REPORT ON THE 1956 TRAWL INVESTIGATIONS
(Confidential)

State of Washington
Department of Fisheries

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Table of Contents

Report on the 1956 Trawl Investigations

List of Tables

List of Tables (contd)

List of Tables (contd)

List of Figures

List of Figures (contd)

GLOSSARY OF TERMS AS DEFINED IN TEXT

ABUNDANCE. Total numbers of individuals within a population, area, or a specific segment of the population regardless of their availability to the fishing fleet.

AVAILABILITY. The number of individuals which are actually accessible to fishing. As the instantaneous fishing rate on the available fish approaches 100 percent the catch approaches the total available population.

BATHYMETRIC RANGE. The range of depths inhabited by a species or populations.

BIOLOGICAL OVER-FISHING. Reduction, through fishing, in the size of the cumulative spawning stock results in a decline in recruitment.

CATCHABILITY. See vulnerability.

CATCH PER UNIT OF EFFORT. Quantitative measures of yield per specified time fishing by an unit of gear.

CHOSEN STOCK. Recruitment to a particular stock; not necessarily the same as the parent stock.

CONTINENTAL SHELF. $<$ 100 fathoms.

CONTINENTAL SLOPE. $>$ 100 fathoms.

CUMULATIVE POPULATION MORTALITY. Total numbers of individuals lost from fishable population regardless of causes.

CUMULATIVE STOCK LEVEL. Total numbers of all age groups in fishable populations.

"DEEPS". Areas along the continental slope where deep-water trawling occurs and where species inhabiting shallow water during the summer months congregate for spawning. In most instances these "deeps" are associated with Dover or petrale sole spawning areas.

DEMERSAL FISHES. Associated with fish considered to inhabit waters near the ocean floor.

DISCRETE SPAWNING AREA. See discrete stock.

DISCRETE STOCK. Being independent of other stocks of the same species during the spawning period or a group inhabiting a particular geographic area which does not tend to inter-mix with stocks in contiguous waters.

DYNAMIC CHANGES. Involving changes in number, weight, size, or age of fish comprising the fishable population.

ECONOMIC OVER-FISHING. Reduction in the available population through fishing which makes continued exploitation unprofitable.

EXPLOITATION RATE. See fishing rate.

FISHABLE POPULATION. Those fish within the size range capable of being caught by the gear in use. Excludes individuals which are lost through gear selectivity.

FISHERMAN VALUE. Amount paid to fishermen for catch.

GEOGRAPHIC FISHING RANGE. The limit of trawl operations as observed in the fishery. This range should not be confused with potential or fishable range as defined by a vessel capabilities.

HOMING INSTINCT. An innate tendency of adult groups to return regularly to specific areas for spawning. In this definition the filial generations do not necessarily return to the areas where parental spawning occurred.

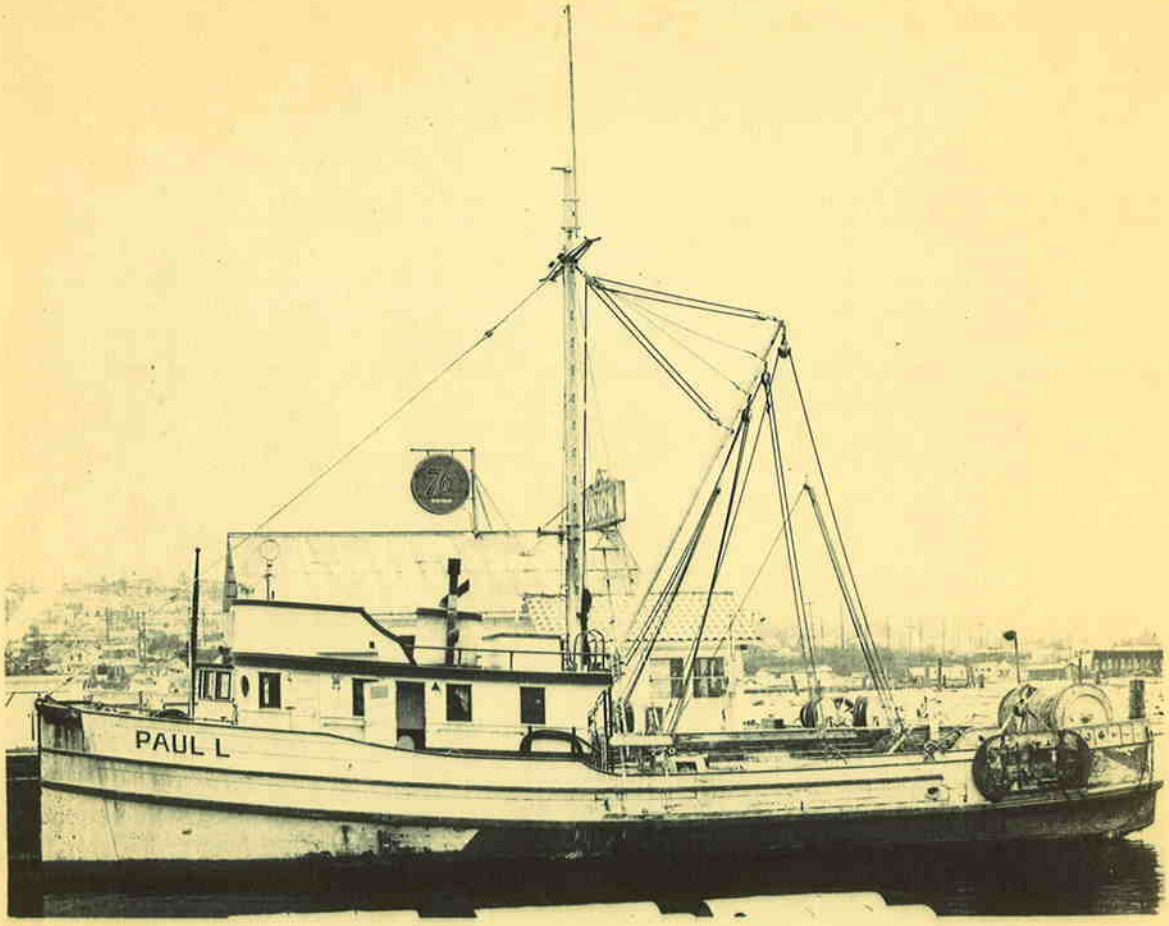
INSHORE GROUNDS. $<$ 100 fathoms.

INSIDE WATERS. Those waters within the State of Washington lying east of Tatoosh Island.

MAXIMUM UTILIZATION. Obtaining the theoretical greatest yield in numbers or weight from a population on a sustained yield basis.

OFFSHORE GROUNDS. $>$ 100 fathoms.

ORIGIN OF CATCH.	Area from which catch was made.
PRODUCTIVITY.	A relative consideration of yield in a defined area, or for a particular species as related to other areas or species. As shown by catch per hour fishing.
QUANTITATIVE CONTRIBUTION.	The catch made from a defined stock divided by the total production of that species.
RECOVERY RATE.	Numbers of tags recovered in specified time divided by the total number of releases.
RECRUITMENT.	Numbers of young fish entering the fishable population. Does not indicate numbers of young existing prior to their entering the fishery.
SCRAP FISH.	Those fish currently listed as being lawful for use as mink or animal feed.
SIGNIFICANT CATCH.	Any catch of a particular species which represents 25 percent or over of the total catch made during a defined number of drags in a particular area.
SIGNIFICANT DEPTH.	The depth at which any significant catch was made.
VERTICAL FISHING RANGE.	The range of depths observed to have been fished by the trawl fleet. This range should not be interpreted as the fishable range defined by limits of the gear.
VULNERABILITY.	Ease of removal and accessibility.



DRUM TRAWLER - PAUL L.

Drum trawlers were introduced into the Washington trawl fleet in 1954.

REPORT ON THE 1956 TRAWL FISHERY

Preface

During the past three years the trawl research staff has initiated a systematic method of collecting data on the distribution of fishing effort and the origin of catches of demersal fishes marketed in the State of Washington. The instigation of the interview system in 1953 resulted primarily from the need to supplement sales ticket records with reliable figures on the catch per unit of effort by species and area. It was hoped that the interview technique would supply this additional information and establish a method of collecting statistical data having annual continuity. By these means comparative catch records would be available to evaluate and analyze dynamic changes occurring in the various stocks. Such data was considered mandatory to establish the basic knowledge necessary to discharge the responsibilities and obligations of fisheries management entrusted to the State.

The design and objectives of our present program (within the limits of our staff and allocated funds) is to:

1. Define the geographic parameters of the major stocks and populations subject to exploitation by our trawl fisheries and to establish the degree of intermingling these fish populations or stocks may exhibit in time and space with populations inhabiting contiguous geographic areas.
2. To obtain information on the sizes or relative sizes of populations of bottom fish now being exploited and on the occurrence of demersal fish not the object of a fishery so that the potentials of these populations and their reaction to the fishery may ultimately be evaluated.
3. To establish the general life histories of trawl-caught species, i.e. growth, reproduction, recruitment, and behaviour patterns to assist in

proper evaluation of dynamic changes and so that suggested management would be logical and compatible with the knowledge of the life history of the species involved.

We feel the trawl interview system has given us a basic tool of research which has added considerably to our understanding of the characteristics of our fishery and of intrinsic operations which influence catch trends. It has, in our opinion, laid the foundation necessary to carry out the aims and objectives of our long-range program.

The annual report summarizing the results of trawl studies for 1956 is herewith submitted (April 6, 1957).

PART I - REPORT ON PROJECTS

Special investigations under study in 1956 include: (1) Puget Sound studies, (2) cooperative PMFC petrale sole studies, (3) evaluation of tagging work, (4) studies of seasonal distribution patterns of demersal fishes, (5) the animal food fishery, (6) and the international characteristic of our fishery. The evaluation of data collected from interview data is considered a major long-range program and is dealt with under a portion of the report especially devoted to analysis of this data.

PUGET SOUND STUDIES

During the second week of August 1956, trawl personnel accompanied the School of Fisheries boat Commando and assisted in sampling bottom fish populations in various portions of Puget Sound including Carr and Case inlets, Everett Bay, Holmes Harbor, Saratoga Passage and Penn Cove. Examination of English sole in the South Sound region showed a high percentage of the fish continued to be parasitized by the blood worm, Philometra americana; however, cursory inspection indicated a reduction in the degree of infestation and possibly in the percentage of fish

parasitized.

In December 1953 portions of southern Puget Sound including Carr and Case inlets were reopened to limited trawling to encourage the harvesting of scrapfish inhabiting these waters and to reduce the size of a highly parasitized English sole population. The re-opening of this area was part of the general Departmental policy to allow controlled trawling and harvesting of bottom fish stocks within Puget Sound. Prior to the South Sound opening, Holmes Harbor (January 1953) was opened for a six week period. In December 1954 the waters of Hood Canal were re-opened to limited trawling. Since the opening of these areas, considerable quantities of scrapfish and fair catches of food fish have been taken by the trawl fleet. Tables 1a and 1b show recent catches of food fish and scrapfish reported as having been caught in the South Sound and Hood Canal.

Table 1a - Trawl catches for South Sound - open December 1 through March 31.

Food fish	1953-54*	1954-55	1955-56
English sole	37,000	30,000	71,600
Rock sole	1,860	600	22,000
Sand sole		963	17,000
Flounder	69,359	5,645	13,500
Rockfish	92,339	15,769	34,000
True cod	37,380	17,262	20,000
Lingcod	451	1,576	1,800
Perch	10,416	627	2,700
Total	248,805	72,442	182,600
Scrapfish			
Hake	200,000	125,000	
Skate	230,000	75,000	64,000
Dogfish	650,000	450,000	50,000
Scrap			380,000
Ratfish		75,000	
Wormy English sole	962,000	140,000	600,000
Total	2,042,000	865,000	1,094,000

*Open December 1 through February 28.

Table 1b - Trawl catches for Hood Canal - open December 1 through February 28

Food fish	1954-55	1955-56
English sole	222,000	32,000
Rock sole	34,000	14,000
Sand sole	3,000	150
Flounder	10,400	8,000
True cod	40,000	8,000
Lingcod	6,300	2,200
Rockfish	22,500	3,000
Perch	7,300	2,700
Petrale sole	50	
Total	345,550	70,050
Scrapfish		
Dogfish	259,000	
Skate	105,000	1,700
Ratfish	129,000	
Hake	86,000	
Scrap	5,900	12,000
Total	584,900	13,700

Experimental trawling, East Sound

Since May 1947 those waters of East Sound (Figure 1) north of a line projected true west from Moran's Point at the west entrance of Cascade Bay near the town of Rosario have been closed to trawling. In recent years, Orcas Island sport groups have complained of increased dogfish in the area. During August 1955 Mr. Palmen met with sports groups to discuss the possibilities of reopening the East Sound to trawling. Those attending the meeting favored the reopening and arrangements were made for experimental drags to be made in East Sound.

On January 10 and 11, 1956 Mr. Pasquale accompanied the trawler Crusader during experimental fishing in this region. Three drags were made in the closed waters, each drag followed (in a circular pattern) the general shoreline contour. The depth of tows ranged from 12 - 14 fathoms and their average time

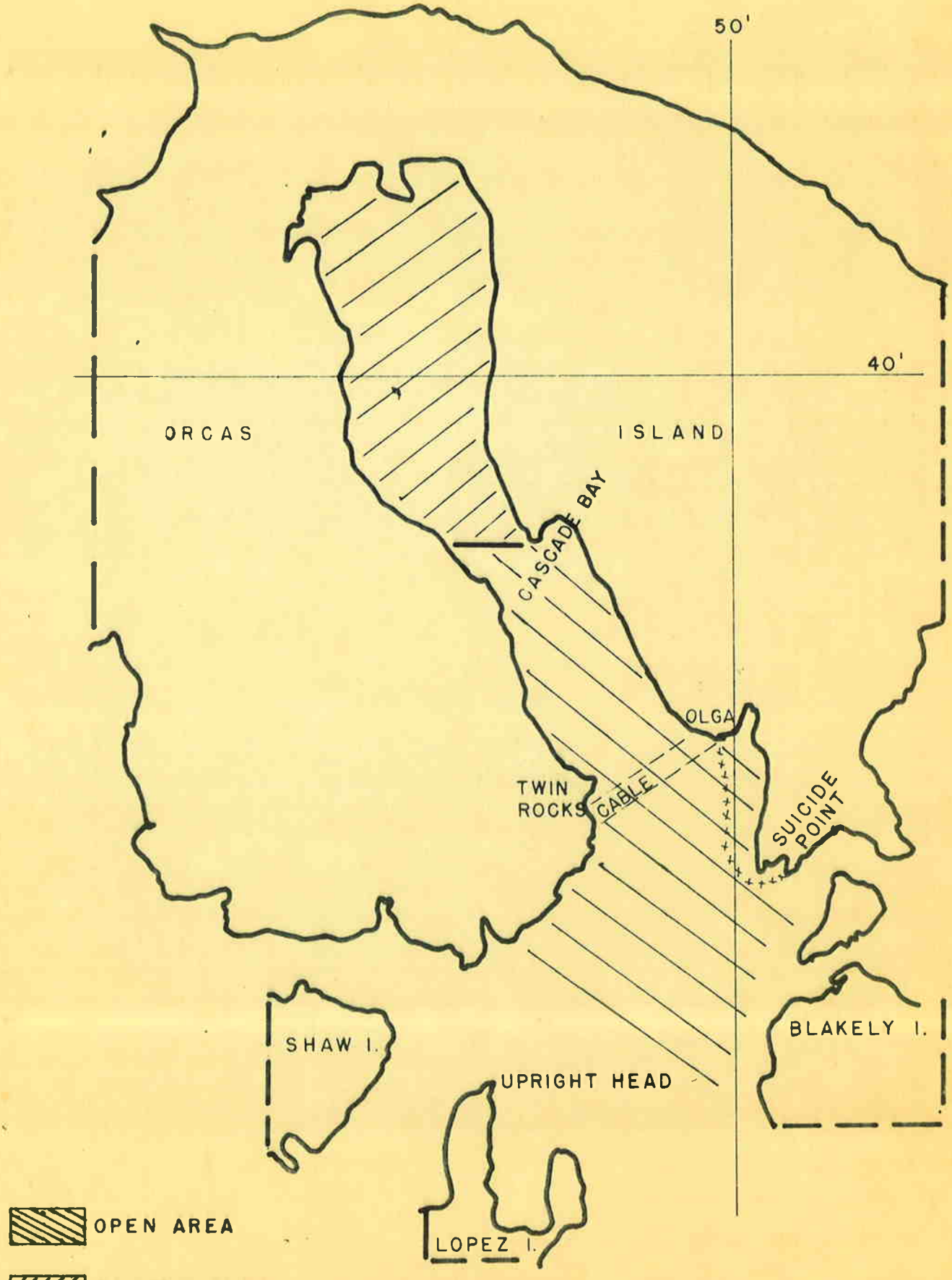


Figure 1 - East Sound exploration area.

time was 3 hours and 10 minutes. In addition to these tows several drags were made in the open waters contiguous to East Sound. Table 2 relates an estimate of the occurrence of marketable and unmarketable fish caught in the closed waters and the adjacent open area. The most prominant food fish caught in the closed area was the starry flounder, while sand sole was second in importance. Skates made up the bulk of scrapfish caught in both areas, dogfish apparently not being abundant during the period the exploratory cruise was made. . It was recommend by the observer that East Sound be reopened to limited trawling as no valid reason could be supported for its continued closure.

Shrimp survey - Bellingham Bay

On July 3, 1956 Nick Pasquale accompanied the trawler Tongass during experimental shrimp trawling in Bellingham Bay. Two tows were made with a small trawl net using $1\frac{1}{2}$-inch stretch measure webbing.

The first tow made off the northern tip of Lummi Island yielded a total of 62 side strip shrimp, Pandalopis dispar. The second tow off of Point Francis yielded about 100 pounds of mixed shrimp including humpbacks, Pandalus hypsinotus, side stripes, and a few pink shrimp, Pandalus borealis. Small amounts of scrapfis were also taken in these tows. Fishermen engaged in the exploratory work did not feel the amounts of shrimp were adequate to encourage a fishery.

Table 2 - Catch of fish in open and closed waters of East Sound, Orcas Island

Species	Closed area						Open area				
	Poundage marketable			Poundage unmarketable			Poundage marketable		Poundage unmarketable		
	Drag #1	Drag #2	Drag #3	Drag #1	Drag #2	Drag #3	Drag #1	Drag #2	Drag #1	Drag #2	Total all drags/species
English sole				0			10	2	6	2	20
English sole	30	10	0	0	0	8	50	10	10	5	123
Rock sole	320	450	400	0	2	0	200	190	70	5	1,637
Sand sole	650	1,000	800	50	8	10	10	200	0	50	2,778
Flounder											
Bellingham sole			15			0	20	0	30	0	65
True cod	30	12		0	0		400	250	0	0	692
Lingcod	20		20	0		0	0	0	0	0	40
Dogfish				0	75	20			350	50	495
SSate*				200	125	1,000			350	450	2,125
Ratfish				0			20				20
Sculpid		0			5				5		10
Flatheads				0			10		0		10
Total	1,050	1,472	1,235	250	215	1,038	720	652	821	562	
C/H all species	553						591				
C/H marketable food fish	393						284				

Table 4 - Catch by area for Canadian vessels, 1945-1955.

Year	Hecate Strait	Goose Islands	Cape Scott	West coast of Vancouver Is.**		Queen Charlotte Strait	Strait of Georgia	Total
				Upper areas	Lower areas			
1945	43,528	163,854	28,116	213,945	359,197	-	1,840	810,480
1946	426,024	684,406	67,906	404,168	805,506	5,275	2,615	2,395,900
1947	1,055,800	163,966	124,960	123,577	292,092	1,592	353	1,762,340
1948	5,475,709	575,174	111,761	156,455	1,402,219	378	95	7,721,791
1949	1,578,605	258,650	120,266	210,453	1,123,904	-	61	3,291,939
1950	347,377	155,995	129,671	324,874	1,086,911	-	1,130	2,045,958
1951	527,013	106,438	123,413	177,807	648,993	200*	1,442	1,585,306
1952	182,900	91,826	83,604	192,399	1,277,290	55	1,216	1,829,290
1953	66,520	64,607	41,588	29,357	843,153	1,471	2,495	1,049,191
1954	18,279	40,688	31,794	135,956	707,540	145	6,491	940,893
1955	26,260	8,468	16,485	199,863	330,099	300	850	582,325

* From Canadian Statistical Area 13 (Lower Johnstone Strait-upper Strait of Georgia).
** West Coast of Vancouver Island catches are divided geographically at Esteban Point, upper areas to the north and lower areas to the south.

Table 3 - Catch by area for American vessels, 1948 to 1955

Year	Hecate Strait	Cape Scott and Goose Island	* West coast of Vancouver Island		Washington coast	Esteban Deep
			Upper areas	Lower areas		
1948	1,143,509	1,317,478	1,890,956	1,501,853	227,979	
1949	2,013,243	558,358	479,762	1,469,192	279,383	
1950	1,178,365	951,576	1,184,200	785,220	253,384	
1951	869,550	482,647	487,960	1,090,826	424,109	
1952	1,078,632	493,557	389,777	918,200	480,351	
1953	466,413	853,086	243,878	500,295	67,520	250,000
1954	647,500	426,360	318,010	792,870	330,150	1,087,480
1955	141,420	966,784	235,689	466,139	406,071	683,957

*West Coast of Vancouver Island catches are divided geographically at Esteban Point, upper areas to the north and lower areas to the south.

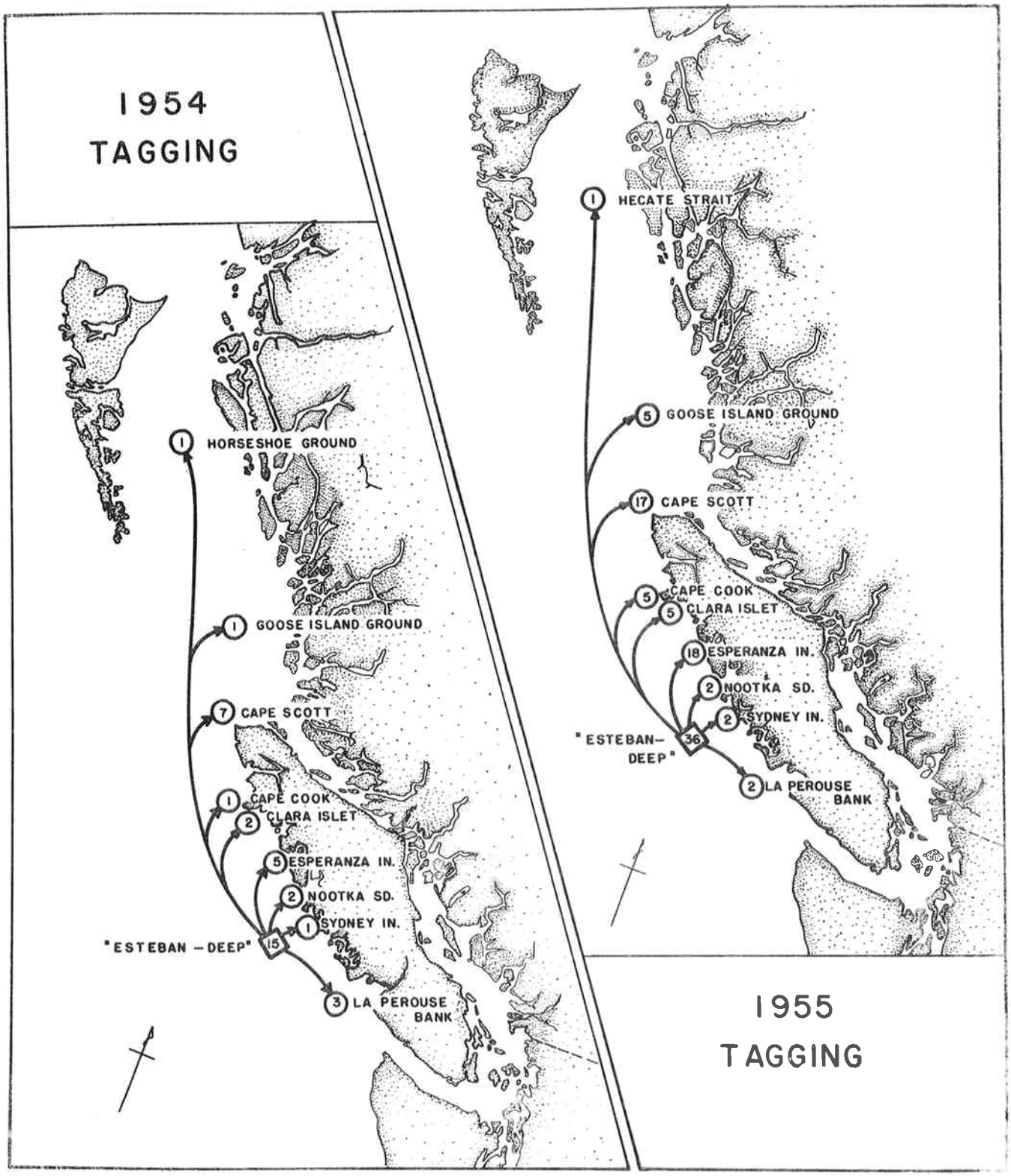


Figure 2 - Pattern of petrale sole recoveires for 1954 and 1955 tagging experiments.

PETRALE SOLE STUDIES

During the spring of 1954 studies were initiated to determine the dispersion pattern of petrale sole from the "Esteban Deep" and to study the movements of the species within parameters delineated by the vertical and geographic range of the trawl fleet. Two tagging experiments were conducted in cooperation with the Fisheries Research Board of Canada. The preliminary results of these experiments have been discussed in the reports on the 1954 and 1955 trawl fisheries. Within the past year, data from these experiments have been compiled, evaluated, and summarized in a written report (Alverson and Chatwin) to be published in the Journal of the Fisheries Research Board of Canada.

The scope of this paper, portions of which are presented below, includes statistical data on the origin of catches made by British Columbia and American trawlers. These are shown in Tables 3 and 4. A review of the tagging studies shows that from 1,795 petrale sole tagged in 1954 and 2,007 tagged in 1955, 144 recoveries were made as of May 30, 1956. Forty-three of these were from the 1954 experiment and 103 from the 1955 work. The pattern of recovery for both experiments was quite similar (Figure 2) in that after spawning at Esteban there was a general northward inshore movement along the northwest coast of Vancouver and eventually into Queen Charlotte Sound and Hecate Strait.

Recoveries on the Esteban grounds made one and two years after the 1954 tagging work and in 1956 at Esteban from the 1955 tagging work indicates that adults of this species may have a homing instinct to particular "deeps" for spawning. Further evidence as to this homing tendency to rather discrete spawning areas is supported by the absence of recoveries of Esteban-tagged fish in other discovered deeps. It is not proposed that the progeny of the Esteban fish or those from other deeps return exclusively to these areas, but that after maturity and recruitment to a particular stock, a fish will assume a migration pattern similar to that displayed by the chosen stock.

The Esteban Deep catches in 1954 and in 1955 constituted 30 and 25 percent of the United States landings, and 24 and 21 percent of the United States and Canadian total landings respectively. Quantitative contributions of males to the various inshore fishing grounds (Figure 3) was estimated by calculating the number of males in the landings by geographic subdivisions and hence the tagged to untagged ratios. The total males by numbers (Tm) by area was calculated as

$$Tm = \frac{CA}{Pm\ \bar{wm} + Pf\ \bar{wf}} \times Pm$$

Where CA = total catch for area in lbs.

Pm = percent males in samples for area.

$\bar{wm}$ = the mean weight of males in area (from sampling)

Pf = the percent of females in samples for area

$\bar{wf}$ = the mean weight of females for area

These estimated contributions are shown in Table 5. Obviously, sampling error tag loss and recruitment would materially affect these figures. However, the model illustrates the Esteban male stock contributes largely to the inshore fishing areas north of Esteban Point - in this case, approximately 53 percent of the total male catch.

The number of female petrale sole tagged and the number recovered was not sufficient to compute estimates of the Esteban stock female contribution to the inshore fisheries. Only 12 tagged females were recovered from the inshore catches - six in the Esteban Point to Cape Cook area and six in the Cape Scott to Hecate Strait area. It is suggested therefore that the Esteban females also contribute greatly to the total catch in the northern areas.

Figure 3 - Major petrale sole fishing areas along Washington and British Columbia coast.

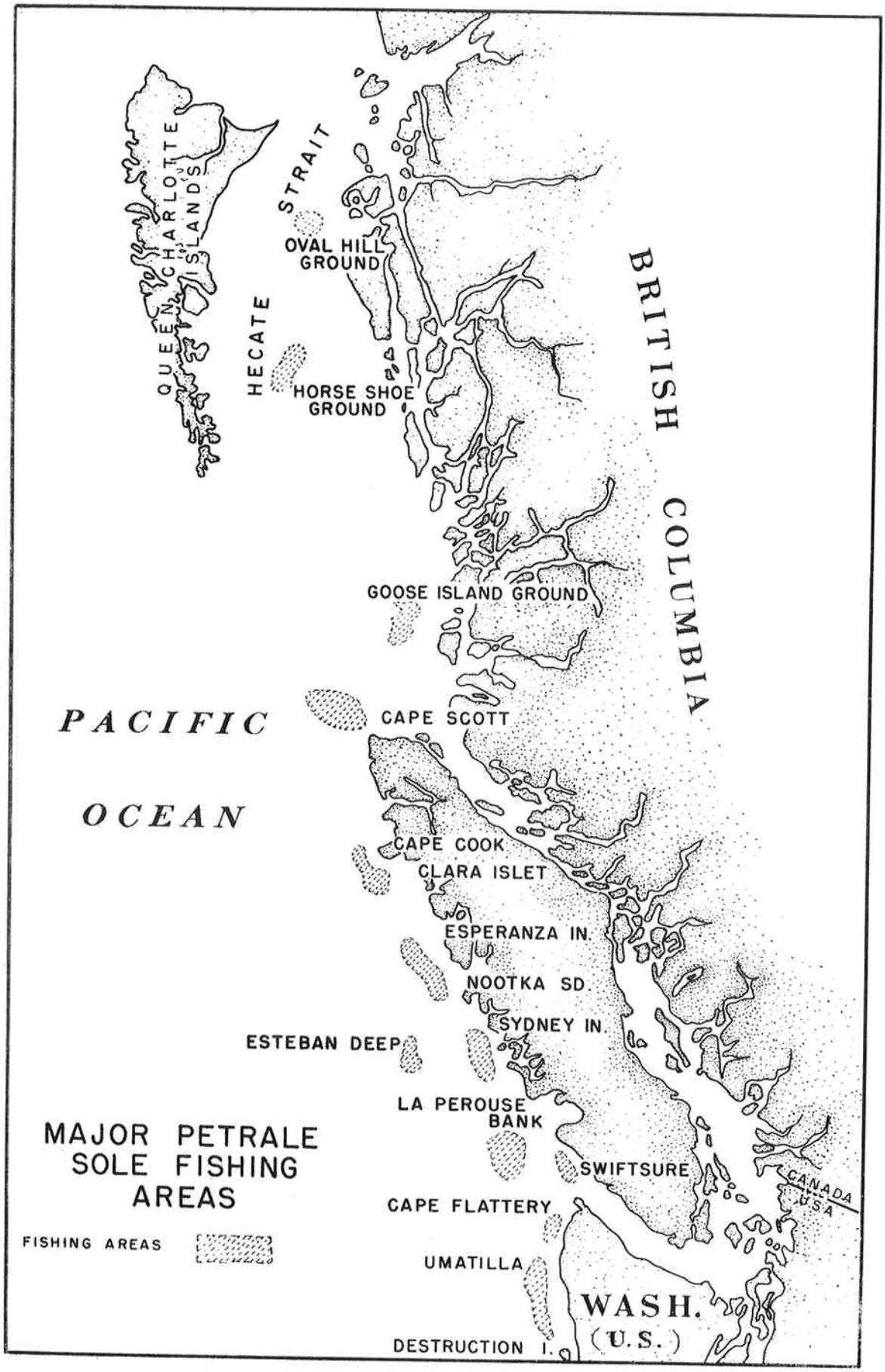


Table 5 - Combined United States and Canadian petrale sole catch by area and calculated contribution of Esteban stocks to the inshore fisheries (April 1, 1955 - May 31, 1956).

	Esteban Point south	Esteban Deep 1956, only	Esteban to Cape Cook	Cape Scott to Hecate Strait
(1) Catch (lbs)	1,099,381	348,000	518,091	1,228,565
(2) Tag recoveries	4	25	30	24
(3) Percent of inshore recoveries	6.9	-	51.7	41.4
(4) Male tag recoveries	4	25(20)*	24	18
(5) Percent males in market samples	28.7	72.4	38.8	44.6
(6) Calculated males in landings	109,884	62,799	71,860	169,818
(7) Tagged to untagged ratio	1:27471	1:3140	1:2994	1:9434
(8) Calculated percent inshore males from Esteban	11	-	100	32 - 33

*Number of returns after March 10 used to calculate Esteban tag ratio.

PMFC COOPERATIVE STUDIES

During the first several months of 1956 regulations were promulgated prohibiting the landings of petrale sole in the states of Oregon and Washington (February 1 to April 15) with the exception that incidental catches not to exceed 6,000 pounds per trip could be marketed.

The instigation of the regulation resulted from the evaluation of a long term decline in the availability of this species coupled with increased fishing effort which followed the development of deep-water fishing. Data pertinent to the statistical history of the petrale sole shows that the species was an important component of the trawl fisheries as early as 1943 when approximately 5.9 million pounds were landed. In the succeeding years, the catch fluctuated between 5 and 6 million pounds and peaked in 1948 at 6.2 million pounds (Table 6). Following

1948, the total catch declined until 1953. The discovery and subsequent exploitation in 1953 of the deep-water stocks (mostly Esteban) resulted in increased total catches in 1954 and 1955.

Table 6 - Annual British Columbia and Washington landings of petrale sole, 1938-1955, in pounds.

Year	British Columbia	Washington	Total
1938	100,000	2,500,000	2,600,000
1939	125,000	2,300,000	2,425,000
1940	250,000	2,800,000	3,050,000
1941	250,000	4,400,000	4,650,000
1942	400,000	4,800,000	5,200,000
1943	450,000	6,000,000	6,450,000
1944	500,000	5,110,000	5,610,000
1945	810,000	5,553,600	6,363,000
1946	2,395,900	5,100,000	7,495,000
1947	1,762,340	4,800,000	6,562,340
1948	7,721,791	6,185,000	13,906,791
1949	3,291,939	4,870,000	8,161,939
1950	2,045,958	4,423,000	6,468,958
1951	1,585,306	3,400,000	4,985,306
1952	1,829,290	3,382,000	5,211,290
1953	1,049,191	2,445,000	3,494,191
1954	940,893	3,606,000	4,546,893
1955	582,325	2,900,000	3,482,325

A measured decrease in availability of petrale stocks off the west coast of Vancouver Island has also been demonstrated by Canadian investigators. The catch per trip for Canadian trawlers fishing the lower west coast of Vancouver Island has declined from 9,800 pounds in 1948 to 3,800 pounds in 1955. Records taken from the Washington trawlers fishing the Hecate Strait grounds have shown a drop from 26,000 pounds per boat trip in 1947 to 7,000 pounds in 1955. Combined United States and Canadian landings have declined from a peak of 13.9 million pounds (1948) to 3.5 million pounds in 1955.

The statistical history of the species suggest the equilibrium yield has been exceeded for this stock or population for the past eight years; that is, the number

of fish being removed by fishing plus those eliminated from the population by natural causes has exceeded the number of recruits entering the fishery. Continued exploitation of the highly vulnerable deeps might accelerate the decline in the cumulative stock level. The immediate purpose of the regulation is to attempt to reduce the total catch and bring into equilibrium the number of fish being harvested with those entering the fishery.

Seasonal closures on a fishery often results in increased fishing effort being exerted on the protected species prior to and following the closure. Some tendency for increased fishing effort was noted on the Esteban grounds during early January 1956, which resulted in increased yield compared with the previous two Januarys; that is, 1954 and 1955. Approximately 80,000 pounds were taken from the Esteban Deep during 1956 as compared with an average of 45,000 pounds during the same period in 1954 and 1955. Following the closed season, the petrale sole catch showed no increase over previous years and the Esteban take was actually down from preceding years. The closure was therefore closely adjusted to the deep-water spawning phase of the petrale sole in 1956. If any adjustments were made, perhaps additional protection in January would be beneficial. Continued study of the annual variation in the time of arrival on the spawning deeps will be necessary to properly adjust this closure.

During the 1956 closed period a total catch of 372,000 pounds was noted; however, this is not the actual poundage of petrale sole removed from the Esteban area. Table 7 shows the estimated catch of petrale sole from the Esteban Deep for 1954, 1955 and 1956, along with catches of Dover sole during the same period. The catch, although considerably down from 1956, was still higher than we had desired.

Table 7 - Petrale and Dover sole landings from Esteban Deep

Month	1954	1955	1956
Petrale			
February	15,350	9,110	26,560
March	587,240	591,890	155,395
April	415,380	131,690	190,725
Total	1,017,970	732,690	372,680
			170,000*
			542,680
*known illegal & discard	70,000		
	100,000		
	170,000		
Dover			
February	-	-	14,520
March	15,000	32,730	575,570
April	150,000	357,695	391,560
	165,000	390,425	981,650

The increased catches of Dover sole during the past three years has changed the characteristics of the deep water fishery in this area. In 1954, when the Esteban grounds were first extensively exploited, catches of Dover sole were small and the bulk of the catch of Dover sole were made in water somewhat deeper (about 220 to 250 fathoms) than that for the petrale sole which were being exploited at depths of 180 to 220 fathoms. The populations of petrale and Dover sole were therefore relatively independent of each other. During the past year a shift was noted for the Dover sole population which apparently moved to somewhat shallower water and to an extent overlapped the population of petrale sole. As a consequence of the shift and the heavy 1956 Dover sole fishery, more incidental limits were obtained than we had expected and vessels which obtained the maximum poundage retainable under law discarded the excess. A portion of the discard was dead and must be considered as adding to the cumulative population mortality. The expanding Dover

sole fishery, therefore, partially offset the savings desired.

The total landings of sole in recent years as compared with the trend for that of petrale sole has shown an opposite trend. The total catch is on the increase and an all-time high was reached in 1956. The increased catches have resulted from a greater diversification in utilization of species such as Dover sole, rock sole, and others. This trend in marketing may be considered an industrial compensation which has helped to sustain the economic value of the sole fisheries.

Obviously, it is desirable to maintain the production of petrale sole at it's highest possible level and to thwart the present decline. To achieve better protection for petrale sole, it might be necessary to close Dover sole fishing concurrent with the petrale sole closure. However, we are cognizant that the economic value of Dover sole taken in this period is considerable and that stocks of this species exploited off the North Washington coast adjacent to Vancouver Island have only recently been fished. We have no evidence to date which indicates biological overfishing on this species.

The added complexities and changing characteristics of deep-water fishing brought about by the Dover sole fishery in the Pacific Northwest demands that continued observations be made on this phase of development.

TAGGING STUDIES

During 1955 and 1956 tagging experiments on lingcod, truecod, English sole, blackcod, and petrale sole were carried out to determine migratory patterns, to obtain data on growth rates, and to assist in evaluating fishing rates on stocks exploited by the fishery. Results of the major tagging experiments in 1955 on petrale sole have been discussed in a previous section. Tagging studies on other species were of a pilot nature to test the utility and recoverability of spaghetti, nylon leader, and Peterson disc tags. These experiments were generally

carried out as parallel tests where two lots of different types of tags were released. A summary of this work follows:

Lingcod - 1955 (Scofield - PMFC cooperative studies)

During the summer of 1955 (August) 407 lingcod were tagged and released off the Washington coast. Of this total, 98 were Peterson disc tags, 277 were nylon leader tags, and 34 were spaghetti tags. As of December 31, 1956, 16 Peterson tags were recovered or 16 percent of the releases. In contrast, 20 or 7 percent of the nylon leader tags were recovered. Both the nylon leader and the Peterson tags were released in the same general area and supposedly subjected to equal fishing pressure. The different rates of recovery between Peterson and nylon leader tags may have resulted from a number of factors. Differential fishing mortality could have existed although the alternate tagging procedure and releasing the tagged fish on the same grounds should minimize this possibility. Nylon leader tags may be easier shed than the Peterson tags or disc tags could be more apparent to fishermen and fillet line workers. There may also be a difference in the viability of the two lots of tagged fish. Selection of tags by gear can also be important. Chi-square test applied to the recovery rates gives a value of 7.258, demonstrating a significant dispersion (at the .01 level) from that expected The preliminary results from this test indicates that Peterson tags may give more reliable estimates of fishing rates. The number of spaghetti tags out was not considered adequate to make comparisons with the other releases.

All of the tagged fish were caught near the areas of release and this species has shown no indications of seasonal horizontal migrations.

Lingcod - 1956 (Commando - Department of Fisheries studies)

In July 1956, 332 lingcod were tagged and released in the area between Cape Flattery and Destruction Island. Two lots were released during this experiment, consisting of 98 nylon leader tags and 239 spaghetti tags. These groups, however,

could not be directly compared as the majority of the nylon leader tags were released in the vicinity of Destruction Island, while many of the spaghetti tags were released near Cape Flattery; hence, subject to a more intense fishery. As of December 31, 1956, 2 or 2 percent of the nylon leader tags had been recovered while 30 or 13 percent of the spaghetti tags were recovered. The high number of recoveries of spaghetti tags (30) for the six month period subsequent to tagging gives a comparatively high rate of removal for the fish released in the Cape Flattery area. This should not, however, be construed to be indicative of the fishing rate on the populations of this species within the parameters of the Cape Flattery to Destruction Island fishery. As previously stated, the intensity of the fishery within this area varies considerably and segments of the population are therefore subject to different fishing rates.

Truecod - 1955 (Scofield - Cooperative PMFC studies)

During August of 1955, 19 truecod were tagged with nylon leader and released in the offshore waters between Cape Flattery and Destruction Island. Considerable difficulty was experienced in obtaining fish suitable for tagging as many of the truecod were bloated and could not sound. No recoveries were reported as of December 31, 1956.

Truecod - 1956 (Commando)

During July 1956, 667 truecod were tagged in the waters from Cape Flattery south to Destruction Island. This was the first major tagging experiment to be conducted by Department scientists on this species. The fish were released in two groups consisting of 175 fish tagged with nylon leader and 492 with spaghetti tags. The majority of both tag lots were released in the waters near Destruction Island and were presumably subject to approximately equal fishing pressure. Eleven truecod bearing spaghetti tags were recovered as of December 31, 1956. Assuming equal opportunity for recovery and no difference in selectivity the recoveries

should have been in a proportion equal to that of the total releases. A chi-square test applied to the recoveries gave a value of 2.40. Although the recoveries suggest that spaghetti tags are more reliable, the number of recoveries are insufficient at this time to demonstrate statistical significant variations from that expected. Canadian experiments on this species demonstrated results contrary to observations we have noted (to date) as nylon leader tags were generally considered superior for tagging this species.

English sole - 1953 (Everett Bay - Cooperative U. W. and Department study)

During the fall of 1953 (October), 420 English sole were tagged and released in Everett Bay bearing Peterson disc tags. A total of 173 recoveries were recorded by the first of October 1956. In a three year period 41.1 percent of the total releases were recovered. Of the total recoveries 4.6 percent or 8 tags were captured outside the area of release. Five of these were taken in waters contiguous to and north of Everett Bay and three south of the release area. The recovery area of four tags was unknown.

English sole - 1955 (Everett Bay - Cooperative U. W. and Department study)

Between December 17-21, 1955, 952 English sole were tagged and released in the Everett Bay area of Puget Sound. Two experimental lots of tags were released in this study consisting of 453 Peterson disc and 499 spaghetti tags. As of October 1, 1956, 88 Peterson disc and 93 spaghetti tags were recovered. The recoveries during the nine month period subsequent to release demonstrates a fishing rate on the tagged lots of 18.6 and 19.4 respectively. Assuming the untagged fish were equally vulnerable to the Everett Bay fishery the exploitation rate or rate of removal from this stock would probably not be less than that indicated from the tag recoveries.

In parallel tagging experiments as discussed previously and carried out in the Everett Bay studies, it is impossible to categorically define factors or variables

responsible for differences in recovery rates. Differences in viability of the tagged fish, selectivity of tags, tag loss or shedding, and differences in the fishing rates on the tagged lots may compound observed differences or one or several variables may minimize or dampen the effect of another.

The experimentor may exercise a degree of control over several of these factors, such as minimizing differential exploitation rates. If fish from each drag are tagged alternately with each type of tag being tested, the chance for error from this factor is small. Tests have also been devised for determining the ability of fillet workers and fishermen to observe and report different types of tags. Shedding and the effects of tagging may be tested by holding specimens in aquaria or holding ponds; however, these controlled environmental tests do not closely emulate natural conditions.

In the experiment on English sole, considerable care was taken to minimize differences in exploitation rates and to tag only fish showing a high degree of viability. As a special effort was made to interest Everett Bay fishermen in this study and as catches in this area are generally hand picked, it is doubtful that tags of either group were more often selected or recovered because they were more apparent. It is obvious from the percent recovery of each lot (18.6 and 19.4) that the groups gave almost equal fishing rates. A Chi-square test on the number of observed and expected returns for the two groups yielded a value of .0886 showing no significant variation from that expected.

Movement seems to have been random and no defined migration pattern was displayed for the small percentage of fish which emigrated from the Everett area. The indication of a rather discrete stock in this area conforms with previous studies made in northern Puget Sound (Pruter and Van Cleve).

English sole - 1956 (Commando)

During August 1956, 857 English sole were tagged and released from Cape Flattery to Destruction Island. Of this total, 210 were tagged with nylon leader

tags and 647 with spaghetti tags. Nine recoveries (8 spaghetti and 1 nylon leader tag) were reported as of December 31, 1956. Of the nine recoveries, two rather interesting migrations were noted. One tag was recovered by a trawler off Trinidad Head, California and one near the Columbia River. The number of recoveries are insufficient to make any conclusions in respect to differences in recovery rates.

Blackcod - 1955 (Holmes Harbor)

Several tagging studies were carried out in 1955 on blackcod. These experiments have been summarized and submitted for publication by Alonzo T. Pruter. Interesting movements were noted from the Holmes Harbor region to the offshore waters adjacent to Canada and one recovery was made near Middleton Island in the Gulf of Alaska.

Blackcod - 1955 (Scofield)

In August 1955, 678 blackcod were tagged and released in the waters from Umatilla to Destruction Island. Only four recoveries have been noted from this release.

Blackcod - 1956 (Holmes Harbor)

In May 1956, 659 blackcod were tagged and released at the Holmes Harbor herring trap. Of this total, 335 were tagged with spaghetti tags and 324 were tagged with Peterson disc tags. As of December 31, 1956, 21 (6.5 percent) spaghetti and 22 (6.5 percent) Peterson disc tags were reported recovered. The recoveries were all made in or near the Holmes Harbor area.

STUDIES OF SEASONAL DISTRIBUTION PATTERNS OF DEMERSAL FISHES

The study of fish populations and their distribution patterns have in many instances been handicapped by insufficient knowledge of the behavior of a species throughout its geographic and bathymetric range. As the fishery is usually the basic tool which must be utilized to study movements (horizontal and vertical) and dynamics of a marine fish population, it therefore becomes the function limiting the investigators' observations. That is, when the fishery is not operative throughout a large segment of a population's distribution, either because of physical limitations on gear (i.e. depth) or because of a geographic operational range, the lack of antecedent knowledge of the behavior throughout the population's distribution may preclude factual evaluation of changes in catch effort measures. It also restricts the study of movement to the time and area of the operative fishery. The application of population models in dynamic studies to actual fisheries may in many instances fail or yield misleading results because of inadequate data concerning a species seasonal behavior even within the parameters of the fishery.

Unfortunately, the extension of a fishery throughout a greater portion of a population's distribution are governed by its economic tendencies and the evolutionary aspects of gear. However, an investigator may suspect the limiting ability of collected statistics to produce comparative catch per unit of effort data. Observations of erratic annual fluctuations in catch per unit of effort measures or seasonal and/or annual disappearance of the species within the range of the fishery suggest this possibility.

The adoption of the trawl interview system has resulted in the collection of data which has shed considerable light on the seasonal depth behavior of many of the commercially important demersal fishes. This data has enabled a better definition of the depth parameters of certain species and their seasonal schooling

behavior within these boundaries.

Recent studies of this nature have been advanced by the (1950) development and extension of trawl fishing to the deep water grounds along the continental slope of Washington and Vancouver Island. The evaluation of interview records supplemented by tagging work has appreciably broadened our concepts of these movements and their effects on measures of abundance.

The discovery of deep-water stocks of petrale sole and subsequent tagging experiments on Esteban stock revamped previous concepts as to the migratory behavior of this species. The results of this work showed the highly mobile characteristics of this population through a considerable geographic range and a seasonal movement into deep water for spawning. The density measures and, hence, vulnerability of these schooled deep-water stocks were nearly twice that measured for the inshore summer grounds. A seasonal representation of the depth distribution of petrale sole, as reflected by catch records, is shown in Figure 4. The population during the summer months appears to concentrate along the continental shelf at depths between 30 and 70 fathoms. During the winter months there is a definite shift to deep water. The graphic representation of this seasonal change in depth shows a portion of the population remaining in shallow water during the winter period. This indication of a residual shallow water segment of the population is probably an artifact of the process of moving on and off the deep-water spawning grounds. The rate of emigration from the inshore grounds to specific deeps probably follows a sigmoid relationship where the initial shift (in numbers of fish) to deep water is very slow, increases rapidly, and then tapers quickly after most of the fish have arrived on the spawning grounds. The total time encompassing this movement (about 4 months) is sufficiently long for a portion of the earlier arrivals to complete spawning and begin their emigration to summer feeding areas.

Variations in the percentage of fish annually exploited on these newly

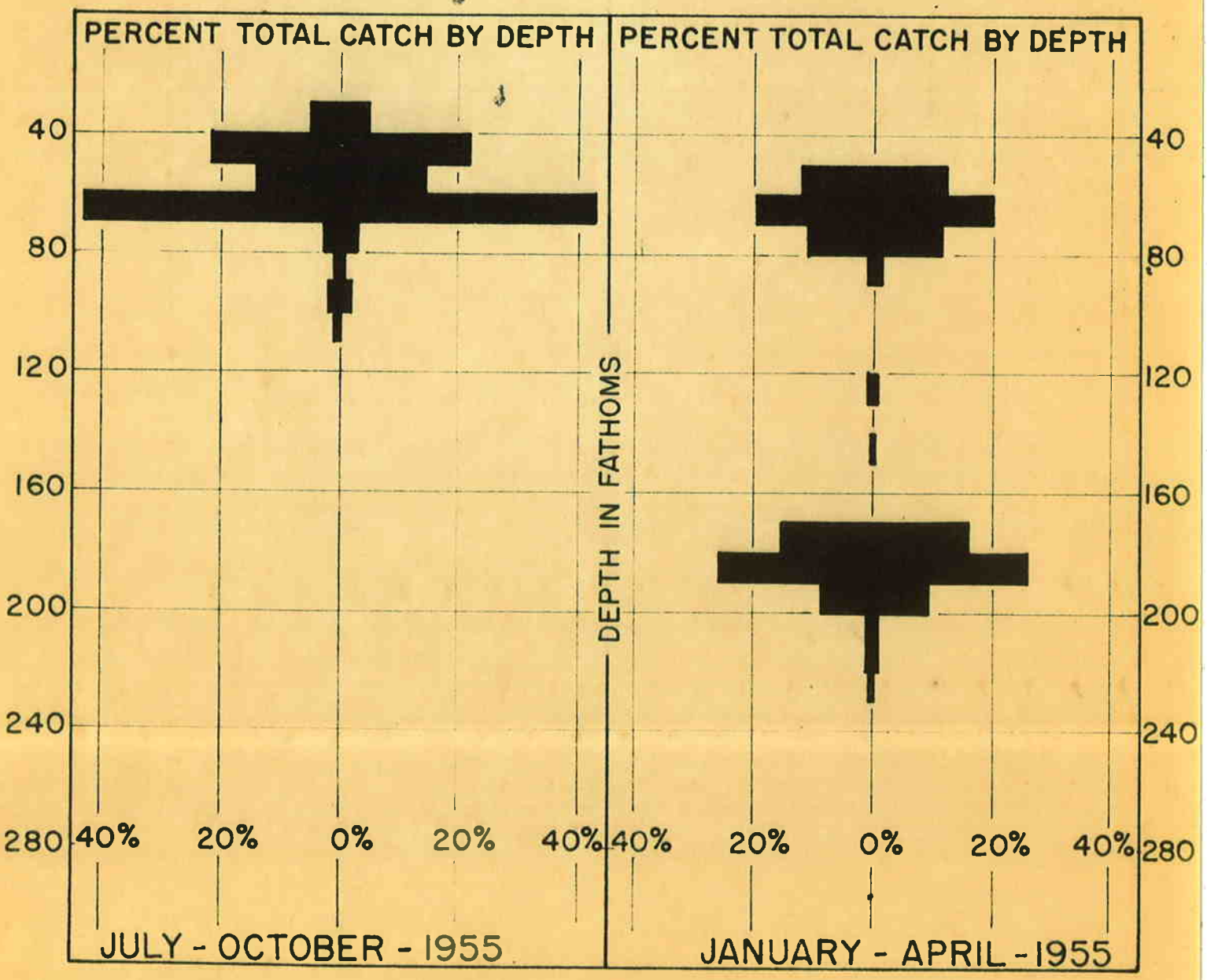
Figure 4

SEASONAL CATCHES BY DEPTH FOR PETRALE SOLE - 1955

JULY - OCTOBER - SIGNIFICANT CATCH PER HOUR - 460

JANUARY - APRIL - SIGNIFICANT CATCH PER HOUR (S) - 304

JANUARY - APRIL - SIGNIFICANT CATCH PER HOUR (D) - 916



GRAPH IS COMPOSITE FOR ESTEBAN TO HECATE STRAIT AREA.

discovered highly vulnerable deeps has modified the historical pattern of the fishery and invalidates direct comparisons of annual catch per effort measures. To minimize measured differences in catch per effort reflecting major changes in schooling behavior occurring within various portions of the distribution parameters, catch per unit of effort relationships should be confined (by time and space) to segments of the population exhibiting similar patterns. Hence, in measures of catch per effort on petrale sole, the knowledge of seasonal differences in vulnerability allows for corrective measures in final evaluation.

Changes in schooling behavior or dispersion as related to depth has been noted for many of our demersal fishes. Figure 5 compares seasonal catches by depths for Dover sole and differences in catch per hour trawling for the two seasonal bathymetric ranges. In summer the species is captured at depths between 40 and 100 fathoms, while the winter fishery operates at depths below 160 fathoms. The catch per hour trawling in the winter is over eight times that measured on the inshore summer grounds - similar large scale depth movements have been noted for blackcod and turbot.

Practically all species of commercial importance under investigation show a definable seasonal depth movement. Differential schooling behavior which may result from these seasonal changes, although under study, is not yet understood. Evidence indicates that these changes, even when small, may have important bearing on the catchability of the species. A three year study on English sole shows a strong relationship* between depth of the stocks and catch per hour trawling (Figure 6). The reasons for this change in schooling behavior may be the result of an accumulation for spawning in winter months or a more confined or restricted habitat in the deep-water bathymetric range.

A continued and complete evaluation of the available data is now in process and should help to increase the validity of our studies on the changes occurring in stock sizes.

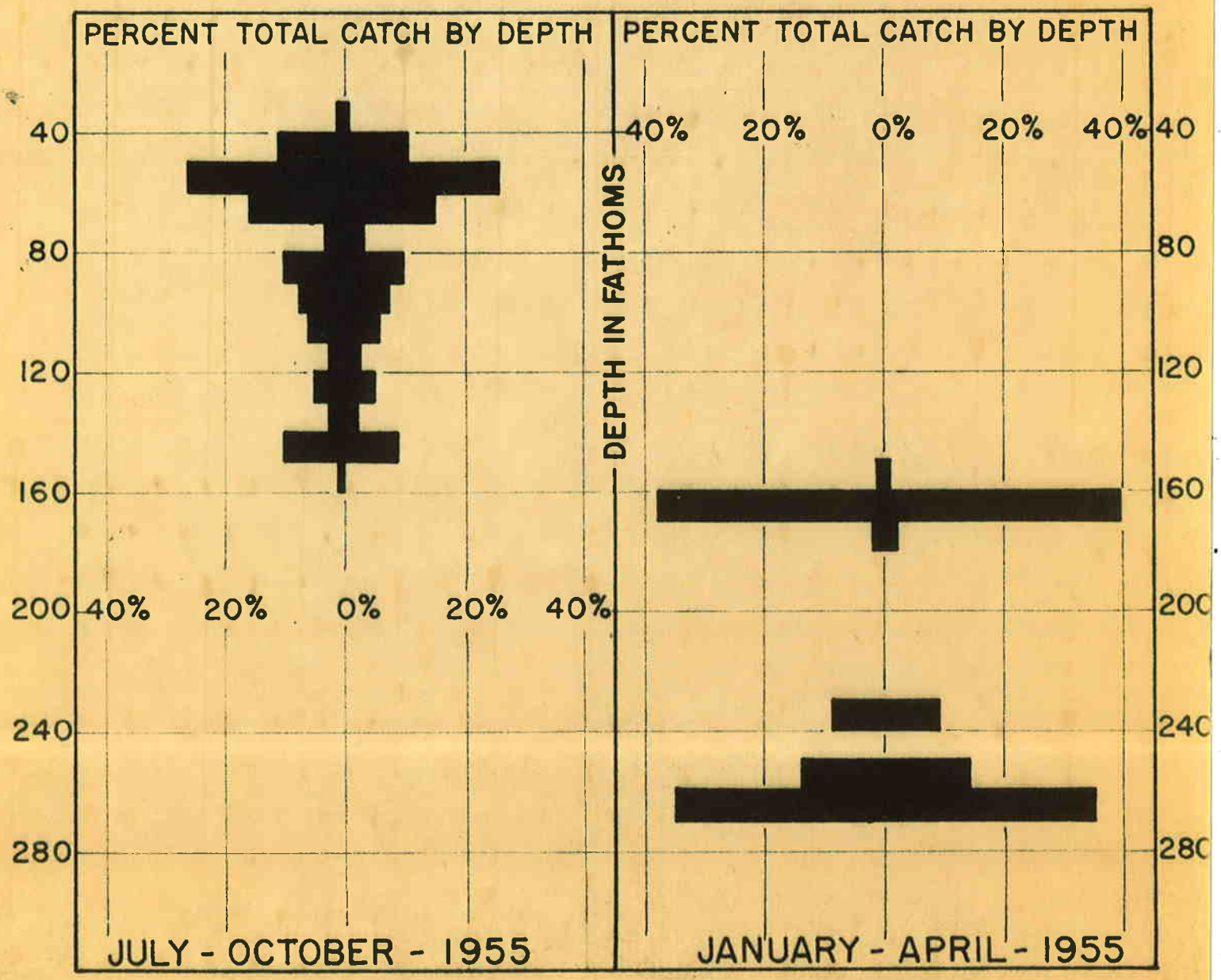
* Seasonal effects of fishing on the stock size are not considered.

Figure 5 -

SEASON CATCHES BY DEPTH FOR DOVER SOLE - 1955

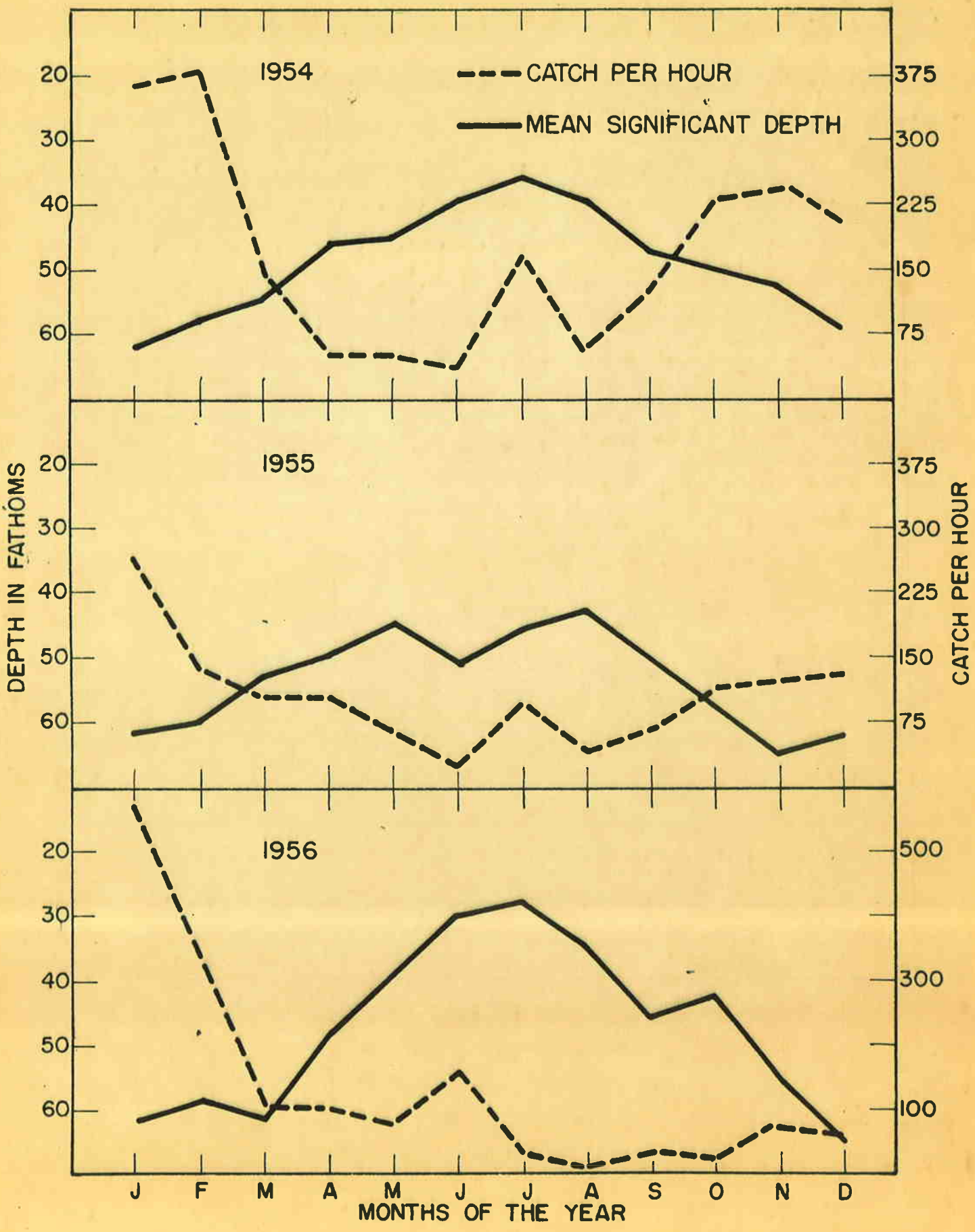
JULY - OCTOBER - SIGNIFICANT CATCH PER HOUR - 458

JANUARY - APRIL - SIGNIFICANT CATCH PER HOUR - 3900



GRAPH IS COMPOSITE FOR CAPE FLATTERY TO DESTRUCTION AREA.

Figure 6 - Catch per hour fishing as related to seasonal changes in depth 1955-1956.



ANIMAL FOOD FISHERY

The mink farm industry in the State of Washington annually purchases between 20 and 30 million pounds of fillet scrap and round fish for animal food. The demand for whole bottom fish (about 4,000,000 pounds landed in 1956) has increased during the past three years and at times requests have been made to relax Department restrictions on utilizing bottom fish for this purpose. The responsibility of the trawl research staff has been the evaluation of fishing intensities now being exerted towards particular species and the effects which increased exploitation would have. The lack of statistical data for the earlier years of our trawl fishery precludes the establishment of statistical justification of maximum utilization for most food fish. This does not rule out the possibility that many trawl species are being fished at or near their maximum capacity. There are, however, a number of stocks and species of bottom fish which have not been heavily prosecuted by food fish trawlers. It has been the opinion of staff biologists that because of our limited knowledge of fishing rates on the important species of food fish that the Department should encourage the exploitation of species not being exploited for food fish. To accommodate the need for greater amounts of whole bottom fish in the fur farm industries and to stimulate better utilization of the demersal fishes available to the trawl fleet, a regulation allowing the use of certain bottom fish was adopted in March 1956. This regulation made it lawful to use the black rockfish, Sebastodes melanops; rock salmon, S. paucispinis or S. brevispinus; priest fish, S. mystinis; and yellow tailed rockfish, S. flavidus for mink food. Also included in this list was the rose fish, Sebastodes diploproa; the two species of sand dabs, Citharichthys; the rex sole, Errex zarchirus; and the slender sole, Lyopsetta exilis.

THE INTERNATIONAL CHARACTERISTIC OF THE TRAWL FISHERY

A growing interest and concern has been expressed by many nations throughout the world in the changing concepts of territorial limits or boundaries. The right to exercise some control over the fisheries contiguous to a nation's coastal areas has been established and has resulted in expanding oceanic territorial claims extending up to several hundred miles seaward. The United Nations apparently feels that there is some justification in these claims and will re-evaluate the time honored three mile limit in 1958. The results of this meeting may have serious economic effects on many of our offshore marine fisheries.

In the light of these developments, we have compiled data showing the highly international aspect of the Washington trawl fisheries. In the past three years 61.3 percent of the total catch of food fish landed in the State has originated in international waters off the British Columbia coast. The average distribution of catch in percent (1954-56), as shown in Table 8 is probably characteristic of the fishing pattern manifested in the past ten years. Washington trawl vessels have historically fished these waters since rapid development of the trawl fishery in 1942. In studying Table 9 the reason for the popularity of trawl grounds further to the north is obvious. The high productivity of these grounds is demonstrated by the higher catch per hour trawling. This is especially true of the grounds from Cape Scott north. The productivity of grounds off the Washington coast have been reduced by the prolonged and intensive fishing in this area. This, however, does not necessarily indicate over fishing (in the biological sense) but more likely reflects reduced cumulative stock levels. To be a draw to the fleet the northern grounds must remain at a higher productive level or have a greater abundance of the more valuable species.

Table 8 - Washington trawl fleet - percent total catch (all species combined) 1954-1956.

Area	1954	1955	1956	3 year average
Hecate Strait	12.8	15.2	7.2	11.7
Goose Island	23.4	9.6	11.2	14.6
Cape Scott	8.4	11.9	16.6	12.4
Cape Cook	--	--	-.6	.2
Esperanza	2.9	5.2	3.7	3.9
Nootka	1.1	1.6	.5	1.1
Esteban	9.9	12.0	10.0	10.6
Ucluelet	.9	.7	.2	.6
Barkley Sound	.7	.9	1.3	.9
40 Mile	5.0	3.2	5.0	4.4
Swiftsure	1.1	1.2	.4	.9
Cape Flattery	5.8	8.7	10.8	8.5
Umatilla	12.3	13.0	9.8	11.7
Quillayute	5.6	4.9	7.5	6.0
Destruction	4.8	5.1	4.5	4.8
Grays Harbor and south	0.1	.3	.4	.3
Inside	4.4	4.5	9.7	6.3
S. E. Alaska	.5	1.9	.5	.9

Table 9 - Washington trawl fleet - catch per hour (all species combined) 1954 - 1956.

Area	1954	1955	1956	3 year average
Hecate Strait	2,170	2,018	1,391	1,946
Goose Island	1,793	1,370	1,406	1,570
Cape Scott	1,379	1,240	1,163	1,217
Cape Cook	965	158	1,178	1,080
Esperanza	1,040	1,007	783	927
Nootka	1,858	1,445	1,084	1,463
Esteban	1,368	1,098	1,421	1,267
Ucluelet	992	856	900	919
Barkley Sound	2,394	947	960	1,099
40 Mile	1,199	1,363	1,188	1,229
Swiftsure	1,386	1,651	304	914
Cape Flattery	892	659	1,141	872
Umatilla	1,081	776	915	845
Quillayute	810	787	882	832
Destruction	694	675	692	682
Grays Harbor and south	547	648	590	601
Puget Sound	479	244	333	327
S. E. Alaska	-	1,728	1,038	1,635

The distribution of effort for the period 1954-56 is shown in Table 10. For the period under study the Washington trawl fleet expended 44 percent of its total effort in waters off Vancouver Island or in Hecate Strait. A table of the species composition, averaged for the years 1954-56, is shown in Table 11.

The high proportion of the catch originating from the northern grounds is self evidence of the impact an extension of territorial rights may have on our trawl fishery.

Table 10 - Washington trawl fleet - percent of total hours fished by area (1954-1956).

Area	1954	1955	1956	3 year average
Hecate Strait	7.1	6.8	4.6	5.8
Goose Island	15.7	6.5	7.2	9.1
Cape Scott	7.3	8.9	12.7	9.9
Cape Cook	-	-	.4	.1
Esperanza	3.3	4.7	3.9	4.2
Nootka Sound	.7	1.0	.4	.7
Esteban	8.7	9.3	6.2	8.2
Ucluelet	1.1	.8	.2	.7
Barkley Sound	.3	.9	1.2	.8
40 Mile	5.0	2.2	3.8	3.5
Swiftsure	1.0	.7	1.3	1.0
Cape Flattery	7.9	11.9	8.4	9.5
Umatilla	13.7	15.2	9.6	12.6
Quillayute	8.3	5.6	7.5	7.1
Destruction	8.2	6.1	5.7	6.8
Grays Harbor and south	.3	.5	.7	.5
S. E. Alaska	-	1.0	.4	.6
Puget Sound	11.1	16.8	25.7	18.8

Table 11 - Percent contribution of major species by area for years 1954 - 1956 combined. (Washington trawl fleet).

Area	Petrale sole	English sole	Dover sole	Rocksole	Starry flounder	Ocean perch	Truecod	Lingcod	Blackcod	Rockfish
Hecate Strait	6.0	15.5	1.0	7.1	.1	1.4	62.0	5.2	-	1.8
Goose Island	2.5	1.6	3.9	4.3	-	42.8	24.8	4.8	.4	14.8
Cape Scott	14.0	1.3	1.0	3.1	-	11.0	39.2	5.9	.4	24.1
Cape Cook	20.1	.7	1.3	-	-	0	22.3	1.4	-	54.3
Esperanza	8.2	.6	1.7	.1	-	2.1	36.8	6.9	.2	43.3
Nootka	5.9	-	1.2	-	-	64.3	3.7	12.4	.3	12.1
Esteban	24.5	-	20.5	-	-	26.6	7.4	4.5	1.6	14.8
Ucluelet	19.2	1.1	.3	-	-	.5	50.4	27.8	-	.7
Barkley Sound	2.1	-	-	-	-	1.2	79.6	16.7	-	.6
40 Mile	20.3	-	2.0	-	-	2.4	30.3	38.8	4.5	1.9
Swiftsure	11.9	.5	8.4	-	.7	4.9	39.7	25.3	2.7	5.8
Cape Flattery	2.2	6.8	15.3	-	1.4	6.5	31.4	4.1	21.2	11.1
Umatilla	3.8	10.9	14.4	-	8.5	9.7	27.3	5.7	7.9	12.0
Quillayute	2.0	33.7	4.0	-	5.2	8.1	21.6	5.5	3.3	16.6
Destruction	3.6	26.6	18.7	-	.3	4.6	21.7	6.2	2.4	15.9
Grays Harbor and south	21.6	22.4	16.8	-	-	2.4	8.6	4.9	.5	22.7
S. E. Alaska	0	0	0	0	100.0	0	0	0	0	0
Puget Sound	-	48.3	1.9	3.3	14.2	0	28.2	2.0	-	2.0

GENERAL DATA FROM TRAWL INTERVIEWS

The Washington trawl fleet during 1956 landed approximately 47 million pounds of bottom fish with a fisherman value of 2.4 million dollars. Both the total catch and value were above 1955.

The calculated total State landings by species of trawl-caught fish are shown in Table 12, which includes the value to the fishermen for each species. The catch is broken down to show the proportion taken in offshore waters as compared with the poundage taken within Puget Sound. Total landings were up about 10 percent over those of 1955. Species accounting for the major increase in total catch were blackcod, Pacific ocean perch, English sole, and turbot. These species showed a total increase of 9 million pounds. Turecod and lingcod were the species showing major declines, having a combined decrease of 4 million pounds. Changes in market conditions have greatly influenced the trends in these species; although availability of fish was certainly a factor influencing the origin of catches. Other species, including starry flounder, Dover sole, petrale sole, rockfish, and rocksole had total catches about equal to 1955.

Table 12 - Estimated total 1956 trawl landings and value

Species	Catch in thousands			Dollar value to fishermen
	Outside	Inside	Total	
Truecod	9,095	1,039	10,134	405,000
Lingcod	2,701	65	2,766	138,000
Blackcod	3,308	-	3,308	263,500
Rockfish	5,764	58	5,822	232,000
Ocean perch	5,825	-	5,825	232,100
Petrale sole	2,921	-	2,921	263,000
English sole	2,771	2,185*	4,955	347,000
Dover sole	3,487	93	3,580	232,500
Rock sole	686	128	827	41,350
Flounder	1,307	486	1,793	71,700
Turbot**	3,000	-	3,000	60,000
Bellingham sole **	200	-	200	4,000
Scrap	-	1,500	1,500	8,250
Total	4,107	5,553	46,631	2,397,300

*Includes wormy sole from south Sound.
**Mink food.

The 1956 catch was landed by a fleet of 125 vessels (116 in 1954 and 1955) operating out of Seattle, Blaine, Everett, Tacoma, Bellingham, Anacortes, and Grays Harbor. Although a large number of vessels annually participate in the trawl fishery the total is not indicative of the actual strength of the fleet. The bottom fish industry, sensitive to market demands, reacts quickly to changes by increasing or decreasing the number of vessels in operation. Many trawl fishermen operate only during the off periods from other major fisheries (halibut and salmon) The fleet usually peaks during the winter lent season and reaches a low during mid-summer.

The highly transient nature of the fishery is shown in Table 13 which tabulates the number of months of activity for vessels engaged in trawl fishing. Following across on line one of the table we see that of the total of 125 boats, eight reported landings for only one month during the year. The boats operating for any period, e.g. six months or more, may be read as the cumulative total for that period. For instance, 79 vessels reported landings in six or more months of the year and 46 boats were active for only five months or less. The average number of trips reported for the boats operating during the period (ranging from 1 to 12 months) is shown in the last column of the table. Of the 125 boats participating in the fishery during 1956, 29 operated strictly within Puget Sound while 96 fished in offshore waters for at least part of the year. A list of trawl vessels which landed catches during some period of 1956 is shown in Table 14.

Table 13 - Months activity of total trawl boats reporting landings in 1956 and average number of trips for active period.

Months active	Number of boats	Percent of total fleet	Average trips reported
1	8	6.4	1.9
2	7	5.6	8.1
3	10	8.0	14.3
4	5	4.0	15.2
5	16	12.8	17.9
6	17	13.7	21.4
7	18	14.5	19.4
8	6	4.8	26.1
9	12	9.2	42.8
10	7	5.6	46.6
11	9	7.2	34.3
12	10	8.0	24.9

Table 14 - List of trawl vessels participating in 1956 fishery.

Alda B	Harmony	Puget Girl
Al H	Havana	
Aloma	Heather	Radio
Alrita	Helen W	Regina
Alsek	Hercules	Rio Del Mar
Altana	Hydra	Roberta
Anna H		
Ann B	John W	Sacco
Arthur H		St John
Avalon	Kansas	St John II
	Katherine	Shirley Lee
Barbara Ann	Kelly B	Shushartie
Barbara S	Kiska	Silverland
Betty Jane	Kristine	Sockeye
Blanco		Sogn
Bobetta	Lady Olga	Solta
Bonnie C	Lemes	Soupfin
Brisk	Lemes II	Stanley
	Lituya	Sunbeam
Chelsea K	Lorenz	Sunward
Christian S		Susan
Christy	Majestic	
Claudia	Majestic	Theresa S
Claudia H	Marie II	Thoreen
Clio	Martle	Tongass
Comet	Midway	Tordenskjold
Commando	Mildred	Traveller
Confidence	Mitkof	Tulip
Coolidge II	Morning Star	
Crusader	My Lady	Vernon
	My Lark	Victory Maid
Dakota	Myrtle	Vigorous
Dixie Maid		Voyager
Don Edwards	Nestor	
Dutchie C	New Elida	Western Flyer
	Newport	Western Maid
Emblem	Nick C II	
Emily Jane	Nina B	Yaquina
Esperanto	Northern Light	
Estep	Notre Dame	Zarembo II
Evening Star		
Excell II	Opal	
	Oregonian	
Fenwick		
Frigidland	Pacific Breeze	
Frisco	Panther	
Frostland	Paradise	
Gallant Maid	Paragon	
Gem	Patricia Joan	
Gladiator	Paul L	
Grizzley II	Plover	
Guide	Pt Defiance	

The origin of trawl-caught fish, distribution of fishing effort, average catch per hour fishing and the productive index for the 1956 fishery is shown in Table 15. A total of 47,303 hours were reported expended in capturing the total trawl catch, with an average catch of 887 pounds per hour. The fleet effort was up approximately 3,000 hours while the catch per hour fishing dropped slightly - 905 to 887 pounds per hour. Total estimates of round fish and flatfish catches by area are given in Table 16.

Table 15 - Summary of catch/effort data and productive index,* 1956 trawl landings (all species combined).

Area	Catch	Hours fished	Catch per hour	Productivity index
Hecate Strait	3,034,879	2,182	1,391	1.56
Goose Island	4,714,282	3,352	1,406	1.58
Cape Scott	6,962,396	5,988	1,163	1.31
Cape Cook	248,663	211	1,178	1.33
Esperanza	1,541,564	1,968	783	0.88
Nootka Sound	230,806	213	1,084	1.22
Esteban	4,184,254	2,944	1,421	1.60
Ucluelet	92,744	103	900	1.01
Barkley Sound	549,129	572	960	1.08
40 Mile	2,086,221	1,756	1,188	1.34
Swiftsure	181,727	597	304	.34
Cape Flattery	4,544,215	3,983	1,141	1.29
Umatilla	4,109,118	4,490	915	1.03
Quillayute	3,147,098	3,569	882	.99
Destruction	1,870,059	2,703	692	.78
Grays Harbor and south	188,393	319	590	.66
Puget Sound	4,054,653	12,166	333	.38
S. E. Alaska	194,150	187	1,038	1.17
Total	41,934,351	47,303	887	1.00

*Catch per hour by area / Catch per hour all areas, 1956

Table 16 - Catch by species and area for 1956

Area	Ocean perch	Rockfish	Lingcod	Blackcod	True cod
Hecate Strait	154,350	51,130	136,045		1,698,060
Goose Island	2,038,195	724,070	211,260	21,590	1,092,590
Cape Scott	1,021,780	1,543,765	593,835	12,730	2,287,156
Cape Cook	0	128,310	4,000	0	64,925
Esperanza	30,215	780,765	121,265	105	503,245
Nootka	111,410	22,830	84,420	0	2,205
Esteban	1,185,430	609,940	65,685	54,845	43,315
Ucluelet	0	0	16,285	675	59,855
Barkley Sound	0	1,080	62,215	0	478,180
40 Mile	119,290	40,715	733,915	90,420	643,755
Swiftsure	29,510	6,480	58,650	3,515	32,946
Cape Flattery	395,390	402,350	200,410	1,929,320	664,395
Umatilla	419,270	494,865	127,300	936,935	690,885
Quillayute	112,775	641,065	160,685	215,930	435,335
Destruction	200,570	280,790	113,135	40,455	363,385
Grays Harbor and S.	7,305	35,950	12,520	1,010	25,385
S. E. Alaska	0	0	0	0	0
Inside	250	58,053	65,223	600	1,038,392
Total	5,825,740	5,822,158	2,766,848	3,308,130	10,134,009

Area	Petrale sole	English sole	Dover sole	Rocksole	Starry flounder
Hecate Strait	45,867	558,777	29,920	281,440	79,290
Goose Island	80,051	58,526	385,330	102,670	0
Cape Scott	967,865	89,980	140,850	304,435	0
Cape Cook	45,478	2,200	3,750	0	0
Esperanza	67,529	8,265	23,575	6,600	0
Nootka	9,291	430	220	0	0
Esteban	959,188	3,695	1,262,156	0	0
Ucluelet	5,264	665	0	0	0
Barkley Sound	5,264	1,100	340	950	0
40 Mile	422,816	4,440	28,580	2,290	0
Swiftsure	17,826	1,895	26,825	0	4,080
Cape Flattery	46,845	183,015	594,640	0	127,850
Umatilla	87,738	151,950	619,460	0	580,715
Quillayute	42,913	1,153,845	72,885	0	311,665
Destruction	70,328	496,676	294,910	0	9,810
Grays Harbor and S.	46,788	55,625	3,810	0	0
S. E. Alaska	0	0	0	0	194,150
Inside	845	*2,184,145	92,890	128,645	485,610
Total	2,921,896	4,955,229	3,580,141	827,030	1,793,170

*Includes wormy sole from southern Puget Sound.

The intensity of monthly sampling is shown in Table 17. A total of 815 vessel landings were covered by port interviews in 1956 which accounted for about 30,000,000 pounds of fish. Interviews were made for 71.4 percent of the vessels landing fares from offshore waters and 40.3 percent of the trawl catches made from within Puget Sound (ports of Bellingham and Seattle). Landings made in areas not covered by port interviews are tabulated from sales tickets at the end of the year and the catch distributed according to the pattern indicated from interview record All interview data collected in 1956 was coded and placed on I.B.M. cards; close to 6,000 cards were punched for this purpose.

Table 17 - Sampling by month (1956) of otter-trawl landings

	Inside			Outside		
	Landings	Sampled	Percent	Landings	Sampled	Percent
January	60	33	55.0	55	40	72.7
February	39	21	53.8	82	68	82.9
March	48	23	47.9	100	68	68.0
April	37	20	54.0	89	81	91.1
May	19	15	78.9	88	65	73.9
June	14	9	64.2	76	57	75.0
July	15	8	53.3	51	34	66.6
August	21	16	76.1	65	48	73.8
September	17	8	47.1	56	35	62.5
October	60	16	26.6	79	50	63.2
November	102	16	15.6	65	39	60.0
December	77	20	25.9	48	25	52.0
Total	509	205	40.3	854	610	71.4

THE FISHERY IN 1956

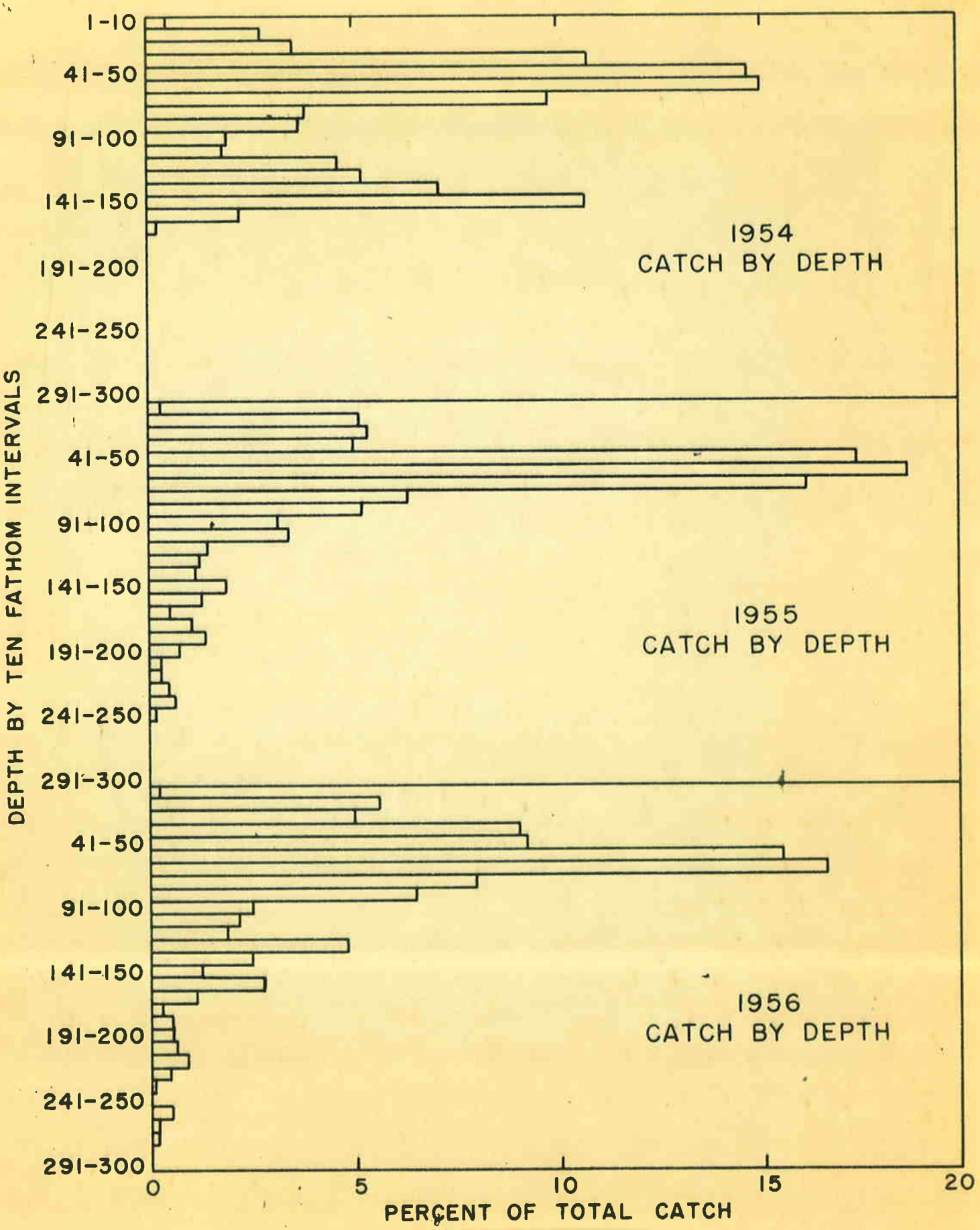
The catch of 47 million pounds of bottom fish made in 1956 may be considered as a prosperous year of the trawl fleet. The total catch of bottom fish landed by all types of gear amounted to 49.5 million pounds. Trawl vessels accounted for 95 percent of this total.

Changes in the halibut fishing season influenced the sharp rise in blackcod catches while low prices effected declines in total landings of lingcod and true cod. Changes in the halibut regulations which provided a longer season reduced the number of setline vessels active in the blackcod fishery. The setline catch of blackcod was therefore far short of the average landings made by this fishery. The shortage created by reduced effort in the line fishery was compensated for by greatly increased landings of small blackcod (3-4 pounds) in the trawl fishery.

During the summer months, price cuts were made on practically all species of bottom fish. As a result of reduced prices, fishermen tended to avoid the low valued species such as truecod, lingcod and rockfish. These species brought 3 to 3.5 cents a pound on the food fish market.

The fishing pattern during the year was similar to that of 1955 with vessels operating from the Columbia River north to southeast Alaska. Several trawlers fishing out of Bellingham fished north of Juneau, Alaska. Although the geographic parameters of the fishery was little changed, there was a definite tendency for increased effort in the deeper portions of the bathymetric range. The total annual catch made below 100 fathoms (Table 18) was 21.4 percent as compared with 14.5 percent in 1955. The total catch made in deep water (>100 fathoms) is largely predicated on the demand for the deep-water Pacific ocean perch and increased winter activity towards capturing Dover and petrale sole. The range of deep-water fishing has increased from 180 fathoms in 1954 to 280 fathoms in 1956. While no catches in 1954 were reported from depths exceeding 200 fathoms, in 1956 close to 3/4 million

Figure 7 - CATCH IN PERCENT BY TEN FATHOM INTERVALS
1954 TO 1956



pounds were harvested at depths between 200 and 280 fathoms. The percentage of the total annual catch made in 10 fathom intervals from 1954-56 is shown in Figure 7.

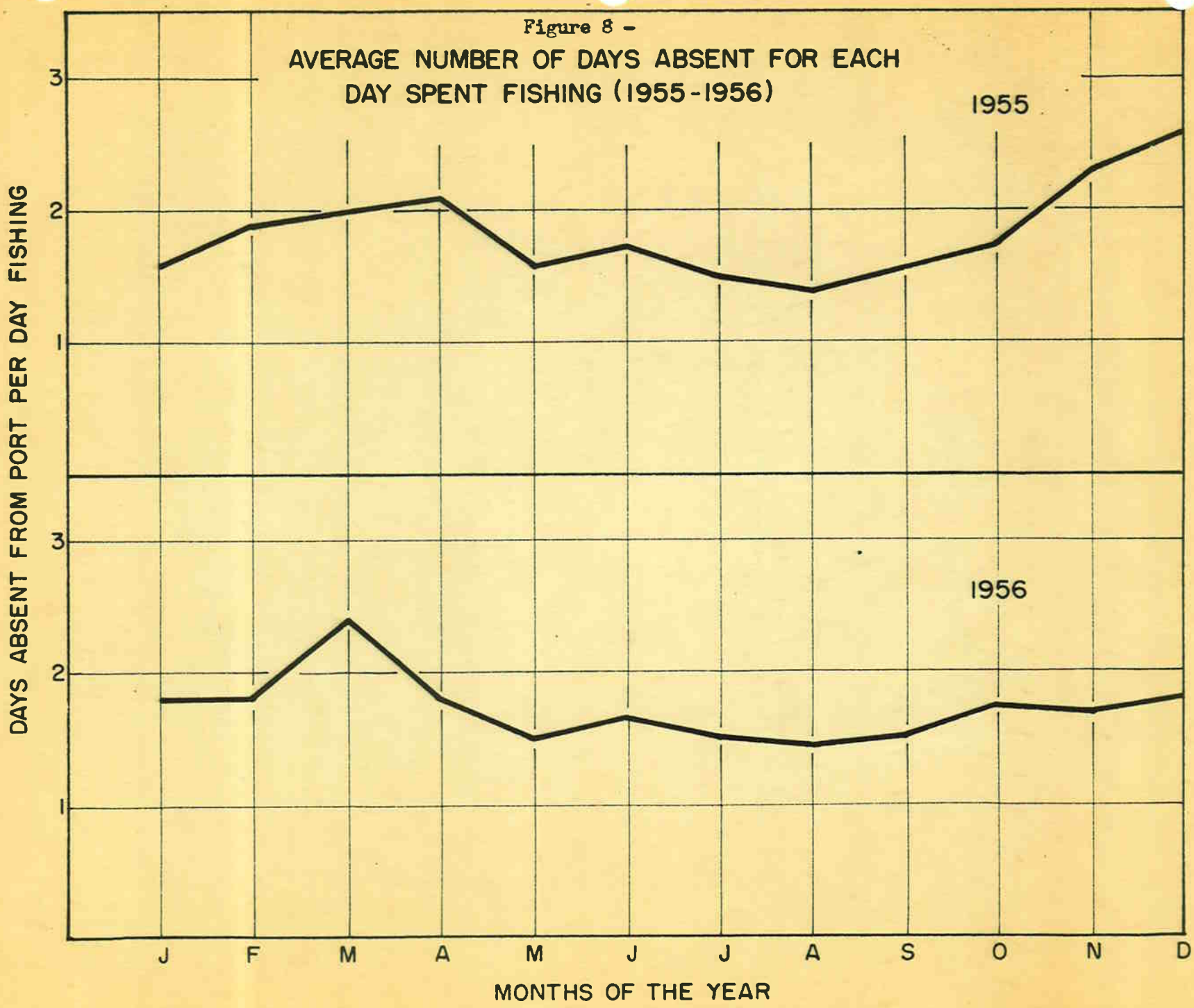
Table 18 - Percent of total 1956 catch by depth.

Depth	Percent of total		
	1954	1955	1956
0-100	67	85.5	78.6
101-200	33	12.9	18.9
201-299	0	1.6	2.5

The effects weather may have on catches from year to year or on comparative seasons from one year to the next may be measured to some extent by the average number of fishable days as related to a period of absence. The average number of days absent in 1955 and 1956 by months for each day fished is shown in Figure 8. By comparing the days absent for each day fished for the same months, i.e. January 1955 versus January 1956, some index of the possible effects of weather may be obtained. Accordingly, more time was spent at sea during January 1956 for each day fished than in January 1955 - the implication being that weather conditions were somewhat better in this month during 1955. An annual index may also be achieved by a like comparison. If the total days absent is compared to the total days fished for the two years, an index of 1.81 days absent per day fished is obtained for 1955 against 1.78 for 1956. Here the annual index indicates 1956 had weather conditions slightly more favorable than 1955.

The main ports of landing were Seattle, Bellingham, and Everett; however, fair amounts of fish were also landed at Blaine, Neah Bay, Aberdeen, and Anacortes. A list of fish processors by port is given on the following page.

Figure 8 -


AVERAGE NUMBER OF DAYS ABSENT FOR EACH DAY SPENT FISHING (1955-1956)
1955
1956
DAYS ABSENT FROM PORT PER DAY FISHING
3
2
1
3
2
1
J
F
M
A
M
J
J
A
S
O
N
D
MONTHS OF THE YEAR

Bottom fish processors, by port, are listed below:

Seattle

Eardley Fish Company	Pier 62
Main Fish Company	Pier 49, Box 3092
Northwest Fisheries	Pier 24, Seattle
San Juan Fish Company	P. O. Box 3086
Seattle Seafood, Inc.,	Pier 61
Sea Port Fish Co.,	Pier 57

Bellingham

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

Everett

Chase Sea Foods	P. O. Box 216
New England Fish Company	Pier 3

Anacortes

Skagit Fisheries	P. O. Box 275

In addition to the regular fish producers, reduction plants handling scrap include:

Tacoma

Puget Sound Rendering Works	8317 Tyler St., S. W.
Carston Packing Company	1623 East Jay Street

Everett

Puget Sound By-Products	Box 651

Anacortes

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

Blaine

Blaine Fish Products	Blaine, Washington

PART II

Evaluation of Catch Trends

PART II - EVALUATION OF CATCH RECORDS

The automation of trawl catch records has made the tabulation of catches by area and summation of regional fishing a simple task. The IBM system, adopted in July 1954, accommodates the following information:

1. Vessel
2. Date of landing
3. Port of landing
4. Days absent from port
5. Days actually fished
6. Area of fishing
7. Number of tows made in defined area.
8. Average time and total time per fishing effort in defined area.
9. Average depth of fishing effort in defined area.
10. Catch by species in pounds for defined area and depth.
11. Twenty-five percent significant level of tows in defined area by species.

Advantages of this system include ready availability of any segment of the data, and greatly reduced tabulating time, combined with the precision of machine summaries. Evaluation of catches by species during 1956* and indicated trends taken from interview records follow:

PETRALE SOLE (EOPSETTA JORDANI)

Petrale sole ranked eighth in poundage and fourth in value for trawl-caught fish in 1956. Both the catch and value are slightly down from 1955; dropping from seventh to eighth in poundage and from second to fourth in value. The regulation restricting landings of petrale sole from February 1 to April 15 was partly responsible for the reduced catch. Major areas of production were Cape Scott, Esteban and 40 Mile Bank. These three fishing banks accounted for 80 percent of the catch in 1956.

The highly mobile characteristics of the petrale sole, as recently illustrated from tagging experiments, greatly affect the total yield and catch per effort measures for any specific area. Circumstantial evidence of this mobility is borne out by extreme annual fluctuations in total catch and C/E measures. Observed

*For effort by months and areas for 1955 and 1956 see Appendix 1 and 2.

variations in these measures of productivity, pointed out in the 1955 trawl report, were again noted in 1956. The total catch of petrale sole from 40 Mile Bank more than doubled from 1955 to 1956 and the catch per hour fishing rose from 185 pounds in 1955 to 241 pounds in 1956. The increased yield and catch per hour trawling cannot be attributed strictly to increased effort or greater recruitment. Although variations in total stock size obviously affect catch indices, the rate and direction of fluctuations in specific areas are closely related to seasonal changes in the distribution of petrale sole. These catch indices are considerably modified if the total effort and catch are considered through a large segment of the population's distribution.

Catch by area as indicated by interview records, catch per hour fishing, relative productive index, and monthly landings for petrale sole are given in Tables 19 and 20. Results of United States and Canadian tagging experiments strongly suggest that stocks to the north and south of Esteban Point are different population entities and should be treated as such. A major component of the northern population was noted to be Esteban fish; however, indications of mixing with other stocks was apparent in the Hecate Strait region. The catch per hour trawling and catch per significant effort for areas tentatively defined as having populations exhibiting independent reactions to the fishery are shown in Figure 9. In all areas the basic catch per hour has declined although the southern regions showed an increase in significant catch per hour.

There is no clear indication either from tagging or catch records that the 40 Mile-Swiftsure fishery is not exploiting the same stocks as those south to Destruction Island. The original separation of these areas was made on basis of the sub-marine topography in the vicinity of Cape Flattery. The deep-water trough separating the shallower shelfs off Vancouver Island(to the north and to the south of this area)were originally considered possible barriers to migration. Recent studies, however, refute this theory, and perhaps the division is not warranted.

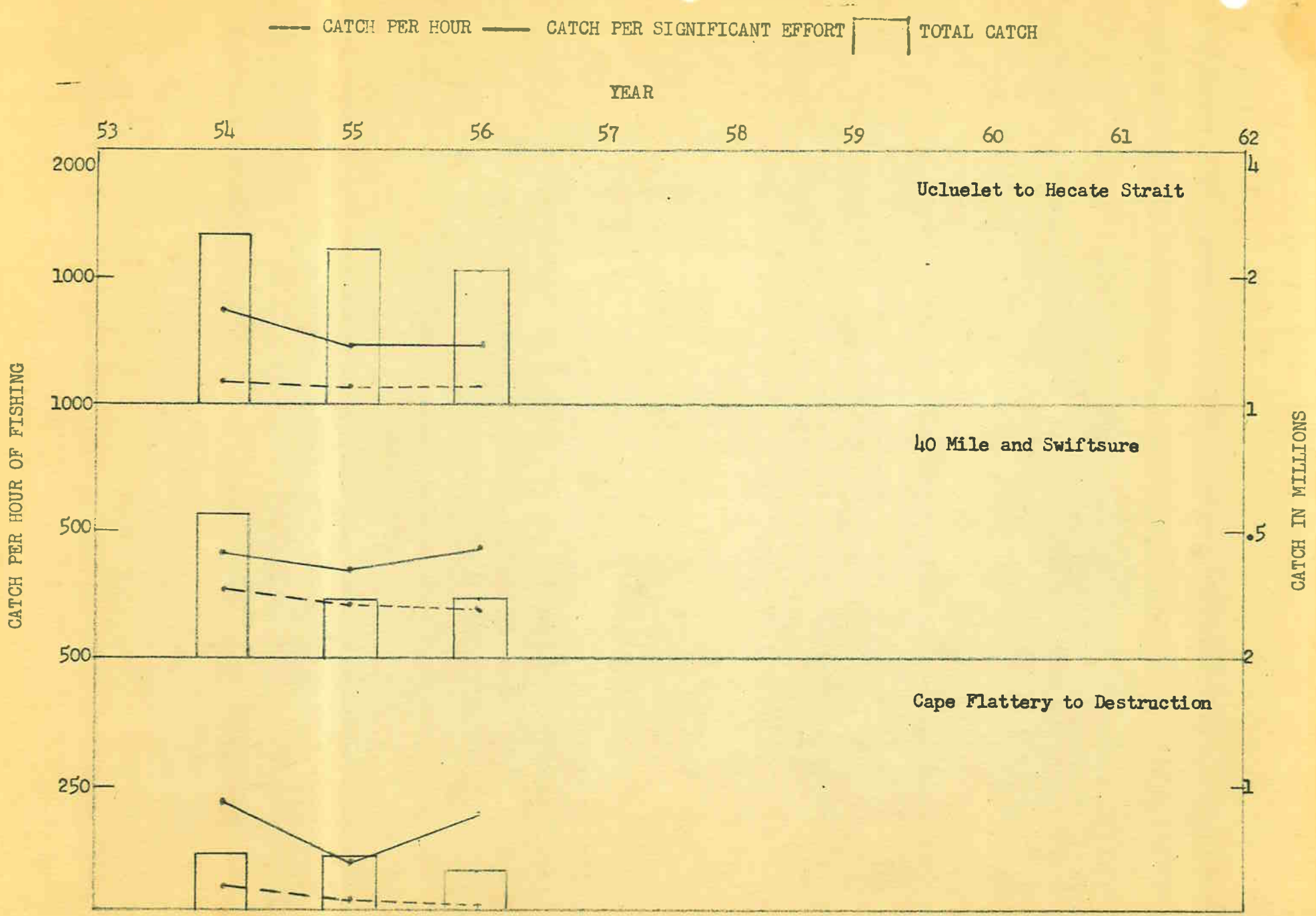


Figure 9 - Total catch, catch per hour and significant catch per effort for petrale sole

Table 19 - Summary catch/effort data and productive index,* 1956 trawl landings of petrale sole.

Area	Catch	Hours	C/H (lbs.)	Productive index	Significant C/H**
Hecate Strait	45,867	2,182	21	3.39	-
Goose Island	80,051	3,352	24	.39	200
Cape Scott	967,865	5,988	162	2.61	356
Cape Cook	45,478	211	216	3.48	264
Esperanza	67,529	1,968	34	.55	169
Nootka	9,291	213	44	.71	190
Esteban	959,188	2,944	326	5.26	719
Ucluelet	5,264	103	511	8.24	14
Barkley Sound	5,264	572	9	.15	185
40 Mile	422,816	1,756	241	3.89	433
Swiftsure	17,826	597	30	.48	250
Cape Flattery	46,845	3,983	12	.19	65
Umatilla	87,738	4,490	20	.32	208
Quillayute	42,913	3,569	12	.19	375
Destruction	70,328	2,703	26	.42	254
Grays Harbor and S.	46,788	319	147	2.37	187
Puget Sound	845	12,166	-	-	-
S.E. Alaska	-	187	-	-	-
Total	2,921,896	47,303	62	1.00	

*Catch per hour by area
Catch per hour all areas 1956

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

Table 20 - Catch by month of petrale sole for major producing areas, 1956

	Hecate Strait Goose Island	Cape Scott	Esperanza	Esteban	40 Mile	Umatilla
January		91,522		119,060		1,135
February		83,855	2,420	42,904		3,390
March	1,915	21,280	24,845	141,753		2,375
April	23,780	49,379	35,203	177,254	321	25,915
May	21,420	36,198	5,061	12,601	6,642	24,741
June	29,260	34,780			106,952	7,845
July	12,629	78,495		535	32,451	4,690
August	6,664	137,166				3,672
September	8,110	109,580		160	111,490	795
October	15,000	109,380		1,920	116,000	5,000
November	7,140	71,230		180,025	48,960	2,890
December	-	145,000		282,976		5,290
Total	125,918	967,865	67,529	959,188	422,816	87,738

Depth distribution

During 1956 petrale sole were harvested at depths between 31 and 260 fathoms. The difference in the summer and winter bathymetric ranges have been discussed previously. The major summer production was made at depths between 31 and 100 fathoms with the depths between 31 - 80 fathoms being especially productive. Most of the winter catch came from the Esteban, Destruction, Umatilla, and Willapa deeps at depths between 150 and 250 fathoms. The catch in ten-fathom intervals for the three areas is shown in Table 21.

Table 21 - Catch in pounds by area (in 10 fathom intervals) for petrale sole - 1956.

Depth range	Cape Scott	Esteban	40 Mile Bank
31- 40	-	500	147,300
41- 50	6,400	3,600	99,700
51- 60	80,800	1,540	1,000
61- 70	175,950	-	6,000
71- 80	186,475	-	
81- 90	66,900	203,500	
91-100	70,500	3,600	
101-110	15,300	1,950	
111-120	-	1,030	
121-130	2,000	3,300	
131-140		2,175	400
141-150		7,600	
151-160		73,200	
161-170		4,100	
171-180		10,400	
181-190		45,500	
191-200		19,500	
201-210		54,400	
211-220		34,300	
221-230		31,400	
231-240		2,500	
241-250		-	
251-260		5,500	

*As shown from interviews; not extrapolated to total catch by area.

Size range

Petrale sole market samples in 1956 ranged from 30 to 62 cm. in length. As has been noted in the past, stocks exploited on the southern grounds have a smaller average size than those sampled from northern areas. The graphed size distributions for petrale sole sampled from various banks are shown in Figures 10 and 11. A length-weight relationship for petrale sole caught in the vicinity of Cape Flattery was originally established by Cleaver. The possibility that this relationship is stock dependent and that different length weight curves could conceivably exist has been considered. Regressions of the log of the weight plotted against length are shown (Figure 12) for samples taken from fish caught at Umatilla and Cape Scott. The base line measure of length has been offset 5 cm. for the Umatilla sample so the slopes may be compared visually. Note that the regressions are practically identical. The length-weight curve established closely agrees with that evolved by Cleaver.

Management

In recent years the total catch and the catch per hour fishing has been declining for this species. An evaluation of the petrale sole fishery has been covered under the PMFC studies. It has been the staff's feeling that the available data supports biological over fishing.

ENGLISH SOLE (PAROPHRYS VETULUS)

English sole ranked fourth in poundage and second in value for trawl-caught fish in 1956. The total catch was up over a million pounds from 1955, and the total value increased by about $75,000. The major increase in catch came from the waters inside Puget Sound while production from Hecate Strait was down. The total yield from the Cape Flattery to Destruction grounds was about equal to that of 1955 although the catch per hour towing showed a definite upswing. Tables 22 and 23 show the catch-effort relationship and catch by month for English sole.

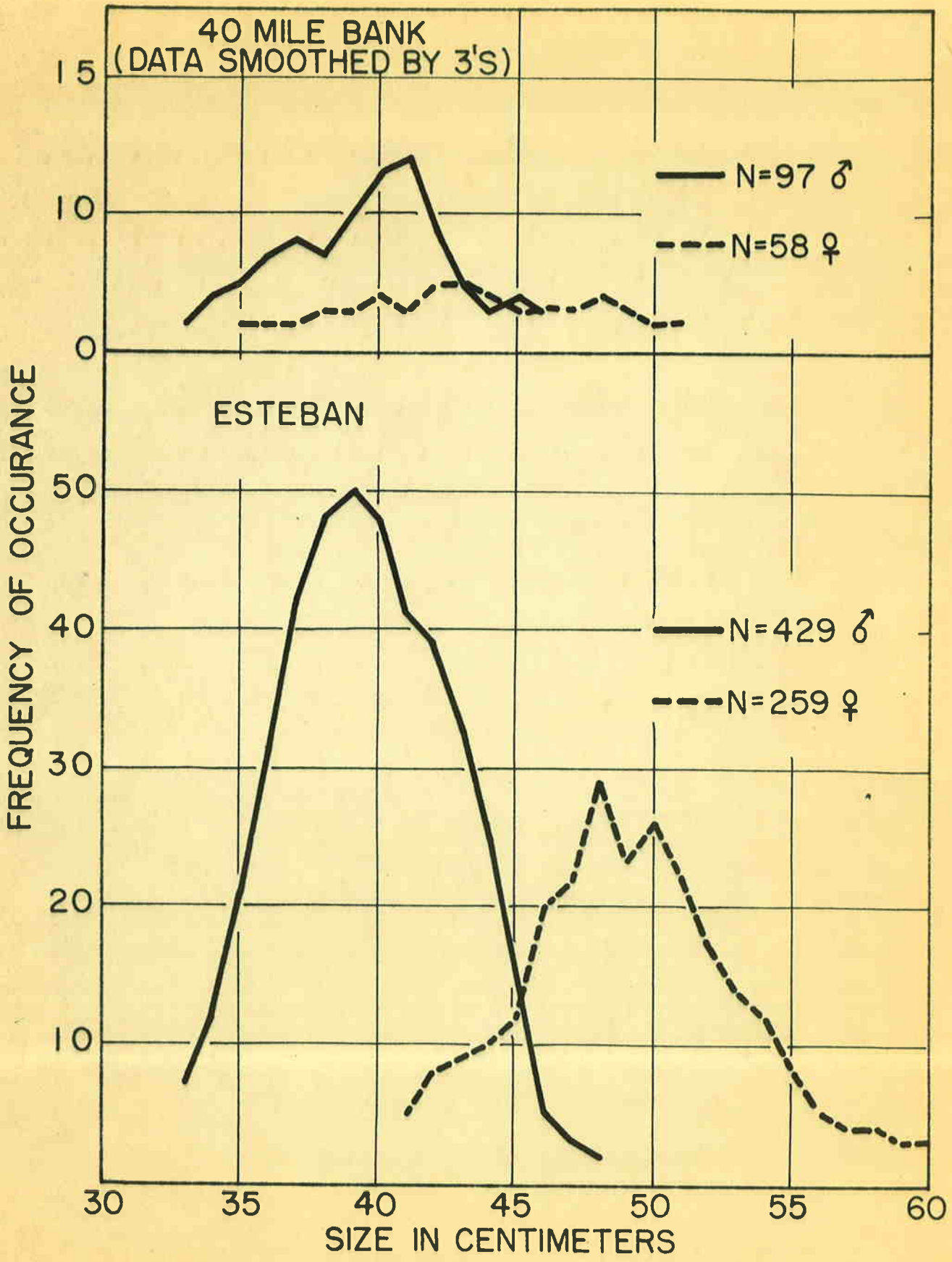


Figure 10 - Length frequencies for petrale sole sampled, January-June 1956.

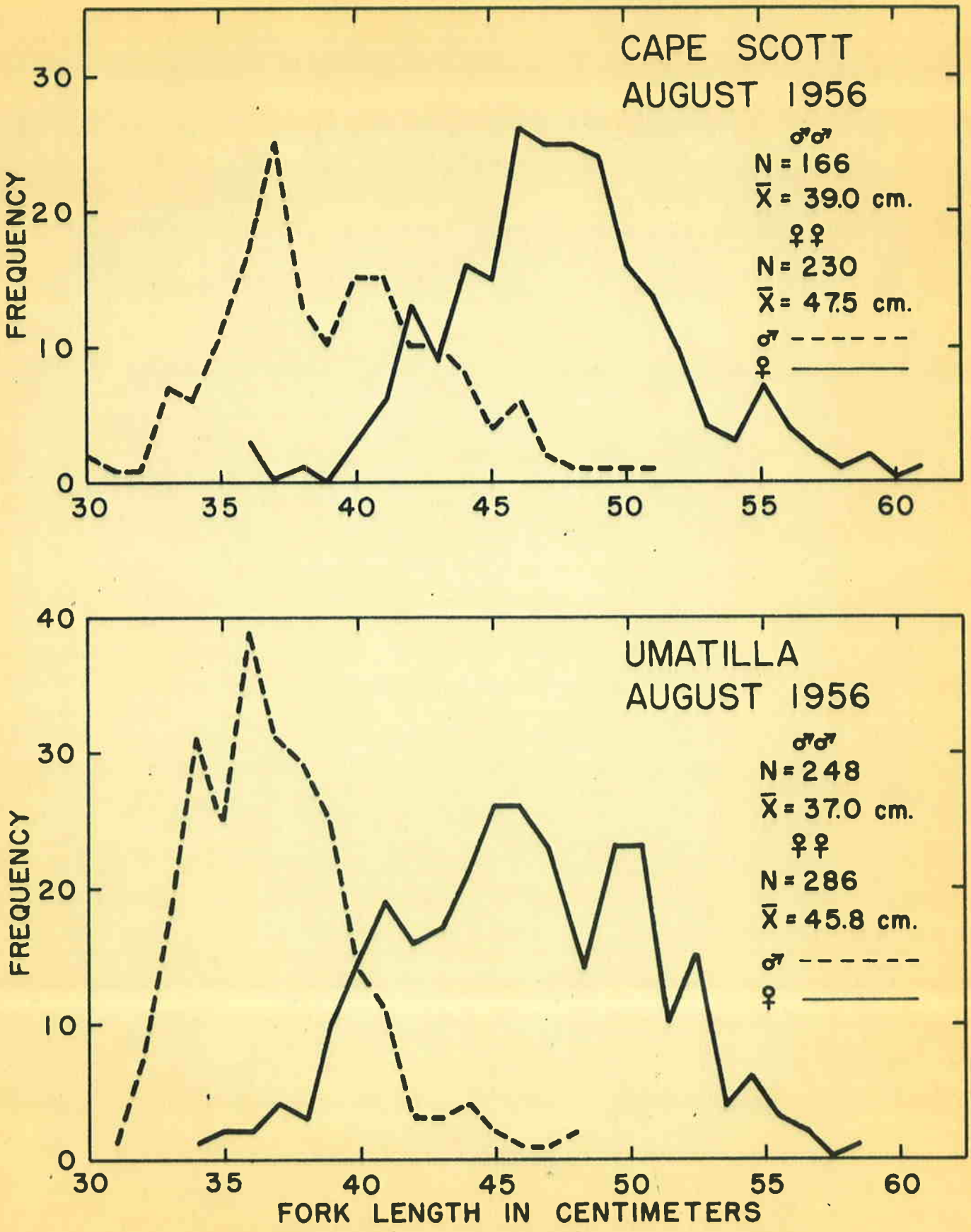


Figure 11 - LENGTH FREQUENCY DISTRIBUTION OF PETRALE SOLE

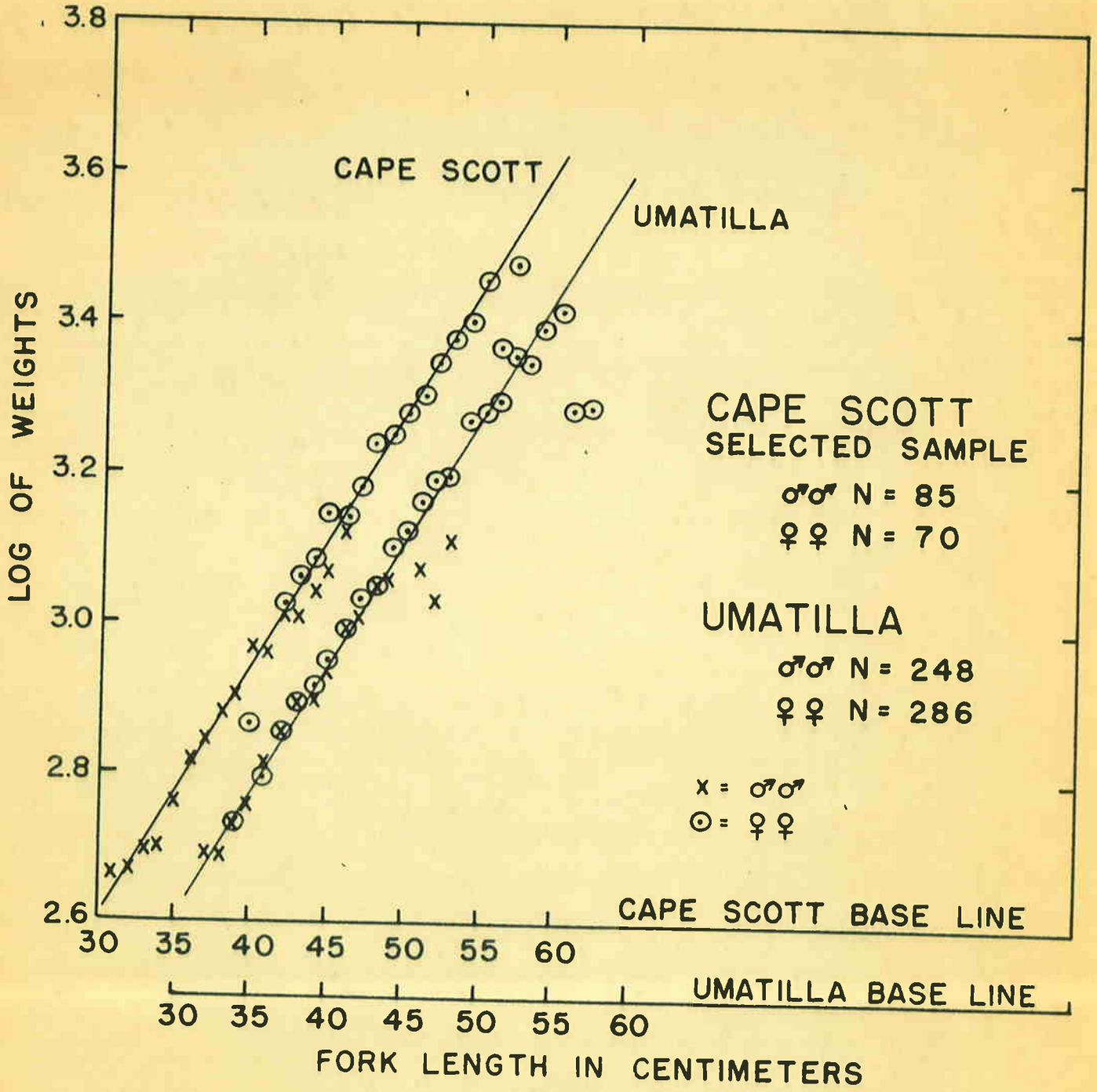


Figure 12 - PETRALE - LOG OF WEIGHT VS. LENGTH

Table 22 - Summary catch/effort data and productive index,* 1956 trawl landings of English sole.

Area	Catch	Hours	C/H (lbs.)	Productive Index	Significant C/H
Hecate Strait	558,777	2,182	256.0	2.44	594
Goose Island	58,526	3,352	17.5	.17	170
Cape Scott	89,980	5,988	15.0	.14	134
Cape Cook	2,200	211	10.4	.10	-
Esperanza	8,265	1,968	4.2	.04	-
Nootka Sound	430	213	2.1	.02	25
Esteban	3,695	2,944	1.3	.01	250
Ucluelet	665	103	6.5	.06	250
Barkley Sound	1,100	572	1.9	.02	-
40 Mile	4,440	1,756	2.5	.02	200
Swiftsure	1,895	597	3.2	.03	-
Cape Flattery	183,015	3,983	46.0	.44	262
Umatilla	151,950	4,490	34.0	.32	160
Quillayute	1,153,845	3,569	323.0	3.08	521
Destruction	496,676	2,703	18.0	.17	280
Grays Harbor and S.	55,625	319	17.0	.16	208
S. E. Alaska	-	187	-	-	-
Puget Sound	2,184,145	12,166	180.0	1.71	229
Total	4,955,229	47,303	105	1.00	327

*Catch per hour by area / Catch per hour all areas, 1956

Table 23 - Catch by month of English sole for major producing areas, 1956

Month	Hecate Strait	Cape Flattery	Umatilla	Quillayute	Destruction	Puget Sound
January	35,060	27,555	31,840	432,073	61,825	186,227
February	97,525	44,950	47,345	530,075	26,860	414,955
March	104,520	9,960	19,955	39,725	73,835	606,330
April	139,347	21,345	1,210	13,017	86,221	150,550
May	127,500	2,025	3,645	31,455	96,330	64,136
June	15,960	1,330	11,240	59,875	80,715	49,590
July	10,720	2,065	3,620	6,970	13,380	22,335
August	21,400	410	3,195	3,605	1,770	35,680
September	795	26,485	11,370	400	-	61,975
October	-	28,000	5,190	-	4,500	117,435
November	-	3,230	4,760	32,810	51,240	379,606
December	5,950	15,660	8,580	3,840		95,326
Total	558,777	183,015	151,950	1,153,845	496,676	2,184,185

Depth distribution

English sole caught by the trawl fleet were taken at depths from 5 to 100 fathoms. The bathymetric range inhabited by the adults in quantity is apparently relatively narrow. Ninety-five percent of the production in offshore waters was taken between 20 and 70 fathoms while ninety percent of the Puget Sound catch was maae at depths between 10 and 40 fathoms. There is mounting evidence that populations within Puget Sound do not exhibit seasonal depth and geographic changes similar to the offshore stocks. Table 24 shows the catch by 10 fathom intervals for the major producing areas.

Table 24 - Catch in pounds by area (in 10 fathom intervals) for English sole - 1956*

Depth range	Hecate Strait	Quillayute	Destruction	Puget Sound
1 - 10				6,615
11 - 20				471,800
21 - 30		14,250	55,050	169,735
31 - 40	187,000	47,100	80,300	104,175
41 - 50	171,600	30,950	83,750	25,390
51 - 60	43,630	459,400	45,450	11,600
61 - 70	18,200	295,150	67,700	25,700
71 - 80		1,275	15,675	2,800
81 - 90		1,200		
91 -100				970
101 -110				
111-120				1,200

*As shown from interviews; not extrapolated to total catch by area.

Size and age

Length frequency samples for English sole caught on the Quillayute grounds along with several age samples were made during January and June 1956. The graphed distribution for these data are shown in Figures 13 and 14. The average size of English sole marketed from this area were somewhat smaller than for samples taken in 1953, 1954, and 1955. The large numbers of 3,4, and 5-year-old fish in samples may, coupled with the measured increased catch per hour, indicate the entrance of strong year classes into the fishery.

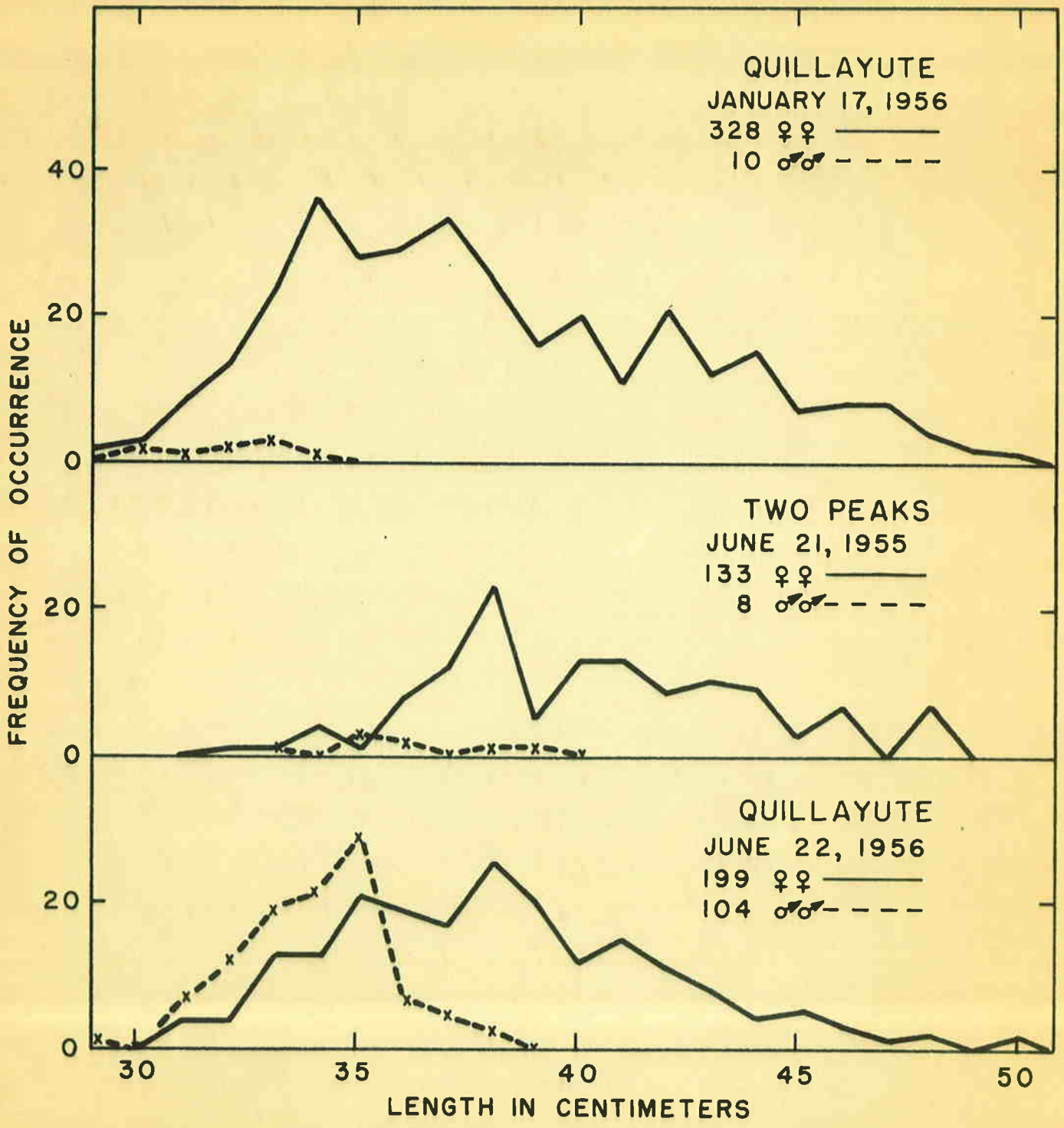


Figure 13 -LENGTH FREQUENCY DISTRIBUTION FOR ENGLISH SOLE 1955 AND 1956

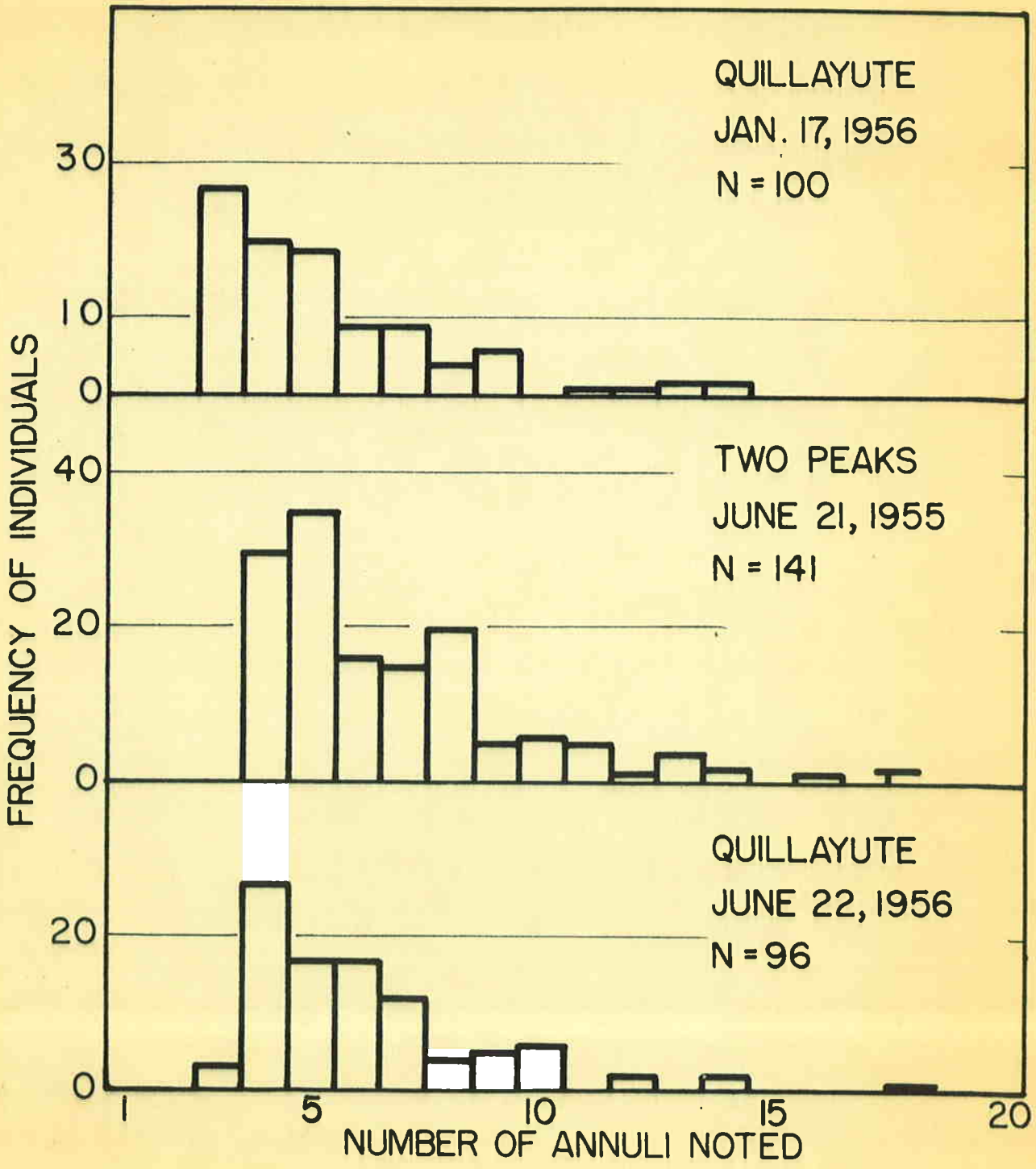


Figure 14 - AGE FREQUENCY FOR SAMPLES OF ENGLISH SOLE.

Management

English sole off the Washington coast and within Puget Sound have been subjected to a rather intense fishery for a number of years. Although the catch has fluctuated considerably no defined trend has developed. The catch per hour trawling measures made since 1953 (Figure 15) do not indicate reduced availability of the species.

It is interesting to note the similar patterns developing in abundance indices between Puget Sound and the Cape Flattery to Destruction grounds. Although these stocks are separated geographically by about 100 miles and tagging studies have shown practically no interchange between them, they portray similar trends.

DOVER SOLE (MICROSTOMUS PACIFICUS)

Dover sole ranked fifth in poundage and fifth in value for trawl-caught fish in 1956. Total catch of this species remained about equal to that of 1955 and the major portion of the production continued to come from Goose Island, Esteban and the grounds from Cape Flattery to Destruction Island.

The catch per hour trawling and other data concerning the origin of catches is shown in Table 25. Abundance trends (Figure 16) in two of the major trawl grounds show increases in the catch per hour and significant catch per hour over 1955. A radical increase in the basic catch per hour trawling and significant catch per hour is noted for the Esteban area. This was related to the excellent deep-water fishing in this region during 1956.

Dover sole catches by month for the major producing areas are shown in Table 26. As in 1955 the landings were heavy during the spring and fall seasons. The exploitation of the deep-water Esteban fishery during the period February through May accounted for close to 1/3 of the total annual catch.

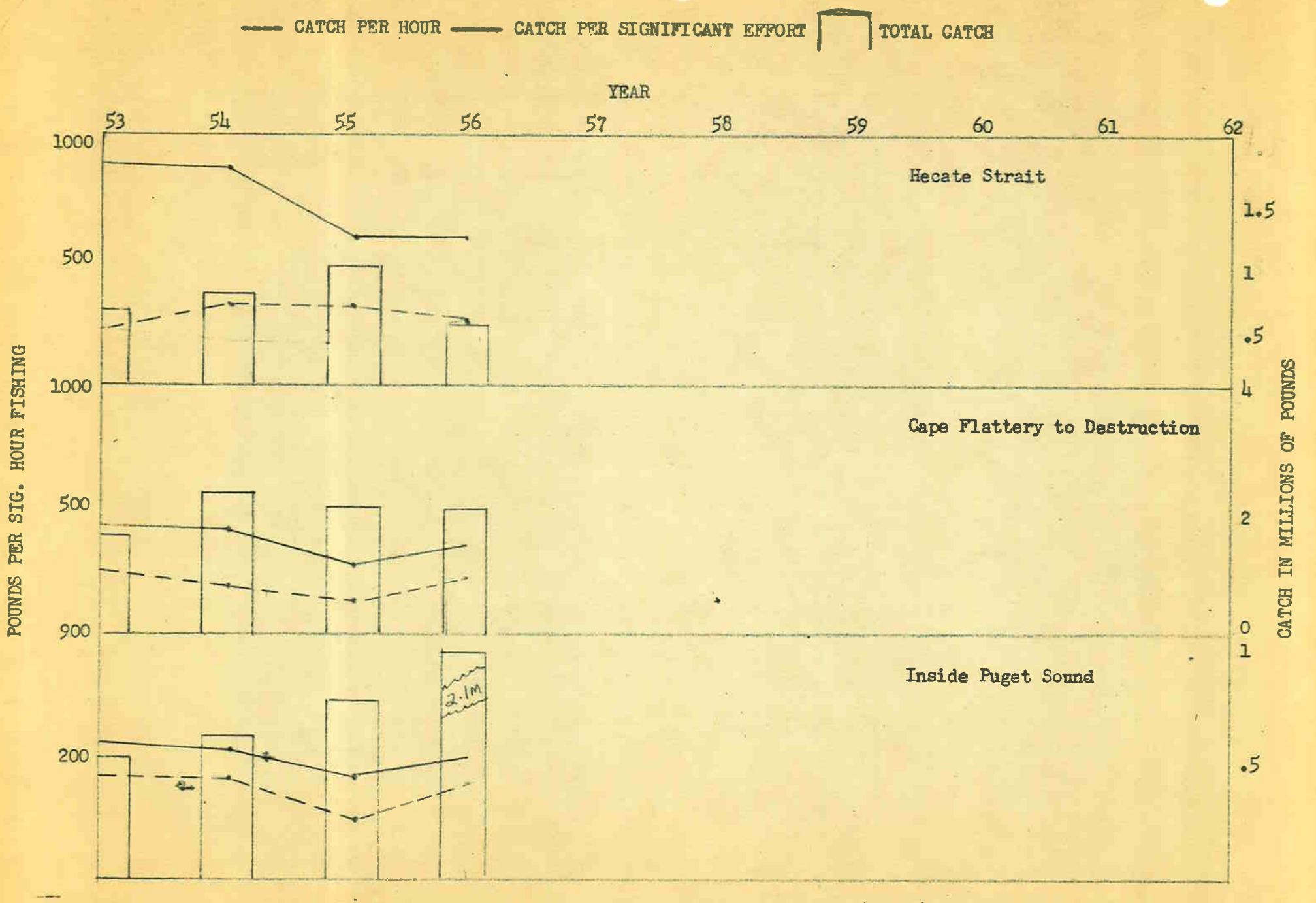


Figure 1.5 – Total catch, catch per hour, and catch per significant effort for english sole.

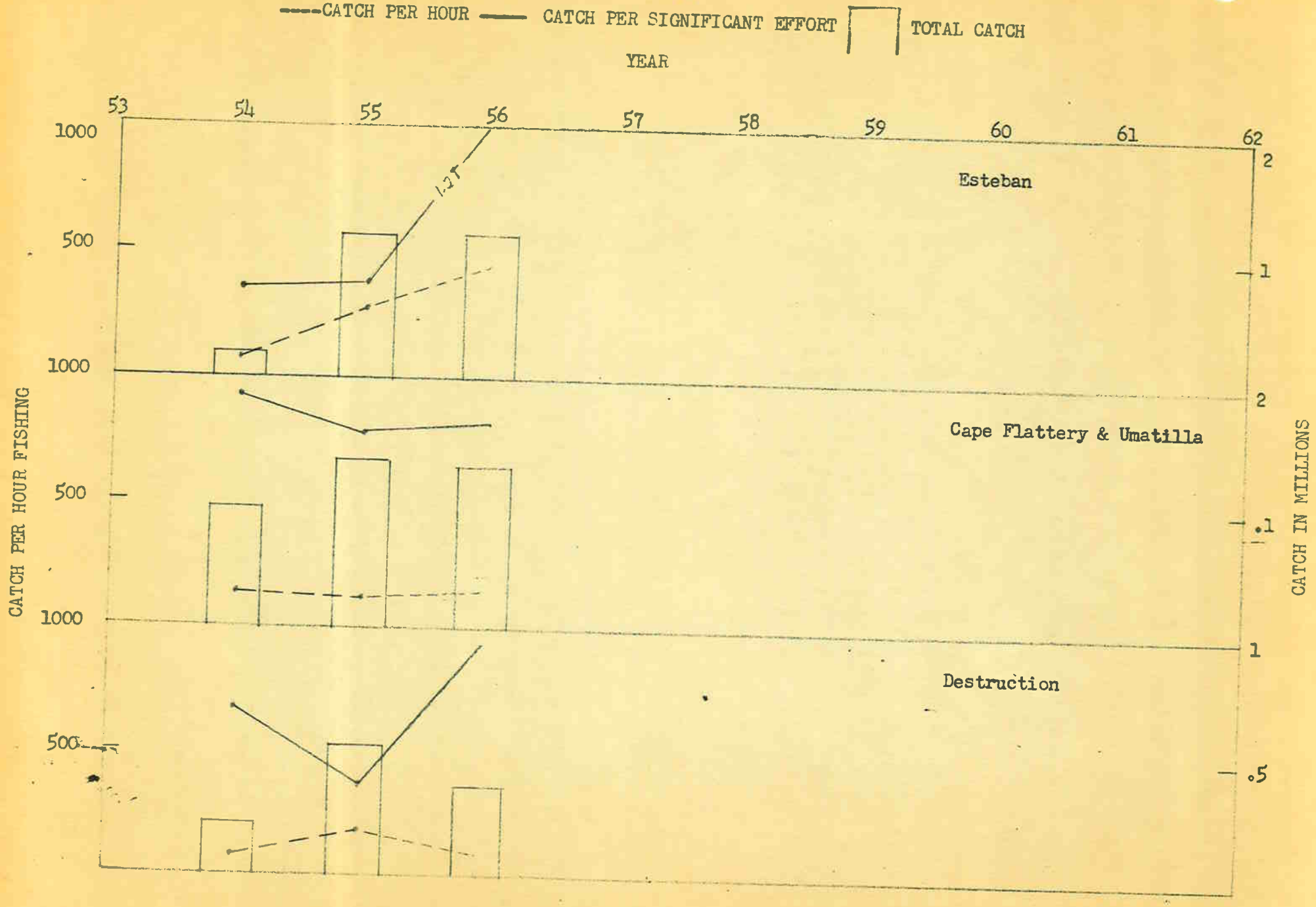


Figure 16 – Total catch, catch per hour, catch per significant effort for dover sole

Table 25 - Summary of catch/effort data and productive index,* 1956 trawl landings of Dover sole.

Area	Catch	Hours	C/H (lbs.)	Productive index	Significant C/H
Hecate Strait	29,920	2,182	14	.18	—
Goose Island	385,330	3,352	115	1.51	457
Cape Scott	140,850	5,988	24	.32	879
Cape Cook	3,750	211	18	.23	750
Esperanza	23,575	1,968	12	.16	367
Nootka Sound	220	213	1	.01	-
Esteban	1,262,156	2,944	429	5.64	1,227
Ucluelet	-	103	-	-	-
Barkley Sound	340	572	-	-	-
40 Mile	28,580	1,756	16	.21	372
Swiftsure	26,825	597	45	.59	211
Cape Flattery	594,640	3,983	149	1.96	882
Umatilla	619,460	4,490	138	1.82	830
Quillayute	72,885	3,569	20	.26	404
Destruction	294,910	2,703	109	1.43	954
Grays Harbor and S.	3,810	319	12	.16	400
S. E. Alaska	0	187	-	-	-
Puget Sound	92,890	12,166	8	.11	35
Total	3,580,141	47,303	76	1.00	849

*Catch per hour by area / Catch per hour all areas, 1956

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

Table 26 - Catch by month of Dover sole for major producing areas, 1956.

Months	Goose Island	Esteban	Cape Flattery	Umatilla	Destruction
January	-	47,500	-	-	-
February	-	106,933	1,210	-	485
March	-	506,608	-	-	63,755
April	-	433,727	26,575	4,070	11,550
May	109,166	102,343	248,060	121,695	13,230
June	176,624	-	5,985	55,195	665
July	10,720	2,010	63,015	17,060	3,215
August	14,825	9,655	72,360	57,130	-
September	7,475	4,770	39,685	59,750	1,590
October	6,250	1,250	55,130	29,250	-
November	54,510	510	79,550	263,200	4,420
December	5,760	46,850	3,070	12,110	196,000
Total	385,330	1,262,156	594,640	619,460	294,910

Depth distribution

Dover sole caught in 1956 were taken at depths ranging from 10 to 280 fathoms. The depths between 70 and 240 fathoms were especially productive during 1956 with a definite trend for the fleet to fish the deeper range between 100 and 200 fathoms. Table 27 gives the catch by depth as shown from interviews for the major grounds.

Table 27 - Catch in pounds by area (in 10 fathom intervals) for Dover sole - 1956*

Depth range	Goose Island	Esteban	Cape Flattery	Umatilla	Destruction
11 - 20				3,500	
21 - 30			4,000	1,500	500
31 - 40			1,000		300
41 - 50		1,000		2,500	1,000
51 - 60	4,000	2,300	24,715	18,500	1,900
61 - 70	300		29,480	35,700	400
71 - 80			4,100	1,800	200
81 - 90	200	1,500	7,215	3,000	50
91 - 100	6,400		23,660	17,305	1,500
101 - 110	3,000	300	4,800	31,900	
111 - 120	31,000		1,000	4,000	3,000
121 - 130	62,300	22,800	150	20,500	
131 - 140	73,000		29,000	37,100	1,000
141 - 150	26,000	15,000	17,000	11,000	
151 - 160	3,000	46,600	116,000	59,000	2,500
161 - 170		7,000	95,000	59,000	
171 - 180		13,200			1,000
181 - 190		12,900		3,000	400
191 - 200		83,200			6,500
201 - 210		63,700			
211 - 220		152,000			43,000
221 - 230		67,875			
231 - 240		20,000			1,370
241 - 250					
251 - 260		50,000			50,000
261 - 270					4,000
271 - 280		8,000			

* As shown from interviews; not extrapolated to total catch by area.

Management

Dover sole stocks have been intensely fished for the past three years. Prior to 1954 catches of this species made by the Washington fleet were insignificant. No adverse trends have been detected.

STARRY FLOUNDER (PLATICHTHYS STELLATUS)

Starry flounder ranked tenth in poundage and ninth in value for trawl-caught fish in 1956. The total catch and value for this species were slightly up from 1955. The areas of major catch were S. E. Alaska, Cape Flattery to Quillayute, and Puget Sound. A summary of the catch-effort data by area is shown in Table 28. The pattern of monthly landings was for catches from inside areas (Puget Sound and S. E. Alaska) to increase in the winter months while offshore catches, mainly from the area between Cape Flattery and Quillayute, to be heavy during the summer months (Table 29).

Depth distribution

Starry flounder appear to inhabit shallow water at depths from 1 to 50 fathoms. Close to 95 percent of the catch landed in 1956 was taken in water shallower than 50 fathoms. Table 30 gives the catch in 10 fathom intervals for the areas of major production.

Length and weight

A length-weight curve and length frequency graph for starry flounder sampled from the Umatilla grounds are shown in Figures 17a and 17b. Starry flounder landed by trawlers may in many instances represent selected catches as markets will not accept smaller fish. The frequency curve shown therefore may be atypical of the available stocks. It is noted that the length weight curve appears to be almost rectilinear. This, however, was the result of sampling fish almost all above the size where the weight increment is rapidly increasing for a standard length increment.

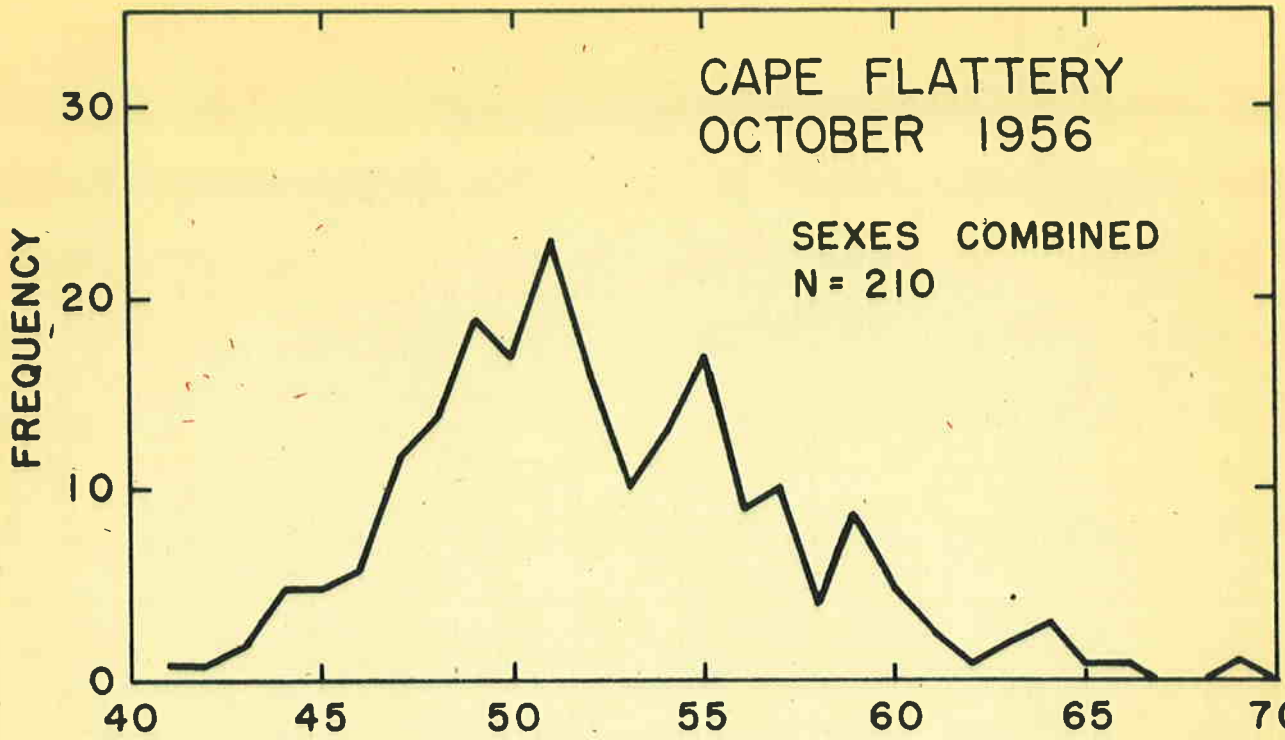


Figure 17A - LENGTH FREQUENCY DISTRIBUTION OF STARRY FLOUNDER

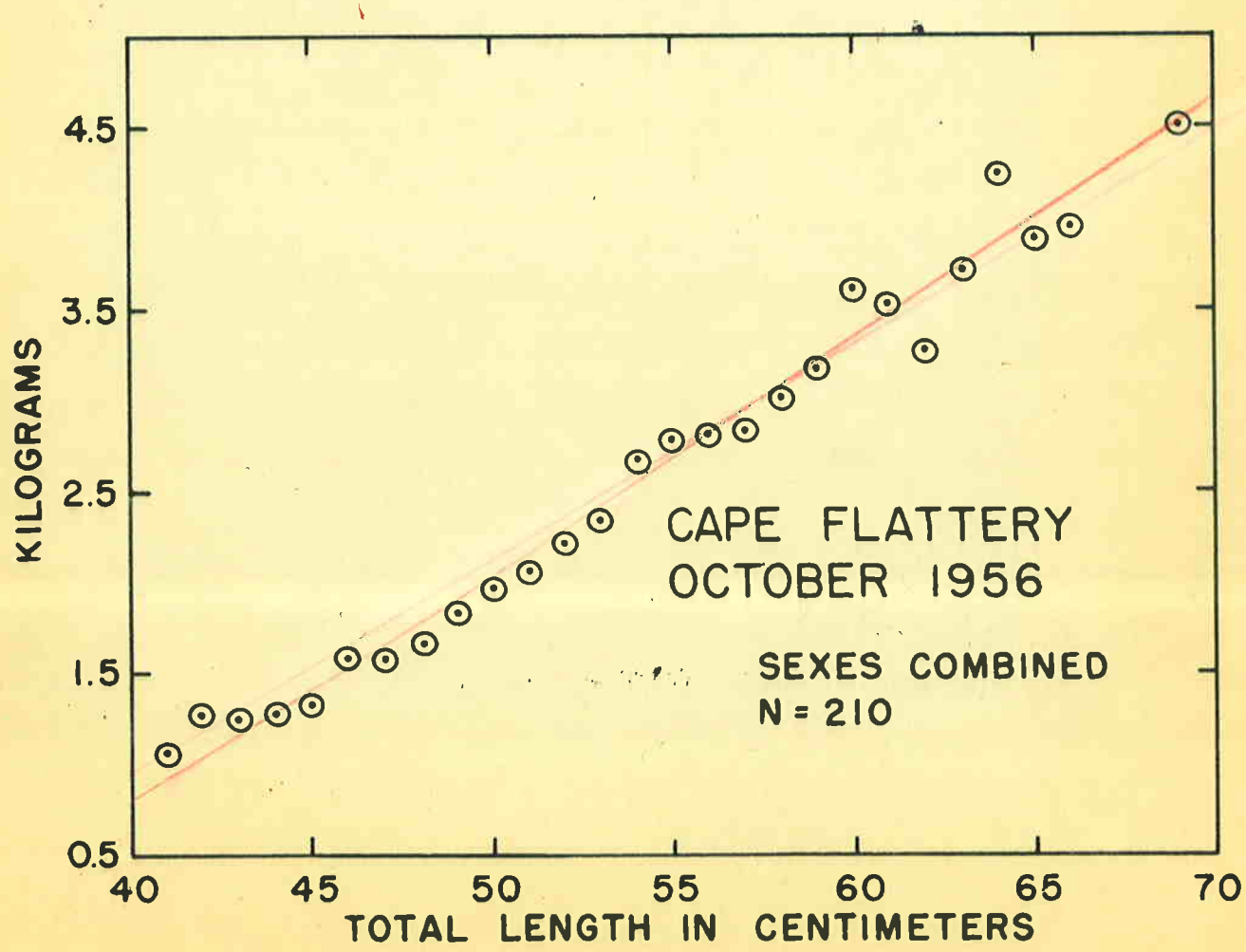


Figure 17B - LENGTH-WEIGHT RELATIONSHIP OF STARRY FLOUNDER

Management

The volume of starry flounder landed is largely governed by market acceptance which limits the catch for a large portion of the year. The trends in catch by area and catch per hour trawling are shown in Figure 18.

Table 28 - Summary catch/effort data and productive index,* 1956 trawl landings of starry flounder.

Area	Catch	Hours	C/H (lbs.)	Productive index	Significant C/H
Hecate Strait	79,290	2,182	36	.90	732
Goose Island	0	3,352	-	-	-
Cape Scott	0	5,988	-	-	-
Cape Cook	0	211	-	-	-
Esperanza	0	1,968	-	-	-
Nootka Sound	0	213	-	-	-
Esteban	0	2,944	-	-	-
Ucluelet	0	103	-	-	-
Barkley Sound	0	572	-	-	-
40 Mile	0	1,756	-	-	-
Swiftsure	4,080	597	7	.18	1,500
Cape Flattery	127,850	3,983	32	.80	433
Umatilla	580,715	4,490	129	3.23	693
Quillayute	311,665	3,569	87	2.18	762
Destruction	9,810	2,703	4	.10	246
Grays Harbor and S.	0	319	-	-	-
S. E. Alaska	194,150	187	104	2.60	1,392
Puget Sound	485,610	12,166	40	1.00	187
Total	1,793,170	47,303	40	1.00	580

*Catch per hour by area / Catch per hour all areas, 1956

**Includes Alaska

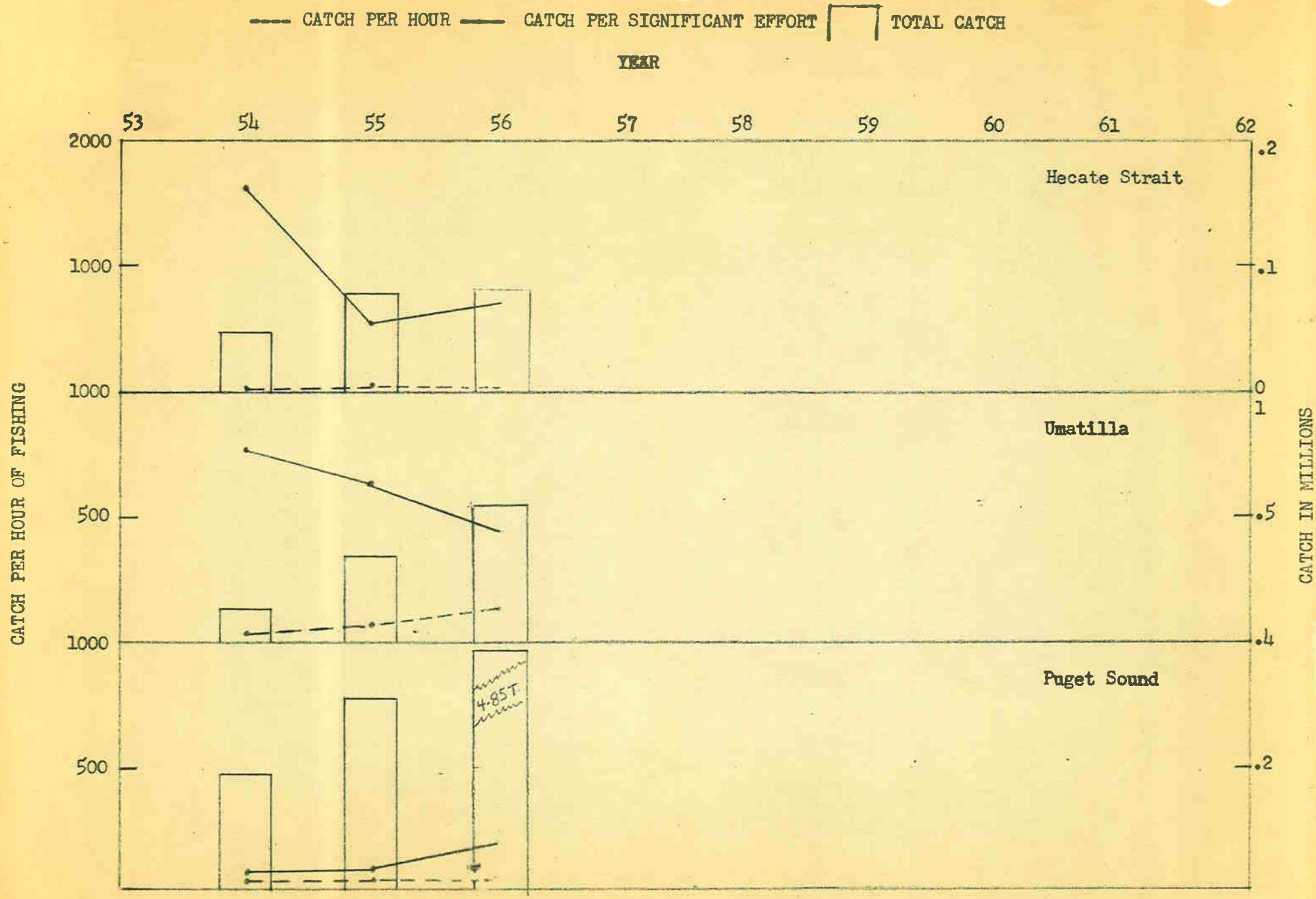


Figure 18 - Total catch, catch per hour, and catch per significant effort for starry flounder

Table 29 - Catch by month of starry flounder for major producing areas, 1956.

	Cape Flattery	Umatilla	Destruction	Puget Sound	S. E. Alaska
January	-	140	550	134,045	151,800
February	-	-	-	38,695	42,350
March	-	-		33,250	-
April	-	-	85,380	8,770	-
May	-	-	-	1,855	-
June	-	-	665	3,590	-
July	-	39,580	37,840	2,880	-
August	-	471,720	184,960	445	-
September	21,720	67,575	1,590	-	-
October	105,750	-	-	920	-
November	-	1,700	680	147,200	-
December	380	-	-	113,960	-
Total	127,850	580,715	311,665	485,610	194,150

Table 30 - Catch in pounds by area in 10 fathom intervals for starry flounder - 1956*

Depth range	S. E. Alaska	Umatilla	Quillayute	Puget Sound
1 - 10				16,340
11 - 20	3,000	283,500	64,000	105,148
21 - 30	173,500	76,300	165,300	26,140
31 - 40	45,000	26,000	9,000	5,950
41 - 50			1,000	1,420
51 - 60		20,100		
61 - 70		3,500	1,400	
71 - 80				
81 - 90				
91 - 100				

*As shown from interviews; not extrapolated to total catch by area.

ROCKSOLE (LEPIDOPSETTA BILINEATA)

Rocksole ranked eleventh in poundage and eleventh in value for trawl-caught fish landed during 1956. The total catch declined slightly from 1955 and the catch per significant effort was down for two of the major production areas. The total catch by area and catch effort data are shown in Table 31 while the catch by month is shown in Table 32. Trends in the catch per hour trawling and total catch are shown in Figure 19.

Table 31 - Summary catch/effort data and productive index,* 1956 trawl landings of rocksole.

Areas	Catch	Hours	C/H (lbs.)	Productive index	Significant C/H**
Hecate Strait	281,440	2,182	128	7.52	1,159
Goose Island	102,670	3,352	31	1.82	325
Cape Scott	304,435	5,988	51	3.00	430
Cape Cook	0	211	0	-	-
Esperanza	6,600	1,968	3	-	-
Nootka	0	213	0	-	-
Esteban	0	2,944	0	-	-
Ucluelet	0	103	0	-	-
Barkley Sound	950	572	2	.11	-
40 Mile	2,290	1,756	1	.06	-
Swiftsure	0	597	0	-	-
Cape Flattery	0	2,983	0	-	-
Umatilla	0	4,490	0	-	-
Quillayute	0	3,569	0	-	-
Destruction	0	2,703	0	-	-
Grays Harbor and S.	0	319	0	-	-
Puget Soumd	128,645	12,166	11	.64	200
S. E. Alaska	0	187	0	-	-
Total	827,030	47,303	17	1.00	

* $\frac{\text{Catch per hour by area}}{\text{Catch by all areas, 1956}}$

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

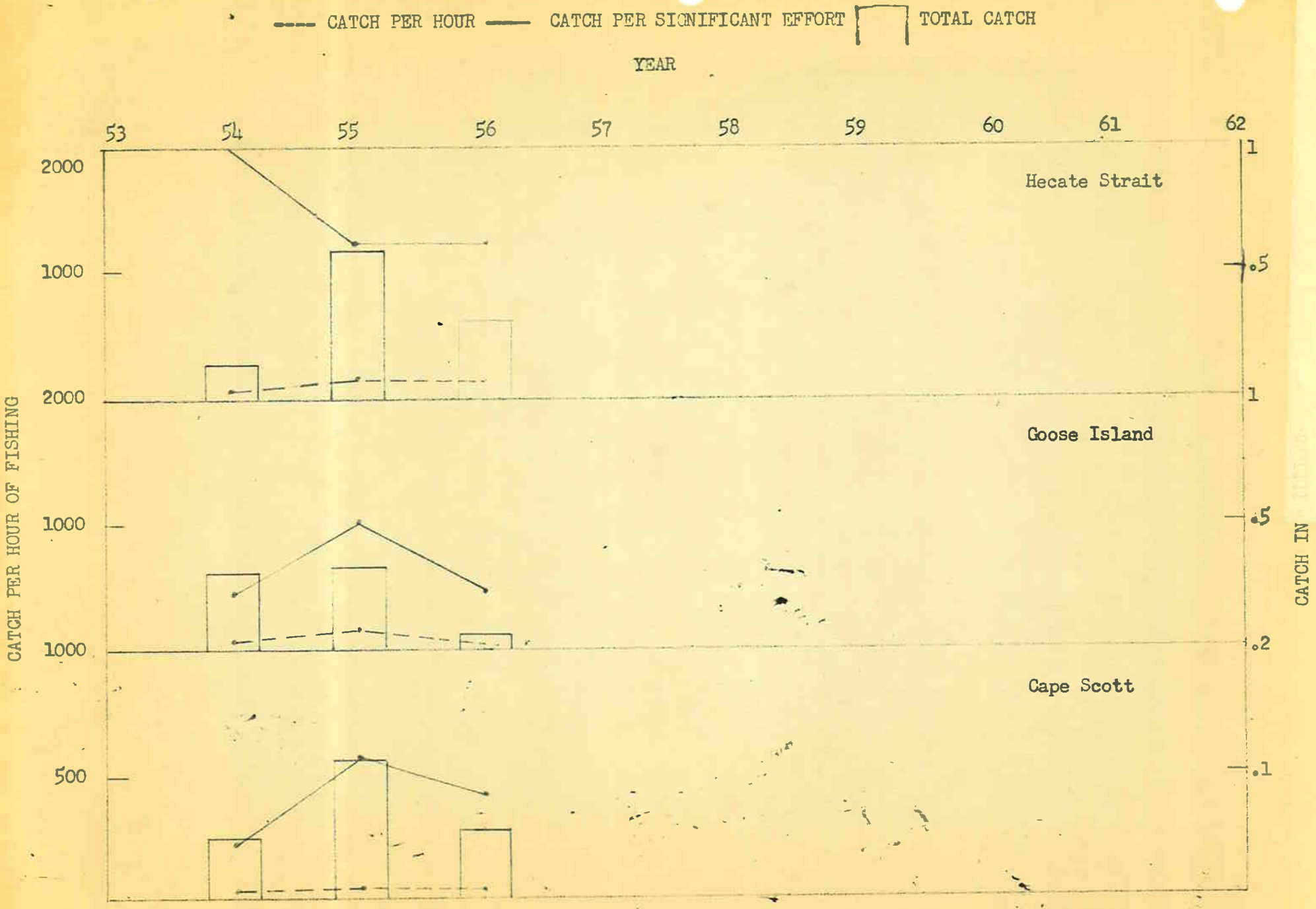


Figure 19 - Total catch, catch per hour, and catch per significant effort for Rocksole

Table 32 - Catch by month of rocksole for major producing areas, 1956.

	Hecate Strait	Goose Island	Cape Scott	Puget Sound
January	-	-	1,100	30,250
February	-	-	5,445	23,850
March	29,400	11,025	2,500	24,255
April	5,940	39,900	43,310	315
May	72,900	12,825	99,145	1,430
June	53,200	19,285	47,880	-
July	45,200	17,730	54,940	-
August	74,800	1,905	36,925	-
September	-	-	12,560	-
October	-	-	630	-
November	-	-	-	18,395
December	-	-	-	27,350
Total	281,440	102,670	304,435	128,645

Depth distribution

Rock sole are generally caught in waters ranging from 10 to 100 fathoms. The major production is taken at depths from 30 to 70 fathoms.

Management

This fishery like starry flounder may be considered as a fringe operation. The stocks are not heavily exploited by U. S. vessels and their availability has remained at a comparatively high level.

OTHER FLATFISH

Turbot (Atheresthes stomias)

The catch of turbot for mink food has increased greatly during the past several years and close to 3 million pounds was landed during 1956. A large portion of the catch is taken on the banks close to Cape Flattery with the 40 Mile and Swiftsure areas being the major producers. The species appears to inhabit a rather wide bathymetric range being taken at depths between 21 and 260 fathoms. A large portion of the catch is made in depths greater than 100 fathoms. Records of

discarded turbot suggest that this species is abundant over the range of the Washington trawl fishery.

Sand sole (Psettichthys melanostictus)

Small amounts of sand sole are landed by trawlers fishing the Puget Sound area during the winter months. At times this species may be marketed as English or Dover sole.

Bellingham sole (Isopsetta isolepis)

Several thousand pounds of Bellingham sole were landed during 1956 from the Umatilla area. The catches were marketed for animal food. Discard records indicate that this species is abundant during the winter months off the Washington coast at depths between 40 - 58 fathoms.

Other species occasionally marketed include the Rex sole (Errex zachirus), slender sole (Lyopsetta exilis), C. O. sole (Pleuronichthys coenosus), sand dabs (Citharichthys) and flathead sole (Hippoglossoides classodon).

TRUECOD (GADUS MACROCEPHALUS)

Truecod ranked first in poundage and first in value for trawl fish landed by the Washington fleet during 1956. The species has led Washington bottom fish production since 1950 and has exceeded 10 million pounds annually for the past three years.

The northern areas, Cape Scott, Goose Island, and Hecate Strait acccunted for close to 50 percent of the catch during 1956. Good catches were also made in waters between Cape Flattery and Destruction Island, and within Puget Sound.

The total State catch has fallen off from the peak of 13 million pounds landed in 1954. The decline is probably related to both reduced availability and market conditions. Catch-effort data for truecod is given in Table 33 and the monthly landings for the major producing areas are shown in Table 34. Trends in abundance are given in Figures 20 and 21.

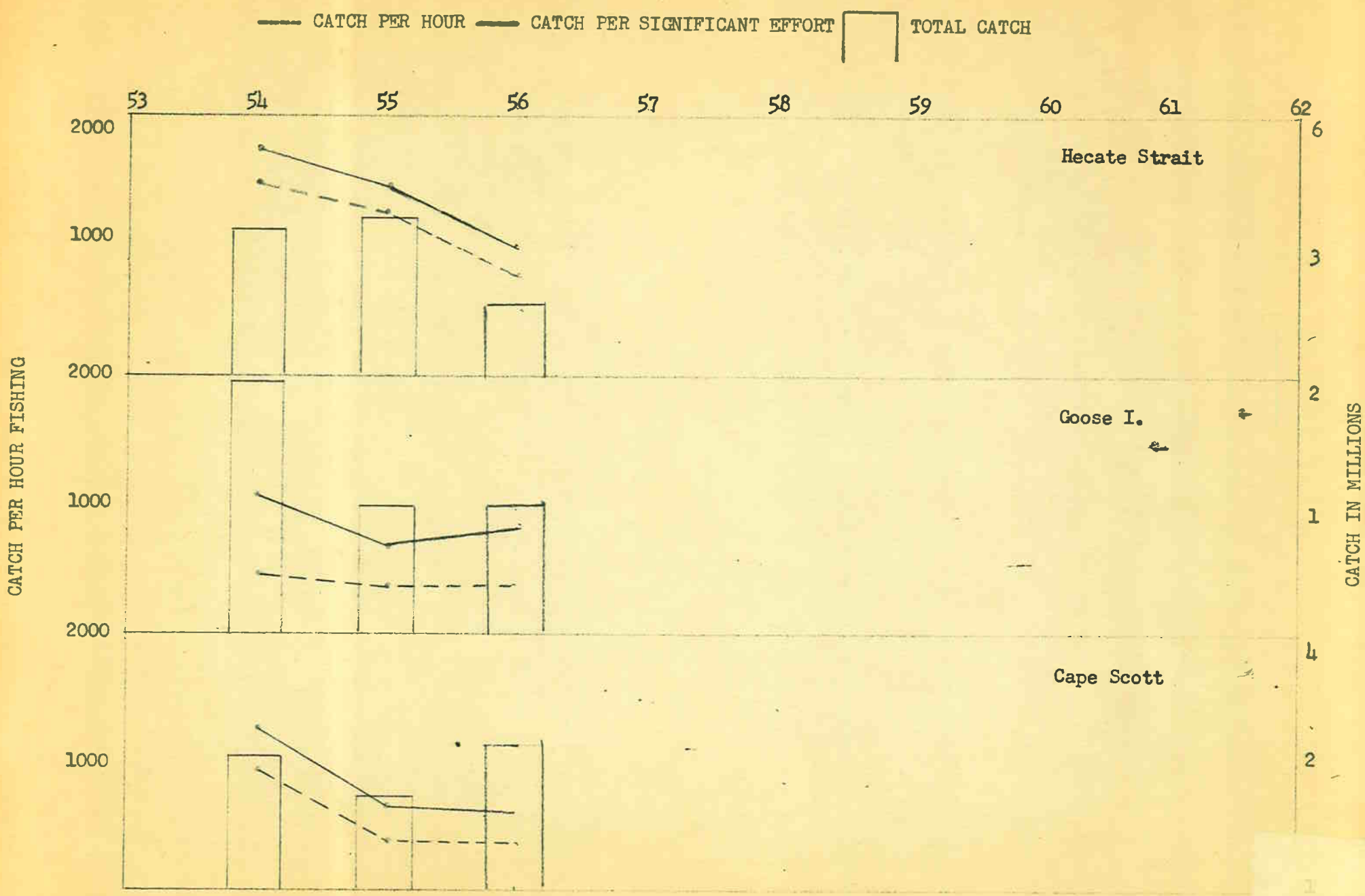


Figure 20 - Total catch, catch per hour, and catch per significant effort for True Cod (Northern areas)

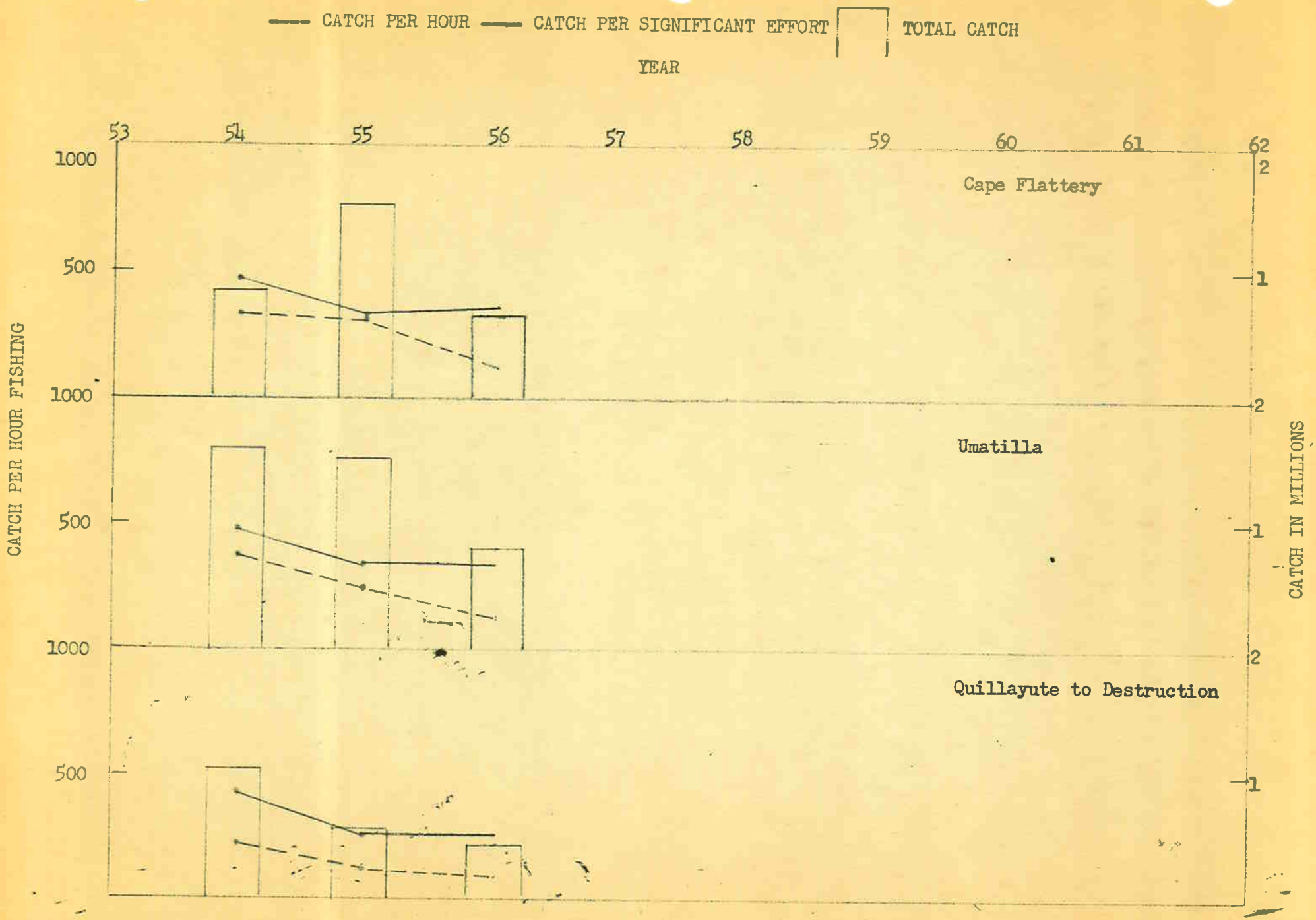


Figure 21 - Total catch, catch per hour, and catch per significant effort for Truecod (southern areas)

Table 33 - Summary catch/effort data and productive index,* 1956 trawl landings of truecod.

Area	Catch	Hours	C/H (lbs.)	Productive index	Significant C/H**
Hecate Strait	1,698,060	2,182	778	3.64	918
Goose Island	1,092,590	3,352	326	1.52	856
Cape Scott	2,287,156	5,988	382	1.79	579
Cape Cook	64,925	211	308	1.44	486
Esperanza	503,245	1,968	256	1.20	41
Nootka	2,205	213	104	.49	-
Esteban	43,315	2,944	15	.07	322
Ucluelet	69,855	103	678	3.17	846
Barkley Sound	478,180	572	836	3.91	909
40 Mile	643,755	1,756	367	1.71	622
Swiftsure	32,946	597	55	.26	182
Cape Flattery	664,395	3,983	167	.78	357
Umatilla	690,885	4,490	154	.72	304
Quillayute	435,335	3,569	122	.57	271
Destruction	363,385	2,703	134	.63	295
Grays Harbor and S.	25,385	319	80	.37	182
Puget Sound	1,038,392	12,166	85	.40	120
S. E. Alaska	-	187	-	-	-
Total	10,134,009	47,303	214	1.00	-

*Catch per hour by area / Catch per hour all areas, 1956

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

Table 34 - Catch by month of truecod for major producing areas, 1956

Month	Hecate Strait	Goose Island	Cape Scott	Esperanza	Cape Flattery	Umatilla
January	29,560	46,750	26,950	-	3,575	11,605
February	171,050	52,395	211,100	58,080	97,595	76,595
March	747,500	195,880	183,310	312,815	52,170	36,955
April	193,700	178,950	66,770	127,480	29,290	25,630
May	213,850	125,550	255,025	4,050	26,530	70,045
June	246,100	42,560	272,460	-	41,095	122,975
July	21,440	146,630	346,910	-	7,305	9,380
August	20,400	166,400	133,416	-	29,240	97,720
September	-	64,235	145,945	-	54,575	102,620
October	-	57,500	233,700	310	245,810	32,250
November	39,100	11,900	96,050	510	67,800	92,790
December	15,360	3,840	315,520	-	9,410	12,320
Total	1,698,060	1,092,590	2,287,156	503,245	664,395	690,885

Depth distribution

Truecod are usually caught at depths ranging from 10-100 fathoms and are seldom encountered below 100 fathoms. Eighty-five percent of the offshore production comes from depths between 30 and 80 fathoms, while catches from the waters inside Puget Sound are made at depths between 11 - 70 fathoms. Table 35 relates the catch in ten-fathom intervals as shown from 1956 interview records.

Table 35 - Catch in pounds by area (in 10 fathom intervals) for truecod - 1956*.

Depth range	Hecate Strait	Goose Island	Cape Scott	Esperanza	Umatilla
1 - 10					
11 - 20					41,850
21 - 30					22,200
31 - 40	287,000				27,500
41 - 50	321,400	400	6,000	3,500	52,700
51 - 60	464,900	140,500	271,700	193,800	134,390
61 - 70	110,000	369,100	575,100	165,850	159,100
71 - 80		195,500	475,200	6,000	5,790
81 - 90		69,050	174,200		3,000
91 - 100			61,100		1,715
101 - 110	23,000		500		2,500
111 - 120			1,000		300
121 - 130		11,000	6,500		13,000
131 - 140				2,000	700

*As shown from interviews not extrapolated to total catch by area.

Size

Length frequency graphs for truecod sampled in 1956 are shown in Figure 22. The fishery is composed of fish ranging from 40 to 85 cm. with the 55 to 75 cm. group dominated the samples during 1956.

Management

The catch trends indicate that the abundance of truecod has declined during the past three years. Reduced cumulative stock levels may have resulted from the active fishery, although length frequency measures from the northern areas have

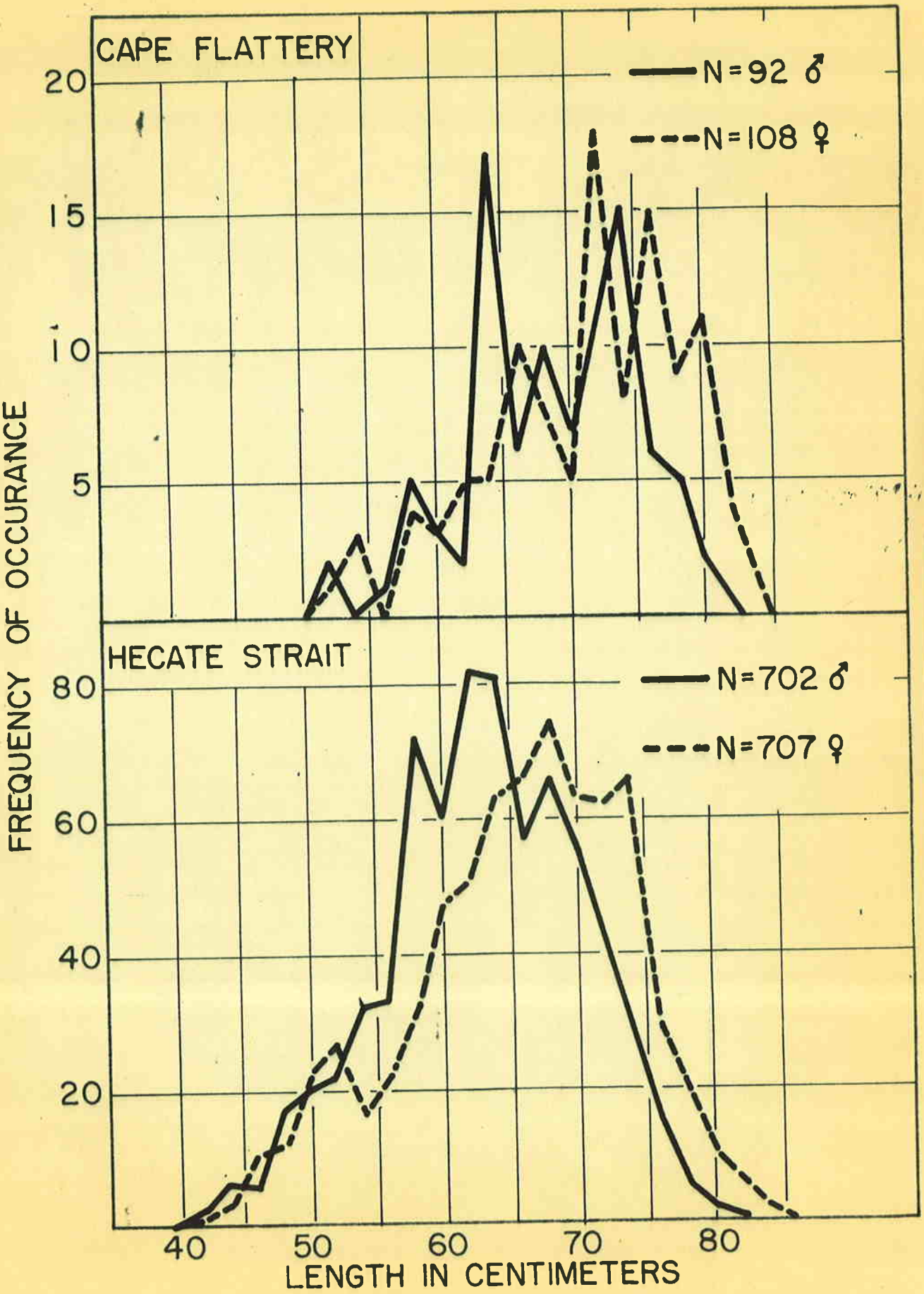


Figure 22 - LENGTH FREQUENCY DISTRIBUTIONS FOR TRUECOD CAUGHT JAN. TO JUNE, 1956.

not shown a significant shift to the left as might be expected. Conversely the few samples which have been taken off the Washington coast have shown an average increase in size of almost ten centimeters. Poor recruitment may have contributed to the reduced availability.

PACIFIC OCEAN PERCH (SEBASTODES ALUTUS)

Pacific ocean perch ranked second in poundage and sixth in value for trawl-caught fish landed in 1956. The total catch was up two million pounds from 1955. The Queen Charlotte Sound area, Esteban grounds and the deep-water banks off the Washington coast were areas from which most of the catch originated. The availability of the species was good and the market demand better than in 1955. The catch per hour fishing (Table 36) remained at a comparatively high level. Because Pacific Ocean perch are exploited on exposed deep-water banks, the species is not fished as intensely during the winter months. The landings normally peak during the summer and fall and drop off following November (Table 37).

Depth distribution

Pacific ocean perch were recorded as having been caught at depths between 60 and 280 fathoms; however, most of the catch (95 percent) is taken from depths exceeding 90 fathoms. The catch in 10 fathom intervals is given in Table 38.

Size distribution

Length frequency samples of Pacific Ocean perch taken during 1956 are plotted in Figures 23 and 24a. The fish ranged from 25 to 53 cm in length with females being considerably larger than males. It should be noted that the size range of perch taken is comparatively narrow, with the smallest and largest individuals showing only a ten inch spread. A very slow growth rate is postulated for this rockfish and a large number of year classes are known to enter into the fishery. A length weight curve for a sample taken from Cape Scott is shown in Figure 24b.

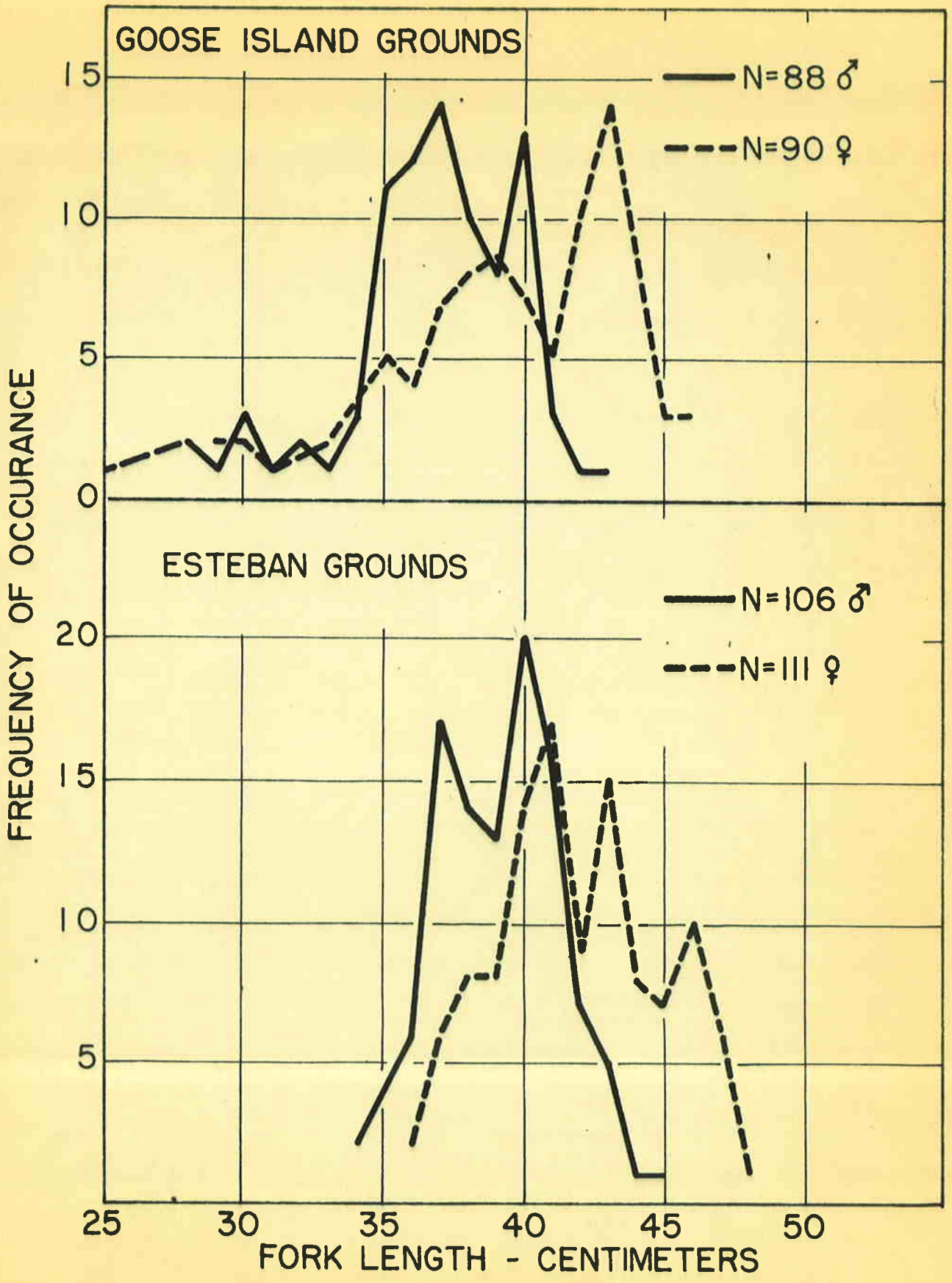


Figure 23 - LENGTH FREQUENCY FOR PACIFIC OCEAN PERCH CAUGHT JAN. TO JUNE, 1956.

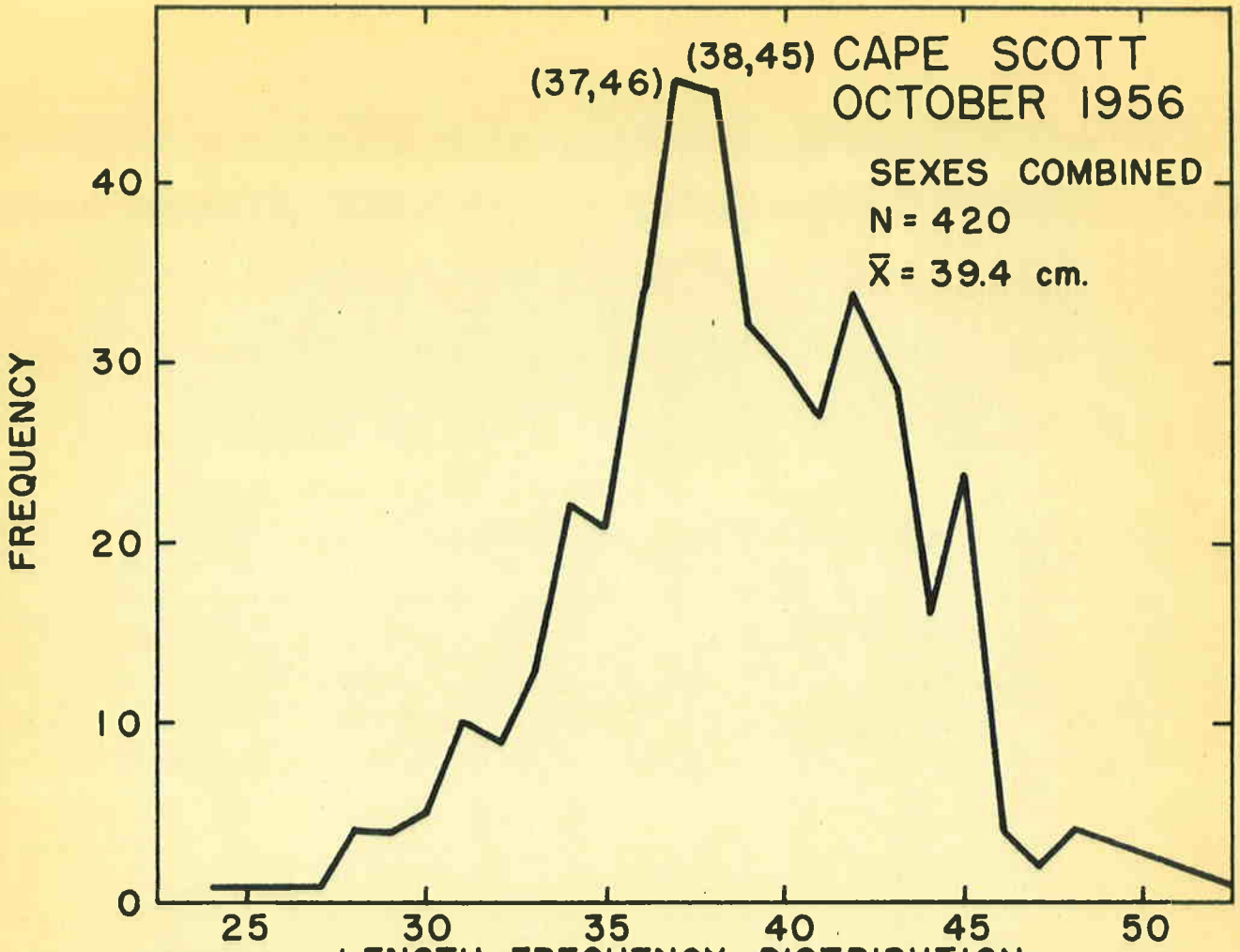


Figure 24A - LENGTH FREQUENCY DISTRIBUTION OF PACIFIC OCEAN PERCH

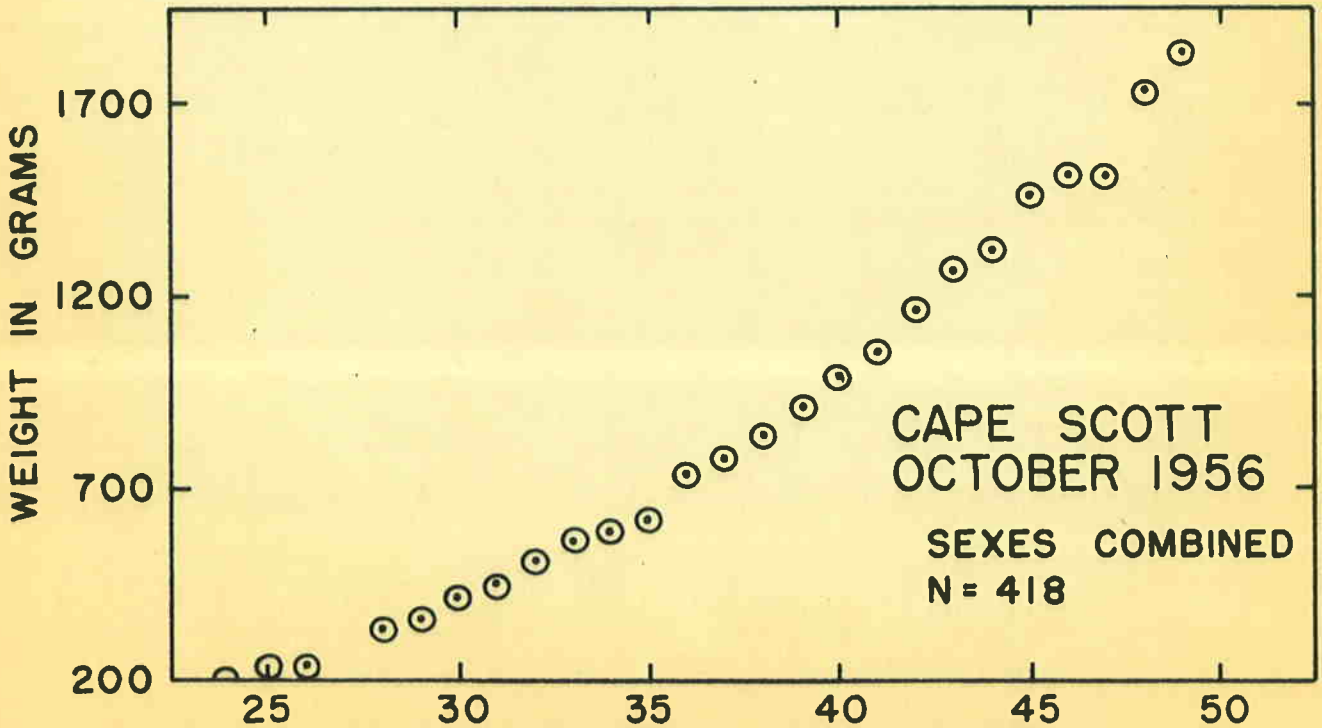


Figure 24B - FORK LENGTH IN CENTIMETERS

LENGTH-WEIGHT RELATIONSHIP OF PACIFIC OCEAN PERCH

Table 36 - Summary catch/effort data and productive index,* 1956 trawl landings of ocean perch.

Area	Catch	Hours	C/H (lbs.)	Productive index	Significant C/H**
Hecate Strait	154,350	2,182	71	.58	2,500
Goose Island	2,038,195	3,352	608	4.94	1,227
Cape Scott	1,021,780	5,988	171	1.39	1,143
Cape Cook	-	211	-	-	-
Esperanza	30,215	1,968	15	.12	908
Nootka	111,410	213	523	4.25	1,183
Esteban	1,185,430	2,944	403	3.28	949
Ucluelet	-	103	-	-	
Barkley Sound	-	572	-	-	
40 Mile	119,290	1,756	68	.55	1,894
Swiftsure	29,510	597	49	.40	188
Cape Flattery	395,390	3,983	99	.80	904
Umatilla	419,270	4,490	93	.76	683
Quillayute	112,775	3,569	32	.26	634
Destruction	200,570	2,703	74	.60	1,123
Grays Harbor and S.	7,305	319	23	.19	392
Puget Sound	250	12,166	-	-	
S. E. Alaska	-	187	-	-	
Total	5,825,740	47,303	123	1.00	

* Catch per hour by area / Catch per hour all areas, 1956

** Ocean perch in catch representing 25 percent or over of total fare made during particular effort.

Table 37 - Catch by month of Pacific Ocean perch for major producing areas, 1956.

	Goose Island	Cape Scott	Esteban	Cape Flattery	Umatilla
January	-	-	149,875	-	-
February	6,050	-	195,085	6,655	3,630
March	-	734	100,420	29,400	-
April	-	-	196,410	99,950	70,380
May	420,025	53,325	33,750	110,920	96,525
June	747,190	159,200		1,330	32,875
July	78,990	103,080	84,320	66,630	42,160
August	83,640	325,880	159,800	35,360	12,240
September	143,400	116,070	69,960	11,925	1,590
October	292,500	108,750	113,750	21,320	46,250
November	199,200	150,900	9,860	11,900	64,200
December	67,200	3,840	72,200	-	39,750
Total	2,038,195	1,021,780	1,185,430	395,390	419,270

Table 38 - Catch in pounds by area (in 10-fathom intervals) for Pacific Ocean perch - 1956.

Depth range	Goose Island	Cape Scott	Esteban	Cape Flattery	Umatilla
51 - 60			2,000	8,000	1,500
61 - 70	4,000	8,900			
71 - 80		5,000		2,000	
81 - 90	4,000	85,300	20,000	1,500	200
91 - 100	30,000	78,700	31,000	1,350	1,530
101 - 110	21,000	335,500	20,300	10,000	13,000
111 - 120	199,500	20,000	32,500	25,000	7,900
121 - 130	556,000	48,000	159,000	58,300	137,400
131 - 140	298,000		2,900	27,000	18,700
141 - 150	177,000	45,000	39,300	27,000	12,800
151 - 160	15,000	30,000	248,700	42,050	48,000
161 - 170			55,400	38,500	12,000
171 - 180			46,500		
181 - 190			44,900		2,000
191 - 200			13,000		
201 - 210			42,200		
211 - 220			14,100		
221 - 230			9,100		

*As shown from interviews, not extrapolated to total catch by area.

Management

Catch trends (Figure 25) do not indicate the stocks are being adversely affected by the present fishery and the availability during 1956 was apparently somewhat better than in 1955.

ROCKFISH (SEBASTODES)

Rockfish ranked third in poundage and seventh in value for trawl-caught fish landed in 1956. The total catch was almost equal to that of 1955 and the value of the catch increased $12,000.00. A variety of Sebastodes are caught by Washington trawlers; however, the orange rockfish (S. pinniger), yellowtailed rockfish (S. flavidu the flagsnapper (S. ruberrimus), rosefish (S. diploproa), and the salmon rockfish (S. pavcispinis) were the most commonly caught species. The difficulty of segregatio precludes the establishment of a catch-effort study; however, a general summary for all species combined is given in Table 39.

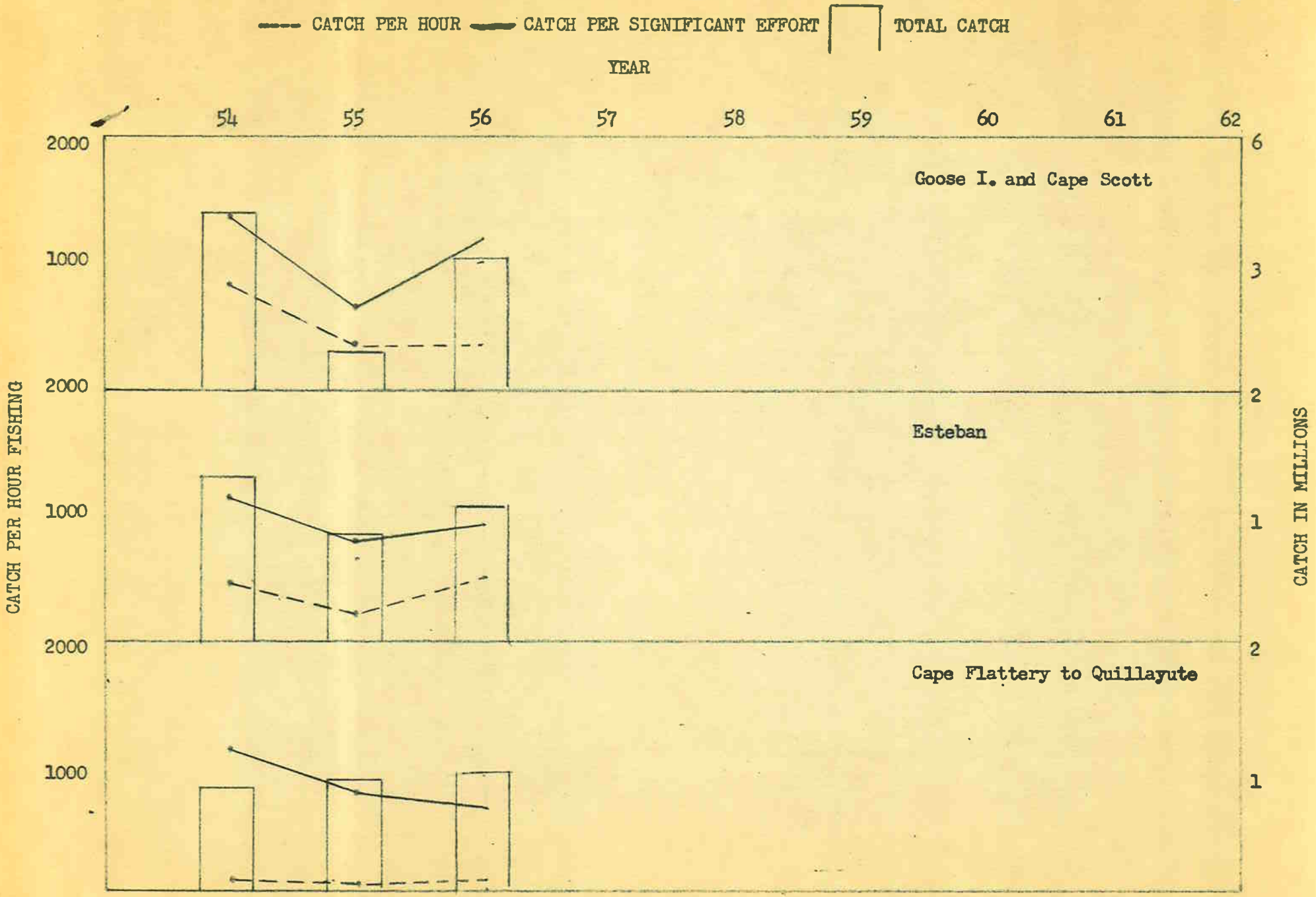


Figure 25 - Total catch, catch per hour, and significant catch per effort for ocean perch.

Table 39 - Summary catch/effort data and productive index,* 1956 trawl landings of rockfish (red and black combined).

Area	Catch	Hours	C/H (lbs.)	Productive index	Significant C/H**
Hecate Strait	51,130	2,182	23	.19	250
Goose Island	724,070	3,352	216	1.76	967
Cape Scott	1,543,765	5,988	258	2.10	499
Cape Cook	128,310	211	608	4.94	772
Esperanza	780,765	1,968	397	3.23	578
Nootka Sound	22,830	213	107	.87	623
Esteban	609,940	2,944	207	1.68	614
Ucluelet	-	103	-	-	-
Barkley Sound	1,080	572	2	.02	-
40 Mile	40,715	1,756	232	1.89	253
Swiftsure	6,480	597	11	.09	63
Cape Flattery	402,350	3,983	101	.82	268
Umatilla	494,865	4,490	110	.89	340
Quillayute	641,065	3,569	180	1.46	365
Destruction	280,790	2,703	104	.85	278
Grays Harbor and S.	39,950	319	125	1.02	267
Puget Sound	58,053	12,166	5	.04	-
S. E. Alaska	-	187	-	-	-
Total	5,822,158	47,303	123	1.00	100

* $\frac{\text{Catch per hour by area}}{\text{Catch per hour all areas, 1956}}$

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

Depth distribution

Rockfish taken by trawl fleet were caught at depths from 11 to 230 fathoms. Best catches were reported at depths between 40 - 100 fathoms. Usually the varieties reported as black rockfish are taken on the shallower (10 - 50 fathoms) portion of the continental shelf while the red varieties are taken in deeper water.

Management

The complexity of the scorpaenid landings makes abundance measures of the various species difficult. The total catch of scorpaenids (other than S. alutus) has been maintained at a level largely governed by market acceptance. An all-time

high for rockfish production was attained in 1945 when a total of 25 million pounds was caught. Between 1946 and 1952 the catch fluctuated between 6 and 13 million pounds. With the inception of the Pacific Ocean perch fishery in 1952 the catch of other rockfish dwindled. Total rockfish catches however, if perch are included, have stabilized at a level close to 10 million pounds annually.

LINGCOD (OPHIODON ELONGATUS)

Lingcod ranked ninth in poundage and eighth in value for trawl-caught fish marketed during 1956. The total catch declined from the peak year reached in 1955 largely as a result of low summer price paid for the species. Catch-effort data for 1956 is shown in Table 40 with the monthly catches for major lingcod grounds given in Table 41. A small decline in the basic catch per hour trawling was noted for all major areas; however, in several instances, the catch per significant effort increased over 1955 (Figures 26 and 27).

Depth distribution

During 1956, lingcod were caught at depths between 11 - 140 fathoms. Most of the catch, however, is reported as having been caught at depths between 31 and 80 fathoms. Table 42 shows the catch reported in ten-fathom intervals for major lingcod grounds.

Size range

Length frequencies for male and female lingcod taken on 40 Mile or La Perous Bank are shown in Figure 28.

Management

Populations of lingcod have shown no trends indicating greatly reduced stock levels.

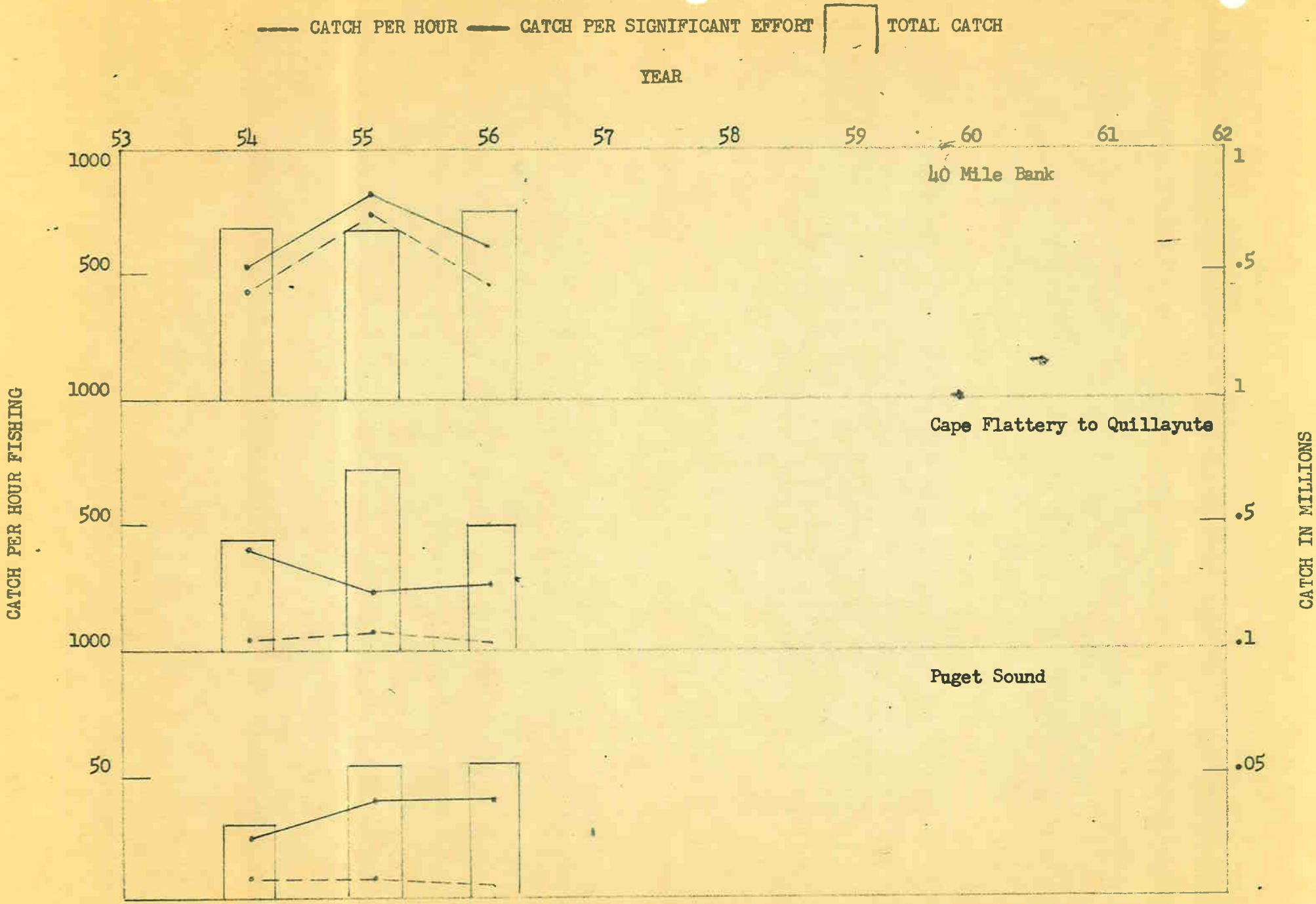


Figure 26 --Total catch, catch per hour, and catch per signficant effort for Lingcod (Southern areas)

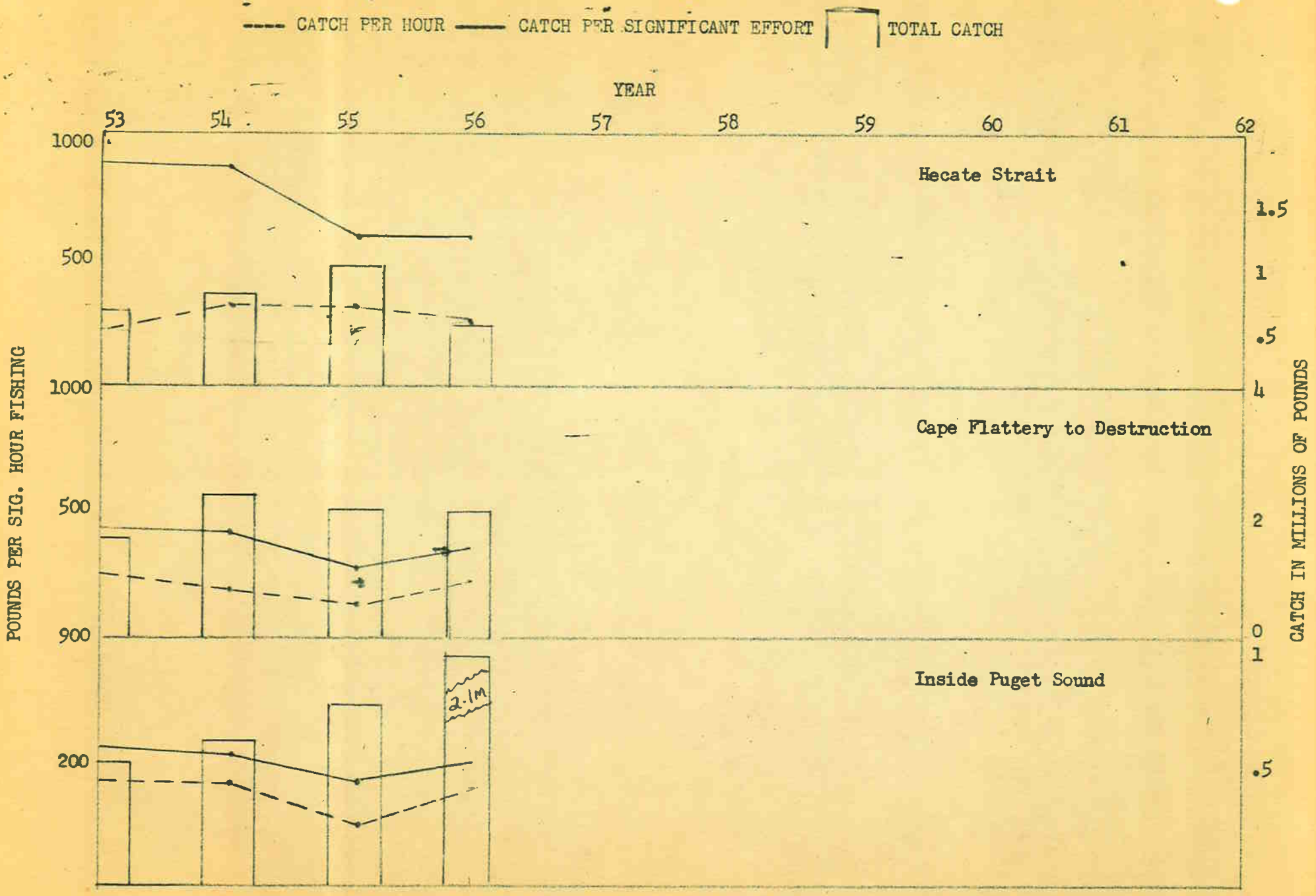


Figure 15 - Total catch, catch per hour, and catch per significant effort for english sole.

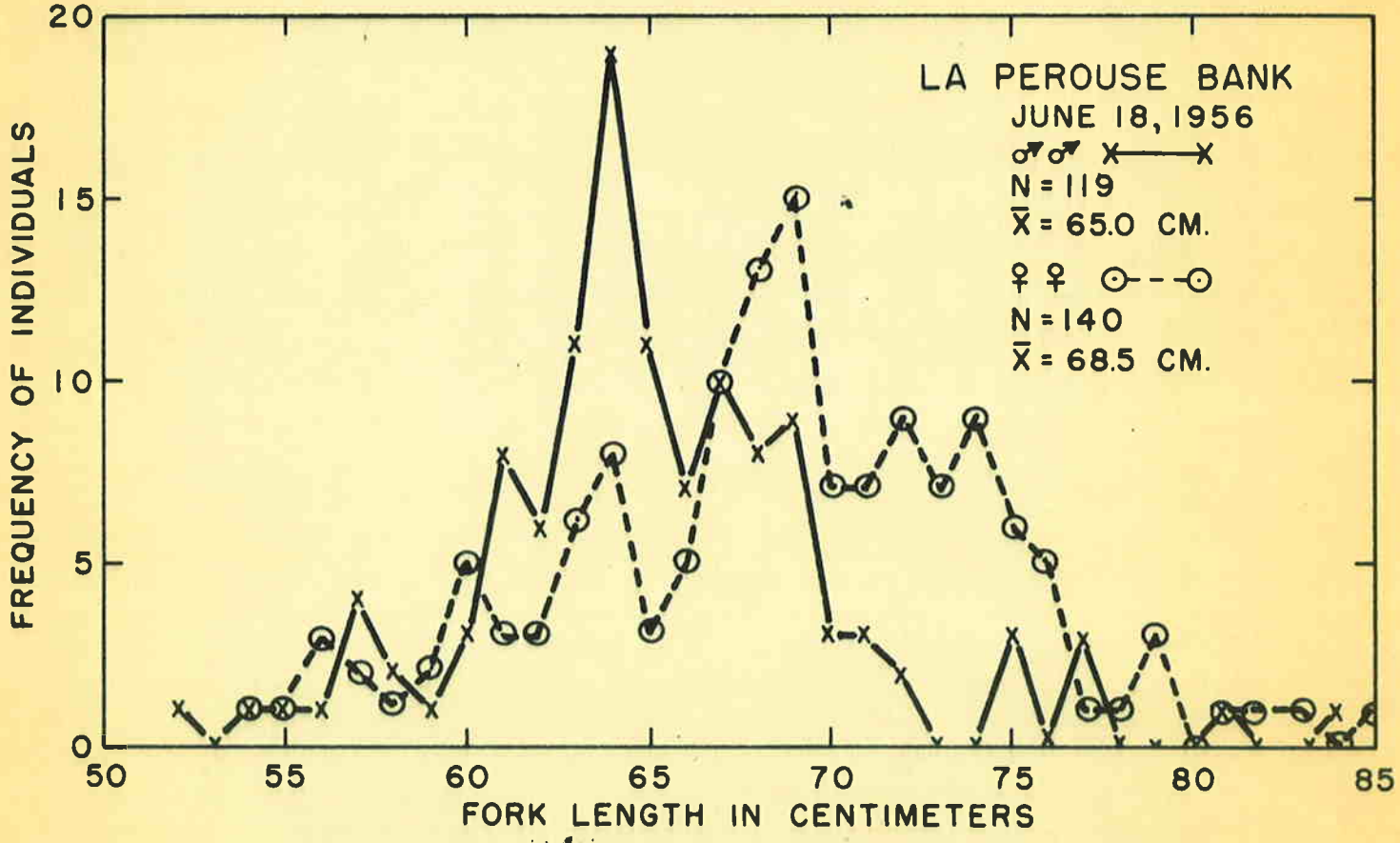


Figure 28 - LENGTH FREQUENCY DISTRIBUTION OF LINGCOD

Table 40 - Summary catch/effort data and productive index,* 1956 trawl landings of lingcod.

Area	Catch	Hours	C/H (lbs.)	Productive index	Significant C/H**
Hecate Strait	136,045	2,182	62	1.07	7,500
Goose Island	211,260	3,352	63	1.09	1,169
Cape Scott	593,835	5,988	99	1.71	726
Cape Cook	4,000	211	19	.33	-
Esperanza	121,265	1,968	62	1.07	248
Nootka	84,420	213	40	.69	1,516
Esteban	65,685	2,944	22	.38	152
Ucluelet	16,285	103	158	2.72	235
Barkley Sound	62,215	572	108	1.86	341
40 Mile	733,915	1,756	417	7.18	572
Swiftsure	58,650	597	98	1.68	469
Cape Flattery	200,410	3,983	50	.86	349
Umatilla	127,300	4,490	28	.48	335
Quillayute	160,685	3,569	45	.78	201
Destruction	113,135	2,703	42	.72	249
Grays Harbor and S.	12,520	319	39	.67	166
Puget Sound	65,223	12,166	5	.09	45
S. E. Alaska	0	187	0	.00	-
Total	2,766,848	47,303	58	1.00	

* $\frac{\text{Catch per hour by area}}{\text{Catch per hour by all areas, 1956}}$

** Lingcod in catch representing 25 percent or more of total fare made during particular effort.

Table 41 - Catch by month of lingcod for major producing areas, 1956.

Month	Goose Island	Cape Scott	40 Mile	Cape Flattery	Quillayute
January	-	12,100	-	3,440	19,950
February	60	129,300	-	2,845	49,500
March	3,085	69,690	-	2,845	8,535
April	15,640	14,210	5,500	3,985	8,560
May	6,320	19,845	8,720	2,320	31,050
June	23,610	24,075	359,870	2,395	6,450
July	82,225	55,560	122,175	4,635	14,070
August	13,465	163,490	-	4,760	18,495
September	2,225	39,115	135,260	111,315	3,975
October	1,130	37,750	75,190	54,480	-
November	63,500	3,400	27,200	3,910	-
December	-	24,700	-	3,480	100
Total	211,260	593,835	733,915	200,410	160,685

Table 42 - Catch in pounds by area (in 10 fathom intervals) for lingcod - 1956*

Depth range	Goose Island	Cape Scott	40 Mile	Cape Flattery	Quillayute
11 - 20					7,600
21 - 30				39,100	17,200
31 - 40			334,390	10,530	12,200
41 - 50	25,400	5,000	152,860	6,000	23,180
51 - 60	54,880	80,900	5,500	17,070	38,600
61 - 70	53,600	132,000	5,800	33,610	23,570
71 - 80	1,850	121,600		1,550	85
81 - 90	1,600	58,500		250	
91 - 100		19,500		575	
101 - 110		800		1,000	
111 - 120					320
121 - 130	500				
131 - 140	200		100		
141 - 150	50				
151 - 160				320	

* As shown from interviews; not extrapolated to total catch by area.

BLACKCOD (ANOPLOPOMA FIMBRIA)

Blackcod landings made by the trawl fleet during 1956 were the largest on record and the combined trawl and longline catch exceeded 4 million pounds. The species ranked sixth in poundage of trawl fish landed and third in value. Ninty-three percent of the total trawl catch was taken from the waters from Cape Flattery south to Quillayute. This area is a well known nursery area for small blackcod and large concentrations inhabit this ground from June to October each year. During the winter months the blackcod apparently move to deeper water or to areas not exploited by the fishery.

Tables 43 and 44 show the catch-effort data by area and monthly landings for the major areas respectively. Heavy landings occur during the summer months and only small catches are made during the winter period.

Table 43 - Summary of catch/effort data and productive index*1956 trawl landings of blackcod.

Area	Catch	Hours	C/H (lbs.)	Productive index	Significant C/H**
Hecate Strait	-	2,182	-	-	
Goose Island	21,590	3,352	6.44	0.92	
Cape Scott	12,730	5,988	2.13	0.30	
Cape Cook	-	211	-	-	
Esperanza	105	1,968	0.05	-	
Nootka Sound	-	213	-	-	
Esteban	54,845	2,944	18.63	2.67	753.33
Ucluelet	675	103	6.55	0.94	
Barkley Sound	-	572	-	-	
40 Mile	90,420	1,756	51.49	7.37	1,055.6
Swiftsure	3,515	597	5.89	0.84	4,250.0
Cape Flattery	1,929,320	3,983	484.38	69.31	1,382.5
Umatilla	936,935	4,490	208.67	29.86	855.1
Quillayute	215,930	3,569	60.50	8.66	1,172.3
Destruction	40,455	2,703	14.97	2.14	
Grays Harbor and S.	1,010	319	3.17	0.45	
Puget Sound	600	12,166	0.05	-	
Total	3,308,130	47,303	6.99	1.00	

* $\frac{\text{Catch per hour by area}}{\text{Catch per hour all areas, 1956}}$

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

Table 44 - Catch by month of blackcod for major producing areas, 1956.

Month	40 Mile	Cape Flattery	Umatilla	Quillayute
January	-	-	-	-
February	-	-	-	-
March	-	-	-	-
April	-	55	550	-
May	-	4,630	1,270	-
June	15,235	-	65	-
July	27,385	9,515	39,350	9,650
August	19,040	3,400	193,200	146,280
September	22,260	487,140	271,270	-
October	6,500	1,424,580	333,130	60,000
November	-	-	-	-
December	-	-	-	-
Total	90,420	1,929,320	936,935	215,930

Depth distribution

Blackcod inhabit a comparatively wide depth range. Catches made during 1956 were recorded as having been caught at depths from 31 to 270 fathoms. The bulk of the catch, however, is made during the summer months at depths between 41 and 80 fathoms. The catch in 10-fathom intervals is shown in Table 45.

Table 45 - Catch in pounds by area (in 10-fathom intervals) for blackcod - 1956*

Depth range	Cape Flattery	Umatilla	Quillayute
11 - 20		88,650	9,000
21 - 30	59,000	18,000	16,500
31 - 40	26,000	11,500	22,200
41 - 50	148,200	11,000	
51 - 60	240,900	154,600	68,000
61 - 70	344,100	136,000	25,000
71 - 80	289,500	99,500	
81 - 90	65,631	16,000	
91 - 100	300		
101 - 110	600	3,600	
111 - 120		4,200	
121 - 130	50	4,550	
131 - 140	5,750		
141 - 150			
151 - 160	700	200	
161 - 170	1,000		

* As shown from interviews; not extrapolated to total catch by area.

Size of fish

Trawl-caught blackcod usually average somewhat smaller than those landed by longline vessels. This may partly be the result of behavior changes which are related to age. Large schools of mature blackcod above 55 cm are seldom encountered by trawlers while the smaller sizes between 40 and 50 cm occur in large numbers on certain banks. Perhaps as the fish mature they move into canyons and rocky areas where they are available to trawl gear. Figure 29 compares the length frequency distribution for trawl and line caught blackcod landed in Seattle.

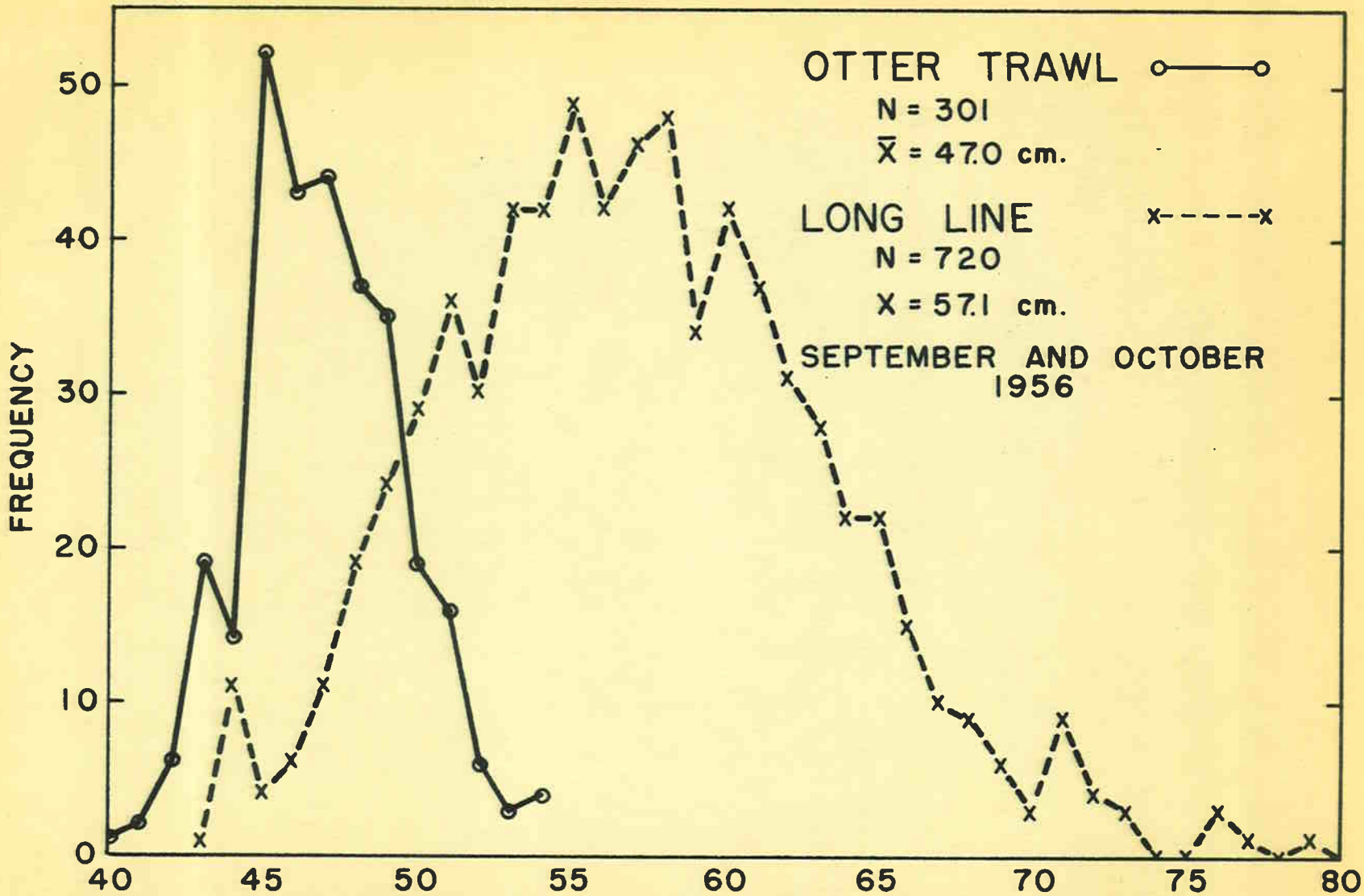


Figure 29 - LENGTH FREQUENCY DISTRIBUTION OF SABLEFISH*

*DRESSED - MEASURED IN CENTIMETERS, ORIGIN OF DORSAL TO END OF TAIL

Management

Trawl-caught blackcod have in the past accounted for a small percentage of the total catch; however, they were heavily exploited in 1956. Future measures of abundance of the species will be noted with interest.

THE HABITAT

Although each species has been evaluated as a discrete fishery, a species cannot be divorced from the myriad of other marine animals competing for food and space within the same habitat. The complexity of natural checks and balances which regulate a population's size are beyond our scope of measure. It is important, however, to be cognizant that the effects of exploitation on any segment of the bottom fauna may ultimately alter the unexploited portion. Although these relationships are presently little understood they could have important bearing on the future productivity of our trawl fishery.

SUMMARY

The total yield of bottom fish landed sheds little light on conditions of the stocks of various species comprising the fishery. Reduced availability of any major species normally results in compensatory heavy exploitation for other more abundant forms. The complexity of species involved and the plasticity of the fishery requires a careful inspection of its intrinsic behavior before any facet may be evaluated.

The collection of interview records has given us the statistics to approach this problem and added the familiarity necessary for proper analysis.

APPENDIX

APPENDIX I

EFFORT BY MONTH FOR WASHINGTON TRAWL FLEET - 1955

(Hours)

Area	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Hecate Strait	126	428	685	562	376	308	85	210	137	0	41	40	2,998
Goose Island	109	14	596	269	597	224	334	178	225	143	30	72	2,791
Cape Scott	102	557	575	265	353	142	152	276	73	357	544	520	3,916
Cape Cook	-	-	10	-	9	-	-	-	-	-	-	-	19
Esperanza	-	3	663	876	279	78	21	70	38	14	3	23	2,068
Nootka	0	0	42	74	30	53	0	61	29	14	3	128	434
Esteban	62	78	897	714	696	754	498	252	196	11	91	102	4,351
Ucluelet	-	-	3	142	161	63	-	-	-	-	-	-	368
Barkley Sound	0	9	2	62	171	77	34	0	2	-	-	-	357
40 Mile	0	0	0	11	97	321	59	30	164	222	3	13	920
Swiftsure	8	-	12	7	55	87	8	47	27	47	-	-	298
Cape Flattery	14	1,612	1,189	242	232	256	249	177	226	414	509	103	5,223
Umatilla	1,477	1,304	311	345	456	302	411	623	387	558	264	234	6,672
Quillayute	438	280	95	280	98	53	99	377	271	173	83	226	2,473
Destruction I.	37	137	322	197	128	98	112	110	496	802	177	382	2,998
Grays Harbor & S.	-	92	27	-	8	-	25	20	15	-	-	26	213
Puget Sound	2,446	922	666	503	789	296	124	107	106	389	467	547	7,363
S. E. Alaska	78	5	34								95	218	430
Total	4,897	5,441	6,129	4,549	4,535	3,112	2,211	2,538	2,392	3,144	2,310	2,634	43,892

APPENDIX II

EFFORT BY MONTH AND AREA FOR 1956 - TRAWL FLEET

(Hours)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Hecate Strait	84	290	868	314	306	64	48	116	32	0	44	16	2,182
Goose Island	59	246	320	319	433	771	322	256	151	225	178	72	3,352
Cape Scott	287	661	435	488	632	425	389	809	428	524	307	603	5,988
Cape Cook	-	-	-	41	134	30	-	-	-	-6	-	-	211
Esperanza	-	82	760	937	103	0	15	17	3	36	4	11	1,968
Nootka	9	52	29	40	12	12	36	5	0	5	13	0	213
Esteban	92	292	447	629	189	3	90	103	75	146	299	579	2,944
Ucluelet	-	-	-	8	74	3	18	-	-	-	-	-	103
Barkley S.	-	11	4	121	290	79	3	-	-	-	51	13	572
40 Mile	-	-	2	37	59	643	289	9	206	228	253	30	1,756
Swiftsure	3	1	-	95	89	133	144	97	-	31	4	-	597
Cape Flattery	24	327	241	236	331	101	208	200	517	1,150	437	211	3,983
Umatilla	177	345	337	133	408	405	284	847	615	330	437	172	4,490
Quillayute	645	1,170	365	248	238	139	159	275	36	28	192	74	3,569
Destruction	90	80	490	512	710	307	90	22	15	22	271	94	2,703
Grays Harbor & S.	-	8	-	221	76	14	-	-	-	-	-	-	319
Puget Sound	1,530	1,104	1,465	1,542	862	504	280	395	408	1,156	1,120	1,800	12,166
S. E. Alaska	127	37	-	-	-	-	-	-	-	-	-	23	187
Total	3,127	4,706	5,804	6,014	4,842	3,603	2,375	3,151	2,486	3,887	3,610	3,698	47,303

Appendix III

PUGET SOUND BOTTOMFISH (EXCLUDING HALIBUT) LANDINGS BY GEAR

In number of pounds - 1956

Species	Drag seine	Gill net	Set net	Purse seine	Otter trawl	Troll	Hand line	Set line	Total
English sole	4,178				4,414,598				4,418,776
Petrale sole					2,855,490	2,450		5,933	2,863,873
Dover sole					3,588,097				3,588,097
Rex sole					38,461				38,461
Rock sole					715,934				715,934
Sand sole					28,850				28,850
Butter sole(Bellingham)					35,140				35,140
Unclassified					111,030				111,030
Flounder	150	30			1,616,251				1,616,431
Turbot					3,085,918				3,085,918
Blackcod		400			3,259,113	10,694		1,359,958	4,630,165
Lingcod	373	643	3,347	564	2,822,453	294,303	47,071	149,690	3,318,444
Pacific Ocean perch					4,973,713			1,061	4,974,774
Other rockfish	3,768	150	74	35	5,623,955	18,233	5,578	105,580	5,757,373
True cod	94	120	43		9,531,795	197	9,323	145	9,541,717
Surf perch	86,535	40	205	208	9,984				96,972
Skate					448,996		8		449,004
Ratfish					856,203				856,203
Scrap fish		2,001	13,900		2,780,873				2,796,774
Sharks		4,270	5,200		406,750				416,220
Octopus					16,368	17		58	16,443
Total	95,098	7,654	22,769	807	47,219,972	325,894	61,980	1,622,425	49,356,599

APPENDIX IV
WASHINGTON SOLE LANDINGS BY SPECIES - 1948-1956

Year	Petrale	English	Dover	Rock	Flounder	Sand
1948	6,185,462	5,497,359			1,610,584	
1949	4,870,315	4,704,273			587,445	
1950	4,422,827	4,186,152			1,373,035	
1951	3,407,773	4,784,120	982,690	490,194	1,314,672	79,000
1952	3,382,051	4,789,484	1,598,686	1,420,966	1,266,787	76,694
1953	2,445,808	2,676,277	1,316,450	388,374	806,090	51,748
1954	3,606,129	5,010,027	1,910,016	520,243	833,636	45,849
1955	2,972,052	4,114,550	3,275,324	963,548	1,536,261	30,176
1956	2,863,873	4,418,776	3,588,097	715,934	1,616,431	28,850

APPENDIX V
WASHINGTON ROUNDFISH LANDINGS BY SPECIES - 1948-1956

Year	Truecod	Rockfish	Ocean perch	Blackcod	Lingcod	Halibut
1948	5,378,658	10,755,840		2,072,244	5,764,776	10,009,449
1949	5,495,491	13,224,158		2,765,254	4,395,502	10,124,384
1950	6,346,303	12,615,652		2,238,031	3,258,561	8,742,915
1951	8,420,990	10,488,914		3,659,623	2,771,779	11,368,343
1952	9,997,915	10,024,942	1,695,589	2,316,493	2,696,601	13,375,872
1953	8,199,614	4,307,997	3,101,572	2,256,237	1,752,235	14,783,952
1954	15,407,275	6,671,723	6,671,869	2,667,205	2,444,252	17,666,429
1955	12,576,418	5,945,565	3,459,565	3,015,532	3,978,250	16,138,072
1956	9,541,717	5,757,373	4,974,774	4,630,165	3,318,444	16,236,055