5	66.3	65.7

Table 3.4.--Indices of sablefish abundance in the Gulf of Alaska, 1967-79, CPUE (kg/10 hachi).

Year	Shumagin	Chirikof	Kodiak	Yakutat	South-eastern	Shumagin-Southeastern
1967	184	234	175	175	301	212
1968	153	226	272	282	257	263
1969	239	246	239	238	229	235
1970	221	245	266	255	229	235
1971	177	206	207	223	204	207
1972	220	198	210	203	207	208
1973	214	216	213	206	203	209
1974	181	191	185	191	195	190
1975	154	188	181	186	184	177
1976	165	210	182	196	191	186
1977	144	133	133	142	139	139
1978	*	*	136	137	---	135
1979	*	*	60	74	---	109
1980 1/	*	*	*	*	---	122
1981 1/	*	*	*	*	---	151

* = Prior to 1978, Japanese longliners were not permitted to fish in depths shallower than 500 m. Since 1978, some of these longliners have been permitted to fish in waters shallower than 500 m for Pacific cod. Therefore, the total longline fishing effort no longer reflects total effort on sablefish.

-- No foreign longlining has been permitted east of 140°W longitude since 1978.

1/ Source: Okada et al. 1982.

Table 3.5.--CPUE (t/1000 hooks) for sablefish in Japanese longline fishery for observed hauls from >500 m depth as determined by U.S. observers. Numbers of observed hooks in thousands is shown in parentheses.

Year	Shumagin	Chirikof	Kodiak	Yakutat	Southeast	Shumagin-Yakutat t/hook	Shumagin-Yakutat kg/hachi
1977	.237 (191)	---	.247 (510)	.361 (500)	.428 (773)	.293	132
1978	.236 (549)	.204 (494)	.241 (1,525)	.232 (1,155)	1/	.232	104
1979	.140 (1,041)	.202 (931)	.228 (1,781)	.268 (1,359)	1/	.216	97
1980	.286 (273)	.275 (211)	.350 (347)	.254 (209)	1/	.298	134
1981	.238 (375)	.419 (220)	.491 (203)	.194 (104)	1/	.334	150
1982	.480 (383)	.483 (253)	.641 (213)	.527 (121)	1/	.522	235

Table 3.6.--CPUE (t/1000 hooks) for large sable (67 cm and greater) in the Japanese longline fishery for hauls from >500 m depth as determined by U.S. observers.

Year	Shumagin	Chirikof	Kodiak	Yakutat	Southeast	Shumagin-Yakutat
1977	.123	---	.169	.211	.269	.179
1978	.140	.107	.141	.126	1/	.132
1979	.085	.109	.117	.149	1/	.117
1980	.133	.100	.174	.086	1/	.131
1981	.112	.130	.167	.037	1/	.122
1982	.106	.087	.176	.197	1/	.132

1/ The area east of 140°W in Yakutat was colsed to foreign longlinig beginning in 1978.

Table 3.7.--Percentage of Japanese longline catch with U.S. observer aboard by INPFC area for 1977-1982.

Year	Shumagin	Chirikof	Kodiak	Yakutat	Southeast
1977	2.0	0	5.6	4.2	8.3
1978	13.3	16.5	21.9	10.7	-
1979	34.9	21.9	23.8	19.3	-
1980	14.9	10.9	13.1	5.1	-
1981	16.0	14.3	9.6	0.8	-
1982	21.8	14.3	13.6	5.7	-

Table 3.8.--Distribution of Japanese longline catch in t of sablefish in the Gulf of Alaska.

Year	Shumagin	Chirikof	Kodiak	Yakutat
1977	2316	963	2252	4258
1972	1173	761	1676	2491
1979	775	1059	1723	1890
1980	705	1204	1032	1154
1981	1225	1345	1167	2507
1982	1212	1126	1055	1112

Table 3.9.--Relative population weight (RPW) as an index of sablefish biomass for the Gulf of Alaska, 1979-1982, from Saski (1983).

Year	Shumagin	Chirikof	Kodiak	Yakutat	South-eastern	Total
Total						
1979	11,580	61,237	55,413	35,148	25,324	188,702
1980	17,819	57,951	57,945	52,437	27,982	214,134
1981	27,851	52,437	51,640	66,712	51,123	249,763
1982	41,309	87,115	79,715	67,076	44,752	319,967
101-400m						
1979[1/]	--	--	--	--	--	--
1980	12,739	51,319	48,955	44,994	18,658	176,665
1981	20,888	45,183	39,030	55,991	38,510	199,602
1982	31,353	72,125	60,026	51,872	31,453	246,829
401-1000m						
1979[1/]	--	--	--	--	--	--
1980	5,080	6,632	8,990	7,443	9,324	37,469
1981	6,963	7,254	12,610	10,721	12,613	50,161
1982	9,956	14,990	19,689	15,204	13,299	73,138
Fish >58.1 cm in FL						
1979	7,493	37,284	40,053	25,224	19,891	129,945
1980	11,121	39,120	31,006	25,445	16,593	123,285
1981	16,431	35,662	32,868	46,292	40,207	171,460
1982	32,642	64,381	55,377	39,631	33,088	225,119

[1/] Data not available because of incomplete size composition by depth.

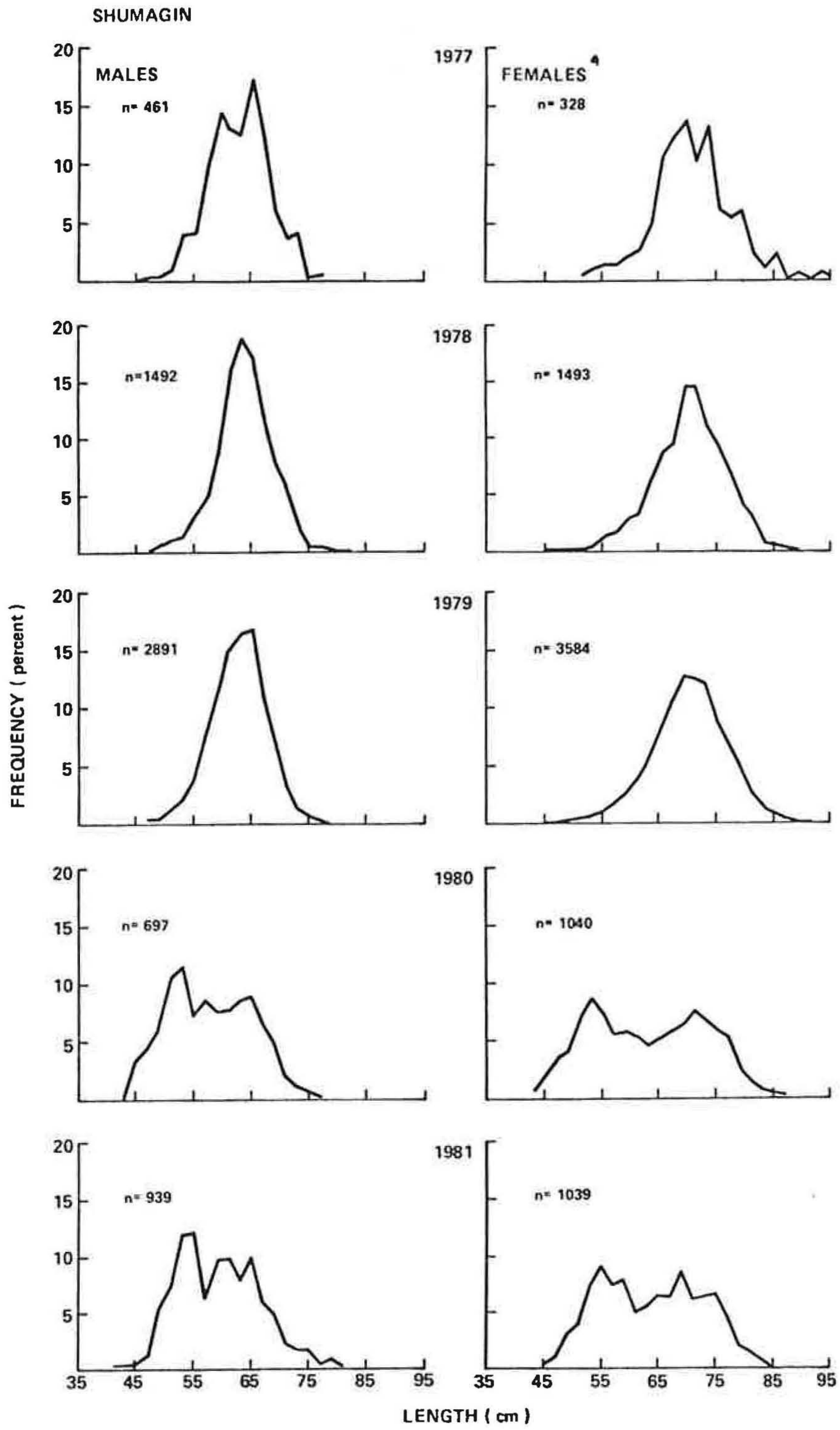

Figure 3.1--Sablefish length/frequency by U.S. observers on Japanese longline vessels in the Shumagin Area, deeper than 500 m, from 1977 to 1981.

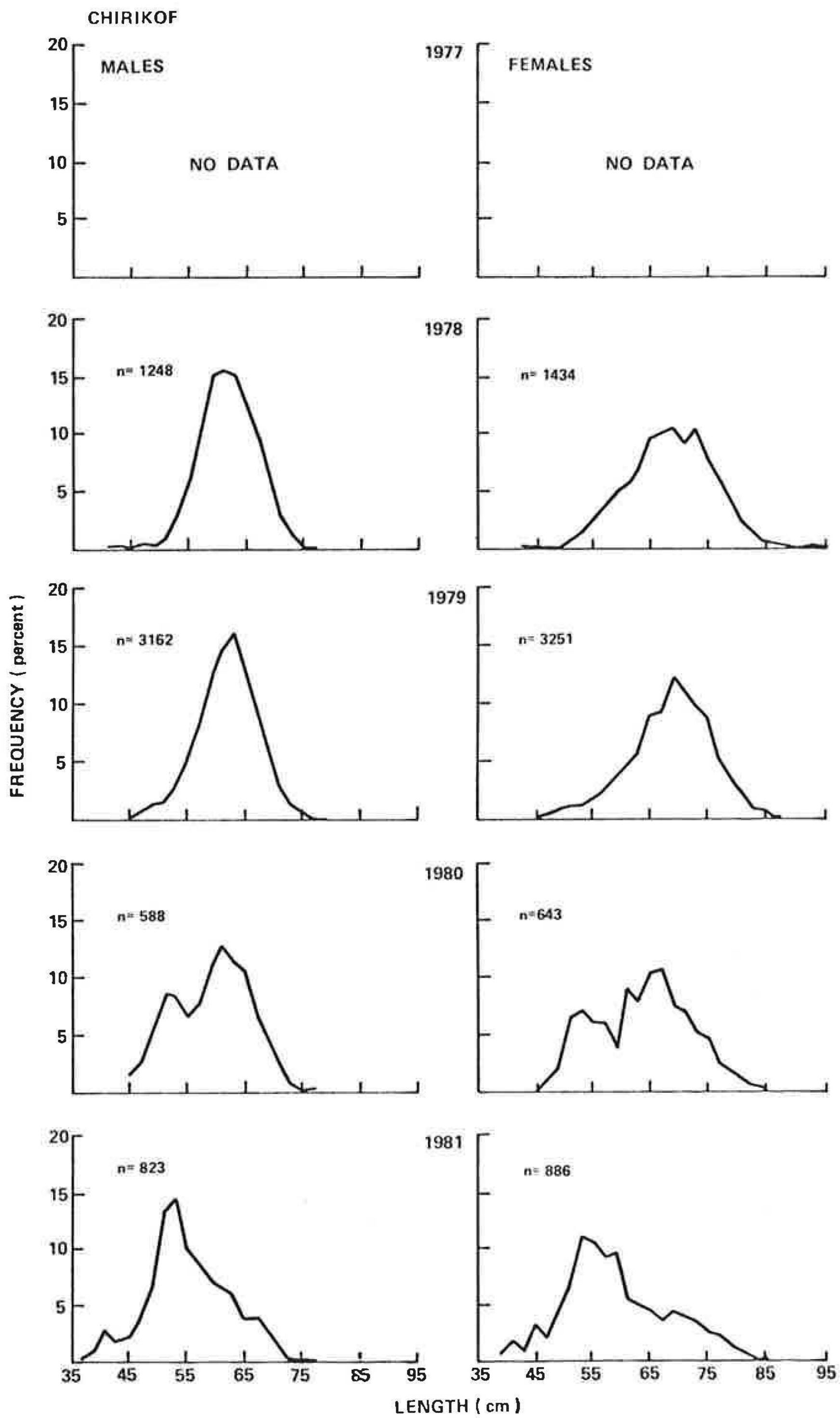

Figure 3.2--Sablefish length/frequency by U.S. observers on Japanese longline vessels in the Chirikof Area, deeper than 500 m, from 1977 to 1981.

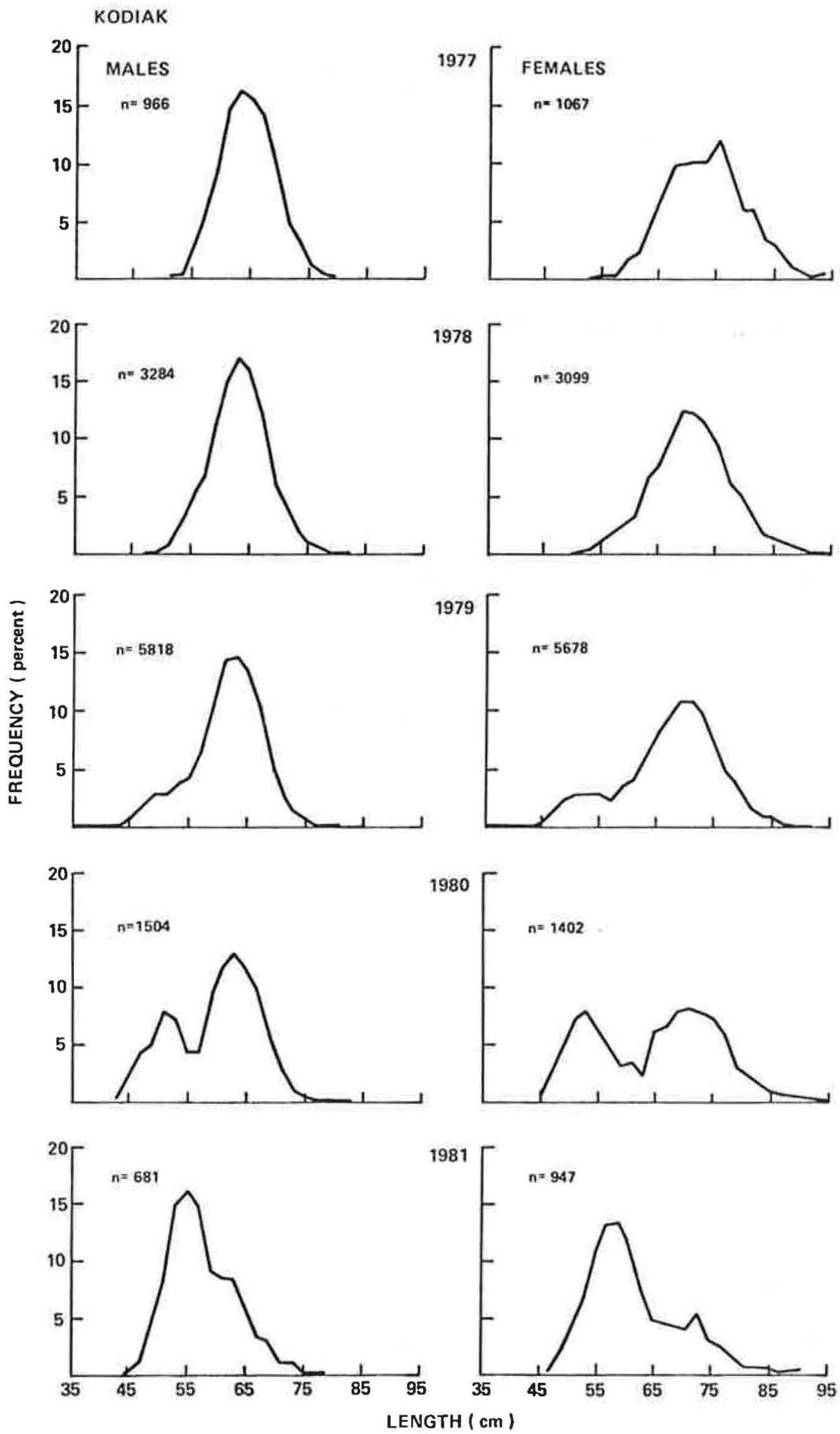

Figure 3.3--Sablefish length/frequency by U.S. observers on Japanese longline vessels in the Kodiak Area, deeper than 500 m, from 1977 to 1981.

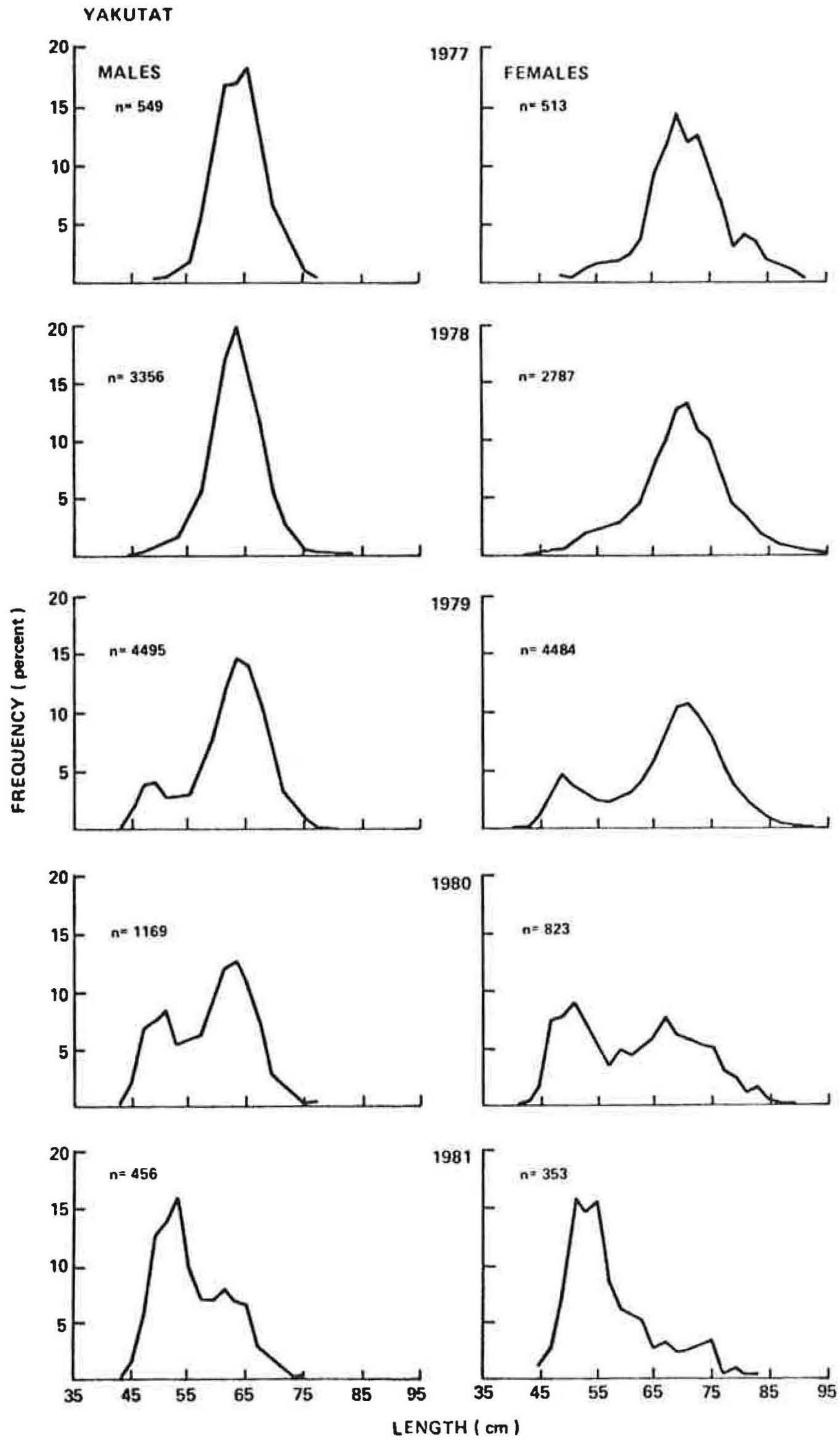

Figure 3.4--Sablefish length/frequency by U.S. observers on Japanese longline vessels in the Yakutat Area, deeper than 500 m, from 1977 to 1981.

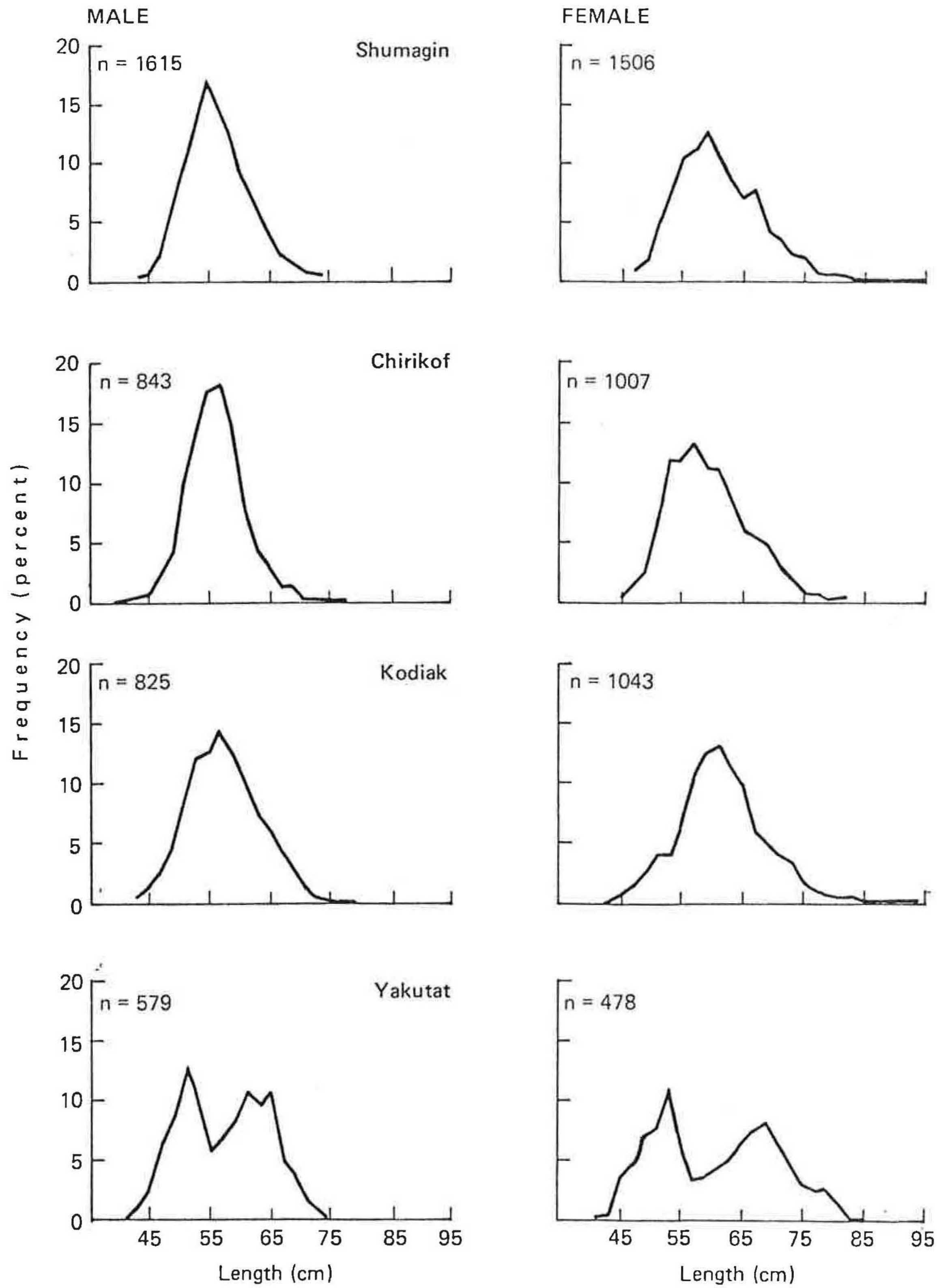

Figure 3.5--Sablefish length frequency from U.S. observers on Japanese longline vessels in the Gulf of Alaska, fishing deeper than 500 m in 1982.

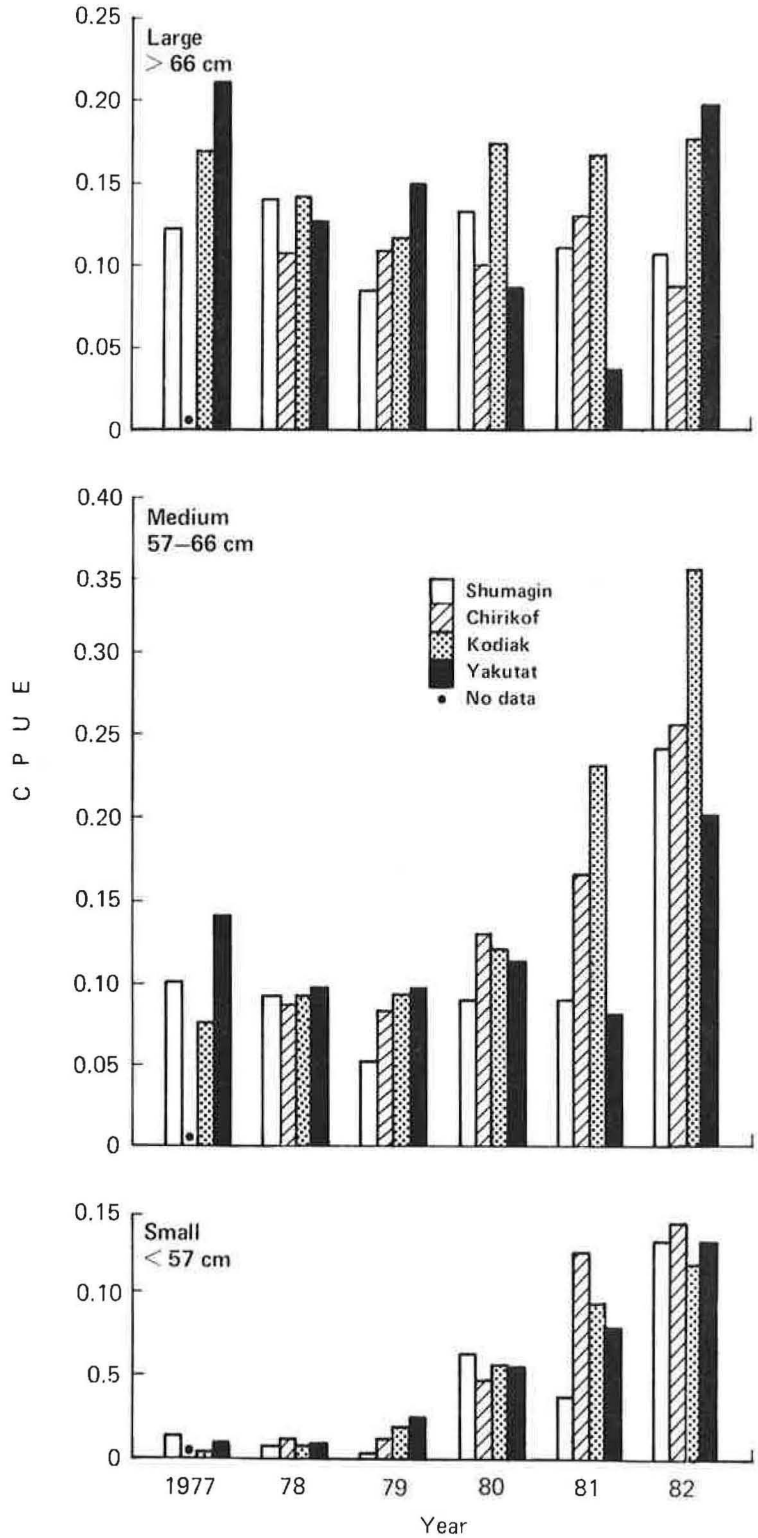

Figure 3.6--CPUE (t/1000 hooks) for small (<57 cm), medium (57-66 cm), and large (>66 cm) sablefish in the Japanese longline fishery for hauls from >500 m depth as determined by U.S. observers, 1977-82.

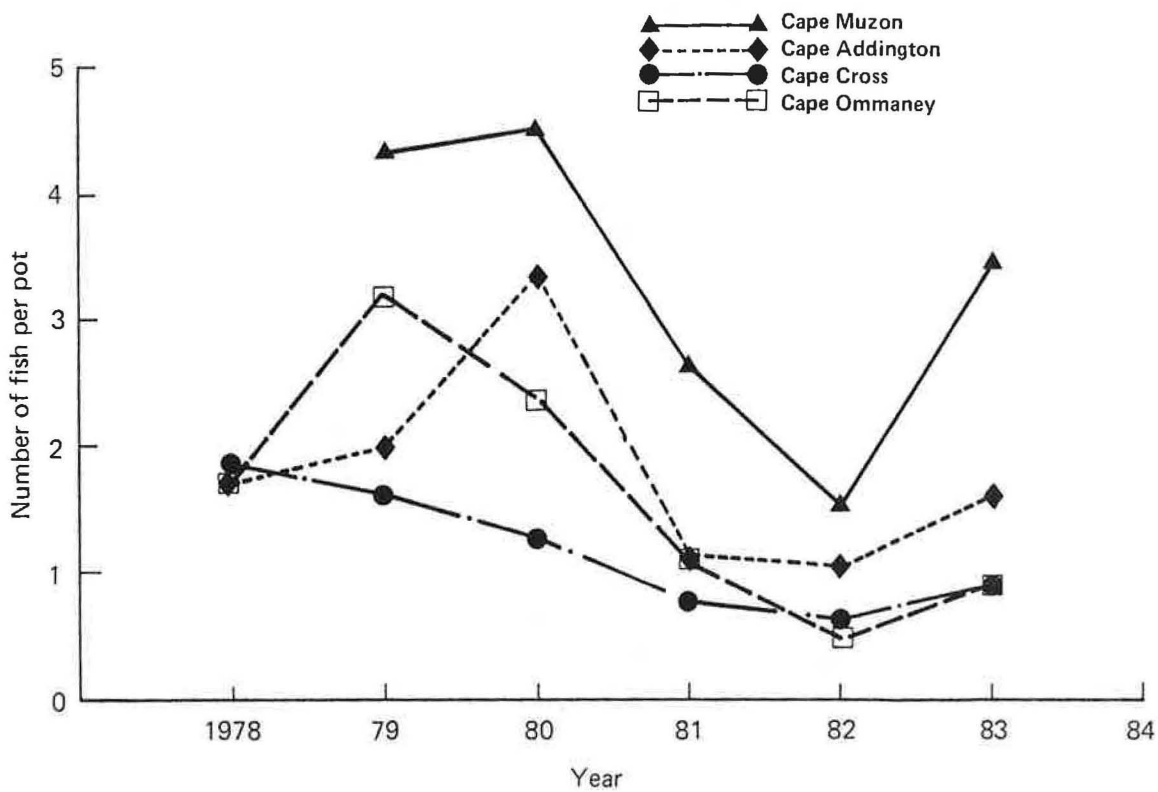

Figure 3.7--Average number of fish ≥ 57 cm per pot from the U.S. sablefish survey Southeast Alaska for 1978 to 1983.

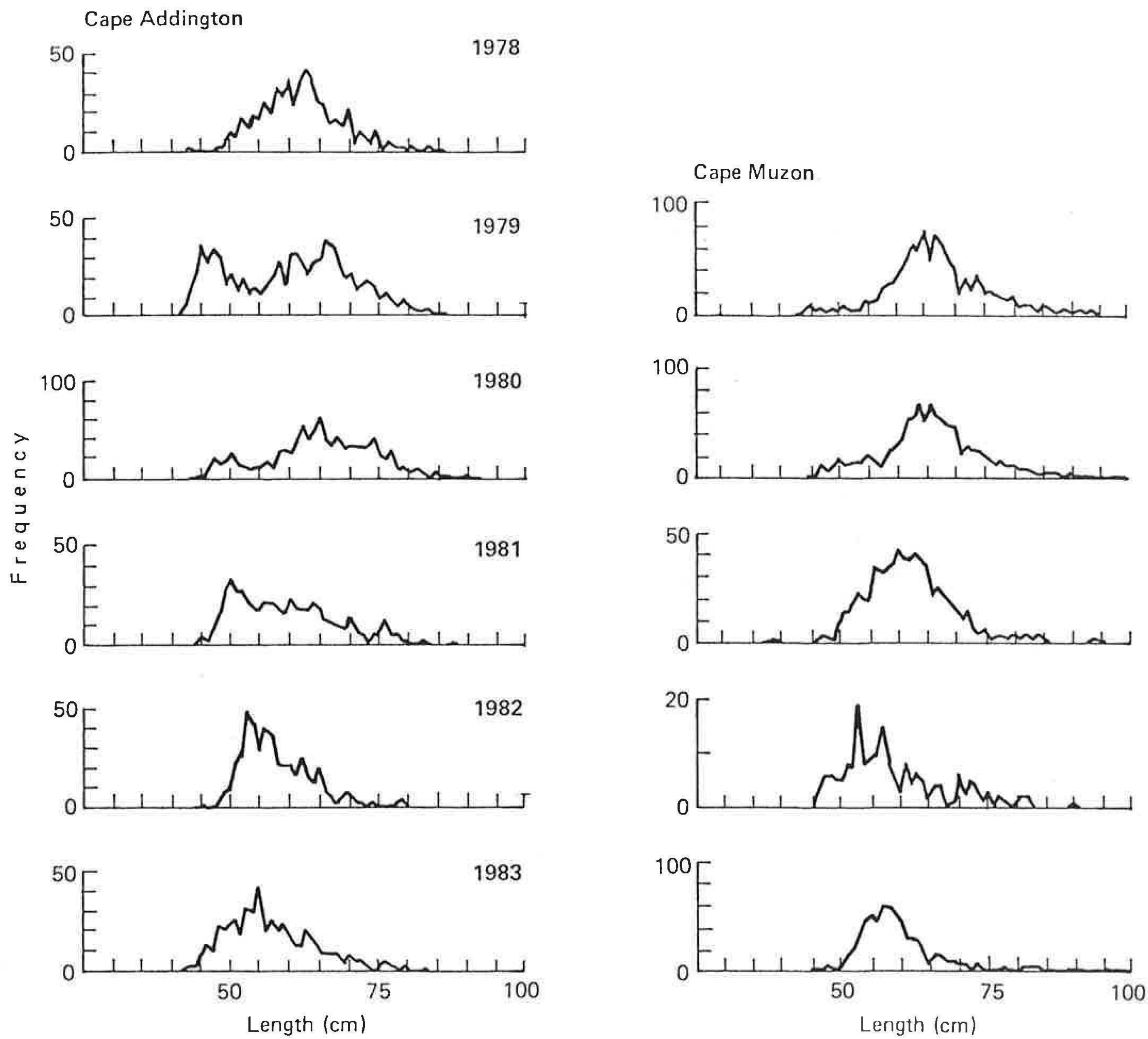

Figure 3.8--Length frequency for sablefish (both sexes combined) from U.S. pot survey at Cape Addington, 1978-1983 and Cape Muzon, 1979-1983, Cape Ommaney and Cape Cross, 1978-1983.

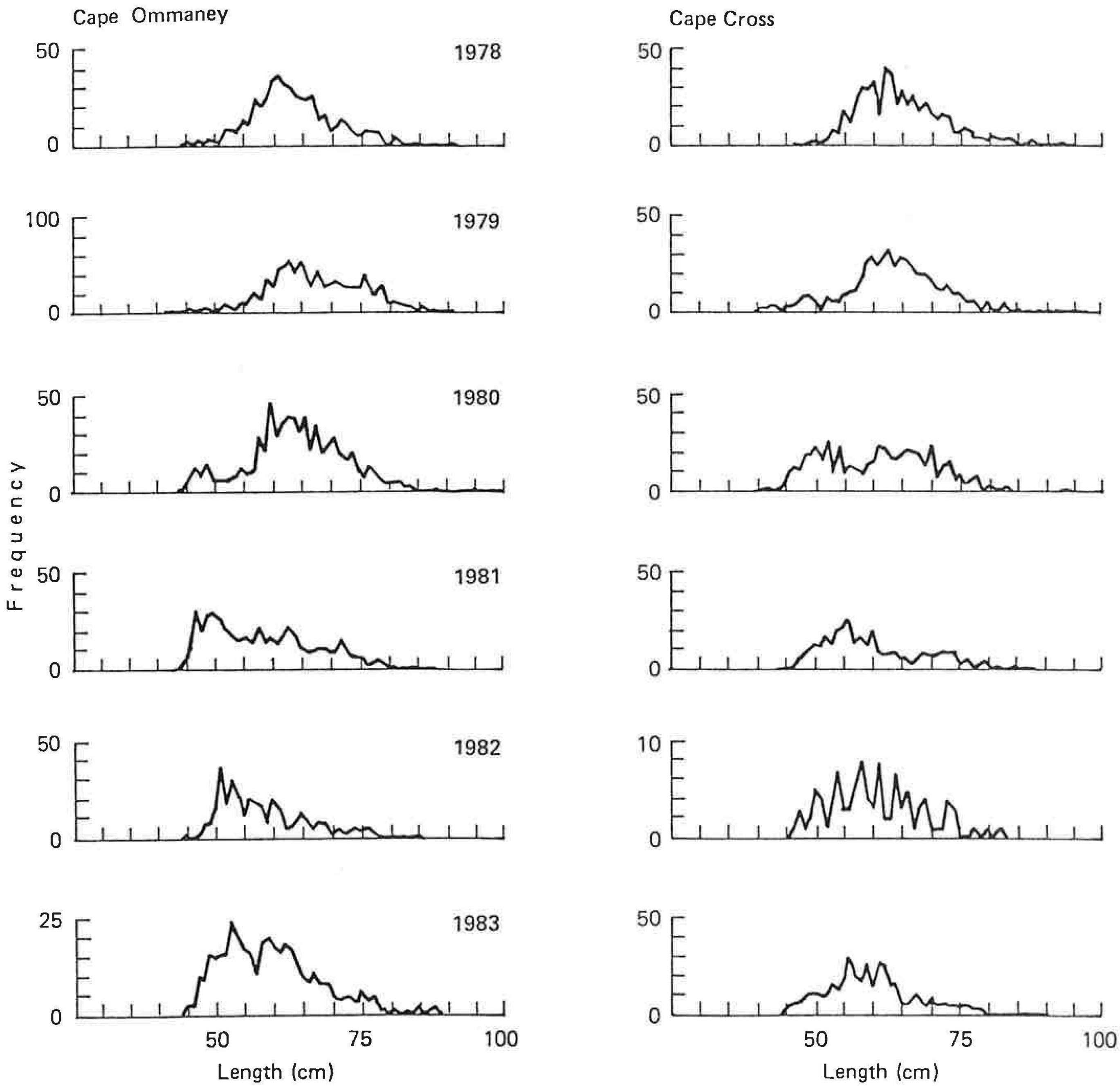

Figure 3.8--Continued

PACIFIC COD[1/]

Harold H. Zenger, Jr.[2/]

INTRODUCTION

In North American waters, Pacific cod occur on the continental shelf and upper slope from Santa Monica Bay, California (34 degrees N latitude) though the Gulf of Alaska, Aleutian Islands, and eastern Bering Sea to Norton Sound (Bakkala et al. 1981).

Since 1977 the importance of Pacific cod in Gulf of Alaska groundfish catches has grown, increasing from 2,223 metric tons (t) in 1977 to 36,018 t in 1981, and dropping to 33,563 t in 1982. Its growing importance to U.S. fishermen is shown in the sixfold increase in domestic landings from 991 to 6,434 t between 1981 and 1982 (Table 4.1).

At this time, management of Pacific cod stocks in the Gulf of Alaska has not reached a critical point since they are relatively healthy and the OY of 60,000 t is almost twice as high as the present harvest level. Continued use of midwater trawls rather than demersal nets in the Shelikof Strait pollock fishery will limit incidental joint-venture cod catches. However, preliminary figures supplied by the Alaska Department of Fish and Game (ADFG), Kodiak, Alaska, indicate that the U.S. directed cod fishery for Pacific cod landed 2,460 t in the first 5 months of 1983, almost three times as high as for the same period in 1982. In addition to the joint-venture agreements with Japanese and Korean fishing companies, a new joint-venture with a Portuguese firm was begun in May 1983 that, unlike the former, is interested primarily in Pacific

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1/ This report is a revised update of the 1982 INPFC document; Zenger, H. and N. Cummings. 1983. Pacific cod. In Ito, D. and J. Balsiger (ed), Conditions of groundfish resources of the Gulf of Alaska in 1982. U. S. Dept. Commer. NOAA Tech. Memo. NMFS F/NWC-52, 204 p.

2/ Northwest and Alaska Fisheries Center, National Marine Fisheries Service, NOAA, 2725 Montlake Boulevard East, Seattle, WA 98112.

cod. By the end of May 1983 best blend estimates of the foreign cod catch stood at 10,660 t or 41% of the current Total Allowable Level of Foreign Fishing (TALFF) allocation.

FISHERY STATISTICS

Three nations, Japan, Korea, the US, and a number of US foreign joint-ventures captured Pacific cod in the Gulf of Alaska during 1982. Japan led with 24,450 t or 73% of the total all-nation catch of 33,563 t (Table 4.1). U.S. landings were 6,434 t, Korea took 2,486 t and joint-ventures accounted for 193 t. Approximately half of the Japanese catch came from the Chirikof INPFC area, whereas the U.S. catches were greatest in the Shumagin and Kodiak areas (Table 4.2). The latter represents the reemergence of the U.S. as a major cod harvesting nation in the Gulf of Alaska. The

Japanese continue to harvest the majority of their catch in the Gulf with longlines, whereas Korea and the joint-ventures employ trawlers (Table 4.3). Since 1979 between 91 and 92% of the total Japanese catch was made by longlines. Over 50% of the longline catch came from the Chirikof INPFC area (Table 4.4). In 1982 the combined Shumagin and Chirikof areas produced 77% of the total Pacific cod catch in the Gulf of Alaska (Table 4.5).

The most consistent, relatively long-term source of Pacific cod size composition data from the Gulf of Alaska comes from the Japanese longline fishery. Length frequency data collected by the NMFS foreign observer program during 1979-82 are summarized by 3-month periods in Figure 4.1. Length frequencies were weighted by the best blend cod catch for each quarter year. The resulting histograms show the relative contribution of each centimeter size class to the total quarterly catch. During the fourth quarter of 1979 first indications of recruitment from old cod became more notable in the following year and by the end of 1980 that cohort composed the majority of the total Japanese longline catch of Pacific cod. The 1977 year-class has virtually supported the fishery since mid-1981. Although the large 1977 cohort may have masked recruitment of the subsequent two year-classes, what appears to be the 1980 year-class (40-50 cm fish) began recruiting to the fishery during the last quarter of 1982 and the first quarter of 1983 (Figures 4.1 and 4.2).

Historically, foreign fisheries have taken Pacific cod incidentally to target species such as pollock and sablefish. Various regulations have been implemented by the North Pacific Fishery Management Council (NPFMC) that effect cod fisheries in the Gulf of Alaska. Amendment 2 to the Gulf of Alaska Fishery Management Plan allowed a directed foreign longline fishery for Pacific cod west of 157° W outside of 12 miles year-round beginning in 1979. Amendment 4 permitted a Pacific cod longline fishery between 140-157° W beyond 12 miles except that fishing would be closed within the 400 m isobath during the U.S. halibut season. Those regulations permitted increased foreign exploitation of what appears to be an unusually successful year-class of Pacific cod. Based on U. S. foreign observer data for the years 1979 to 1982, Pacific cod from the Japanese longline fishery operating in waters shallower than 500 m shows an increasing trend in the Shumagin area, a lesser increase for the Chirikof area, and a decreasing trend for Kodiak (Table 4.6).

Optimum yield (OY) has varied somewhat since the concept was adopted by NPFMC. In 1977 OY was established at slightly less than the previous year's total catch. From 1978 to 1981 OY varied between 34,800 and 70,000 t, settling at 60,000 t in 1982 (Table 4.7). The distribution of OY is currently 28, 56, and 16% in the Western, Central, and Eastern regulatory areas, respectively. (The Western area is the Shumagin INPFC area; the Central area is composed of the Chirikof and Kodiak INPFC areas; and the Eastern area refers to the combined Yakutat and Southeastern INPFC areas). Actual 1982 catches were distributed as 34.5, 59.5, and 6% to the respective areas. Annual catches of Pacific cod in all three regulatory areas were well below the final allocations (Tables 4.7 and 4.8). Results of 1981 research vessel trawl surveys showed that 59% of the available biomass was located in the Western regulatory area, 39% in the Central, and 2% in the Eastern area (Zenger and Cummings 1983).

CONDITION OF STOCKS

For some time, scientists at the Northwest and Alaska Fisheries Center (NWAFC) have suspected that the scales used to determine ages of Pacific cod taken in Alaskan waters were not reliable indicators. That suspicion was recently confirmed by an expert on the aging of Atlantic cod. After observing both scales and otoliths from Pacific cod, the Norwegian scientist identified the latter as most reliable, although somewhat difficult to read. It is anticipated that future collections of Pacific cod age stuctures made by NWAFC in Alaskan waters will be of otoliths rather than scales. After a methodology is developed to interpret Pacific cod otoliths and routine processing of otoliths begins, questions pertaining to year-class strength and age composition should be resolved.

No comprehensive U.S. groundfish surveys were conducted in the Gulf of Alaska in 1982 to allow an updated MSY to be calculated. In 1979 Low et al. reported MSY as 88,000-177,000 t and in 1982 MSY was reported as 95,000-190,000 t based on various Gulf of Alaska groundfish surveys that were performed in 1980 and 1981 (Zenger and Cummings 1983). Data collected by the NMFS foreign observer program suggest that Japanese longline CPUE of Pacific cod was virtually unchanged between 1981 and 1982 (Table 4.6). This indicates that the stocks are in stable condition. Apparently, no strong year-classes follow the 1977 cohort, although the 1980 year-class does appear to be stronger than those of the preceding two years.

A Gulf-wide triennial groundfish survey is planned for 1984, after which revised CPUE, biomass, and size and age compositions will be available for Pacific cod. In addition, cod will be tagged and released to study geographical movements.

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Table 4.1.--Annual catch in metric tons of Pacific cod in the Gulf of Alaska by fishing nations and for joint-ventures, 1971-1982.

Year	Japan	U.S.SR	Korea	Poland	Mexico	U.S.[b]	JV	Total
1971[a]	461	176	--	--	--	19	--	656
1972	830	2,696	--	--	--	61	--	3,587
1973	2,590	3,395	--	--	--	59	--	6,044
1974	2,951	2,136	--	--	--	143	--	5,230
1975	3,252	2,551	--	--	--	127	--	5,930
1976	3,291	2,995	--	--	--	221	--	6,507
1977	1,428	525	--	--	--	270	--	2,223
1978	8,846	1,141	1,369	14	--	783	7	12,160
1979	10,428	835	844	127	939	985	711	14,869
1980	30,582	1,942	1,666	55	--	728	466	35,439
1981	27,768	--	7,066	135	--	991	58	36,018
1982	24,450	--	2,486	--	--	6,434	193	33,563

[a] Non-domestic fishery figures for 1971-77 are foreign reported catches and the 1978-82 non-domestic and joint-venture figures are best blend estimates supplied by the NMFS Foreign Observer Program, Seattle, Washington. Source of Japan and U.S.SR 1971-1976 catches is INPFC Bulletin No. 41 (Forrester et al. 1983).

[b] U.S. catch data furnished by the Alaska Department of Fish and Game, Juneau, Alaska.

Table 4.2.--Annual catches in metric tons of Pacific cod by Gulf of Alaska INPFC area for fishing nations and joint-ventures, 1977-1982.

	Year					
	1977[a]	1978	1979	1980	1981	1982
Japan						
Shumagin	377	4,073	3,067	6,624	9,032	6,491
Chirikof	296	3,537	5,598	17,403	14,807	12,318
Kodiak	457	971	1,414	4,551	2,334	3,571
Yakutat	285	199	294	1,961	1,517	2,070
Southeastern	13	66	55	43	78	--
Total	1,428	8,846	10,428	30,582	27,768	24,450
U.S.S.R.						
Shumagin	196	86	6	361	--	--
Chirikof	50	995	165	906	--	--
Kodiak	279	60	663	675	--	--
Yakutat	--	--	1	--	--	--
Total	525	1,141	835	1,942	--	--
Korea						
Shumagin	--	1,361	788	1,627	2,241	539
Chirikof	--	8	--	--	4,069	1,850
Kodiak	--	--	--	--	25	97
Yakutat	--	--	49	39	731	--
Southeastern	--	--	7	--	--	--
Total	--	1,369	844	1,666	7,066	2,486
Poland						
Shumagin	--	--	9	9	41	--
Chirikof	--	--	118	46	94	--
Kodiak	--	14	--	--	--	--
Total	--	14	127	55	135	--
Mexico						
Shumagin	--	--	100	--	--	--
Chirikof	--	--	376	--	--	--
Kodiak	--	--	463	--	--	--
Total	--	--	939	--	--	--
U.S.-Foreign joint-ventures						
Shumagin	--	7	11	13	--	21
Chirikof	--	--	17	223	58	167
Kodiak	--	--	683	230	--	5
Total	--	7	711	466	58	193

Table 4.2 cont'd.

	Year					
	1977[a]	1978	1979	1980	1981	1982
U.S.[b]						
Shumagin	53	64	--	70	238	4,480
Chirikof	16	167	267	49	38	23
Kodiak[c]	140	443	606	415	683	1,887
Yakutat	6	2	27	4	2	1
Southeastern	55	107	85	190	30	43
Total	270	783	985	728	991	6,434
Grand total	2,223	12,160	14,869	35,439	36,018	33,563
Percent of total ground-fish catch	1.2	7.2	8.7	16.5	14.2	14.0

[a] Non-domestic fishery figures for 1977 are foreign reported catches, and 1978-1982 non-domestic and joint-venture figures are best blend estimates supplied by the NMFS Foreign Observer Program, Seattle, Washington.

[b] U.S. catch data furnished by the Alaska Department of Fish and Game, Juneau, Alaska.

[c] May include small catches from lower Cook Inlet.

Table 4.3.--Annual foreign and joint-venture catches in metric tons of Pacific cod by vessel type in the Gulf of Alaska, 1978-82.

Nation	Year 1978	1979	1980	1981	1982
Japan					
Sm. trawler	433	312	1,525	1,032	702
Lg. frz. trawler[a]	346	385	727	825	1,024
Surimi trawler[b]	1,267	187	558	636	226
Longliner	6,800	9,545	27,771	25,274	22,499
U.S.S.R.					
Lg. frz. trawler	1,140	835	1,942	-	-
Korea					
Sm. trawler	-	-	-	988	237
Lg. frz. trawler	1,369	844	1,657	6,074	2,249
Longliner	-	-	9	3	T
Poland					
Lg. frz. trawler	14	127	55	135	-
Mexico					
Sm. trawler	-	883	-	-	-
Lg. frz. trawler	-	56	-	-	-
Joint-venture					
J.V. mothership	7	711	466	58	193
Total	11,376	13,885	34,710	35,025	27,130

[a] In 1978 and 1979, catches were reported as being from medium trawlers.

[b] In 1978 and 1979, catches were reported as being from large trawlers.

Source: All data cited in this table are best blend estimates of foreign and joint-venture catches as reported by the NMFS Foreign Observer Program, Seattle, Washington.

Table 4.4.--Annual Japanese longline catch, in metric tons, of Pacific cod by INPFC area, and the percentage of the total Japanese all-gear cod catch that was harvested by longliners, 1978-1982.

Year	INPFC area				Total longline catch	Percentage of Japanese cod catch
	Shumagin	Chirikof	Kodiak	Yakutat		
1978	3,812	2,972	15	2	6,800	77
1979	2,592	5,467	944	182	9,545	92
1980	5,958	17,061	3,228	1,525	27,771	91
1981	8,509	13,847	1,870	1,048	25,274	91
1982	5,582	11,631	2,945	2,070	22,499	92

Data source: NMFS Foreign Fisheries Observer Program, Seattle, Washington.

Table 4.5.--Annual catches in metric tons of Pacific cod by Gulf of Alaska INPFC area, 1977-82.

Year	Shumagin	Chirikof	Kodiak	Yakutat	SE	Total
1977	626	362	876	291	68	2,223
1978	5,591	4,707	1,488	201	173	12,160
1979	3,981	6,541	3,829	371	147	14,869
1980	8,704	18,627	5,871	2,004	233	35,439
1981	11,552	19,066	3,042	2,250	108	36,018
1982	11,531	14,358	5,560	2,071	43	33,563

Table 4.6.--Catch per unit effort for Japanese longliners derived from samples collected by NMFS observers in the Shumagin, Chirikof, and Kodiak INPFC areas for fishing depths shallower than 500 meters for 1979-82.

Year/ INPFC area	Total estimated sample catch (metric tons)	Total hooks fished (x1000)	CPUE for total sample (t/1000 hooks)	Mean depth per set (m)
1979				
Shumagin	573.7	982.0	0.5842	217
Chirikof	800.5	1,313.7	0.6093	204
Kodiak	140.1	236.1	0.5935	215
1980				
Shumagin	579.7	923.5	0.6277	133
Chirikof	1,048.9	1,660.2	0.6318	268
Kodiak	126.6	251.0	0.5044	213
1981				
Shumagin	911.0	1,318.6	0.6909	224
Chirikof	1,012.0	1,611.0	0.6282	168
Kodiak	49.3	136.9	0.3601	158
1982				
Shumagin	712.8	989.5	0.7204	122
Chirikof	1,149.0	1,693.0	0.6787	137
Kodiak	129.4	284.0	0.4556	95

Table 4.7.--Initial and final catch allocations, in metric tons of Pacific cod, for the Western, Central, and Eastern regulatory areas in the Gulf of Alaska, 1977-82.

	Initial				Final			
	West	Central	East	Total	West	Central	East	Total
1977								
OY [a]								6,300
DAH								4,000
RES								-
TALFF								2,300
1978								
OY				40,600				40,600
DAH				15,500				15,500
RES				8,120				0
TALFF				16,980				25,100
1979								
OY	9,600	19,400	5,800	34,800	9,600	19,400	5,800	34,800
DAH	4,300	8,600	2,600	15,500	240	3,480	280	4,000
RES	2,730	5,570	1,700	10,000	500	850	150	1,500
TALFF	2,570	5,230	1,500	9,300	8,860	15,070	5,370	29,300
1980								
OY	16,550	33,540	9,900	60,000	16,560	33,540	9,900	60,000
-DAP	240	3,480	280	4,000	740	1,588	230	2,558
-DNP	600	1,200	1,200	3,000	100	1,200	200	1,500
-JVP	1,040	1,370	590	3,000	1,040	1,370	90	2,500
DAH	1,880	6,050	2,070	10,000	1,880	4,148	520	6,558
RES	3,312	6,708	1,980	12,000	0	0	0	0
TALFF	11,368	20,782	5,850	38,000	14,680	29,382	9,380	53,442
1981								
OY	19,320	39,130	11,550	70,000	19,320	39,130	11,550	70,000
-DAP	280	4,060	327	4,667	480	1,060	127	1,667
-DNP	700	1,400	1,400	3,500	700	1,400	1,400	3,500
-JVP	1,213	1,598	688	3,499	413	598	188	1,199
DAH	2,193	7,058	2,415	11,666	1,593	3,058	1,715	6,366
RES	3,864	7,826	2,310	14,000	0	0	0	0
TALFF	13,263	24,246	6,825	44,334	17,727	36,072	9,835	63,634
1982								
OY	16,560	33,540	9,900	60,000	16,560	33,540	9,900	60,000
-DAP	240	3,480	280	4,000	4,152	2,680	70	6,902
-DNP	600	1,200	1,200	3,000	-	-	-	-
-JVP	1,040	1,370	590	3,000	1,040	370	0	1,410
DAH	1,880	6,050	2,070	10,000	5,192	3,050	70	8,312
RES	3,312	6,708	1,980	12,000	0	0	0	0
TALFF	11,368	20,782	5,850	38,000	11,368	30,490	9,830	51,688

[a] OY = Optimum Yield; DAH = Domestic Annual Harvest; RES = Reserve; TALFF = Total Allowable Level of Foreign Fishing; DAP = Domestic Annual Processing; JVP = joint-venture Processing; DNP = Domestic Non-Processed catch.

Table 4.8.--Annual catch in metric tons of Pacific cod in the Gulf of Alaska, by fishery regulatory areas, 1977-1982.

Year	Western	Central	Eastern	Total
1977	626	1,238	359	2,223
1978	5,591	6,195	374	12,160
1979	3,981	10,370	518	14,869
1980	8,704	24,498	2,237	35,439
1981	11,552	22,108	2,358	36,018
1982	11,531	19,918	2,114	33,563

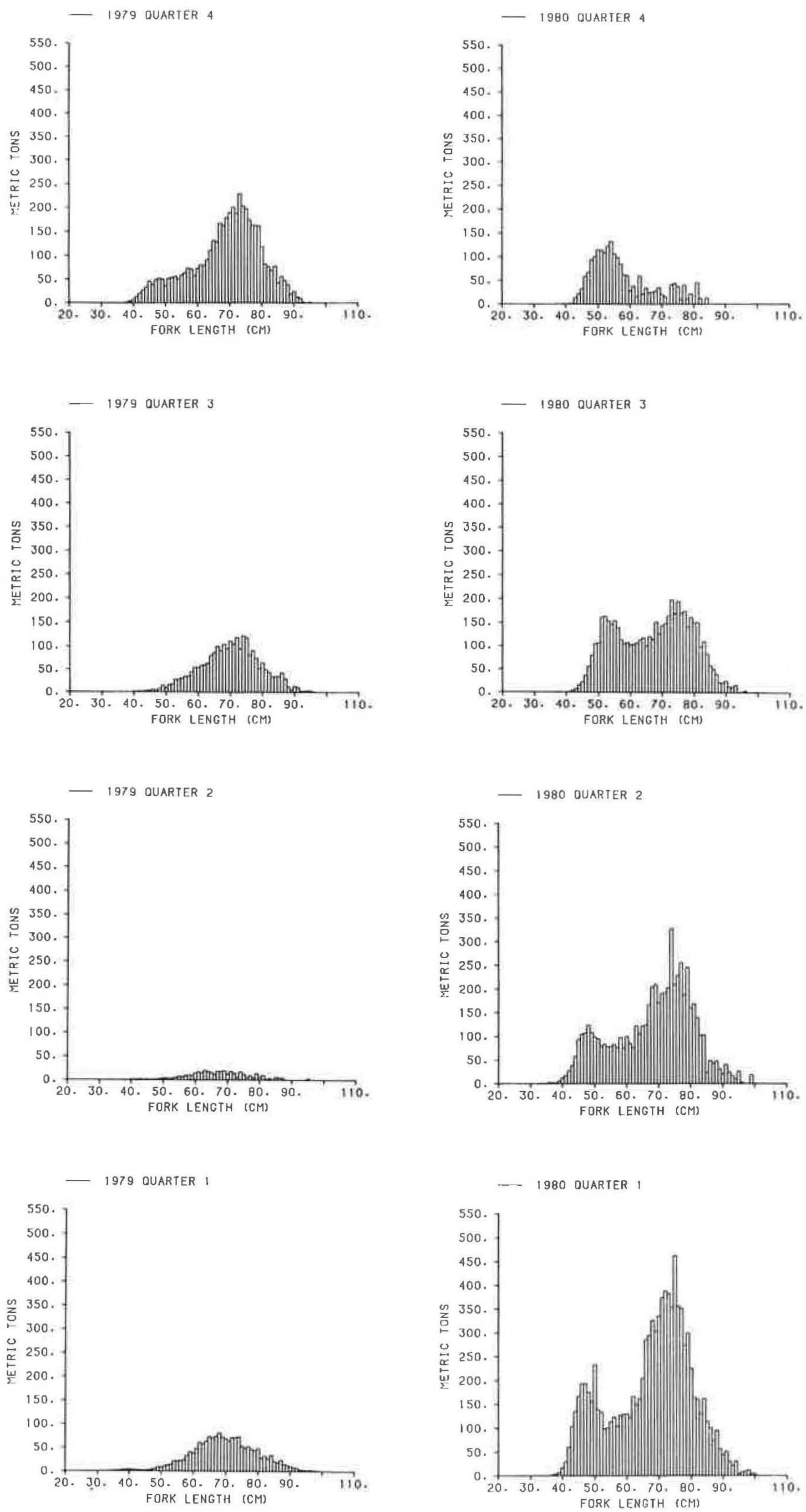

Figure 1.--Length frequencies expressed as metric tons of best blend Japanese longline catches of Pacific cod per centimeter of fork length, by quarter, 1979-1982. (Best blend catch estimates and length frequencies furnished by the U.S. Foreign Fisheries Observer Program, Seattle, Washington).

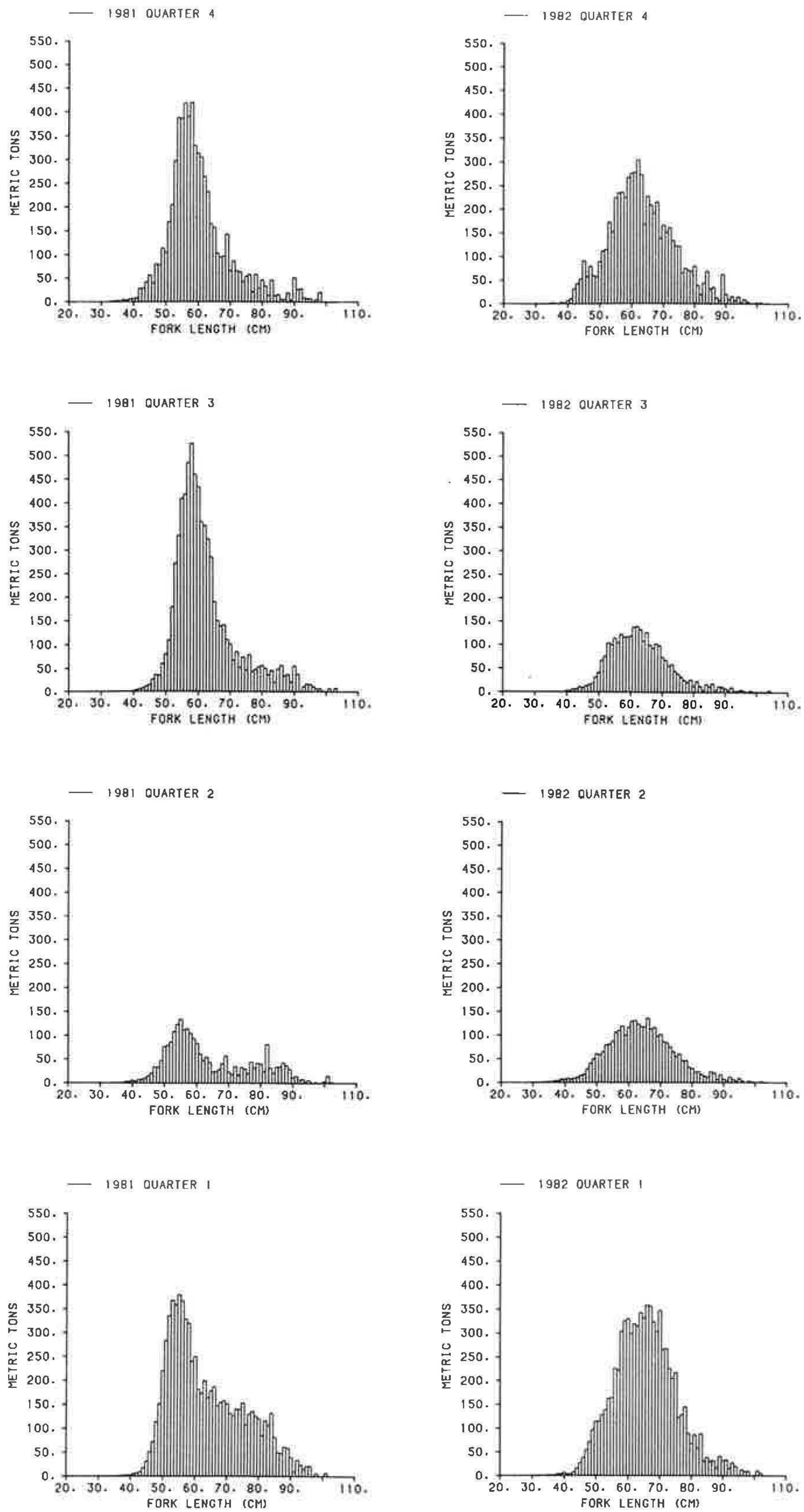

Figure 1.--Continued.

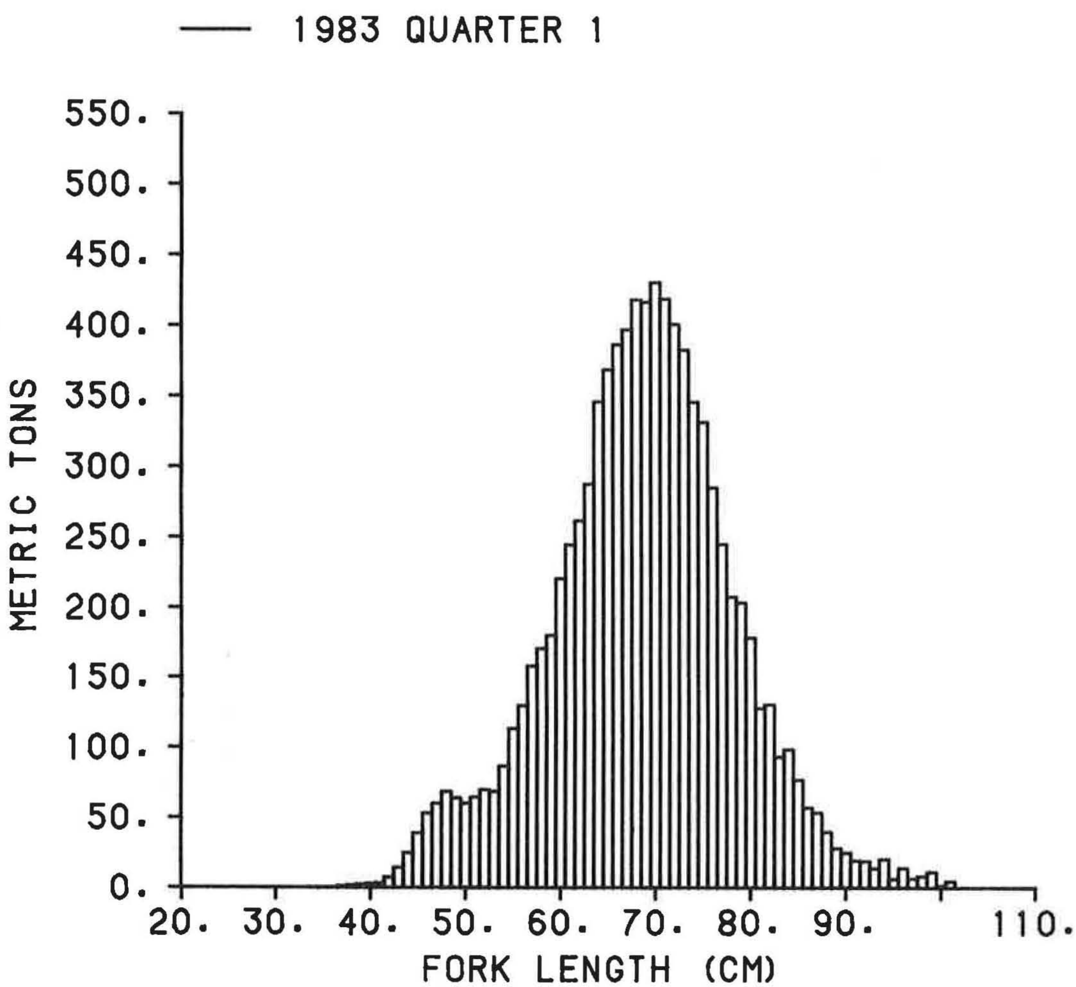

Figure 2.--Length frequencies expressed as metric tons of best blend Japanese longline catches of Pacific cod per centimeter of fork length for the first quarter of 1983. (Best blend catch estimates and length frequencies furnished by the U.S. Foreign Fisheries Observer Program, Seattle, Washington).

ATKA MACKEREL[1/]

by

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INTRODUCTION

Atka mackerel, Pleurogrammus monopterygius, are distributed throughout the Gulf of Alaska, but are primarily found in the Kodiak, Chirikof, and Shumagin International North Pacific Fisheries Commission (INPFC) statistical areas of the western Gulf of Alaska at depths from 50 to 350 m. Morphological studies by a Soviet scientist suggest that there are separate stocks in the Gulf of Alaska and Aleutian Islands (Levada 1979a).

Atka mackerel are harvested exclusively by foreign nations. Soviet fleets dominated the fishery from 1972 to 1980 while the Republic of Korea (ROK) dominated in 1981-82. From 1978, Atka mackerel has decreased in relative importance from 2nd in 1978 to last in 1982 by total weight landed (Table 5.1).

During 1982, 69% of the 6,758 t of Atka mackerel was taken by the Republic of Korea while Japan harvested 31% (Table 32). Fishing occurred mainly in the summer and early fall. Japan harvested 47% of their total catch with large freezer trawlers, 36% with small trawlers, and 17% with surimi trawlers, while the Republic of Korea harvested 89% with large freezer trawlers and 11% with small trawlers. The Chirikof INPFC statistical area produced 52% of the landings (3,508 t) followed by Shumagin (3,162 t), Kodiak (87 t), and Yakutat (1 t).

Since 1974, landings of Atka mackerel in the Gulf have ranged from 6,759 to 27,776 t. Catches peaked in 1975, declined through 1979, then increased

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1/ This report is a revised update of the 1982 INPFC document by L. Ronholt 1982. Atka Mackerel. In Ito, D. and J. Balsiger (ed) Condition of groundfish resources of the Gulf of Alaska in 1982. U. S. Dept. Commer., NOAA Tech. Memo. NMFS F/NWC-52, 204 p.

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again in 1980 and 1981, and in 1982 declined to the lowest level since 1974. With the exception of 1978 and 1981 the Kodiak area has produced roughly 75% or more of the total yearly catch since 1975. The Chirikof area provided most of the landings in 1978 and 1981.

Sequential (year to year) size composition data for Atka mackerel are available only from the Kodiak INPFC area (Figures 5.1-5.2). The 1971-1977 data are from Levada 1979b, who describes them only as representing the Gulf of Alaska. It is evident from Levada's discussions and from an analysis of related catch statistics that these data came primarily from the Kodiak area. The length frequency curves for 1971-1977 shown in Figures 5.1 and 5.2 are characterized by a single mode peaking near 29-34 cm and having a high percentage of the sample condensed into a 3-4 cm interval. With the exception of 1973, the mean length varied from 29-32 cm, thus indicating continued steady recruitment.

Size composition data for the 1975-1981 Kodiak fishery are available from either the U.S. observer program or the Soviet literature (Levada 1979a,b; Fadeev and Kharin 1981) (Figures 5.3-5.4). From 1975-1977 the U.S. observer data and the Soviet data are similar with mean size ranging from 27-31 cm. In 1978-79 the catch size composition curves were bimodal with increasing mean size, while in 1980-81 the curves were again of single mode with the mean size continuing to increase up to 41.8 cm in 1981. The 1978 and 1981 U.S. observer data should be viewed cautiously due to the small sample size.

During 1981 size compositions of Atka mackerel landings are very similar for the three INPFC areas for which data are available with specimens ranging from 30 to 50 cm and averaging 39-40 cm (Figure 5.5). The data from the Kodiak INPFC area should be viewed cautiously due to the small sample size. In 1982 size composition data are available only for the Shumagin INPFC area (Figure 5.6). During 1982, a larger percentage of smaller atka mackerel (<32 cm) were captured than during 1981. The peak of the principal size mode increased from 39 to 42 cm.

Condition of Stocks

Only limited information is available to define spawning time and areas for Atka mackerel in the Gulf of Alaska. Fadeev and Kharin 1981 by analysis of data collected aboard Soviet research and commercial fishing vessels have confirmed that spawning occurs from July to October in the Albatross Bank area in the Kodiak INPFC area. Since Atka mackerel eggs are adhesive, plankton surveys have yielded data only on the locations and occurrence of larvae. The occurrence of Atka mackerel larvae on Albatross Bank to Portlock Bank from October through March has been documented (Kendall et al. 1980). The Soviet research vessel Seskar conducted an ichthyoplankton survey from Unimak Pass to Portlock Bank from April 4 to May 24, 1978 (Borets 1979). Atka mackerel larvae were encountered throughout the survey area. In most instances larval concentration occurred in close proximity to known areas of adult Atka mackerel aggregations.

CPUE data are available from U.S. observers aboard foreign vessels and from Soviet fishery publications (Table 5.3). Although the absolute values of the CPUE data vary considerably, the same trends are evident for comparable data 1977-80 from both resources.

Age determinations by Soviet scientists using scales and U.S. scientists using otoliths do not agree; therefore, the age analysis for Gulf of Alaska data has provided only questionable information (Levada 1979a,b; Fadeev and Kharin 1981).

Data from the U.S. observer program, which U.S. scientists have analyzed for indications of year-class strength, are shown in Table 5.4. These data indicated that for those years when data are available the largest percentage of the harvested fish were usually 3 or 4 years old. Estimates of mean length at age by U.S. scientists using otoliths collected by U.S. observers have been highly variable (Table 5.5).

MSY

In 1977 the available biomass of Atka mackerel in the Gulf of Alaska was estimated at 110,000 t based upon Soviet hydroacoustic and trawl surveys in the Gulf of Alaska and Aleutian Islands. Based upon Soviet research which supports the harvesting of 30% of the exploitable biomass, the MSY was established at 33,000 t.

During 1979 the Soviets conducted a trawl survey of Atka mackerel in the Gulf of Alaska. Based on this survey and on the assumption that 30% of the biomass was harvestable annually, biomass was estimated at 95,552 t and MSY at 28,700 t (Fadeev 1979).

More recent analysis of the stock condition and MSY was conducted by Efimov (1981). To circumvent the disagreement concerning aging, Efimov used fishery data to estimate biomass ranging from 69,210 t in 1975 to 89,167 t in 1979 (Table 5.6). He further estimated the MSY at 28,300 t for fish of harvestable age (3 to 8 years).

This MSY for Atka mackerel was derived from high biomass level rather than the average population that can be expected over a long period (1975-1979). The stability of the mean size of the individuals in the catch (1971-1977) and the increasing CPUE (1975-1977) (Levada 1979b) demonstrated continued strong annual recruitment into the commercial stock over that period and, therefore, continued good condition of the stock. The increasing CPUE's and particularly the increasing mean size from 1975 to 1979 (Table 5.6) indicate a strong year-class or classes moved through the fishery resulting in increased biomass. Estimated MSY should be based upon the average biomass of the early 1970's when the stock was stable and not on the years of increasing biomass (1975-79).

MSY can also be estimated using the equation developed by Alverson and Pereyra (1967) and modified by Gulland (1969):

$MSY = a\ M\ B_o$

where

a = constant 0.4 (Gulland) or 0.5 (Alverson and Pereyra)

M = instantaneous natural mortality rate

B_o = virgin biomass.

Using the value of M = .6 (Efimov 1981), a = .4, and Efimov's minimum biomass estimate of 69,210 t, a conservative MSY of 16,610 t can be calculated for the 3 to 5 year old fish. Similarly, a less conservative MSY value of 26,750 t can be obtained using M = .6, a = .5, and B_o = 89,167 t. The estimated range for MSY is then 16,610 to 26,750 t with a mean value of about 22,000 t.

EY

There are no data which suggest that the current EY should vary from the MSY.

ABC

Increasing mean CPUE's in the Soviet commercial fishery 1975-79 viewed in conjunction with an increasing biomass and increasing mean size demonstrates that one or more larger than normal year-classes are moving through the fishery. Fadeev and Kharin (1981), using data collected by Soviet scientists aboard commercial and research vessels, found two prominent year-classes prevalent in the Gulf of Alaska in 1980 (1976-77). These two year-classes produced 89% of the total catch. Therefore, in 1981 availability of the 1976 year-class decreases drastically and in 1982 the production of the 1977 year-class should drop similarly. Without indication of strong recruitment, the available surplus yield may be expected to decline. Fadeev and Kharin (1981) also report a reduction in the mean CPUE of the Soviet fleet from 2.5 t/hr in 1979 to 1.3 t/hr in 1980.

It now appears that during 1978 and 1979 the ABC for Atka mackerel in the Gulf of Alaska could have been higher to allow harvesting the increased biomass created by two larger than normal year-classes moving through the fishery.

The decreasing mean CPUE of the Soviet fleet in 1980 and the projected passing of the two dominant year-classes through the fishery without indication of strong recruitment suggest that the ABC for 1983 should be set no higher than the mean MSY estimate (22,000 t).

RECENT RESEARCH RESULTS, REQUIREMENTS, AND SCHEDULE

During March-April 1978 the NMFS, Northwest and Alaska Fisheries Center, surveyed the groundfish resources along the southeast coastline of Kodiak Island. As part of this survey certain biological data were collected from Atka mackerel for the first time (Table 5.7). Length-weight relationships were described as:

males: weight (g) $= .0078196$ length (cm) $^{3.114099}$

females: weight (g) $= .04818$ length (cm) $^{2.569168}$.

Data gathered during a repeat survey in the winter of 1980 revealed that in the Kodiak area the weight-length relationships were very similar:

males: weight (g) $= .010062$ Length (cm) $^{3.049887}$

females: weight (g) $= .047911$ Length (cm) $^{2.58848}$.

However, one sample collected in the Chirikof INPFC area (1980) indicated a higher exponential value (Table 5.8) or heavier fish for a given size:

males: weight (g) $= .0034443$ Length (cm) $^{3.372805}$

females: weight (g) $= .0043341$ Length (cm) $^{3.285695}$.

Comparison indicates that the Soviet 1975-77 data (Levada 1979a) and the weight at length for Atka mackerel in the Kodiak area are similar, with the

Soviet length-weight relationship showing slightly lighter individuals in the 25-35 cm range and heavier individuals at 37 and above sizes (Table 5.9). The difference in the length-weight relationship may be due to sampling error.

The relationship developed from the Soviet data, sexes combined, was

weight (g) = 0.00159 Length (cm) $^{3.56}$

During 1978 and 1980 the National Marine Fisheries Service conducted trial tagging studies during their groundfish surveys. Atka mackerel were tagged using the "T" bar type plastic tag successfully used on sablefish. During 1978, tagged specimens were retained in a live tank aboard the research vessel Miller Freeman and returned to Seattle where they were placed in a live tank at the Seattle Marine Aquarium. Although there was steady attrition and some tag loss, several specimens survived nearly 8 months, still retaining tags.

Age readings of the samples collected during the U.S. groundfish surveys in 1978 and 1980 have not been completed. Age data are available, however, from scale samples collected by the USSR. Levada (1979) gives the following relationship between length and age:

Age (years)	Mean length (cm)
1	12.2
2	20.4
3	24.8
4	29.0
5	32.2
6	34.6
7	36.7
8	38.4

The age composition of Atka mackerel in the Gulf of Alaska in 1975-77 is presented in Table 5.10 (Levada 1979b). In 1975-77 nearly 60% of the catch consisted of 5-year age group specimens and 25-30 percent 6-year fish, while in 1980 44 and 45% of the catch was aged to be 4- and 5-year groups (Fadeev and Kharin 1981). Data provided by Levada shows that 5-year-old fish, on the average, are 32.2 cm, while the 1981 data indicates 5-year-old fish are 38.7 cm. These discrepencies in mean size at age indicate problems in aging interpretation.

Analysis of the available U.S. data base, therefore, has indicated several shortcomings which make it difficult to assess the status of the Atka mackeral in the Gulf of Alaska. To adequately manage this resource, data on the size-sex composition of the catch, mean length, mean weight, annual CPUE, and age are necessary. The greatest need is to resolve the discrepancies in aging techniques obtained from otoliths and scales. Tagging studies should also be undertaken as an aid to defining stocks, their boundaries, and their migrations within areas. The majority of information available for Atka mackerel has been provided by the Soviets from research surveys and the commercial fishery. With cessation of Soviet fishing efforts in the Gulf of Alaska, continuity of the existing data will be lost. A new data series can be developed based upon data collected by observers sampling aboard foreign fishing vessels and data provided by foreign nations harvesting the resource.

No specific research is presently scheduled for Atka mackerel in the Gulf of Alaska.

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Table 5.1--Foreign landings in the Gulf of Alaska for major species or species group.

Year	Species	Weight (t)
1978	WalleyepPollock	96,327
	Atka mackerel	19,585
	All flounder	14,314
	Pacific cod	11,369
	Pacific ocean perch	8,169
1979	Walleye pollock	103,187
	All flounder	13,474
	Pacific cod	13,174
	Atka mackerel	10,950
	Pacific ocean perch	9,750
1980	Walleye pollock	112,996
	Pacific cod	34,243
	All flounder	15,496
	Atka mackerel	13,162
	Pacific ocean perch	12,447
1981	Walleye pollock	130,323
	Pacific cod	34,968
	Atka mackerel	18,727
	All flounder	14,442
	Pacific ocean perch	12,177
1982	Walleye pollock	92,612
	Pacific cod	26,936
	Atka mackerel	6,750
	All flounder	8,986
	Pacific Ocean perch	7,988

Table 5.2--Foreign catches of Atka mackerel in metric tons in the Gulf of Alaska by International North Pacific Fisheries Commission (INPFC) statistical areas.

		INPFC statistical areas					
		Shumagin	Chirikof	Kodiak	Yakutat	Southeastern	Total
		t					
1974	USSR	4,742	2,748	10,041	-	-	17,531
	Japan	-	-	-	-	-	3/
							17,531
1975	USSR	2,132	743	23,688	1,213	-	27,776
	Japan	-	-	-	-	-	3/
							27,776
1976	USSR	-	-	19,721 1/	311 2/	-	20,032
	Japan	-	-	-	-	-	3/
							20,032
1977	USSR	69	2,056	17,120	0	0	19,245
	Japan	-	-	-	-	-	3/
							19,245
1978	USSR	184	17,320	883	0	0	18,387
	Japan	243	265	338	125	165	1,136
	Korea	61	2	0	0	0	63
							19,586
1979	USSR	5	708	9,552	0	0	10,265
	Japan	322	8	227	11	0	568
	Korea	81	0	0	0	0	81
	Mexico	11	4	21			36
							10,950
1980	USSR	899	90	9,484	0	0	10,473
	Japan	35	179	1,511	171	Tr	1,896
	Korea	736	0	0	0	0	736
	Poland	48	9	0	0	0	57
							13,162
1981	Japan	699	1,331	1,369	212	25	3,636
	Korea	2,551	11,147	46	1,066	0	14,811
	Poland	221	59	0	0	0	280
							18,727
1982	Japan	1,922	77	87	1	0	2,087
	Korea	1,241	3,431	0	0	0	4,672
							6,759

1/ Reported as western Gulf of Alaska.
2/ Reported as eastern Gulf of Alaska.
3/ Reported as "other species" category.

Table 5.3--Mean length, weight, and CPUE of Atka mackerel taken in foreign fisheries in the Kodiak area, as determined by data collected by the U.S. observer program and as reported by Fadeev and Kharin 1981, and Levada 1979.

Year	Mean length (cm)	Mean weight	Observer CPUE (t/hr)	Soviet estimated CPUE (t/hr)
1974-5	27.0	0.26	-	1.5[1/]
1976	30.0	0.31	-	2.0[1/]
1977	-	-	0.24	2.2[1/]
1978	35.0	0.53	0.05	1.1[2/]
1979	35.2	0.66	3.73	3.1[2/]
1980	-	0.74	0.71	1.9[2/]

1/ Fadeev, N.S. and V. E. Kharin - 1981
2/ Levada, T. P. - 1979

Table 5.4--Age and sex composition of Atka mackerel from the Soviet fishery in the Kodiak International North Pacific Fisheries Commission statistical area, 1974-80. (Data collected by U.S. observers).

Year	Month	Composition (%) by age group							Sample size	Percentage female
		1	2	3	4	5	6	7		
1974-5	11,12,1	-	1	94	5	Tr[1/]	-	-	2,294	50
1976	12	-	1	71	24	3	-	-	937	50
1977	-	-	-	-	-	-	-	-	695	50
1978	6	-	-	5	53	8	28	5	154	86
1979	8	-	28	7	49	14	2	-	4,282	56
1980	-	-	-	-	-	-	-	-	-	

[1/] Trace (less than 1%).

Table 5.5--Mean length at age of Atka mackerel in the Soviet fishery in the Kodiak International North Pacific Fisheries Commission statistical area, 1974-79. (Data collected by U.S. observers).

Year	Age (yr)						
	1	2	3	4	5	6	7
	Length (cm)						
1974-5	-	20	27	32	35	-	-
1976	-	22	30	30	31	-	-
1977	-	-	-	-	-	-	-
1978	-	-	32	34	37	36	38
1979	-	31	34	37	38	39	-

Table 5.6--Mean catch per unit of effort (CPUE) and estimated biomass of Atka mackerel in the Gulf of Alaska.

Year	Mean CPUE (t/hr)	Biomass (t)	Mean size (cm)
1971	-	-	31.9 3/
1972	-	-	31.9 3/
1973	-	-	34.3 3/
1974	-	-	29.4 3/
1975	1.5 1/	69,210 1/	29.5 3/
1976	2.0 1/	80,128 1/	30.7 3/
1977	2.2 1/	84,354 1/	30.6 3/
1978	2.3 1/	88,286 1/	-
1979	2.5 1/	89,167 1/	35.2 4/
1980	1.9 2/	-	39.0 2/
1981	-	-	-

1/ Efimov (1981).
2/ Fadeev and Karin (1981).
3/ Levada (1979).
4/ U.S. observer program data.

Table 5.7--Length-weight relationships for Atka mackerel in the Kodiak International North Pacific Fisheries Commission statistical area, March-April 1978 and February-April 1980.

	Weight (g)			
	1978		1980	
Length (cm)	Males	Females	Males	Females
23	136	-	-	-
24	155	-	-	-
25	176	-	-	-
26	199	208	208	-
27	224	229	234	-
28	251	252	261	267
29	280	275	290	292
30	311	301	322	319
31	345	327	356	347
32	381	354	392	377
33	419	384	431	408
34	460	415	472	441
35	503	447	515	476
36	549	480	561	512
37	598	515	610	549
38	-	552	662	588
39	-	590	716	629
40	-	629	774	-
41	-	-	835	-
Sample size	402	439	171	200

Table 5.8--Length-weight relationships for Atka mackerel in the Chirikof International North Pacific Commission statistical area, February-April 1980.

	Weight (g)	
Length (cm)	Male	Female
31	-	344
32	411	382
33	456	423
34	504	467
35	556	513
36	611	563
37	670	616
38	734	672
39	801	732
40	872	796
41	948	863
42	1,028	934
43	1,113	1,009
Sample size	98	71

Table 5.9--Comparison of US-USSR length-weight data (sexes combined).

Length (cm)	Weight (g)			
	USSR data	U.S. data		
	Kodiak, 1975-77	Kodiak, 1978	Kodiak, 1980	Chirikof, 1980
12	12	-	-	-
20	66	-	-	-
25	162	176[1/]	-	-
29	264	277	291	-
32	362	365	385	397
35	464	475	495	534
37	608	556	580	643
38	695	-	625	702
40	-	-	-	834
41	-	-	-	905
42	-	-	-	981
43	-	-	-	1,061

1/ Males only

Table 5.10--Age composition of Atka mackerel landings from the Gulf of Alaska 1975-77.

	Composition (%) by age group							Mean length of catch
Year	1	2	3	4	5	6	7	(cm)
1975[1/]	-	-	4	60	30	5	1	30.3
1976[1/]	-	1	5	58	29	5	2	30.7
1977[1/]	-	1	10	61	25	2	1	31.2
1980[2/]	-	3	44	45	7	1	-	39.0

1/ Levada (1979b).
2/ Fadeev and Kharin (1981).

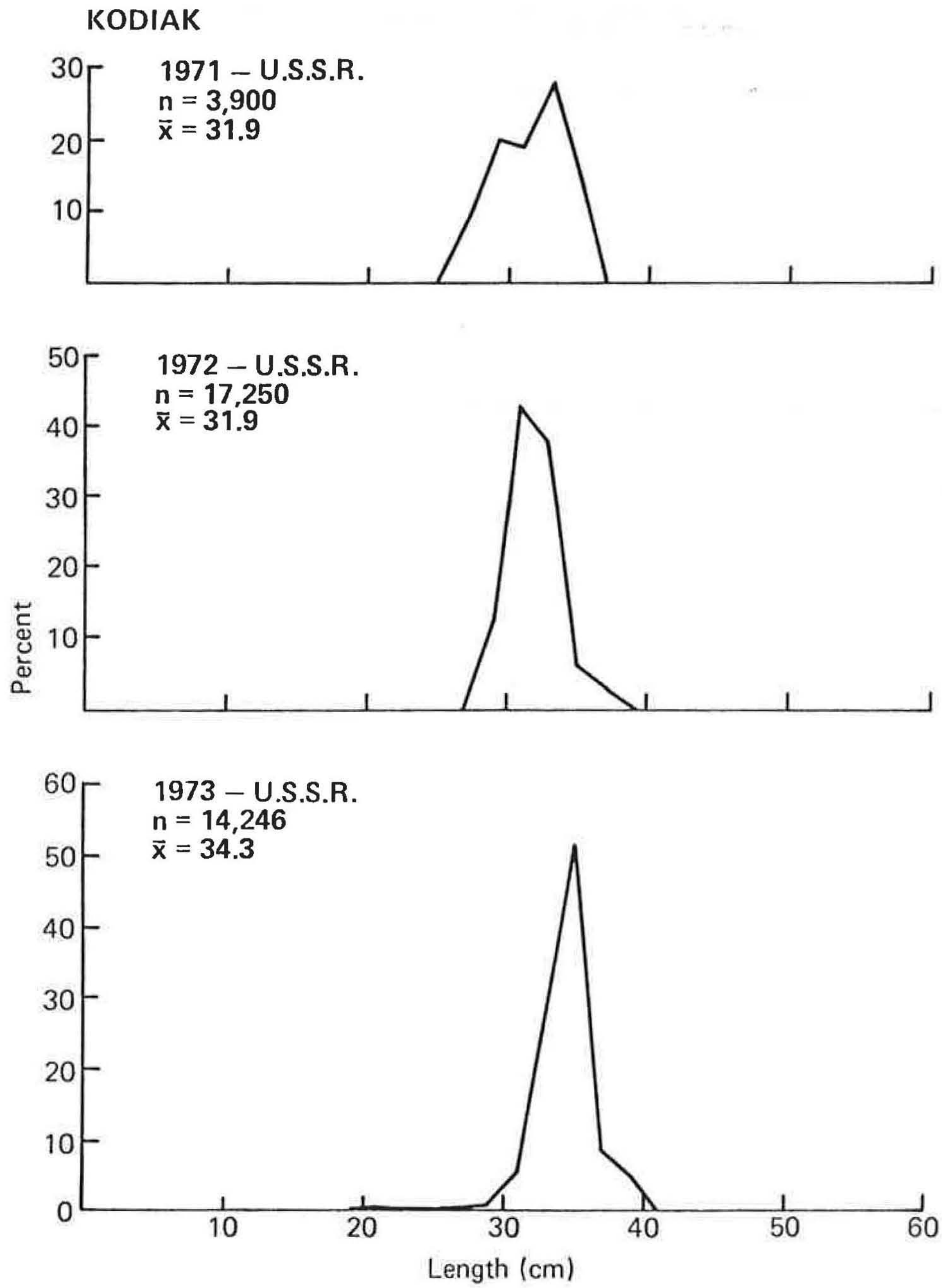

Figure 5.1--Size composition of Atka mackerel in the 1971-1973 landings from USSR landings in the Kodiak INPFC area. (Source: Levada 1979b).

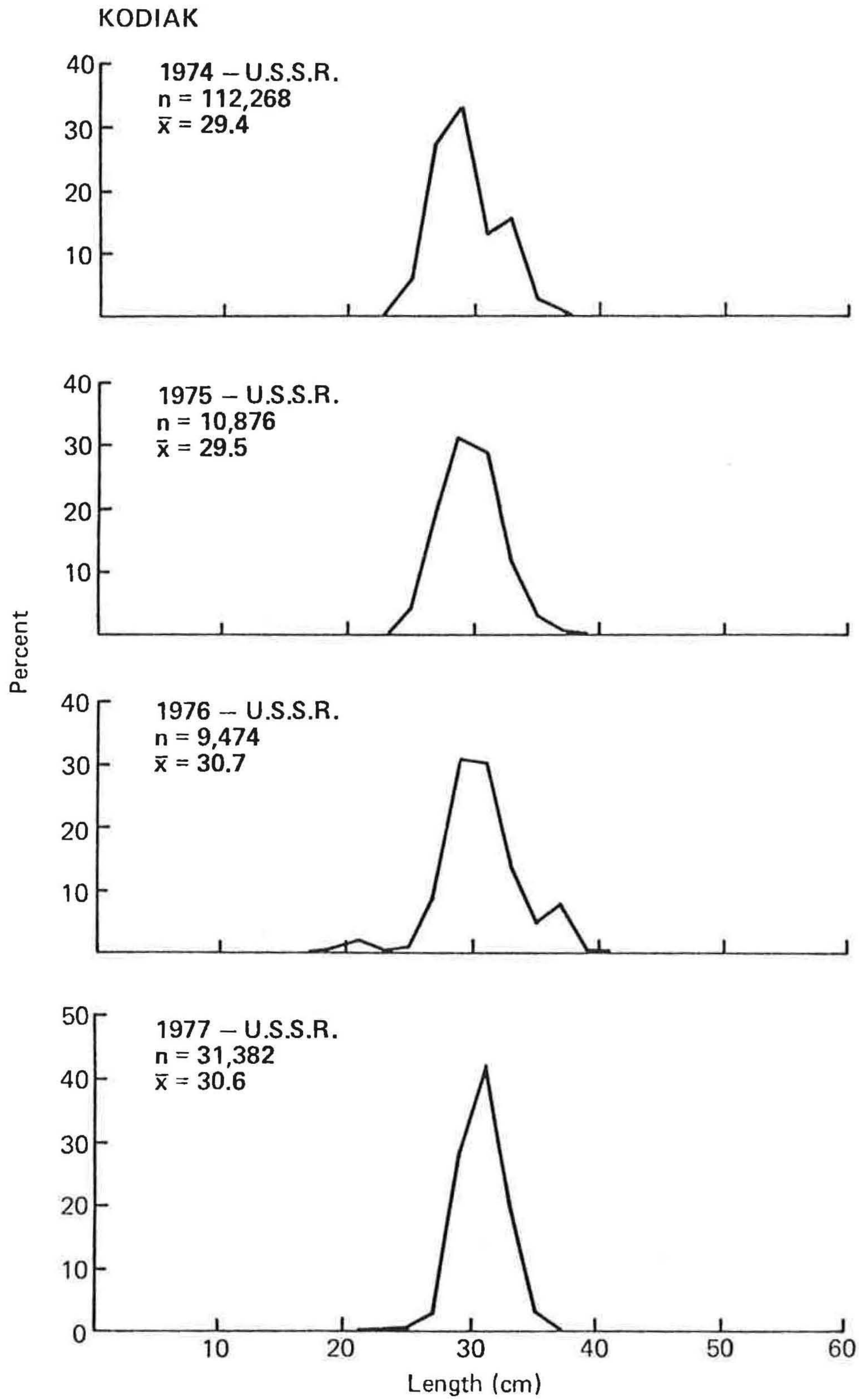

Figure 5.2--Size composition of Atka mackerel in the 1974-1977 landings from USSR landings in the Kodiak INPFC area. (Source: Levada 1979b).

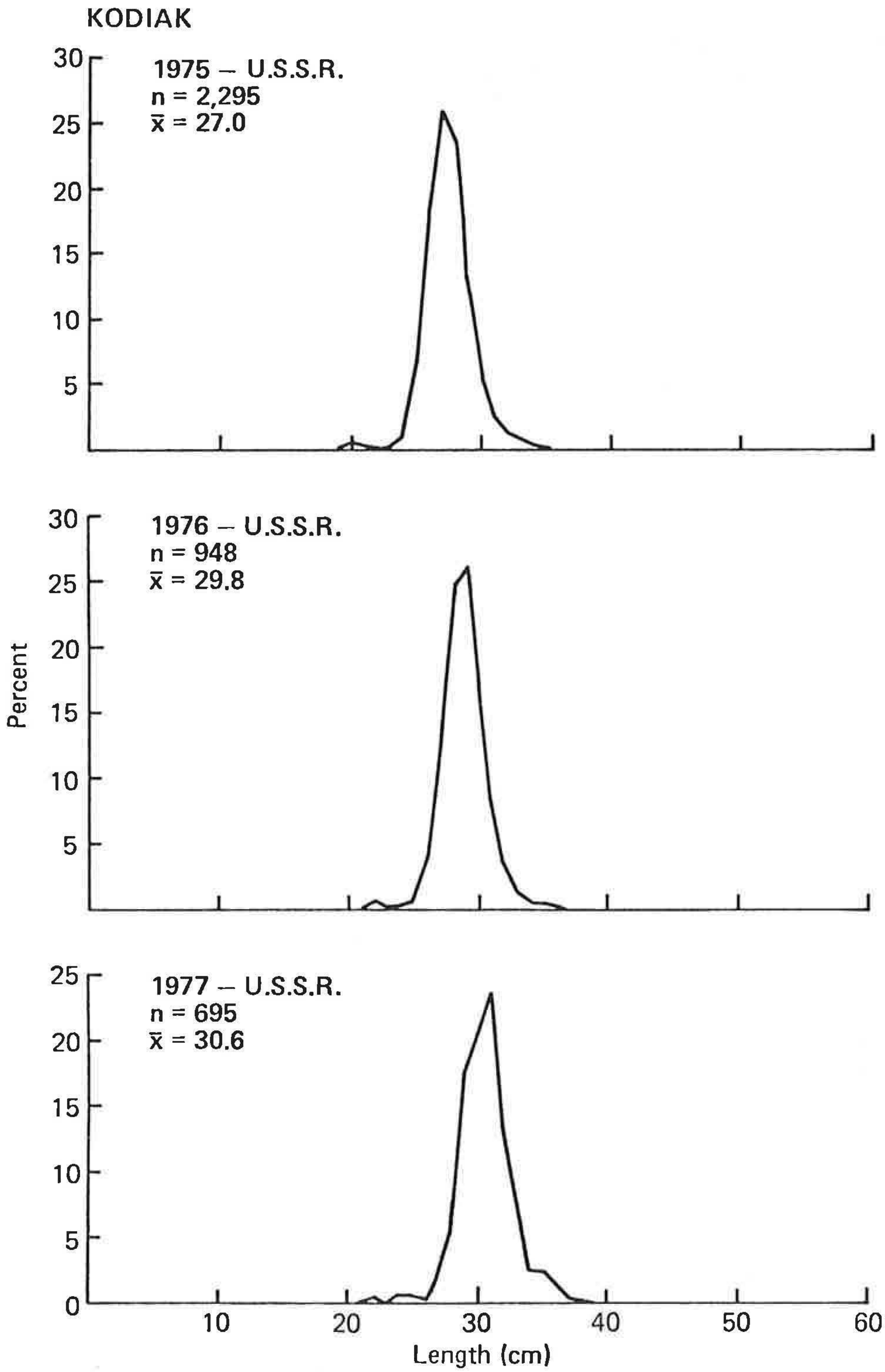

Figure5.3--Size composition of Atka mackerel in the 1975-1977 landings from USSR landings in the Kodiak INPFC area. (Source: U.S. observer program).

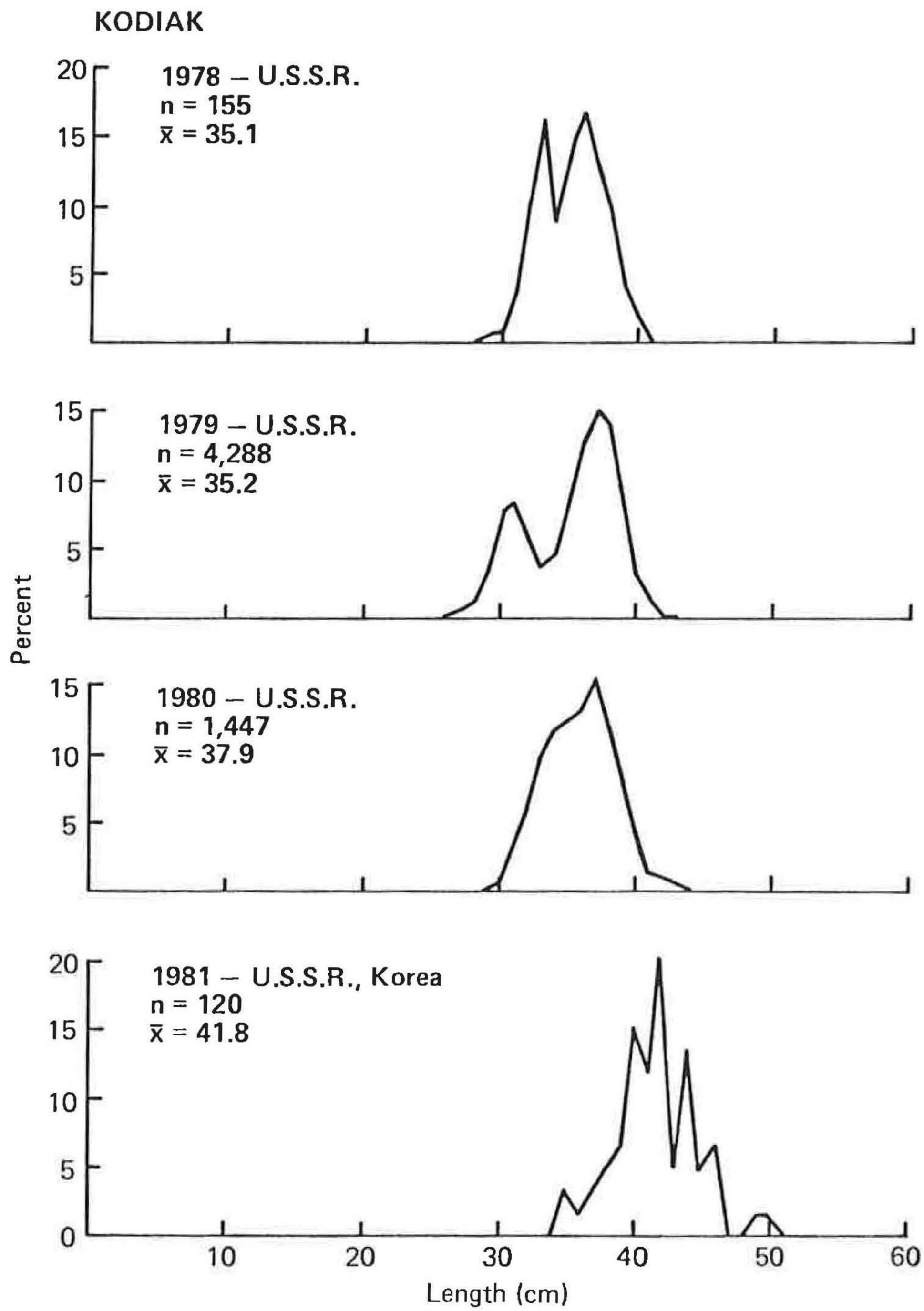

Figure 5.4--Size composition of Atka mackerel in the 1978-1981 landings by nation from the Kodiak INPFC area. (Source: U.S. observer program and Republic of Korea).

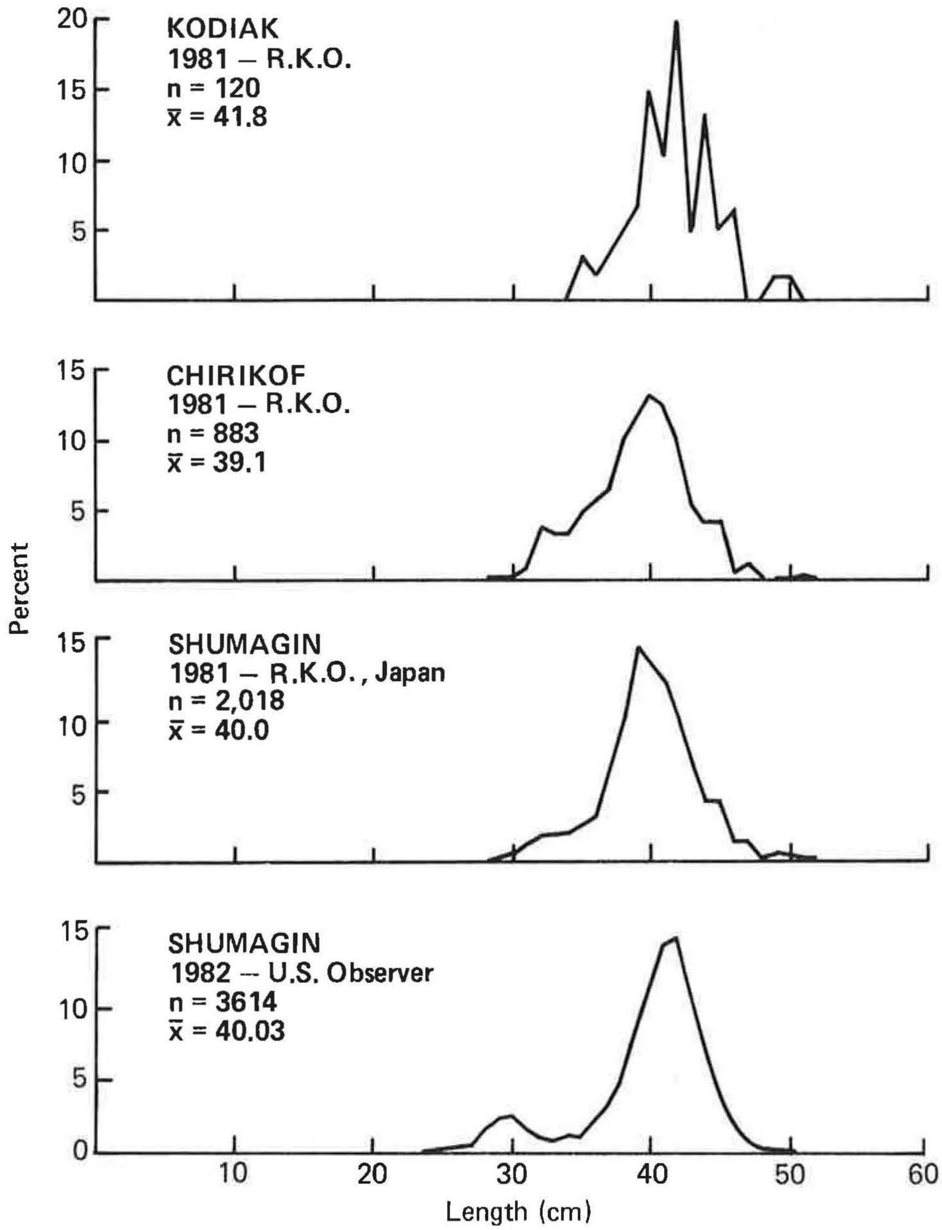

Figure 5.6--Size composition of Atka mackerel in the 1981 and 1982 landings from the Gulf of Alaska by INPFC areas and nation. (Source: U.S. observer program).

PACIFIC OCEAN PERCH[1/]

by Herbert Shippen[2/] and Gary Stauffer[2/]

INTRODUCTION

General Distribution

The Pacific ocean perch (POP) species group is fished throughout the Gulf of Alaska. These species, however, extend well beyond the Gulf of Alaska. The category "Pacific ocean perch" as employed in the current Gulf of Alaska Groundfish Management Plan includes five *Sebastes* species:

- *S. alutus*, Pacific ocean perch,
- *S. polyspinis*, northern rockfish,
- *S. aleutianus*, rougheye rockfish,
- *S. borealis*, shortraker rockfish, and
- *S. zacentrus*, sharpchin rockfish.

Each of these species has its distinct, unique range, but all tend to coincide in the Gulf of Alaska (Eschmeyer et al. 1983):

Species	Geographic range	Depth range - m
S. alutus	Japan & Bering Sea to S. Calif.	55-640
S. polyspinis	Bering Sea to Yakutat	70-360
S. aleutianus	Aleutian Is. to S. Calif.	180-730
S. borealis	Kamtchatka to N. Calif.	to 305
S. zacentrus	Gulf of Alaska to S. Calif.	90-320

Of the five species which constitute the Pacific ocean perch category, *S. alutus* has been widely studied with respect to its distribution and biology; relatively little is known about the biology of the other species.

1/ This report is a revised update of the 1982 INPFC document by Shippen, H. and J. W. Stark. 1983. Pacific Ocean Perch. *In* Ito, D. and J. Balsiger (ed.). Condition of groundfish resources of the Gulf of Alaska in 1982. U. S. Dept. of Commer. NOAA Tech. Memo. NMFS F/NWC-52, 204 p.

2/ Northwest and Alaska Fisheries Center, National Marine Fisheries Service, NOAA, 2725 Montlake Blvd. East, Seattle, WA 98112.

Relative Importance

Fisheries surveys of the northeastern Pacific Ocean during the 1950's and early 1960's identified S. alutus as the dominant rockfish and a prominent member of the demersal community. Alverson et al. (1964) called this species "the dominant form in the aggregate species catch at depths from 100 to 149 fathoms" (180-270 meters). Surveys conducted from 1963 to 1966 in the Gulf of Alaska, indicated that S. alutus made up 90 percent of the total rockfish catch, (Westerheim 1970).

In 1961, a resource assessment survey of the Gulf of Alaska by the International Pacific Halibut Commission (IPHC) and the Bureau of Commercial Fisheries (BFC) indicated a high abundance of S. alutus. In the 101-200 m depth zone, S. alutus ranked fourth in abundance after arrowtooth flounder (Atheresthes stomias), Pacific cod (Gadus macrocephalus) and Tanner crab (Chinoecetes bairdi). In the 201-400 m depth zone, S. alutus was second in rank order of relative abundance after arrowtooth flounder (Table 6.1).

Similar surveys conducted by the National Marine Fisheries Service, (formerly the Bureau of Commercial Fisheries) during 1973-76 indicated a marked decrease in the abundance of S. alutus relative to the 1961 survey. During the 1973-76 period, the catch per hour of S. alutus in the 101-200 m depth zone was one-eighth of its 1961 level , and one-twentieth in the 201-400 m zone.

During the interval between the surveys of 1961 and 1973-76, trawl fisheries targeting on Pacific ocean perch in the Gulf of Alaska were carried out by the U.S.S.R. and Japan (Okada 1982).

Critical Management Issues

Catch per unit of effort (CPUE) trends from the 1961 IPHC-BCF and 1973-76 NMFS Gulf of Alaska surveys suggest that the current abundance of S. alutus is only a fraction of its former level. Furthermore, there has been little evidence of significant recruitment to the fishable population in recent years. The population of S. alutus appears to have been severely depleted and shows little sign of significant recovery in the immediate future.

In 1982 the North Pacific Fishery Management Council (NPFMC) amended the Fishery Management Plan (FMP) for Gulf of Alaska groundfish fishery to reduce the catch of Pacific ocean perch in the eastern Gulf of Alaska. These actions included the following:

1. closed the area east of 140°W to all foreign fishing,
2. deleted U.S. sanctuaries east of 140°W,
3. permitted foreign mid-water fishing only, year-round between 140°W and 147°W, and
4. reduced the acceptable biological catch for Pacific ocean perch in the Eastern Regulatory Area (east of 147°W) to 875 metric tons from 29,000 mt.

It is anticipated that these changes will eliminate Pacific ocean perch as a target species and will contribute to the rebuilding of the Pacific ocean perch population in the eastern Gulf of Alaska.

Multispecies Nature of Fisheries

Pacific ocean perch in the Gulf of Alaska are caught in a multispecies fishery. Not only are the five species lumped in the category of POP taken but also a number of other rockfishes, round fishes, flatfishes, sharks and rays. The more commonly caught non-POP rockfishes include:

S. brevispinis	silvergray rockfish
S. ciliatus	dusky rockfish
S. crameri	darkblotched rockfish
S. entomelas	widow rockfish
S. flavidus	yellowtail rockfish
S. proriger	redstripe rockfish
S. babcocki	redbanded rockfish
S. variegatus	harlequin rockfish
S. reedi	yellowmouth rockfish

In addition to the fishes of the genus *Sebastes*, the thornyheads (*Sebastolobus* sp.) are frequently caught, especially the shortspine thornyhead, *Seb. alascanus*.

The more common roundfishes and flatfishes such as the walleye pollock, sablefish; Atka mackeral, various sculpins, rex sole, rock sole, Dover sole, and arrowtooth flounder are also taken by fisheries targeting on Pacific ocean perch.

The proportion of the five species lumped as Pacific ocean perch varies with the particular area of catch. Based on survey results in the various International North Pacific Fishery Commission (INPFC) areas (Figure 6.1), *S. alutus*, *S. aleutianus*, and *S. borealis* are found throughout the Gulf with *S. alutus* generally being the most common species. The distributions of *S. polyspinis* and *S. zacentrus* are more restricted; *S. polyspinis* is limited to the Chirikof and Kodiak areas and *S. zacentrus* to the Yakutat and Southeastern areas (Table 6.2).

FISHERY STATISTICS

Historical Catches

Commercial fisheries by the United States and Canada for Pacific ocean perch began in the late 1940's off the Pacific Northwest coast (Major and Shippen 1970).

Soviet fisheries for Pacific ocean perch started in the 1950's in the Aleutian Islands and Bering Sea regions and expanded into the central Gulf of Alaska in 1960. A fleet of 160 Soviet ships operated in the eastern Gulf of Alaska in 1965 (Chitwood 1969). A substantial part of the Soviet catch was Pacific ocean perch, but no records have been provided by the U.S.S.R. except as part of a general rockfish catch.

Japan began trawl fishing operations in the Gulf of Alaska in 1963 (Chitwood 1969) and has provided catch records for Pacific ocean perch since 1964. The Pacific ocean perch catch by Japan peaked at about 64,000 t in 1966 and declined to about 20,000 t in 1977 (Table 6.3).

The R.O.K. began fishing in the Gulf of Alaska in 1966 (Chitwood 1969), but records of her catch of Pacific ocean perch begin with 1976. The R.O.K. took nearly half the Pacific ocean perch catch from the Gulf of Alaska in 1978, but has taken relatively little since then.

Poland and Mexico, have also participated in the fishery for Pacific ocean perch in the Gulf of Alaska, but their catches have been minor in comparison to the amounts taken by the U.S.S.R., Japan, and the R.O.K.

Current Catches

Catches by INPFC area (Figure 6.1) month, vessel class, and nation are shown for 1982 (Tables 6.4 and 6.5). The 1982 catch by Japan was about 70% of the 1981 catch, largely because the OY for the eastern regulatory area was reduced from 16,800 to 875 t in 1982 (Table 6.6). The R.O.K. catch of Pacific ocean perch in 1982 was about half that of 1981. Poland and the

U.S.S.R. did not fish in 1982. The 1981 and 1982 domestic and joint venture catches of Pacific ocean perch were 1.3 t and 4.7 t, respectively.

Japan received most (82%) of the foreign allocation of Pacific ocean perch in 1982 while the other nations received lesser amounts (R.O.K., 17.7%; Federal Republic of Germany, 0.3%; and Poland, 0%) (Table 6.7). Of the four Japanese vessel types participating in the 1981 and 1982 Pacific ocean perch fishery, only two classes, the large freezer trawlers and the small trawlers took significant amounts (Table 6.8).

Most of the catch of Pacific ocean perch from the Gulf of Alaska was taken during the summer and fall months (Table 6.4 and 6.5). This seasonal distribution was influenced by NPFMC regulations that prohibit or restrict trawl fishing during the early part of the year to protect the domestic fishery for the Pacific halibut, *Hippoglossus stenolepis*.

CONDITION OF STOCKS

Stock Units

Identification of Pacific ocean perch stocks and their migration patterns is hampered by the inability of these fish to survive the rigors of capture and tagging, especially the decompression in being removed from depth to the surface. For this reason, scientists studying migrations of Pacific ocean perch have had to base their conclusions on apparent changes in abundance or population characteristics. Recently, biochemical methods have been employed to study stock identification.

On the basis of changes in distribution and sex ratio, Lyubimova (1963, 1965) hypothesized that female Pacific ocean perch spend the summer and early fall foraging in the western part of the Gulf of Alaska near Unimak Pass. During September and October, they leave that area after mating and migrate to the southeastern part of the Gulf where they winter and gestate for spawning the following spring.

Another Soviet scientist, however, reviewed much of the same evidence as Lyubimova and came to somewhat different conclusions: 1) Pacific ocean perch do not make extreme seasonal migrations along the shelf, 2) seasonal movements of Pacific ocean perch are largely between deep and shallow bottoms within a limited geographical area, and 3) Pacific ocean perch form a series of local populations which are only partially intermixed (Fadeev 1968). Fadeev cautioned that because of localized populations and slow growth rates, fishing activities should be carefully distributed so as to avoid exceeding the reserves of each local group.

Based on year-class strength and size composition, Westrheim (1970) identified Dixon Entrance as the boundary between the Gulf of Alaska and the British Columbia Pacific ocean perch stocks. Similarly, Chikuni (1975) hypothesized four stocks of Pacific ocean perch: 1) Gulf of Alaska;

2) eastern Pacific (British Columbia to California); 3) Aleutian Islands; and 4) eastern slope (Bering Sea to Kurile Islands).

Studies using biochemical methods have substantiated the earlier work described above. Wishard et al. (1980) identified three stocks of *S. alutus*, one off Washington and Oregon, another from the Gulf of Alaska, and a third from the vicinity of Prince William Sound in the northern Gulf which had previously not been recognized.

Age Composition

During the early 1960's, before the period of intense fishing of Pacific ocean perch by Japan and the U.S.S.R., the dominant age group in the catch was 6-9 yr. About three-fourths of the catch was calculated to be individuals 10 yr of age or younger (Lyubimova 1964).

Otoliths from Sebastes Alutus for age interpretation have been collected by U.S. observers on foreign ships since 1976. These otoliths have been interpreted by a technical staff at the Northwest and Alaska Fisheries Center. A review of the age structure of Pacific ocean perch catches collected between 1976 and 1980 suggests that few, if any, year-classes of notable strength have been recruited to the fishable part of the population in those years. In the Shumagin area, the 345 otoliths examined from 1977 indicated no markedly successful year-classes in the catch; although in the next year, 1978, there was some increase in the 6- to 8-year-olds, these year-classes were virtually depleted by 1979 (Figure 6.2). In the Chirikof areas, remnants of year-classes from the 1960's were evident in 1978, together with a fair showing of 7- to 9-year-old specimens. The scanty data from 1980, however, suggest that little remained of these year-classes by that time. In the Kodiak area, specimens from the 1971 and older year-classes appeared in the 1976 catch, and this body of fish was present in 1977 and 1978. In 1979 and 1980, however, these previously strong year-classes had declined, and no younger year-classes were evident. In the Yakutat area, the fishery in 1975-77 had representatives from the year-classes of 1963-70, but these fish appeared to be gone in 1978 and 1979. Some modest recruitment of Pacific ocean perch seems to have occurred in 1980 in the Yakutat area. In the Southeastern area, the fishery in 1976 was domii nated by 12- to 17-year-old specimens. This group of fish was apparently depleted during the next two years and was virtually gone by 1978. Modest numbers of Pacific ocean perch from the 1962-71 year-classes appeared in 1979 in the

Southeastern area, but they declined substantially in the 1980 catch. There is no evidence from th 1980 data of any successful year class after 1971. Otolith samples collected in 1981 and 1982 are waiting to be aged pending further research on ageing techniques.

Size Composition

Length composition information has been collected from Sebastes alutus in the Gulf of Alaska by U.S. observers on foreign fishing vessels. There have not been any trends in the mean length of the sampled fish since 1975 (Table 6.9). The specimens taken in the Southeastern area are considerably larger than those commonly taken from the Chirikof area.

Research Survey Results

Demersal resource assessment surveys to depths of 400 m were conducted over the entire Gulf of Alaska in 1961 and again in 1973-76. Results of these surveys, conducted before and after a period of intense fishing for Pacific ocean perch during the mid-1960's, document a substantial decrease in the relative abundance of this species (Table 6.10).

Surveys of rockfish resources suggest that there have been some increases in the relative abundance of Sebastes alutus in recent years. In the summer of 1978 the catch per hour for S. alutus remained at the low levels experienced in 1973-76, but some improvement is evident in surveys conducted in 1979 and 1981 (Table 6.11).

Commercial Fishery Records

Statistical information from Japanese trawl fisheries in the Gulf of Alaska documented a general decline in Pacific ocean perch CPUE since the inception of the fishery in 1964 until the present (Figure 6.3). The overall catch rate for the 1982 Japanese fishery was 0.15 t/h in the Western and Central regions, unchanged from the 1980 and 1981 values. For the Gulf of Alaska as a whole the commercial catch per hour during the 3-yr period from 1964-66 was about 5.5 t, but during the recent 3-yr period, 1979-81, it had declined to about 0.3 t. It should be recognized, however, that more fishing effort was directed toward Pacific ocean perch during the early years of this fishery than has been the case more recently. The decline in the catch rate for 1982 is in part the result of the closure of the Southeastern area where rockfish, including Pacific ocean perch, were principal target species.

Based on a cohort analysis of the catch-at-age data for the Gulf of Alaska foreign fishery from 1963 to 1979, Ito (1982) concluded that the exploitable stock of S. alutus decreased 92% during the period from 1963 to 1976 and that year class size underwent a continuous long term decline. He noted that this decline in estimated stock abundance paralleled the nominal catch per trawl hour over the same period as shown in Figure 6.3. Apparently, the annual harvest in each of these 14 years exceeded the annual surplus production preventing any increase in abundance.

MAXIMUM SUSTAINABLE YIELD ESTIMATES

Maximum sustainable yield (MSY) is defined by the NPFMC management plan as the largest average catch that can be taken continuously from a stock under current environmental conditions. At present the NPFMC estimates the Gulf of Alaska MSY for Pacific ocean perch to be 125,000 t but recognizes that current stock levels are well below the numbers that might produce this level. Chikuni (1975) estimated the potential MSY for the Pacific ocean perch in the Gulf of Alaska at about 150,000 t, but he also added a reservation that stocks must first recover from their present low levels.

EQUILIBRIUM YIELD ESTIMATES

Equilibrium yield (EY) is defined by the NPFMC management plan as the annual or seasonable harvest that allows the stock to be maintained at approximately the same level of abundance over a period of several years apart from the effects of the environment.

The NPFMC plan as of September 1979 placed the Gulf-wide EY for Pacific ocean perch at 50,000 t, a level well below the estimated 125,000 t MSY, but which still has not resulted in a detectable increased in recruitment.

ALLOWABLE BIOLOGICAL CATCH ALLOCATIONS

The allowable biological catch (ABC) may be set lower than MSY to help rebuild depleted fish stocks. In the Gulf of Alaska FMP the ABC for Pacific ocean perch was set at 50,000 t, the same as the EY. The ABC for 1981 was apportioned to the three NPFMC regulatory areas as follows: Western, 5,300 t; Central, 15,700 t; and Eastern, 29,000 t. The basis for the relative apportionment was the distribution of the Pacific ocean perch catch by Japan in 1973-75.

Optimum yield (OY) may deviate from ABC for economic, social, or ecological objectives; and in the case of Pacific ocean perch in the Gulf of Alaska, the OY was set for 1981 at 29,167 t, apportioned as follows to the three regulatory areas: Western, 3,150 t; Central, 9,217 t; and Eastern, 16,800 t. In 1982 the OY was 2,700 t in the Western area, 7,900 in the Central area and 875 t in the Eastern area. The reported amounts actually caught by the foreign fisheries were approximately half of the allocation in each area in 1981 and approximately three quarters of the total allocation in 1982 (Table 6.6).

COMMENT ON THE CURRENT CONDITION OF PACIFIC OCEAN PERCH STOCKS IN THE GULF OF ALASKA

There continues to be little evidence of any significant improvement in the condition of Pacific ocean perch stocks. Recruitment to the fishable stocks is sporadic and transient. The catches for 1981 and 1982 were less than one-quarter of the allocated ABC. Because of the slow growth rate of the individual fish and apparent lack of successful year-classes, it may be several years before any significant change in the status quo can be expected.

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Table 6.1--Relative abundance (catch per hour) of S. alutus in Gulf-wide summer surveys of bottomfish resources1/.

	Depth Zone m			
	101-200		201-400	
Survey period	kg/h	rank4/	kg/h	rank4/
19612/	50.1	4	75.6	
1973-763/	6.1	13	3.4	

1/ Source: Ronholt, Shippen, and Brown, 1978

2/ IPHC-BCF surveys, 1961

3/ NMFS surveys, 1973-76

4/ Ranking within 15 major species caught by bottom trawls

:19.4.3

Table 6.2.--Distribution by weight (percent) of rockfish species in the "Pacific ocean perch" category within the Gulf of Alaska International North Pacific Fisheries Commission (INPFC) areas as found in research cruises, 1981 and 1982.

	INPFC AREA												
	CHIRIKOF			KODIAK				YAKUTAT		SOUTHEASTERN			
Research Cruise	Shantar 81-1	Miller Freeman 81-3	MYS Dalniy 82-1	Shantar 81-1	Miller Freeman 81-3	Ocean Harvester 81-1	Oh Dea San 81-1	Pat San Marie 81-2	Ocean Harvester 81-1	Miller Freeman 81-7	Pat San Marie 81-2	Ocean Harvester 81-1	Miller Freeman 82-1
S. alutus	29.8	59.6	76.0	62.7	16.4	27.8	64.1	85.0	85.6	80.1	78.1	81.6	84.7
S. polyspinis	30.0	39.0	6.3	19.1	80.6	35.8	24.5	0.1	0.8	0.0	0.0	0.0	0.0
S. aleutianus	23.2	1.4	9.3	8.2	0.8	12.7	8.2	6.6	4.7	5.0	1.7	1.3	4.6
S. borealis	17.1	0.0	8.4	10.0	2.2	23.6	3.4	3.4	4.7	11.9	0.8	4.8	7.0
S. zacentrus	0.0	0.0	0.0	0.0	0.0	0.1	0.0	4.9	4.3	3.0	19.4	12.4	3.8
Total	100.1	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.1	100.0	100.1	100.1	100.1

Table 6.3--Pacific ocean perch[1] catches from the Gulf of Alaska by nation and region, 1964-82[2].

		INPFC REGION					
Nation	Year	Shumagin	Chirikof	Kodiak	Yakutat	South-Eastern	Total
Japan	1964	1,610	1,150	10,614	11	0	13,385
USSR	1964	-	-	-	-	-	230,000
Total	1964	-	-	-	-	-	243,385
Japan	1965	9,171	12,555	20,839	33	0	42,598
USSR	1965	-	-	-	-	-	306,000
Total	1965	-	-	-	-	-	348,598
Japan	1966	14,373	21,068	28,368	422	718	64,949
USSR	1966	-	-	-	-	-	135,800
Total	1966	-	-	-	-	-	200,749
Japan	1967	5,834	6,937	17,922	13,625	9,162	53,510
USSR	1967	-	-	-	-	-	66,500
Total	1967	-	-	-	-	-	120,010
Japan	1968	1,216	2,481	8,236	30,874	12,163	54,970
USSR	1968	-	-	-	-	-	45,200
Total	1968	-	-	-	-	-	100,170
Japan	1969	2,027	5,772	11,346	18,404	16,090	53,639
USSR	1969	-	-	-	-	-	18,800
Total	1969	-	-	-	-	-	72,439
Japan	1970	504	5,592	11,366	10,602	16,317	44,381
USSR	1970	0	0	0	0	0	0
Total	1970	-	-	-	-	-	44,381
Japan	1971	2,800	5,033	12,125	14,159	13,960	48,077
USSR	1971	-	-	-	-	-	29,700
Total	1971	-	-	-	-	-	77,777
Japan	1972	4,233	2,837	11,439	15,481	16,628	50,618
USSR	1972	-	-	-	-	-	24,000
Total	1972	-	-	-	-	-	74,618
Japan	1973	4,796	5,678	9,505	17,087	10,307	47,373
USSR	1973	-	-	-	-	-	5,600
Total	1973	-	-	-	-	-	52,973
Japan	1974	4,082	3,497	8,096	10,690	10,615	36,980
USSR	1974	-	-	-	-	-	11,000[3]
Total	1974	-	-	-	-	-	47,980
Japan	1975	4,158	3,996	10,016	8,420	7,541	34,131
USSR	1975	-	-	-	-	-	10,000[4]
Total	1975	-	-	-	-	-	44,131

Table 6.3.--Continued.

		INPFC					
Nation	Year	Shumagin (t)	Chirikof (t)	Kodiak (t)	South- Yakutat (t)	Eastern (t)	Total (t)
Japan	1976	4,557	3,645	8,730	9,625	8,796	35,353
USSR	1976	-	-	-	-	-	10,000[4/]
ROK	1976	1,339	26	177	45	28	1,615
Total	1976	-	-	-	-	-	46,968
Japan	1977	1,567	2,531	4,977	5,428	4,744	19,247
USSR	1977	536	594	588	108	4	1,830
ROK	1977	560	T	0	0	0	560
Total	1977	2,663	3,125	5,565	5,536	4,748	21,637
Japan	1978	429	430	1,203	1,337	1,149	4,548
ROK	1978	3,021	25	0	0	3	3,049
Poland	1978	0	0	4	0	0	4
USSR	1978	193	280	82	7	8	570
Total	1978	3,643	735	1,287	1,344	1,160	8,171
Japan	1979	652	116	832	1,714	4,083	7,397
ROK	1979	193	0	0	498	134	825
Poland	1979	2	3	0	0	0	5
USSR	1979	30	122	908	5	0	1,065
Mexico	1979	67	18	372	0	0	457
Total	1979	944	259	2,112	2,217	4,217	9,749
Japan	1980	169	553	2,507	4,649	2,912	10,770
ROK	1980	353	0	0	55	0	408
Poland	1980	29	1	0	0	0	30
USSR	1980	290	123	826	0	0	1,239
Total	1980	842	656	3,333	4,704	2,912	12,447
Japan	1981	741	1,495	1,882	3,927	2,297	10,343
ROK	1981	463	862	16	444	0	1,785
Poland	1981	29	13	0	7	0	49
Total	1981	1,234	2,370	1,898	4,377	2,297	12,177
Japan	1982	1,407	3,009	2,722	17	0	7,156
ROK	1982	339	490	2	0	0	832
Total	1982	1,746	3,499	2,724	17	0	7,988

Notes on Table 6:3

1/ Definition of Pacific ocean perch (POP):
1964-78: POP = *Sebastes alutus*

1979-82: POP = *Sebastes alutus*, *S. polyspinis*, *S. aleutianus*, *S. borealis*, and *S. zacentrus*

2/ Sources of catch information:
Japan and ROK, 1964-1977: statistical data supplied by the fisheries agencies

U.S.S.R., 1964-1977: Okada 1982

1978: Anonymous, 1979
1979: Nelson et al, 1980
1980: French et al, 1981
1981: Nelson et al, 1982
1982: Nelson et al, 1983

3/ Includes rockfishes other than Pacific ocean perch

4/ Catches quota of rockfishes, including POP, regulated by U.S.-U.S.S.R. fishing agreement.

Table 6.4--Japan 1982 POP (5 species) Blend Est.[1/]

Vessel REGION - Class	Month 1	2	3	4	5	6	7	8	9	10	11	12	Total
Shumagin													
Small Trawler					0.00	17.35	19.54	30.85	53.24	132.72	149.11	5.10	407.91
Surimi Trawler	0.00	0.50		0.00		22.00	0.74	0.88		2.36	3.47	4.50	34.45
Lg Frz Trawler						109.74	131.44	330.60	244.98	33.19	65.71	21.77	937.43
Longliner	2.30	2.20	0.50	0.10	0.50	1.98	0.74	0.70	2.11	3.80	3.42	9.13	27.48
Total	2.30	2.70	0.50	0.10	0.50	151.07	152.46	363.03	300.33	172.07	221.71	40.50	1,407.27
Chirikof													
Small Trawler					0.00	11.90	6.44	27.11	96.16	254.03	222.87	12.40	630.91
Surimi Trawler	0.00	0.00		0.00	0.00	4.20		5.01	3.71	3.24	5.37	1.39	22.92
Lg Frz Trawler						389.63	312.58	294.05	718.67	590.01	32.90		2,337.84
Longliner	0.00	0.40	0.99	1.97	0.70	2.30	0.10	0.17	3.00	3.18	1.59	3.41	17.81
Total	0.00	0.40	0.99	1.97	0.70	408.03	319.12	326.34	821.54	850.46	262.73	17.20	3,009.48
Kodiak													
Small Trawler						29.46	73.28	43.39	268.40	251.45	215.52		881.50
Surimi Trawler	1.80	0.00				0.10		0.10			20.79		22.79
Lg Frz Trawler						238.91	174.43	329.61	580.61	334.87	144.10		1,802.53
Longliner		0.08	0.60	0.07	0.20	3.60	1.60	0.00	0.20	6.17	0.96	2.16	15.64
Total	1.80	0.08	0.60	0.07	0.20	272.07	249.31	373.10	849.21	592.49	381.37	2.16	2,722.46
Yakutat													
Small Trawler							1.56	1.60					3.16
Surimi Trawler													
Lg Frz Trawler													
Longliner			0.00	0.26	0.00	0.01	0.33			3.00	5.80	4.30	13.70
Total			0.00	0.26	0.00	0.01	1.89	1.60		3.00	5.80	4.30	16.86
All regions													
Small Trawl					0.00	58.71	100.82	102.95	417.80	638.20	587.50	17.50	1,923.48
Surimi Trawler	1.80	0.50		0.00	0.00	26.30	0.74	5.99	3.71	5.60	29.63	5.89	80.16
Lg Frz Trawler						738.28	618.45	954.26	1,544.26	958.07	242.71	21.77	5,077.80
Longliner	2.30	2.68	2.09	2.40	1.40	7.89	2.77	0.87	5.31	16.15	11.77	19.00	74.63
Grand Total	4.10	3.18	2.09	2.40	1.40	831.18	722.78	1,064.07	1,971.08	1,618.02	871.61	64.16	7,156.07

1/ Data source: Nelson et al, 1983.

Table 6.5.--Korea 1982 POP (five species) Best Blend Est.[1/]

Vessel Region - Class	Month 1	2	3	4	5	6	7	8	9	10	11	12	Total
Shumagin													
Small Trawler						6.76	0.00	1.20		1.10	3.53		12.59
Surimi Trawler													
Lg Frz. Trawler						255.88	42.59	14.35		2.90	10.33		326.05
Longliner			0.00	0.00	0.00	0.00							0.00
Total			0.00	0.00	0.00	262.64	42.59	15.55		4.00	13.86		338.64
Chirokof													
Small Trawler						20.56	1.50	4.20	4.97	17.43	46.97		95.63
Surimi Trawler													
Lg. Frz. Trawler						45.80	7.12	7.95	143.00	154.04	32.43	4.40	394.74
Longliner						0.00			0.00				0.00
Total						66.36	8.62	12.15	147.97	171.47	79.40	4.40	490.37
Kodiak													
Small Trawler								0.40			0.02		0.42
Surimi Trawler													
Lg. Frz. Trawler						1.64							1.64
Longliner			0.00	0.30	0.00				0.00				0.30
Total			0.00	0.30	0.00	1.64		0.40	0.00		0.02		2.36
Yakutat													
Small Trawler													
Surimi Trawler													
Lg. Frz. Trawler													
Longliner					0.00					0.17			0.17
Total					0.00					0.17			0.17
All Regions													
Small Trawler						27.32	1.50	5.80	4.97	18.53	50.52		108.64
Surimi Trawler													
Lg. Frz. Trawler						303.32	49.71	22.30	143.0	156.94	42.76	4.40	722.42
Longliner			0.00	0.30	0.00					0.17			0.47
Grand Total			0.00	0.30	0.00	330.64	51.21	28.10	147.97	175.64	93.28	4.40	831.54

[1/] Data source: Nelson et al, 1983.

Table 6.6--Allowable biological catch, optimum yield, foreign catch allocation, and reported foreign catch for Pacific ocean perch (5 species) in the Gulf of Alaska in 1981 and 1982.

NPFMC area	Allowable biological catch1/	Optimum yield1/3/	Foreign catch allocation1/3/	Reported foreign catch
	- - - - - - -	- - - - - - - t	- - - - - - -	- - - - - - -
1981				
Western	5,300	3,150	3,048	1,234.5
Central	15,700	9,217	8,852	4,268.2
Eastern	29,000	16,800 2/	11,906	6,674.5
Total	50,000	29,167	23,806	12,177.2
1982				
Western	5,300	2,700	2,555	1,745.9
Central	15,700	7,900	7,745	6,224.6
Eastern	29,000	875	775	17.0
Total	50,000	11,475	11,075	7,987.5

1/ Source: North Pacific Fisheries Management Coucil (NPFMC) Fishery Management Plan.
2/ Includes 3,360 t held in reserve.
3/ OY adjusted for 14 month reporting year.

Table 6.7.--Pacific ocean perch (5 species) allocations by foreign nation and North Pacific Fishery Management Council (NPFMC) area in 1982.

Nation	NPFMC area Western	Central	Eastern	Total (t)	(%)
	- - - - - - - - - t	- - - - - - - - -			
Japan	2,048	6,687	344	9,079	82.0
Korea	492	1,043	429	1,964	17.7
West Germany	15	15	3	33	0.3
Total	2,555	7,745	775	11,075	100.0
Percent	23.1	69.9	7.0	100.0	

Table 6.8.--Japanese catch in metric tons of Pacific ocean perch[1/] by gear type.

Vessel Class	1981	1982	mean percentage
Small Trawler	3357.62	1923.47	30.2
Surimi Trawler	355.52	80.15	2.5
Large Freeze Trawler	6513.51	5077.81	66.2
Trawl Sub Total	10,226.65	7081.43	98.9
Long liner	115.95	74.61	1.1
Grand Total	10,342.60	7156.03	100.0

1/ Five species, *S. alutus*, *S. polyspines*, *S. aleutianus*, *S. borealis*, and *S. zacentrus*.

Table 6.9.--Mean size composition (fork length) in the *Sebastes alutus* catch from the Gulf of Alaska as determined from samples collected by U.S. observers, 1975-82.

Sex and INPFC[1/] area	1975	1976	1977	1978	1979	1980	1981	1982
Males				cm				
Shumagin	30.2	30.7	29.2	29.6	32.1	-	31.6	30.9
Chirikof	28.5	30.4	31.1	30.9	31.4	33.2	28.2	30.4
Kodiak	31.4	31.1	32.5	32.8	33.8	34.2	33.4	32.0
Yakutat	31.2	33.6	33.5	34.3	34.3	33.9	33.9	-
Southeastern	36.6	36.0	34.8	33.9	35.8	36.1	36.3	-
Females				cm				
Shumagin	30.3	30.6	29 1	29.8	32.4	-	32.4	31.2
Chirikof	29.1	30.0	31.2	31.3	31.1	30.8	28.3	30.7
Kodiak	32.2	31.0	33.1	33.5	33.1	34.9	34.0	32.9
Yakutat	31.2	33.7	34.5	35.4	35.6	35.1	35.1	-
Southeastern	37.4	37.7	35.8	34.8	37.4	37.5	37.7	-

1/ International North Pacific Fisheries Commission statistical areas.

Table 6.10.--Average catch per unit of effort (CPUE) for *S. alutus* in the Gulf of Alaska, 1961 and 1973-76, by region and depth zone.[1/]

Region[2/]	1961 CPUE (kg/h)		1973-76 CPUE (kg/h)	
	101-200 m	201-400 m	101-200 m	201-400 m
Fairweather	7.4	149.7	2.9	0.0
Yakutat	66.3	85.0	4.6	6.2
Prince William	48.8	80.1	10.9	1.5
Kenai	80.4	31.8	4.7	0.0
Kodiak	25.2	2.9	2.4	11.7
Shelikof	2.4	10.5	1.4	1.0
Chirikof	135.0	67.8	18.3	0.4
Shumagin	29.3	431.4	-	-
Sanak	7.2	228.6	0	53.5
Total	50.1	75.6	6.1	3.4

1/ Source: Ronholt, Shippen, and Brown, 1978.
2/ Regions do not correspond to International North Pacific Fisheries Commission statistical areas.

Table 6.11.--Relative abundance of *Sebastes alutus* (catch in kg/h) in resource assessment surveys, 1978-81.

Year	Area	No. of station samples	Relative abundance (kg/h)	Reference
1978	Southeastern	74	53	1/
1978	Yakutat	100	4	1/
1978	Kodiak	53	4	1/
1978	Chirikof	24	4	1/
1979	Kodiak	73	114	2/
1979	Chirikof	55	98	2/
1979	Shumagin	43	131	2/
1979	Southeastern	15	84	2/
1981 3/	Yakutat	63	335	4/
1981 3/	Yakutat	59	193	4/
1981 3/	Cape Ommaney	72	143	4/
1981 3/	Kodiak	17	80	4/

1/ Feldman and Rose 1981.

2/ Cruise results, *Nore-Dick* 79-1.

3/ Beginning with 1981, surveys were confined to index sites which were areas of recorded high production by commercial fisheries and thus are not directly comparable to earlier surveys.

4/ Cruise results, *Ocean Harvester* 81-1 and *Pat San Marie* 81-2.

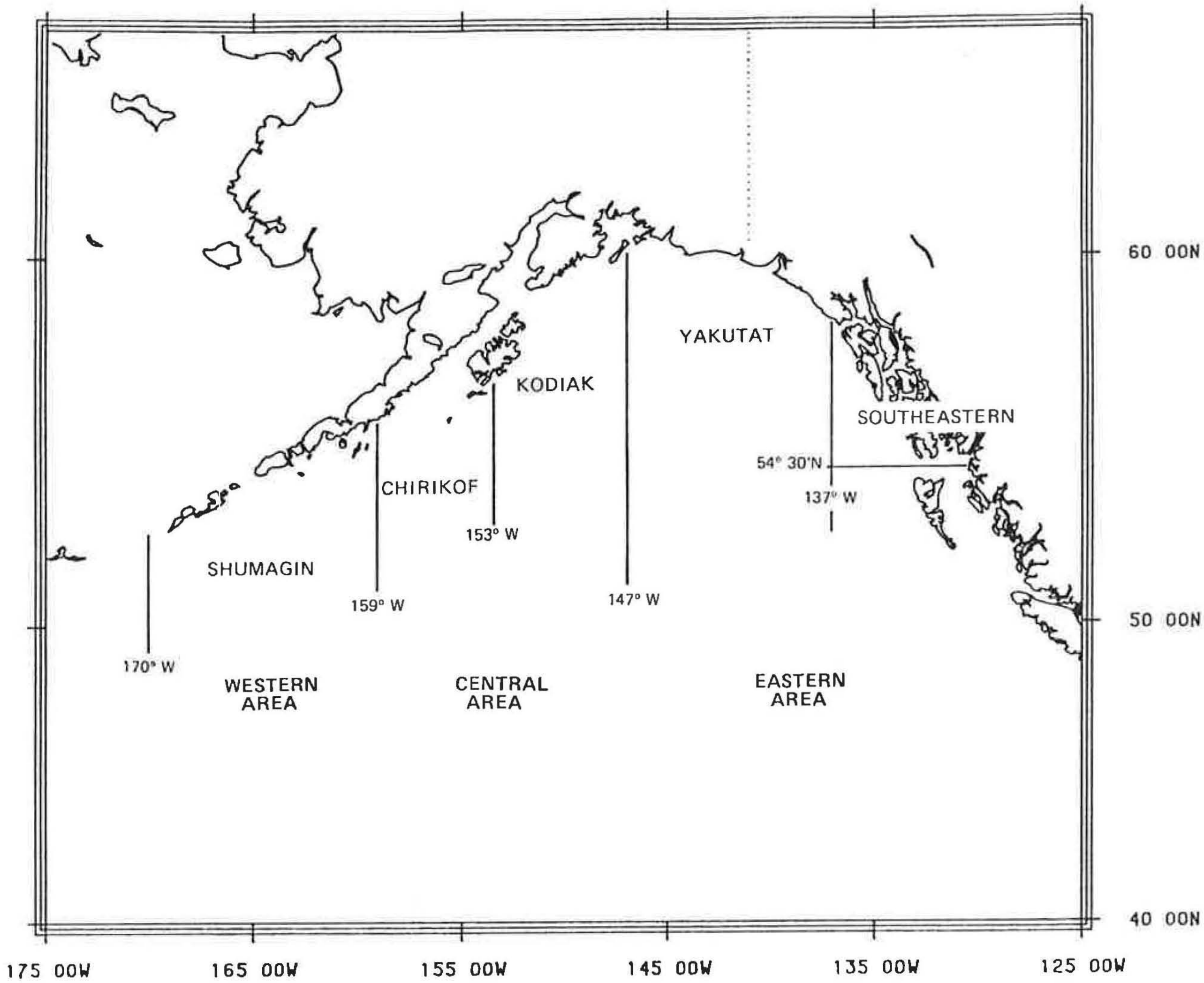

Figure 6.1--Regulatory areas in the Gulf of Alaska of the North Pacific Fishery Management Council (NPFMC).

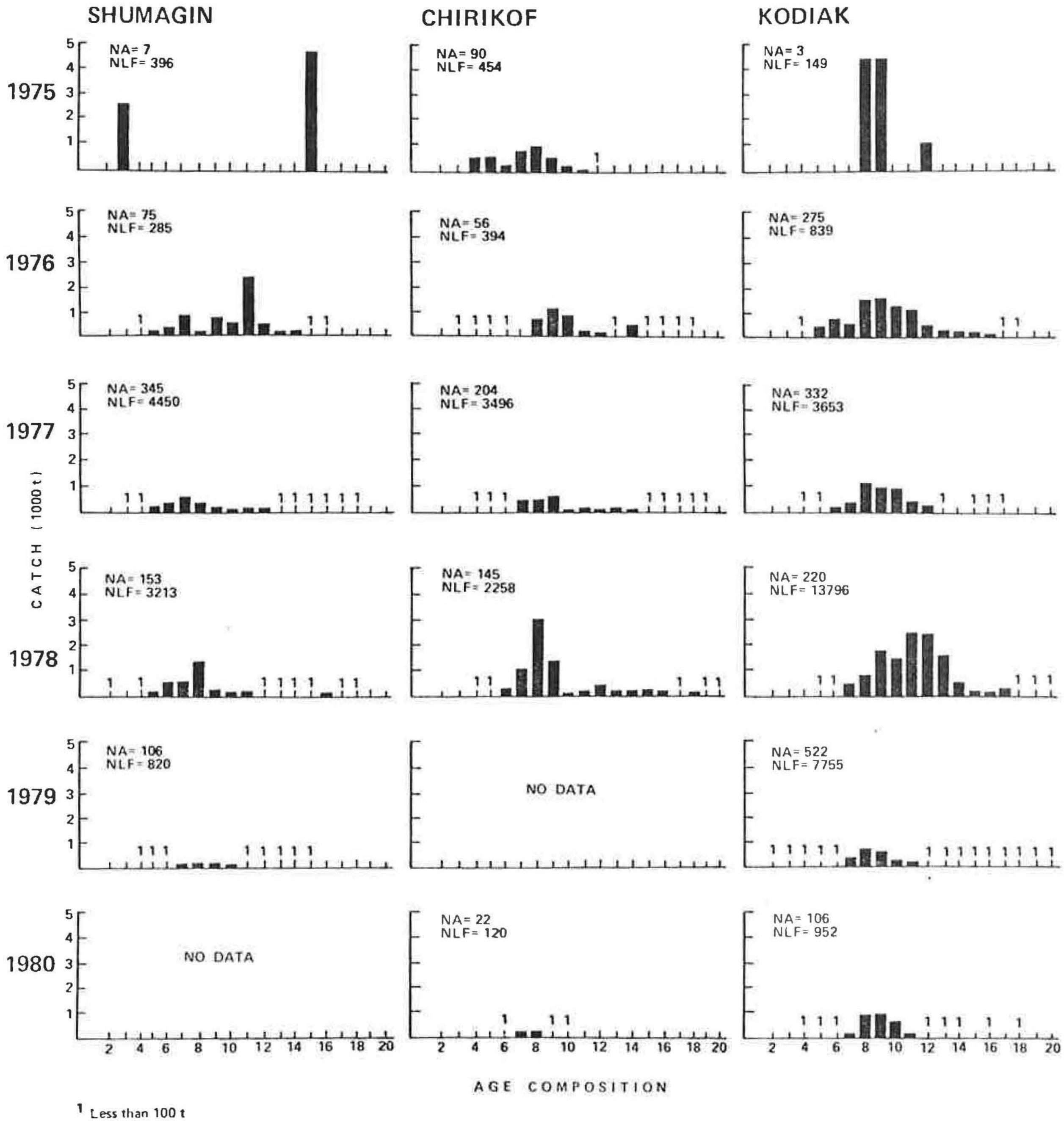

Figure 6.2A.--Age composition of Pacific ocean perch (S. alutus) captured in the Gulf of Alaska by foreign trawlers, 1975-80.

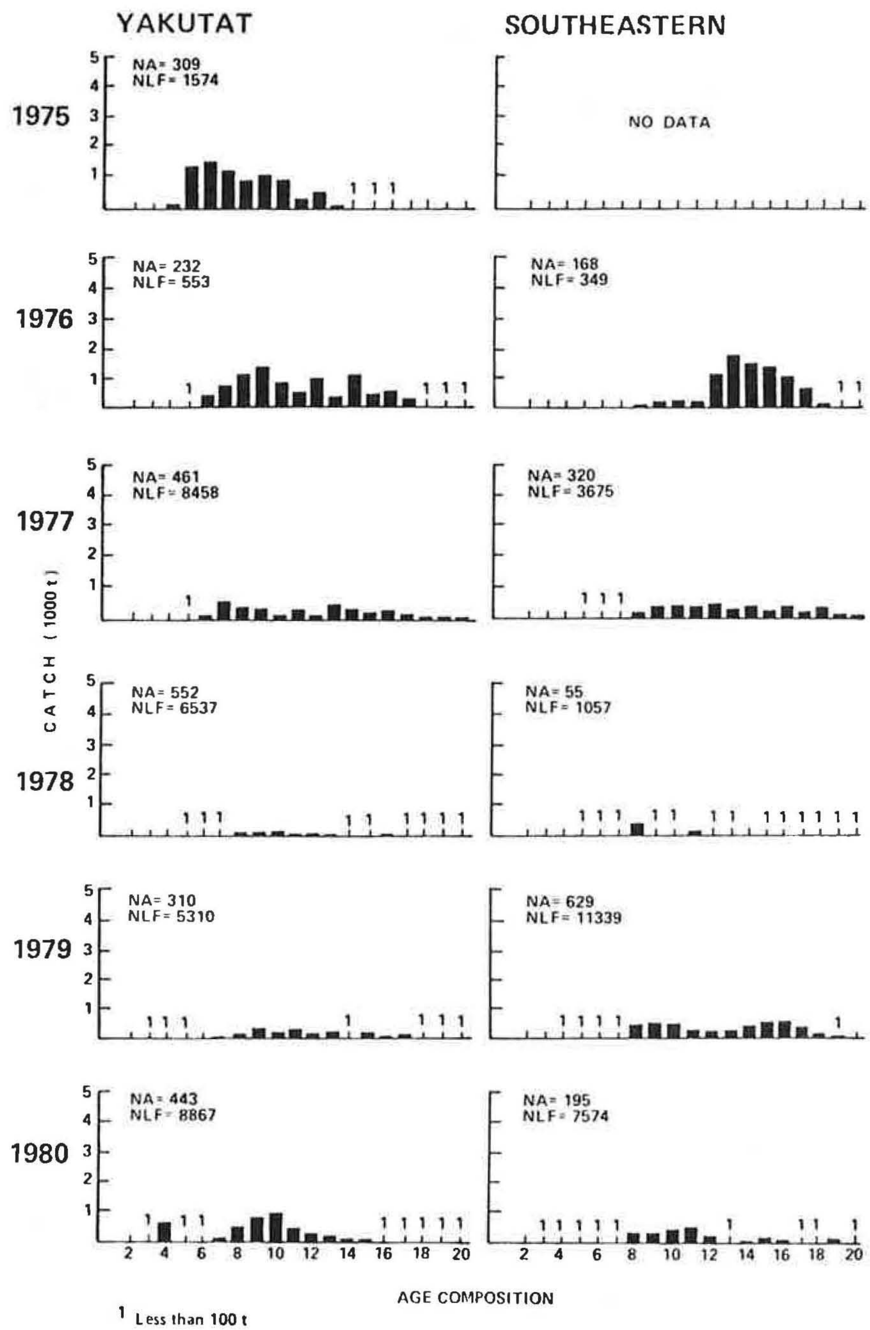

Figure 6.2B--Age composition of Pacific ocean perch (*S. alutus*) captured in the Gulf of Alaska by foreign trawlers, 1975-80.

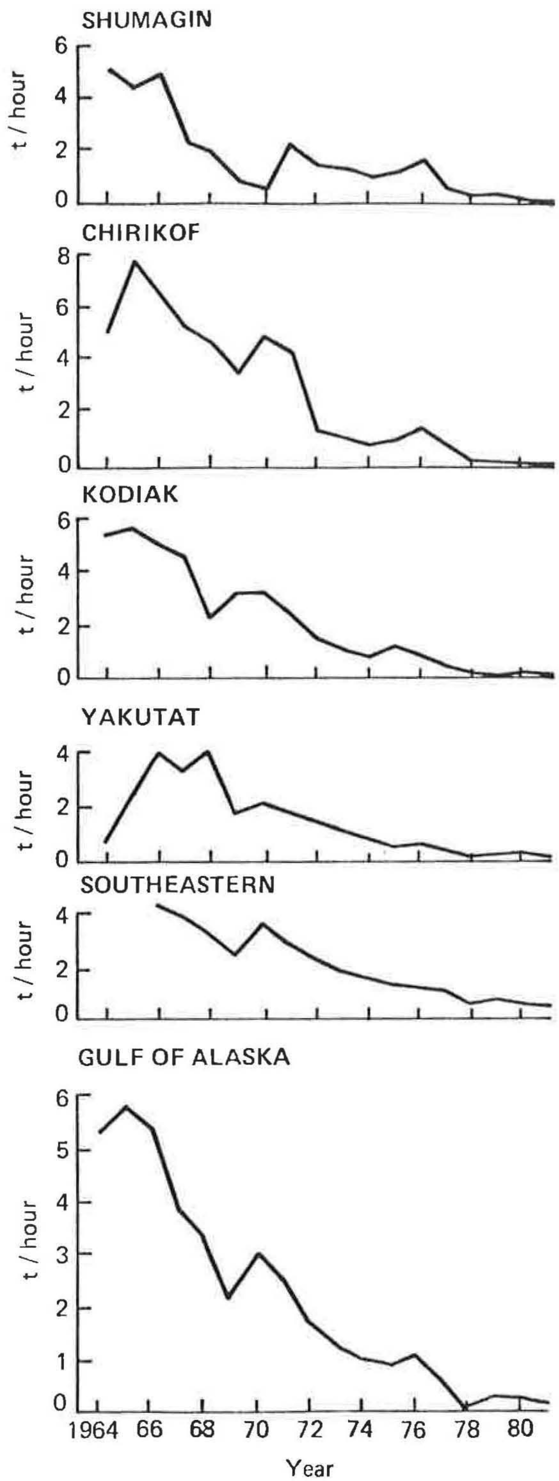

Figure 6.3.--Catch per unit of effort by Japan for Pacific ocean perch in Gulf of Alaska trawl fisheries, 1964-81.

Flatfish[1/]

by Craig S. Rose[2/]

The fishery for flatfish in the Gulf of Alaska, excepting Pacific halibut, Hippoglossus stenolepis, has primarily been either incidental to those for other fish or a low priority alternate fishery. The allocations for 1982 (Table 7.1) were similar to those of the past five years. Generally, the reserve and some of the domestic quota have been added to the foreign quota in the final allocation. Thus far, the catches have remained considerably below the quotas. This, and the fact that optimum yield has been set at 50% of the allowable biological catch to protect halibut stocks result in flatfish stocks that are far from fully exploited.

In 1982, the catch of flatfish in the Gulf dropped from the level of recent years. While the catch has fluctuated within 1200 metric tons (t) of 15,000 t, the 1982 total was only about 9000 t (Table 7.2). One apparent cause of this drop was Amendment 10 to the GOA groundfish management plan (June 1, 1982) which closed all waters East of 140 degrees longitude to foreign fishing and limited foreign trawlers between 140 and 147 degrees to midwater trawling only. The catches in the Southeastern and Yakutat International North Pacific Fisheries Commission (INPFC) statistical areas were reduced to less than 3% of recent values, with the only flatfish catches being incidental in longline fisheries. In addition, the Shumagin area catch dropped by 50%. The Kodiak area catch rose to its second highest level in five years, probably augmented by some shift of effort from the closed areas to the east.

The fisheries of Japan and the Republic of Korea (ROK) harvested nearly all of the GOA flatfish catch with domestic and joint venture

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1/ This report is a revised update of the 1982 INPFC document; Rose, C. and Eric Brown. 1982. In Ito, D. and J. Balsiger (ed), Conditions of groundfish resources of the Gulf of Alaska in 1982. U. S. Dept. Commer., NOAA Tech. Memo. NMFS F/NWC-52, 204 p.

2/ Northwest and Alaska Fisheries Center, National Marine Fisheries Service, NOAA, 2725 Montlake Blvd. E., Seattle, WA 98112.

fisheries accounting for only about 2%. Japan remained the principal harvester, taking just over 70% of the catch. Two-thirds of their portion came from the Kodiak area with lesser harvests in the Chirikof and Shumagin Areas. The ROK fishery took two-thirds of their catch from the Chirikof area with most of the remainder coming from the Shumagin area.

Historically, most of the Gulf flatfish catch has been incidental to fisheries for other species. A significant exception to this appeared to occur in the summer of 1982. Flatfish made up 62%, 77%, and 49% of the June, July, and August catches by large Japanese freezer trawlers in the Kodiak area. These catches represented 68% of Japan's flatfish catch from that area and a third of all Gulf flatfish catches. The proportion of flatfish is higher than usual for most trawler types in the central Gulf during these months except where Pacific Ocean perch or Atka mackerel appear to be the target species. It is possible that this is due to uncertainty over the Central Gulf pollock quota at that time. Flatfish proportions dropped back noticably in September after the pollock question was resolved.

While the Gulf flatfish fishery includes many species, it is managed as a single stock. The major species, which account for approximately 99% of the total flatfish catch, are arrowtooth flounder, *Atheresthes stomias*; flathead sole, *Hippoglossoides elassodon*; rock sole, *Lepidopsetta bilineata*; rex sole, *Glyptocephalus zachirus*; and Dover sole, *Microstomus pacificus*. To allow a comparison of the distribution of the fishery with that of the resource, the foreign catches by INPFC area are presented with graphs of apparent abundance from resource assessment surveys for the total flatfish catch and for each of the major species in Figures 7.1-7.6.

It is important to note that the vertical scales of these graphs vary. Otherwise, one could be mislead regarding the relative abundance of the five species. These survey values should be used for comparison of relative abundance only as the catchability characteristics of the trawls used have not been quantified. It should also be noted that these surveys were more concentrated on the edge of the continental shelf and may be less representative of populations over the entire shelf area.

As can be seen in Figure 7.1, the shift in catches to the west in 1982 actually put their distribution more in line with that of the resource. While such alignment is desirable, this improvement is probably not important due to the underexploited nature of the stocks. A more notable fact is that a significant portion af the available resource is effectively closed to foreign harvest.

The arrowtooth flounder catch dropped considerably in 1982 both in tons and in percentage of the flatfish catch (Figure 7.2). The catches of this species which had been taken in the eastern Gulf were lost with little or no compensating rise in the other areas.

The rock sole catch also decreased, though it held its own relative to the total flatfish catch (Figure 7.3). This decrease can be associated with the lower flatfish catch in the Shumagin area, which contains the highest abundance of that species. Rock sole appears to represent a larger portion of the flatfish resource than has been reflected in the catches. Its distribution is notably shallower than that of the other major species, which may reduce its occurrence in the fisheries for pollock and rockfish.

Catches of both flathead sole and rex sole increased dramatically in 1982 (Figures 7.4 and 7.5). Both species have their highest abundance in the Kodiak area, where the flatfish catch was concentrated. The catch may also have been affected by the targeted fishing mentioned earlier, as the proportion of these species in the Kodiak flatfish catch increased from 14% to 40%. This increase was mirrored by a comparable drop in the proportion of the less desirable arrowtooth flounder.

The catch of Dover sole dropped slightly in 1982, with most of the loss coming from the eastern areas while catches in the other areas stayed fairly constant (Figure 7.6). The proportion of Dover sole in the flatfish catch increased slightly.

Other flatfish species captured in the Gulf of Alaska are listed in Table 7.3. Of these, the most consistently occuring is the Greenland turbot which is taken in the deep waters of the Shumagin area.

The maximum sustainable yield (MSY) of flatfish in the Gulf of Alaska has been calculated at 67,000 t on the basis of an exploitable biomass estimate of 770,000 t. Since flatfish have been only lightly exploited, allowable biological catch is considered equal to MSY. The biomass estimate was calculated from data collected during a series of assessment trawl surveys carried out in the early 70's. If anything, these biomass estimates are conservative since they assume that all flatfish in the trawl's path are captured (catchability = 1.0). These trawl data were also used to allocate the MSY between the management areas of the Gulf. Results from a more recent series of trawl surveys (1978-1981) did not differ enough from previous estimates to warrant changes in either the MSY or its distribution.

Future monitoring of flatfish stocks in the Gulf of Alaska will continue to consider both commercial fisheries data and resource assessment surveys. A major survey of the Gulf is currently scheduled for the summer of 1984. This will probably include better coverage of continental shelf areas which should allow a improved update on the status of flatfish stocks in the Gulf of Alaska.

Table 7.1--1982 initial allocations of flatfish in the Gulf of Alaska. (values in metric tons)

	Western	Central	Eastern	Total
Optimum Yield	10,400	14,700	8,400	33,500
Domestic Harvest	700	1,120	1,360	3,180
Reserve	2,080	2,940	1,680	6,700
Foreign Harvest	7,620	10,640	5,360	23,620

Table 7.2--Catch of flounders (t) by nation from the Gulf of Alaska during 1978-81.

	Japan	USSR	Korea	Poland	Mexico	Joint-Venture	US	Total
Shumagin								
1978	2,268	0	270	0	0	0	6	2,544
1979	2,202	26	557	15	17	0	0	2,817
1980	336	976	1,710	0	0	8	0	3,030
1981	1,229	0	1,984	11	0	0	0	3,224
1982	804	0	608	0	0	6	0	1,418
Chirikof								
1978	2,268	188	26	0	0	0	4	2,486
1979	488	107	0	4	19	0	1	619
1980	936	40	0	0	0	106	0	1,082
1981	1,349	0	2,300	4	0	18	0	3,671
1982	1,270	0	1,628	0	0	12	0	2,910
Kodiak								
1978	3,809	8	0	13	0	0	82	3,912
1979	4,100	231	0	0	77	0	54	4,462
1980	5,086	823	0	0	0	92	46	6,047
1981	2,099	0	7	0	0	0	66	2,172
1982	4,472	0	146	0	0	0	51	4,669
Yakutat								
1978	2,955	0	0	0	0	0	0	2,955
1979	3,238	5	47	0	0	0	7	3,297
1980	4,071	0	24	0	0	0	0	4,095
1981	2,573	0	735	0	0	0	0	3,308
1982	57	0	1	0	0	0	0	58
Southeastern								
1978	2,536	0	0	0	0	0	760	3,296
1979	2,341	0	1	0	0	0	322	2,664
1980	1,495	0	0	0	0	0	0	1,589
1981	2,153	0	0	0	0	0	412	2,565
1982	0	0	0	0	0	0	94	94
Total								
1978	13,836	196	296	13	0	0	852	15,193
1979	12,369	369	605	19	113	0	384	13,859
1980	11,924	1,839	1,734	0	0	206	140	15,843
1981	9,403	0	5,026	15	0	18	478	14,940
1982	6,603	0	2,383	0	0	18	145	9,149

1/ Foreign and JV catches from NMFS Observer Program, Seattle (best blend estimate).

2/ Domestic catches from Alaska Department of Fish and Game, Juneau.

Table 7.3--Other species of flounder commonly encountered in Gulf of Alaska fisheries.

Petrale sole	*Eopsetta jordani*
Greenland turbot	*Reinhardtius hippoglossoides*
Deepsea sole	*Embassichthys bathybius*
Slender sole	*Lyopsetta exilis*
Starry flounder	*Platichthys stellatus*
English sole	*Parophrys vetulus*
Butter sole	*Isopsetta isolepis*
Yellowfin sole	*Limanda aspera*

Catch: Year(s)	Southeast	Yakutat	Kodiak	Chirikof	Shumagin	TOTAL
INPFC AREA						
1978–81	2132	3412	4086	1963	2902	14,495
1982	0	58	4618	2910	1418	9005

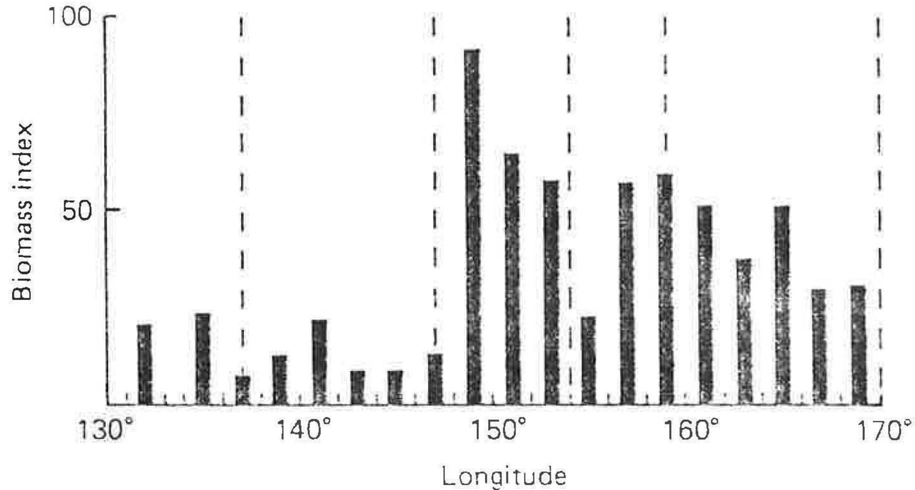

Figure 7.1--Foreign catch (t) of flatfish in the Gulf of Alaska with resource distribution as estimated from trawl survey data.

Catch: Year(s)	Southeast	Yakutat	Kodiak	Chirikof	Shumagin	TOTAL	Percent of flatfish catch
INPFC AREA							
1978–81	2008	3109	3086	1529	2237	11,969	83
1982	0	4	2284	2606	1068	5962	66

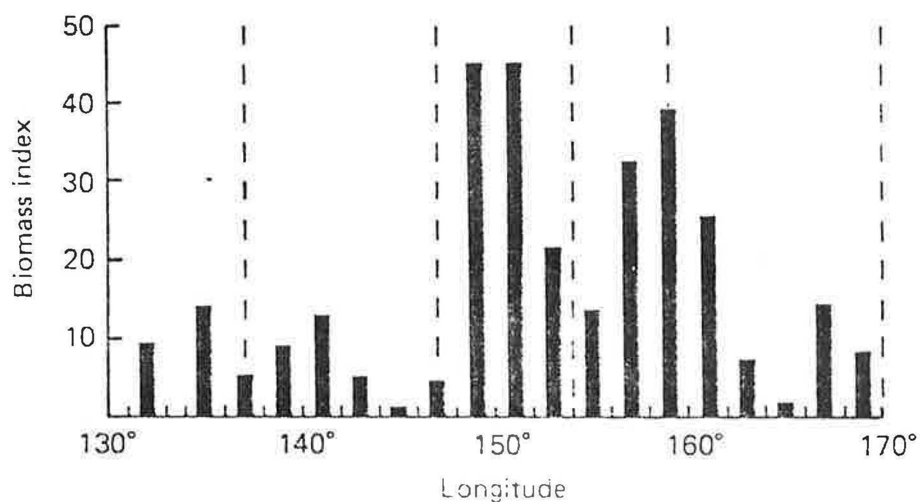

Figure 7.2--Foreign catch (t) of arrowtooth flounder in the Gulf of Alaska with resource distribution as estimated from trawl survey data.

INPFC AREA

Catch Year(s)	Southeast	Yakutat	Kodiak	Chirikof	Shumagin	TOTAL	Percent of flatfish catch
1978-81	2	7	56	54	295	414	3
1982	0	0	80	23	195	298	3

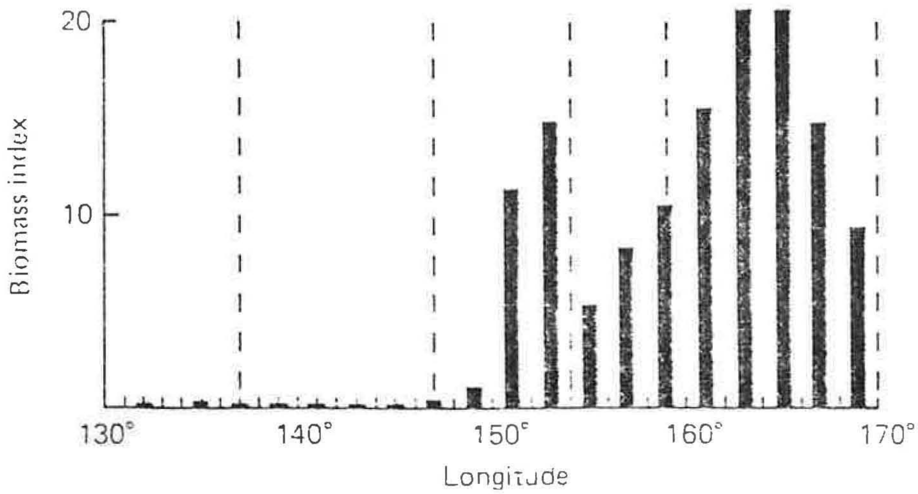

Figure 7.3--Foreign catch (t) of rock sole in the Gulf of Alaska with resource distribution as estimated from trawl survey data.

INPFC AREA

Catch Year(s)	Southeast	Yakutat	Kodiak	Chirikof	Shumagin	TOTAL	Percent of flatfish catch
1978-81	0	103	165	184	43	495	3
1982	0	40	1025	108	63	1236	14

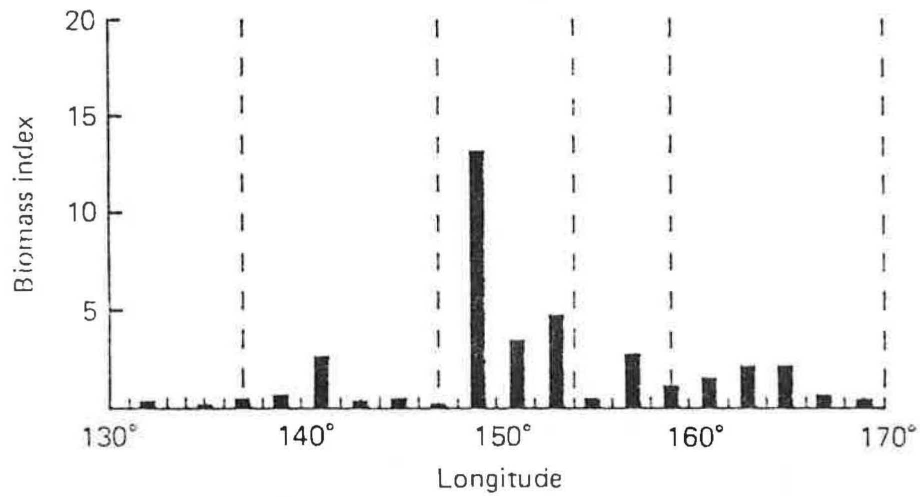

Figure 7.4--Foreign catch (t) of flathead sole in the Gulf of Alaska with resource distribution as estimated from trawl survey data.

INPFC AREA

Catch Year(s)	Southeast	Yakutat	Kodiak	Chirikof	Shumagin	TOTAL	Percent of flatfish catch
1978–81	86	58	416	117	101	778	5
1982	0	0	818	105	36	959	11

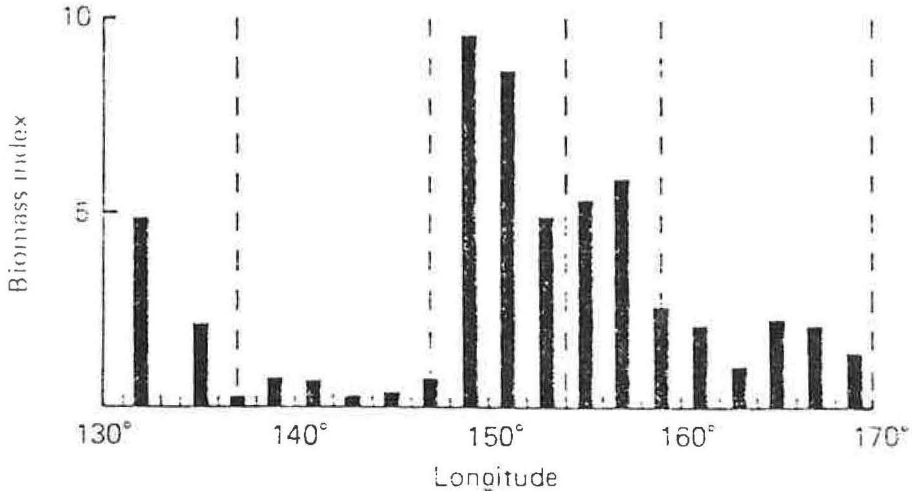

Figure 7.5--Foreign catch (t) of rex sole in the Gulf of Alaska with resource distribution as estimated from trawl survey data.

INPFC AREA

Catch Year(s)	Southeast	Yakutat	Kodiak	Chirikof	Shumagin	TOTAL	Percent of flatfish catch
1978–81	32	106	357	53	48	596	4
1982	0	6	364	56	30	456	5

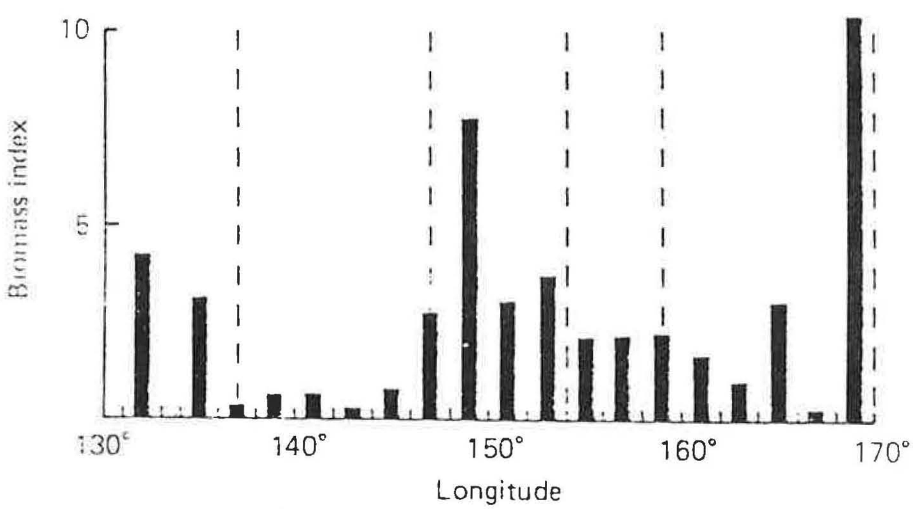

Figure 7.6--Foreign catch (t) of Dover sole in the Gulf of Alaska with resource distribution as estimated from trawl survey data.

Preliminary Information on Walleye Pollock From Results of the Spring 1983 Bottom Trawl Survey of Shelikof Strait

by Eric Brown[1/]

Introduction

On March 20, 1983, personnel from the Northwest and Alaska Fisheries Center's Resource Assessment and Conservation Engineering Division (RACE) completed a 17-day bottom trawl survey of Shelikof Strait (Figure 8.1) with the principal objective of determining the age specific biomass distribution of the near bottom component of walleye pollock. Preliminary information based on bottom trawl data collected aboard the NOAA ship CHAPMAN is presented in this paper.

Survey Methods

Vessel and Gear

The vessel used for the survey was the NOAA ship CHAPMAN, a 39 m combination trawler/crabber powered by a 1,250 shaft horsepower main engine. All hauls were made with the two panel 25.3/34.1 m eastern otter trawl constructed of 10.2 cm mesh in the wings and body and 8.9 cm mesh in the intermediate and codend sections. When towed with 1.6 cm x 55 m double dandylines and 1.8 x 2.7 m steel V-doors, the mean effective path width and vertical opening is approximately 18.3 and 2.4 meters respectively. Time on bottom was monitored by a leadrope mounted sonde unit, and the distance fished was computed from a combination of Doppler, Loran-C, and radar.

Sampling Methodology

Bottom depths fished ranged from 183-324 m with the majority of tows (33) occurring between 240-293 m. Tows were generally one-half hour in duration, except when fishing in dense fish sign, then the haul time was reduced to

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avoid excessively large catches. Mininum haul duration was set at ten minutes so that accurate estimates of the distance fished could be computed. The average trawling speed was 2.1 nm/hr and all trawling was completed during daylight hours.

Catches of approximately 1,000 kg or less were completely processed whereas catches greater than 1,000 kg were sampled using the methods described by Hughes (1976) to obtain a representative portion of the total catch. Individual pollock obtained from random samples were sexed, measured, and examined for stage of sexual maturity. Approximately 2,000 randomly collected otoliths were taken from pollock both inside and outside the spawning aggregation.

Survey Design

A two-day echo sounding survey of Shelikof Strait completed by the NOAA Ship MILLER FREEMAN on February 27 indicated that, while pollock densities were generally high, the fish were broadly distributed. The initial survey strategy was to randomly select sampling sites from a 3,600 square nautical mile (nm) grid composed of 144 blocks, each approximately 25 square nm and bounded by the 137 m isobath (Figure 2). Utilizing this scheme and beginning in the northeast and continuing to the southwest, 25 stations were completed.

New information from a concurrent hydroacoustic - midwater trawl survey of Shelikof Strait by the MILLER FREEMAN and from the commercial fishing fleet, indicated that pollock had formed the type of dense spawning aggregation seen in previous years. Sampling was then intensified to include each block within the spawning aggregation which extended 75 nm in a narrow 2-8 nm band. Whenever possible, additional trawl hauls were randomly selected adjacent to and inside the aggregation boundaries.

Results

Fifty-two bottom trawls were completed during the survey, of which 51 were considered successful for purposes of data analysis. Twenty-one tows were completed inside the spawning aggregation while 30 tows were completed throughout the remaining areas of Shelifof Strait.

Expendable bathythermographs (XBT's) taken throughout the survey area indicated bottom temperatures ranged from 4.6 - 6.5° C with a mode of approximately 5.0° C and surface temperatures ranged from 2.5 - 5.0° C with a mode of approximately 3.8° C.

Catch Per Unit Effort

Walleye pollock accounted for nearly 83 percent (5,964 kg/hr) of the total CPUE obtained during the survey (Table 8.1). Other important constituents included arrowtooth flounder (332 kg/hr) and Pacific halibut (314 kg/hr). Commonly occurring species taken in lesser amounts were sablefish, Pacific cod, flathead sole, skates, Tanner crab (bairdi), and eulachon (smelts).

Within the approximately 340 square nm spawning aggregation, pollock catch rates ranged from 544 kg/hr to over 30,391 kg/hr (Table 8.2 and Figure 8.3). Highest catch rates occurred in the central and northern portion of the aggregation before dropping abruptly at approximately 58°13'N.

Biomass

The standing stock or biomass was approximated using the following relationship:

$$\overline{P}_W = \frac{(CPUE)(A)}{c\overline{a}}$$

where $\overline{P}_W$ is the average standing stock in weight of the exploitable population; A is the total area; a is the average bottom area covered by the trawl per nautical mile; and c is a coefficient related to the degree which pollock are vulnerable to capture when in the path of the trawl. A similar method was used to estimate the population of pollock with numbers being substituted for weight in the CPUE function. For walleye pollock in the Gulf of Alaska, the coefficient c, is not known and in this report, estimates of biomass have been calculated using a catchability coefficient of one.

Based on a total survey area of approximately 3,600 nm^2 the near bottom component of pollock has been estimated at 184,000 t (Table 8.3). Of this total, over 142,000 t (77%) was contained within the approximately 340 nm^2 spawning aggregation.

Age readings from 527 otoliths were used to make preliminary estimates of population numbers by age (Table 8.4 and Figure 8.4). Within the spawning aggregation, nearly 82 percent of the observed pollock were composed of three year-classes. Five year olds accounted for 33 percent of the population followed by four year olds (28%) and six year olds (21%). Outside the spawning aggregation, five year olds were again dominant (28%) but were followed by age six (22%) and age four (18%) pollock.

Mean lengths at age obtained from the 527 read otoliths show that with the exception of the three year olds, both male and female pollock taken outside the spawning aggregation had longer mean lengths than those inside the spawning aggregation (Table 8.5). Generally, small differences were observed from ages one through five with larger differences occurring at ages six and higher.

Size Compostion

Throughout the survey area, pollock ranged in weight from 0.3 - 0.9 kg with most between 0.5 and 0.6 kg. The size distribution of pollock within the spawning concentration was composed of a single large mode with a mean length 40.9 cm for males and 42.8 cm for females (Figure 8.5). Very few fish were observed below 35 cm or above 50 cm for both sexes. Outside the spawning concentration, the size distribution for both sexes was characterized by two minor modes at approximately 12 and 23 cm and a dominant mode at 44 cm. Along with the occurrence of smaller fish observed outside the spawning concentration was a higher proportion of larger fish over 55 cm.

Sex Ratios

Catches within the spawning aggregation were often characterized by high proportions of either males or females (Figure 8.6) with males accounting for nearly 67 percent of the aggregation total. Where sexual stratification was evident, there appeared to be no definite pattern which would suggest the expected location of either sex although males clearly dominated many of the catches taken in the northern portion of the aggregation.

Four of the five highest catch rates (27, 23, 26, and 30 thousand kg/hr) had the lowest (1, 2, 7, and 22 percent) proportion of females, although other large catches (28, 11, and 19 thousand kg/hr) contained high proportions (73, 86, and 75 percent) of females. Better knowledge of the movements of both sexes during spawning would be of great value to the commercial fleet which are in part attempting to target on females for roe.

Reproduction

During March, 92 percent of the spawning concentration was observed to be in a pre-spawning or spawning condition, 4 percent were considered too immature to spawn during 1983 and approximately 3 percent were still developing sexually for perhaps a later spawn (Table 8.6). Outside the spawning aggregation, 86 percent were either in a mature or spawning condition, 11 percent were immature, a reflection of the two smaller length modes, and 3 percent were still developing. The mean lengths of pre-spawning and spawning fish within the spawning aggregation were significantly lower than those observed outside the spawning aggregation as were the mean lengths for developing and spent fish.

Pacific Halibut

Pacific halibut, which averaged over 6 kg apiece, were encountered throughout the survey area with significant catches occurring both inside and outside the spawning concentration. Twenty-two hauls contained at least 10 halibut; 14 hauls had between 11-20, while one haul contained 100 halibut averaged 4.5 kg apiece (Table 8.5).

References Cited

Hughes, S. E. 1976. System for sampling large trawl catches of research vessels. Journal of the Fisheries Research Board of Canada, Vol. 33. No. 4. Part I: 833-839.

Table 8.1.--Catch per unit effort (CPUE) for principal species encountered during March 1983 bottom trawl survey of Shelikof Strait.

Species	CPUE (kg/hr)	Percent of Total
Walleye pollock	5,964	82.5
Arrowtooth flounder	332	4.6
Pacific halibut	314	4.3
Sablefish	195	2.7
Pacific cod	110	1.5
Flathead sole	98	1.4
Skates	67	0.9
Tanner crab (Bairdi)	30	0.4
Eulachon (smelts)	30	0.4
Others	91	
Total	15,943	

Table 8.2.--Haul and catch information for walleye pollock obtained during March 1983 bottom trawl survey of Shelikof Strait.

Haul Number	Depth (m)	Duration of haul (hr)	Catch (kg)	Catch Rate (kg/hr)	Percent Females	Bottom Temp (°c)
1	196	.50	364	728	82	--
2	207	.50	74	149	60	--
3	243	.50	35	71	55	--
4	218	.50	1,955	3,911	63	--
5	219	.50	88	176	58	--
6	210	.50	65	130	--	--
7	210	.50	28	55	--	5.0
8	201	.50	174	349	64	--
9	305	.50	16	32	--	--
10	256	.50	85	171	71	--
11	245	.50	159	318	70	5.0
12	240	.25	590	2,360	55	--
13	260	.50	166	332	59	--
14	272	.50	60	120	60	--
15	280	.50	33	66	--	5.0
16	262	.50	31	61	--	5.2
18	243	.50	574	1,147	57	--
19	183	.49	224	456	61	--
20	263	.50	171	342	73	--
21	198	.20	15	76	--	5.2
22	203	.10	5	45	--	4.9
23	285	.50	181	362	86	4.8
24	289	.50	65	131	53	4.6
25	287	.17	1,092	6,424	53	--
26	313	.50	99	199	--	--
27	252	.20	43	214	--	--
28	309	.33	1,122	3,398	40	5.0
29	300	.50	278	555	60	4.7
30	251	.32	1,270	3,970	91	5.1
31	251	.32	161	502	89	5.2
32	324	.25	6,879	27,517	73	4.7
33	285	.50	312	624	16	--
34	304	.50	237	473	61	--
35	285	.30	4,790	15,967	40	--
36	271	.17	965	5,674	84	5.0
37	285	.17	1,560	9,179	39	4.6
38	289	.25	456	1,823	66	--
39	258	.50	45	90	--	--
40	283	.17	1,833	10,781	86	--
41	316	.17	3,246	19,094	75	--
42	271	.33	107	324	--	--
43	282	.25	1,506	6,024	46	--
44	271	.16	4,881	30,503	22	--
45	256	.17	4,432	26,069	7	5.0
46	271	.50	1,461	2,923	30	5.0
47	291	.16	3,720	23,252	2	--
48	271	.16	1,403	8,769	17	--

Table 8.2. (Continued)

Haul Number	Depth (m)	Duration of haul (hr)	Catch (kg)	Catch Rate (kg/hr)	Percent Females	Bottom Temp (°c)
49	294	.17	4,622	27,191	1	--
50	293	.17	1,516	8,919	35	5.0
51	274	.33	383	1,161	15	5.7
52	199	.33	142	432	74	5.0

Table 8.3.--Biomass estimate of near bottom component of walleye pollock from March 1983 bottom trawl survey of Shelikof Strait.

	Area (nm^2)	No. Hauls	Biomass (mt)	Numbers (10^6) Males	Females
Spawning Aggregation	340	21	142,191	194.9	96.8
Outside Spawning Aggregation	3,286	30	41,646	25.9	47.1
Total	3,626	51	183,837[1/]	220.8	143.9

[1/] Confidence intervals:

80% 142,588 - 225,085 mt
90% 130,236 - 237,438 mt
95% 119,134 - 248,539 mt

Table 8.4.--Population estimates of near bottom component of walleye pollock from March 1983 bottom trawl surey of Shelikof Strait.

Age Class	Inside Spawning Aggregation		Outside Spawning Aggregation		Total	
	Numbers (10^6)	%	Numbers (10^6)	%	Numbers (10^6)	%
1	1/	2/	.1	.1	.1	2/
2	.3	0.1	5.4	7.3	5.7	1.6
3	15.7	5.4	2.7	3.7	18.4	5.1
4	82.7	28.4	13.5	18.4	96.2	26.4
5	95.3	32.7	20.7	28.3	116.0	31.8
6	60.3	20.7	16.3	22.4	76.6	21.0
7	27.9	9.6	8.0	11.0	35.9	9.8
8	6.1	2.1	2.3	3.1	8.4	2.3
9	1.3	0.5	0.4	0.5	1.7	0.5
10	0.2	0.1	0.1	0.2	0.3	0.1

1/ Less than .1 x 10^6

2/ Less than 0.1 percent

Table 8.5.--Mean lengths at age of near bottom component of walleye pollock from March 1983 bottom trawl survey of Shelikof Strait.

Age class	Mean Lengths (cm)			
	Inside Spawning Aggregation		Outside Spawning Aggregation	
	Males	Females	Males	Females
1	11.3	--	11.8	--
2	22.7	22.4	22.7	22.6
3	35.2	38.0	34.1	37.6
4	38.5	40.5	38.9	41.4
5	42.0	44.0	42.9	44.8
6	42.5	44.6	43.6	46.3
7	43.0	44.3	44.9	46.0
8	43.1	44.9	44.6	47.2
9	44.0	48.9	44.0	48.7
10	--	49.0	56.0	49.0

Table 8.6.--Reproductive condition of walleye pollock during March 1983 bottom trawl survey of Shelikof Strait.

Gonad Condition	Spawning Concentration Mean Length (cm)	%	Outside Spawning Concentration Mean Length (cm)	%
Immature	36.4	4.3	25.8	10.9
Developing	40.7	2.5	43.7	2.5
Mature	42.6	41.9	45.3	45.5
Spawning	41.1	50.9	43.0	40.7
Spent	40.0	0.3	42.6	0.3

Table 8.7.--Frequency of occurrence of Pacific halibut taken in trawl hauls during March 1983 bottom trawl survey of Shelikof Strait.

Frequency of Halibut	Number of Hauls
1-10	22
11-20	14
21-30	8
31-40	2
41-50	3
51-60	1
> 60	1

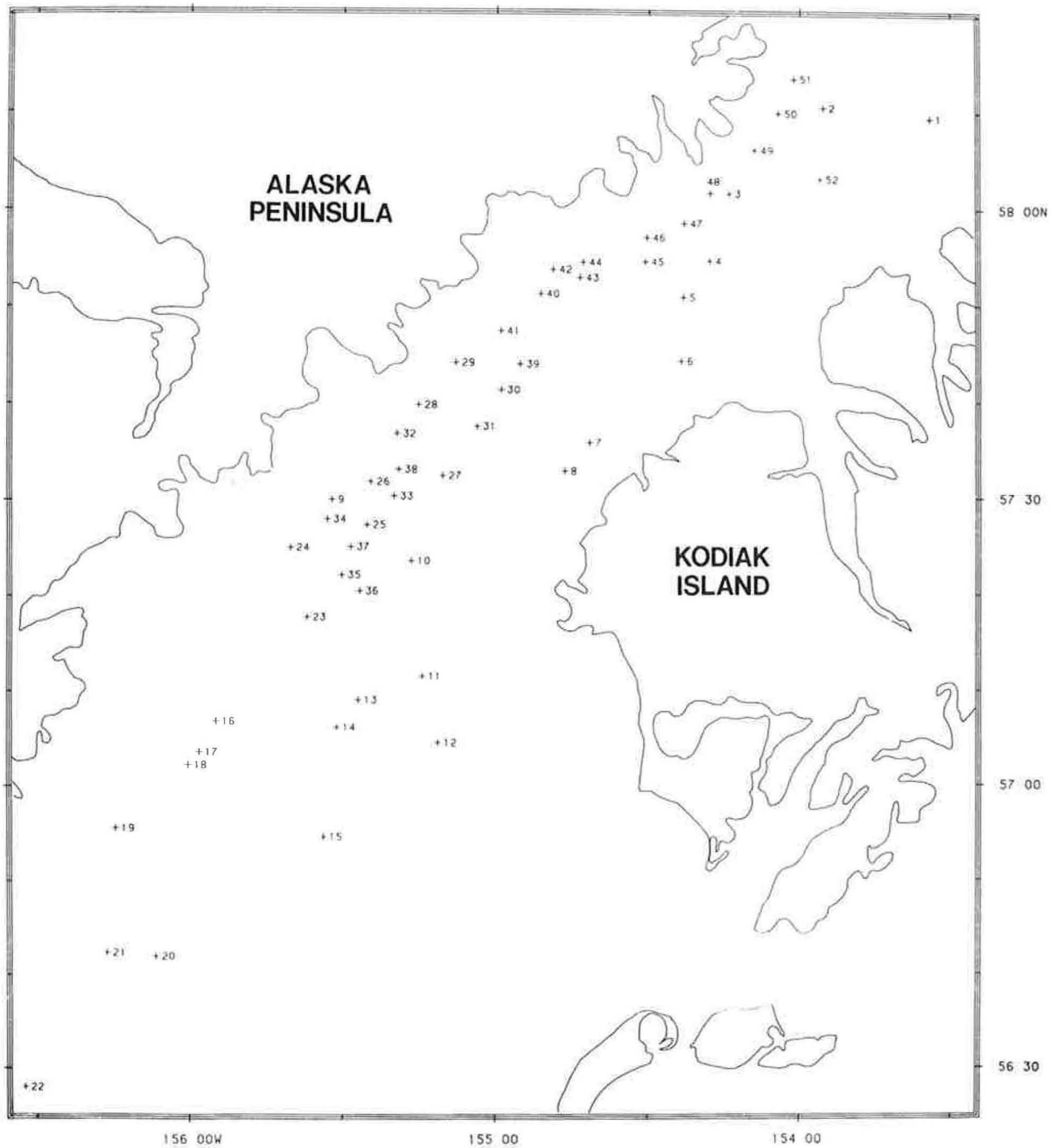

Figure 8.1.--Sampling pattern and corresponding haul numbers of stations completed during March 1983 bottom trawl survey of Shelikof Strait.

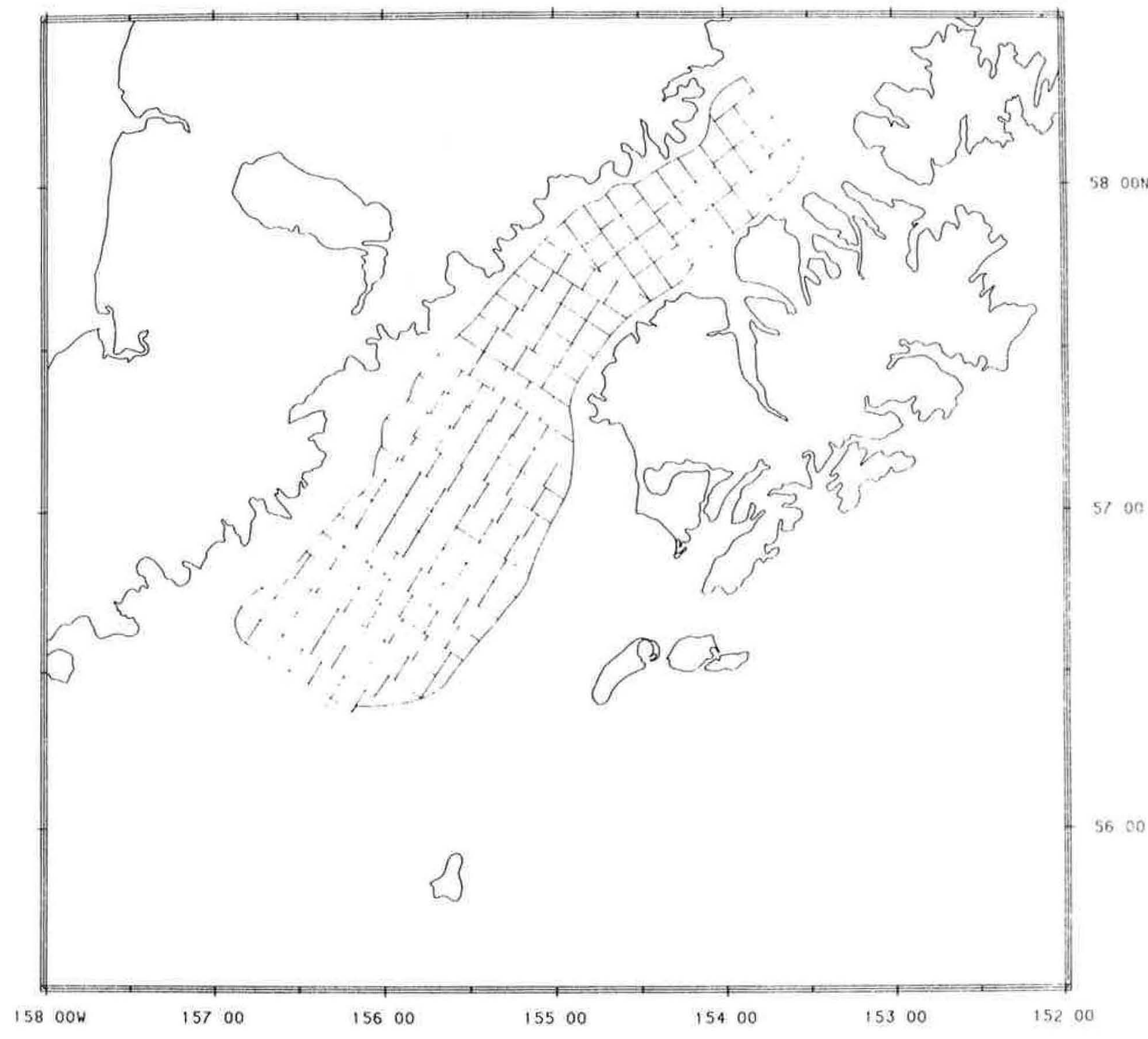

Figure 8.2.--Survey grid employed during March 1983 bottom trawl survey of Shelikof Strait. Each block is approximately 5 x 5 nm, or 25 square nm.

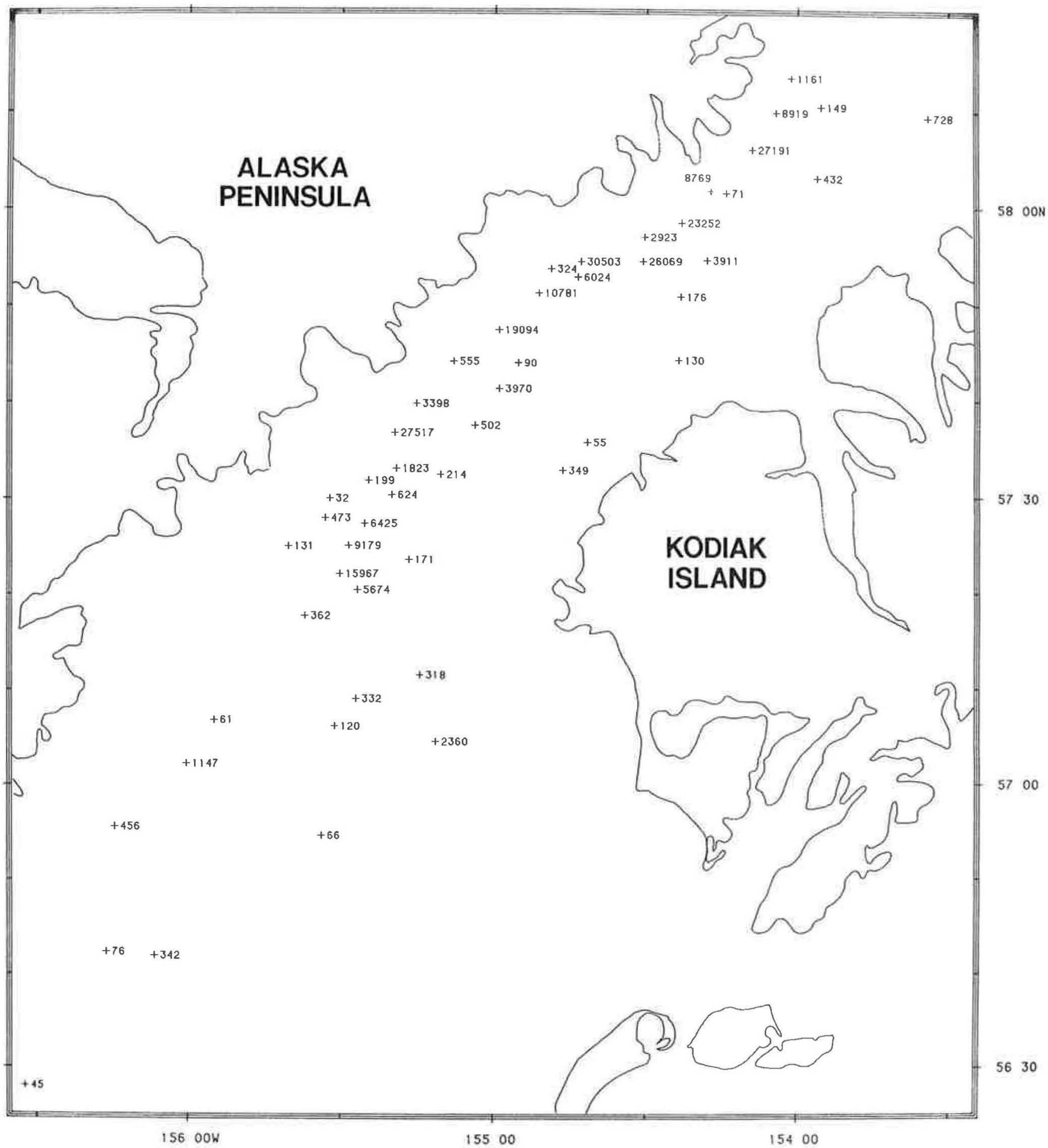

Figure 8.3.--Catch rates (kg/hr) for walleye pollock obtained during March 1983 bottom trawl survey of Shelikof Strait.

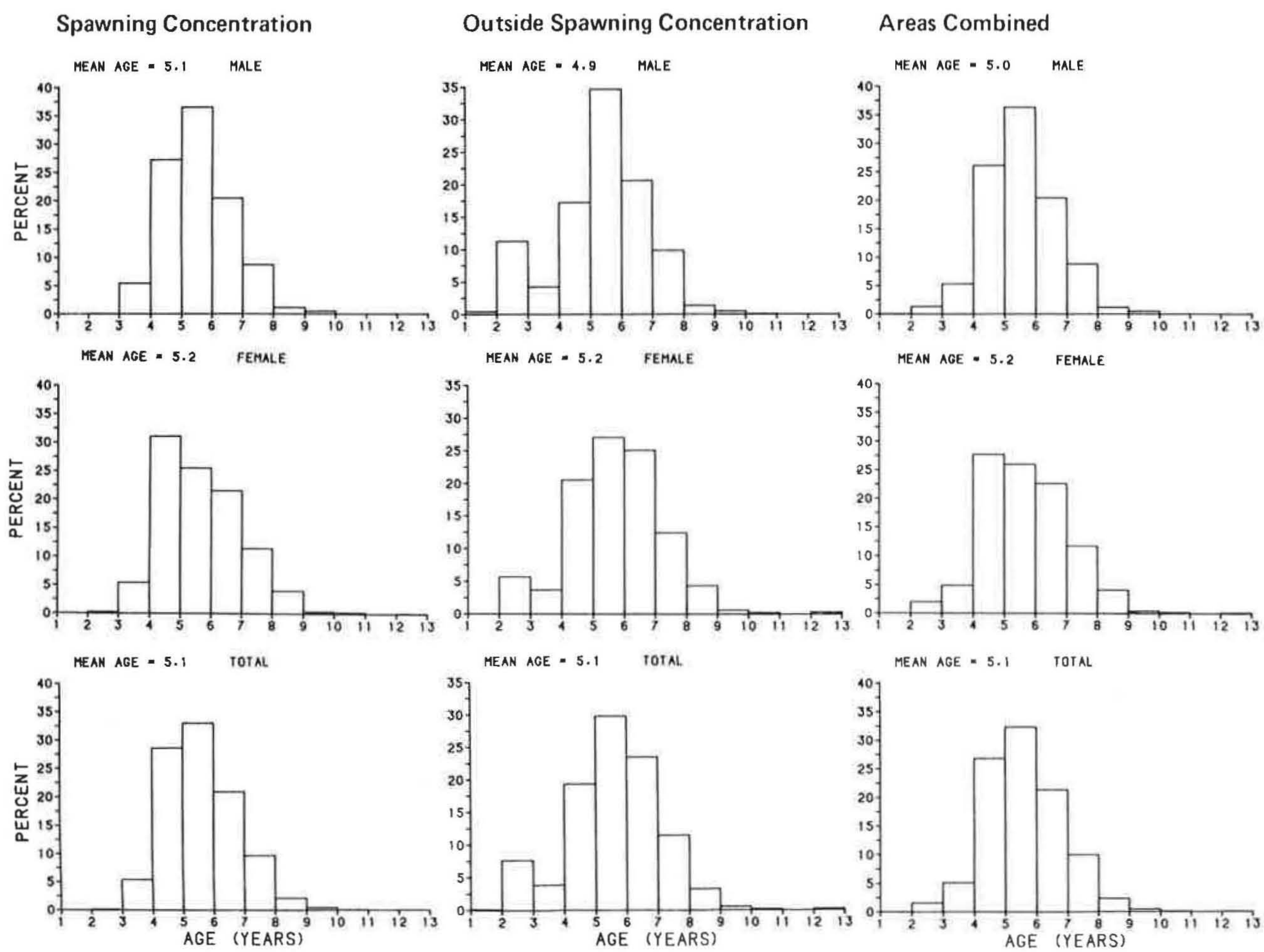

Figure 8.4.--Preliminary age distribution of walleye pollock from March 1983 bottom trawl survey of Shelikof Strait.

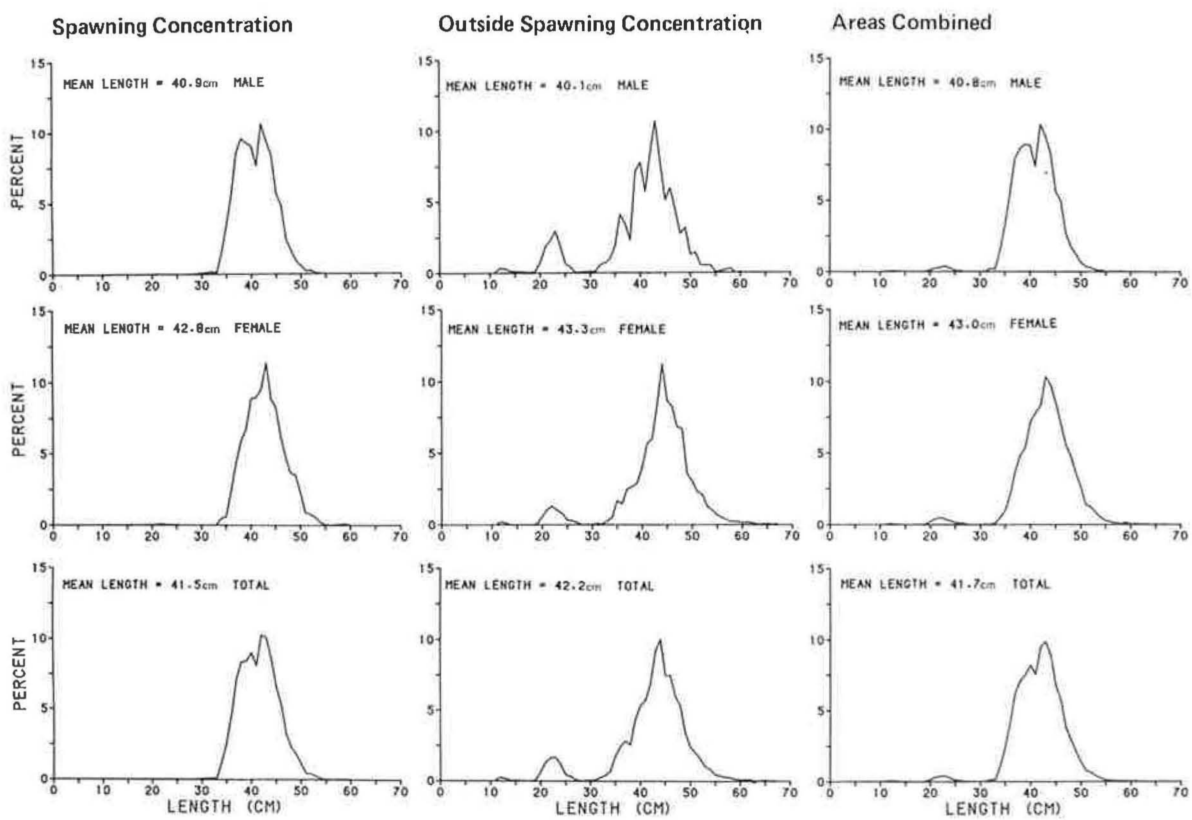

Figure 8.5.--Length distribution of walleye pollock from March 1983 bottom trawl survey of Shelikof Strait.

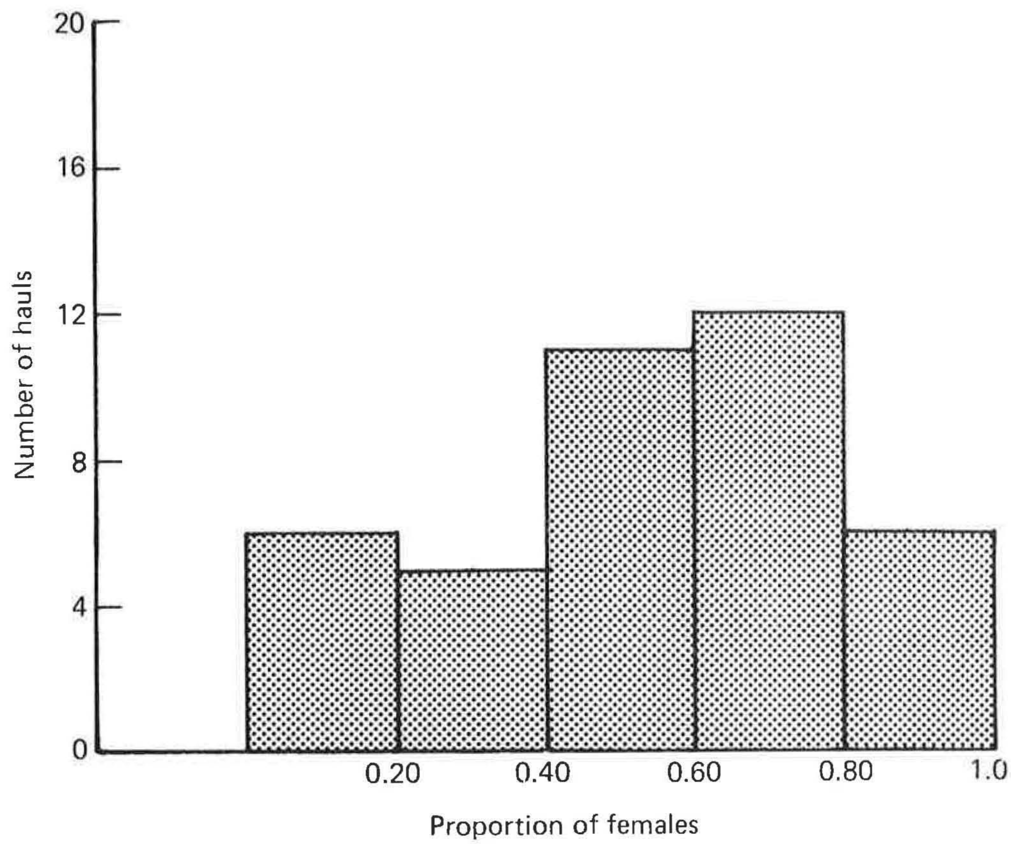

Figure 8.6.--Proportion of female pollock observed in trawl hauls during March 1983 bottom trawl survey of Shelikof Strait.

1983 U.S. Research Surveys and Research Plans for 1984 in the Northeast Pacific Ocean

by Lael Ronholt[1/]

Field Research Conducted in 1983

United States

(A) Gulf of Alaska

(1) Groundfish Study Areas

Bottom trawling surveys were conducted to monitor changes in the distribution, abundance and biological stock parameters of the groundfish stocks in selected study areas. A cooperative U.S.-U.S.S.R. survey utilizing the Soviet research vessel Milogradova surveyed the area from Unimak Pass to Kodiak Island during April - May 1983. During April-May, 1983 the NOAA research vessel John N. Cobb conducted a survey of groundfish from Dixon Entrance to Cape Spencer. During August-Sept. 1983, a cooperative U.S.-Republic of Korea groundfish survey was conducted in the Kodiak and Middleton study areas aboard the Korean research vessel Oh Dae San. During July and August, 1983, the NWAFC, in cooperation with the NOAA Undersea Research Program office and the International Pacific Halibut Commission, conducted two fishery investigations utilizing a deep submersible. The submersible, Mermaid II, operated from the mothership Aloha to permit investigations to (1) study factors associated with halibut longline gear, bait types and hook designs and (2) observe prerecruit rockfish species, their abundance, distribution and species composition. A total of 52 dives were completed over a 23-day period to a maximum depth of 900 ft seaward of Baronof and Chichagof Islands in Southeastern Alaska.

1/ Northwest and Alaska Fisheries Center, National Marine Fisheries Service, NOAA, 2725 Montlake Boulevard East, Seattle, WA, 98112.

(2) Trawl comparison study.

A comparison of the relative fishing power and size selectivity of standard and modified nor'eastern and eastern trawls wil be conducted off Kodiak Island Sept.-Oct. 1983 using the NOAA Ship _Miller Freeman_.

(3) Pollock

Hydroacoustic - midwater trawl surveys of Shelikof Strait and the adjacent shelf areas off southeast Kodiak Island and west to Unimak Pass were conducted aboard the NOAA ships _Miller Freeman_ and _Chapman_ during March-April 1983. Objectives of the surveys were to determine the biomass and biological characteristics of the spawning aggregation of pollock in Shelikof Strait and to investigate the presence of other aggregations in adjacent areas.

A bottom trawling survey to determine the near bottom component of the pollock spawning concentration in Shelikof Strait was conducted during March. Survey operations aboard the NOAA ship _Chapman_ were conducted simultaneously with hydroacoustic operations aboard the NOAA Ship _Miller Freeman_.

(4) Sablefish Index Sites

The four established sablefish indexing sites off southeastern Alaska were successfully sampled during May-June 1983, using the NOAA ship _John N. Cobb_. Data were collected to monitor changes in the abundance of the sablefish stock and to produce data on biological parameters. Tests were conducted to compare the effectiveness of different aged baits and the relative efficiency of rectangular and conical traps. Although operations were extended to the Whale Bay and Alsek Canyon areas in an attempt to establish new indexing sites, these efforts were only partially successful.

(B) West Coast

(1) Bottom trawl survey

A comprehensive bottom trawl survey to monitor changes in the distribution, abundance and biological stock parameters of the rockfish and Pacific whiting stocks was conducted from Monterey, California to Vancouver Island. This triennial survey was conducted aboard the chartered research vessels Warrior II and Nordfjord from July-Sept. 1983.

(2) Hydroacoustic-midwater trawl survey.

In conjunction with the west coast rockfish and Pacific whiting bottom trawl survey a hydroacoustic-midwater trawl survey will be conducted from Monterey, California to Vancouver Island to determine the near and off bottom components of the Pacific whiting biomass and to collect biological data needed for management of this resource. These operations were conducted aboard the charter vessel Golden Sun from July-August 1983.

(3) Sablefish

Sablefish index sites on the west coast will be sampled with traps to measure changes in the abundance of the sablefish stock and to provide data on biological parameters. Sampling will be conducted from the NOAA ship Chapman during Oct.-Nov. 1984.

(4) Ichthyoplankton

A cooperative U.S.-U.S.S.R. ichthyoplankton survey off Washington-Oregon-Northern California was conducted aboard the Soviet research vessel Ekvator from April-May 1983. This was the sixth in a series of such cruises which began in 1980. Approximately 125 bongo/neuston/hydrographic stations are occupied on each cruise. A similar survey is planned aboard the NOAA ship Miller Freeman in November 1983.

Field Research Plans 1984

(A) Gulf of Alaska

(1) Groundfish study areas

During 1984 a major survey is planned for the Gulf of Alaska to monitor changes in the distribution, abundance and biological stock parameters of the groundfish species. Sampling is scheduled to be conducted in the groundfish study areas and will be expanded to other areas and in particular deeper water if foreign cooperation can be enlisted.

(2) Pacific cod

A survey is planned in either the Kodiak or Unimak Pass area to monitor the conditions of the Pacific cod stocks and to start a tagging experiment to study movements and migrations and stock definition.

(3) Pollock

During March 1984 a hydroacoustic survey to monitor the condition of the pollock spawning stock in Shelikof Strait is planned along with an ichthyoplankton survey in Shelikof Strait, a bottom trawl acoustic survey is planned for the Middleton Island area.

(4) Sablefish Index Sites

During 1984, the annual survey of the four established sablefish index sites off southeastern Alaska is scheduled. Sampling will be conducted using the conical traps.

(B) West Coast

(1) Ichthyoplankton in the Gulf of Alaska in 1984 ichthyoplankton studies will focus on a biomass estimate of the pollock spawning in Shelikof Strait. Plankton samples will be taken aboard the NOAA ship Miller Freeman in April-May to provide such as estimate, as well as trace the drift and factory affecting survival of the larvae.

(2) Groundfish

A bottom trawl groundfish resource assessment survey of the mid to upper slope of the continental shelf off Washington and Oregon is planned for 1984.

(3) Sablefish Index Sites

A survey of the sablefish index sites with traps is anticipated to be conducted during 1984 using a modified experimental design.