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BOTTOM TRAWLING EXPLORATIONS OFF THE WASHINGTON AND BRITISH COLUMBIA COASTS, MAY-AUGUST 1960

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ABSTRACT

Exploration of several areas of the continental shelf off Washington and British Columbia, where the bottom had previously been considered too rough for commercial fishing, was carried out by the U. S. Bureau of Commercial Fisheries exploratory fishing vessel John N. Cobb in 1960. The explorations, made possible by the development in recent years of high-resolution echo-sounding equipment and navigational aids that permit precision pin-pointing of bottom areas, were conducted by (a) running an initial series of closely-spaced echo-sounder transects over the rough bottom areas, (b) dragging a heavy chain attached between two trawl doors over areas showing promise on the echo-sounder recordings, and (c) evaluating the fish populations of those areas where the chain was dragged successfully by exploratory fishing with commercial otter-trawl gear. The explorations resulted in the delineation of several trawlable areas off Cape Flattery and one relatively large area northwest of Scott Island--all within depths presently fished by the commercial fleet. In most of these areas exploratory trawling resulted in good catches of commercially-valuable groundfish.

INTRODUCTION

In the past, groundfish explorations by the U. S. Bureau of Commercial Fisheries in the northeastern Pacific Ocean have been conducted in waters off Alaska where no North American commercial trawl fisheries for groundfish yet exist (Ellson, Knake, and Dassow, 1949; Ellson, Powell, and Hildebrand, 1950; Schaefers, Smith, and Greenwood, 1955; and Johnson, 1959) and in deep water adjacent to exploited grounds off Oregon, Washington, and British Columbia (Alverson 1951 and 1953).

There remain, however, large segments of the continental shelf within the present operating depth range of Pacific Northwest trawlers that are not fished because the bottom is considered too rough. Many of these "foul bottom" areas are adjacent to grounds fished by trawlers operating out of Washington and Oregon ports. Systematic surveys of these "unfishable" regions are now possible, owing to the development in recent years of high-resolution echo sounders and precise navigational aids. Echo sounders are available that not only show the depth of water under a vessel, but also provide information on the degree of hardness and give detailed data on configuration of the bottom. Navigational aids such as loran and radar can be used to pinpoint the location of trawlable areas.

In 1960 the Bureau, using a new survey technique, conducted explorations off Cape Flattery, Wash., in a region known locally as the "spit" and off the north end of Vancouver Island, British Columbia--both regions in which bedrock, coral, and large boulders had prevented fishing by commercial trawlers. Objectives of the explorations were (1) to locate areas suitable for trawling and (2) to evaluate the commercial potential of groundfish inhabiting those areas.

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METHODS AND GEAR

The exploratory fishing vessel John N. Cobb (Ellson 1950) was used for the surveys. The procedure followed in exploring a given area was (1) to run a series of sounding transects to determine the character of the bottom, (2) to drag a heavy chain over areas suggested as being trawlable by the sounding, and (3) to drag a commercial otter-trawl net over those grounds on which the chain was successfully dragged. The latter permitted evaluating the commercial potential of the groundfish present.

At the conclusion of each net drag a bathythermograph cast was made to determine surface-to-bottom water temperatures, and a Dietz-LaFond sampler was used to obtain samples of bottom deposits.

The position of the vessel was determined frequently during sounding transects, chain drags, and trawl-net drags. If the area was located so that two loran signals could be received, the vessel position was established by the use of loran only. When only one loran channel could be received, radar bearings were used to complete fixes. When land was outside radar range, radar buoys (Johnson 1959) were anchored at known positions and were used as reference points.

Sounding transects were generally made on grids approximately $\frac{3}{4}$ of a mile to $1\frac{1}{2}$ miles apart. When a transect course was run, the echo sounder provided a recording of the bottom

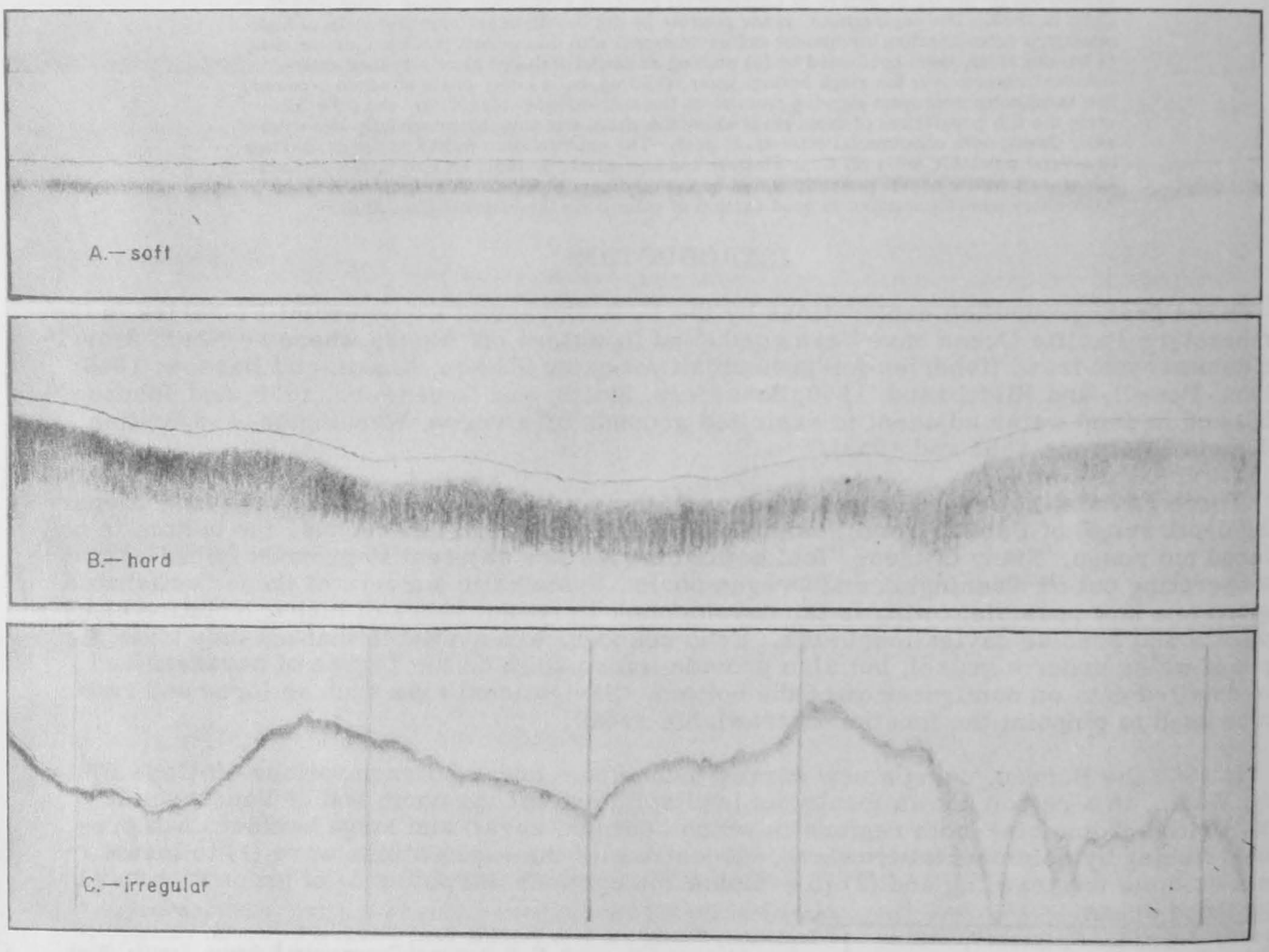

Fig. 1 - Sample tracings of echo-sounder paper showing soft and hard bottom of fairly uniform depth (A and B) and irregular bottom (C).

on paper. At the start and end of each transect, as well as at frequent intervals between, marks were made on the paper, which could be related to plotted positions on the chart. This provided a permanent record of the bottom in the regions surveyed. After a series of sounding tracks was completed, the echo papers were studied to evaluate the general substrate and bottom configuration (fig. 1).

Indicated snags and bottom types (soft, intermediate, and hard) were noted on the navigation chart. Thus, after a series of sounding transects was completed, the characteristics of the bottom of the region surveyed could be evaluated from inspection of the chart. A wet- or dry-paper white-line echo sounder (38 kc., 220 volt; 50 cycle/sec. AC) having a maximum depth range of 1,750 fathoms was used for sounding.

From the composite pictures obtained from the sounding transects, drags were made on promising-looking grounds (generally those showing soft bottom) with a $\frac{3}{4}$-inch chain, 42 feet long (fig. 2). The chain was attached between the otter doors in place of the net and was dragged to locate possible snags and other obstructions on the bottom that were not shown by the echo sounder. This procedure of dragging the chain before a drag was made with the net prevented damage to, or loss of, nets that otherwise would have occurred. Chain drags were also made in areas where hard bottom was indicated, since trawling is often feasible over such grounds if the topographic changes are not abrupt and large boulders are not present.

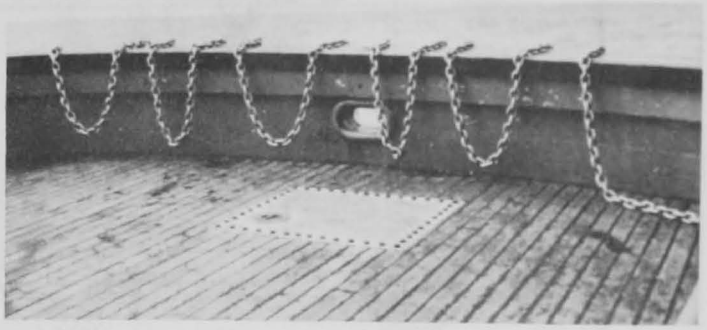

Fig. 2 - Chain ($\frac{3}{4}$-inch diameter, 42 feet long) used in explorations to locate obstructions on bottom.

After the chain was successfully dragged through an area, a 400-mesh eastern otter-trawl net (Greenwood 1958) rigged according to commercial practice, was used to sample the populations of fish present. Drags with the net were usually of 1-hour duration, although some were as long as 2 hours.

The total weight of each species of fish and shellfish caught was estimated for each drag and representative length-frequency samples of the commercially-valuable species of fish were taken in each of the major areas explored.

AREAS EXPLORED

The region explored is shown in figure 3. The area west of Cape Flattery was surveyed during the period May 2 to June 24, 1960, and those adjacent to the Scott Islands and east of Cape St. James, the southermost point of the Queen Charlotte Islands, were explored from July 18, to September 9, 1960.

The Cape Flattery "spit" area lies between La Perouse Bank and the 100-fathom isobath. The continental shelf in this region slopes off gradually from around 50 to 85 fathoms and then drops off abruptly.

Off the northwest tip of Vancouver Island the Scott Islands form a westerly chain delimiting the southern boundary of Queen Charlotte Sound. The continental shelf to the south of the islands is narrow, and the slope beyond 100 fathoms is steep. In contrast, the continental shelf is relatively flat in the area explored northwest of the islands, extending nearly 20 miles to seaward before reaching a depth of 100 fathoms.

RESULTS

During the exploratory cruises a total of 126 sounding tracks, 118 snag-chain drags, and 56 drags with the trawl net were made. Several trawlable grounds were delineated off Cape

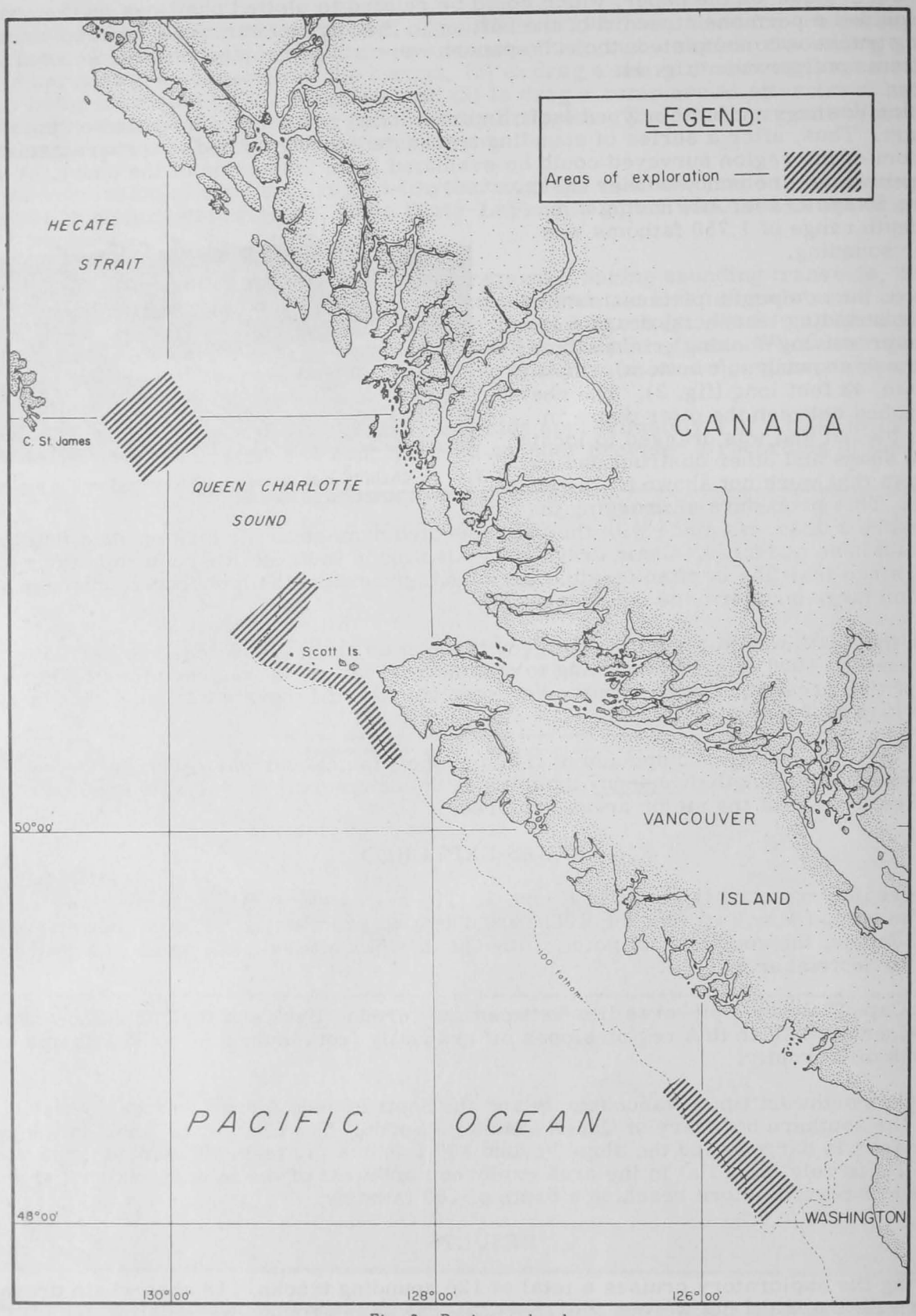

Fig. 3 - Region explored.

Flattery, and one relatively large trawlable area was found northwest of the Scott Islands. Exploratory fishing in most of these areas resulted in good catches of commercially valuable groundfishes.

CAPE FLATTERY "SPIT" AREA: A total of 75 chain drags and 38 trawl-net drags was made in the "spit" area west of Cape Flattery. During these drags the chain hung up 55 times; however, the net was snagged in only three instances. Sounding transects showing the general interpreted substrate features of this area are shown in figure 4, and the position of each net drag and the snags encountered are shown in figure 5.

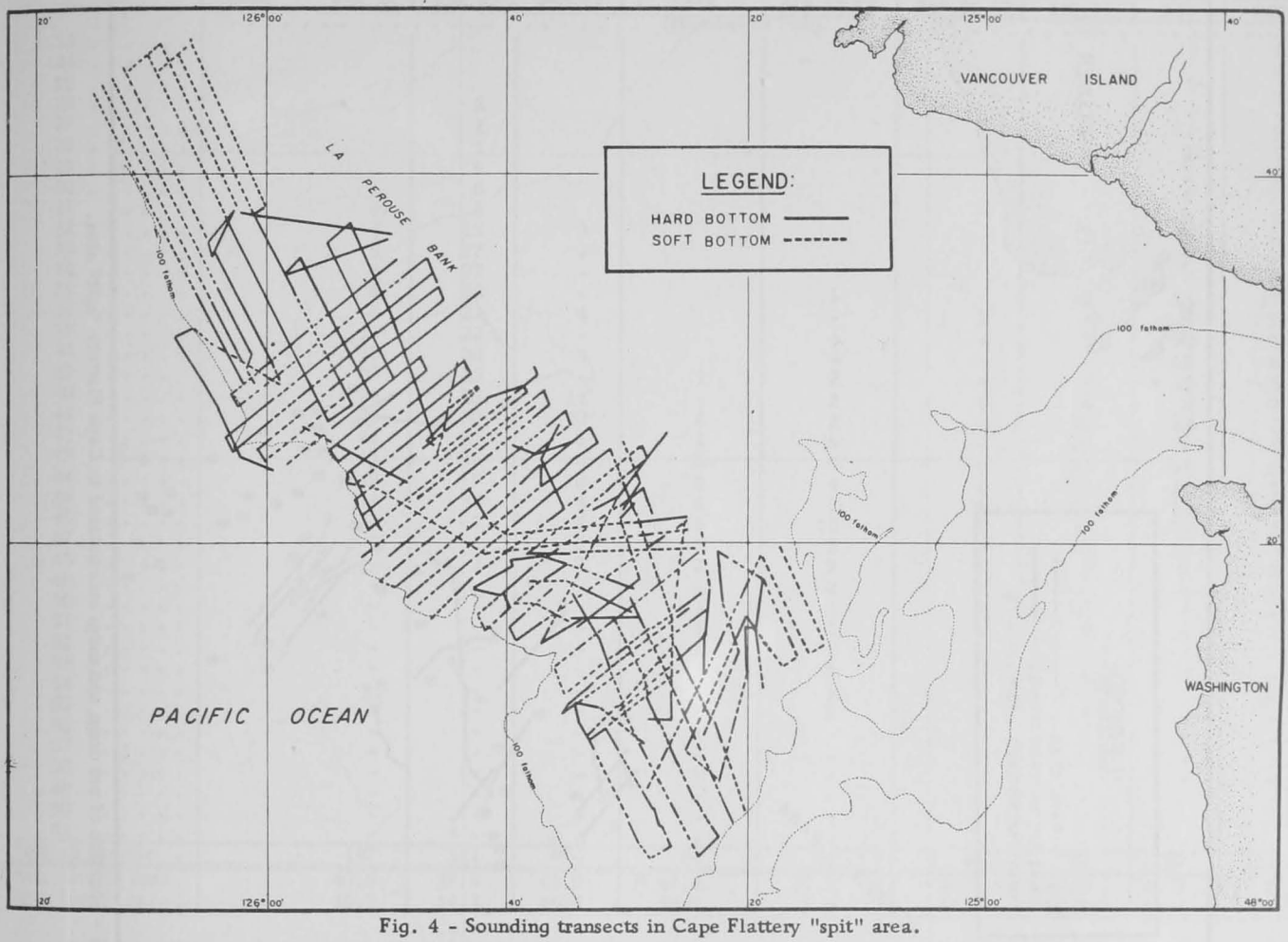

Fig. 4 - Sounding transects in Cape Flattery "spit" area.

In the "spit" area, five grounds in which commercial trawling could be conducted were delineated. These grounds may be oriented on figure 5 from the following drag numbers:

Ground	Drag No.
1	1 - 22
2	3 - 11
3	12 - 15
4	16 - 23
5	24 - 37

Dogfish shark (Squalus acanthias) dominated the catches from the two drags made on ground 1 at depths from 58 to 97 fathoms.

Approximately 15 square miles of trawlable bottom at depths ranging from 66 to 84 fathoms were located on ground 2. Catches of Petrale sole (Eopsetta jordani) averaging

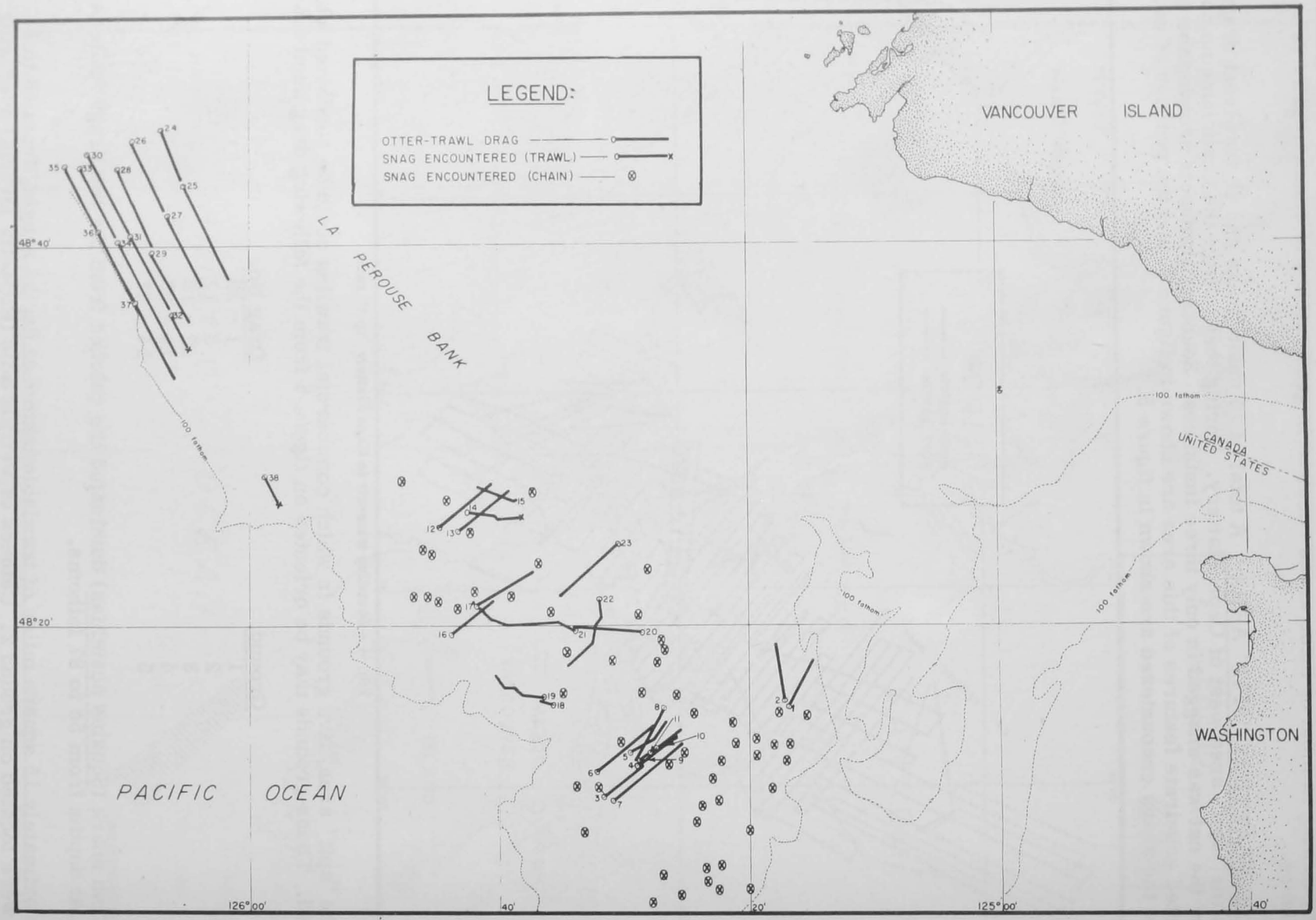

Fig. 5 - Location of net drags and snags encountered in Cape Flattery "spit" area.

1,150 pounds per hour were made in drags 4 and 5. Most of the Petrale sole caught on this ground were of commercial size. Length frequency samples of this species taken in drags 10 and 11 are shown in table 1. Fair catches of black rockfish, primarily the silvergray rockfish (Sebastodes brevispinus), were made in most of the drags on this ground.

Table 1 - Representative Length Frequencies of Several Important Species of Fish Caught off Cape Flattery, Wash., and Near Cape Scott, British Columbia

Total Length Cm.	Rockfish						Flounders		
	Pacific Ocean Perch			Silver Gray	Canary	Convict	Petrale Sole	Dover Sole	Rock Sole
	Drag #26,35	#40,42	#50,52	#48	#48,50,52	#48,50,52	#10,11	#40	#46
	(Number of Fish)								
23									1
24									-
25									-
26		2							-
27		1							2
28		1						2	1
29		5						2	4
30		6						4	7
31	4	5						3	3
32	4	15	2				2	5	5
33	3	27	-				-	3	9
34	4	27	-				-	7	5
35	6	38	-		1		3	13	17
36	6	21	4		-	1	4	9	7
37	10	22	-		-	-	5	12	7
38	10	20	4		-	-	5	12	4
39	20	35	-	1	2	-	8	12	3
40	23	23	14	-	2	1	4	9	9
41	26	30	10	4	2	-	13	13	7
42	21	21	6	1	5	-	22	15	6
43	19	15	8	5	4	1	29	15	5
44	12	9	10	3	4	1	24	10	5
45	11	13	4	3	5	4	14	14	5
46	3	2	8	6	10	1	13	13	2
47	5	1	2	3	5	4	10	11	-
48	-	2	2	2	2	8	8	9	3
49	-	-	-	4	2	8	1	6	3
50	-	-	-	1	1	8	3	1	-
51	-	-	-	1	1	4	1	4	-
52	-	-	-	2	1	1	-	3	-
53	-	-	-	3	3	1	-	-	-
54	-	-	-	1	1	1	-	-	-
55	-	-	-	2	2	-	1	-	-
56	-	-	-	1	-	-	-	-	-
57	-	-	-	-	-	-	-	-	-
58	-	-	-	-	-	-	-	-	-
59	-	-	-	-	-	-	-	-	-
60	-	-	-	-	-	-	-	-	-
61	-	-	-	1	-	-	-	-	-
Total of Sample	187	341	74	44	53	44	170	207	120
Avg. Length cm.	40.5	37.5	41.9	47.1	45.5	48.1	43.0	40.9	37.2
Avg. Length in.	15.9	14.8	16.5	18.5	17.9	18.9	16.9	16.1	14.6

A trawlable area of about 10 square miles was found on ground 3 at depths ranging from 57 to 72 fathoms. Drags 12 to 14 made in this area produced an average of 2,200 pounds of Dover sole (Microstomus pacificus) per hour of fishing. Almost all of the Dover sole were of commercial size.

A trawlable area of about 28 square miles was found on ground 4. Test drags yielded mainly canary rockfish (Sebastodes pinniger) and silvergray rockfish. Rockfish catches ranged up to 4,500 pounds per hour of fishing. Drag 23 on this ground produced 1,000 pounds of Dover sole per hour of fishing.

On the northwest corner of the area surveyed off Cape Flattery (ground 5), approximately 60 square miles of trawlable ground were found at depths ranging from 61 to 92 fathoms. Exploratory fishing in this portion of the area produced catches of Pacific ocean perch (Sebastodes alutus) up to 3,750 pounds per hour, with an average catch for 12 drags (26 to 37) of about 1,250 pounds per hour. Measurements of this species caught in drags 26 and 35 (table 1) show an average length of 40.5 cm. (15.9 inches), with a range from 31 cm. (12.2 inches)

to 47 cm. (18.5 inches). In the two shallowest drags (24 and 25) turbot (Atheresthes stomias) dominated the catches.

CAPE SCOTT AND QUEEN CHARLOTTE SOUND AREA: A total of 43 chain drags and 18 net drags was made in the Cape Scott-Queen Charlotte Sound area. The sounding transects are shown in figure 6, and the location of each net drag and the snags encountered are shown in figure 7.

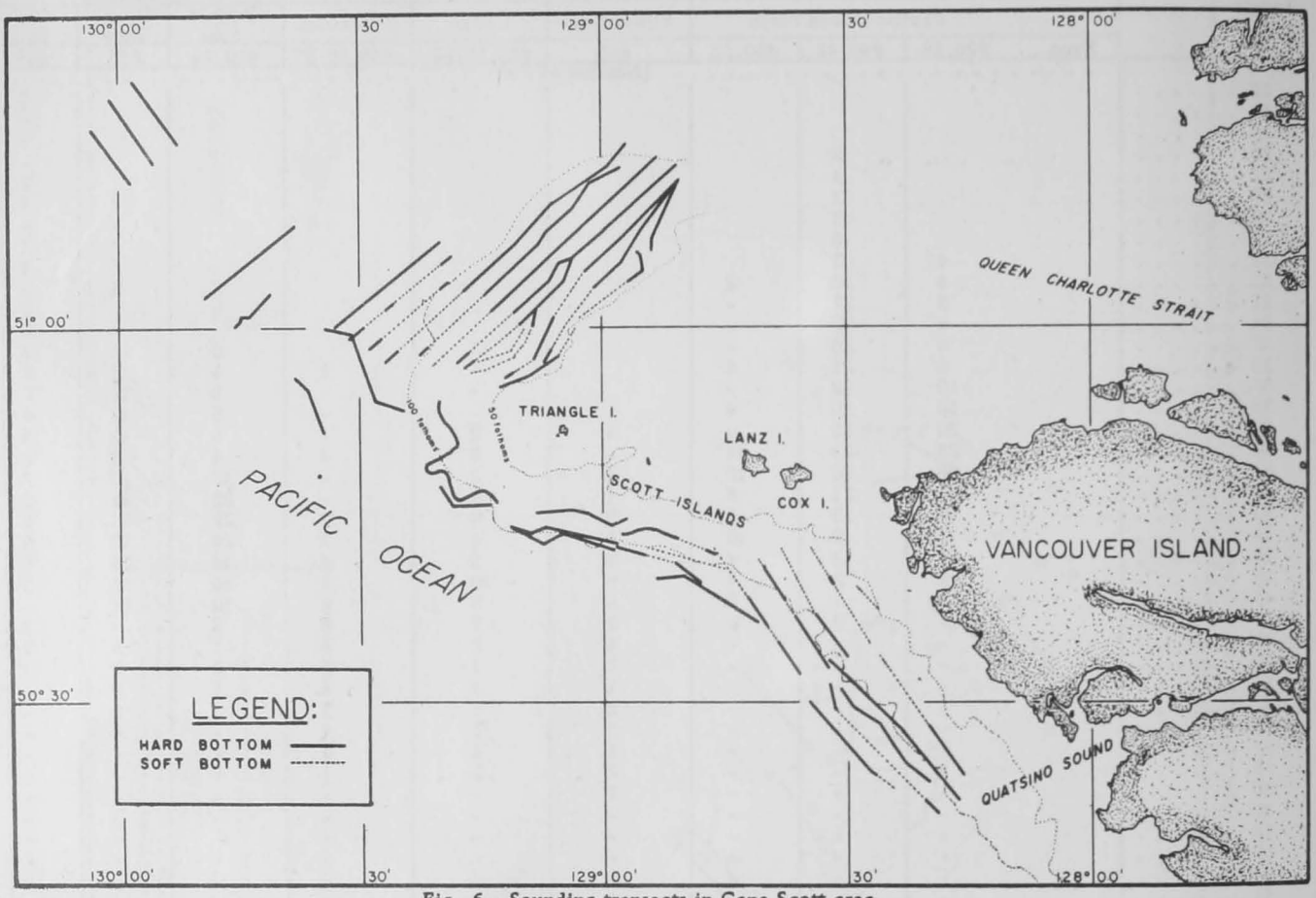

Fig. 6 - Sounding transects in Cape Scott area.

Grounds south of the Scott Islands generally were very uneven and hard. The snag chain hung up 28 times in a total of 33 drags made with this gear, and only 7 drags with the net could be made. A small trawlable area approximately 1 mile wide and 6 miles long was located south of Triangle Island at depths between 104 and 116 fathoms. Drag numbers 40, 41, and 42 made on that ground resulted in good catches of Pacific ocean perch. Drag number 40 also provided 1,200 pounds of Dover sole. The Dover sole from this drag were of good size, averaging 41 cm. (16.1 inches) in length (table 1). Samples of Pacific ocean perch (table 1) from drags 40 and 42 ranged from 26 cm. (10.2 inches) to 48 cm. (18.9 inches) in length, with an average length of 37.5 cm. (14.8 inches).

Northwest of Triangle Island a large trawlable area of approximately 60 square miles was found. Soundings made during the survey suggest that the continental shelf in this area extends seaward a considerable distance farther than indicated on the sailing or navigational charts. Eleven drags were made in this area at depths ranging from 50 to 119 fathoms. The shallowest drags (numbers 46 and 47) made in 50 to 53 fathoms produced mainly rock sole (Lepidopsetta bilineata), which averaged about 750 pounds per hour of fishing. The rock sole taken in drag 46 averaged 37.2 cm. (14.6 inches) and ranged from 23 cm. (9.1 inches) to 49 cm. (19.3 inches) in length (table 1). A few petrale sole also were mixed in these catches. In deeper drags at depths between 73 and 119 fathoms, rockfish dominated the catches.

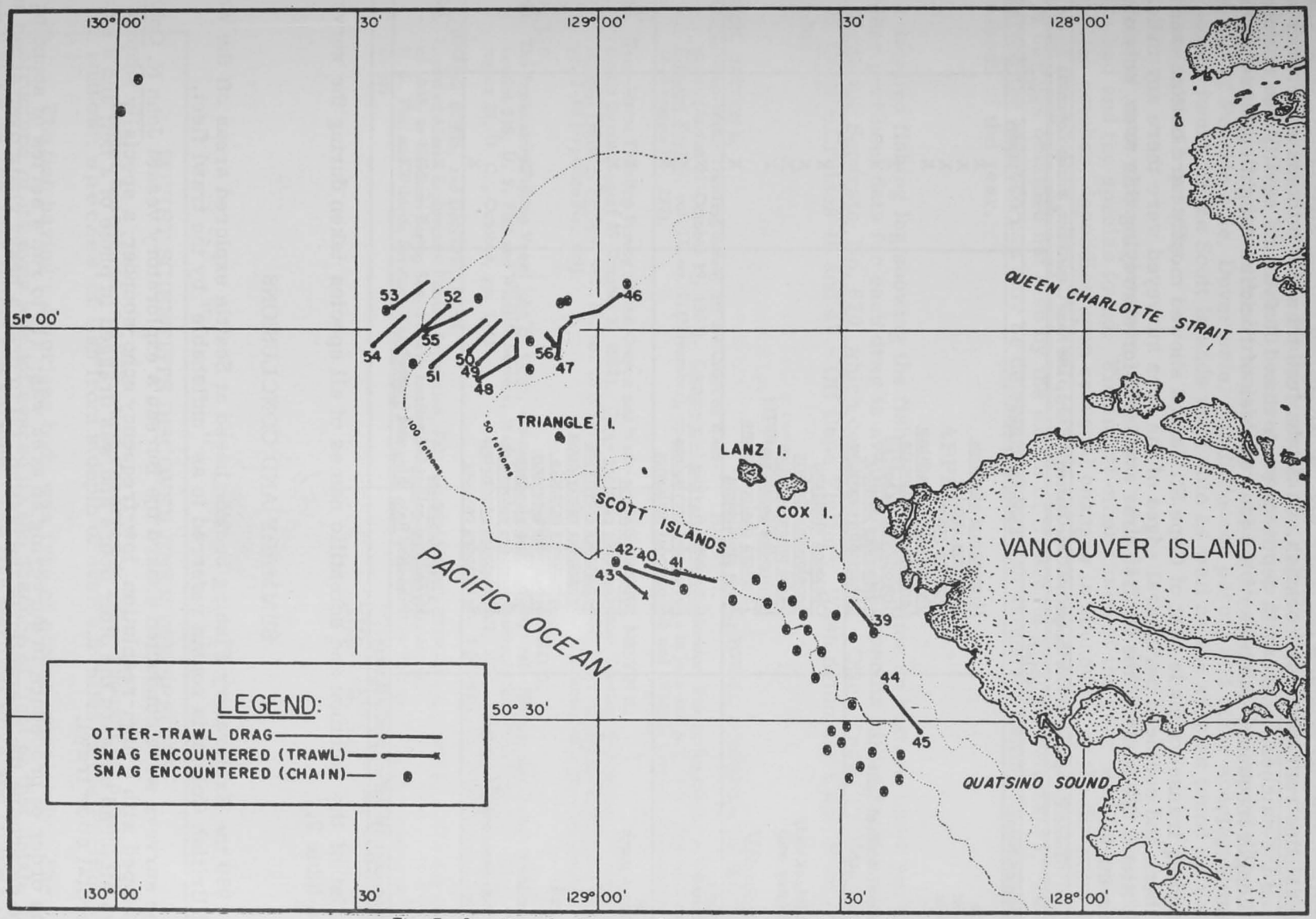

Fig. 7 - Location of net drags and snags encountered in Cape Scott area.

The dominant species encountered were the Pacific ocean perch, silvergray, canary, and convict (Sebastodes rubrivinctus) rockfish. In depths less than 100 fathoms silvergray rockfish dominated the catches, whereas in depths greater than 100 fathoms mostly red rockfish were taken. Length frequency samples of the four species of rockfish caught on these grounds are shown in table 1.

Sounding transects made east of Cape St. James showed mostly hard bottom, and only at the northern and southern peripheral edges of the area surveyed were there any indications of soft bottom. Because of the limited time available for surveying this area, only one chain drag was made.

Table 2 - Species of Fish Caught off Cape Flattery, Wash., and Near Cape Scott, British Columbia

Species		Area	
Common Name	Scientific Name	Cape Flattery	Cape Scott
Flatfish:			
Dover sole	Microstomus pacificus	X	X
English sole	Parophrys vetulus	X	X
Petrale sole	Eopsetta jordani	X	X
Rex sole	Glyptocephalus zachirus	X	X
Rock sole	Lepidopsetta bilineata		X
Halibut	Hippoglossus stenolepis	X	X
Turbot (Arrow-toothed halibut)1/	Atheresthes stomias	X	X
Mottled sand dab1/	Citharichthys sordidus		X
Roundfish:			
Lingcod	Ophiodon elongatus	X	X
Sablefish (black cod)	Anoplopoma fimbria	X	X
True cod (gray cod)	Gadus macrocephalus	X	X
Hake1/	Merluccius productus	X	X
Whiting (pollack)1/	Theragra chalcogramma		X
Shad1/	Alosa sapidissima	X	
Black rockfish:			
Yellow-tailed	Sebastodes flavidus	X	X
Silvergray	Sebastodes brevispinus	X	X
Black	Sebastodes melanops	X	
Red rockfish:			
Pacific ocean perch	Sebastodes alutus	X	X
Canary	Sebastodes pinniger	X	X
Red snapper	Sebastodes ruberrimus		X
Convict	Sebastodes rubrivinctus	X	X
Olivebacked	Sebastodes saxicola		X
Stripetail	Sebastodes zacentrus		X
Greenstriped1/	Sebastodes elongatus	X	X
Widow1/	Sebastodes entomelas		X
Rock salmon (Bocaccio)1/	Sebastodes paucispinis		X
Redstriped	Sebastodes proriger	X	X
Other fish:			
Dogfish1/	Squalus acanthias	X	X
Ratfish1/	Hydrolagus colliei	X	X
Skates1/	Primarily Raja rhina and binoculata	X	X

1/Limited commercial value at present time.

A list of the common and scientific names of all species taken during the surveys is given in table 2.

SUMMARY AND CONCLUSIONS

In 1960 the Exploratory Fishing Section based at Seattle explored areas off the Washington and British Columbia coasts referred to as "unfishable" by the trawl fleet.

The surveys were conducted aboard the Bureau's exploratory vessel John N. Cobb, which was equipped with a high-resolution, low-frequency echo-sounder; a specially adapted chain that was attached between the otter doors and was dragged in place of a net; and a standard commercial otter trawl.

The order of procedure in surveying an area was: (1) to run a series of sounding transects to determine the character of the bottom, (2) to drag a heavy chain over areas suggested by the soundings as being trawlable, and (3) to drag a commercial otter trawl net over those grounds on which the chain was successfully towed.

Trawlable grounds and concentrations of commercially valuable groundfish were found in the "spit" area west of Cape Flattery and in the regions bordering the Scott Islands. The area explored off Cape St. James, however, appeared to have little if any trawling bottom. Off Cape Flattery the discovered trawlable grounds were found to be inhabited by commercial quantities of Petrale sole, Dover sole, Pacific ocean perch, and other species of rockfish. On the grounds found off the Scott Islands rock sole as well as the species found off Cape Flattery were taken in quantity.

Time of year when exploratory drags are made largely determines the size of the catches obtained and the species found. Fishing at other times of the year would produce larger or smaller catches, depending upon seasonal changes in abundance of the different species inhabiting the grounds. Thus, the value of the explorations should be judged not only by the size of catches obtained but also by the extent of trawlable grounds delineated. The potential yield from the grounds can only be determined through extensive fishing by the trawl fleet at all seasons of the year.

APPENDIX

A detailed fishing log showing the fishing positions, time on bottom, catch particulars, and other pertinent data for each drag is available as an appendix to the reprint of this article. Write for Separate No. 620, which contains "Table 3 - Otter Trawl Fishing Log - M/V John N. Cobb - Cruises 46 and 47 - Off Cape Flattery, Washington and Cape Scott, British Columbia."

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SOVIET SCIENTISTS DISCOVER UNKNOWN SPECIES

Soviet scientists in 1960 were reported to have brought up a hitherto unknown species of fish from a depth of over 4.5 miles in the Pacific.

The fish having a colorless body was free of scales completely. The structure of its eyes was influenced by the absence of light at that depth, some 24,786 feet below the surface. The fish were jellylike and no bigger than a pin head. (Japanese newspaper, November 18, 1960.)