REPORT OF THE 1954 TRAWL INVESTIGATIONS

Note: All calculations for catch by area and total catches are computed from interview estimates.

For final figures, data should be corrected for actual landings from Tables 17 and 26.

REPORT OF THE 1954 TRAWL INVESTIGATIONS

Compiled by

D. L. Alverson

State of Washington
Department of Fisheries

REPORT OF THE 1954 TRAWL INVESTIGATIONS

Table of Contents

Table of Contents, Cont.

List of Tables, Cont.

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List of Tables

List of Tables, Cont.

List of Figures

"Paragon" - High boat for 1954. 1,200,000 pounds of foodfish;
1,000,000 pounds of scrapfish.

June 2, 1955

REPORT ON THE 1954 TRAWL INVESTIGATION

The following report, compiled as a reference source on the research activities carried out in 1954, encompasses the various studies and problems in which trawl personnel were involved. A summation of material published in progress reports is presented, along with a detailed analysis of interview catch records by species, area, and depth.

THE SALES TICKET SYSTEM IN RESPECT TO THE WASHINGTON TRAWL FISHERY

A special study made during 1954 involved a critical examination and comparison of sales ticket data with data collected from interview forms. Statistical information from sales tickets and matching interview forms were compared for the period from April 1 through December 31, 1953. The random sample of interview landings and matching sales tickets data included 159 boat trips, which landed 6,176,000 pounds.

Comparison of the total landings (Table 1) showed fair agreement although several species were underestimated. A breakdown of the origin of catch from sales tickets and from interviews is shown in Table 2. The Table gives the percent of comparable catches for each area and species. The sales ticket percentage given for any area should be compared with the added total of all interview areas which are within the sales ticket region. The discrepancies for seven major species, Pacific ocean perch (Sebastodes alutus), English sole (Parophrys vetulus), petrale sole (Eopsetta jordani), Dover sole (Microstomus pacificus), trusced (Gadus macrocephalus), rockfish (Sebastodes species), and lingcod (Ophiodon elongatus), are shown graphically in Figures 1 through 7.

A comparison of the total fishing effort by area is shown in Figure 8. It is apparent that the graphs indicate inordinate discrepancies between the two systems and the errors indicated in the origin of catch by sales ticket are sufficient to preclude the use of these statistics for analysis of

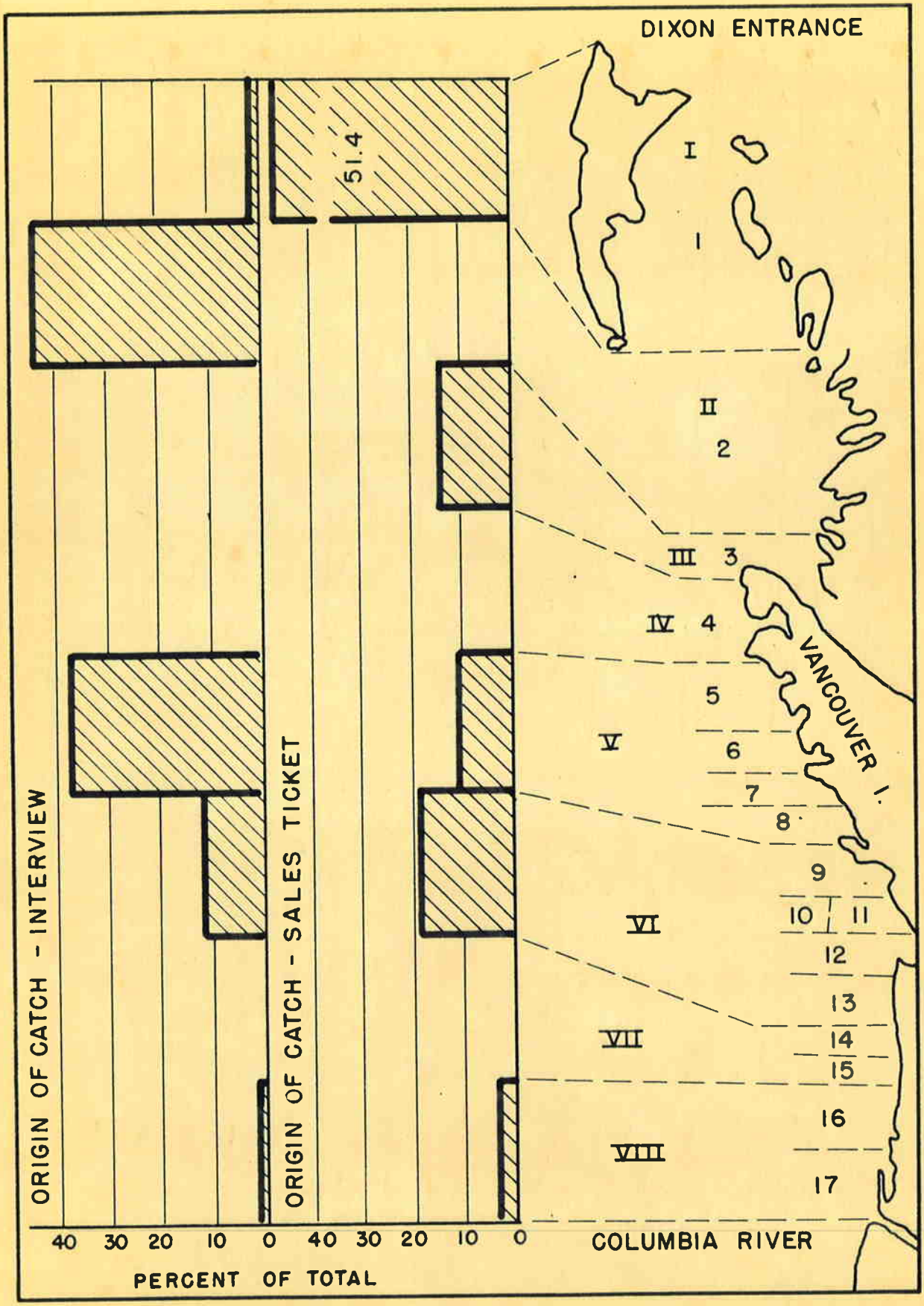


Figure 1 - Distribution of catch of Pacific ocean perch from sales ticket and interview forms, (percent of total April - December, 1953).

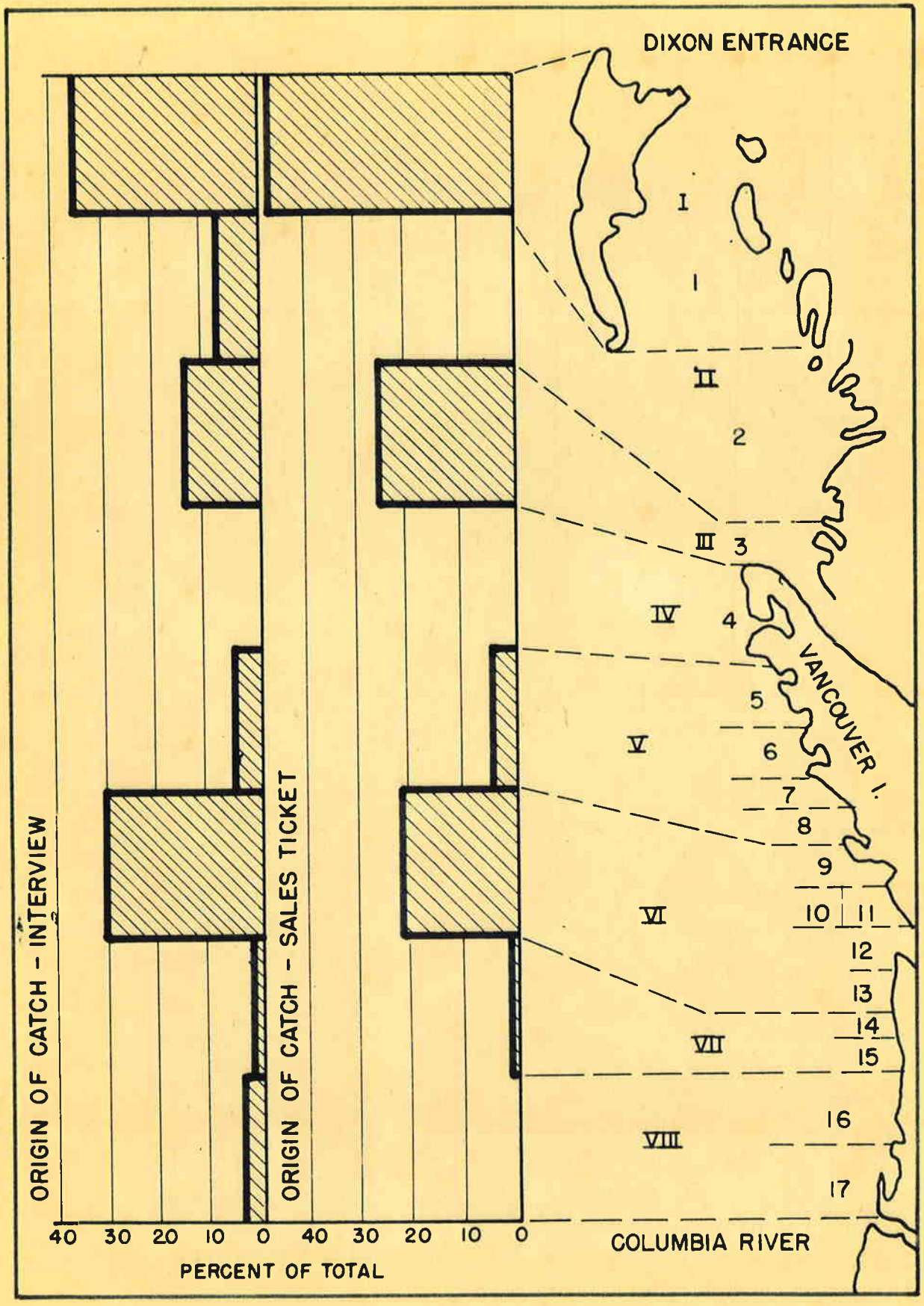


Figure 2 - Distribution of catch of English sole from sales ticket and interview forms, (percent of total April - December, 1953).

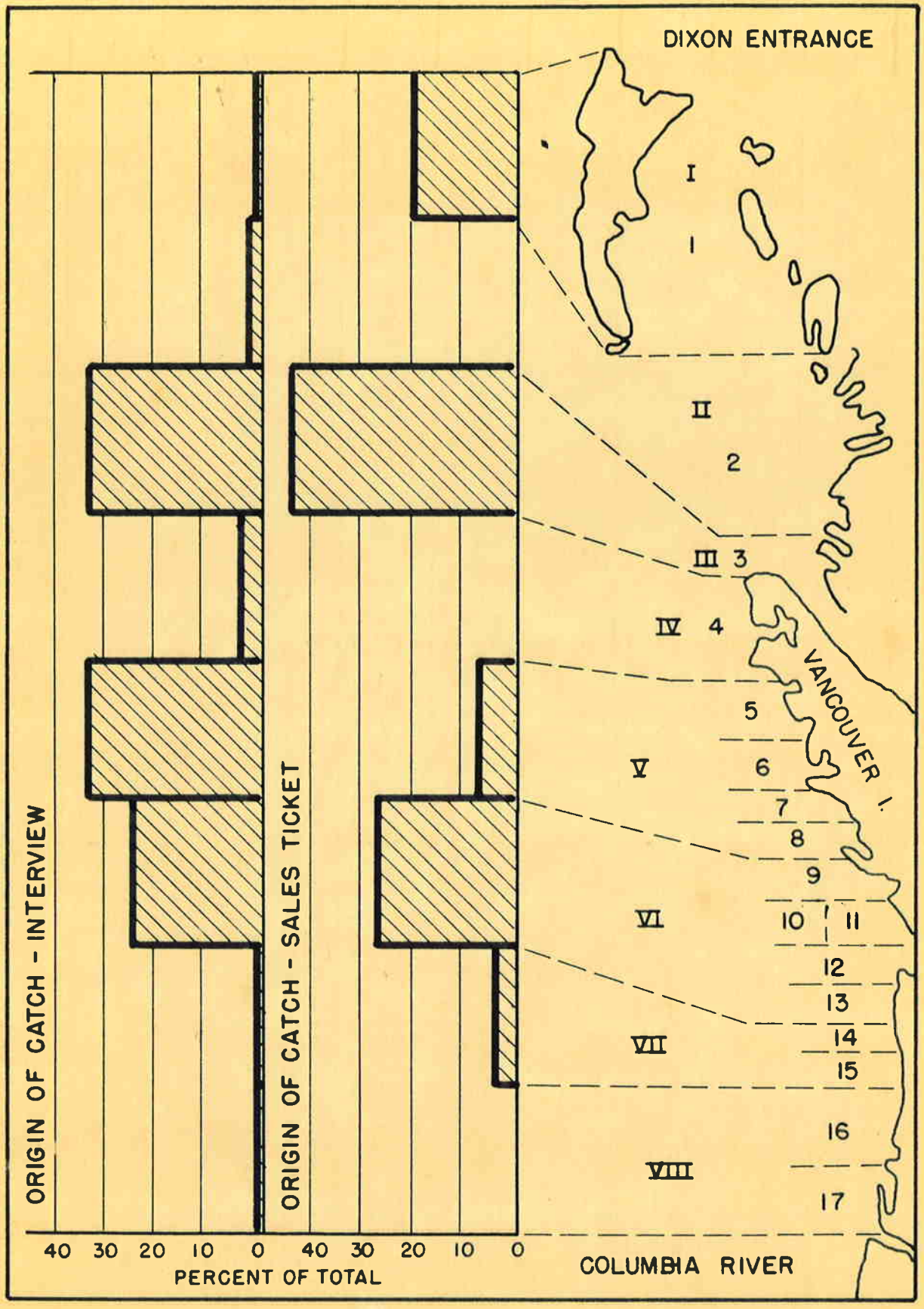


Figure 3 - Distribution of catch of petrale sole from sales ticket and interview forms, (percent of total April - December, 1953).

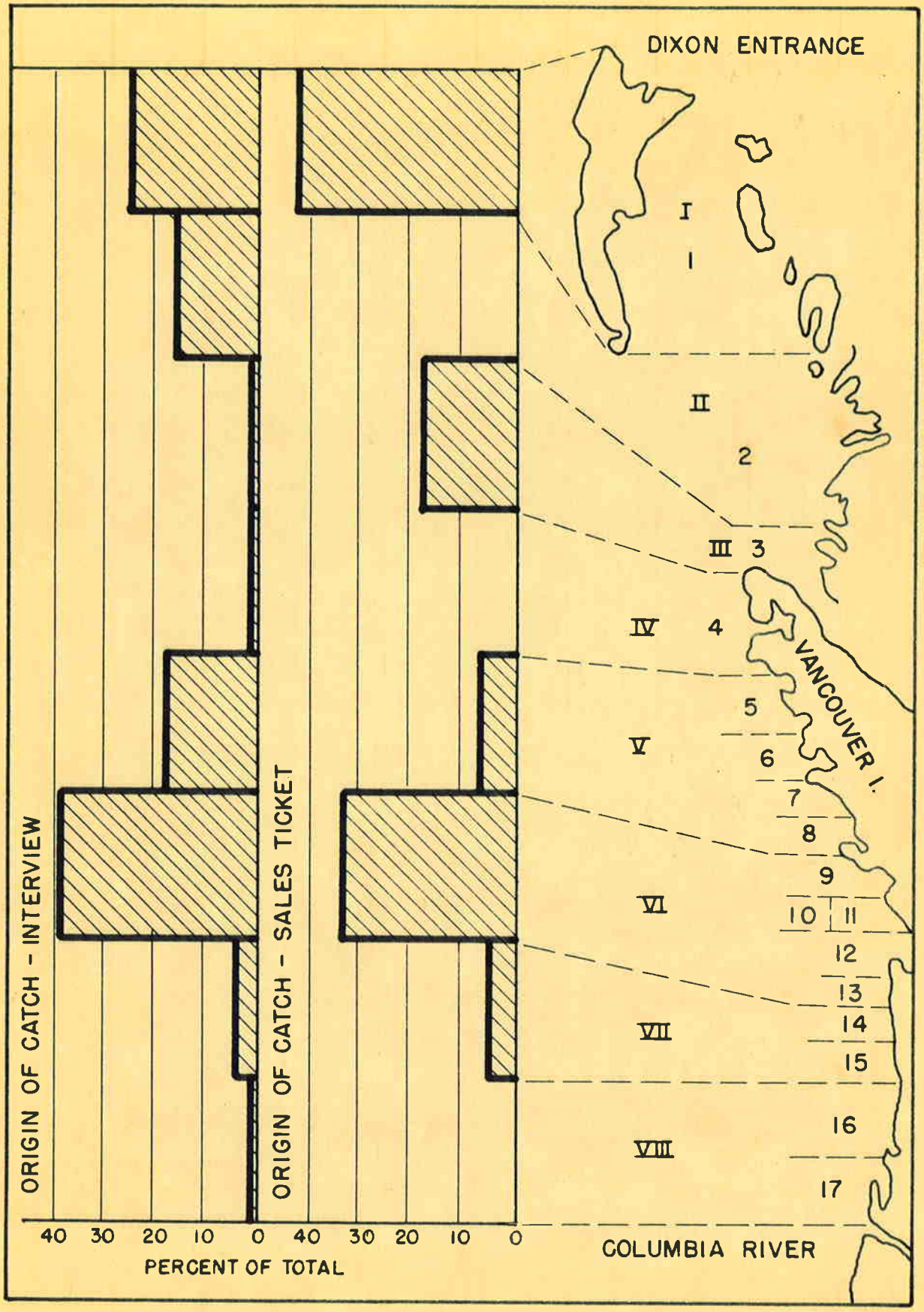


Figure 4 - Distribution of catch of Dover sole from sales ticket and interview forms, (percent of total April - December, 1953).

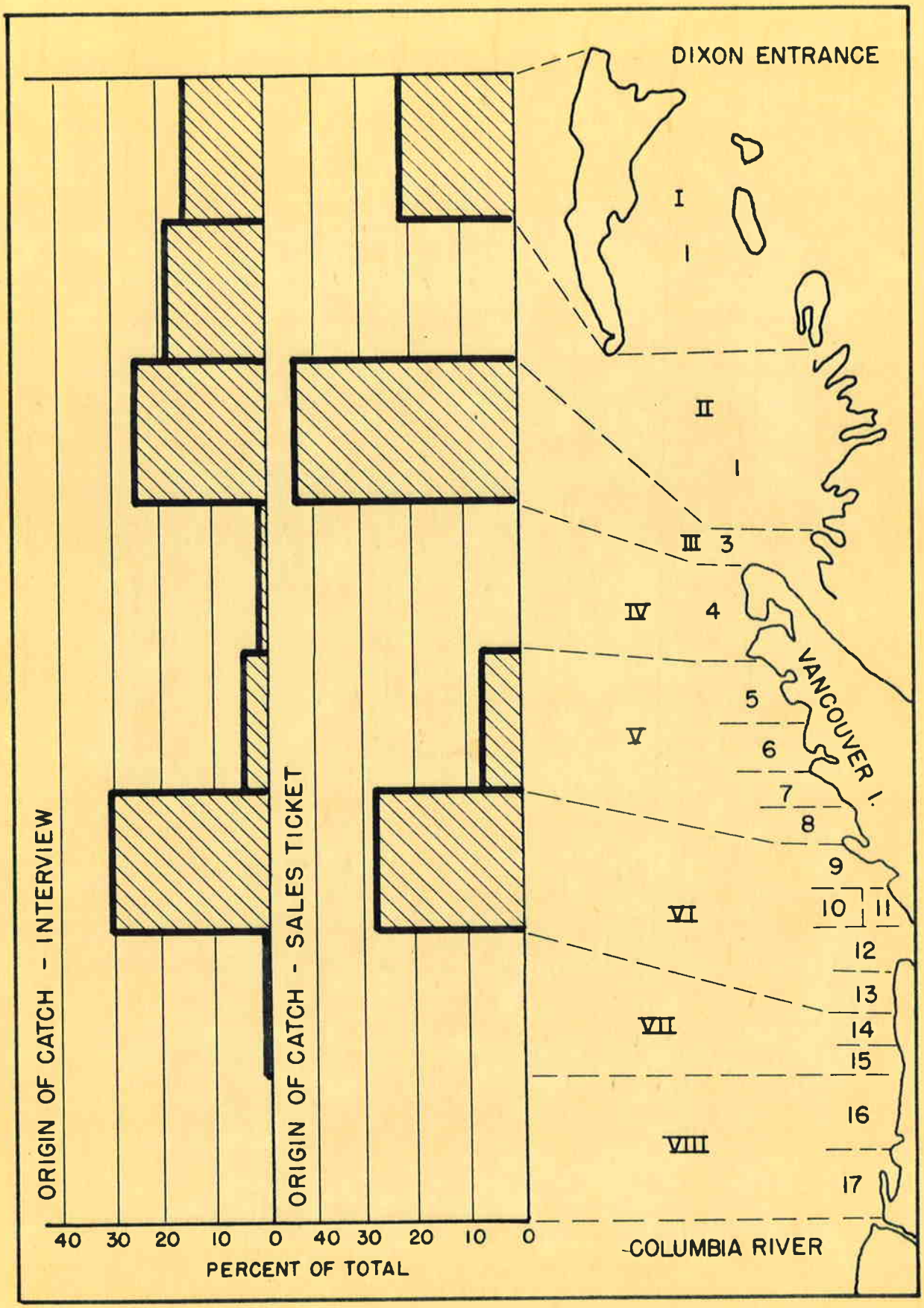


Figure 5 - Distribution of catch of truecod from sales ticket and interview forms, (percent of total April - December, 1953).

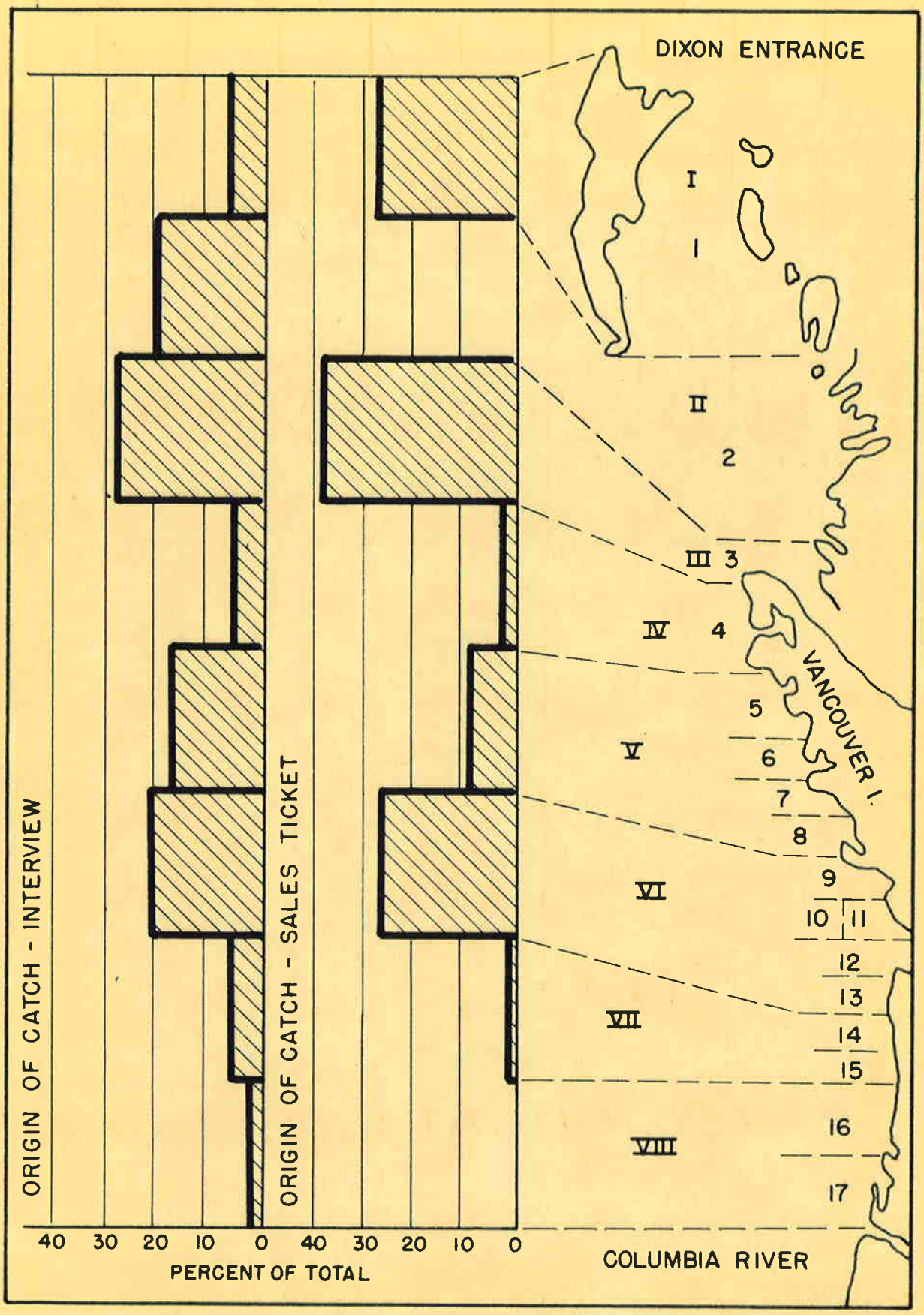


Figure 6 - Distribution of catch of rockfish from sales ticket and interview forms, (percent of total April - December, 1953).

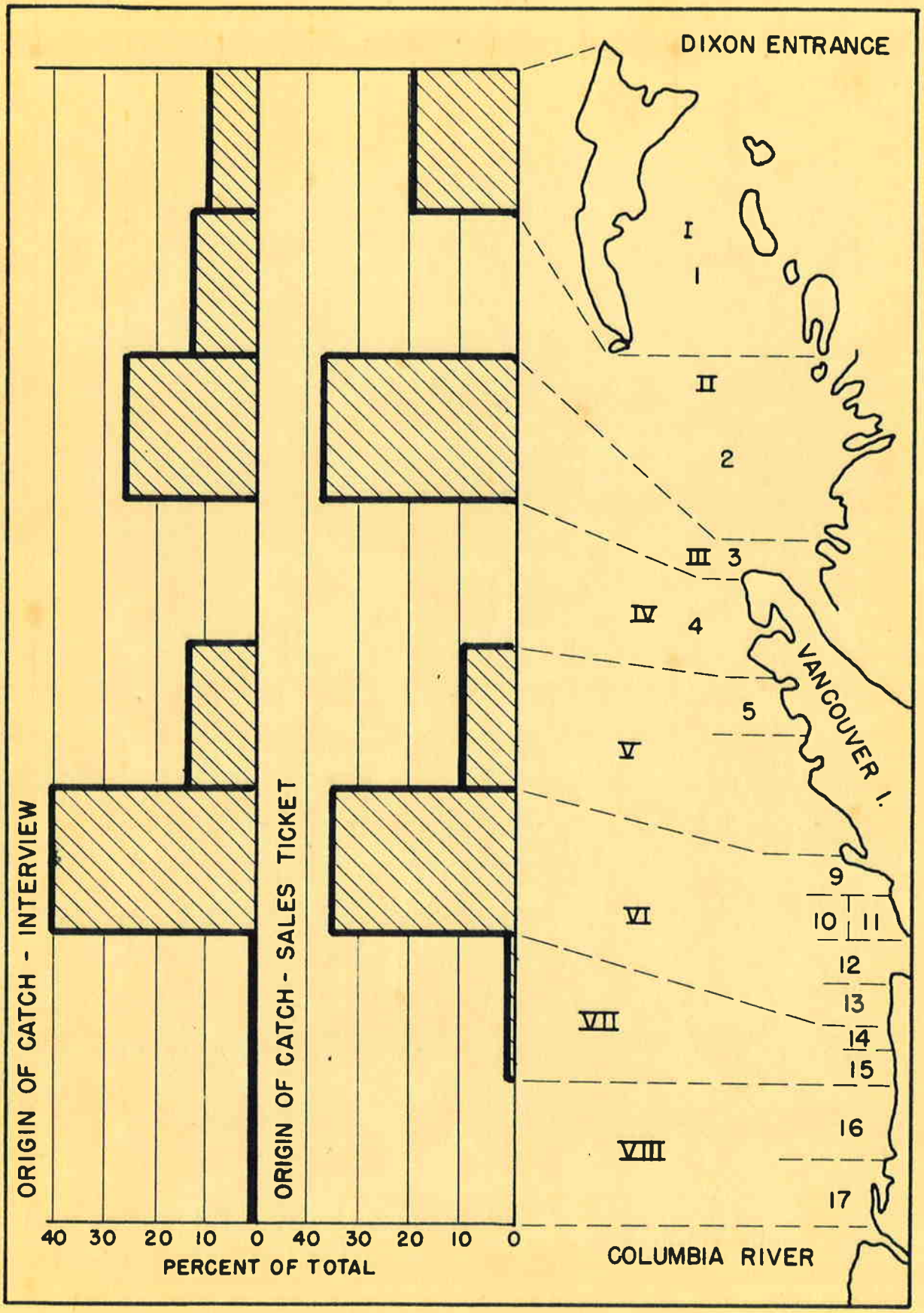


Figure 7 - Distribution of catch of lingcod from sales ticket and interview forms, (percent of total April - December, 1953).

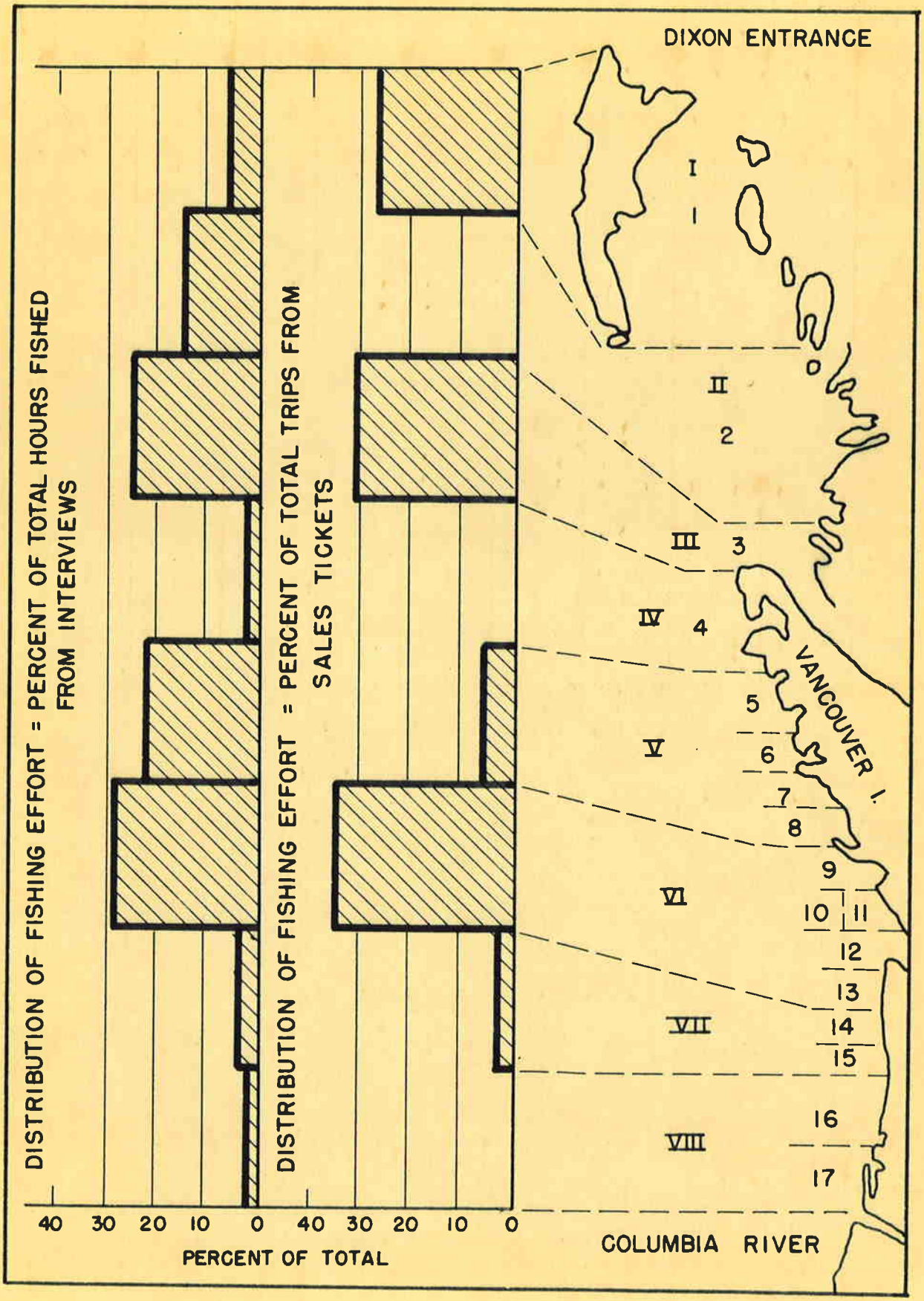


Figure 8 - Distribution of fishing effort as shown from sales tickets and interview forms.

Table 1 - Comparison of total catch, Sales Tickets - Interviews.

Species	Interview	Sales ticket	Interview / Sales ticket	Interview
Petrale sole	994,805	1,028,080	96.8	- 3.2
English sole	136,149	159,148	85.5	-14.5
Dover sole	670,540	661,802	101.3	- 1.3
Rock sole	97,400	97,912	99.5	- .5
Starry flounder	17,188	18,800	91.4	- 8.6
Rockfish	855,265	892,050	95.9	- 4.1
Lingcod	313,000	302,577	103.4	- 3.4
Trawcod	1,713,715	1,882,417	91.0	-
Ocean perch	1,157,985	1,150,959	100.1	- .1
Blackcod	102,485	113,040	90.7	- 9.3
Total	6,058,532	6,306,785	96.1	- 3.9

Table 2 - Origin of catch (percent of total by species) as shown by sales tickets and interview forms, April - December, 1953.

Comparable Areas

SPECIES	s* / i	I 1	II 2	III 3	IV 4	V 5	V 6	V 7	V 8	VI 9	VI 10	VI 11	VI 12	VI 13	VII 14	VII 15	VIII 16-17
Petrale sole	s	18.6		43.6		7.5				26.4					3.8		
Petrale sole	i	1.3	2.6	33.5	3.1	2.2	4.5	27.0	.1	.4	13.8	2.3	6.6	2.2			.2
English sole	s	48.8		24.2		3.5				22.4					1.2		
English sole	i	38.6	7.3	14.9				3.7	.7	.7		1.8	4.5	23.1	.6	1.1	2.9
Dover sole	s	41.7		17.9		4.5				32.3					3.7		
Dover sole	i	23.9	15.8	.1	.1	.6		17.7			1.0	4.1	22.9	11.1	2.5		.4
Rocksole	s	80.6		14.7		.2				4.5							
Rocksole	i	58.1	8.2	33.2		.1			.1					.3			
Starry flounder	s	95.2								4.8							
Starry flounder	i	56.8											43.2				
Rockfish	s	24.5		36.5	1.6	9.5				25.9					2.0		
Rockfish	i	4.9	19.0	27.9	3.9	.4	.1	15.8	.1	.1	2.9	8.9	2.8	6.3		4.3	1.5
True cod	s	22.3		42.8		5.7				28.8					.3		
True cod	i	13.2	17.6	34.0	.2	.3		2.7	.1	1.5	3.9	8.1	12.0	5.3	.1	.5	
Lingcod	s	19.8		36.1		9.3				34.1					.7		
Lingcod	i	9.7	13.1	24.0	.3	.2	1.6	10.2	.1	1.0	23.7	6.9	6.5	1.9	.1	.2	.6
Blackcod	s	30.7		6.0		5.9				56.5					.8		
Blackcod	i	12.5	4.3	4.4		.3		2.5			15.6	25.9	25.8	8.7			
Ocean perch	s	51.4		14.9		11.6				18.7					3.3		
Ocean perch	i	.7	46.8			.1		38.3			4.3		.1	7.6	2.0		

* s = sales tickets; i = interview form.

abundance trends.

Interview System

The Washington interview system was patterned after a similar system currently being used by the Fisheries Research Board of Canada for the British Columbia trawl fishery. Interviewing of vessel landings was considered necessary to obtain essential data needed for proper management and study of this fishery. Sales tickets, which have previously been used to follow abundance trends for trawl species, apparently do not offer sufficient information on the effort expended by area or by species. Sales ticket areas, which usually include a number of fishing banks, often have little biological significance and are in general too broad to follow changes in abundance of individual stocks or populations. The sales ticket system also lacks the personal contact which is needed to detect changes in fishing techniques, economic trends, and buying practices. Because of the limitations of sales ticket data for use in biological studies, the interview system was initiated in April, 1953 to supplement these records with data needed to analyze fluctuations in trawl landings.

A total of 18 different offshore areas is used to record the origin of trawl catches on interview forms as compared with eight major statistical areas. Sales ticket areas and the equivalent interview areas are shown in Figure 9.

To obtain a better graphic illustration of the individual interview areas, charts were made outlining the boundaries of the offshore grounds. If an interviewer were in doubt as to the origin of the catch the graphs were shown the skipper and the area of catch pointed out. The interview areas are shown in Figures 10 through 16.

During 1954 a total of 771 vessel's landings were sampled with an estimated catch of 29,181,962 pounds. The number of interviews, landings, and estimated sampled catch is shown in Table 3. From the ratio of landings, and sampling

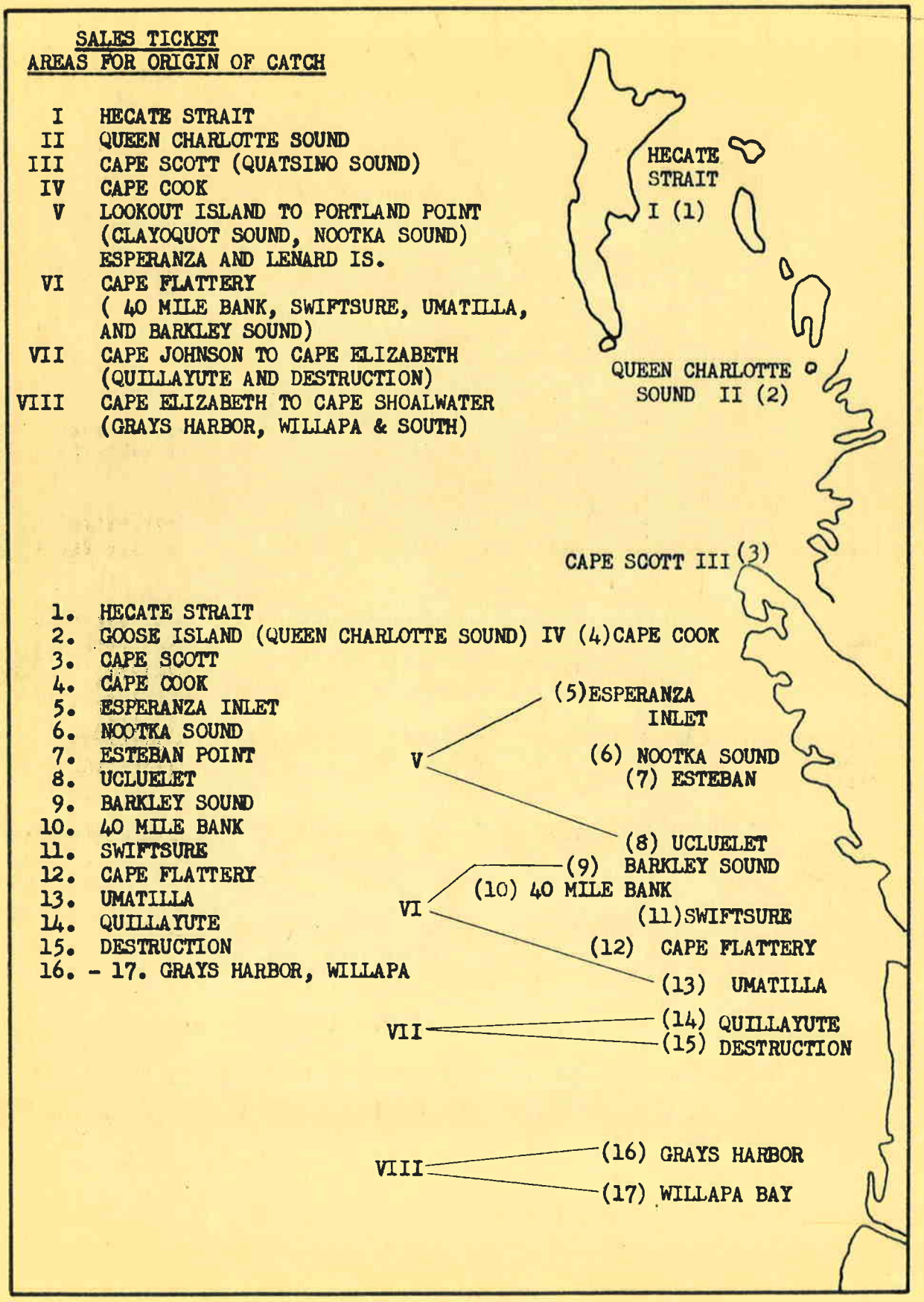
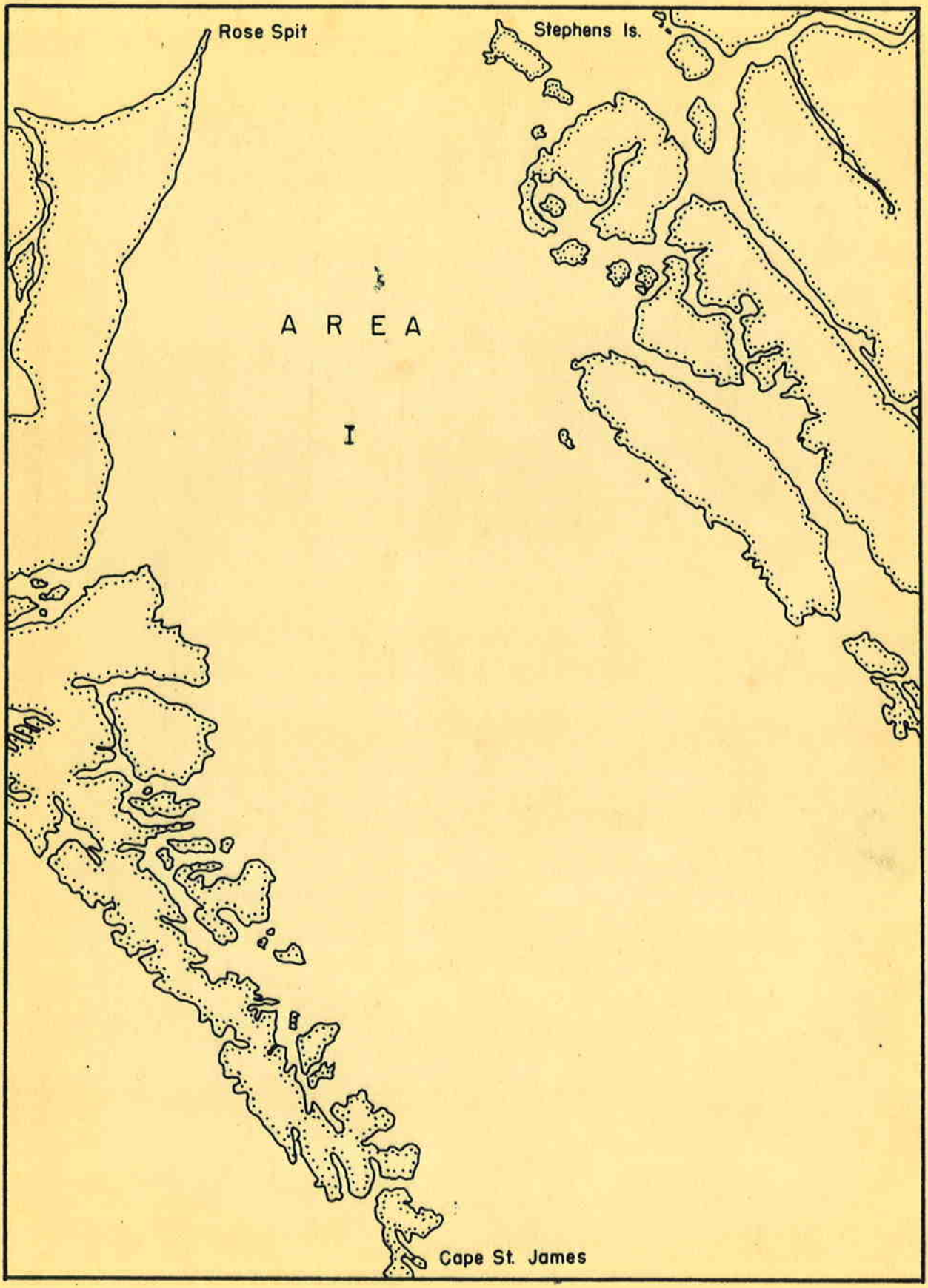


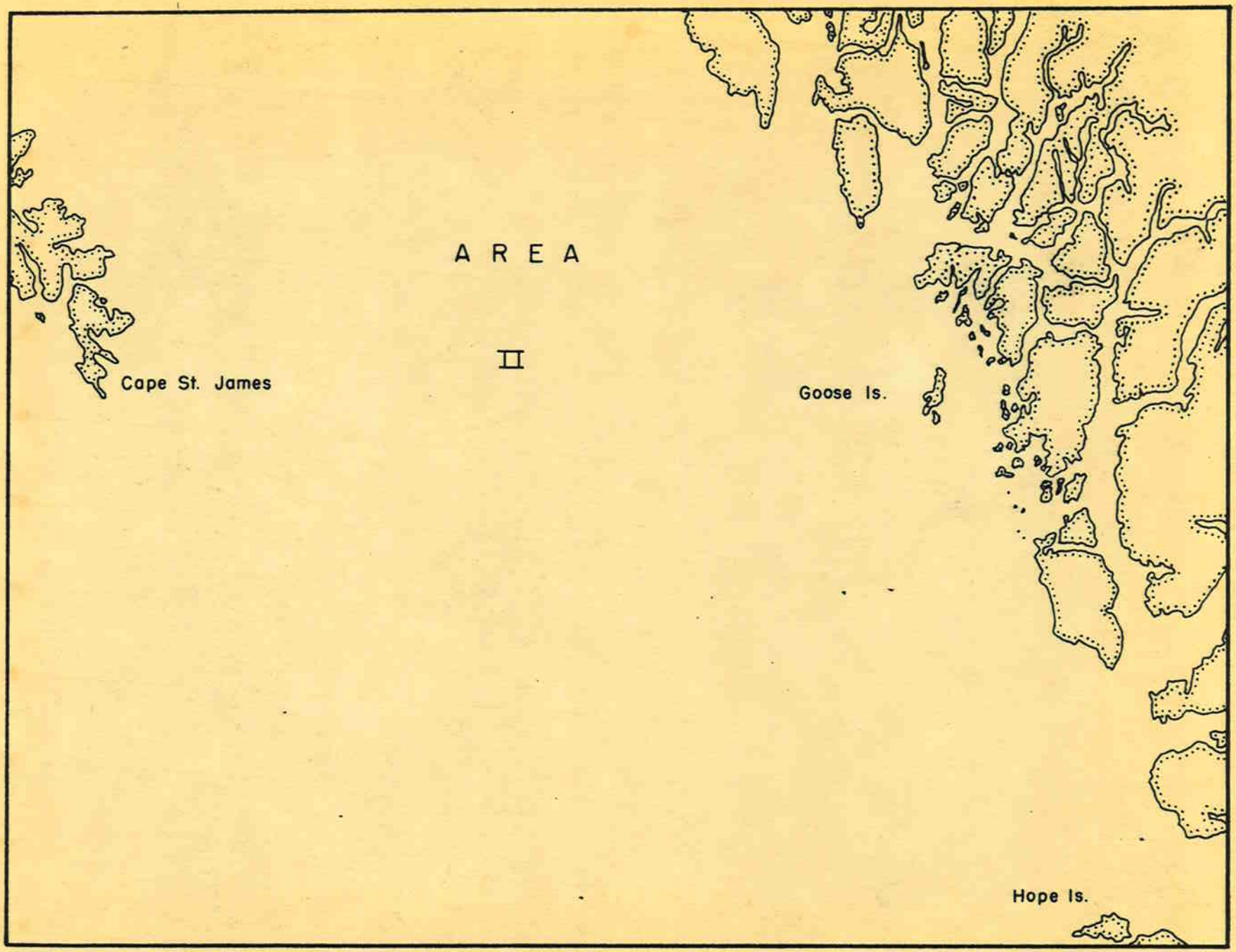
Figure 9 - Comparative fishing areas - sales tickets - interview.

1953



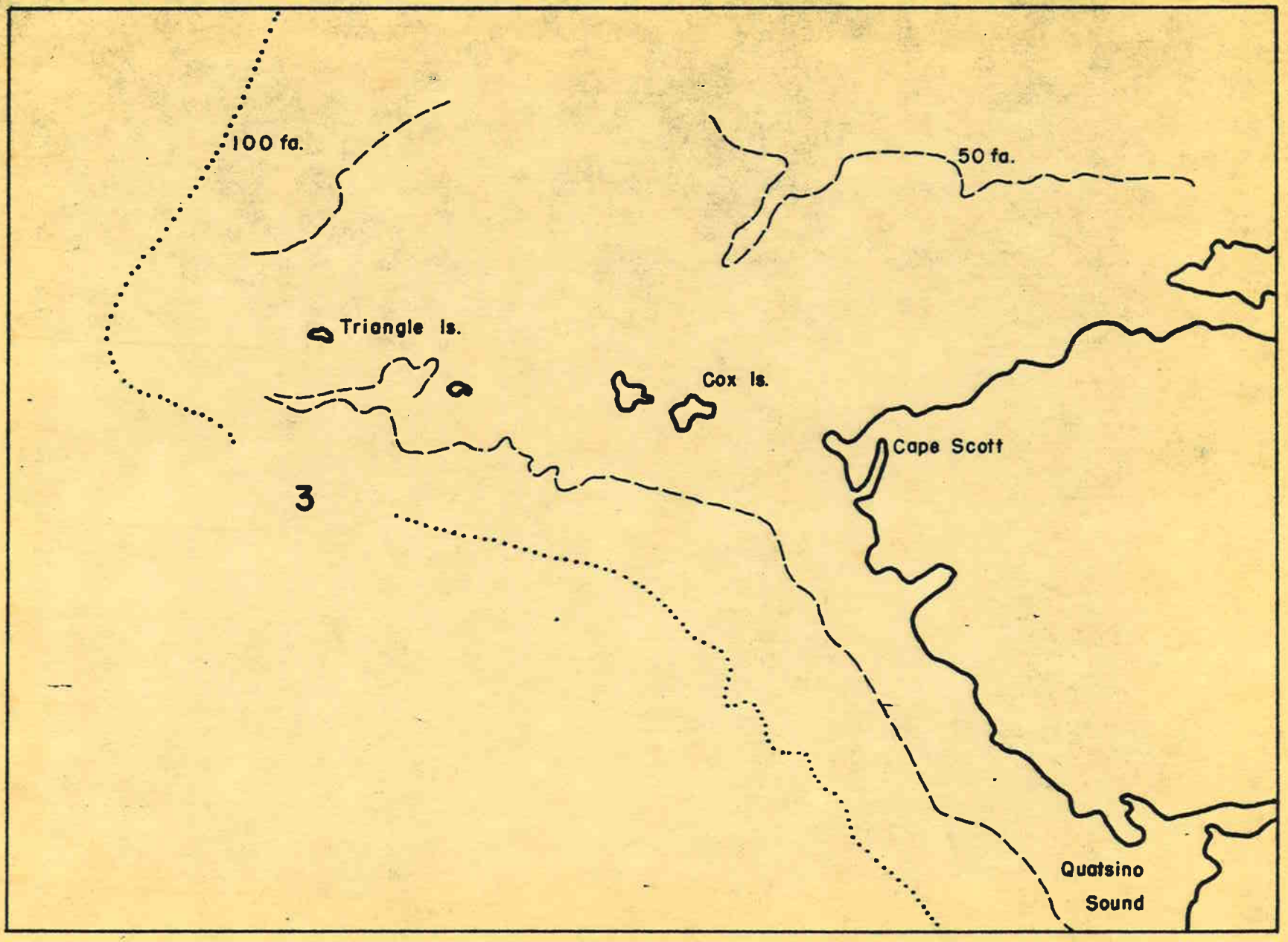
HECATE STRAIT

Figure 10.



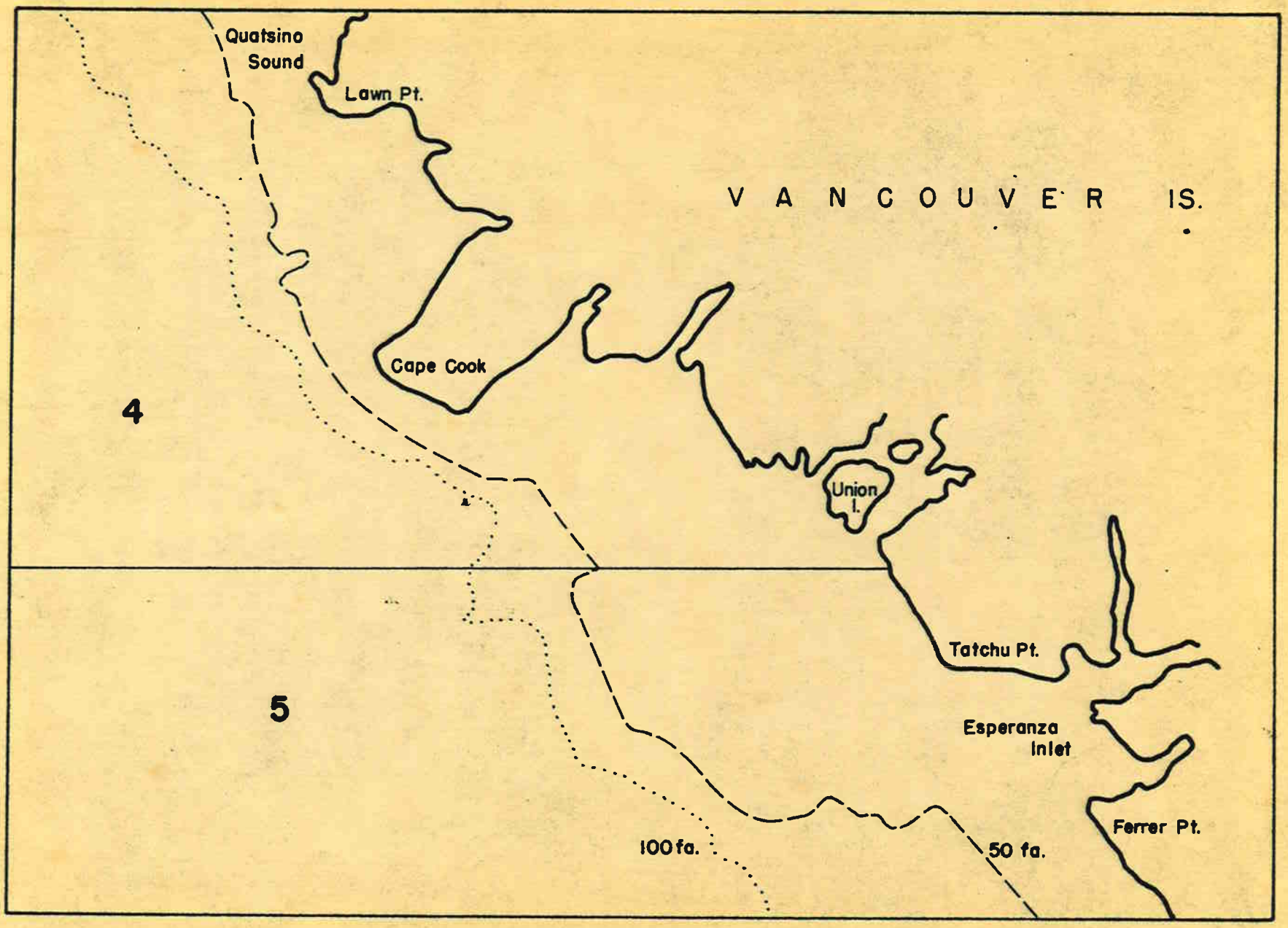
GOOSE ISLAND GROUNDS

Figure 11.



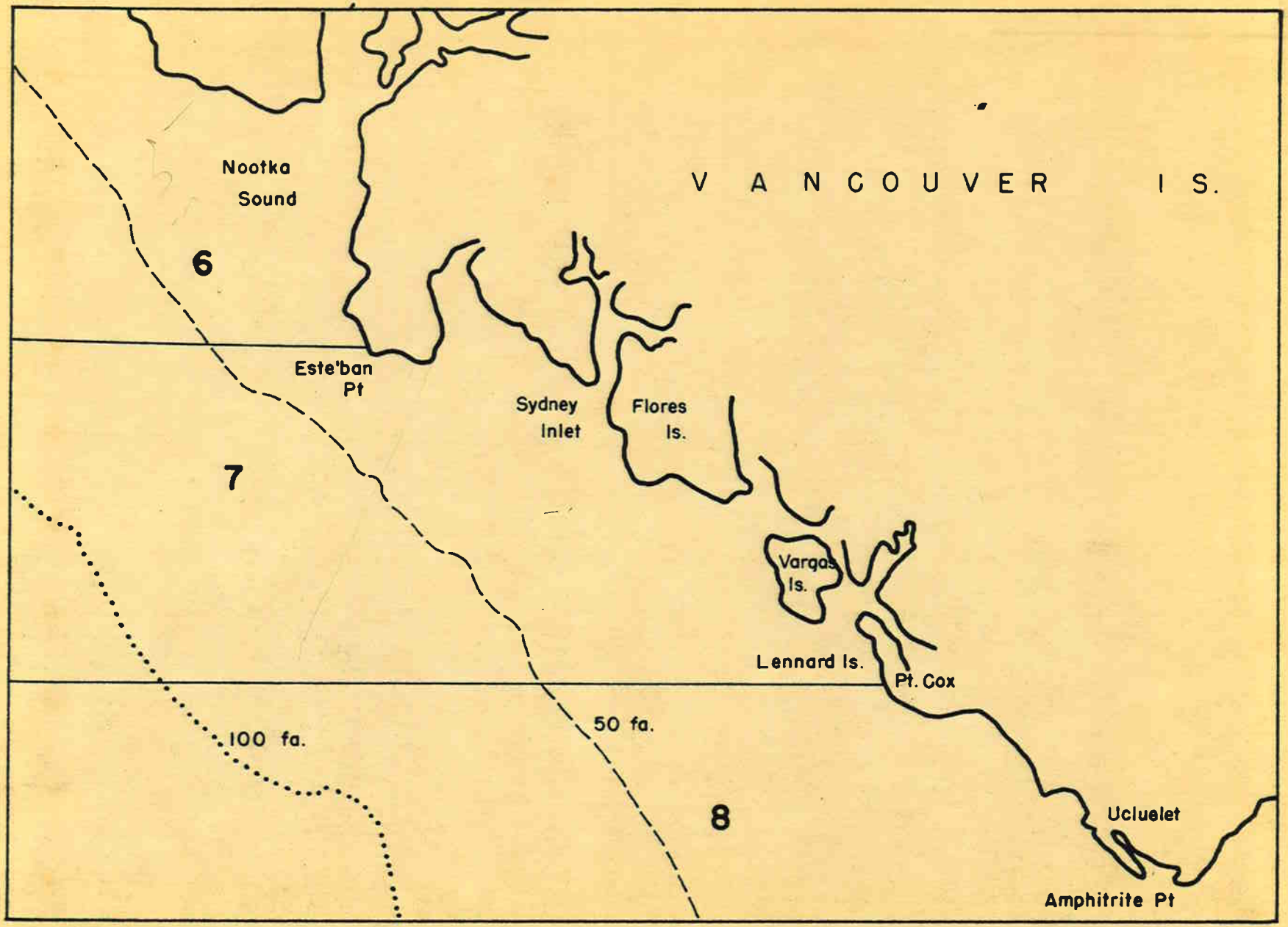
Cape Scott Grounds

Figure 12.



Cape Cook - Esperanza

Figure 13.



Nootka Sound - Este'ban, Sydney Inlet - Amphitrite Pt. & Ucluelet

Figure 14.

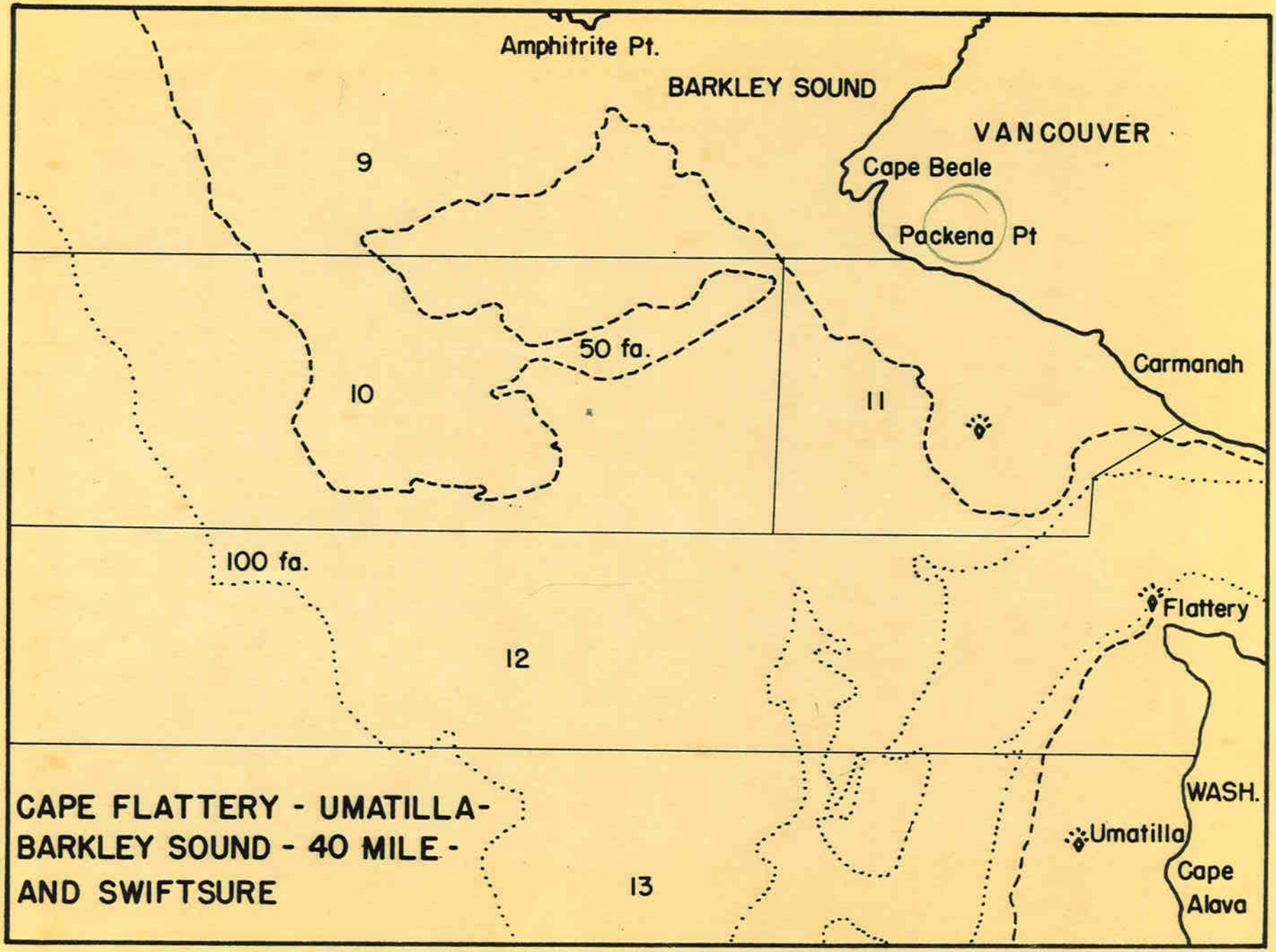
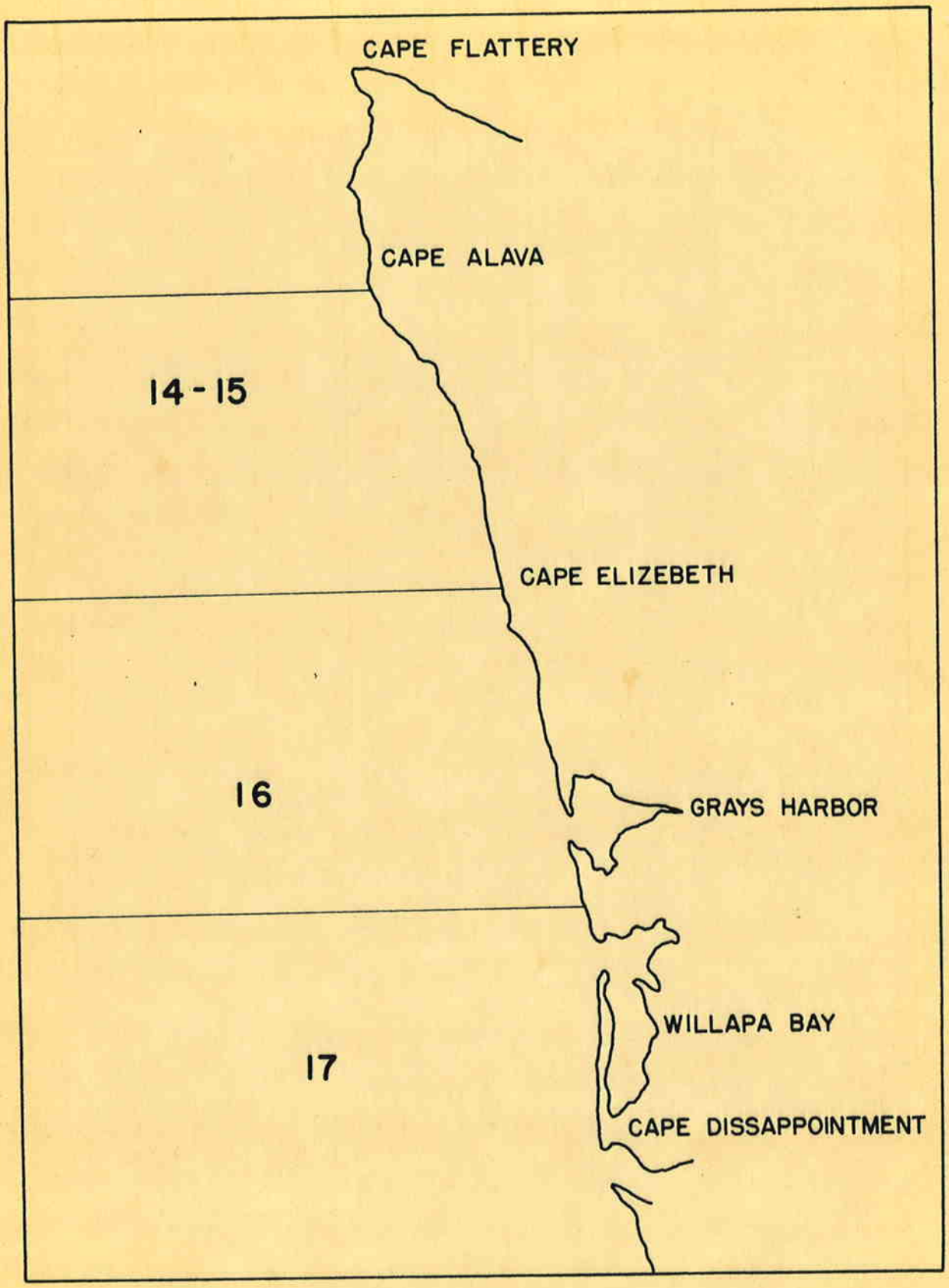

Amphitrite Pt.
BARKLEY SOUND
VANCOUVER
9
Cape Beale
Packena Pt
50 fa.
10
11
Carmanah
100 fa.
12
Flattery
WASH.
Umatilla
Cape
Alava
CAPE FLATTERY - UMATILLA-
BARKLEY SOUND - 40 MILE -
AND SWIFTSURE
13

Figure 15.



WASHINGTON COAST

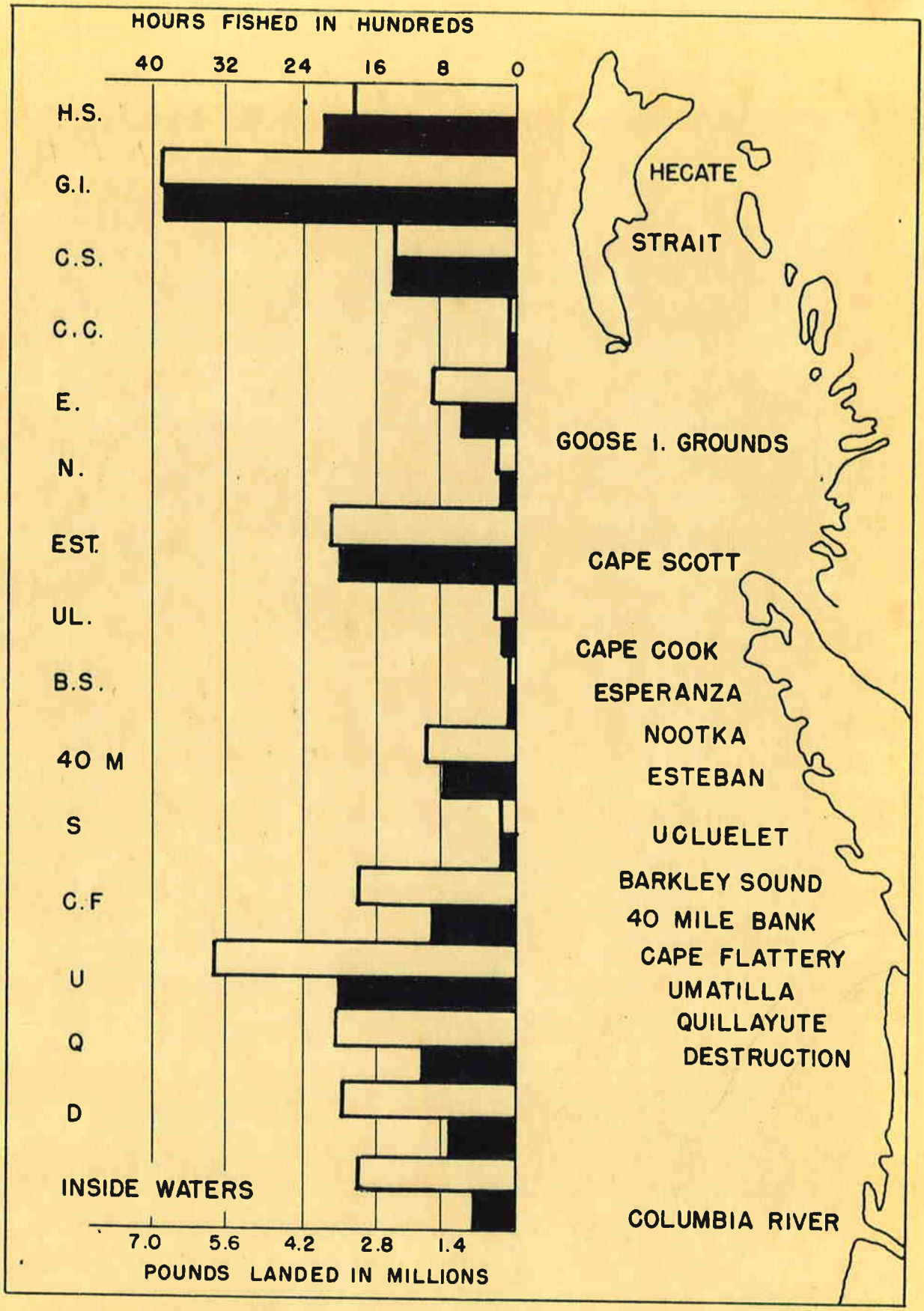
Figure 16.

intensity, and also from supplementary data received from the Washington Trawl Association, a total estimated catch for the year was computed (Table 4).

Table 3 - Sampling by month of otter trawl landing, 1954.

Month	Inside		Outside		Pounds
	landings	sampled	landings	sampled	
January	54	33	47	42	1,563,795
February	52	19	66	43	1,913,365
March	35	8	126	87	4,074,934
April	12	3	82	70	2,543,095
May	12	3	86	59	2,682,517
June	6	2	56	44	2,117,274
July	4	3	64	40	2,295,470
August	4	4	66	51	2,843,387
September	6	3	69	62	3,383,053
October	16	6	71	58	2,169,451
November	31	7	76	60	1,772,086
December	65	22	62	42	1,623,571
Total	297	113	871	658	29,181,998

A breakdown of catch for all species combined, hours fished, and catch per hour by interview area has been compiled in Table 5. The productive index by area has been established to better interpret the catch per hour relationship between the various fishing banks. The productivity index for any area is equal to the catch per hour for that area divided by the catch per hour for all areas combined. Areas with low productivity index readings are those adjacent to the Washington coast while the areas having high productivity index readings are those producing good catches of trucood or Pacific ocean perch. A graphic depiction of the effort and catch in areas fished by Washington trawlers is shown in Figure 17, while the relative productivity index is shown in Figure 18.



EFFORT AND PRODUCTION WASHINGTON TRAWL FLEET 1954

EFFORT CATCH

Figure 17.

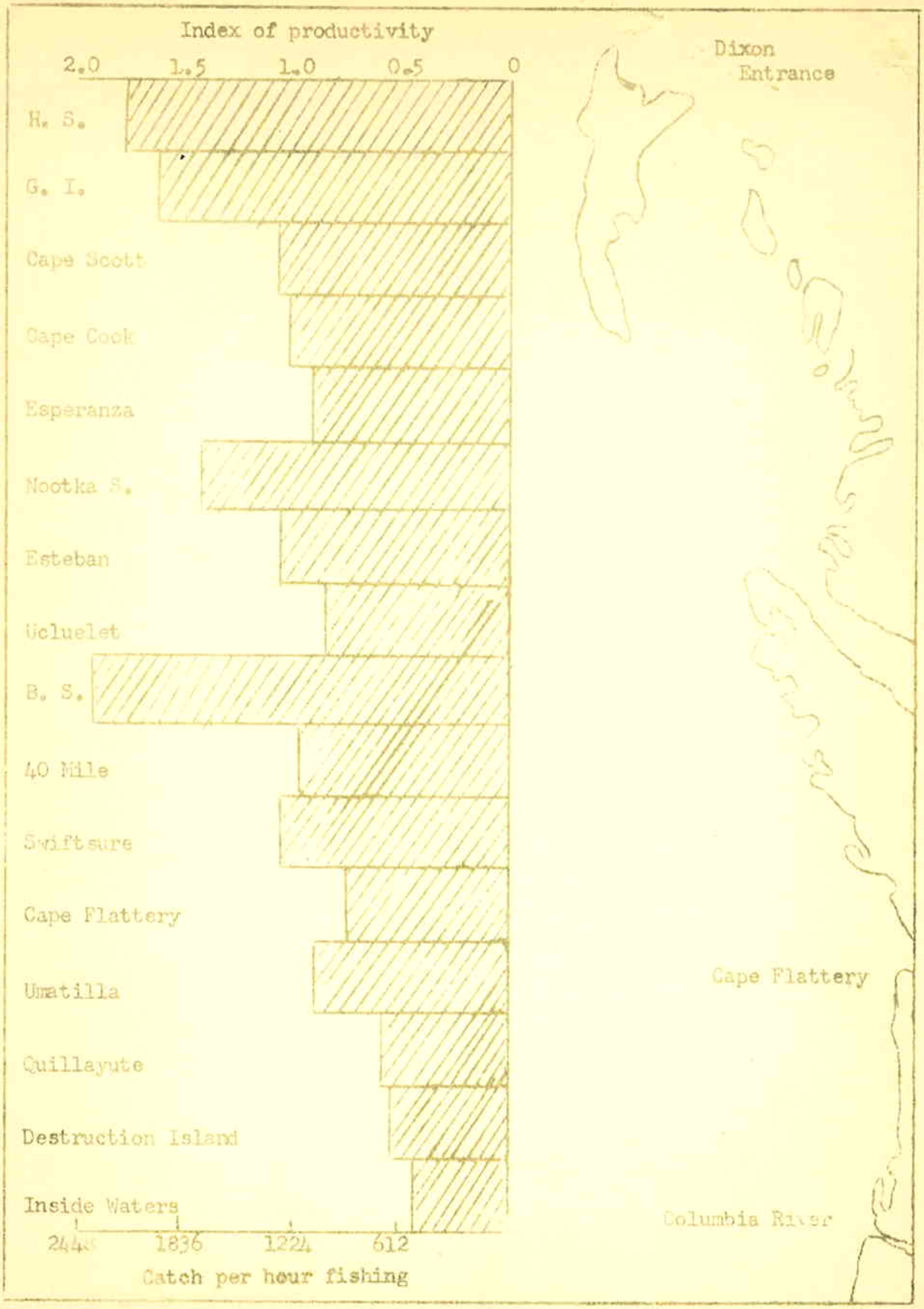


Figure 18. Catch per hour and productive index by area, Jan.-Dec., 1954. (all species combined)

Table 4 - Estimated 1954 trawl landings from interviews.

Species	Food Fish Outside	Inside	Total	$ Value
Truecod	12,900,000	620,000	13,520,000	540,800
Lingcod	2,040,000	50,000	2,090,000	104,500
Blackcod	370,000		370,000	29,600
Redrock	1,990,000	40,000	2,030,000	81,200
Blackrock	620,000	5,000	625,000	25,000
Mixed rock	1,890,000	50,000	1,940,000	77,600
Ocean perch	7,000,000		7,000,000	280,000
Petrale sole	3,660,000		3,660,000	329,400
English sole	3,170,000	600,000	3,770,000	263,000
Dover sole	1,705,000	25,000	1,730,000	86,500
Rock sole	520,000	40,000	560,000	22,400
Flounder	510,000	190,000	700,000	28,000
Miscellaneous	100,000	100,000	200,000	10,000
Total	36,476,500	1,695,000	38,195,000	
Mink food and scrapfish			4,500,000	55,000

I.B.M. System

During July 1954, a system, devised with the aid of the statistical section, was initiated whereby all numerical information collected on standard interview forms would be tabulated onto I.B.M. cards. The I.B.M. system, placed in operation in July, produces monthly summaries of (1) catch by species and hours fished; (2) total catch by species; (3) catch by depth for significant catches*; (4) catch by boat. A number of other reports will be processed at the end of each year, which will allow more time for analysis of trawl data. From July 1 to December 31, 1954, a total of 2700 I.B.M. cards was punched to accommodate trawl data and it is estimated that 7500 cards will be used in 1955.

*Any species catch representing 25% or more of total catch in area being fished.

Table 5 - Summary of catch/effort data and productivity indices, 1954 trawl landings (all species combined) based on interviews.

Area	Catch	Hours fished	Catch per hour	Productivity Index
Hecate Strait	4,900,000	2,258	2,170	1.8
Goose Island	8,919,000	4,974	1,793	1.5
Cape Scott	3,210,000	2,328	1,379	1.15
Cape Cook	28,000	29	965	.80
Esperanza	1,100,000	1,058	1,040	.86
Nootka	420,000	226	1,858	1.55
Esteban	3,800,000	2,778	1,368	1.14
Uclulet	345,000	348	992	.83
Barkley Sound	249,000	104	2,394	1.99
40 Mile	1,912,000	1,594	1,199	.99
Swiftsure	426,000	307	1,386	1.15
Cape Flattery	2,228,000	2,498	892	.74
Umatilla	4,700,000	4,348	1,081	.89
Quillayute	2,144,000	2,647	810	.67
Destruction	1,819,000	2,621	694	.58
Grays Harbor	54,000	100	547	.46
Puget Sound	1,695,000	3,538	479	.40
Miscellaneous	236,000	———	———	———
Total	38,193,000	31,756	$\bar{X}$ 1,202	1.00

* $\frac{\text{Catch per hour by area}}{\text{Catch per hour all areas, 1954}}$

GENERAL INFORMATION ON THE 1954 FISHERY

During the year, the landings were the largest reported since 1945. A total of 116 vessels participated in the fishery although a fair portion of these were active for only a short period (a list of boats known to have made trawl landings in 1954 is given in Table 6). Washington trawlers fished from the Columbia River north to S. E. Alaska, a distance of over 700 miles.

During the past several years the Washington trawl fleet has developed offshore deep-water dragging. Prior to 1950 practically the entire fleet fished at depths between 10 and 100 fathoms. The offshore expansion resulted from the discovery of Pacific ocean perch grounds and the development of the "perch" market while the innovation of Loran and other fish finding devices substantially aided the efficiency of deep-water fishing. Deep-water trawling which has progressed steadily has been watched closely during the past two years to obtain information on the stocks under exploitation. An analysis of the July through December interview data as summarized by I.B.M. shows that 33 percent of the sampled catch was caught in depths below 100 fathoms. (Figure 19). The exploitation of deep-water fish is mainly predicated on Pacific ocean perch; however, good catches of Dover sole, petrale sole, and red rockfish are also made on the continental slope.

The effect or future effect of deep-water fishing necessitates a knowledge of the populations or stocks being exploited on the various ground and their seasonal vertical depth distribution. An analysis of the interview data and past catch records regarding the quantities and distribution of catches from below 100 fathoms sheds some light on conservation and management aspects of the fishery. Pacific ocean perch accounts for the majority of fish poundage landed from depths below 100 fathoms, approximately 7 million pounds caught in 1954. The remainder of the deep-water harvest, about 4,000,000 pounds, consisted of petrale sole, Dover sole, red rockfish, and blackcod.

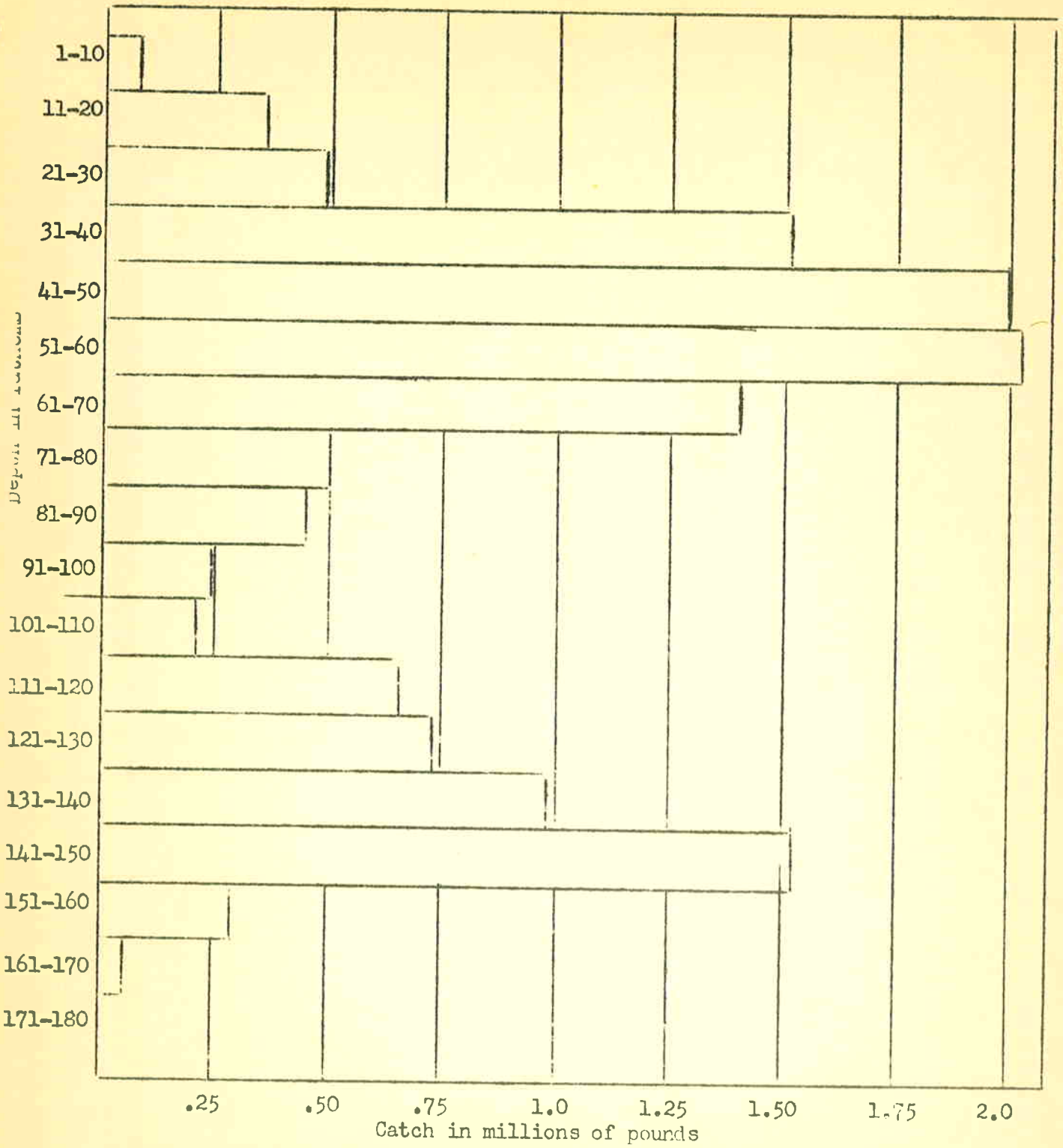


Figure 19. Catch by depth as shown from interviews, July-Dec., 1954.

Table 6 - Boats making trawl landing in 1954.

Albany
Alda B.
Aloma
Alrita
Alsek
Anna A.
Ann B.
Arlice
Arthur H.
Avalon

Barbara Ann
Barbara S.
Betty Jane
Blanco
Bonnie C.
Bobetta
Brisk
Brookfield

Chelsea K.
Claudia H.
Confidence
Crusader

Daisy
Dakota
Duchie C.

Eloise III
Emblem
Emily Jane
Esperanto
Estep
Evening Star
Evelyn C.
Escel II

Famous Maid
Fenwick
Frigidland
Frostland

Gallant Maid
Gem
Gladiator
Grizzly II
Guide

Harmony
Heather
Helen W.
Hercules
Hydah

Jeanette F.

Karen T.
Kristing

LaConner
Lady Olga
Leading Lady
Lemes
Lemes II
Little Yank
Lituya
Lorenz

Majestic
Mariner
Marie II
Martle
Midway
Mildred
Mitkoff
Morning Star
Mylark

Nestor
New Elida
Newport
Nick C. II
Nina B.
Northern Light
Notre Dame

Opal

Pacific Breeze
Paradise
Panther
Paragon
Patricia Joan
Paul L.
Plover
Point Defiance

Radio
Regina
Rio Del Mar
Roberta

Santa Maria
Sea Port
Sehome
Shushartie
Sockeye
Solta
St. John
St. John II
Sogn
Soupfin
Sunlight
Sunset
Sunward
Sunwing II
Susan

Tagaloff
Thoreen
Theresa S.
Thomas J.
Tommy M.
Tongass
Tordenskjold
Tulip

Victory Maid
Vernon
Vigorous
Voyager

Western Flyer
Western Maid
Western Sun

Yaquina
Zarembo II

The Pacific ocean perch fishery is being carried out at depths entirely below 100 fathoms. The depth distribution for commercial exploitation ranges from 100 to 160 fathoms and this species apparently has no inshore component population, as stocks are not found on the adjacent shallower banks. The "perch" fishery was first exploited by Washington trawlers in 1950 and is still in a phase of development, exploration, and expansion. The full potential of the fishery is unknown and over-fishing is not apparent from catch records.

Tagging experiments (see section on petrale sole) have indicated that the petrale sole taken in deep water are in part, at least, composed of fish which are exploited on the inshore grounds and the catch per effort data indicates a high vulnerability on the deep-water banks. Since 1948 there has been a steady decrease in the catch of petrale sole and the recent discovery of the deep-water winter petrale banks has intensified the effort expended in harvesting this species. A complete summary of the deep-water petrale fishery is discussed in the section on petrale sole.

Dover sole is a species which has not generally been utilized by Washington fish processors. Only in the past several years has any quantity of this species been landed by Washington boats, and interview data shows that most Washington boats avoid taking this species.

The extent of isolation or mixing between blackcod in deep water and those on the shallower banks is not known. Pacific Marine Fisheries investigations have shown indications of over-fishing on this species and trawl catches have shown signs of over-fishing during recent years.

With the exception of petrale sole, the deep-water fishery has not developed any serious conservation or trawl management problems. The fishery is mostly predicated on species which are not found on the inshore grounds or species which have not been actively exploited. Actually, the fishery has reduced the effort expended on the inshore grounds.

MARKETING TRENDS

The 1954 increased landings resulted from a strong market demand for both Pacific ocean perch and truecod. The inception of fish sticks in 1953 found a ready consumer demand which resulted in unlimited landing of truecod. The majority of perch sales resulted from U. S. Army orders; however, domestic sales also increased on the west coast. The main ports of landing have continued to be Bellingham and Seattle, although fair quantities have been landed at Anacortes, Everett, and Aberdeen. In addition to the fish dealers in these localities, trawl-caught fish is also shipped by truck from various coastal areas (Neah Bay and Blaine). Bottom fish processors, by port, are listed below:

Seattle

Eardly Fish Company	Pier 62
Main Fish Co.	Pier 49, Box 3092
Northwest Fisheries	15th N. W. and Shilshole
San Juan Fish Co.	P. O. Box 3086
Seattle Seafood, Inc.	Pier 61
Sea Port Fish Co.	Pier 57

Bellingham

Bornstein Fish Co.	P. O. Box 188
Dahl Fish Co.	601 West Chestnut
May Sea Food	1206 Central Ave.

Everett

Chase Sea Foods	P. O. Box 216

Anacortes

Skagit Fisheries	P. O. Box 275

In addition to the regular food fish producers, reduction plants handle scrap at Tacoma, Everett, Blaine, and Anacortes.

Tacoma

Puget Sound Rendering Works	8317 Tyler St. S. W.
Carstons Packing Co.	1623 East Bay St.

Everett

Puget Sound By-Products	Box 651

Anacortes

Skagit Fisheries	P. O. Box 275
J. E. Trafton & Sons	Box 340

Blaine

Blain Fish Products	Blaine, Wash.

ANALYSIS BY SPECIES

The tabulation of data obtained through the trawl-interview system aids in determining the importance of trawl banks and the relative poundage of various species which they contribute to the total trawl catch. In an evaluation of of trends in abundance levels, it is necessary to treat each species and each stock or population as an entity. For most species neither tagging nor morphometric data have been obtained to establish the identity of separate stocks; however, in many instances tentative stock identification may be made by studying the geographic origin of the catches. A preliminary separation of the populations of each species under exploitation has been attempted with the 1954 data. An analysis of species contribution by area, probable stock or populations involved in the fishery, and related biological and statistical data follows.

Petrale Sole (Eopsetta jordani)

Petrale sole ranked fifth in poundage (3,660,000 lbs.) and second in value ($329,400) for trawl-caught fish during 1954. The major petrale producing grounds were Esteban, Hecate Strait, and 40 Mile Bank, with fair catches being made at Cape Scott and Esperanza (see Table 7 for catch/effort data). The major production from most of the banks is made in relatively short periods which show little chronological consistancy when compared on a coastwise basis. Table 8 gives the monthly production of petrale sole from the major producing areas. The lack of any seasonal coastwise trend for petrale catches and the short period of productivity for these areas suggests

migratory stocks are being exploited. This is partially substantiated by recent tagging work.

Table 7 - Summary catch/effort data and productive index* - 1954 trawl landings of petrale sole.

Area	Catch	Hours	C/H (lbs.)	Productive index	Significant** C/H
Hecate Strait	647,500	2,258	287	2.49	1,509
Goose Island	184,160	4,974	37	.32	398
Cape Scott	242,200	2,328	105	.91	291
Cape Cook	13,360	29	460	4.03	---
Esperanza	252,980	1,058	239	2.07	555
Nootka	31,790	226	140	1.21	300
Esteban	1,164,920	2,778	419	3.64	1,150
Uclulet	135,400	348	389	3.38	480
Barkley Sound	14,950	104	143	1.24	---
40 Mile	496,220	1,594	311	2.70	599
Swiftsure	54,930	307	178	1.54	236
Cape Flattery	91,240	2,498	37	.32	261
Umatilla	221,810	4,348	51	.44	285
Quillayute	55,780	2,647	21	.18	---
Destruction	45,220	2,621	17	.15	100
Grays Harbor	7,340	100	73	.63	---
Inside	200	3,538	---	---	---
Total	3,660,000	31,756	115	---	---

* $\frac{\text{Area catch per hour}}{\text{Average catch per hour (all areas)}}$

** Petrale sole in catch represented 25 or over of total fare made during particular effort

Table 8 - Catch by month of petrale sole for major production areas, 1954.

Month	Esteban	Hecate Strait	40 Mile	Cape Scott	Esperanza
January	71,520	-	-	400	
February	15,350	-	-	30,030	
March	587,240	-	-	42,650	39,570
April	415,380	-	-	4,670	60,070
May	9,340	4,670	2,000	6,670	126,800
June	660	22,070	8,140	24,760	260
July	6,070	-	51,390	34,170	10,940
August	40,070	571,740	39,580	9,610	8,670
September	1,860	43,690	159,090	31,690	-
October	2,530	2,000	225,280	11,340	6,670
November	11,080	3,330	10,740	37,240	-
December	33,820	-	-	8,970	-
Total	1,164,920	647,500	496,220	242,200	252,980

Depth Distribution

The petrale sole may inhabit depths from a few to several hundred fathoms. During the summer and fall month the most productive depth lies between 31 and 60 fathoms (Figure 20), with the strata between 51 to 60 fathoms yielding the largest poundage. Actually the indicated vertical distribution of the species varies between the major producing areas or grounds, and although the greatest inshore harvest of the species occurs between 51 and 60 fathoms, better catches of petrale sole from 40 Mile Bank are made between 31 and 40 fathoms (Figure 20-B). The vertical distribution graph for any particular area may be affected by this type of bottom and the trawlability of the grounds. During the late fall and winter months inshore catches are slow. The majority of the

adult fish evidently seek deeper water for their spawning activities and are found at depths ranging from 140 to 220 fathoms. The catches, indicated on Figure 20-C, are mostly from the Esteban Deep and were caught during the winter and early spring months.

ESTEBAN DEEP STUDIES

During the past year the trawl staff has been engaged in a study of a deep-water petrale stock off the west coast of Vancouver Island. The fishery, discovered in March of 1953, has been described in the past two progress reports. The "Esteban Deep" was considered unique because of the depth at which the petrale sole were caught (160-220 fathoms) and because of their extreme vulnerability to the fishery. In 1953 six boats landed 250,000 pounds of petrale sole from the Esteban grounds in about three weeks. By March, 1954 many of the Washington trawlers added more cable to their drums and during the same three week period (March 20 - April 10) close to 900,000 pounds were landed.

Biologists and fishermen were concerned with the possibility that the fishery was a component of inshore stocks which supported the summer petrale fishery. To obtain more information on the Esteban petrale stock a cooperative tagging program was carried out with the Fisheries Research Board of Canada. Between April 9 and 11 a total of 1,795 tags were released at depths between 200 and 205 fathoms (charter of M/S Heather).

Previous tagging work carried out by Canadian workers along the west coast of Vancouver Island and in Hecate Strait has shown that at least a portion of the Esteban fish were being drawn from the more northern grounds in Queen Charlotte Sound and in Hecate Strait (Figure 21). The results of the Canadian tagging experiments were reported in the October, 1954 Progress Reports of the Pacific coast stations. All Esteban recoveries of Canadian tags were released

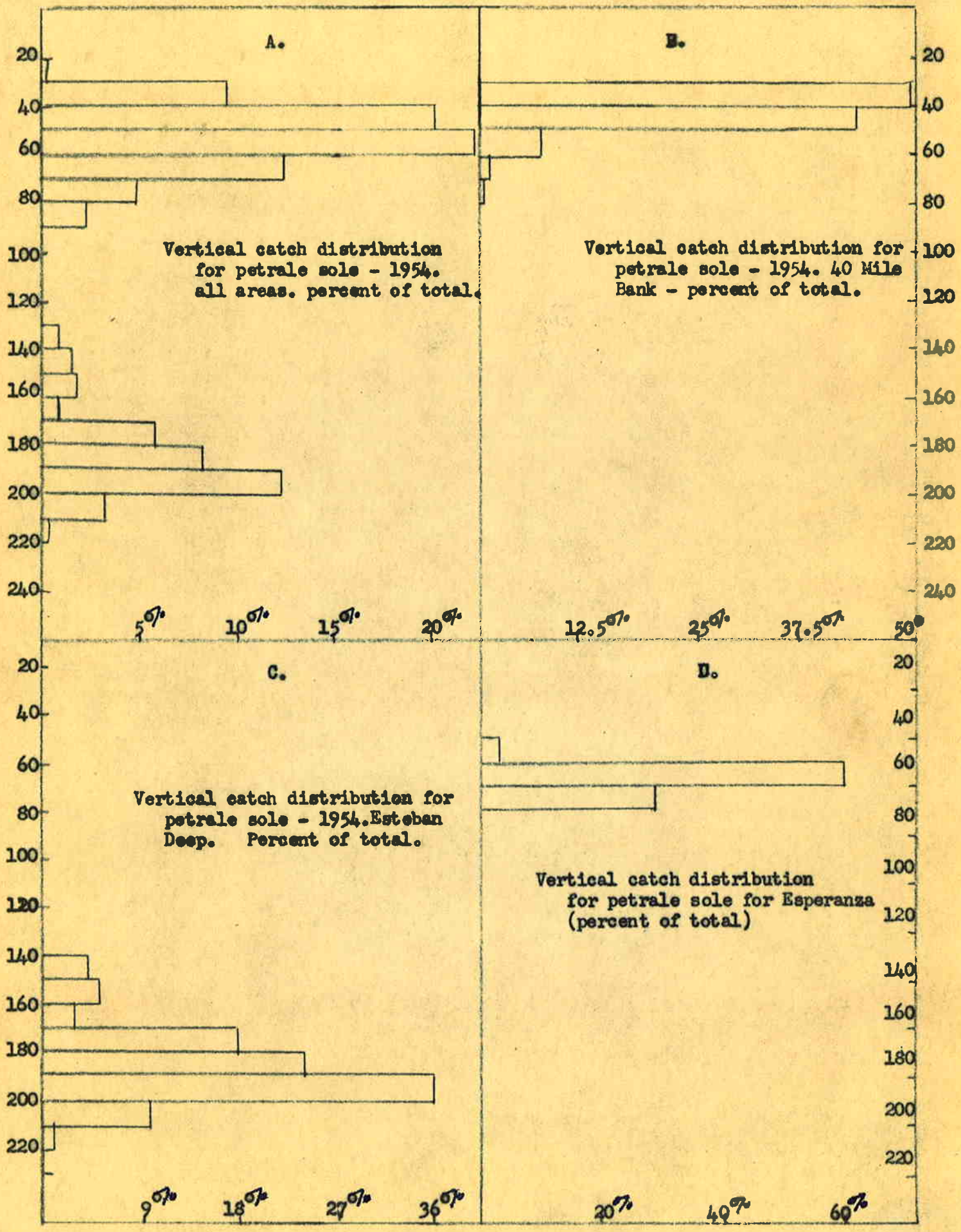


figure 20 - Vertical catch distribution for petrale sole, 1954.

March 1952 - April 1954

Figure 21. Number of Canadian tagged petrale sole released at indicated areas and recovered in "Esteban Deep".

north of the recovery area with the majority having been released in the Queen Charlotte Sound - Hecate Strait area. This was surprising as greater tagging intensity was carried out south of the recovery area (40 Mile Bank) and none of these tags were recovered at Esteban.

Results of the cooperative Canadian-American tagging showed a reverse direction back towards the Queen Charlotte - Hecate Strait region (Figure 22). Only two tags were taken south of the Esteban area. If the recoveries were shown in relation to the total petrale catch by area (since the time of tagging) the northward trend is still apparent. Tag recoveries tend to indicate a cyclic migration of the petrale population along the Vancouver Island coast, moving south during winter months and north in the spring.

Only fourteen tags were recovered from those released at Esteban (as of December 31, 1954). A heavy tagging mortality was suspected during tagging as the fish seemed to be in distress after release; however, the low recovery may also indicate that the Esteban stock is not heavily exploited on inshore grounds. Further information regarding this assumption collected during the 1955 season.

The vulnerability or availability of the Esteban stock during the 1954 season was approximately twice that of any of the other major petrale producing areas with the exception of Hecate Strait (Figure 23). The high availability of the Esteban stock seems to result from close schooling of spawning fish. A study of market samples have shown that almost the entire Esteban catch was mature fish.

Length frequency measurements have been made for petrale catches sampled from 40 Mile Bank, Esteban, and Hecate Strait, and the frequency curves from these areas are graphically compared in Figures 24, 25, and 26. The Esteban and Hecate Strait samples show the most similar type curves although the Hecate Strait curve has shifted to the right. This may be the result of spring and summer growth. Both Esteban and Hecate Strait samples show an absence of

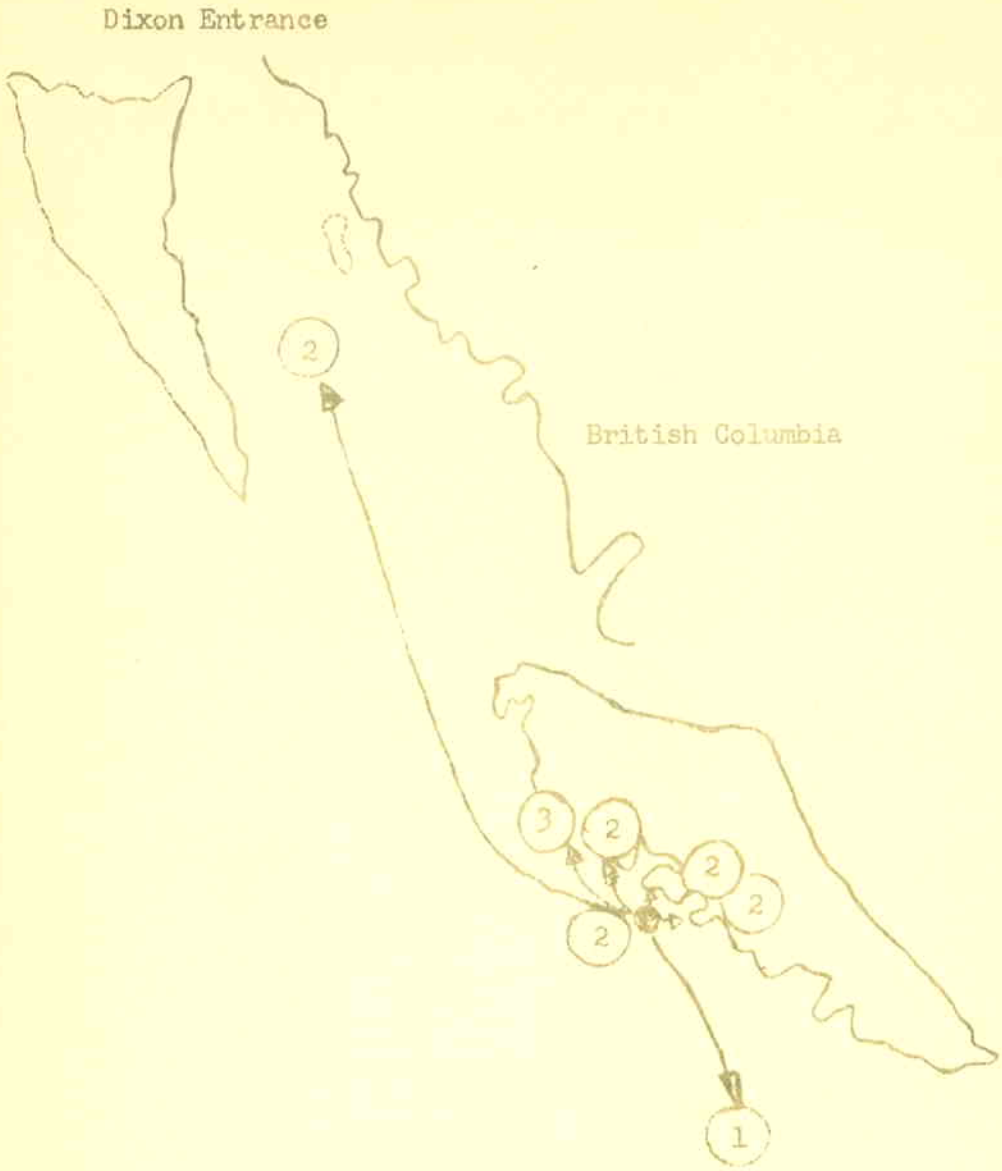
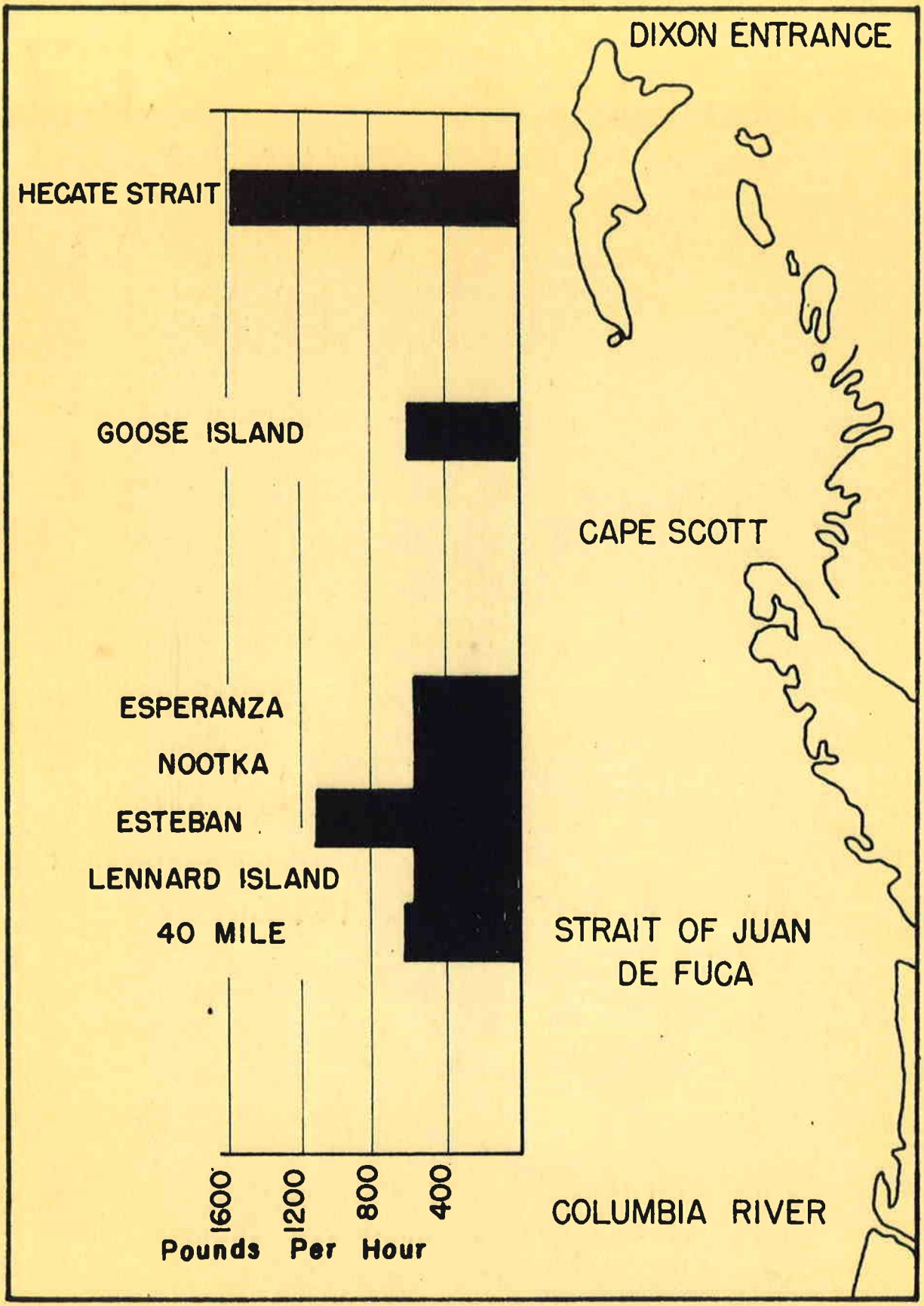
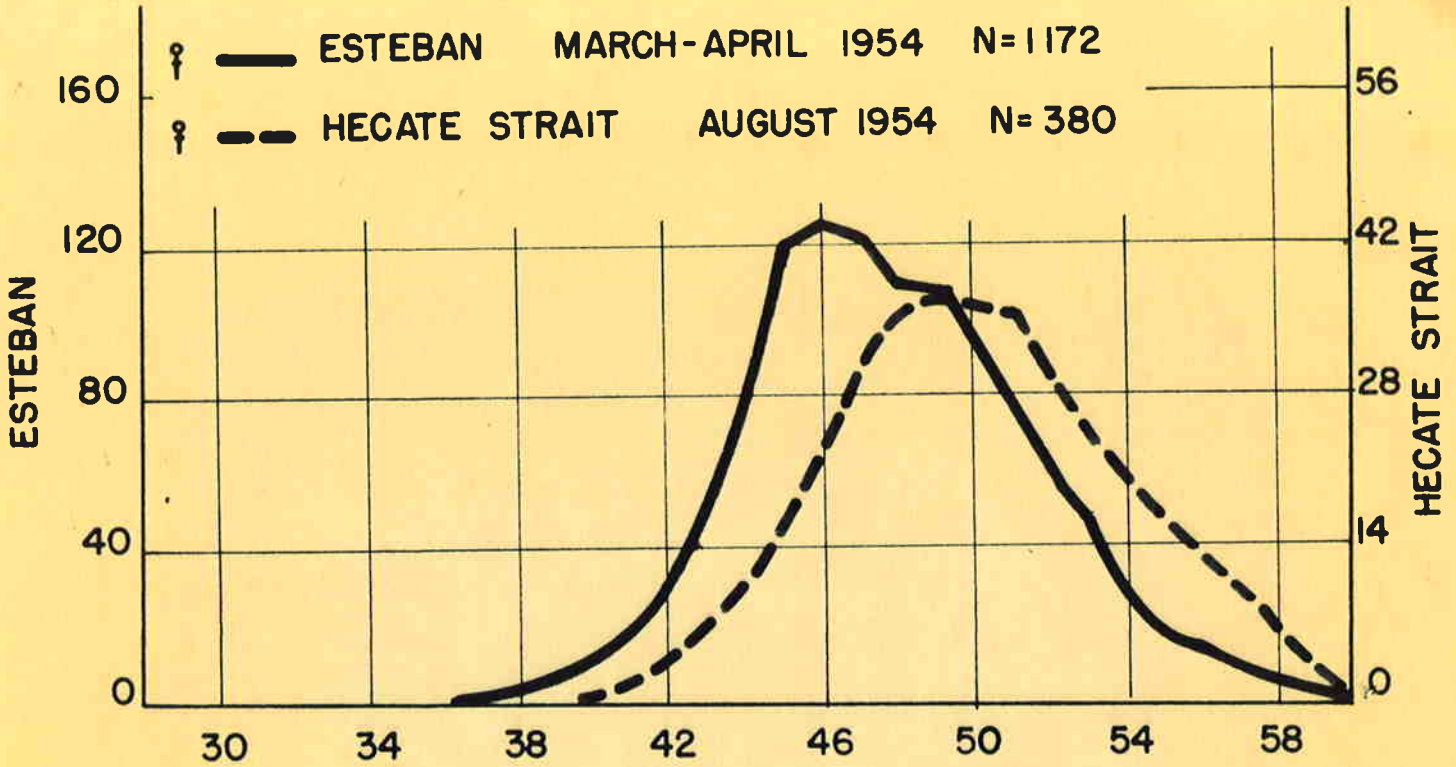


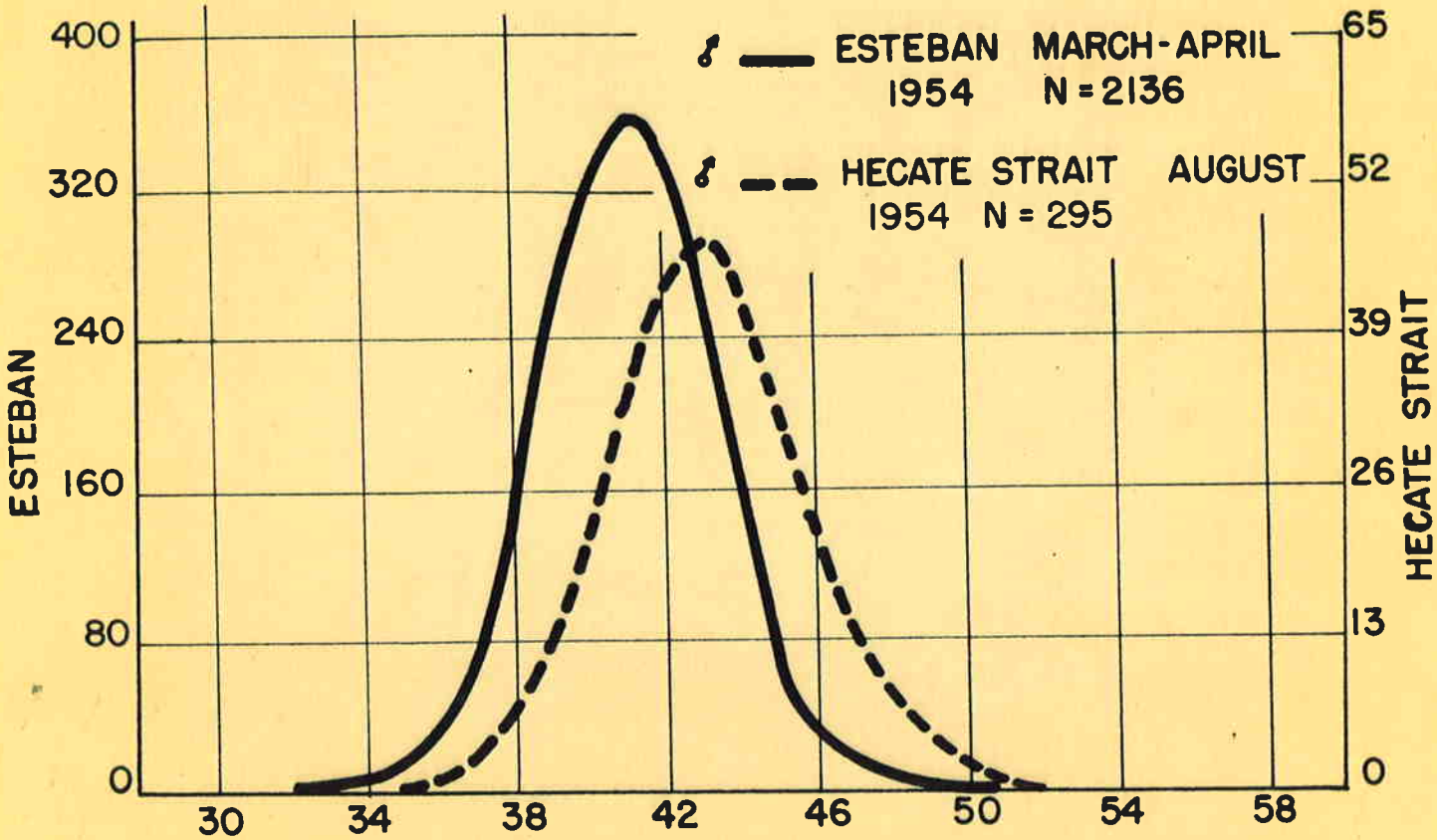
Figure 22. Number of recovered tagged petrale sole from Esteban Deep in indicated areas.



AVAILABILITY OF PETRALE SOLE IN POUNDS PER HOUR (1954)

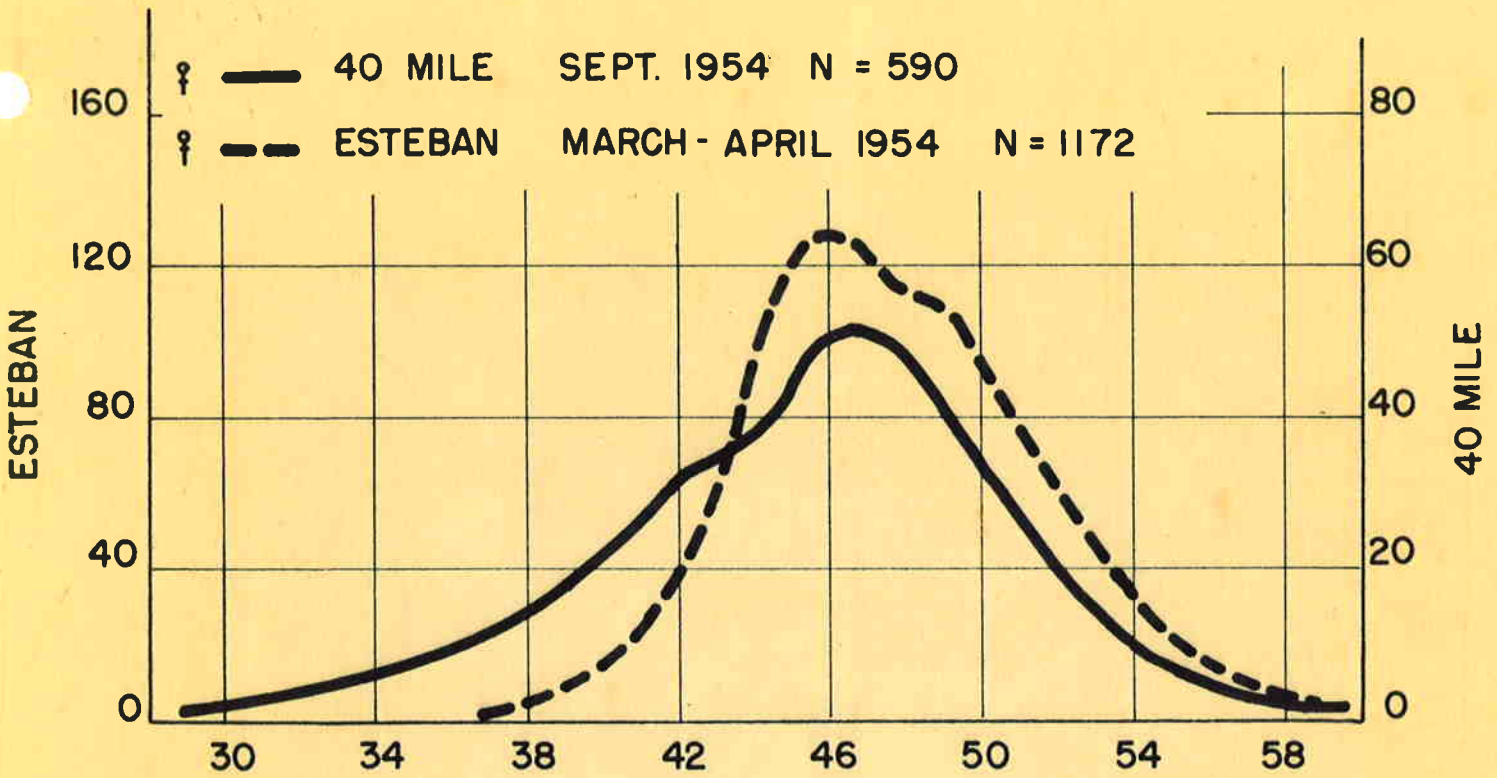
Figure 23.

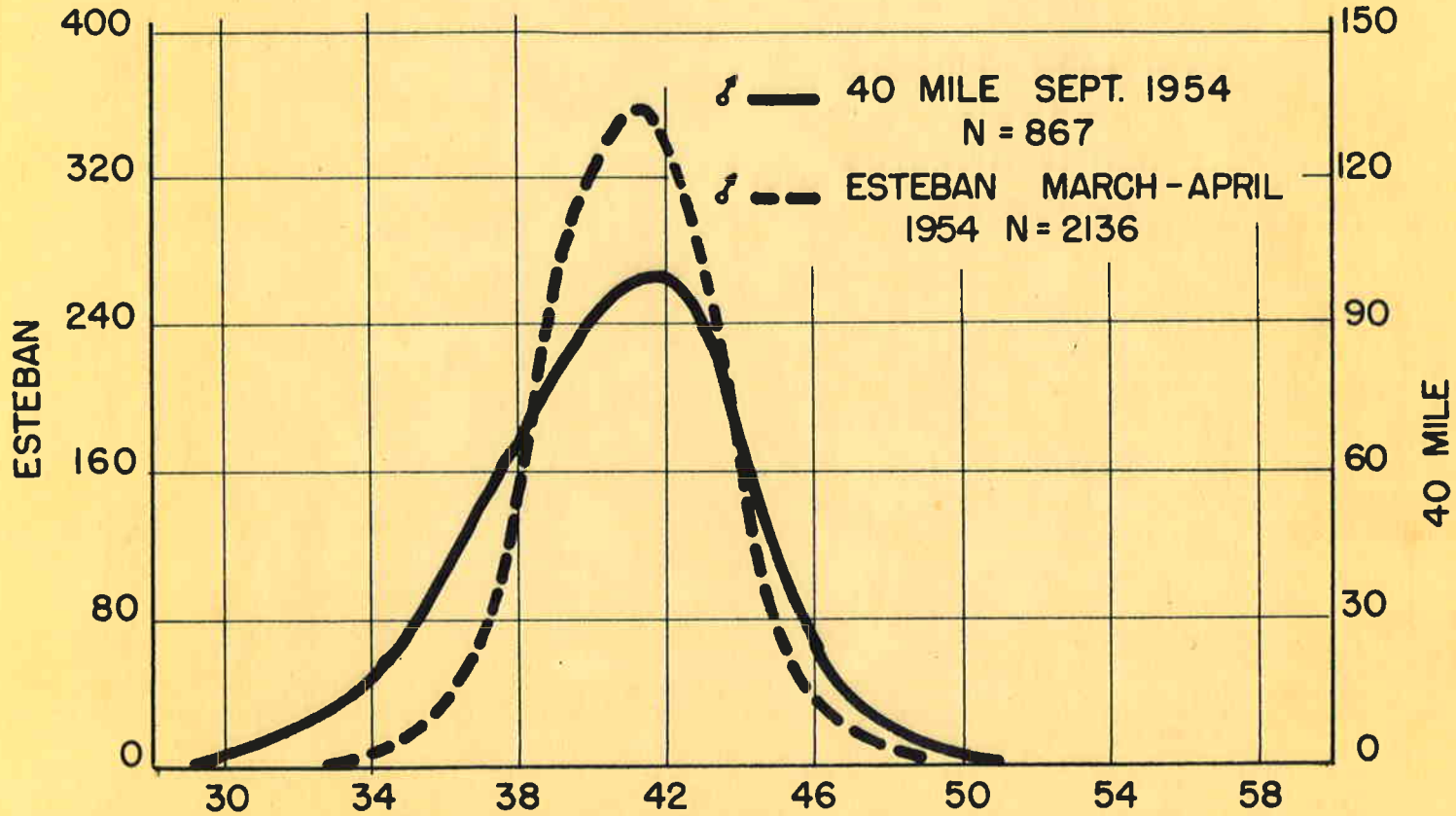




COMPARISON-ESTEBAN AND HECATE STRAIT PETRALE LENGTH FREQUENCIES

Figure 24.

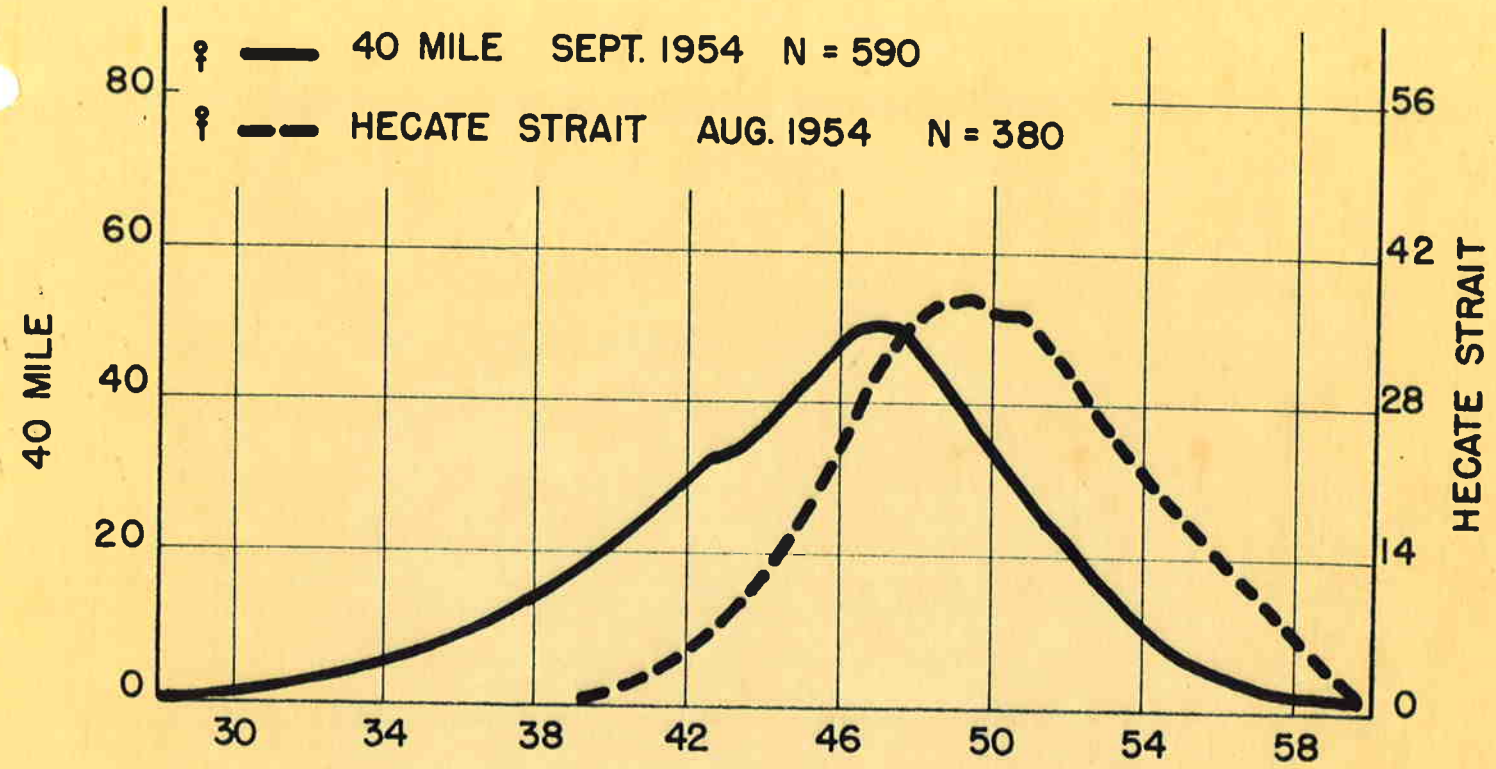


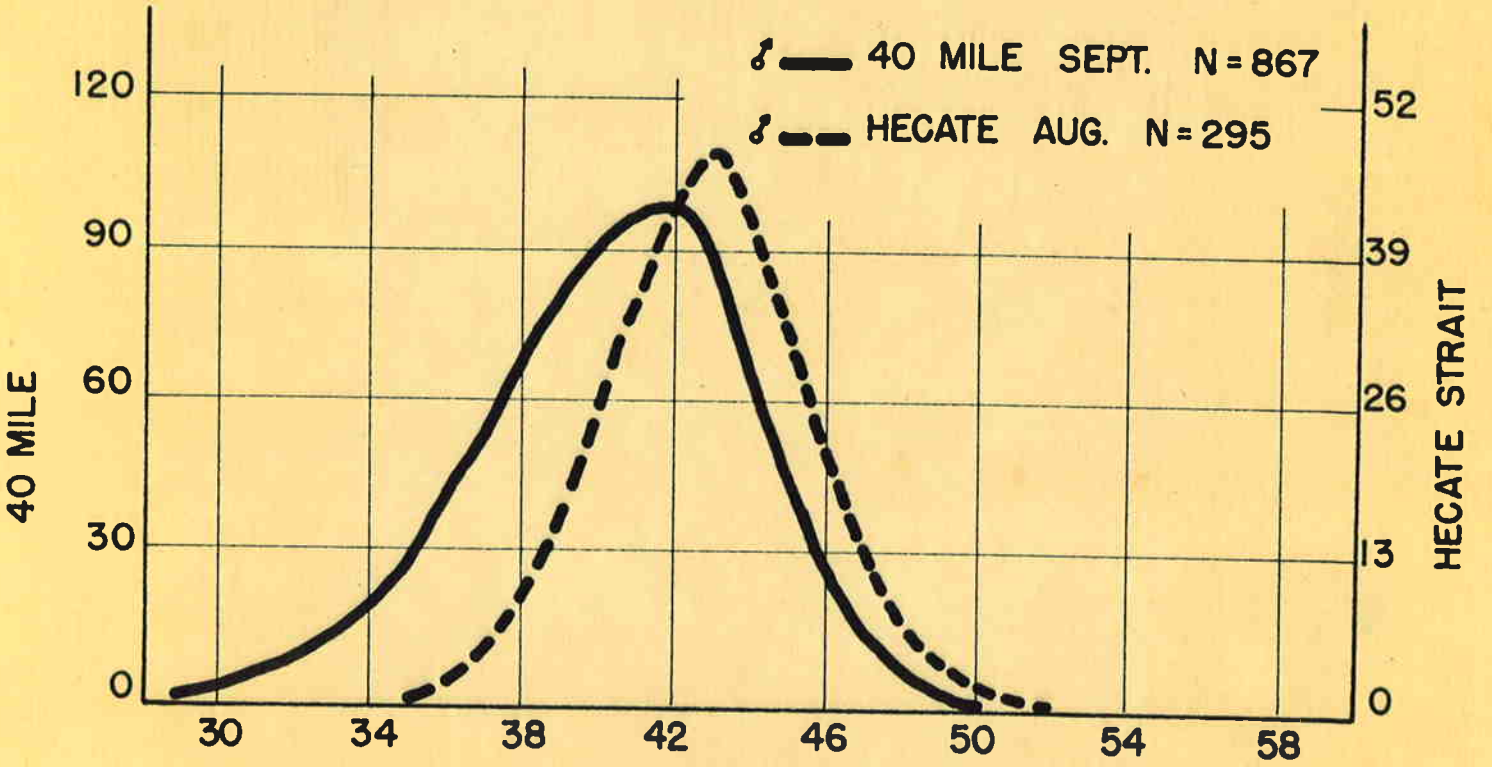


COMPARISON - ESTEBAN AND 40 MILE PETRALE

LENGTH FREQUENCIES

Figure 25.





COMPARISON - 40 MILE AND HECATE STRAIT PETRALE LENGTH FREQUENCIES

Figure 26.

small fish compared with 40 Mile samples. These data support the tagging results which indicate the Esteban, north coast of Vancouver Island, and Hecate Strait fish belong to the samp population. Those fish caught on 40 Mile Bank and Umatilla are probably of different origin.

Washington landings of petrale sole reached a peak in 1948 when 6 million pounds were landed. Since 1948 the total catch has declined steadily until 1953 when slightly over 2,000,000 pounds were landed (Table 9). The 1954 landings are estimated to be 3.5 million pounds, of which 950,000 pounds were caught in the Esteban Deep.

Table 9 - Washington sole landings by species.

Species	1948	1949	1950	1951	1952	1953	1954
English	5,497,359	4,704,273	4,186,152	4,824,120	4,789,484	2,676,277	5,010,027
Petrale	6,185,462	4,870,315	4,422,827	3,405,773	3,382,051	2,445,308	3,606,129
Dover				982,690	1,598,686	1,316,450	1,910,016
Rocksole				490,194	1,420,966	388,374	522,341
Sand				79,000	76,694	51,748	45,849
Rex				3,405	17,770	5,841	7,723
Butter				100	12,870	14,055	79,487
Other	530,180	249,271	424,186	5,893	443,504	358,247	304,299
Total	12,213,001	9,823,859	9,033,165	9,791,175	11,742,025	7,256,800	11,485,871

Note: Sole landings were not separated by species prior to 1948. For 1948, 1949, and 1950 the separation of dover, rock, sand, rex, and butter sole was not considered reliable and they are therefore shown under "other" category.

Refer to Progress Report - cut to a few pages

THEORETICAL MIGRATORY STIMULI

Tagging results indicate that a cyclic migratory pattern, north in the spring and south during winter, occurs with the Esteban - Hecate Strait petrale stock. The reasons for this extensive movement is not apparent from existing biological and oceanographic data; however, sufficient data have been gathered to speculate as to the stimuli which may activate this movement.

The Esteban petrale stock is an aggregate of mature spawning fish. The fish are highly concentrated in a confined area approximately 6 miles long and one-half mile wide. The majority of the fish have been caught at depths ranging from 160 to 220 fathoms, with the maximum production occurring at about 200 fathoms. Bottom samples observed by trawlers have indicated a blue-gray mud or clay type of bottom.

Has this petrale stock moved some 450 miles to the south to locate a physical and chemical environment which is optimum for the survival of the young, or has the migration occurred to assist prevailing oceanographic conditions in the distribution of the progeny back to the habitat of the adult? Perhaps it is a combination of these factors. Superficially it would not seem that the Esteban region would offer physical or chemical oceanographic conditions which differ greatly from those found in many areas along the continental slope off Vancouver Island or in Queen Charlotte Sound. There are many regions closer to Hecate Strait at comparable depth levels which seem to offer a like environment. The wide geographic distribution of the species and its spawning range makes it doubtful that a rather isolated critical physical and chemical environment is a prerequisite to successful spawning. However, since several other deep-water petrale spawning grounds have been located at depths between 160 to 220 fathoms, a density - temperature relationship may be a requirement for the optimum development and survival of the pelagic egg. The possibility that the southward migration occurs as a

from an attempt by the adult to compensate for ocean drift also seems

ent to the various petrale stocks must occur by one of several (1) spawning may occur on the banks along the Continental Shelf ...n no movement by the adults to compensate for ocean drift, the pelagic egg being at the mercy of ocean currents. Those that survived would move inshore and commence their littoral existance miles from parent banks (according to the prevailing drift and time of development). Recruitment to individual stocks would be a hetrogeneous mixture derived from any number of spawning grounds. Hense, the perpetuation of any particular population would depend upon the successful spawning of other stocks. In this instance, nature would seemingly have developed an inefficient method of maintaining the fishery. (2) Spawning may occur on many of the inshore banks with no compensation by the adult for current drift, but with a subsequent migration by the young back to parent areas. Results of tagging experiments indicate that spawning occurs (at times) considerable distance from the adult habitat. (3) Spawning may occur in restricted predetermined regions which are geographically located to take advantage of prevailing currents and aid the recruitment of young to the adult stocks general geographic range. A study of the current pattern along the west coast of Vancouver Island in March (from Rpt. of Int. Fish Comm.) shows a northward movement of the surface waters into Hecate Strait. In this case the young of the Esteban spawn would be carried toward the Queen Charlotte Sound - Hecate Strait region.

The period of development, pelagic existance, and vertical depth distribution of the young are unknown; however, this rythmic movement would seem a logical method of perpetuating the stock by receiving maximum benifit from the spawn deposition. If this theoretical relationship exists then the various stocks would display a degree of independence from others and the population size would be related to the successful recruitment of its own progeny. A

migration of this type would not differ essentially from that shown by salmon to a parent stream or by the Atlantic eel to Sargasso Sea.

MANAGEMENT

Due to the declining petrale catches during recent years fishermen have suggested restrictions to protect the Esteban stocks. Several facts seem to support fishermens' claims that protection is needed: (1) a declining catch although the effort has increased during the past year; (2) greater vulnerability on the spawning grounds; (3) an added fishing intensity on a stock which is evidently declining. The restricting the petrale catch and thereby decreasing the total take may be successful in two ways. It could prevent reducing the spawning stock below its ability to maintain the fishery, and it could help to restore the seed stock if this condition already exists.

A suggested restriction which would accomplish a degree of protection would be a percentage limit on landings during the winter period of high availability. This would curtail the total effort expended toward this species.

ENGLISH SOLE (Parophrys vetulus)

English sole ranked fourth in poundage (3,770,000), and third in value ($263,000) for trawl-caught fish in 1954. The major producing grounds were Hecate Strait, Cape Flattery to Destruction Island, and inside Puget Sound. These three regions produce over 95 percent of the total English sole landed in the State. The absence of English north of Cape Flattery (along the west coast of Vancouver Island) and south of Queen Charlotte Sound is rather conspicuous and raises the question as to why the fish are not found in commercial quantities through this area. Dr. Ketchen (Fisheries Research Board of Canada) has suggested that a sandy type bottom may be a necessary environment for development of the young. Both offshore areas producing good catches of English sole feature this type of habitat while the west coast area of Vancouver Island is almost void of sandy bottom or beach areas. The wide

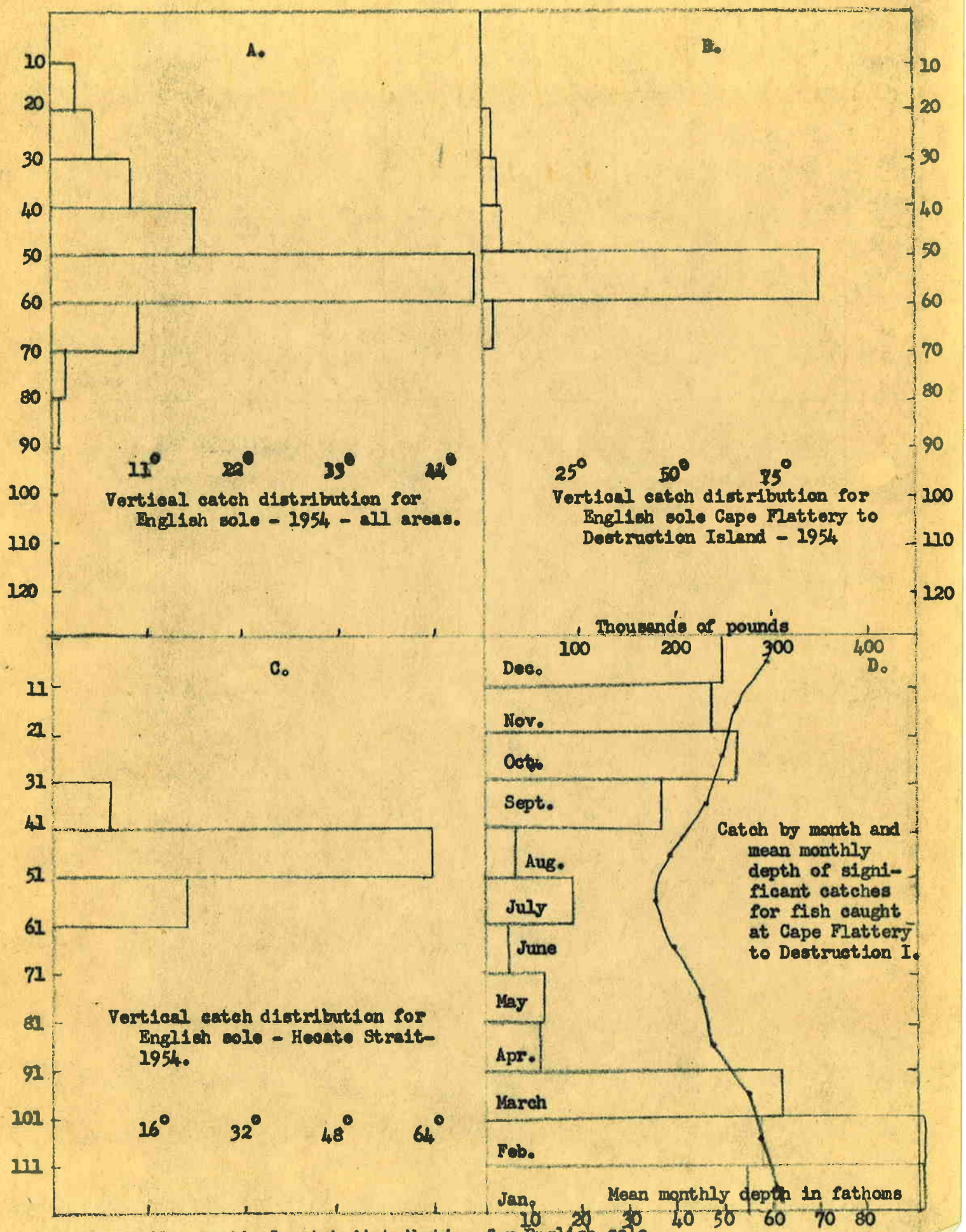


Figure 27 - Vertical catch distribution for English sole.

mean monthly depth of significant catches and total monthly catch of English sole caught off the Washington coast (Cape Flattery to Destruction Island). The graph indicated the largest catches are made during periods when the fish are in deep water. During the late fall and winter, the period of major spawning activity, English sole evidently tend to school up in deeper water.

Table 10 - Summary catch/effort data and productive index*, 1954 trawl landings of English sole

Area	Catch	Hours	C/H (lbs.)	Productive index	Significant** C/H
Hecate Strait	721,000	2,258	319	2.68	843
Goose Island	105,800	4,974	21	.18	409
Cape Scott	35,400	2,328	15	.13	180
Cape Cook	-	29	—	—	—
Esperanza	4,500	1,053	4	.03	—
Nootka	100	226	1/2	—	—
Esteban	5,400	2,778	2	.02	428
Uclulet	4,100	348	12	.10	—
Barkley Sound	-	1,104	—	—	—
40 Mile	2,300	1,594	1	—	—
Swiftsure	2,300	307	7	.06	—
Cape Flattery	194,200	2,498	78	.66	245
Umatilla	705,400	4,348	162	1.36	413
Quillayute	733,000	2,647	277	2.34	408
Destruction	644,300	2,621	246	2.06	405
Grays Harbor	20,100	100	201	1.69	165
***Inside	592,100	3,538	167	1.40	223
Total	3,770,000	31,756	119		

* Average catch per hour / Average catch per hour (all areas)

** English sole in catch represented 25 or over of total fare made during particular effort.

*** 850,000 pounds of wormy English sole were landed from southern Puget Sound which is not included in the above figure.

Table 11 - Catch by month of English sole for major production areas.

	Hecate Strait	Cape Flattery	Umatilla	Quillayute	Destruction
January	115,700	50,000	196,500	13,000	13,000
February	80,600	11,300	58,700	213,500	213,500
March	128,100	36,400	23,300	126,800	126,800
April	114,200	3,500	24,300	13,300	13,300
May	130,900	8,100	31,400	9,100	9,100
June	22,700	5,900	13,900	-	1,300
July	77,000	6,300	31,100	40,300	17,700
August	18,200	3,500	8,500	19,500	2,600
September	3,700	23,100	72,400	28,300	55,500
October	18,200	27,300	34,500	41,500	159,900
November	11,700	-	91,700	120,000	25,800
December	-	18,800	119,100	107,700	5,800
Total	721,000	194,200	705,400	733,000	644,300

Age Study

Put in separate heading under Project — refer to Progress Rpt

During the past year, Art Palmen continued his study on the use of interopercular for use in determining the age of English sole. In a comparison of the readability of the otolith and interopercular it was demonstrated that the physical nature of the interopercular bone allowed for a more critical inspection, which resulted in more consistent readings. Not only do errors in aging English sole otoliths increase with older fish, but the error remains at all ages. Only 75 percent of the otoliths agreed between two readings as compared to 93 percent agreement for the interopercula. These percentages indicated that the interopercula can be read with greater precision. A third reading of the debatable specimens followed roughly the same pattern, leaving 3.2 percent of the otoliths and only .4 percent of the interopercula unclassified.

Sixty-seven percent of the otolith and interopercula agreed in the final readings. A correlation table (Table 12) was set up to compare those in disagreement and a tendency to include false annuli on otoliths of the younger year classes (6 annuli and under) and to eliminate true annuli in older year classes was noted. The value of these comparisons is more readily appreciated when considering the growth rate of the species. Age-length plots (Figure 28 shows less fluctuation in the case of the interopercular bone and significantly less deviation from the calculated mean rate of growth.

Table 12 - Correlation between the ages read on 1389 English sole interopercula and corresponding otoliths.

Number of annuli	Interopercula														Total
	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
3	35	1													36
4	11	216	15	1											243
5	3	53	222	29	5		1								313
6	1	10	38	185	33	2		1							270
7		1	5	42	160	25	4	6	1	2					246
8				7	26	46	11	4	5	1					100
9					3	6	30	21	5	4					69
10						2	6	15	10	10	3	1			47
11							1	5	12	9	4	4		2	37
12										4	3	2	3	1	13
13							1		1		2	1	4	1	10
14												1	2	2	5
15															
16															
Total	50	281	280	264	227	81	54	52	34	30	12	9	9	6	1,389

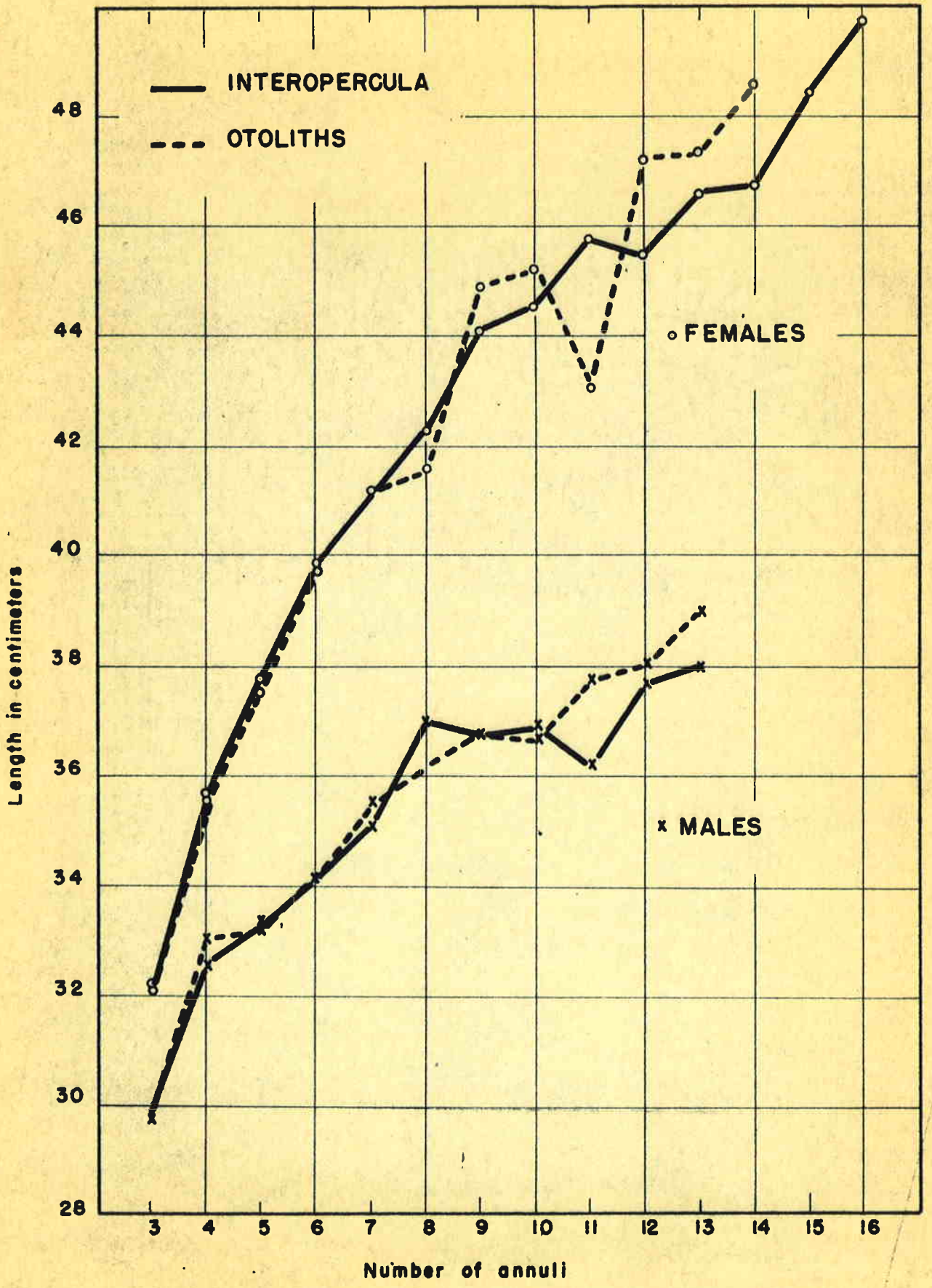


Figure 28. Age-length plot for male and female English sole.

In conclusion, it is recommended that the interopercular method for aging English sole be adopted.

Put in separate heading under Projects. Refer to reference give author

Population Studies - Holmes Harbor-Saratoga Passage

Studies were continued to analyze population fluctuations with the Holmes Harbor population of English sole. (See Appendix No. 1, Preliminary Study of the Population of English Sole in Holmes Harbor, Washington.) A special trawl season was again permitted in Holmes Harbor which extended from January 1 through February 13. Captains of trawlers were again requested to record their catches on special forms supplied by the Department. Fifteen different trawlers fished at some time during the season, while the maximum present during any one day was nine. According to records kept by the fishermen, approximately 30,300 pounds of English sole were caught during the season. A total of 1,067 tagged English sole was caught by trawlers fishing the area included between Penn Cove and Everett Bay during the period September 15, 1953 to February 15, 1954. The recoveries are being analyzed by the Department of Fisheries and the University of Washington. A special report on the Problems of Sampling a Puget Sound Population of English Sole (Parophrys vetulus) was presented at a meeting of the International Council for the Exploration of the Sea, and a report on the Holmes Harbor-Saratoga Passage-Everett Bay Trawl Study was also drafted and mailed to fishermen cooperating in the investigation (Appendix No. 2).

DOVER SOLE (Microstomus pacificus)

Dover sole, ranked seventh in poundage (1,730,000 pounds) and seventh in value ($186,500) for trawl-caught fish during 1954. Areas producing good catches of this species included the Goose Island grounds, Esteban, Cape Flattery, Umatilla, and Destruction Island. Dover sole catches made off Umatilla are generally taken in drags made on the east side of the submarine canyon which runs southwest from Cape Flattery, while those caught at Esteban and Goose Island are mostly taken from the "perch" grounds. The catch per effort data by area for Dover sole are given in Table 13. The landings of Dover sole by Washington vessels is largely governed by market acceptance which has been very limited. Through most of the year, buyers would not accept Dover sole under 18" in length. This species is not currently under any biological investigations by the staff.

Depth Distribution

Dover sole, caught by Washington vessels, are caught at depths ranging from 21 to 170 fathoms. Slightly over 50 percent of the catch of this species is made at depths exceeding 100 fathoms, mostly from 120 to 150 fathoms. When taken in deeper water, the species is commonly associated with Pacific ocean perch catches. A large part of the catch of Dover sole made on the Goose Island grounds, Esteban, and Umatilla is the result of effort expended towards capturing ocean perch and the Dover sole are incidental in these landings. Dover sole catches made on the Continental Shelf are most commonly taken at depths between 41 and 60 fathoms and 91 and 100 fathoms. Graphic depictions of the vertical catch distribution for Dover sole are given in Figure 29..

Dover sole stocks are not heavily exploited by Washington vessels and although these grounds are spasmodically fished by Oregon trawlers the production is evidently governed by market limits and does not reflect the availability of the species to the fleet - conservational regulation to limit production not deemed necessary.

Table 13 - Summary catch/effort data and production index*, 1954 trawl landings of Dover sole.

Area	Catch	Hours	C/H (lbs.)	Productive index	Significant C/H
Hecate Strait	72,600	2,258	32	.59	200
Goose Island	161,700	4,974	32	.59	400
Cape Scott	9,600	2,328	4	.07	462
Cape Cook	-	29	-		-
Esperanza	10,200	1,058	9	.17	200
Nootka	4,800	226	21	.39	-
Esteban	200,000	2,778	72	1.33	700
Ucluelet	2,400	348	7	1.30	-
Barkley Sound	-	104	-		-
40 Mile	77,400	1,594	11	.20	-
Swiftsure	48,000	307	156	2.89	1,313
Cape Flattery	311,500	2,498	125	2.31	993
Umatilla	620,200	4,348	149	2.76	988
Quillayute	36,600	2,647	14	.25	284
Destruction	209,600	2,621	80	1.48	679
Grays Harbor	-	100	-		-
Inside Waters	25,000	3,538	7	.13	4
Total	1,730,000	31,756	54	-	-

* $\frac{\text{Average catch per hour}}{\text{Average catch per hour (all areas)}}$

** Dover sole in catch represented 25 percent or over of total fare made during particular effort.

ROCKSOLE (Lepidopsetta bilineata) and FLOUNDER (Platichthys stellatus)

A total of 700,000 pounds of starry flounder and 520,000 pounds of rocksole was landed during 1954.

The major portion of starry flounder landed by Washington vessels are caught in the Stikine River area of southeast Alaska, Umatilla, and inside Puget Sound. The species is not highly desired by local buyers as the fillet recovery is very low. The species is generally captured in shallow water and the major production has been from depths between 11 and 20 fathoms. Tentatively the two major producing offshore areas (Umatilla and the Stikine River Flats) will be treated as independent populations. Catches of starry flounder from inside waters are made from numerous bays and inlets throughout the Sound and stock identification from catch records is not feasible. No biological studies concerning this species were carried on by the trawl staff. The total catch of this species is a direct result of demand and it cannot be used as an index of availability. No conservation regulations are considered necessary.

Practically the entire catch of rocksole landed by Washington trawlers was caught on the Hecate Strait, Goose Island and Cape Scott grounds. The species has only limited demand and the majority of this species are landed during winter months when bottom fish are in strong demand. Because of the rather incidental nature of the fishery no definite pattern is shown in the vertical catch distribution; however, the species is not usually caught at depths below 70 fathoms.

Catch effort data for starry flounder and rocksole are shown in Tables 14 and 15. No biological studies were made on either of these species and conservational regulations are not considered necessary.

Table 14 - Summary catch/effort data and productive index*, 1954 trawl landings of starry flounder.

Area	Catch	Hours	C/H (lbs.)	Productive index	Significant** C/H
Hecate Strait	42,800	2,258	19	.86	1,666
Goose Island	500	4,974	-	-	-
Cape Scott	-	2,328	-	-	-
Cape Cook	-	29	-	-	-
Esperanza	-	1,058	-	-	-
Nootka	-	226	-	-	-
Esteban	2,000	2,778	1	.05	-
Ucluelet	-	348	-	-	-
Barkley Sound	-	104	-	-	-
40 Mile	-	1,594	-	-	-
Swiftsure	3,000	307	10	.45	187
Cape Flattery	900	2,498	-	-	-
Umatilla	140,900	4,348	32	1.45	789
Quillayute	38,500	2,647	15	.68	307
Destruction	3,200	2,621	1	.05	-
Grays Harbor	-	100	-	-	-
Other***	277,000	139	1,993	90.59	3,166
Inside waters	191,200	3,538	54	2.45	113
Total	700,000	31,885	23		

* $\frac{\text{Area catch per hour}}{\text{Average catch per hour (all areas)}}$

** Starry flounder in catch represented 25 or over of total fare made during particular effort.

*** Stikine River Flats - Southeast Alaska.

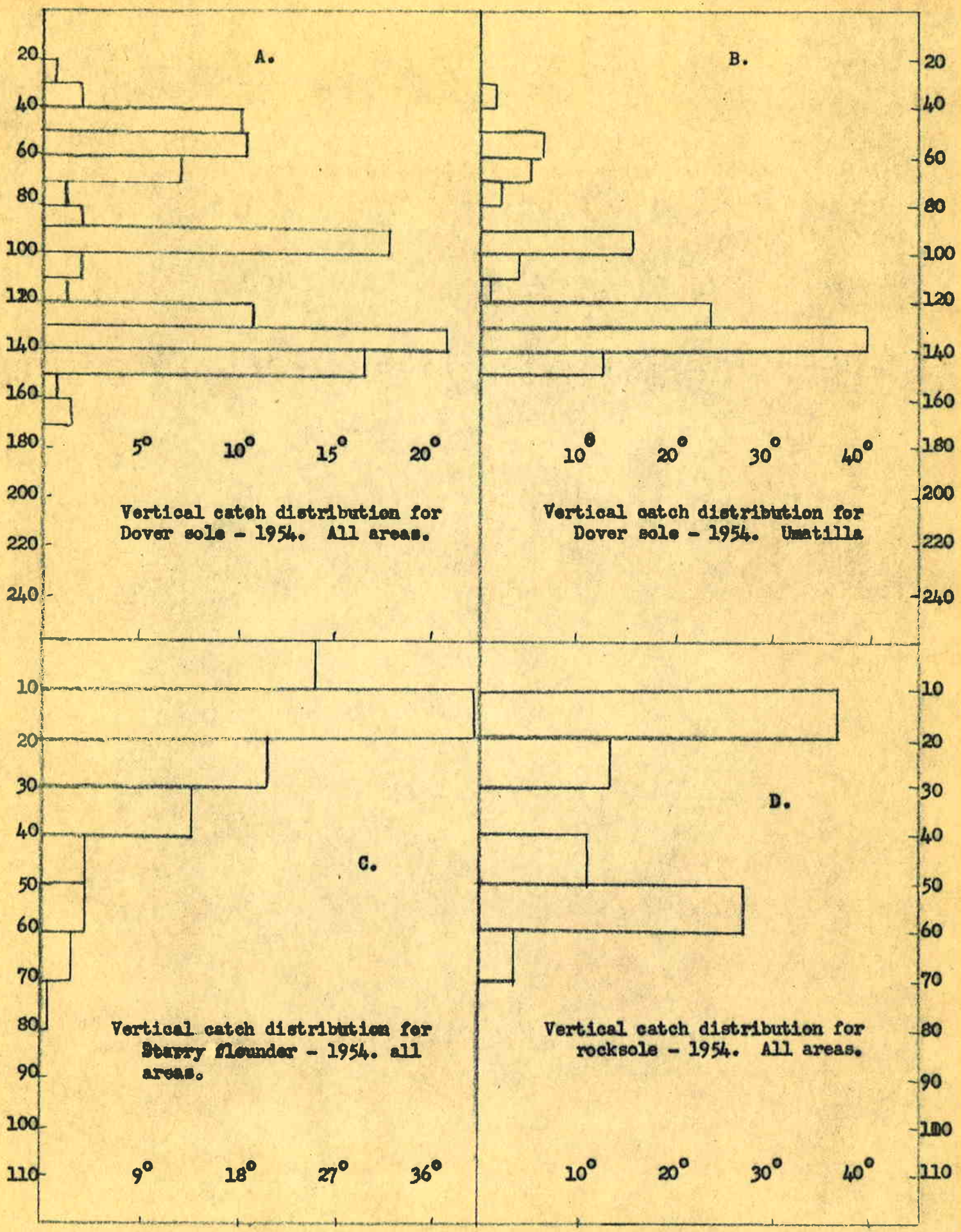


Figure 29 - Vertical catch distribution for Dover sole, Rocksole, and Starry Flounder.

Table 15 - Summary catch/effort data and productive index*, 1954 trawl landings of rocksole.

Area	Catch	Hours	C/H (lbs.)	Productive index	Significance** C/H
Hecate Strait	142,700	2,258	63	3.94	2,022
Goose Island	302,000	4,974	61	3.81	431
Cape Scott	50,000	2,328	21	1.31	227
Cape Cook	-	29	-	-	-
Esperanza	-	1,058	-	-	-
Nootka	-	226	-	-	-
Esteban	-	2,778	-	-	-
Uclulet	-	348	-	-	-
Barkley Sound	-	104	-	-	-
40 Mile	-	1,594	-	-	-
Swiftsure	-	307	-	-	-
Cape Flattery	1,500	2,498	-	-	-
Umatilla	2,100	4,348	-	-	-
Quillayute	-	2,647	-	-	-
Destruction	-	2,621	-	-	-
Grays Harbor	-	100	-	-	-
Inside Waters	21,700	3,538	6	.38	333
Total	520,000	31,756	16		

* $\frac{\text{Area catch per hour}}{\text{Average catch per hour (all areas)}}$

** Rocksole in catch represented 25 or over of total fare made during particular effort.

TRUECOD (Gadus macrocephalus)

Truecod ranked first in poundage (13,595,000) and first in value ($540,000) for trawl-caught fish in 1954. Areas of major production included Hecate Strait, Goose Island, Cape Scott and the area between Cape Flattery to Quillayute off the Washington coast. Fifty-five percent of the truecod landed were taken on the more northern grounds between Hecate Strait and Cape Scott and almost 70 percent of the state's total was caught north of the Strait of Juan de Fuca. An analysis of the monthly landing records indicates that spring and early summer months yielded the best catches while the late fall and early winter months were least productive (Table 16). Catch/effort data for this species is given in Table 17.

It is difficult to differentiate tentative population entities from landing records. However, it is evident that two regions, Cape Scott to Hecate Strait, and Cape Flattery to Destruction Island produce close to 85 percent of the total catch. Possibly the interview areas within each of these two regions should be combined and the catches treated as two aggregate population yields. The amount of migration of truecod from area to area is unknown and is a problem which must be answered before catch/effort data will have meaning.

Fair catches of truecod are made by inside vessels working in the Gulf of Georgia. These trawlers, generally making very short trips, land their catches at Bellingham, Blaines, or Anacortes. As they usually have small loads they may unload and leave the buying dock in a short time. Because of this practice, only a small percentage of inside vessels are interviewed, resulting in poorer records for inside catches.

Depth Distribution

Truecod were caught in trawls at depths ranging from 11 to 110 fathoms (Figure 30A) with the depths between 21 and 80 fathoms yielding the major

poundage. Depths between 41 - 50 fathoms were evidently the most productive, yielding close to 40 percent of the entire catch. Truecod from the more northern grounds were generally caught in water deeper than the vertical catch depth for productive southern areas (Figure 30-B). The geographic catch distribution for truecod indicates a fair availability of the species along many areas of the coast north of Destruction Island.

Table 16 - Catch by month of truecod for major production areas - 1957.

	Hecate Strait	Goose Is.	Cape Scott	Cape Flattery	Umatilla	Quillayute
Jan.	200,000	59,300	-	75,700	164,800	20,300
Feb.	334,900	43,100	65,300	53,700	88,900	73,300
March	1,488,300	234,200	322,400	151,800	85,300	152,600
April	319,700	24,600	303,000	35,500	318,600	79,300
May	597,700	497,300	190,800	28,600	175,400	14,900
June	139,900	354,100	508,100	40,700	110,700	9,700
July	6,900	440,300	415,600	16,600	116,000	24,300
Aug.	56,700	266,800	103,100	9,700	30,800	9,600
Sept.	3,000	187,700	160,000	355,700	242,000	230,000
Oct.	41,700	22,700	22,200	8,500	11,200	15,500
Nov.	137,600	1,400	21,300	4,100	50,000	59,900
Dec.	4,100	37,500	23,300	67,200	232,100	73,100
Total	3,330,500	2,169,000	2,135,100	847,800	1,625,800	763,000

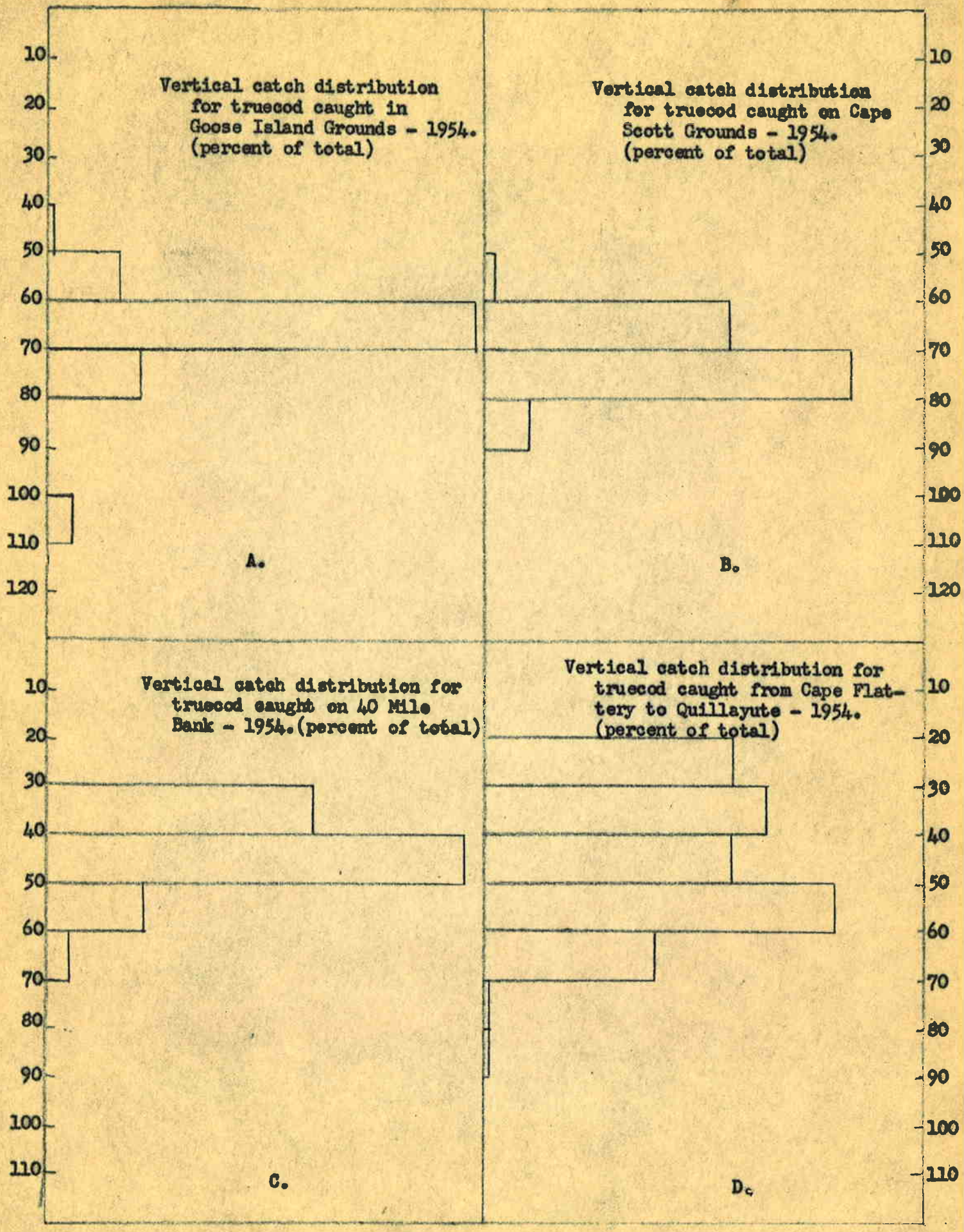


Figure 30 - Catch distribution for truecod, 1954.

Table 17 - Summary catch/effort data and productive index*, 1954 trawl landings of truecod.

Area	Catch	Hours	C/H (lbs.)	Productive index	Significant** C/H
Hecate Strait	3,330,500	2,258	1,475	3.46	1,722
Goose Island	2,169,000	4,974	436	1.02	1,090
Cape Scott	2,135,100	2,328	917	2.15	1,230
Cape Cook		29			
Esperanza	339,000	1,058	320	.75	552
Nootka Sound	33,300	226	147	.35	150
Esteban	248,500	2,778	89	.21	853
Uclualet	116,000	348	333	.78	—
Barkley Sound	217,500	104	2,091	4.91	—
40 Mile	637,800	1,549	255	.60	509
Swiftsure	264,200	307	860	2.02	1,019
Cape Flattery	847,800	2,498	339	.80	483
Umatilla	1,625,800	4,348	374	.88	483
Quillayute	763,000	2,647	288	.68	506
Destruction Is.	433,000	2,621	165	.38	358
Grays Harbor	2,300	100	23	.54	1
Inside	357,200	3,538	101	.14	136
Total	13,520,000	31,756	426		

* $\frac{\text{Average catch per hour}}{\text{Average catch per hour (all areas)}}$

** Truecod in catch represented 25 or over of total fare made during particular effort.

PACIFIC OCEAN PERCH (Sebastodes alutus)

Pacific ocean perch, a species which was not exploited prior to 1950, ranked second in poundage (7,000,000 pounds and fourth in value ($280,000) for trawl-caught fish during 1954. Three areas, Goose Island, Esteban, and the region from Cape Flattery to Quillayute produced 93 percent of the total landings. The Goose Island grounds are mostly in the deep water canyon which extends seaward through Queen Charlotte Sound. This area, the largest producer of Pacific ocean perch, affords more trawlable grounds than any of the other "perch" banks. The trawlable grounds off Vancouver Island are limited to a small area of the continental slope between Nootka Sound and Sydney Inlet (Vancouver Island). With the exception of the Spit (the S. W. terminus of 40 Mile Bank), the submarine canyon which extends southwesterly from Cape Flattery yields the major catches of perch caught off the Washington coast. Most of the perch drags occur on the east slope of the canyon at depths from 120 to 190 fathoms.

The occurrence of a nematode worm in the integument of perch fillets has caused processors to candle this species before packaging, and although all grounds are infested to some extent, certain areas have a very high percentage of parasitized fish. Both the Queen Charlotte Sound and the Esteban fish are in this category.

Perch landings are highest during the spring and summer months and fall off during the fall and winter. This seasonal fluctuation probably reflects meterological conditions rather than market demand, as perch grounds which are considerable offshore are more adversely affected by weather than inshore trawl areas. Landings of "perch" by month for the major producing grounds are given in Table 18, and catch/effort data in Table 19. The complete lack of life history information on this species makes stock identification somewhat doubtful; however, the comparatively wide geographic separation of the major producing grounds would indicate that these areas (Goose Island, Esteban,

and Cape Flattery to Quillayute) could be treated as population entities.

Depth Distribution

Ninty-eight percent of the Pacific ocean perch catch during 1954 came from banks which were between 100 and 160 fathoms in depth, Figure 31-A. The vertical catch distribution for this species has been a major factor in the development of deep-water trawling. With the most productive grounds being between 141-and 150 fathoms trawlers have been forced to add more cable on their drums and explore the deeper water. Graphs for the vertical catch distribution of perch caught at Goose Island, Esteban, and Umatilla are shown in Figures 31-B, C, D.

A popular article regarding the Pacific ocean perch fishery was written and published in the October issue of Pacific Fishermen. (See Appendix 3).

Mesh Regulation

Because of the high degree of gilling in large-mesh nets and the difficulty fishermen experienced in attempting to "split" catches of perch, it was deemed necessary to alter the regulation requiring 4-1/2" mesh for all portions of the net and achieve a workable regulation which would provide maximum protection to flatfish, blackcod, and other species while allowing the ocean perch fishery to operate in an efficient manner. The mesh regulation was therefore written to provide a special permit system for vessels engaged in the perch fishery. The perch permit law is written as follows:

"(s) It shall be unlawful to use, operate or possess aboard any fishing vessel otter trawl fishing gear having net meshes of a size less than 4-1/2 inches between mesh knots, except that it shall be lawful to use, operate or possess otter trawl fishing gear having net meshes of a size less than 4-1/2 inches between mesh knots for the purpose of taking ocean perch with such gear under a written permit from the Department of Fisheries. Such permits shall be valid during six-months periods beginning on January 1 and July 1 and terminating on July 30 and December 31, respectively.

Ocean perch fishermen using, operating or possessing aboard a fishing vessel an otter trawl net having a mesh size of less than 4-1/2 inches between

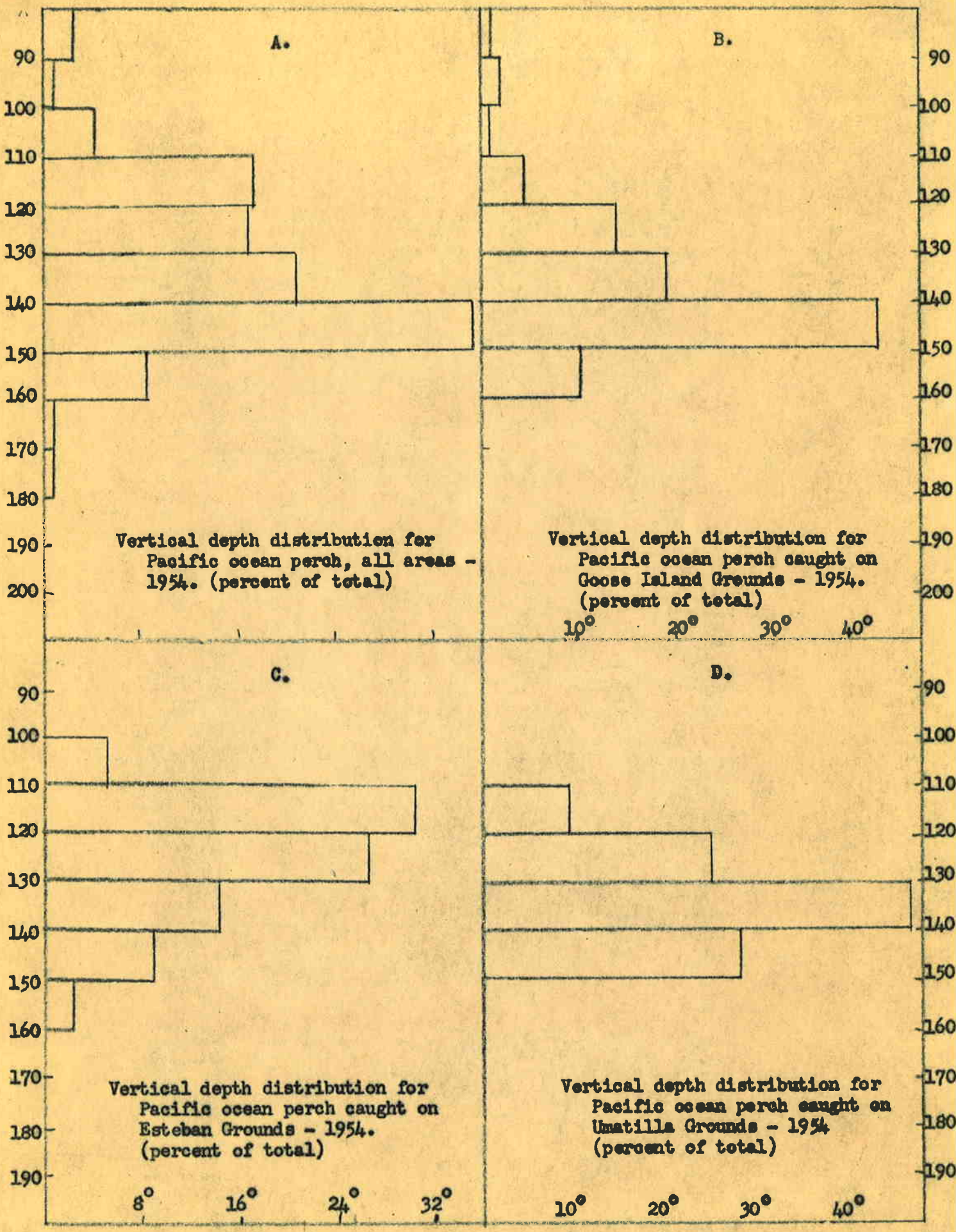


Figure 31 - Vertical depth distribution for Pacific ocean perch, 1954.

knots shall, in addition thereto, at all times carry a fully rigged otter trawl net having a minimum mesh size of 4-1/2 inches between mesh knots.

Applicants for a small mesh net permit under this section shall designate the name or names of the purchaser or purchasers of ocean perch caught with said small mesh net gear and shall be issued said permit subject to the conditions that not less than 20 percent of the aggregate landings of all species during the permit period will be ocean perch. No new permit shall be issued under this section to any permittee whose aggregate landings during a preceding or former permit period did not contain a minimum of 20 percent ocean perch. Persons relinquishing permits held under this section prior to the date of expiration shall be held accountable for their landings up to the date of surrender of such permit.

This regulation shall take effect January 1, 1955, for cod-ends and January 1, 1956, for the remainder of the otter trawl net."

Table 18 - Catch by month of Pacific ocean perch for major production areas, 1954.

	Goose I.	Esteban	Cape Flattery	Umatilla
Jan.	-	122,900	5,800	-
Feb.	-	46,600	53,800	32,600
Mar.	-	359,600	85,600	-
Apr.	53,800	129,600	80,400	81,200
May	402,900	63,400	2,300	102,100
June	589,900	12,700	800	20,000
July	257,500	114,700	15,000	38,200
Aug.	1,022,500	23,200	2,700	55,600
Sept.	1,181,400	183,800	4,600	27,400
Oct.	472,100	100,300	100	47,100
Nov.	308,500	113,600	-	13,800
Dec.	3,400	69,000	12,700	73,400
Total	4,292,900	1,339,400	263,800	485,400

Table 19 - Summary catch/effort data and productive index*, 1954 trawl landings of Pacific ocean perch.

Area	Catch	Hours	C/H (lbs.)	Productive index	Significant** C/H
Hecate Strait	-	2,258	-	-	-
Goose Island	4,292,000	4,974	863	3.92	1,365
Cape Scott	222,200	2,328	95	.43	1,456
Cape Cook	-	29	-	-	-
Esperanza	5,800	1,058	5	.02	-
Nootka	242,400	226	1,073	4.88	2,076
Esteban	1,339,400	2,778	482	2.19	1,154
Uchuelet	3,700	348	11	.05	-
Barkley Sound	13,400	104	129	.59	-
40 Mile	6,900	1,594	4	.02	1,000
Swiftsure	-	307	-	-	-
Cape Flattery	263,800	2,498	105	.48	1,023
Umatilla	485,400	4,348	112	.51	1,225
Quillayute	122,700	2,647	46	.21	1,631
Destruction	2,300	2,621	1	-	5,000
Grays Harbor	-	100	-	-	-
**Inside	-	3,538	-	-	-
Total	7,000,000	31,756	220		

* $\frac{\text{Average catch per hour}}{\text{Average catch per hour (all areas)}}$

** Pacific ocean perch in catch represented 25 or over of total fare made during particular effort.

ROCKFISH (Sebastodes)*

Rockfish ranked third in poundage (4,595,000 and fifth in value (183,800) for trawl-caught fish in 1954. There are eight different species of rockfish which are of commercial importance in the state's trawl catches. These are marketed as either red rockfish, black rockfish, or mixed rockfish. In the group classified as red rockfish, S. pinniger, S. diploproa, and S. rubberimus are the most important while the black rockfish are mainly S. flavidus, S. melanops, S. brevispinus, and S. mystinus. Rockfish apparently are available in large quantities on many of the fishing banks; however, they are not a highly desired group and limits have restricted the poundage being landed. Goose Island, Esteban, Cape Flattery, Umatilla and Destruction Island grounds produced the largest catches of rockfish made by the fleet. A large portion of the catch made at Goose Island and Esteban is composed of S. diploproa which is commonly associated with S. alutus caught in deep water trawling. Catch/effort data and catch by month for rockfish are shown in tables 20 and 21.

Depth Distribution

It is difficult to derive any useful material on catch distribution by depth for this group of fish as the number of varieties involved precludes determining any facts on specific species stratification. In general, species grouped as black rock are caught in water from 10 to 60 fathoms while the red rockfish are caught in deeper water from 50 to 150 fathoms.

* Exclude Pacific ocean perch - Sebastodes alutus

Table 20 - SUMMARY CATCH/EFFORT DATA AND PRODUCTIVE INDEX*
1954 Trawl Landings of Rockfish

Area	Catch	Hours	C/H (lbs.)	Productive Index	Significant** C/H
Hecate Strait	88,500	2,258	39	0.27	142
Goose Island	1,012,000	4,974	203	1.4	396
Cape Scott	540,000	2,328	232	1.60	644
Cape Cook	23,200	29	800	5.51	750
Esperanza	479,000	1,058	454	3.13	470
Nootka	81,300	226	359	2.47	1,692
Esteban	682,500	2,778	246	1.69	1,013
Ucluelet	1,200	348	3	.02	333
Barkley Sound	-	104	-	-	-
40 Mile	42,200	1,594	26	.18	110
Swiftsure	5,300	307	17	.12	688
Cape Flattery	313,700	2,498	125	.86	274
Umatilla	592,800	4,348	136	.94	355
Quillayute	301,600	2,647	113	.78	253
Destruction	363,000	2,621	138	.95	518
Grays Harbor	22,700	100	227	1.56	301
Inside	46,000	3,538	13	.089	165
Total	4,595,000	31,756	145		

*$\frac{\text{Average catch per hour}}{\text{Average catch per hour (all areas)}}$

**Rockfish in catch represented 25 or over of total fare made during particular effort.

Table 21 - Catch by month of rockfish for major production areas. (Pounds)

	Goose I.	Esteban	Cape Flattery	Umatilla	Destruction I.
Jan.	90,290	86,400	57,680	197,000	12,860
Feb.	15,680	46,020	22,070	34,670	101,190
Mar.	24,830	85,650	103,170	13,790	64,640
Apr.	72,230	47,650	15,990	42,050	34,580
May	68,970	33,480	3,140	38,870	11,910
June	102,990	-	10,030	31,980	-
July	126,650	24,450	5,000	20,060	-
Aug.	230,990	29,850	-	59,190	2,510
Sept.	168,530	23,830	77,120	23,450	6,270
Oct.	25,700	28,840	690	27,300	54,670
Nov.	41,000	103,460	-	4,120	69,600
Dec.	44,140	172,870	18,810	100,320	4,770

LINGCOD (Ophiodon elongatus)

Lingcod ranked sixth in poundage (2,030,000 pounds) and sixth in value ($104,500) for trawl-caught fish in 1954. Areas producing good catches include Hecate Strait, Goose Island, 40 Mile Bank, and Umatilla. Lingcod are sold as both round and dressed fish according to the market demand. Usually when the fish are small and mixed with trawled they are sold in the round. The catch per hour by area and total landings by area are shown in Table 22. In general, the summer months yield the best catches although it may vary by area (Table 23).

Depth Distribution

Lingcod are caught at depths between 11 and 140 fathoms; however, only small amounts are caught below the 100 fathom contour. The major production of this species occurred on grounds which were between 31 and 90 fathoms with the banks lying between 31 to 50 fathoms yielding the greatest poundage of fish. A graph depicting the vertical depth distribution is shown in Figure 32-A. The vertical catch distribution for the Hecate Strait, Goose Island, and 40 Mile grounds are shown in Figures 32-B.C.D. No biological activities were carried out in studying this species during 1954.

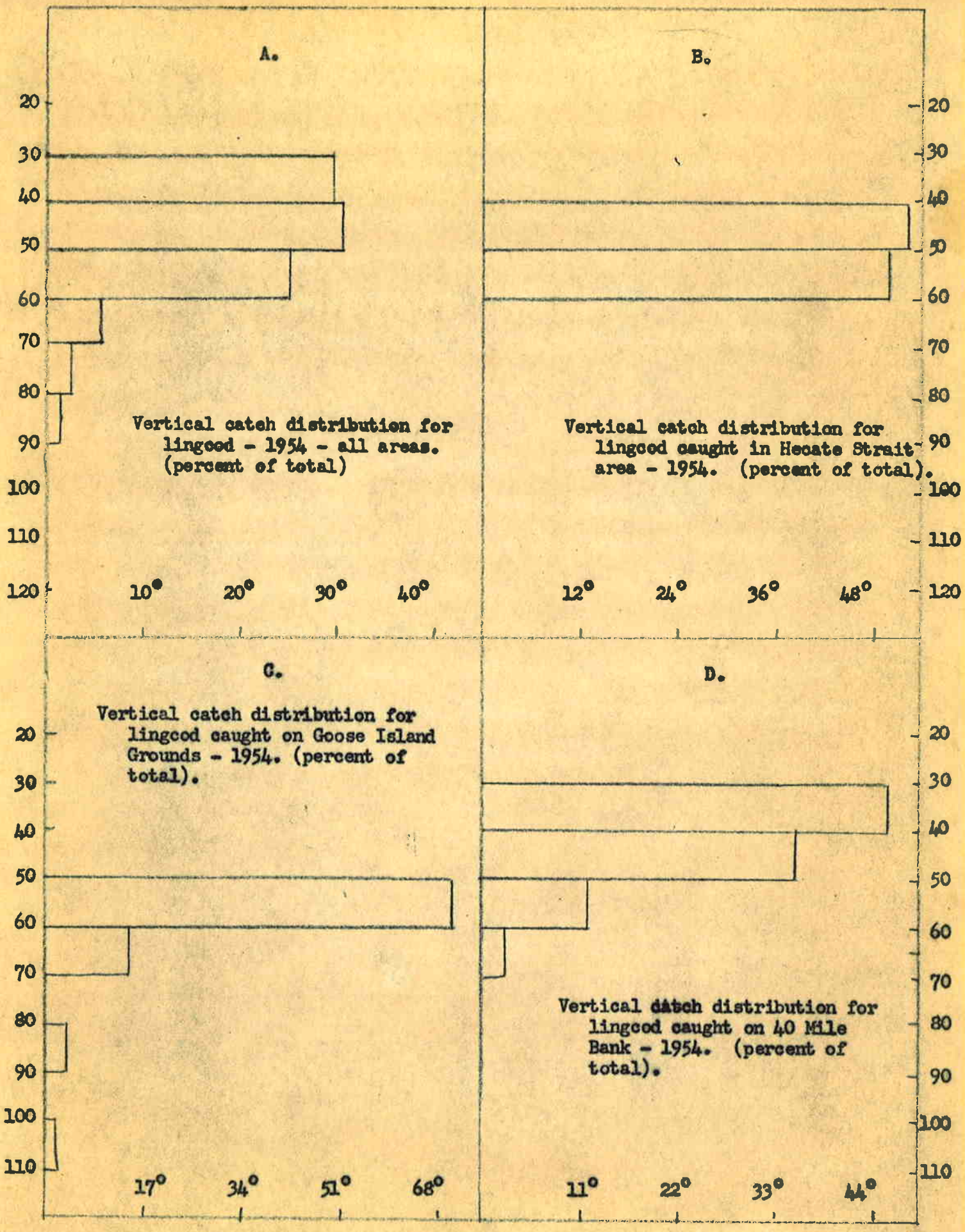


Figure 32 - Vertical catch distribution for lingcod - 1954.

Table 22 - SUMMARY CATCH/EFFORT DATA AND PRODUCTIVE INDEX*
1954 Trawl Landings of Lingcod

Area	Catch	Hours	C/H (lbs.)	Productive index	Significant** C/H
Hecate Strait	176,800	2,258	78	1.2	800
Goose Island	306,800	4,974	62	0.9	969
Cape Scott	83,900	2,328	36	0.55	1,210
Cape Cook	-	29	-		-
Esperanza	51,700	1,058	49	0.75	571
Nootka	3,900	226	17	0.26	240
Esteban	69,800	2,778	25	0.38	2,000
Uchuelet	91,800	348	263	4.05	-
Barkley Sound	11,300	104	109	1.67	-
40 Mile	686,000	1,594	430	6.6	525
Swiftsure	50,700	307	165	2.5	800
Cape Flattery	110,700	2,498	44	.68	231
Umatilla	253,500	4,348	58	.89	352
Quillayute	85,100	2,647	32	0.49	958
Destruction	78,000	2,621	29	0.44	121
Grays Harbor	-	100	-	-	-
Inside	30,000	3,538	8	.12	25
Total	2,090,000	31,756	65		

* Average catch per hour
Average catch per hour (all areas)

** Lingcod in catch represented 25 or over of total fare made during particular effort.

Table 23 - Catch by month of lingcod for major production areas - 1954.

	Hecate Strait	Goose I.	40 Mile Bank	Umatilla
Jan.	23,530	1,000		5,090
Feb.	26,680	5,000		2,600
Mar.	10,260	1,350		1,900
Apr.	16,360	61,350		5,420
May	10,690	44,800	8,930	10,420
June	6,770	16,840	63,560	15,480
July	20,000	18,360	119,150	8,880
Aug.	32,970	22,900	192,110	109,680
Sept.	9,640	18,000	150,200	56,930
Oct.	15,800	115,620	135,600	11,480
Nov.	4,100	1,580	16,450	6,750
Dec.	-	-	-	18,870

BLACKCOD (Anoplopoma fimbria)

Blackcod ranked eleventh in poundage (370,000) and ninth in value ($29,600) for trawl-caught species in 1954. Three general areas which produced the main catches of blackcod were from Cape Scott to Goose Island, Esteban, and the area surrounding Cape Flattery (40 Mile Bank, Cape Flattery and Umatilla). Sixty percent of the total catch was caught in these three areas which are in close proximity to Cape Flattery. During the 1954 season blackcod were seldom on limits and the species was much desired. However, the scarcity of this species made it impossible to actively pursue and, therefore, in most instances blackcod were incidental in trawl catches. Blackcod usually became available to the fishery in early June and were fished heaviest in July, August, and September. By mid-October landings dwindled rapidly and through the winter and spring months they were almost completely absent. The catches by month are shown for the major producing areas in Table 24, while the catch per effort by area is shown in Table 25.

Depth Distribution

A graphed distribution (Figure 33-A) of the vertical catch for blackcod gives a bimodal appearance indicating two productive depth stratas, one from 31 to 70 fathoms and the other between 120 and 150 fathoms. If these catches are segregated and replotted by individual fishing ground it will be seen that blackcod taken in deep water are usually linked to effort being expended toward catching Pacific ocean perch. Figure 33-B.C.D. graphs the depths distribution for blackcod caught at Goose Island, 40 Mile, and Cape Flattery.

Landings of blackcod by Washington trawlers has varied considerably in recent years although the general trend since the peak year of 1944 (1,807,000 lbs.) has been down. Certainly a large factor in this decline is the result of market demand, however, the sharp drop in the past several years seems to be a manifestation of availability as well as economic conditions. The 1954

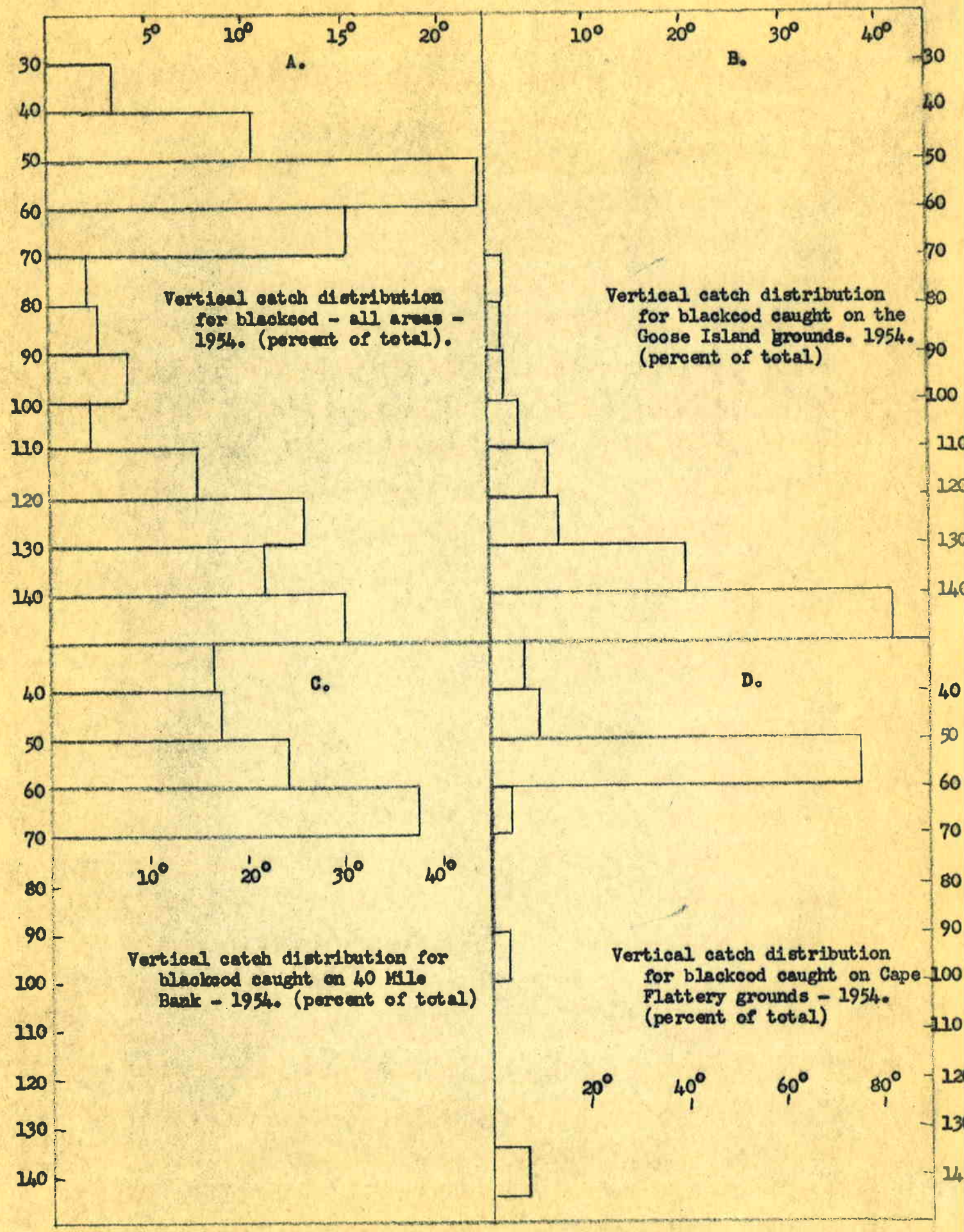


Figure 33 - Vertical catch distribution for blackcod, 1954.

trawl season almost doubled the 1953 season both in effort expended and total pounds landed. The market demand for trawl-caught blackcod was good and few limits were imposed on this species; however, the landings did not follow the upswing in fishing intensity or demand.

Research on the blackcod fishery was carried on by Al Pruter and was not confined to the trawl studies. One of the objectives of the investigation; however, was concerned with number and monetary value of fish less than 3 pounds dressed weight being landed by trawlers. A number of length-weight samples from both setlines and trawlers were taken to determine the size distribution of the landings. These are depicted in Figure 34.

Small blackcod have been a problem among trawlers since the inception of the offshore fishery. During the late spring and early summer large numbers of small blackcod move in on certain inshore grounds and are so abundant that trawlers are forced to seek marketable fish in other areas. The quantities of small blackcod which are destroyed by trawlers is a subject which is debated considerably by setliners. There is little doubt that during certain periods of the year this loss is considerable; however, the extent of loss and its effect on future croppable stocks is unknown. The first indication of small blackcod on the grounds in 1954 was reported on May 24th when the trawler "Grizzly" caught between 3 and 4 thousand pounds per tow S. W. of Umatilla. The vessel made 13 drags in this area and caught an estimated 44,000 pounds of small unmarketable fish. From late May through October, vessels fishing the grounds from 40 Mile Bank to Quillayute reported catching large amounts of undersized blackcod. In the majority of instances no quantitative measure is reported and it is difficult to assign the importance of these catches; however, 423,000 pounds of discarded small fish were actually reported between the period May 1 and October 31. This represents the catch of 25 vessels' landings which give actual discard catch figures when being interviewed.

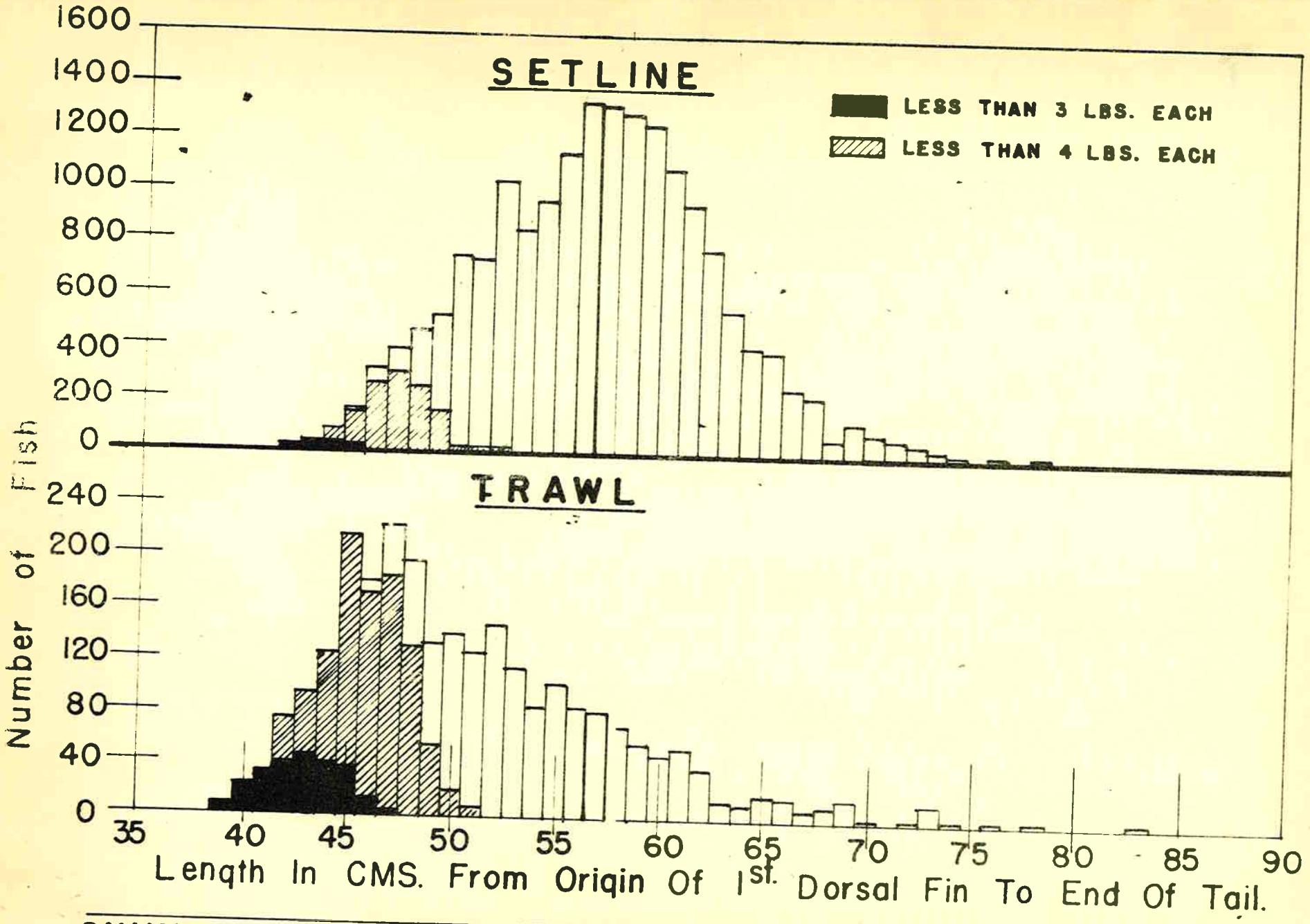


Figure 34.

SUMMARY OF WEIGHTED LENGTH FREQUENCY SAMPLES OF SETLINE AND TRAWL-CAUGHT SABLEFISH LANDED IN SEATTLE

1954

A total of 49 other vessels report numerous amounts of small blackcod in their drags but gave no specific figure. Probable total capture of small fish exceeded 1,000,000 pounds during the year. The number which survived is unknown.

Table 24 - Catch by month of blackcod for major production areas, 1957.

	Goose I.	Cape Scott	Esteban	40 Mile Bank	Cape Flattery	Umatilla
Jan.						
Feb.						
Mar.			1,650			
Apr.			6,900		1,600	
May						
June	550		320	840		1,370
July	2,650	6,500	15,430	49,340	240	2,170
Aug.	22,900		1,280	22,130	1,600	7,390
Sept.		36,600	5,320	24,300	53,360	6,290
Oct.	10,000	4,000	6,800	8,190	2,800	41,100
Nov.						480
Dec.						

Table 25 - SUMMARY CATCH/EFFORT DATA AND PRODUCTIVE INDEX*
1954 Trawl Landings of Blackcod

Area	Catch	Hours	C/H (lbs.)	Productive index	Significant** C/H
Hecate Strait	2,100	2,258	1	-	650
Goose Island	36,100	4,974	7	.06	-
Cape Scott	47,100	2,328	20	.17	-
Cape Cook	500	29	17	.15	-
Esperanza	5,800	1,058	5	.04	157
Nootka	1,300	226	6	.05	-
Esteban	37,700	2,778	14	.12	-
Ucluelet	1,100	348	3	.03	100
Barkley Sound	-	104	-	-	-
40 Mile	104,800	1,594	66	.56	1,175
Swiftsure	8,800	307	29	.25	100
Cape Flattery	59,600	2,498	24	.21	374
Umatilla	58,800	4,348	14	.12	265
Quillayute	500	2,647	0.18	-	-
Destruction	5,800	2,621	2	.02	500
Grays Harbor	-	100	-	-	-
Inside	-	3,538	-	-	-
Total	370,000	31,756	117		

* $\frac{\text{Average catch per hour}}{\text{Average catch per hour (all areas)}}$

** Blackcod in catch represented 25 or over of total fare made during particular effort.

PUGET SOUND TRAWLING

Several areas were reopened to trawling during 1954 including portions of the South Sound and Hood Canal. The season for the Hood Canal fishery extended from December 1, 1954 to February 28, 1955. The total catch records for this fishery, along with other areas recently opened to trawling, are included in Table 26.

Table 26 - Trawl catches - 1954-1955 season.

Hood Canal

Foodfish	Pounds	Scrapfish	Pounds
English sole	222,000	Dogfish	259,000
Rock sole	34,000	Skates	105,000
Sand sole	3,000	Ratfish	129,000
Starry flounder	10,400	Hake	86,000
Truecod	40,000	Starfish	5,900
Lingcod	6,300	Total scrapfish	584,900
Rockfish	22,500		
Perch	7,300		
Petrale sole	50		
Total foodfish	345,550		

South Sound

Foodfish	Pounds	Scrapfish	Pounds
English sole	30,000	Dogfish	450,000
Rock sole	600	Skates	75,000
Sand sole	963	Ratfish	75,000
Dover sole	-	Hake	125,000
Starry flounder	5,645	Total scrapfish	700,000
Truecod	17,262		
Lingcod	1,576		
Rockfish	15,769		
Perch	627		
Total foodfish	72,435		

SARATOGA PASSAGE - HOLMES HARBOR

Foodfish	Pounds	Scrapfish	Pounds
Butter sole	145,300	Dogfish	9,400
Rocksole	4,900	Skates	17,200
Sand sole	3,100	Miscellaneous	143,100
Starry flounder	32,300	Total scrapfish	169,700
Blackcod	1,500		
Truecod	40,200		
Rockfish	8,900		
Perch	3,100		
Total food fish	239,300		

REGULATION CHANGES

Several new regulations effecting trawlers were promulgated during the year. Closed seasons and areas within Puget Sound were reopened and a new order allowing Bellingham sole to be sold as scrap fish was passed. A summary of these new regulations is given below (see Pacific ocean perch for mesh regulation).

(b) It shall be UNLAWFUL to take, fish for, possess, process or otherwise deal in any food fish or shellfish unless they are to be used for human consumption or fishing bait; PROVIDED, that dogfish or shark, arrow-tooth halibut (Atheresthes stomias), pilchard (Sardinops caerulea), hake (Merlucius productus), pollack or whiting (Theragra chalcogramma fucensis), Bellingham sole (Isopsetta isolepis), and fish offal or scrap may be used for any commercial purposes.

A summary of the regulations as they now stand for inside waters follows:

Area 1. All waters outside of Initiative 77 line. Fishing permitted the entire year with the exception of those waters lying inside and easterly of a line projected from Point Whitehorn to the most southwesterly part of Sandy Point in Whatcom County, and the waters of East Sound, Orcas Island, northerly on a line projected true west across East Sound from the point at the west entrance of Cascade Bay near the town of Rosario. These waters are closed to trawling.

Area 2. All waters inside of Initiative 77 line north of Fidalgo Island. Opened April 15 through February 15. Samish Bay is closed to otter trawling.

Area 3. The waters of Skagit Bay and Saratoga Passage north of a line projected from East Point on Whidbey Island to Lowell Point on Camano Island. Open to trawling September 15 through February 15. Holmes Harbor and the waters within one-quarter mile of Camano Island are closed to trawling except for a special season from January 1 through February 15 in Holmes Harbor.

Area 4. Those waters inside of Initiative 77 line north of Point Defiance, except areas 2, 3, and 6. Open April 15 through February 15. Washington Harbor and Discovery Bay remain closed, as do the waters inside of a line projected from Four Mile Rock to Alki Point in Elliott Bay. The waters of Port Madison are open to trawling outside a line drawn true west from Agate Point on Bainbridge Island.

Area 5. Waters south of Point Defiance - open to trawling December 1 through February 28. Closed waters in this area include:

1. Hale Passage and the Narrows - those waters of Hale Passage and the Narrows, east and north of line projected from Fox Point on Fox Island true east to the mainland and from the northwest point of Fox Island true north to the mainland.

2. Budd Inlet - closed south and west of north boundary of restricted berth area.

3. Eld Inlet - closed south and west of line drawn from Flapjack Point true south to the mainland.

4. Totten Inlet - closed south and west of a line projecting true north and true east from the outermost point on the western side of Gallagher Cove, thereby closing the waters of Gallagher Cove to otter trawling.

5. Hammersley Inlet - closed. Inside line drawn from outermost headland of entrance.

6. Waters Inside Harstine Island - closed. Includes waters north of a line drawn from Unsal Point to Brisco Point and south of a line from Salmon Point true east to Harstine Island.

7. Henderson Inlet - Dickerson Point - closed. Inside a line drawn from true east to the mainland.

Because of the poor condition of sole it shall be lawful to utilize species of sole taken from Area 5 for any purpose.

Area 6. All waters of Hood Canal open to trawling December 1 through February 28.

PACIFIC MARINE FISHERIES COMMISSION STUDIES

A cooperative study under the auspices of the Pacific Marine Fisheries Commission was carried out during the period from May 13 to June 9, 1954 to obtain information on the relative selectivity of double cod-ends and hog-ring bags. A series of 36 drags was made at depths ranging from 100 to 150 fathoms. Fishing was carried out off Eureka, California on a well known Dover sole ground. A standard 400 mesh net was used during the test and various cod-end sizes were attached to the net. Results of the test are shown in Table 27.

Table 27 - Comparisons of the results of selectivity test carried out aboard the N. B. Scofield.

Mesh size of cod-end	No. of drags	Time in minutes	Number of Dover caught		
			Total	Marketable	Percent marketable
4" S.	1	70	933	655	66
4-1/4" S.	4	270	244	170	69
4-1/2" S.	7	485	2493	1738	70
4-1/2" D.	5	335	4730	3027	64
5" D.	3	225	922	483	52
4" H.	2	95	516	234	45
5-1/2" H.	2	135	1050	716	68
6" H.	5	330	412	383	93
Total	29	1945	11,360	-	-

Various mesh sizes with the 4-1/2" single control are shown in Figures 35, 36, and 37.

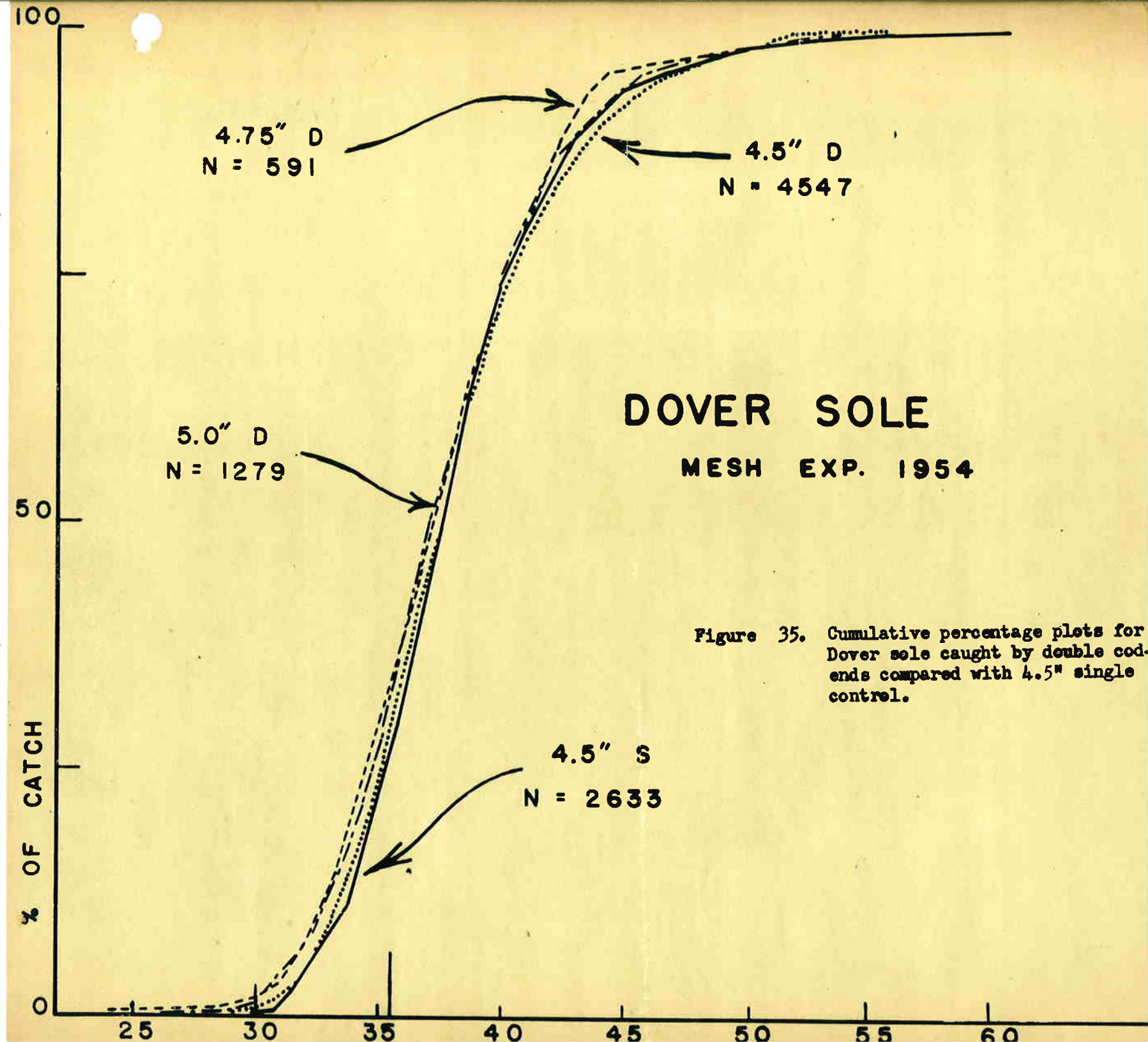


Figure 35. Cumulative percentage plots for Dover sole caught by double cod-ends compared with 4.5" single control.

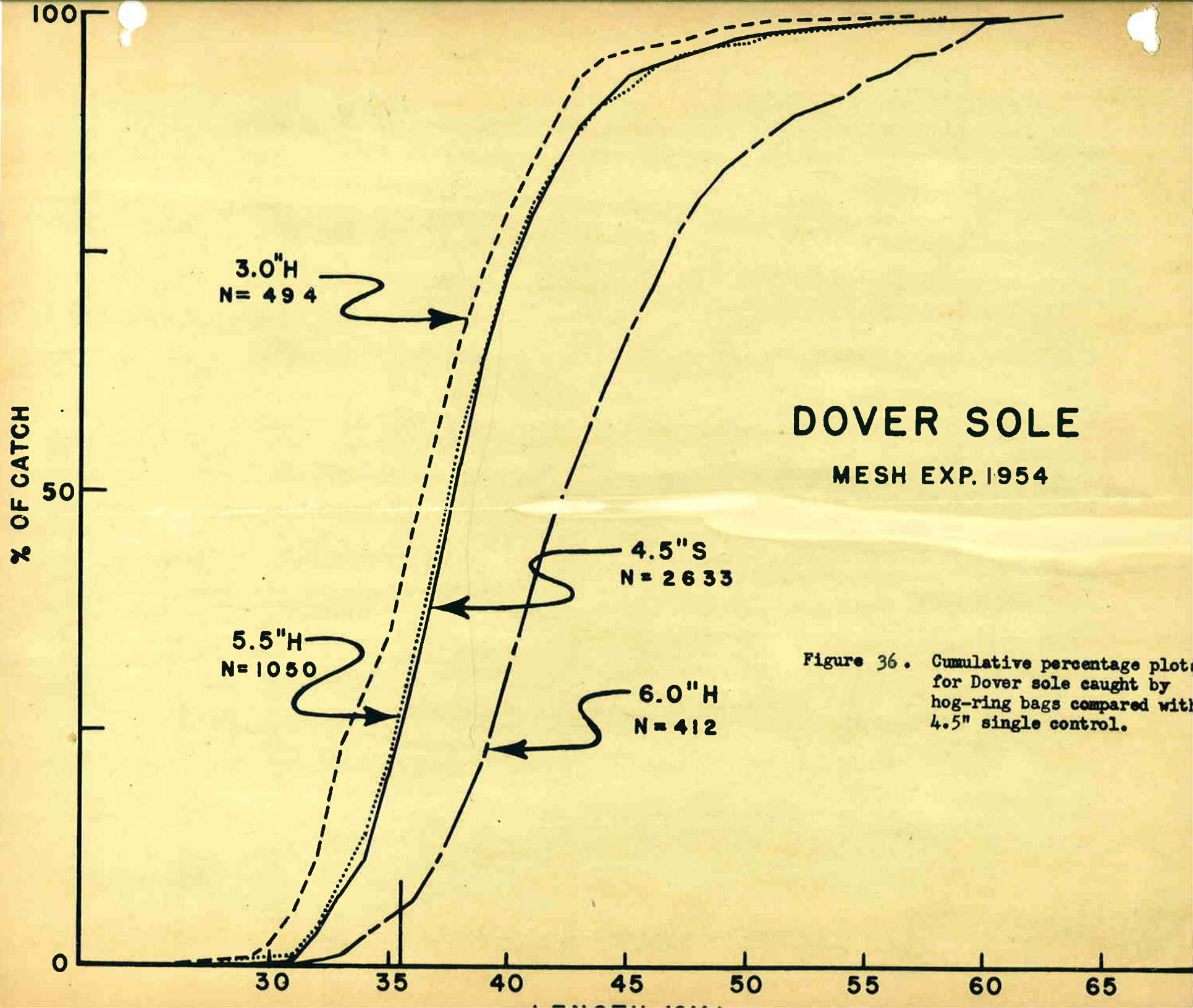


Figure 36. Cumulative percentage plot for Dover sole caught by hog-ring bags compared with 4.5" single control.

Figure 37. Length frequency distribution (percent of total catch) for Dover sole caught in various cod-ends and hog-ring bags.

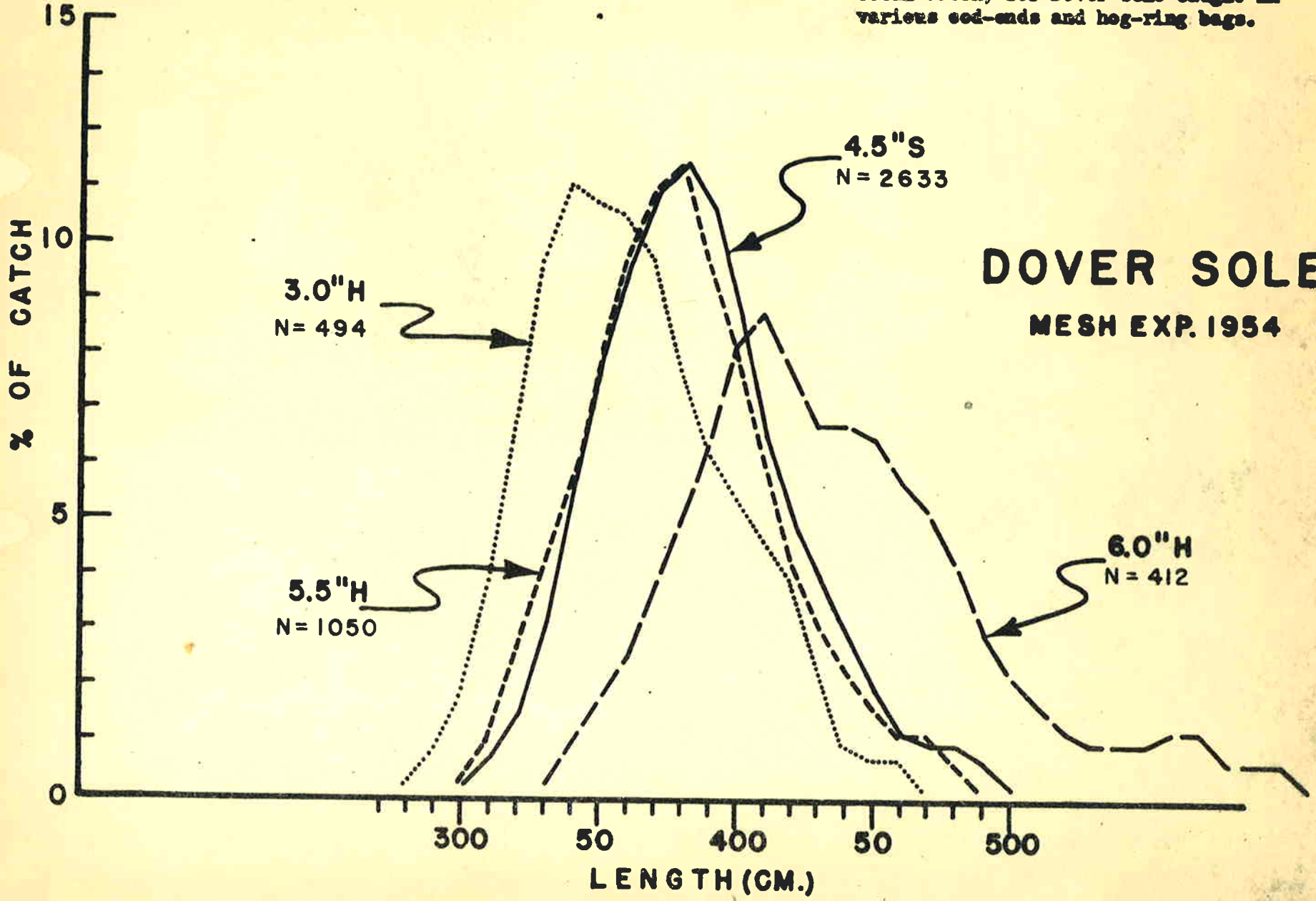


Table 28 - Statewide otter trawl landings - 1948-1954.
(For roundfish)

Species	1948	1949	1950	1951	1952	1953	1954
Blackmod	314,229	586,343	497,822	1,285,841	643,385	224,928	335,284
Lingcod	4,639,453	3,063,672	2,364,953	1,835,710	1,509,196	942,108	1,517,995
Ocean perch					1,995,197	2,941,089	6,671,869
Rockfish	10,262,442	12,610,526	11,185,430	9,508,125	9,584,488	3,732,161	6,195,161
Trumod	5,219,237	5,341,697	8,167,949	8,394,808	9,975,866	8,182,747	15,393,911