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DISTRIBUTION, ABUNDANCE, AND SIZE OF SABLEFISH (Anoplopoma fimbria) FOUND IN DEEP WATER OFF THE MOUTH OF THE COLUMBIA RIVER

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ABSTRACT

Sablefish were taken at depths of 50 to 650 fathoms during Bureau of Commercial Fisheries-Atomic Energy Commission trawling surveys off the Columbia River, Oreg. The surveys, which began in June 1961, were conducted on a seasonal basis at stations located at 25-fathom depth intervals from 50 to 500 fathoms, and at seven additional stations located at varying depths from 600 to 1,050 fathoms. Sablefish catches were generally greater at depths from 200 to 450 fathoms than from any other depth. Catches ranged from 400 to 2,100 pounds per hour trawled. The sizes of sablefish taken ranged from 10 to 37 inches. The mean size of sablefish increased as the depth increased.

Sablefish in a spawning condition were encountered in March.

Data from these cruises and recent data from the Japanese gill-net fishery and exploratory cruises of the John N. Cobb indicate that a large population (or populations) of sablefish occurs in 200 to 400 fathoms of water off the coasts of Oregon, Washington, and in the Gulf of Alaska.

INTRODUCTION

In the years subsequent to World War II there has been increasing evidence collected by scientists (Alverson, et al. 1964, Isaacs 1960, Pneumo-Dynamics Corporation 1961) that sablefish (fig. 1) are perhaps more abundant in deep water (below 200 fathoms) than had been previously anticipated. The initial success demonstrated by Japanese fishing operations along the continental slope in the eastern Bering Sea and Gulf of Alaska have tended to confirm the availability of sablefish in deep water. It has been suggested that the greatest abundance of the species may occur at depths generally beyond the range that they are exploited by North American long-line and trawl vessels.

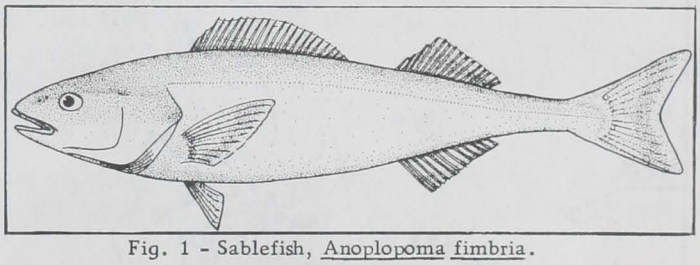

Fig. 1 - Sablefish, Anoplopoma fimbria.

In June 1961 the U. S. Bureau of Commercial Fisheries, in cooperation with the Atomic Energy Commission (A.E.C.), initiated a study of the marine fauna in the area southwest of the mouth of the Columbia River. Although the cooperative Bureau-A.E.C. project had many objectives, one important aspect of the investigation was assessing on a time basis the abundance and distribution of bottom fish and invertebrates inhabiting the Outer Continental Shelf and slope. An additional objective of the study was to ascertain whether fish were sufficiently abundant in deep water (depths of greater than 200 fathoms) that they might in the future support commercial fish operations.

Data from this investigation, collected from June 1961 through November 1963, have been assessed to provide more detailed information concerning the bathymetric distribution and relative abundance of sablefish on the continental slope and shelf.

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METHODS AND GEAR

In order to obtain information on the community of demersal fish inhabiting the waters adjacent to the Columbia River, a trackline was established southwest of the Columbia River lightship at depths between 50 and 1,050 fathoms. During the initial cruise, June 1961, trawl stations were established at 25-fathom intervals at depths from 50 to 450 fathoms. In subsequent cruises deeper stations were established at depths of 475, 500, 600, 650, 750, 850, 900, and 1,050 fathoms. Geographic locations of those stations are given in table 1. The shallowest

Table 1 - Positions of Bureau of Commercial Fisheries-Atomic Energy Commission Trawling Stations off the Columbia River, Oreg.

Station Designation	Depth (Fathoms)	Position		Station Designation	Depth (Fathoms)	Position	
		N. Lat.	W. Long.			N. Lat.	W. Long.
1A	50	46°08.2'	124°12.3'	14A	375	45°56.7'	124°51.0'
2A	75	46°07.4'	124°31.6'	15A	400	45°53.6'	124°52.6'
3A	100	46°03.4'	124°39.4'	16A	425	45°59.2'	124°52.1'
4A	125	46°02.2'	124°43.1'	17A	450	45°54.1'	124°55.5'
5A	150	46°02.8'	124°43.8'	18A	475	45°52.2'	124°52.5'
6A	175	45°59.6'	124°44.1'	19A	500	46°02.7'	124°57.3'
7A	200	46°00.3'	124°45.4'	23A	600	45°44.5'	124°53.9'
8A	225	45°58.2'	124°45.0'	25A	650	45°44.3'	124°54.0'
9A	250	45°58.2'	124°46.2'	29A	750	45°36.3'	124°53.7'
10A	275	45°59.9'	124°49.1'	31A	800	46°01.8'	125°04.5'
11A	300	45°57.5'	124°48.8'	33A	850	45°54.0'	125°08.8'
12A	325	45°58.0'	124°50.3'	35A	900	45°50.0'	125°10.6'
13A	350	45°56.0'	124°49.5'	41A	1,050	45°42.2'	125°13.0'

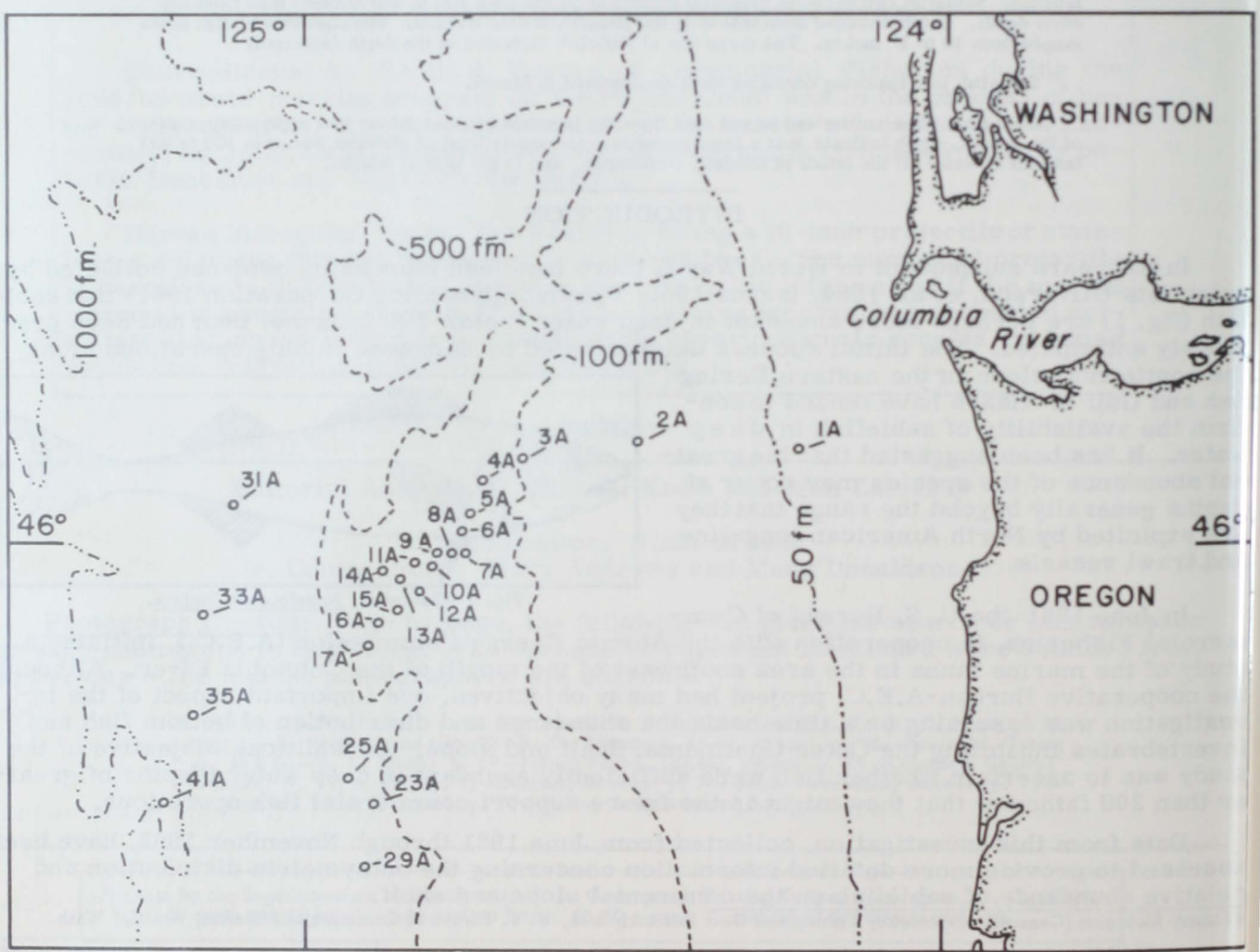

Fig. 2 - Bureau of Commercial Fisheries-Atomic Energy Commission trawling stations off the mouth of the Columbia River.

station (50 fathoms) is located approximately 5 miles southwest of the Columbia River lightship, and other stations are found along a trackline extending in the same general direction to the 1,050-fathom depth contour (fig. 2).

Stations have been frequented approximately four times each year. As originally intended, it was hoped that all stations could be occupied once during each cruise. However, bad weather frequently hampered deep-water operations. Thus, the stations at depths between 50 and 450 fathoms received major emphasis, while stations at greater depths were only occasionally sampled.

The trawl surveys were conducted from aboard the 93-foot Bureau of Commercial Fisheries' exploratory fishing vessel John N. Cobb and from aboard the 68-foot M/V Commando which was chartered from the University of Washington. Both vessels were rigged with standard trawl gear and 1,000 fathoms of cable on each of two drums, which enabled fishing to be conducted to depths of 1,050 fathoms.

Duration of drags made at the 50- and 75-fathom stations was one-half hour, while at greater depths the nets were normally towed for one hour.

Standard 400-mesh eastern commercial otter trawl nets were used to sample the bottom fauna from 50 to 450 fathoms. A western trawl was used during part of the winter cruise in 1962 but was subsequently replaced with an eastern trawl. Since the trawls were constructed of $3\frac{1}{2}$-inch webbing, a $1\frac{1}{2}$-inch mesh liner was placed in the cod end to retain small fish and invertebrates. Commercial aluminum alloy 8-inch diameter floats were used on the headrope of the trawls.

Gulf of Mexico shrimp trawls were used to sample stations at 500-fathom depths and greater. A 43-foot shrimp trawl was used during the initial surveys but was replaced with a 72-foot semiballoon trawl, when it was found that the latter could be operated satisfactorily in deep water. Glass floats ($4\frac{1}{2}$ inches in diameter) were attached to the headrope of the trawls, since aluminum floats could not withstand the pressure at depths of 500 fathoms and greater. As the amount of towing cable available on each drum did not permit double warps (tow cables) to be used in deep water, the shrimp trawl was fished from cables fastened from the two drums in tandem.

Fishing methods with the eastern trawl were similar to those commonly employed by Pacific coast otter trawl vessels. The net was set from the stern and retrieved on the starboard side. Towing speeds varied between 1.8 and 3.0 knots and averaged about 2.5 knots for most tows. Scope ratios used (ratio of tow line to depth of water), on the average, decreased as the depth of water fished increased. Ratios varied from about 3 to 1 at depths of 50 to 100 fathoms to about 2.5 to 1 at 125 to 475 fathoms. Scope ratios were as low as 1.6 to 1 at greater depths.

The catch was emptied into the starboard checker and separated by species. Estimates were made of the pounds of each species caught by multiplying its observed average weight by the total count of individuals in the catch.

The majority of sablefish length measurements used in this report were collected by Oregon Fish Commission personnel during their tagging and maturity studies. Fork-length measurements were made to the nearest centimeter and converted to inches. The Oregon Fish Commission maintains a separate contract with the Atomic Energy Commission for their sablefish migration study but used the Bureau's chartered vessel for tagging.

RESULTS

During the period covered by this report, 189 drags were made on the trackline at depths from 50 to 1,050 fathoms. Sablefish were taken at stations sampled from 50 to 650 fathoms, but were encountered only infrequently at depths greater than 475 fathoms.

AVAILABILITY BY DEPTH: The seasonal catch rate of sablefish by depth for the years 1961 through 1963 are shown in figure 3.

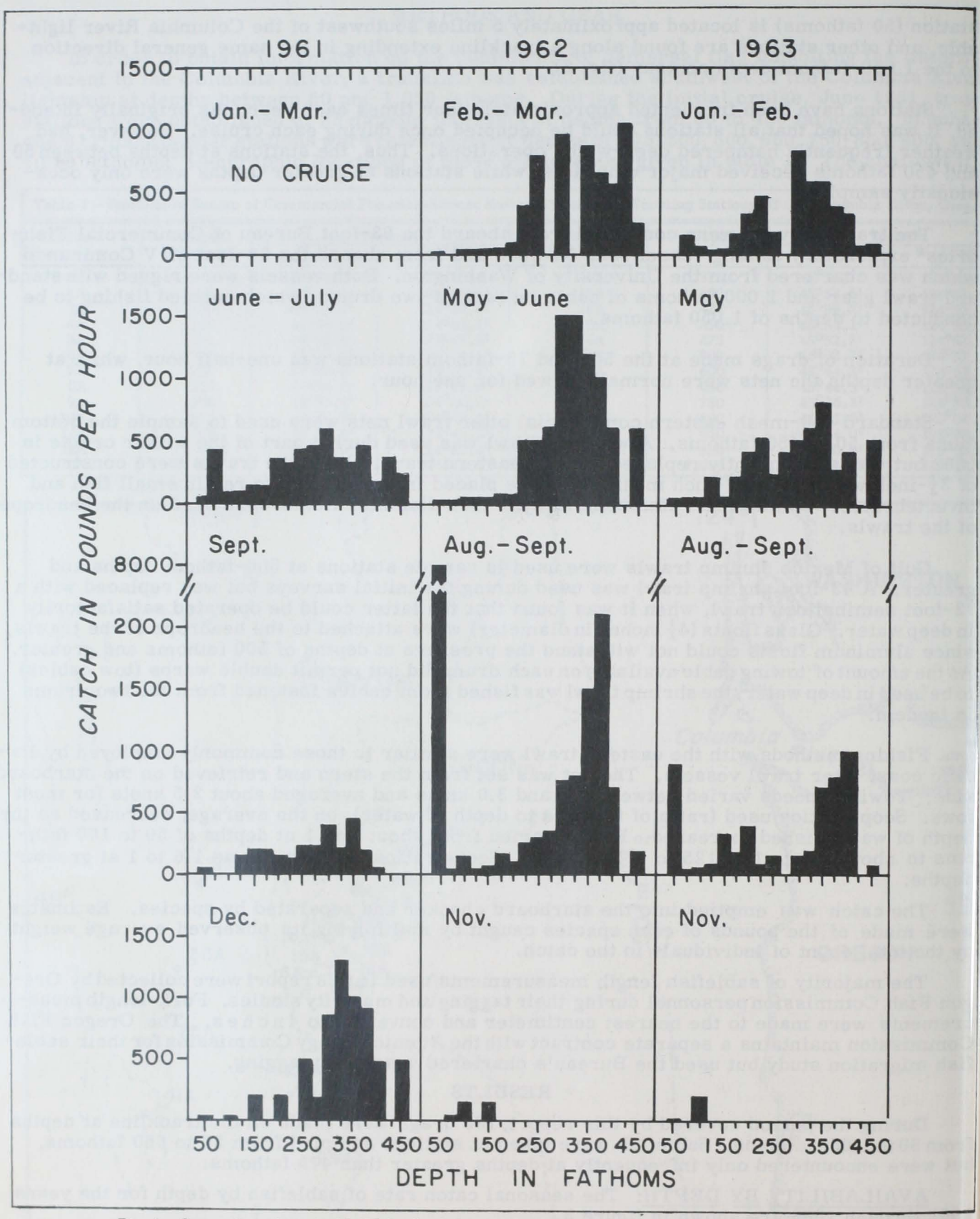

Fig. 3 - Seasonal catches of sablefish by depth for the years 1961-1963 off the mouth of the Columbia River.

Highest catch rates for sablefish were normally attained at stations from 200 to 450 fathoms in depth. A marked seasonal change in availability of the species on the Continental Shelf is implied both in 1962 and 1963. During December through June few sablefish were encountered on the Continental Shelf (50 to 100 fathoms); however, in August and September they were taken in large numbers at depths shallower than 100 fathoms. If the data are examined by years some between-year variation is noted in relative abundance and in bathymetric distribution patterns. For the most part, however, the relative abundance patterns by depth are similar for each of the three years studied. For example, in 1961 the highest catch rates for sablefish on the continental slope were attained at stations occupied from 200 down to 400 fathoms, in 1962 at depths from 225 to 450 fathoms, and in 1963 at depths from 200 to 450 fathoms. In all years relatively large catches of sablefish were encountered on the Continental Shelf (at depths of 100 fathoms or less) during the summer months.

In general, the catch rates on the continental slope were higher in 1962 than for 1961 and 1963, although the trend in availability of sablefish by depth was similar in that year to that encountered in 1961 and 1963. The availability of sablefish in deep water was particularly demonstrated in 1962 when catches exceeding 1,000 pounds per hour fishing were taken at the 300-, 325-, and 425-fathom stations, and a catch of over 2,000 pounds per hour fishing was encountered at the 375-fathom station (August-September cruise).

CATCH OF SABLEFISH IN RELATION TO CATCH OF ALL FISH SPECIES: The contribution of sablefish to the total fish catch by weight was considerably greater at depths from 250 to 450 fathoms than at shallower depths (fig. 4). An exception occurred in 1962 when sablefish comprised 71 percent of the total fish catch at 50 fathoms.

In all years sablefish comprised over 50 percent of the catches at most stations from 275 to 450 fathoms. Highest contributions of sablefish at those depths were 81 percent at 325 fathoms in 1961, 90 percent at 375 fathoms in 1962, and 83 percent at 325 fathoms in 1963.

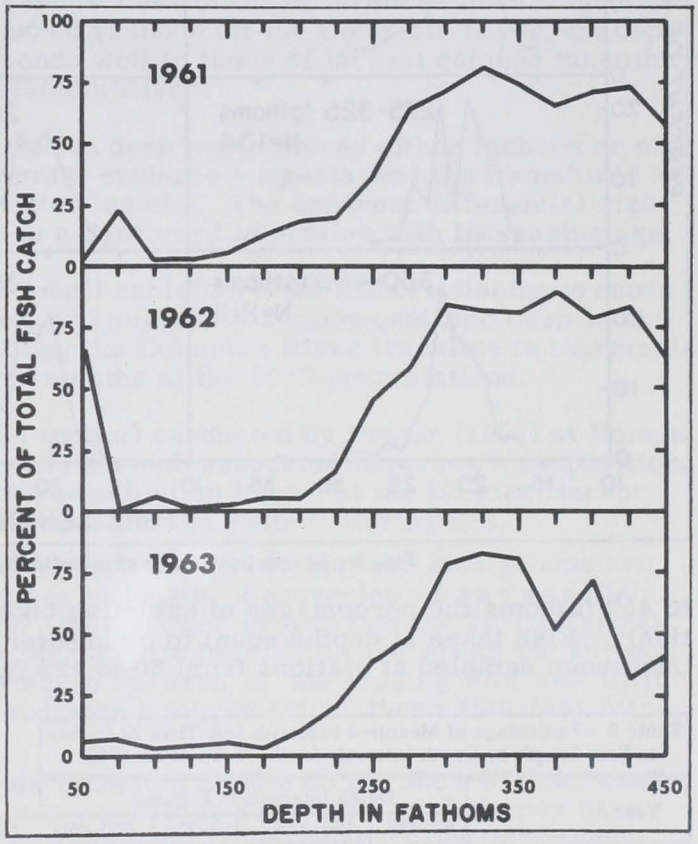

Fig. 4 - Percentage of total catch of fish species comprised of sablefish by 25-fathom depth intervals for the years 1961-1963.

SIZES OF SABLEFISH CAUGHT: Sablefish sampled during the Columbia River trackline studies have ranged from 10 to 37 inches in length. Examination of size samples of sablefish by depth (fig. 5) suggest that larger, older fish inhabit deeper portions of the overall bathymetric range. In both 1962 and 1963 fish taken at depths from 50 to 125 fathoms were smaller than those taken from greater depths. The trend towards larger average size fish with increased depth was observed through all seasons of the year.

The average size of fish taken in the shallower stations (50 to 125 fathoms) in 1962 and 1963 was 15 inches, and within that depth range almost 98 percent of the sampled fish were less than 22 inches in length.1/ Examination of table 2 shows that a sharp decrease occurs in the percentage of fish less than 22 inches in length taken at depths greater than 125 fathoms. For example, in 1962, 71 percent of the fish measured at stations from 150 to 225 fathoms were less than 22 inches in length, and at depth intervals between 250 and 325 fathoms and 350

1/Current minimum legal size allowable for commercial vessels by the States of California, Oregon, and Washington.

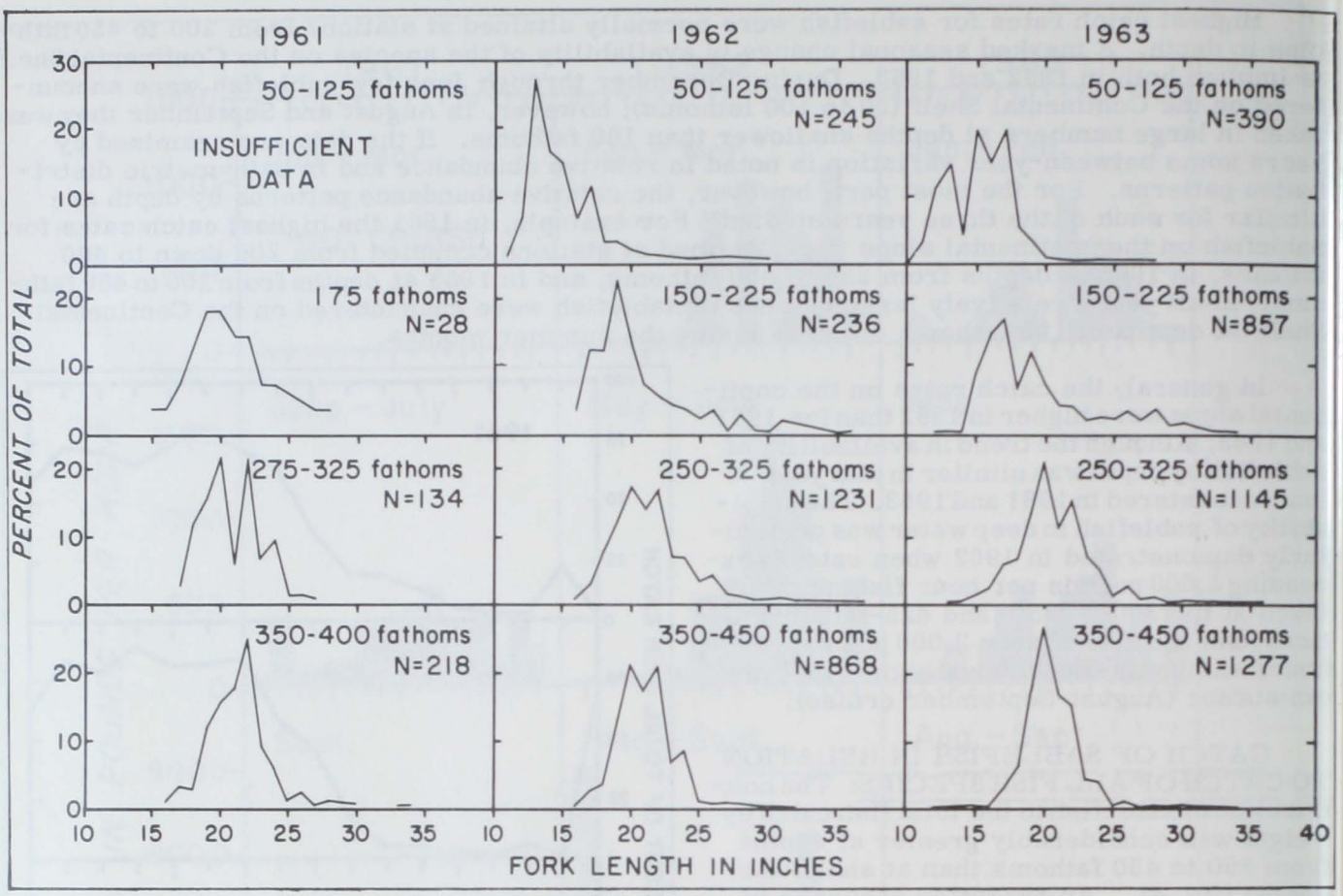

Fig. 5 - Length frequencies of sablefish by depth categories for the years 1961-1963.

to 450 fathoms the percentages of sablefish taken less than 22 inches were 56 and 57, respectively. Fish taken at depths equal to or greater than 250 fathoms averaged 6 inches larger than those sampled at stations from 50 to 125 fathoms (table 3).

Table 2 - Percentage of Measured Sablefish Less Than 22 Inches in Fork Length by Depth Intervals for the Years 1962-1963

Year	Depth Intervals in Fathoms			
	50-125	150-225	250-325	350-450
1962	96	71	56	57
1963	99	74	64	72
Average (1962-63) .	98	73	60	66

Table 3 - Average Fork Lengths of Sablefish by Depth Intervals for the Years 1961-1963

Depth Interval in Fathoms	Average Fork Length in Inches			
	1961	1962	1963	1961-1963
50-125	-	15.2	15.2	15.2
150-225	20.7	20.6	19.6	19.8
250-325	20.8	21.5	20.7	21.1
350-450	21.6	21.3	20.6	21.0

SIZE OF MATURITY: Sablefish in spent or spawning condition were encountered during early March 1962. They were taken at depths of 300 to 450 fathoms along the trackline and at 275 fathoms off the coast of Washington by the John N. Cobb during a bottomfish survey cruise.

Gonads of fish taken from those depths were examined to determine size at maturity. Sablefish sampled ranged from 16 to 32 inches in length. All fish smaller than 17 inches were immature, while those larger than 22 inches were mature. In the intermediate size group (17 to 22 inches), the percentage of mature fish increased with size.

DISCUSSION

The relatively high availability of sablefish on the continental slope at depths between 200 and 475 fathoms supports evidence of earlier scientific explorations that maximum abundance

of sablefish occurs in relatively deep water. The relative abundance of sablefish with depth off the Columbia River appears to be similar to that indicated for the Gulf of Alaska by Japanese commercial operations. During the period April 23-June 30, 1963, the Japanese vessel Seiju-Maru No. 3 caught 559 tons of sablefish in the Gulf of Alaska (Tanonaka and Alverson 1963). Using gill nets which ranged from 5.4 to 6 inches (stretched measure), the Japanese vessel reported good catches of sablefish at depths between 273 and 492 fathoms.

The fish taken in the gill nets averaged 27 inches in length, somewhat larger than those reported in trawl catches taken off the Columbia River at similar depths. However, this does not necessarily indicate that the average size of sablefish in the Gulf of Alaska inhabiting similar depth zones is larger than that for the Columbia River region. Gill nets are much more selective to a particular size of fish than otter trawls, therefore, the average size of fish taken by these gears is not directly compared. Regardless of the differences in average size of sablefish taken in the Gulf of Alaska as compared to those off the Columbia River, the depth range of best Japanese gill-net catches corresponds well to those of largest catches taken during Bureau explorations off the mouth of the Columbia River.

Although no evidence suggests that larger fish in deep water moved either inshore or offshore to any great extent within the year, inferential evidence suggests that the immatures in shallow water move into deeper water during winter months. The apparent differential size of sablefish with depth also suggests that there is a downward migration with increasing age.

Alverson (1960) noted the disappearance of small sablefish from inshore fishing grounds (20 to 60 fathoms) during October and November, and suggested a movement into deep water. This observation coincides with data obtained along the Columbia River trackline in that small sablefish were available only during the summer months at the 50-fathom stations.

Tagging studies on small sablefish (12 to 24 inches) conducted by Pruter (1959) at Holmes Harbor, Wash., also suggested an offshore movement which supported Alverson's supposition. Pasquale (1964) recently reported recovery of three sablefish tagged at the Holmes Harbor site from the Japanese fishery on the continental slope in the eastern Bering Sea.

Tagging in Holmes Harbor during subsequent years has shown that two size groups are present each year which are about 15 and 20 inches in length. Recoveries of tagged fish from the 15-inch group at the tagging site a year later showed growth into the 20-inch group. No recoveries were reported in the area of the tagging site for fish tagged within the 20-inch group. The absence of recoveries from that group in the area of the tagging site and their subsequent appearance in the offshore fishery suggests a movement of those fish into offshore waters and into greater depths.

Although the cooperative Bureau-A.E.C. data collected to date do not show distinct seasonal bathymetric movements for mature fish, some evidence suggests sablefish may have rather extensive north-south migrations. Holmberg and Jones (1954) reported one fish tagged off Newport, Oreg., was recovered 350 miles south of Fort Bragg, Calif., 390 days after tagging, and another tagged off Cape Beale, British Columbia, was caught some 210 miles to the north near Triangle Island, B. C., 310 days subsequent to tagging. Edson (1954) also reports one fish tagged off Middleton Island in the Gulf of Alaska was caught off Cape Flattery, Wash., showing a minimum movement of 1,230 miles. These sporadic recoveries showing long migrations seemed relatively unimportant until the recovery of the three tags in the eastern Bering Sea which were released in Holmes Harbor, Wash. This long migration seemed more important in the light of the fact that only a few offshore recoveries have been made from the Holmes Harbor tagging operations.

Low recovery rates for tagging studies conducted on sablefish have in the past been attributed to shedding of tags, faulty tags, low fishing intensity, and poor condition of tagged fish (high tagging mortality). All of these factors could have a considerable effect on the recovery rate. But perhaps of even more significance is the fact that little or no commercial fishing has occurred at depths where the species is most abundant and throughout most of the geographic range that this species inhabits. Thus low tagging recoveries may imply a large population which is subject to a relatively low fishing rate.

The data collected from the cooperative Bureau-A.E.C. study, recent Japanese fisheries in the Gulf of Alaska, and other exploratory cruises conducted by the John N. Cobb suggest a relatively large population (or populations) of sablefish inhabit waters throughout much of the eastern Pacific at depths from 200 to over 400 fathoms. It would appear that the sablefish population represents one of the large latent resources contiguous to our coast.

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SEABED DRIFTER RELEASED BY U. S. RESEARCH VESSEL RETURNED BY SOVIET TRAWLER

A seabed drifter, released by the U. S. Bureau of Commercial Fisheries research vessel Albatross IV in a program of study to trace bottom currents in the Northwest Atlantic Ocean, was recovered earlier this year by a Soviet trawler fishing south of Long Island. It was returned by way of PINRO (Polar Research of Marine Fisheries and Oceanography) located at Murmansk, apparently the home base of the trawler. It was the second seabed drifter from the Bureau's Woods Hole Biological Laboratory program that was recovered and returned by a Soviet fishing vessel.

Seabed drifters are drifting plastic objects used to obtain information about the movements of the water near the seabed. The type used in the United States has a red stem and yellow saucer-like device, with the serially numbered return labels and instructions for its return stuck to the saucer.