Research Report on the Washington Trawl Fishery 1957 through 1959 (Confidential)

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Foreward

Although this report pertains to the Washington trawl fishery from 1957 through 1959, interview data from the 1955 and 1956 fisheries have been recalculated and presented along with the data for the period covered by this report.

Due to loss and shifting of personnel within the trawl staff during 1957 through 1959, only the vessel interview portion of the trawl program could be continued. Credit is due Mr. K. N. Thorsen and Mr. N. Pasquale for maintaining continuity of the interview program during this period.

H. Heyamoto

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Introduction

The following report is compiled as a reference on the trawl fishery and on the research activities conducted since the last report was written in 1956. At times during this period only a single biologist constituted the trawl research staff. During 1953 a program of interviewing trawl fishermen regarding fishing areas, fishing time, and estimated catch was started. This program has been continued and represents the majority of the total fleet activities. This material has been analyzed for presentation in this report.

The adoption of an austerity research program during the period made it difficult to collect the background information required for the continued appraisal of the status of the trawl fishery. Reiteration of the program and objectives seems appropriate as evidence of cognizance at the technical level of the information required in fulfillment of the state's obligation and responsibility to maintain the resource at its maximum production.

Research program:

1. The individual stocks or populations of each species must be identified and their movements must be determined. Such knowledge is basic in understanding what stocks are affected by a fishery and to what extent they are affected. Tagging has been conducted for this purpose, but more extensive work is needed. Tagging can also provide information on growth and relative abundance.
2. The relative abundance of the stocks of each major species must be determined. Reliable statistics of the catch, fishing areas, and fishing effort are necessary to attain this objective. The fisherman interview program is providing this data, but it needs certain refinements to achieve optimum reliability. At present

the poundages used are the fishermen's estimates of their catch on each series of drags. Their estimates are fairly accurate, but the final weights on the Department fish tickets should be matched with the interview data. The poundages on the interview sheets should be corrected to the total weight by species which appears on the fish receipt.

3. The general life histories of the major species in the fishery should be established. Facts about age, growth, reproduction, recruitment, mortality rates, and behavior are essential in the evaluation of abundance trends noted in the catch statistics.

4. The species composition in the fishing areas should be studied to detect any increase in less desirable species from the constant removal of desirable species. This can best be studied by test fishing with a chartered vessel in conjunction with tagging or other work. It can be substituted by tallying the species composition during trips on regular commercial fishing vessels, but the present manpower and available funds preclude such a course of action.

The Trawl Fishery

The Washington trawl fishery can be divided into two distinct parts, local or inside Puget Sound and outside or ocean. The local or inside Puget Sound fishery is exploited by about 50 vessels ranging in size from 15 to 75 gross tons. Some Puget Sound waters are open to trawling the entire year, some are closed by legislation during the spawning season, some are closed most of the year in order to limit fishing intensity, and certain bays and inlets are closed to trawling entirely.

The outside or ocean trawl fishery is exploited from Heceta Banks, off the Oregon Coast, to Yakutat, Alaska. These are the extreme range limits; the principal exploitation occurs from Destruction Island, off the Washington Coast to Rose Spit in Dixon Entrance. Boats in the outside fleet range in size from 25 to 100 gross tons and the number of vessels fishing outside waters varies from about 80 in winter to as few as 20 in summer. The boats are capable of fishing several kinds of gear. During the fall and winter when seasons are closed for other species many fishermen turn to trawling. During spring months some fishermen change to halibut set-line fishing and salmon trolling. In summer many boats are outfitted with salmon purse seines, some with salmon gill nets, while others are taken to Alaska to serve as salmon tenders. A few vessels (ca 12) are used for trawling in Puget Sound during the winter and in the ocean trawl fishery during the summer.

The trawl gear used in the inside and outside fisheries are practically the same except that the nets used inside are somewhat smaller in size. The trawl net is a huge flat bag with long wings of mesh attached to the opening of the bag. The nets average about 120 feet long and about 75 feet wide.

The top or head cables reinforce the top and bottom edges of the net. The top or head line is buoyed up by floats and projects forward of the bottom or foot line which is weighted. The net is held open and on the sea bottom by two large metal-framed wooden doors or otter boards, hence the name of the fishery. The doors are towed by two long cables which are attached to a pair of winches. The rail is cleared and the towing point placed aft by running the cables through blocks hung on 5 to 6 foot high stanchions. these are set in the quarters of the vessel. Dandyline gear is in general use. This is a set of stops and a "C" link whereby the door is detached from the cables , and the bridles from the door to the net can be wound onto the winch drums. Many of the vessels are now equipped with a drum upon which the net is wound. The use of stabilizers is coming more into practice as these allow fishing in rougher weather.

The eastern net is used most widely as it catches a greater variety of fish. The western box net is primarily a sole fishing net, and although less complicated to construct, it does not catch rockfish as well as the eastern net. Rather than carry extra gear the fishermen use the eastern net. The size of a net is known by the number of meshes around the throat or opening of the net; nets in common use vary from 350 to 400 meshes in circumference. There are about as many variations of nets and gear as there are fishermen in the fishery. A net of 425 meshes in circumference practically limits the size of net that can be handled aboard present vessels.

About 50 species of fish are taken in the trawl nets, but many, being unmarketable, are discarded at sea. Ten principal species are marketed. These are listed in relative order of poundage landed: Pacific true gray cod (Gadus macrocephalus), rockfish (Sebastodes sp.), Pacific ocean perch (Sebastodes alutus), petrale (Eopsetta jordani), lingcod (Ophiodon elongatus),

English sole (Parophrys vetulus), Dover sole (Microstomus pacificus), sablefish or blackcod (Anoplopoma fimbria), starry flounder (Platichthys stellatus), and rock sole (Lepidopsetta bilineata).

Trawl Regulation Revisions

In January 1959, the Washington food fish exemption list was further changed to exclude more species taken by the trawl fishery. Dogfish and other species of shark, arrowtooth halibut or turbot (Atheresthes stomias), hake (Merluccius productus), pollack or whiting (Theragra chalcogramma fucensis), Bellingham sole (Isopsetta isolepsis), and fish offal or scrap may be still used for any purpose. Also from the waters of the Pacific Ocean, priest fish (Sebastodes mystinus), sand dab (Citharichthys sordidus), and slender sole (Lyopsetta exilis), may still be used for any purpose. In effect this change removes from the exemption list, black rockfish (S. melanops), rock salmon (S. paucispinis or S. brevispinis), yellow-tailed or green rockfish (S. flavidus), rosefish (S. diploproa), and rex sole (G. zachirus).

At the same time, January 1959, the definition of bottom fish otter trawl gear was changed to allow the use of $3\frac{1}{2}$-inch mesh in the cod end of the trawl nets. All of the net except the last 75 meshes of the combined cod end and intermediate may be constructed of 3-inch mesh. Measurements are made between the knots. The perch permit system was retained but has become unnecessary with the use of smaller mesh.

An eight per cent tolerance was added to the winter petrale sole closure which, in some cases, allows more than the 3,000 pound limit established per landing for this species.

Catch Statistics

The material reported upon here has been taken entirely from the interview data gathered in Bellingham and Seattle ports during the years 1955 through 1959.

1. The interview data are fishermen's estimates of their catch. This was explained when the objectives were discussed. Comparisons of fish tickets and interview estimates have shown that the latter are, on the average, fairly accurate; but for greater accuracy the estimates should be corrected to the ticket weights for each trip interview. Correction of ocean catches to ticket poundage was initiated in September of 1960.

2. As has been mentioned above, landings are made at the two principal ports, Seattle and Bellingham. The Seattle fishermen typically fish from Destruction Island to Cape Scott, while the Bellingham fishermen operate from Destruction Island to Hecate Strait. The interview sampling was not carried on at the same rate in each port, but a single factor was used to adjust the total interview landings to the total actual landings, usually on a monthly basis. Therefore, when sampling was more intense at Bellingham, the more northerly areas would be increased out of true proportion from the lack of sampling on the southern areas in Seattle.

   A check on this error indicated that the resultant data were not disproportionate to the extent of precluding the use of the material to study trends in the catch. In the future, however, the Seattle and Bellingham interview data will be adjusted separately.

3. The method of analysis as used in the 1954, 1955, and 1956 reports was to divide the poundage of a species caught in one area by the total time spent fishing for all species in that area. This gave a

catch per hour for the particular species. The method penalized all species to some extent, but those taken in shallow (flounder) or at depth (perch and dover) were penalized to such an extent that the final figure indicated how much time was spent fishing other species rather than the trend in catchability of a particular species.

Therefore, all the past data, for which there were IBM reports available, have been reanalyzed. The time fishermen spent fishing each particular species caught in an area was used. The present analysis does not agree with past work, but it should present the catch trends more accurately than in the past.

In this analysis the annual poundage from the interview data was adjusted to the annual poundage from the landing receipts on all species except petrale sole. This adjustment should have been made on the basis of the monthly landings. Each month was sampled at a different rate, and adjusting on a yearly basis gave each month's data equal weight. There was insufficient time to recalculate the other species on a monthly basis, but this refinement will be added to any future analyses.

4. Significant catches are those in which the weight of a species consituted 25 per cent or greater of the total catch for a single series of drags. These were coded into the IBM, and a special report was made. The catchability of fish as measured by catch per hour depends upon two factors: (1) the abundance of fish, and (2) the availability of the fish to be caught. When a net comes up empty, a fishermen could ask whether the fish have all been caught or are they simply hiding among the rocks. In studying the abundance of any fish, the factor of availability must be minimized. Selecting

only catches of a species in which in constitutes 25 per cent or more of the total poundage is one method of obtaining a truer measure of that species abundance and of minimizing the measurement of availability. The 25 per cent level of significance was chosen rather arbitrarily, and it is perhaps too severe in a multiple-species fishery. Some significant catch data were analyzed, but these added nothing that was not evident from the total catch data. In fact, the significant catches, being the best fishing results, tended to increase first and to remain better for a longer period than the total data indicated. The significant catches were often insufficient to show trends.

5. The five year period (1955 through 1959) included in these data is a small portion of the history of fishing on most of the ten species. For most of the species the initial rich fishing has been cropped, and the trends have been established at lower levels of abundance.

6. There are other fisheries exploiting some species. For example lingcod are fished by set line and troll. This makes the trends of poundage, effort and catch per effort in the trawl fishery alone difficult to interpret. In some areas the Canadian trawl fleet is also operative which has the same effect as explained when another type of fishery exploits a species. Until all the data are combined for analysis the true situation will be difficult to determine.

Petrale Sole

The main feature of the Washington trawl fishery for petrale sole in the five year period, 1955 through 1959 has been the Esteban deep fishery. The approximately four million pounds of petrale sole taken largely in the winter of 1956-1957 demonstrates that the market demand is good for this fish.

Because of these winter landings, petrale sole ranked fourth in poundage and second in value during the five-year period. Petrale usually ranks lower both in poundage and in value when the deep winter fishery is restricted.

Tables 1 and 2 have been prepared to show the catch data for all areas and by individual areas. Figure 1-A compares total catch, effort, and catch per hour or fishing success for all ocean areas as landed in Washington ports. For all areas effort decreased slightly from 1955 to 1959, catch increased in 1957 then returned to about the 1955 level in 1959. Fishing success increased in 1957 and decreased again in 1958. By 1959, success was at a level above that of 1955. The 1957 Esteban deep fishery was responsible for the increases in that year as is shown in Figure 1-B which excludes the catches from Esteban deep. Exclusion of the Esteban deep catches from the total catch data does not appreciably affect the conclusions drawn from the total data.

Table 1 - Petrale sole catch data from interviews extrapolated to total landings: Esteban > 100 fms - northward.

	1955	1956	1957	1958	1959	5 yr. average
HECATE STRAITS	4 per cent of total catch					
Pounds	162,899	47,088	159,182	78,438	232,924	136,106
Hours	856	673	717	853	1,287	877
Lbs/hr.	190	83	222	92	181	155
Index lbs/hr	100	44	117	48	95	
GOOSE ISLAND	3 per cent of total					
Pounds	172,655	90,571	69,400	96,147	33,164	92,387.
Hours	1,331	952	758	445	445	786
Lbs/hr.	130	95	92	216	75	118
Index	100	73	71	166	58	
CAPE SCOTT	17 per cent of total					
Pounds	814,490	977,696	467,112	247,630	200,478	541,481
Hours	3,318	5,635	3,109	2,597	1,923	3,316
Lbs/hr.	245	174	150	95	104	163
Index	100	71	61	39	42	
CAPE COOK	2 per cent of total					
Pounds	491	48,324	99,331	74,995	27,923	50,213
Hours	6	229	332	532	117	243
Lbs/hr.	82	211	299	141	239	207
Index	100	257	365	172	291	
ESPERANZA-NOOTKA	6 per cent of total					
Pounds	237,338	95,677	123,664	119,674	300,756	175,422
Hours	1,739	1,494	829	665	1,179	1,181
Lbs/hr.	136	64	149	180	255	149
Index	100	47	110	132	188	
ESTEBAN 100 fms	26 per cent of total					
Pounds	621,444	465,400	2,673,130	150,886	157,928	813,758
Hours	1,535	1,389	2,890	725	789	1,466
Lbs/hr.	405	335	925	208	200	555
Index	100	83	228	51	49	
TOTAL ESTEBAN DEEP-northward	58 per cent of total					
Pounds	2,009,317	1,724,756	3,591,819	767,770	953,173	1,809,367
Hours	8,785	10,372	8,635	5,817	5,740	7,870
Lbs/hr.	229	166	416	132	166	230
Index	100	72	182	58	72	
OCEAN TOTAL excluding ESTEBAN DEEP	74 per cent of total					
Pounds	1,873,940	2,417,046	2,025,256	1,948,629	2,879,617	2,327,660
Hours	18,201	19,196	12,345	14,086	16,590	16,084
Lbs/hr.	103	126	164	138	174	145
Index	100	122	159	134	169	
ESTEBAN northward excluding ESTEBAN DEEP	32 per cent of total					
Pounds	1,387,873	1,259,356	918,689	616,884	795,245	995,609
Hours	7,250	8,983	5,745	5,092	4,951	6,404
Lbs/hr.	191	140	160	121	161	155
Index	100	73	84	63	84	

Table 2 - Petrale sole catch data from interviews extrapolated to total landings: Esteban < 100 fms - southward.

	1955	1956	1957	1958	1959	5 yr. average
ESTEBAN < 100 fms	6 per cent of total catch					
Pounds	268,691	381,771	166,466	60,271	52,869	186,014
Hours	1,490	643	874	463	544	803
Lbs/hr.	180	594	190	130	97	232
Index	100	330	106	72	54	
UCLUELET-BARKLEY SOUND						
	1 per cent of total					
Pounds	12,224	12,206	33,361	51,364	24,459	26,723
Hours	249	284	189	60	58	168
Lbs/hr	49	43	177	856	422	159
Index	100	88	361	1,747	861	
FORTY-MILE BANK	21 per cent of total					
Pounds	192,482	417,375	643,407	603,602	1452,803	661,934
Hours	889	1,492	1,196	990	3,791	1,672
Lbs/hr.	217	280	538	610	383	396
Index	100	129	248	281	176	
SWIFTSURE	2 per cent of total					
Pounds	60,514	8,410	4,331	2,003	166,965	48,445
Hours	302	148	7	157	243	171
Lbs/hr.	200	57	619	13	687	283
Index	100	29	310	07	344	
CAPE FLATTERY-UMATILLA, QUILLAYUTE AND DESTRUCTION ISLAND						
	12 per cent of total					
Pounds	419,293	288,388	231,959	566,475	354,995	372,222
Hours	7,923	7,290	4,125	7,176	6,848	6,672
Lbs/hr.	53	40	56	79	52	56
Index	100	75	106	149	98	
ESTEBAN < 100 fms - southward						
	41 per cent of total					
Pounds	953,204	1,108,150	1,079,524	1283,715	2052,091	1,295,337
Hours	10,853	9,857	6,391	8,846	11,484	9,486
Lbs/hr.	88	112	169	145	179	137
Index	100	127	192	165	203	
OCEAN TOTAL						
Pounds	2,989,200	2,882,446	4,698,386	2099,515	3037,545	3,141,418
Hours	19,736	20,585	15,235	14,811	17,379	17,549
Lbs/hr.	151	140	308	142	175	183
Index	100	93	204	94	116	

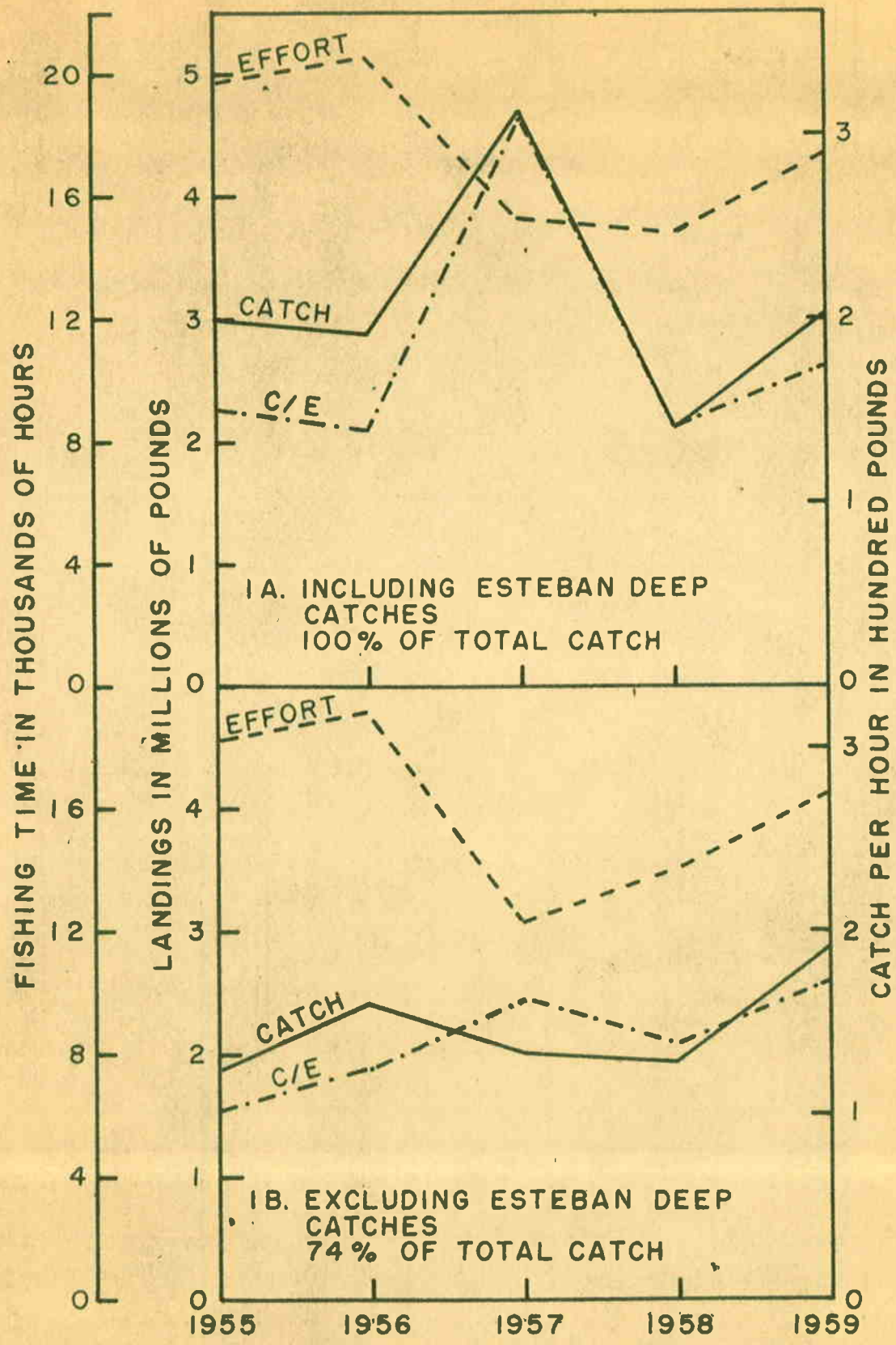


Figure 1 - Petrale sole catch, calculated effort, and catch per hour by year, 1955 through 1959.

The results of tagging experiments on petrale sole have indicated that the stocks of this species may be divided near the 100 fathom line off Esteban Point. In other words, there are two stocks or populations of petrale sole: one population is found from Esteban deep northward into Hecate Strait, and another population from Esteban shallow (less than 100 fathoms) southward. Therefore, the catch data given here have been divided accordingly. Table 1 and Figure 2 are made up of catch statistics from Esteban deep northward. Figure 3 depicts catches from the important areas within the northward population. The northern population of petrale sole contribute 58 per cent of the total Washington landings. This is shown in Figure 2-A, while Figure 2-B excludes the Esteban deep catches.

The concentrations of spawning petrale sole were discovered in Esteban deep about the winter of 1953-1954. The discovery was made by fishermen who were in search of Pacific Ocean perch. About a half million pounds of petrale were taken in each year 1955 and 1956. In 1957 the catch increased to 2.7 million pounds, and it was feared that the inshore petrale fisheries to the northward would suffer because of the removal of even larger poundages from the deep. Consequently, the deep fisheries in winter were restricted. In the meantime other deep water concentrations were found off Destruction Island and Willapa Bay. As a result of the regulation of the Esteban deep fishery the catch, effort and, therefore, the catch per effort has decreased in 1958 and 1959 in Esteban deep (Figure 3-C) and from Esteban northward (Figure 2-A). The northward catch data (Figure 2-B), which contribute 32 per cent to the total catch, show decreasing catch. The effort has also decreased, but the catch per hour has only decreased slightly.

Perhaps, most affected were the petrale catches (Figure 3-A) from Cape Scott grounds. Poundage and fishing success declined in this area. Effort also decreased, but a decrease in fishing effort

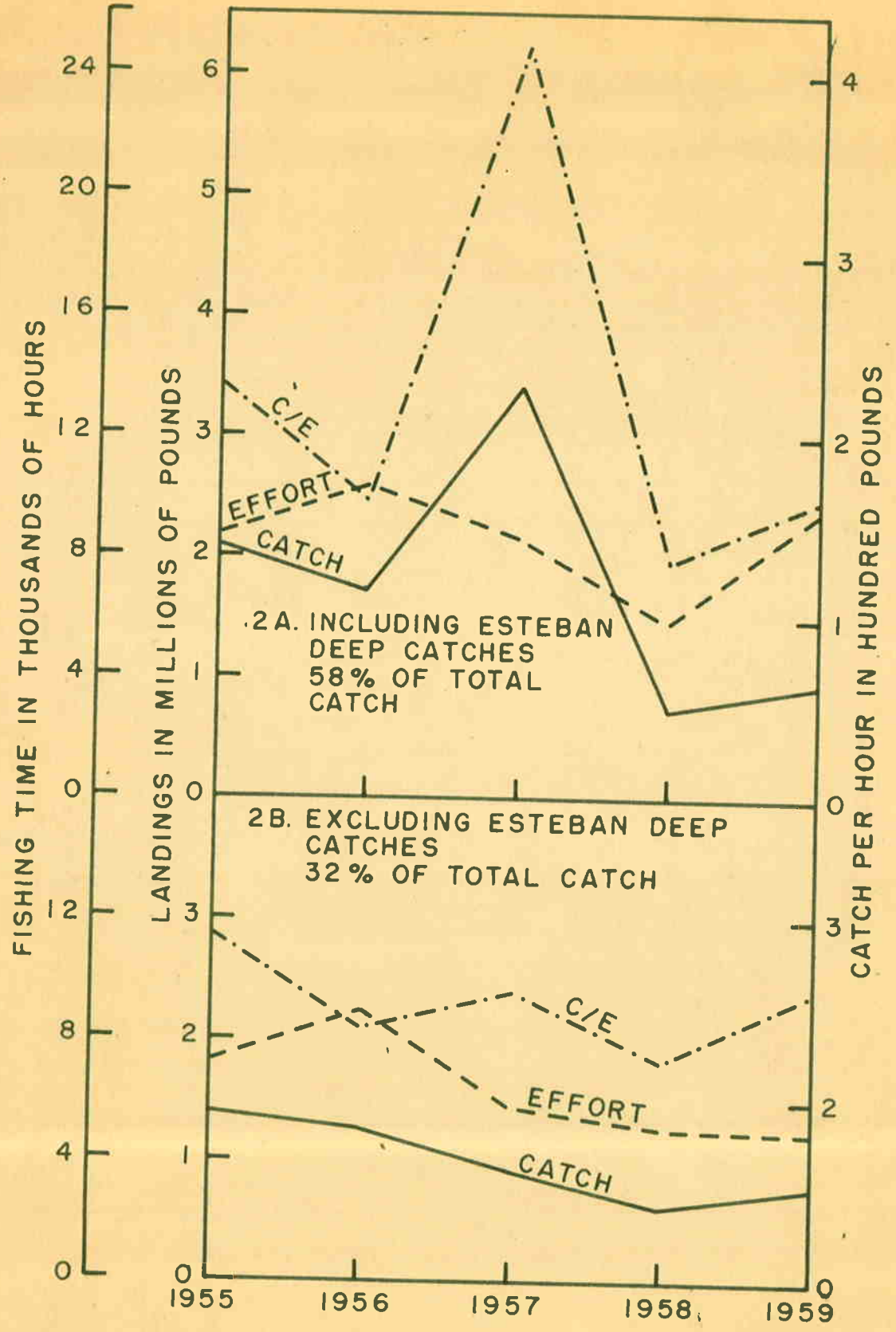


Figure 2 - Petrale sole catch, calculated effort, and catch per hour from areas north of Esteban, including and excluding catches from Esteban deeper than 100 fathoms by year, 1955 through 1959.

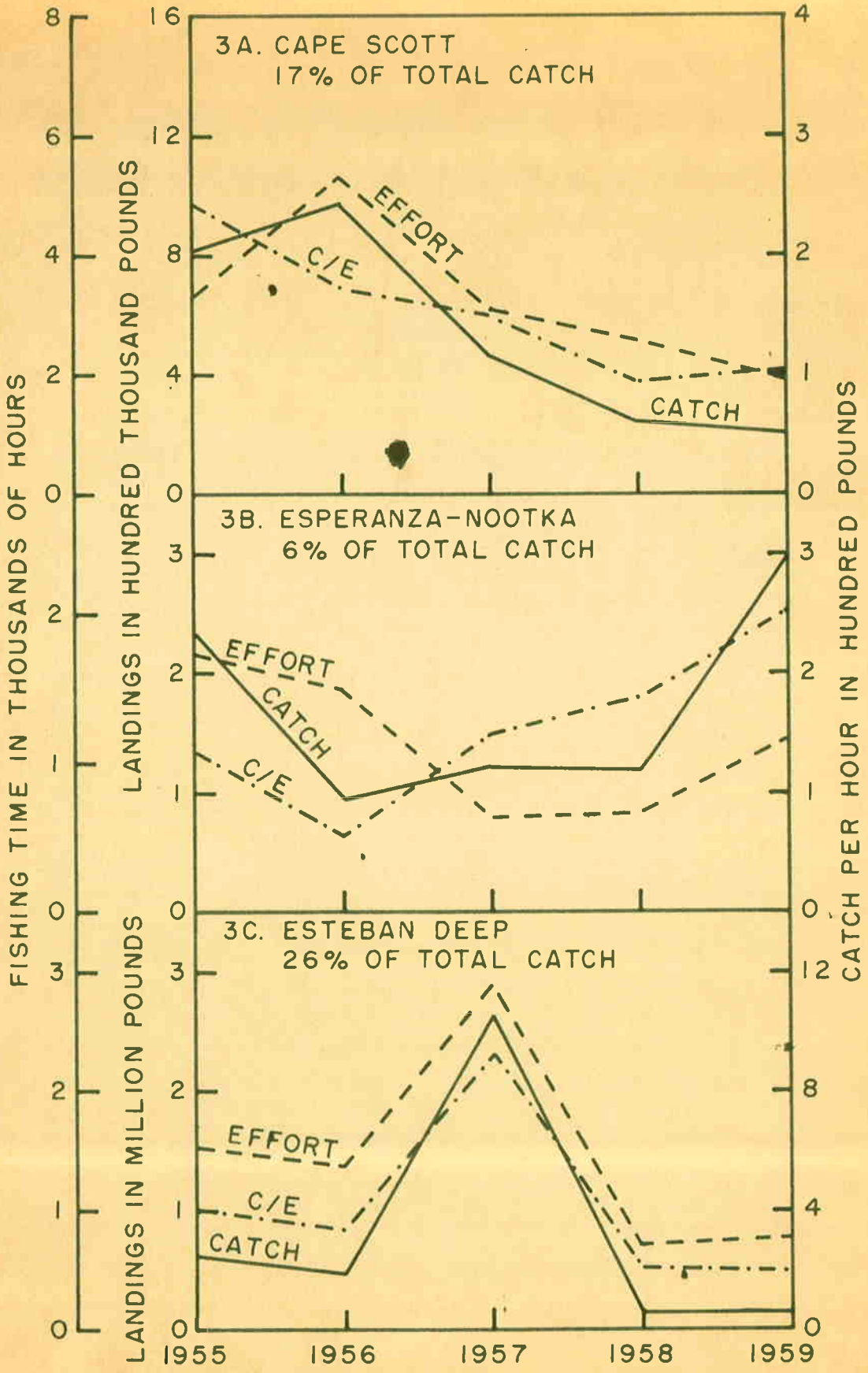


Figure 3 - Petrale sole catch, calculated effort, and catch per hour from Cape Scott, Esperanza-Nootka, and Esteban Deep areas by year, 1955 through 1959.

should not bring about a decrease in catch per hour. It was from this area that numerous fish tagged in Esteban deep were recovered, and many fish tagged here were conversely recovered from the deep fishery. It can be concluded then that the Esteban deep fishery affected the Cape Scott fishery, and catches here will probably remain lower until the young fish produced by the protected population can enter the Cape Scott catch sometime in 1962 or 1963. In four years the 1958 and 1959 year clases should attain a catchable size. Of course, some increase should be evident before this because the growth of all fish that escaped capture through the years should contribute to the landings.

For the stocks of petrale sole southward from Esteban the catch statistics are given in Table 2 and shown in Figures 4 and 5. Figure 4-A shows the combined data from all southern areas which includes Esteban catches at less than 100 fathoms in depth. This area contributed 41 per cent of the total petrale landings. The fishing time or effort decreased in 1957 but increased again through 1959 to a level slightly more than it was in 1955. The catch has increased, and the fishing success has increased over the past five years.

Although tagging studies indicate a single southern population, the catch statistics show a large variation in the vulnerability of the stock in different areas. Figure 5 of 40-mile Bank catches was prepared on the same scale so that all graphs of the petrale sole would be comparable. The 40-mile area contributes largely to the southern landings with some 700,000 pounds of petrale sole taken annually. Effort has averaged only 1.7 thousand hours of fishing during each year. Catch per effort has averaged about 400 pounds per hour. All statistics increased in 1959 when compared with 1955. Within this same southern population of petrale sole is a highly contrasting fishery comprised of the Cape Flattery, Quillayute, and Destruction Island areas. Combined these areas contribute 12 per cent of the total

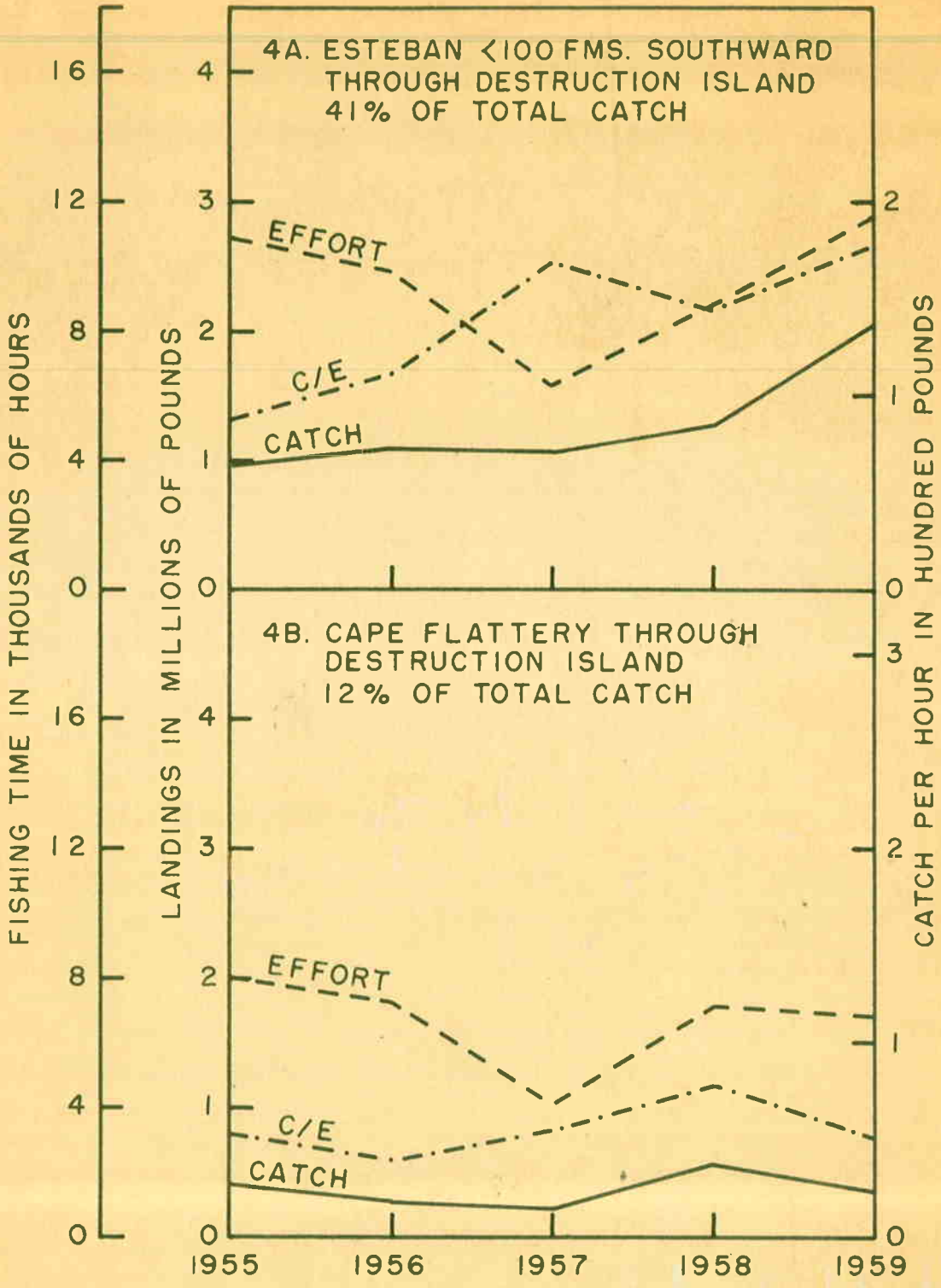


Figure 4 - Petrale sole catch, calculated effort, and catch per hour from areas south of Esteban through the Destruction Island area including Esteban catches less than 100 fathoms, and from Cape Flattery through the Destruction Island area by year, 1955 through 1959.

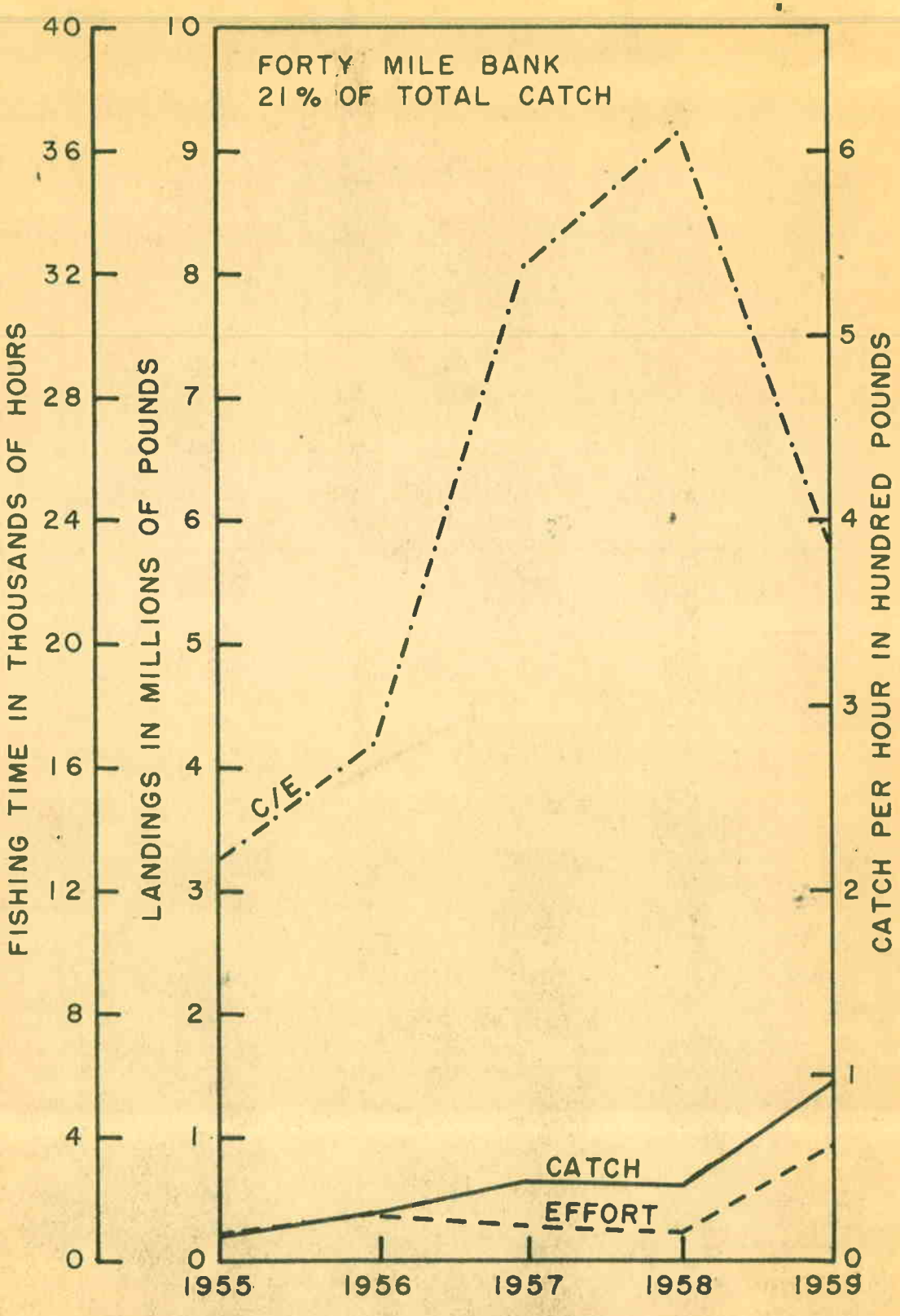


Figure 5 - Petrale sole catch, calculated effort, and catch per hour from the 40-mile Bank area by year, 1955 through 1959.

petrale catch. In this area the catch shown in Figure 4-B is fairly constant at 370,000 pounds annually, or about half the 40-mile Bank production. However, about four times the effort is spent in producing this catch, or 6.7 thousand fishing hours annually. Effort dipped in 1957, but is only slightly decreased when 1959 is compared with 1955. Catch per effort is consequently low averaging only 56 pounds per hour in the five years. Catch per unit of effort decreased in 1956, increased until 1958, and then returned to the 1955 level in 1959. This area is fished rather heavily, but the petrale sole, although reduced to a low level of abundance, seem to be maintaining their numbers at present.

The area to the south of Destruction Island contributes one per cent to the total production, but if the Oregon trawl regulations are relaxed to allow a winter fishery for petrale sole there is the danger that the Willapa deep area may be exposed to exploitation.

English Sole

Better than average landings of petrale sole and lingcod during the 1955-1959 period displaced English sole from its usual fourth position down to sixth in rank by poundage although it ranked fourth in value. This species is slightly more susceptible to the vagaries of market demand than petrale sole.

English sole are usually caught in relatively shallow water (less than 80 fathoms) in three principal areas: Hecate Strait, Cape Flattery-southward, and Puget Sound. The combined total ocean catch includes landings from two separate populations, those off Hecate Strait and those off the Washington Coast. This demonstrates the danger of drawing conclusions from the total ocean catch when it is composed of catches from separate populations. These data are shown in Table 3 and Figures 6, 7, and 8. The combined data

Table 3 - English sole catch data from interviews extrapolated to total landings.

	1955	1956	1957	1958	1959	5 year average
HECATE STRAIT	23 per cent of total catch					
Pounds	902,051	583,646	630,646	568,202	758,972	688,703
Hours	2,483	1,936	2,205	2,184	3,843	2,530
Lbs/hr.	363	301	286	260	197	272
Index lbs/hr	100	83	79	72	54	
CAPE FLATTERY-UMATILLA	17 per cent of total catch					
Pounds	994,869	283,455	264,627	403,277	676,221	524,490
Hours	9,860	4,172	2,462	3,135	3,939	4,714
Lbs/hr.	101	68	107	129	172	111
Index lbs/hr	100	67	106	128	170	
QUILLAYUTE	22 per cent of total catch					
Pounds	515,655	1,175,121	386,936	464,206	758,374	660,058
Hours	2,104	2,872	1,500	1,203	1,181	1,772
Lbs/hr.	245	409	258	386	642	372
Index lbs/hr	100	167	105	158	262	
DESTRUCTION ISLAND	31 per cent of total catch					
Pounds	423,224	480,821	699,835	1,370,307	1,710,445	936,926
Hours	2,520	2,105	1,994	3,096	2,774	2,498
Lbs/hr.	168	228	351	443	617	375
Index lbs/hr.	100	136	209	264	367	
OCEAN TOTAL						
Pounds	3,075,536	2,762,918	2,253,050	2,965,518	4,008,346	3,013,074
Hours	21,678	15,199	10,923	12,126	13,228	14,631
Lbs/hr.	142	182	206	245	303	206
Index lbs/hr.	100	128	145	173	213	
PUGET SOUND						
Pounds	1,058,971	1,723,705	1,567,122	2,011,263	1,652,102	1,602,633
Hours	7,649	9,691	20,896	23,632	24,866	17,347
Lbs/hr.	138	178	75	85	66	92
Index lbs/hr.	100	129	54	62	48	

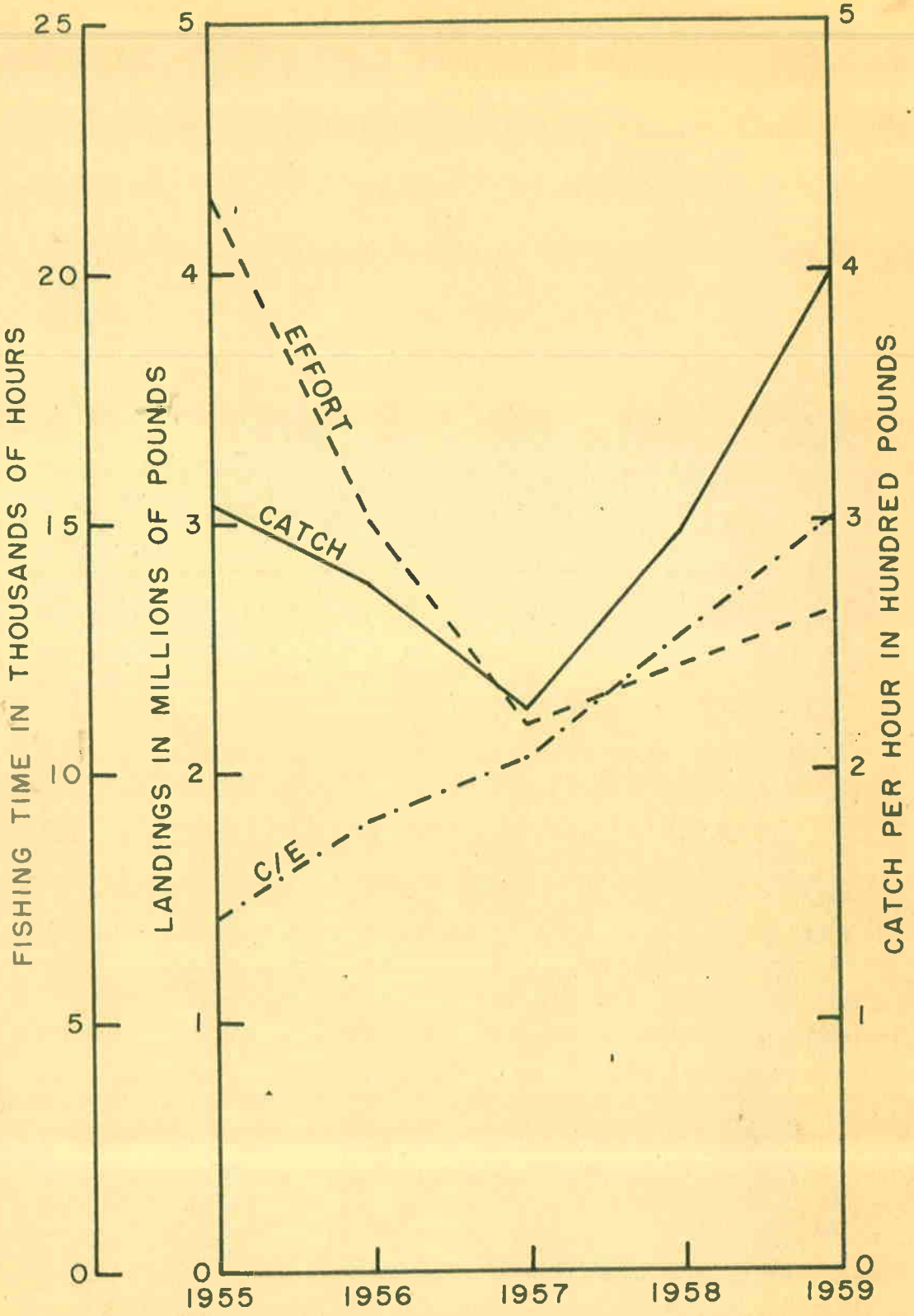


Figure 6 - English sole catch, calculated effort, and catch per hour from all areas except Puget Sound by year, 1955 through 1959.

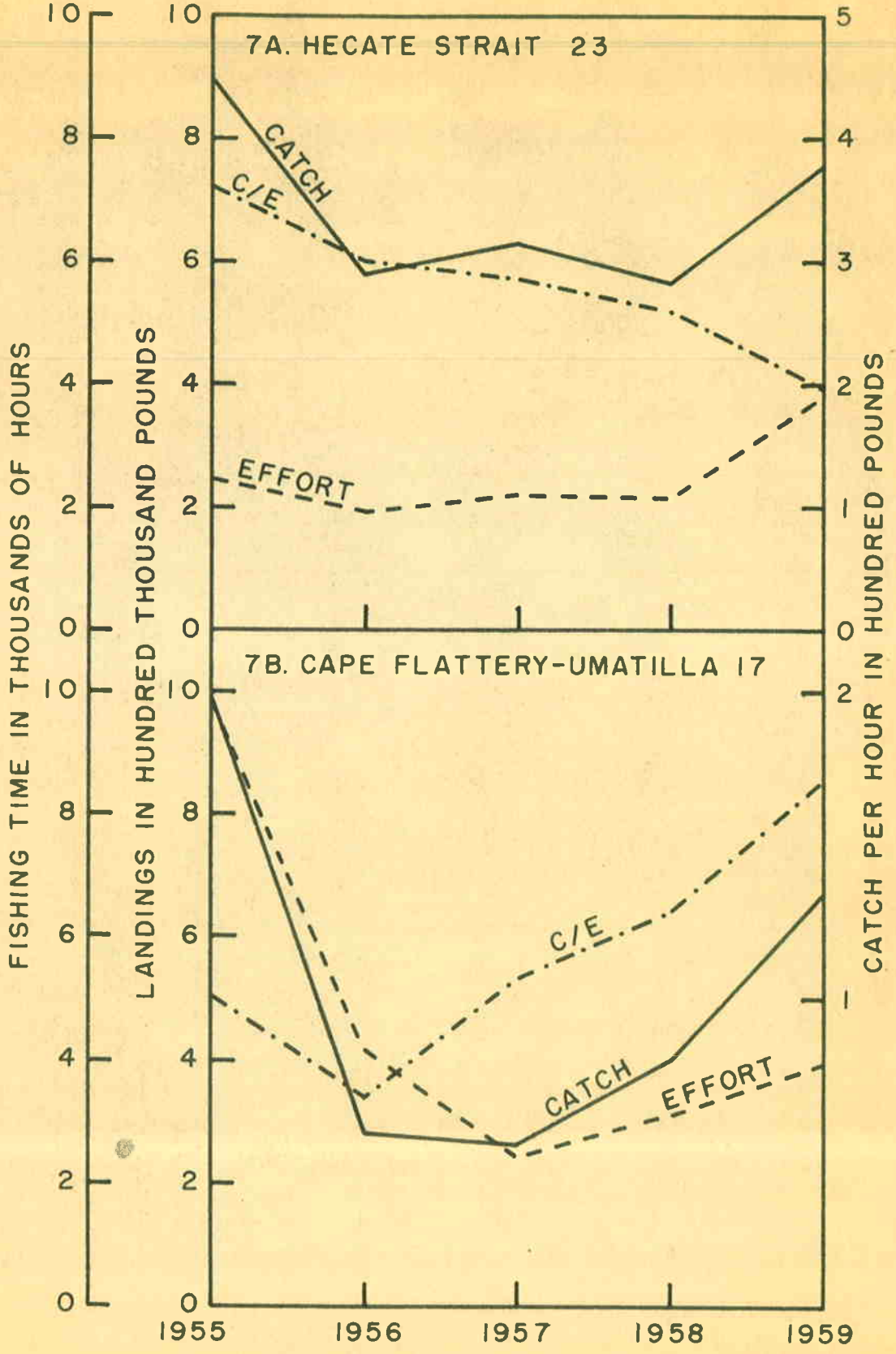


Figure 7 - English sole catch, calculated effort, and catch per hour from Hecate Strait and Cape Flattery-Umatilla areas by year, 1955 through 1959.

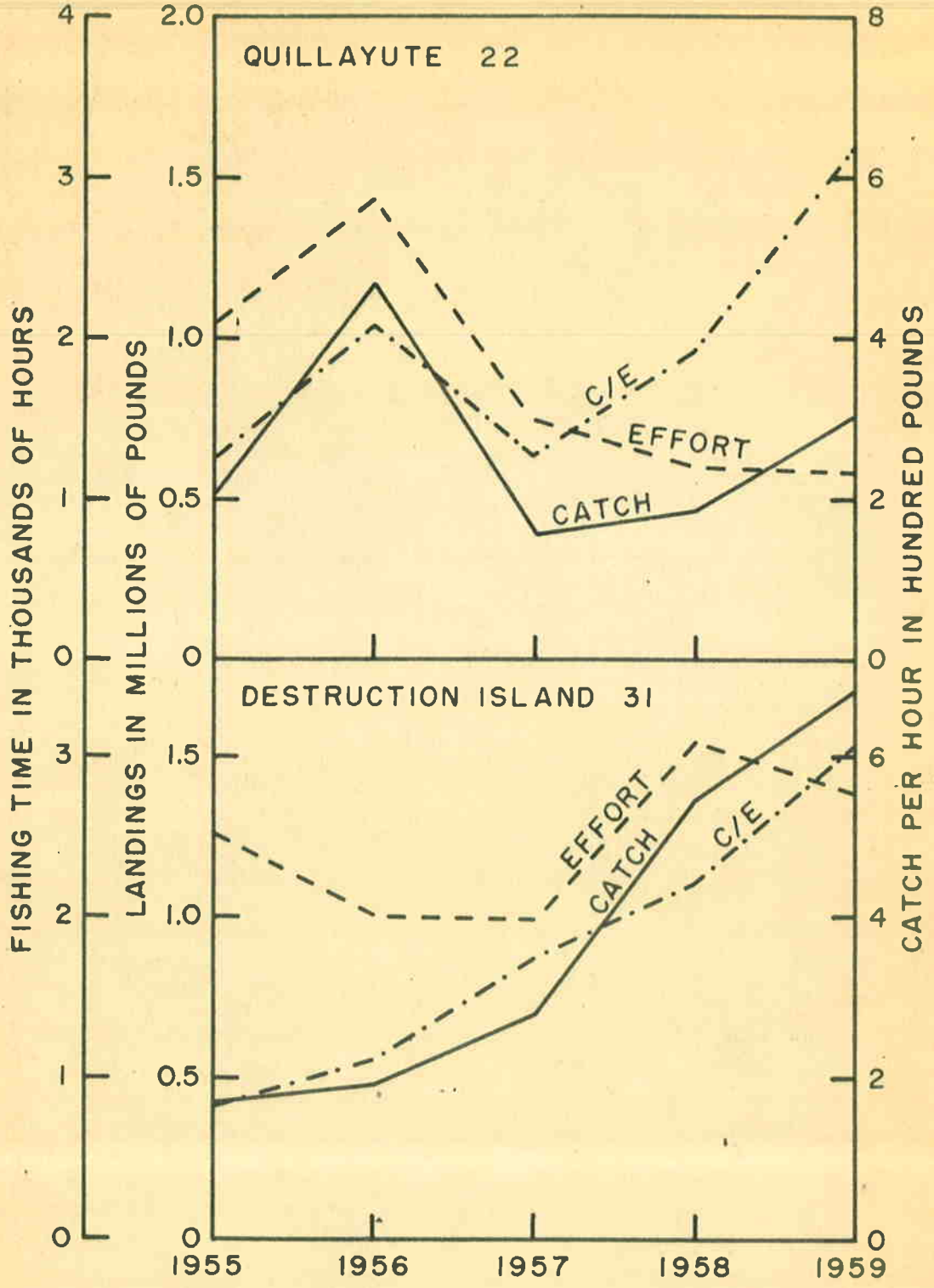


Figure 8 - English sole catch, calculated effort, and catch per hour from Quillayute and Destruction Island areas by year, 1955 through 1959.

(Figure 6) shows that effort and catch decreased for two years and then increased in the latter two years, 1958 and 1959. Fishing success continued to increase which denotes an increased abundance. However, in Hecate Strait (Figure 7-A), which contributes 23 per cent to the Washington English sole ocean trawl catch, poundage declined in 1957, remained at about 600,000 pounds for three years, then increased in 1959, but did not attain the 1955 level of production. Effort remained at about the 2,000 hour level for four years and then increased to 3,800 hours in 1959. Fishing success (C/E) declined each year. The 1959 rate was about one half of the 1955 rate. This is not a favorable condition, and indicates that fish are less available to the fishermen of both countries. Canadians and Americans both exploit this area. Fish are less available for several reasons: either they are less numerous or they are not appearing in their usual habitat for some unknown reason. Catch analyses will not demonstrate which of these two factors is responsible for a decline in fishing success. A separate approach is necessary, such as a continuous analysis of the age composition of the stocks in question. When stocks are declining there are fewer young fish entering the fishable stocks to replace those removed by both fishing and natural causes. The rate of young fish entering the population is called recruitment, and when recruitment declines over a period of time, it is an indication that the total number of fish in an area is decreasing. Conversely, it can then be said that the fish are not off on some mythical migration.

The English sole catches from the Cape Flattery-Umatilla, Quillayute, and Destruction Island areas, although graphed separately, may be discussed simultaneously as catch statistics follow each other in all three areas. These areas contribute 70 per cent to the total ocean catch of English sole. Catch per hour in all three areas is improved in 1959 compared to the rate

of success in 1955. This indicates that the English sole stocks off the Washington Coast are in good condition at this time. The much improved success of fishermen in this area overcame the poor fishing in Hecate Strait, and produced a favorable situation to be evident in the total ocean catch analysis as was mentioned at the start of the discussion of catch statistics for this species.

The Puget Sound fishery for English sole is in poor condition (Figure 9). Fishing effort has tripled in five years. Catch increased, but the increase was only half of the 1955 production. Consequently, catch per unit or fishing success declined to about half of its 1955 rate. There are two intensive fisheries in Puget Sound for English sole: one in the Everett Bay area and one in the Gulf of Georgia. Although it is not definitely known that the decline in these fisheries is the result of a decrease in the abundance of fish, a decline in availability is unlikely. If fish were simply not in their old haunts, the fishermen would soon discover them. The decline in this fishery has already reached the point where it is barely profitable to continue fishing. If allowed to continue, this trend will level out at a point where fishermen are hardly able to meet the expense of continued fishing. The amount of fishing effort should be regulated in some manner to increase the stocks to a more abundant level. There is always the danger that stocks may be driven to a level of abundance from which they cannot recover. It is likely, however, it will be unprofitable to continue fishing before this happens. The Gulf of Georgia is open to trawling all year. The Everett area is open from April 15 through February 15 of the following year.

The southern Puget Sound areas were opened to trawling in 1953 for a limited period (December 1 through March 31) each year. It was hoped that

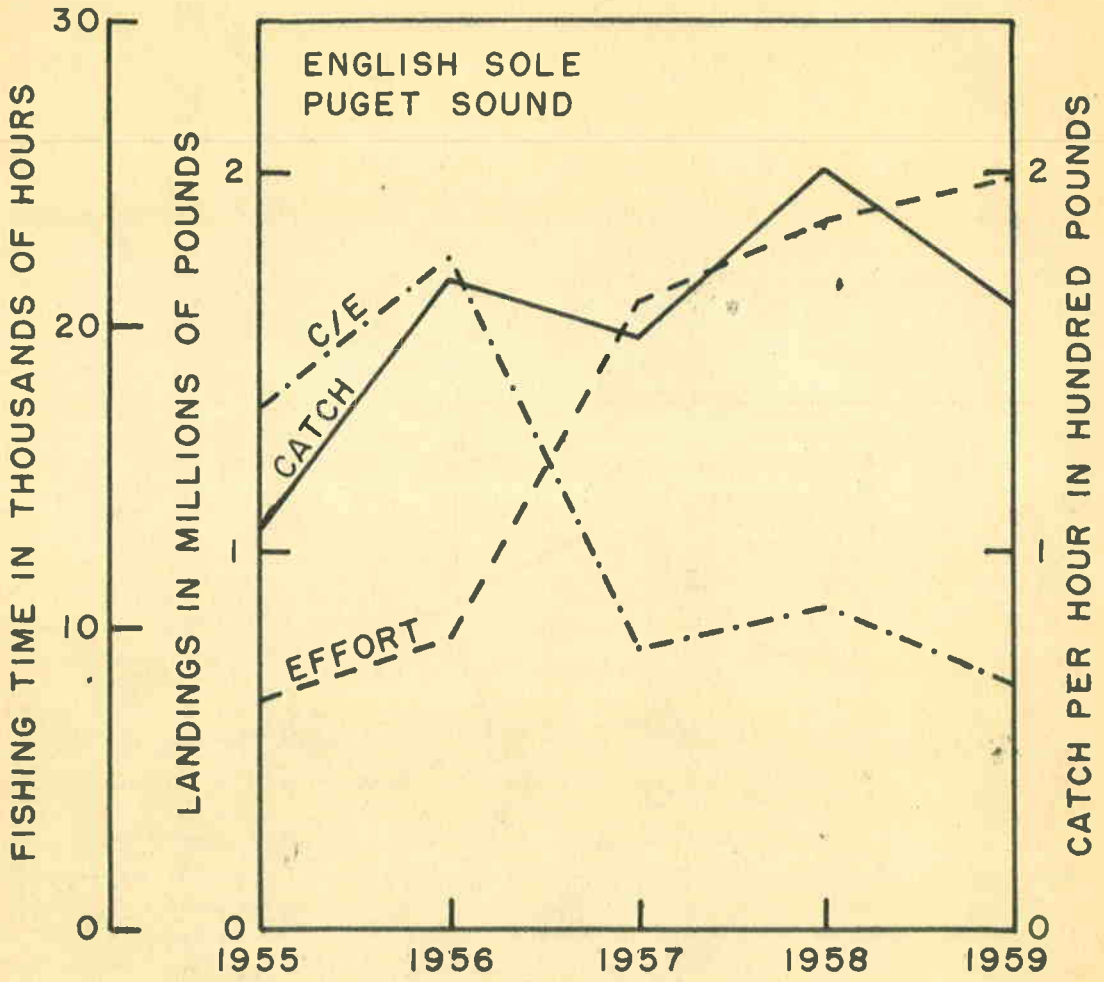


Figure 9 - English sole catch, calculated effort, and catch per hour from Puget Sound areas by year, 1955 through 1959.

fishing would decrease the incidence of the parasitism of the English sole caught in the southern area. Although no specific study has been made of this, observations indicate that the parasitism remains heavy. The fish seem to become increasingly available to the fishery toward the end of the open period. All of the English sole catch, which is the principal species taken is sold for mink food. Although English sole are restricted to use as human food or fish bait, an exception is made for the parasitized fish so that they can be used as animal food.

Dover Sole

This species is more vulnerable to market demand fluctuations than either petrale or English soles. It is taken in deeper water than English sole. Dover sole ranked seventh in poundage and sixth in value during the 1955 to 1959 period.

Dover sole catch statistics are shown in Table 4 and Figure 10. Fishing effort in the ocean areas decreased in 1957, and effort has remained fairly constant since then. Total catch followed the decrease in effort in 1957, but poundage has increased in the latter two year period. Fishing success likewise decreased in 1957, but the increase in production with little increase in effort caused a large increase in catch per hour. In fact, catch per hour in 1959 exceeded that of 1955 which indicates that the Dover sole stocks are in good abundance.

The ocean catch may be broken into four main production areas. The largest poundage is taken in the Cape Flattery-Umatilla area which suggests that the fishermen are not forced to travel very far for this species. Starting to the northward, 14 per cent of the ocean catch is taken in the combined Hecate Strait, Goose Island, and Cape Scott areas (Figure 11-A). In these areas effort has decreased, poundage has generally increased, and catch per

Table 4 - Dover sole catch data from interviews extrapolated to the total landings.

	1955	1956	1957	1958	1959	5 year ave.
HECATE STRAIT-GOOSE ISLAND AND CAPE SCOTT						
	14 per cent of total					
Pounds	161,945	651,422	231,250	314,832	392,319	350,354
Hours	831	3,110	1,119	751	1,498	1,462
Lbs/hr.	195	209	207	419	262	240
Index lbs/hr.	100	107	106	215	134	
ESTEBAN	30 per cent of total ocean catch					
Pounds	1,143,660	1,160,260	474,673	449,202	544,602	754,479
Hours	2,049	1,391	1,882	906	1,086	1,463
Lbs/hr.	558	834	252	496	501	516
Index lbs/hr.	100	149	45	89	90	
CAPE FLATTERY-UMATILLA						
	35 per cent of total catch					
Pounds	1,264,011	1,362,814	370,393	561,740	897,955	891,383
Hours	3,697	3,571	984	1,556	1,519	2,265
Lbs/hr.	342	382	376	361	591	394
Index lbs/hr.	100	112	110	106	173	
DESTRUCTION ISLAND						
	10 per cent of total catch					
Pounds	503,633	237,665	155,899	276,113	77,950	250,252
Hours	1,809	618	617	1,505	414	993
Lbs/hr.	278	385	253	183	188	252
Index lbs/hr.	100	138	91	66	68	
OCEAN TOTAL						
Pounds	3,267,291	3,626,381	1,448,591	1,938,534	2,310,168	2,518,193
Hours	9,351	9,832	5,434	5,679	5,591	7,177
Lbs/hr.	349	369	267	341	413	351
Index lbs/hr.	100	106	77	98	118	

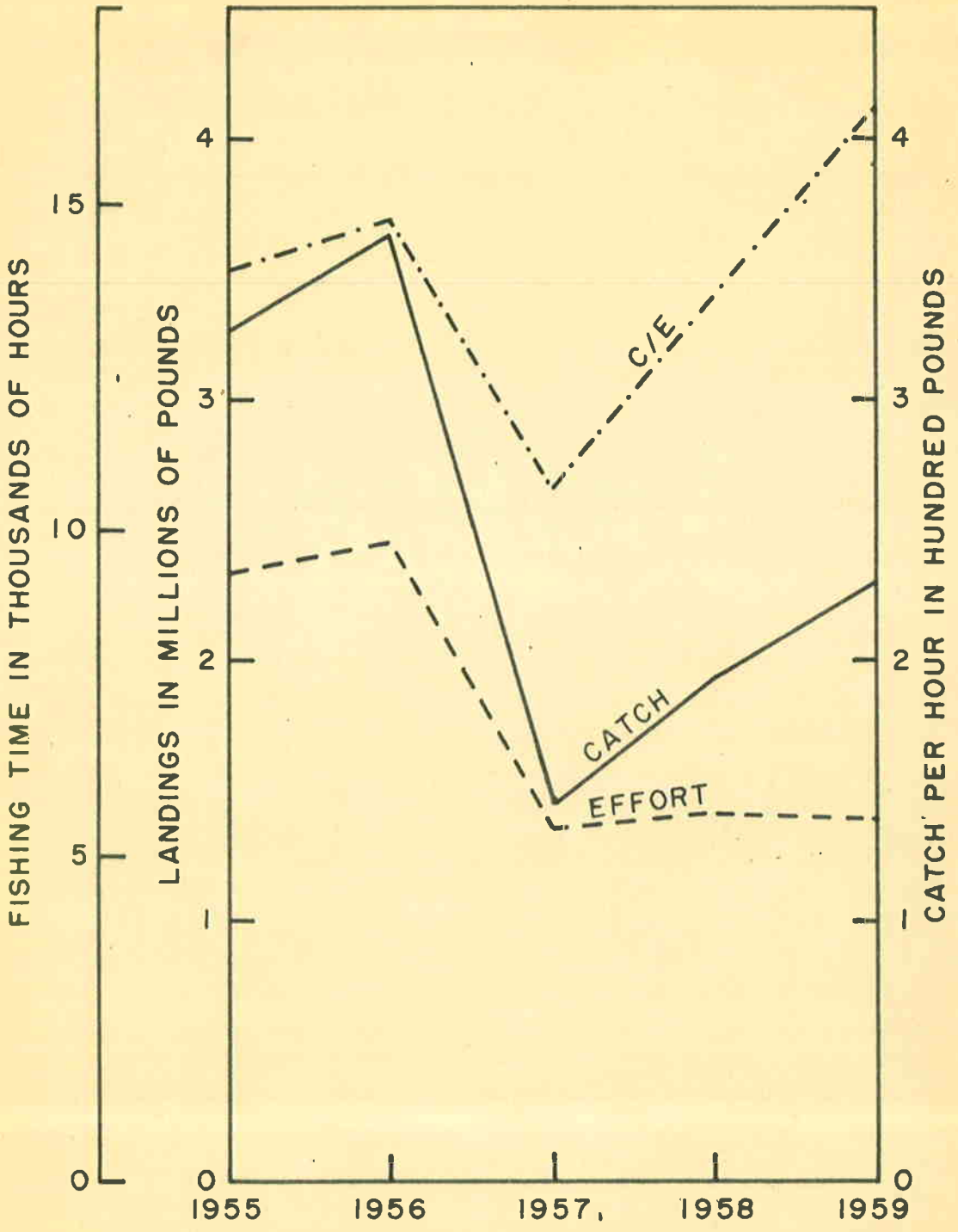


Figure 10 - Dover sole catch, calculated effort, and catch per hour from all ocean areas by year, 1955 through 1959.

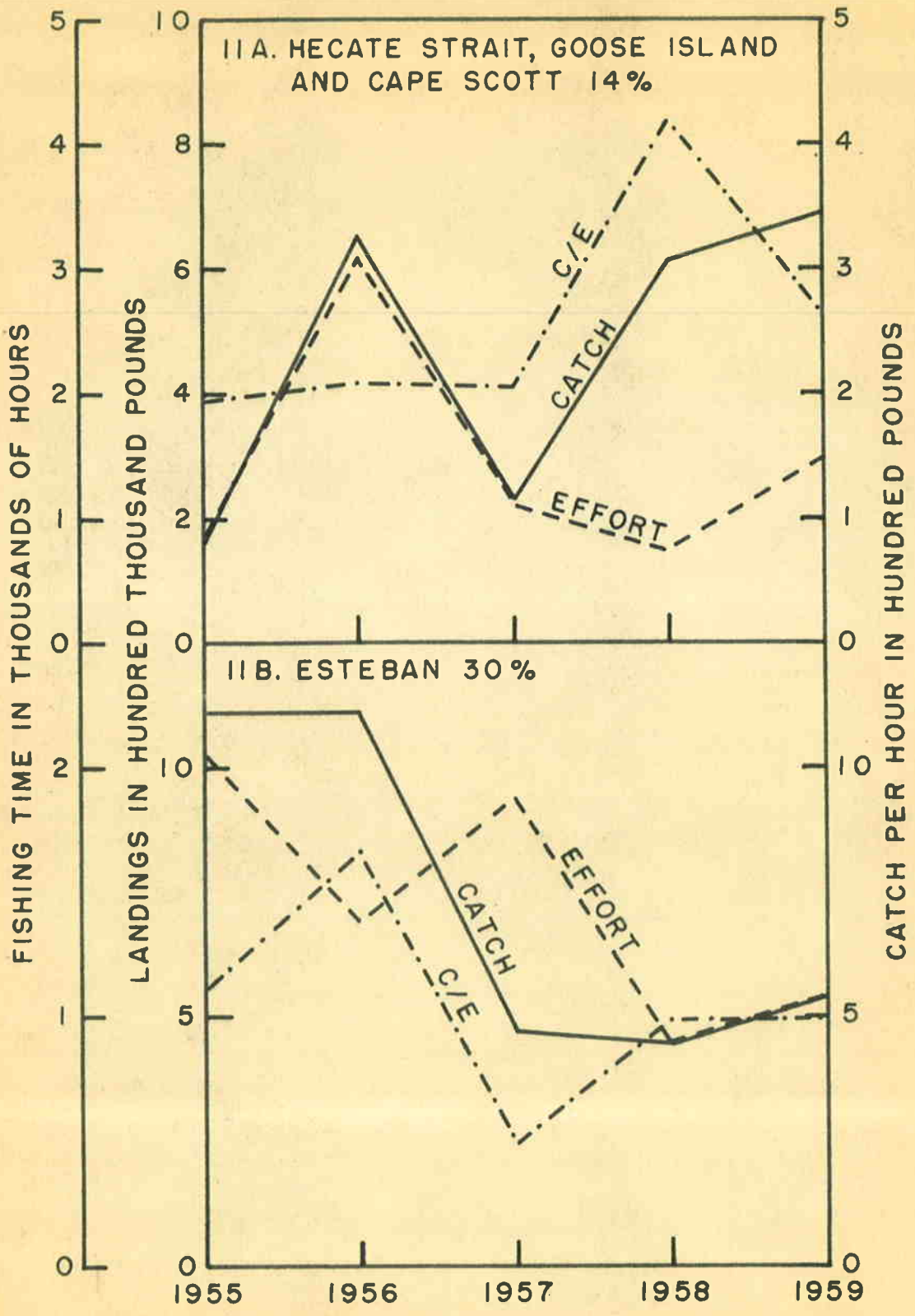


Figure 11 - Dover sole catch, calculated effort, and catch per hour from Hecate Strait-Goose Island-Cape Scott and Esteban areas by year, 1955 through 1959.

hour has increased. Catch and effort followed each other closely until 1958 when less effort produced increased poundage. Evidently, new fishing grounds were discovered that year in the Goose Island area which is the principal fishery in this combined area. The Esteban area (shown in Figure 11-B) is a deep fishery and is affected by the petrale regulation in that the two species become mixed, and it is at times impossible to fish Dover sole without taking more than a limit (8 per cent of a single trip) of petrale sole. Consequently, effort has decreased, and poundage and fishing success have followed the decline in fishing effort. The stocks in the Esteban area, which produced 30 per cent of the five year average catch, are evidently less available to the fishermen.

For the Cape Flattery-Umatilla area (Figure 12-A) where 35 per cent of the Dover sole are harvested, effort has decreased, poundage decreased in 1957 and then recovered somewhat, but catch per hour has improved. Declining effort indicates a lack of interest in these fish and improved fishing success probably reflects the exploitation of newly discovered grounds as well as increased abundance of fish on the old grounds with the lessening of fishing pressure.

Ten per cent of the catch is taken in the Destruction Island area (Figure 12-B). Here effort is also irregularly down, poundage is down, and fishing success is also poorer. These declines are thought to reflect lack of marketability for this species rather than decreased abundance of the stocks. Fishermen often complain of small Dover in this area. Most companies require the fishermen to sort out all Dover sole less than 16 inches. Recovery (per cent of saleable fillet in comparison to the amount of discarded carcass) is low on Dover sole less than 16 inches in length. It may be that the demand for larger Dover sole which belong to the older age groups may render the stocks unable to withstand much fishing pressure. These are

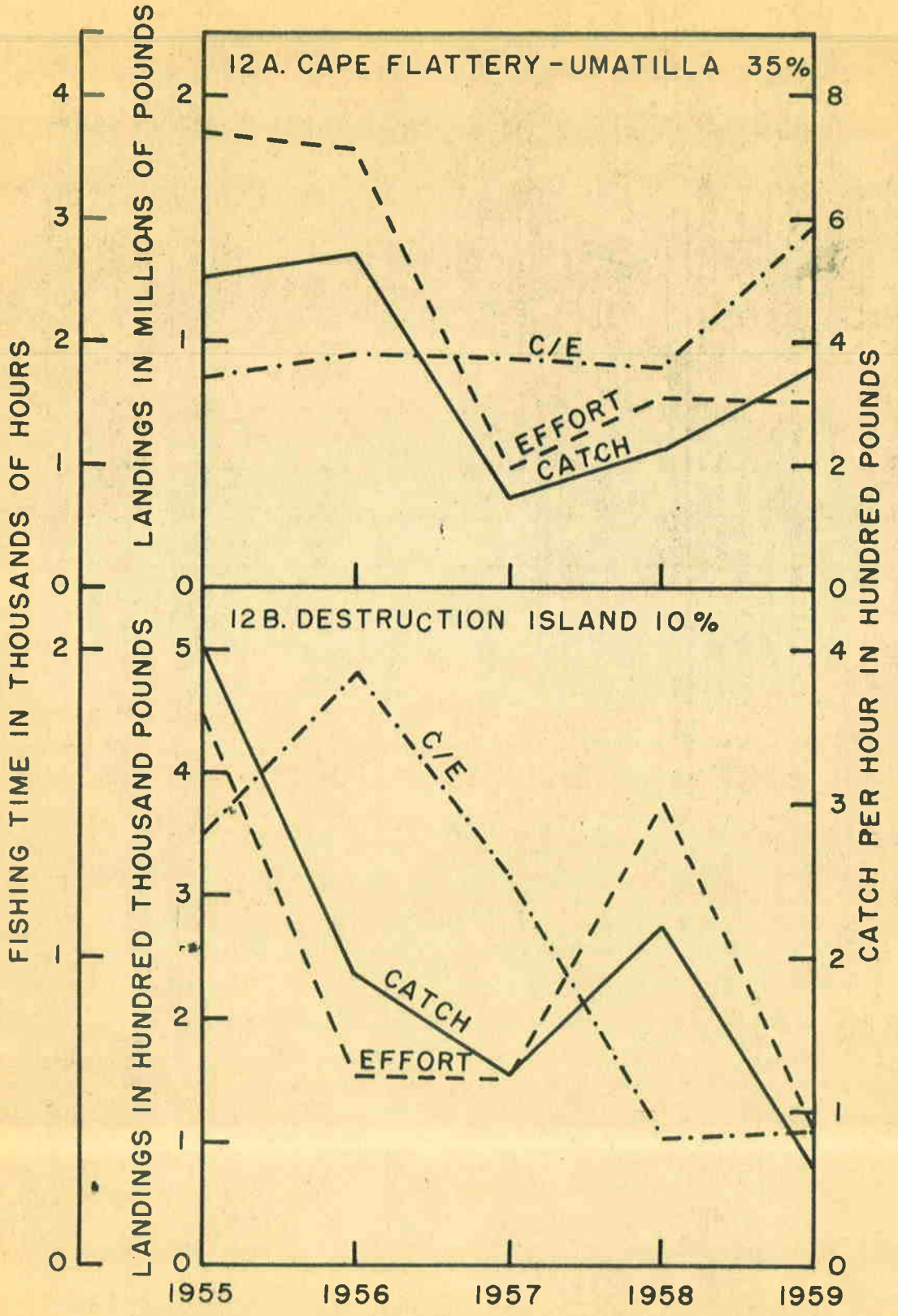


Figure 12 - Dover sole catch, calculated effort, and catch per hour from Cape Flattery-Umatilla and Destruction Island areas by year, 1955 through 1959.

soft-fleshed fish and may not survive being caught at smaller sizes as readily as other firmer species. These theories will have to be investigated.

Some Dover are taken within the Puget Sound area, but these represent a small per cent of the inside landings, and the data are insufficient for analysis.

Rock Sole

During the five year period of study these fish ranked tenth in poundage and in value. Some are caught incidentally on 40-mile Bank and off Esteban Point, but the largest proportion of this species are taken in relatively unmixed catches in the Hecate Strait area. They are mixed with other species on the Goose Island and Cape Scott grounds. Rock sole are also caught in Puget Sound.

When the combined ocean catch from all areas is considered, effort fluctuated widely but was highest in 1959. Catch poundage declined until 1957 and partially recovered in 1958 and 1959 (Table 5 and Figure 13). Catch per hour as a measure of fishing success has declined over the five-year period. These data are difficult to interpret because the Canadian fishermen exploit rock sole rather intensely in these same areas. It may be necessary to combine Canadian and American data on this species to ascertain the effects of the fisheries upon the stocks. The condition of the fishery does not appear favorable because in 1959 increased effort did not produce a proportional increase in catch as is shown by the decrease in catch per hour. This occurs when stocks are less numerous, or, at least, less available to the fishermen.

In the Hecate Strait area effort has increased but catch and catch per effort have declined (Figure 14-A). Forty-seven per cent of the ocean catch came from Hecate Strait, and it appears that the stocks in this area are in the worst condition.

Table 5 - Rock sole catch data from interviews extrapolated to the total landings.

	1955	1956	1957	1958	1959	5 year ave.
HECATE STRAIT	47 per cent of total ocean catch					
Pounds	509,046	252,475	110,783	183,640	200,648	251,318
Hours	627	385	130	691	688	504
Lbs/hr.	812	655	855	266	291	499
Index lbs/hr.	100	81	105	33	36	
GOOSE ISLAND	25 per cent of total ocean catch					
Pounds	271,111	88,193	58,299	152,180	89,046	131,766
Hours	516	545	320	254	276	382
Lbs/hr.	525	162	182	598	323	345
Index lbs/hr.	100	31	35	114	62	
CAPE SCOTT-	23 per cent of total ocean catch					
Pounds	104,696	277,118	63,045	65,629	113,310	124,760
Hours	440	1,842	637	559	441	784
Lbs/hr.	238	150	99	117	257	159
Index lbs/hr.	100	63	42	49	108	
OCEAN TOTAL						
Pounds	884,853	628,248	261,137	409,804	482,281	533,265
Hours	1,583	3,044	1,614	1,636	3,429	2,261
Lbs/hr.	559	206	162	250	141	236
Index lbs/hr.	100	37	29	45	25	
PUGET SOUND						
Pounds	78,695	87,686	52,231	72,822	59,361	70,159
Hours	1,026	926	800	1,473	1,130	1,071
Lbs/hr.	77	95	65	49	53	66
Index	100	123	84	64	69	

The Goose Island grounds (Figure 14-B) contribute 25 per cent to the total ocean rock sole catch. Here the effort has decreased, poundage has decreased, but fishing success has varied considerably. Catch per hour declined in 1956 and 1957, increased to better than the 1955 level in 1958, and then decreased again in 1959. The fluctuations in catch and catch per effort show little relationship to the variations in effort, and it appears that either the lacking Canadian fishing data can provide the answers to the situation or the stocks vary extensively in availability. The former is probably the case as Washington vessels take about 10 per cent of the total catch in Hecate Strait and about 20 per cent of the total catch in the Goose Island area.

Rock sole catches in the Cape Scott area, Figure 15A, contributed 23 per cent to the total Washington catch from ocean areas. Catch and effort increased from 1955 to 1956, but fishing success decreased. Catch, effort, and success all decreased in 1957. From 1957 through 1959 effort continued to

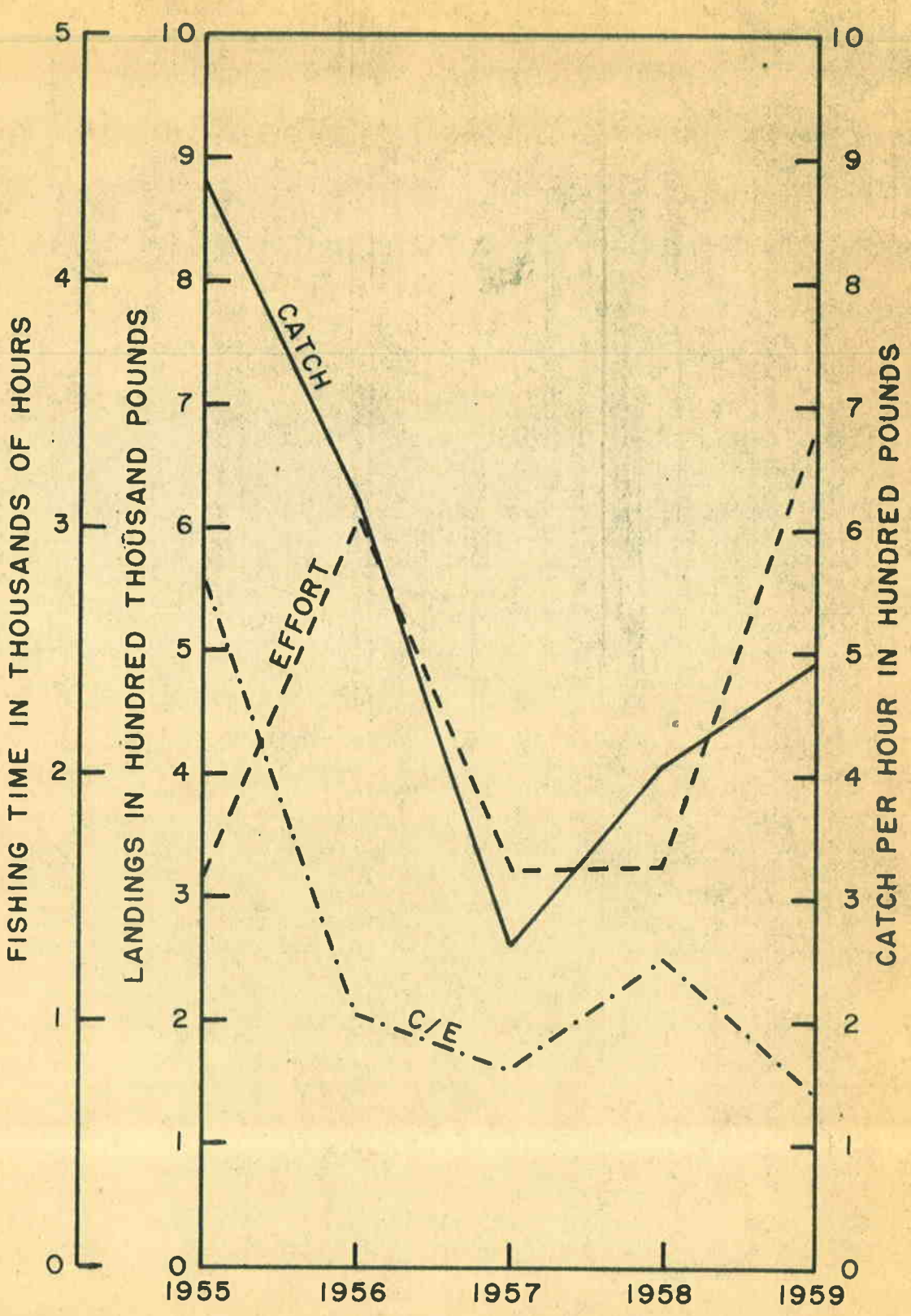


Figure 13 - Rock sole catch, calculated effort, and catch per hour from all ocean areas by year, 1955 through 1959.

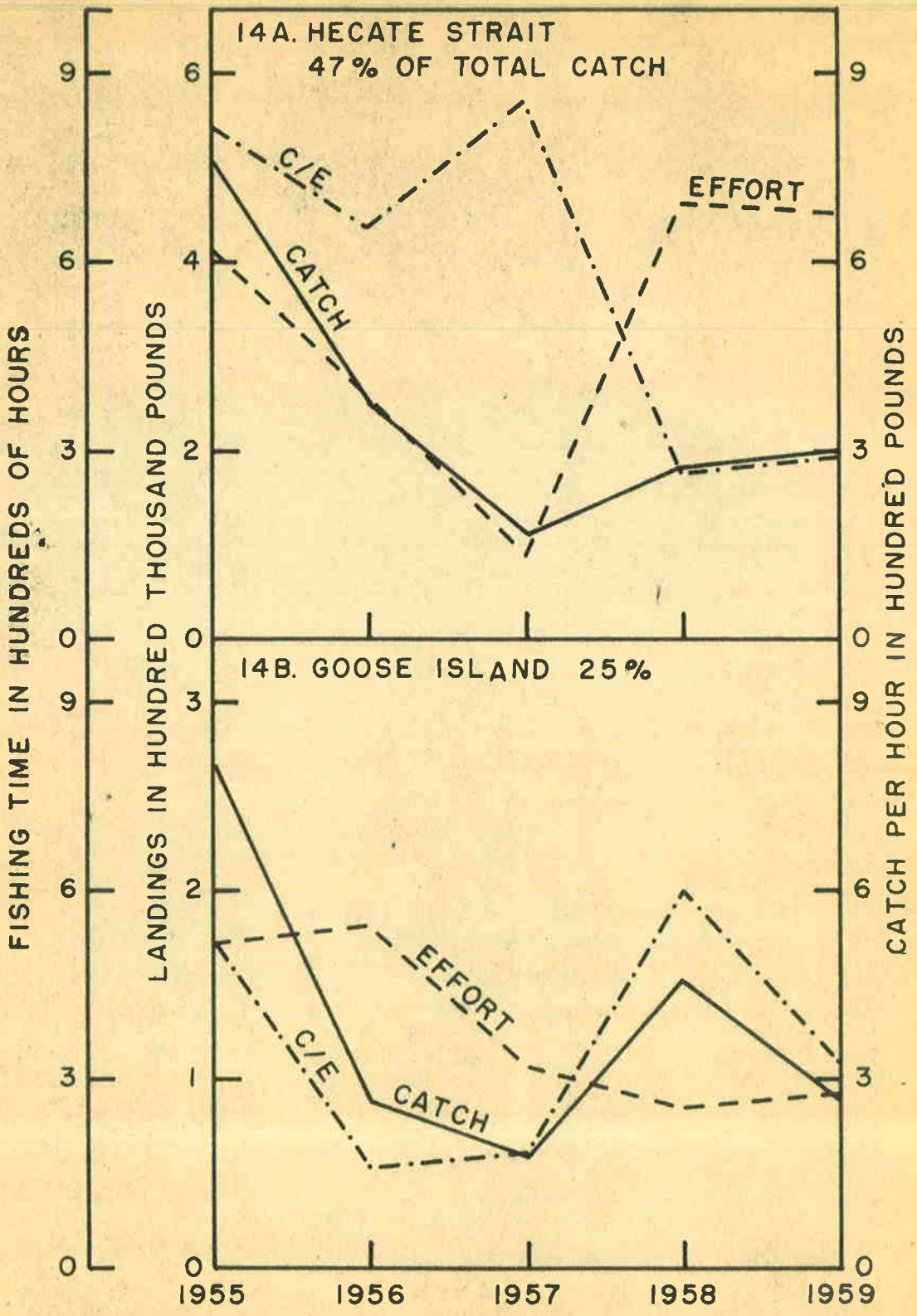


Figure 14 - Rock sole catch, calculated effort, and catch per hour from Hecate Strait and Goose Island areas by year, 1955 through 1959.

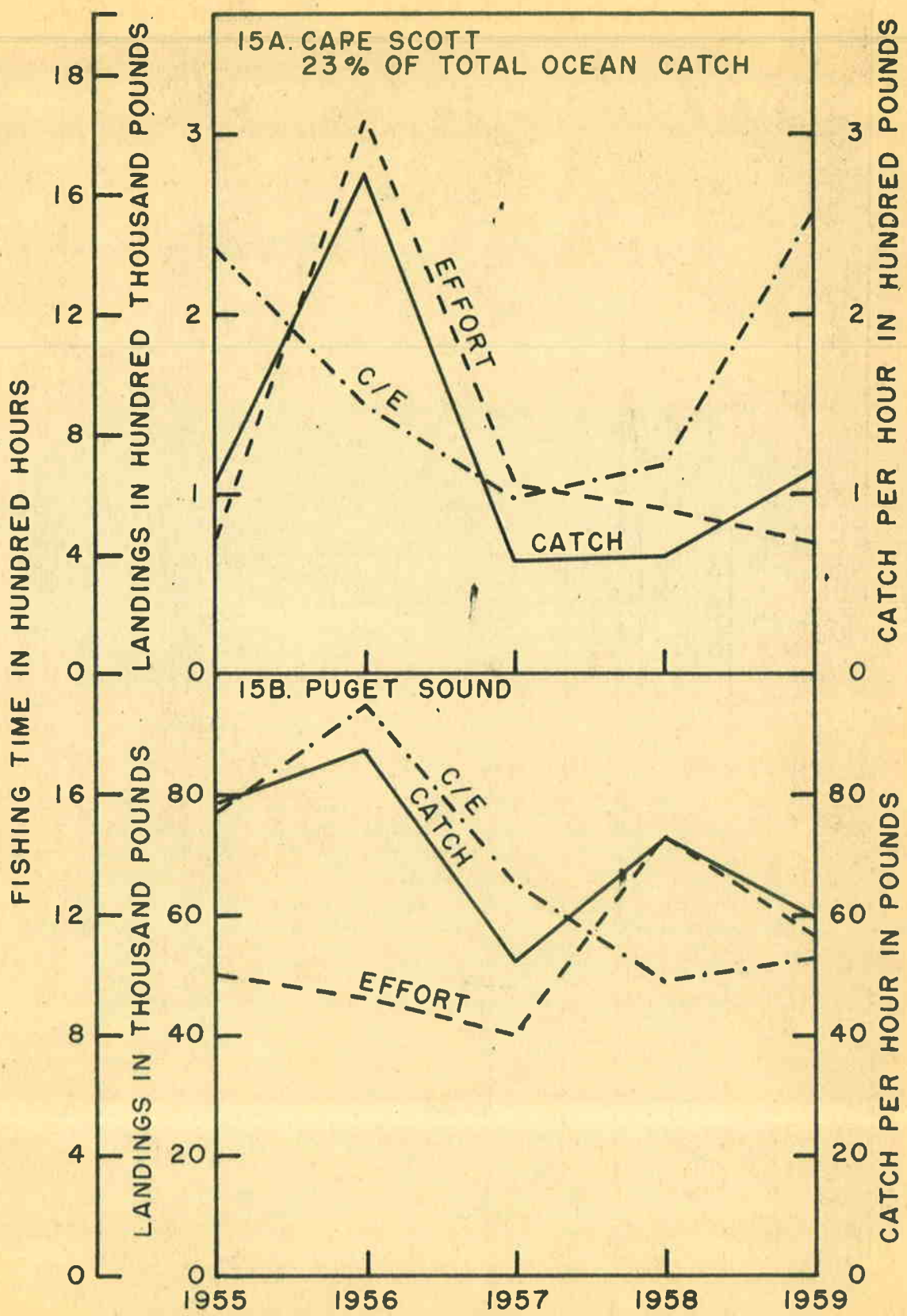


Figure 15 - Rock sole catch, calculated effort, and catch per hour from Cape Scott and Puget Sound areas by year, 1955 through 1959.

decrease, but poundage increased somewhat. Catch per hour increased considerably. The latter is a favorable reaction, but an intelligent interpretation cannot be made from these data which represent 15 per cent of the total rock sole catch from the area.

The Puget Sound fishery for rock sole is depicted in Figure 15-B. In general, effort has increased in the five-year period, poundage has declined, and the catch per hour, as evidence of fishing success, has also declined. These data are consistent with other Puget Sound species in showing an intensive fishery which has been driven to low production. The fishery is in poor condition and is worsening.

Starry Flounder

The bulk of the flounder fishing is conducted at depths of less than 70 fathoms. The catches come from widely divergent areas. In importance, flounder ranks ninth by poundage and value among the various species marketed by this fishery.

The combined ocean catch means little as these fish are taken in S. E. Alaska, Hecate Strait, and off the Washington Coast. The catch from Puget Sound will be presented separately. Table 6 gives the catch data for starry flounder. Figure 16 graphs the catch statistics more for continuity than for any analytical information which might be derived from it. Fishing effort increased through 1956 and 1957, then decreased in 1958 and 1959. Production increased slightly in 1956, then decreased for 1957 and 1958, and recovered somewhat in 1959. Fishing success (catch per hour) decreased the first three years, 1956, 1957 and 1958, and then increased slightly in 1959.

S. E. Alaska contributes 24 per cent of the starry flounder ocean catch. Trawling in this area is peculiar in that the fishermen trawl right into the river mouths for flounder, and if the fish are present, thousands of pounds

Table 6 - Starry flounder catch data from interviews extrapolated to the total landings.

	1955	1956	1957	1958	1959	5-year ave.
S. E. ALASKA	24 per cent of total ocean catch					
Pounds	462,745	285,359	236,378	25,667	101,309	222,292
Hours	270	207	84	39	69	134
Lbs/hr.	1,714	1,376	2,831	667	1,475	1,659
Index lbs/hr.	100	80	165	39	86	
HECATE STRAIT	22 per cent of total ocean catch					
Pounds	72,023	79,231	225,587	202,067	469,405	210,263
Hours	291	282	344	504	581	4,004
Lbs/hr.	247	281	655	401	808	53
Index lbs/hr.	100	114	265	162	327	
CAPE FLATTERY-UMATILLA, QUILLAYUTE, and DESTRUCTION ISLAND	54 per cent of total ocean catch					
Pounds	720,086	975,644	539,429	219,274	78,734	506,633
Hours	1,184	1,964	2,436	931	801	1,463
Lbs/hr.	608	497	221	236	98	346
Index lbs/hr.	100	82	36	39	16	
OCEAN TOTAL						
Pounds	1,254,854	1,344,099	1,010,001	447,895	666,783	944,726
Hours	1,745	2,456	2,924	1,498	1,505	2,026
Lbs/hr.	719	547	345	299	443	466
Index lbs/hr.	100	76	48	42	62	
PUGET SOUND						
Pounds	275,531	286,761	280,462	469,749	199,217	302,344
Hours	3,414	4,350	5,803	6,833	5,044	5,089
Lbs/hr.	81	66	48	69	39	59
Index lbs/hr.	100	81	59	85	48	

are caught. The fish enter the river mouths to spawn in the winter months and, therefore, weather and sea conditions must be favorable to allow trawling. In this area, catch and effort have decreased with some improvement in 1959 (Figure 17-A). Catch per hour has generally decreased with a successful year reported in 1957. The decline in effort indicates that fishermen are not trying for this species as much as they did in 1955.

The flounder fishery off Hecate Strait presents an entirely different set of circumstances (Figure 17-B) than in S. E. Alaska. Here the effort is increasing, catch is increasing, and fishing success is likewise increasing which indicates the stocks of flounder in this area are in good abundance. This area produced 22 per cent of the ocean catch of flounder.

The bulk of the ocean catch of flounder (54 per cent) was taken off the coast of Washington. Figure 18-A shows the catch statistics for this area. Catch increased with an increase in effort in 1956, but success decreased.

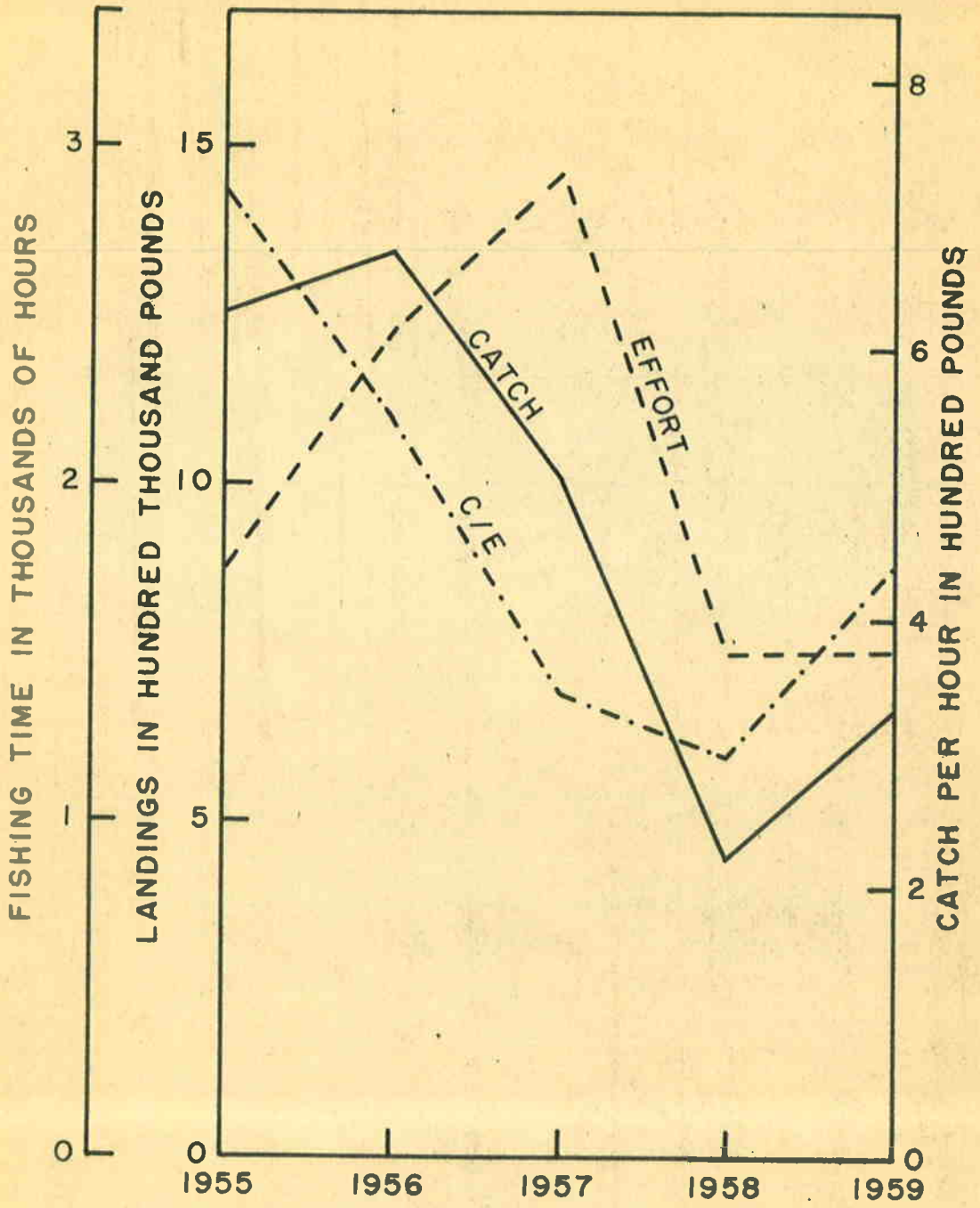


Figure 16 - Starry flounder catch, calculated effort, and catch per hour from all ocean areas by year, 1955 through 1959.

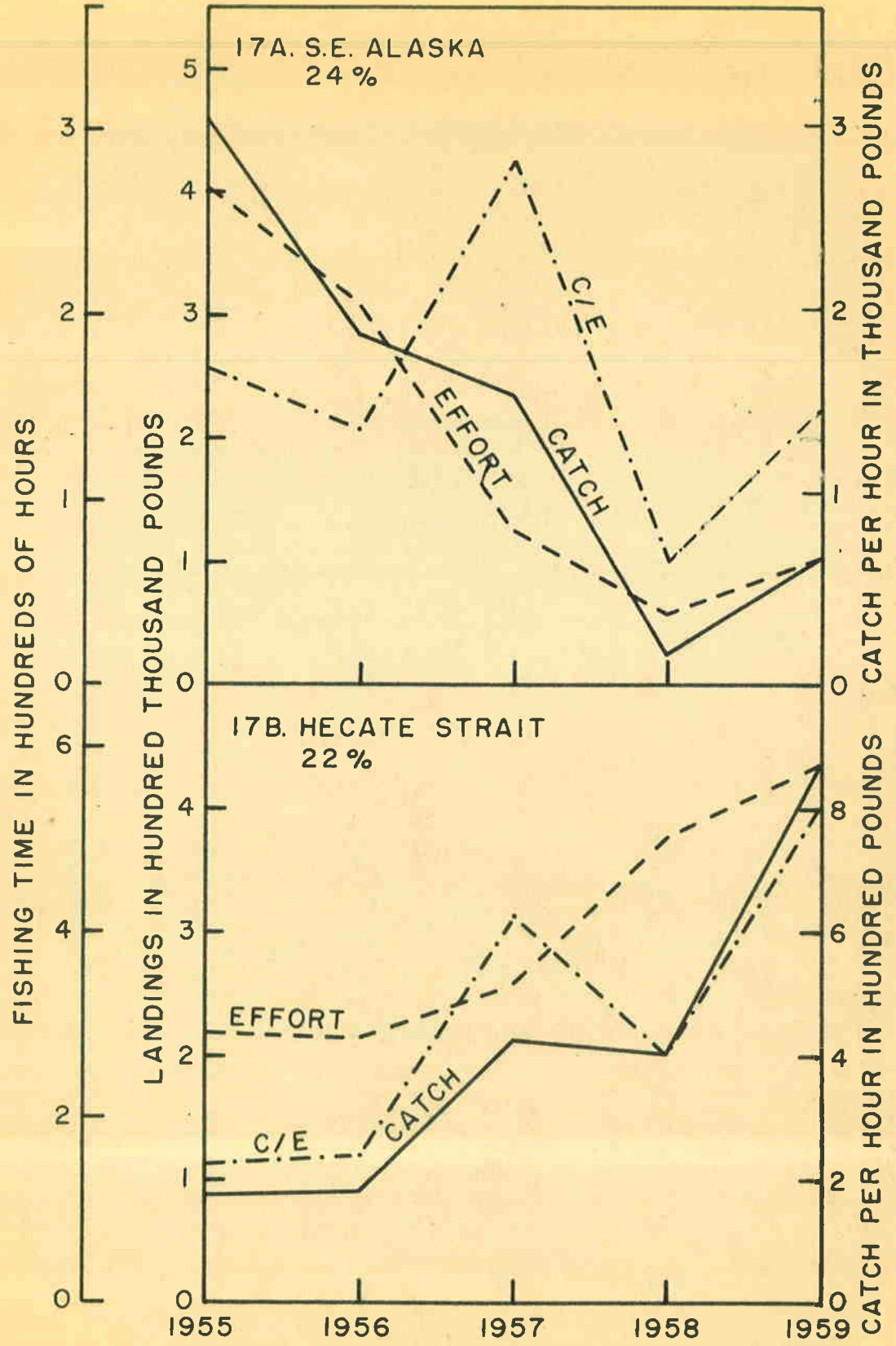


Figure 17 - Starry flounder catch, calculated effort, and catch per hour from Southeast Alaska and Hecate Strait areas by year, 1955 through 1959.

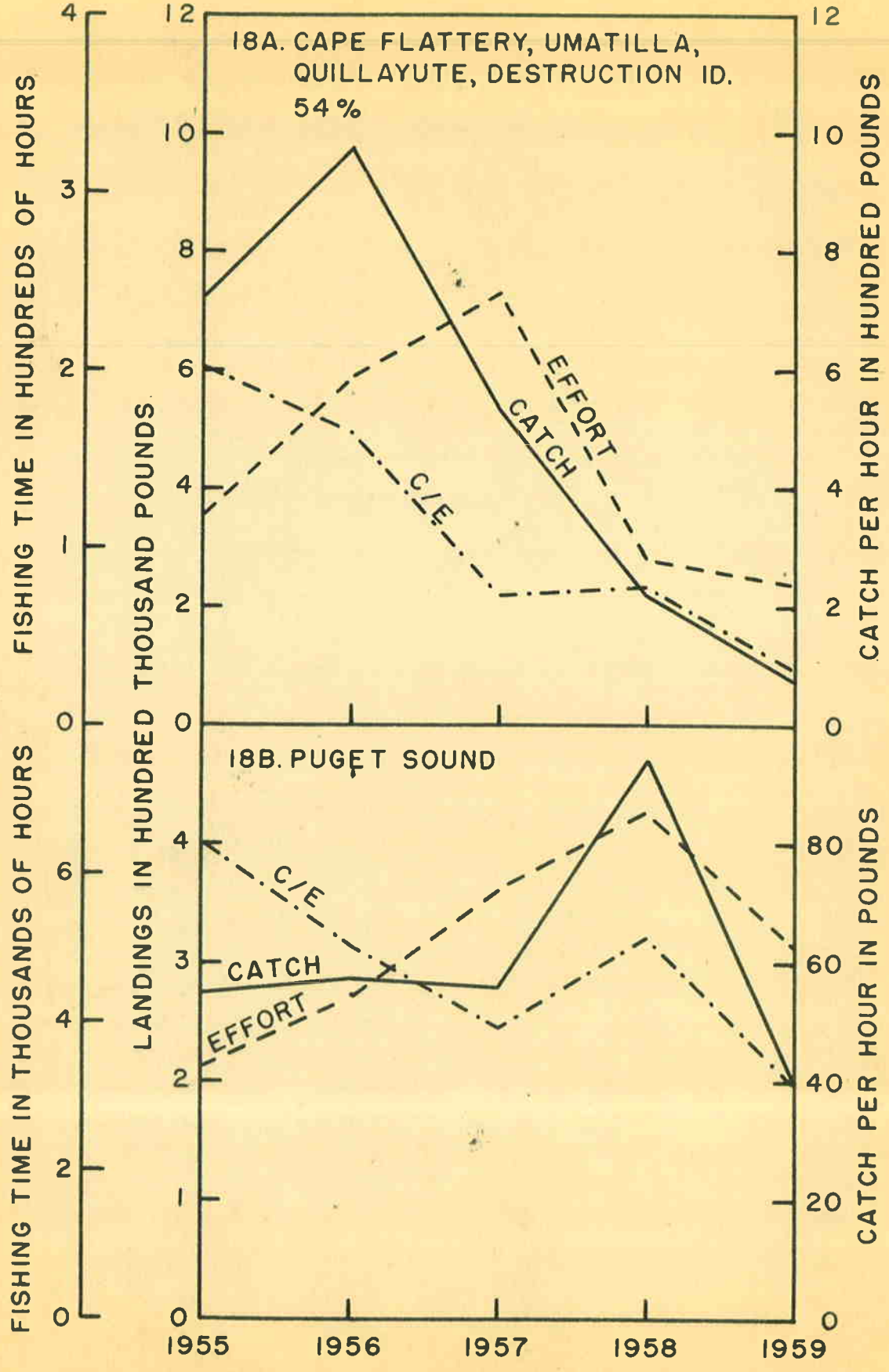


Figure 18 - Starry flounder catch, calculated effort, and catch per hour from the Cape Flattery to Destruction Island and Puget Sound areas by year, 1955 through 1959.

Effort continued to increase in 1957, and both catch and catch per hour declined. In the next two years, 1958 and 1959, all three measures decreased. The unfavorable reactions of the fish to the fishery indicate that the starry flounder stocks are less available and are probably exploited to a point beyond which they cannot maintain themselves.

The flounder statistics for Puget Sound are shown in Figure 18-B. The data are typical of other stocks of fish within the Sound. Effort is increasing generally; a slight decline was exhibited in 1959. Catch leveled for two years, increased in 1958 then declined to a new low in 1959. Catch per hour is generally decreased with some reflection of the increased catches in 1958. Similar to other species, catch per hour has been driven below the 100 pounds per hour rate. Here again, the stocks of fish appear to be at a low level of abundance. As long as there is a slim margin of profit to be gained fishermen will pursue the last fish. Although these fish are not becoming extinct, regulation of effort should bring an increase of fish which would allow fishermen to catch the same poundage with less effort.

Pacific True Gray Cod

The above title includes most of the common names to which this fish is subjected along the coast. This species was in 1959 the most important one landed in Washington by weight and value received by the fishermen.

Considering the combined ocean catch which is given in Table 7 and graphed in Figure 19, effort has decreased during the last five years, catch declined in 1956, but increased after that. Catch per hour decreased in 1956, but increased in later years.

Starting to the northward, Figure 20-A shows the data for Hecate Strait where 39 per cent of the Washington landings originate. The amount of fishing effort increased during the years for which the data are available.

Table 7 - Pacific true gray cod catch data from interviews extrapolated to the total landings.

	1955	1956	1957	1958	1959	5-year ave.
HECATE STRAIT	39 per cent of the total catch					
Pounds	3,590,045	1,581,455	2,803,434	5,035,622	6,772,584	3,956,628
Hours	2,666	1,932	2,415	2,577	4,736	2,865
Lbs/hr.	1,347	818	1,161	1,954	1,430	1,381
1955 Index lbs/hr.	100	61	86	145	106	
GOOSE ISLAND-CAPE SCOTT	22 per cent of the total catch					
Pounds	2,325,809	3,089,822	3,598,041	1,539,872	675,165	2,245,742
Hours	4,894	5,871	4,274	2,898	1,750	3,937
Lbs/hr.	475	526	842	531	386	570
Per cent change lbs/hr.	100	111	177	112	81	
ESPERANZA-ESTEBAN	6 per cent of the total catch					
Pounds	1,364,347	529,446	454,566	124,192	470,686	588,647
Hours	3,780	2,204	2,150	1,060	1,227	2,084
Lbs/hr.	361	240	211	117	384	282
Per cent change lbs/hr.	100	66	58	32	106	
UCLUELET-FORTY-mile and SWIFTSURE	8 per cent of the total catch					
Pounds	914,120	1,153,939	1,053,086	475,867	550,403	829,483
Hours	1,858	2,135	1,672	1,355	3,052	2,014
Lbs/hr.	492	540	630	351	180	412
Per cent change lbs/hr.	100	110	128	71	37	
CAPE FLATTERY-UMATILLA	16 per cent of the total catch					
Pounds	2,901,161	1,193,145	634,563	1,352,047	1,792,667	1,574,717
Hours	9,940	5,334	2,895	4,052	4,259	5,296
Lbs/hr.	292	224	219	334	421	297
Per cent change lbs/hr.	100	77	75	114	144	
QUILLAYUTE-DESTRUCTION ISLAND	9 per cent of the total catch					
Pounds	572,021	782,389	975,589	1,202,698	945,861	895,712
Hours	3,708	4,548	3,359	4,384	3,423	3,884
Lbs/hr.	154	172	290	274	276	231
Per cent change lbs/hr.	100	112	188	178	179	
OCEAN TOTAL						
Pounds	11,673,684	8,433,503	9,591,725	9,813,000	11,217,653	10,145,913
Hours	26,890	22,465	17,049	16,434	18,529	20,273
Lbs/hr.	434	375	563	597	605	500
Per cent change lbs/hr.	100	86	130	138	139	
PUGET SOUND						
Pounds	934,439	1,127,411	1,688,690	2,388,801	1,692,663	1,766,401
Hours	13,058	12,239	19,769	18,626	18,513	16,441
Lbs/hr.	72	92	85	128	91	107
Index	100	128	118	178	126	

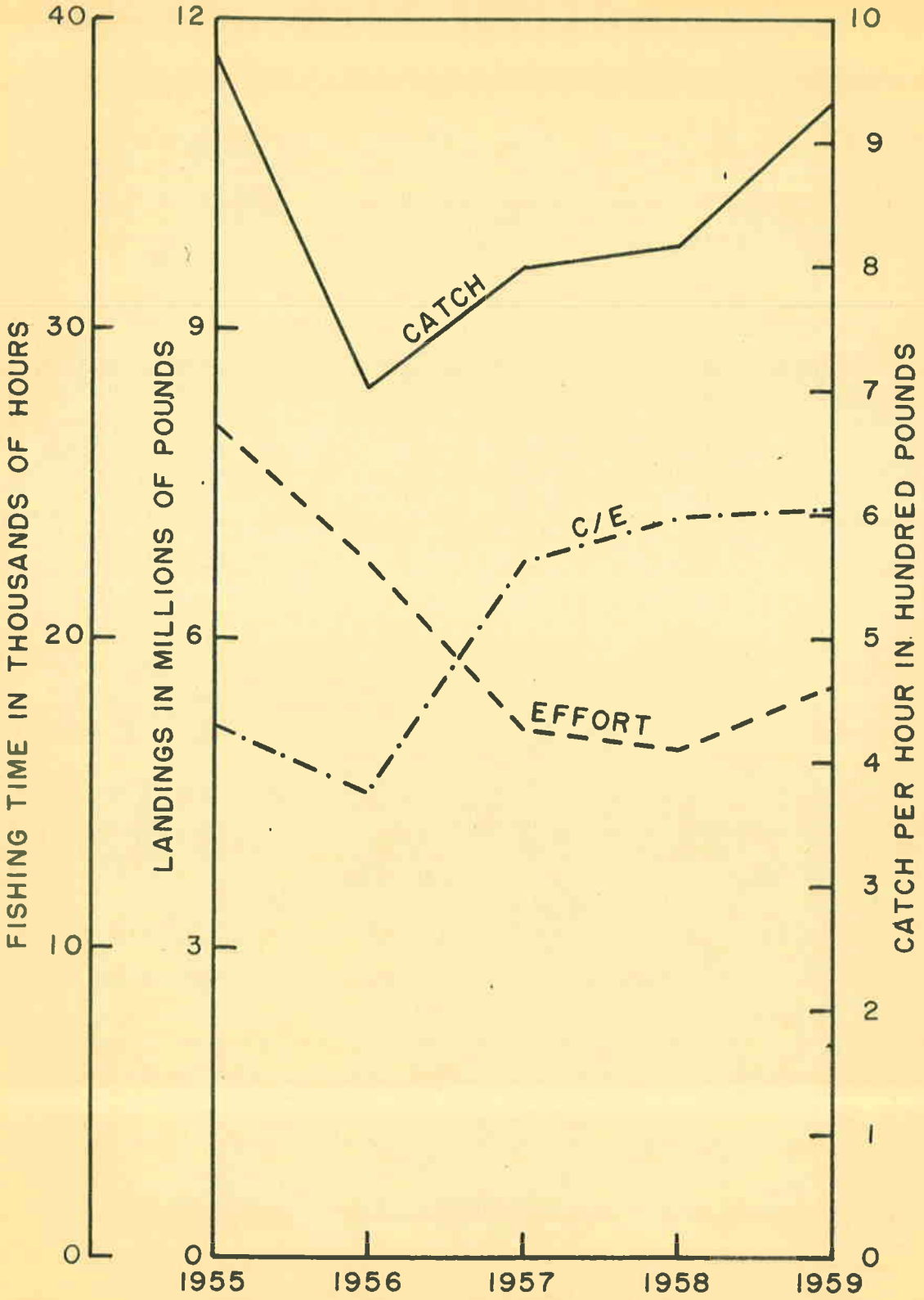


Figure 19 - Pacific cod catch, calculated effort, and catch per hour from all ocean areas by year, 1955 through 1959.

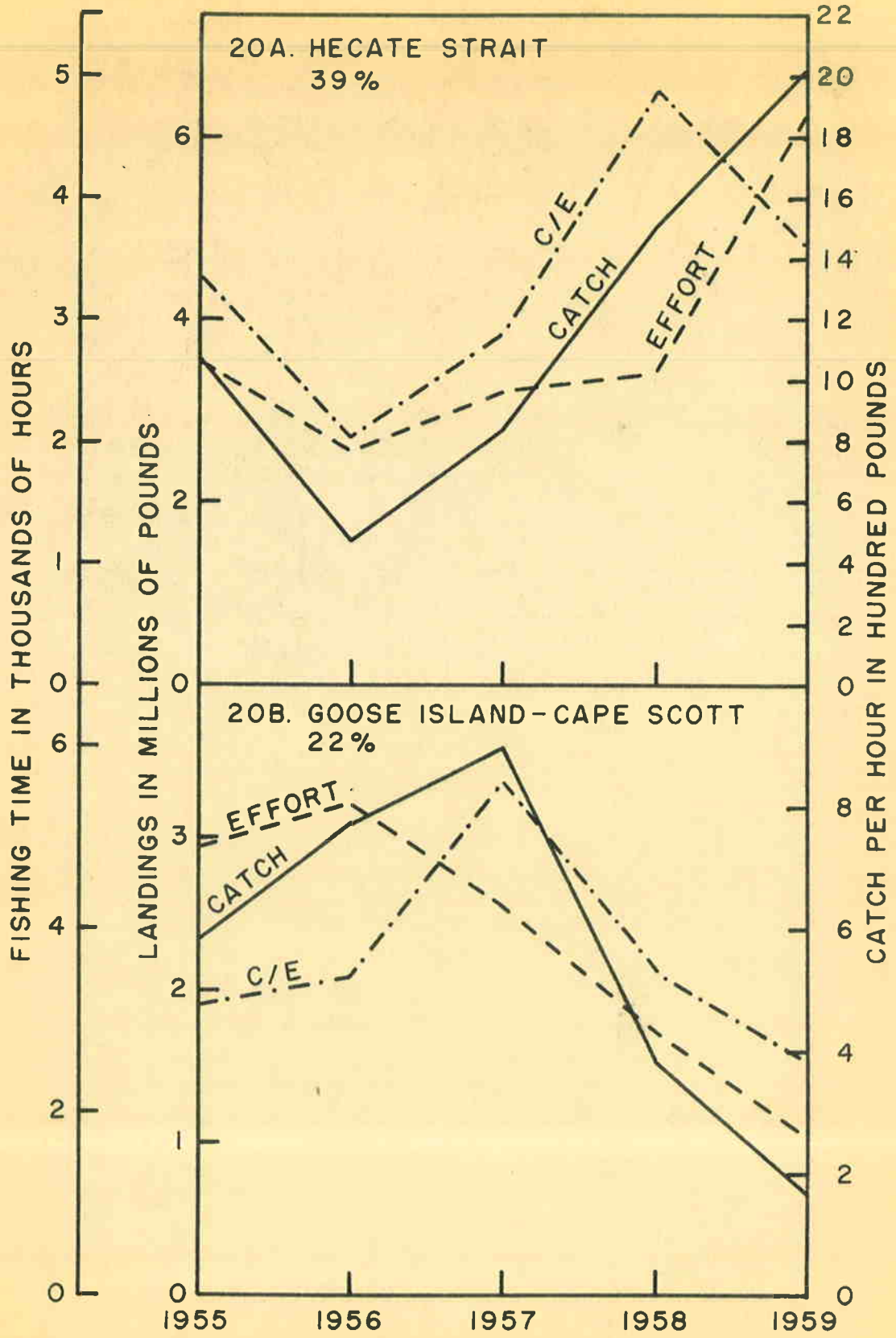


Figure 20 - Pacific cod catch, calculated effort, and catch per hour from Hecate Strait and Goose Island-Cape Scott areas by year, 1955 through 1959.

Poundage has also increased. Fishing success or catch per hour followed the decline of effort and catch in 1956. The catch per hour then increased for two years, but in 1959, when both effort and catch increased, catch per hour declined. The high catch per hour rate for these stocks is indicative of a newly exploited fishery, however, this is an old fishery. In fact, the initial abundance has been cropped to the point where the catch consists of a few incoming year classes. Unstable conditions usually result from such a fishery. Declining fishing success may eliminate the American fishermen who must have good fishing to make the long trip to these waters profitable.

Figure 20-B gives the fishing data for the combined Goose Island and Cape Scott grounds which produces 22 per cent of Washington's trawl-caught cod. Fishing effort increased in 1956 and then decreased rather steadily for the last three years. Catch increased until 1957 and then followed effort in decline. Catch per hour of fishing followed the poundage in its variations which indicates unfavorable conditions in this segment of the cod fishery.

The catch statistics for the Esperanza and Esteban areas have been combined (Figure 21-A). This combined area produces 6 per cent to the cod catch. All three statistics declined from 1955 to 1958 in this area. In 1959 a slight increase in effort produced a larger catch and a large increase in the catch per hour rate. This could be the discovery of new stocks, or an increase in abundance of fish resulting from the declining fishing effort, or the entry of an abundant year class into the fishery. Stocks in this area seem to be maintaining their abundance, although the catch rate is about one fifth of that found in Hecate Strait.

Eight per cent of the Washington trawl cod catch in the five-year period came from the combination of three areas: Ucluelet, 40-mile Bank, and Swiftsure (Figure 21-B). From 1955 to 1956 effort, catch, and catch per hour all increased. This is a favorable circumstance. From 1956 to 1957 effort

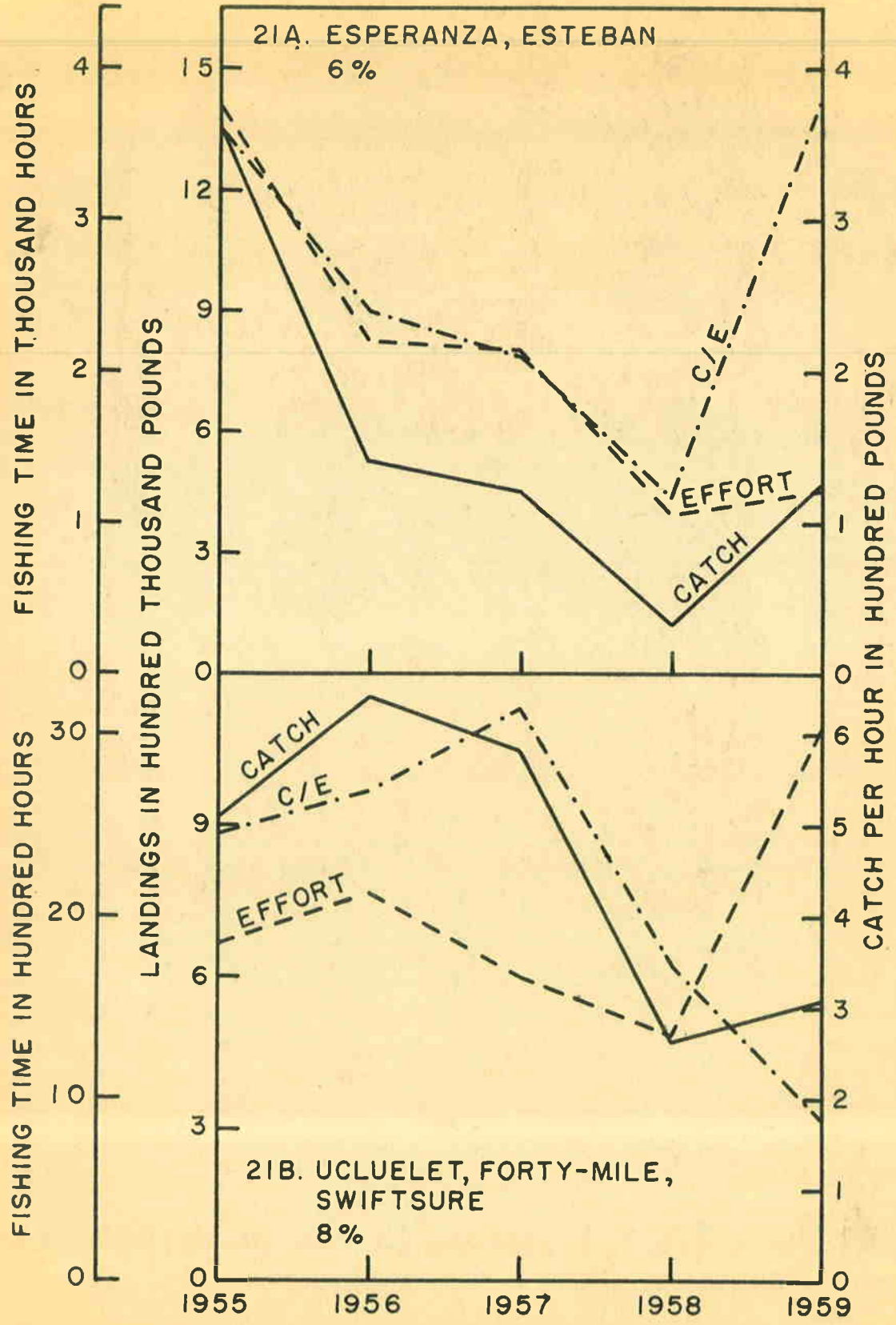


Figure 21 - Pacific cod catch, calculated effort, and catch per hour from Esperanza-Esteban and the Ucluelet-40 mile-Swiftsure Bank areas by year, 1955 through 1959.

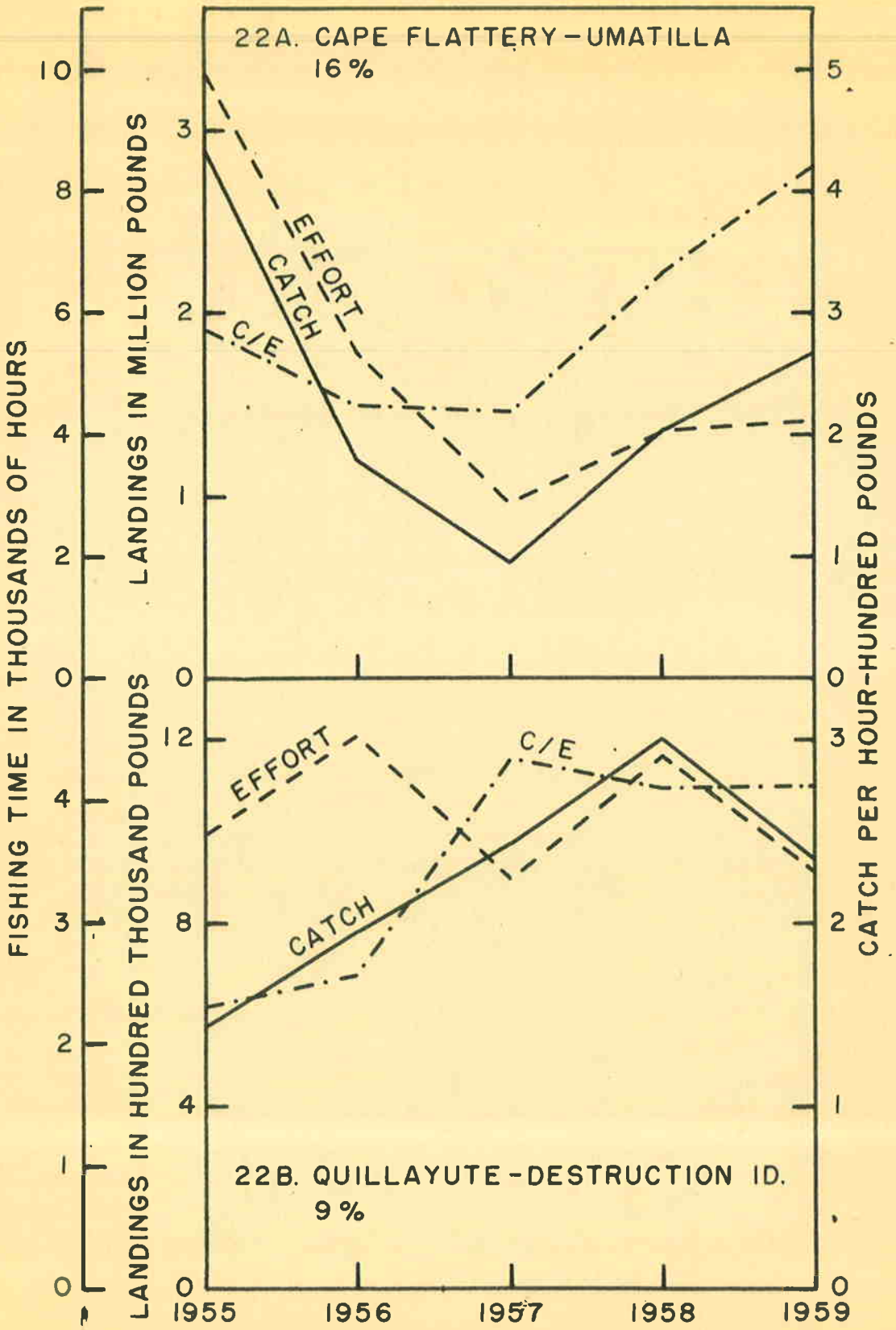


Figure 22 - Pacific cod catch, calculated effort, and catch per hour from the Cape Flattery-Umatilla and Quillayute-Destruction Island areas by year, 1955 through 1959.

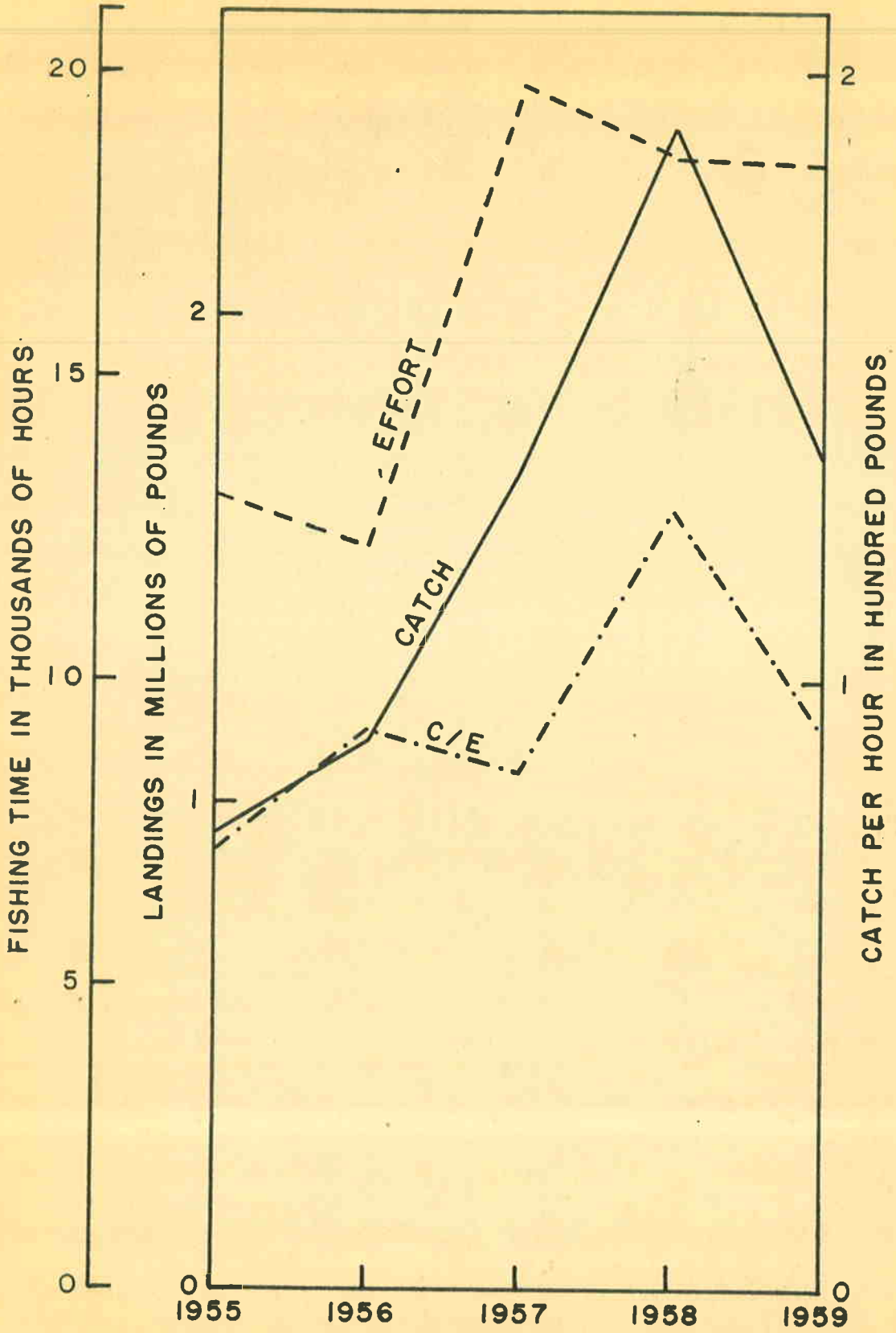


Figure 23 - Pacific cod catch, calculated effort, and catch per hour from the Puget Sound area by year, 1955 through 1959.

and catch decreased, but catch per hour continued to increase which is a more favorable reaction. In 1958 all three measures decreased which is not cause for alarm. However, in 1959 a large increase in effort produced only a slight increase in poundage and a decrease in catch per hour. This is not a desirable situation, and is puzzling after the former reactions. Such developments indicate that the Canadian catch may be large enough to affect the abundance of fish in the area or the fish were simply not available to be caught in 1959.

The Cape Flattery-Umatilla area (Figure 22-A) produced 16 per cent of the total catch averaged over the 1955 through 1959 period. Effort decreased considerably during 1956 and 1957. Catch also decreased. The rate of catch (C/E) decreased to a lesser degree. Effort increased in 1958 and to some extent in 1959, and the catch followed the increase in effort. Catch per hour increased considerably in the latter two years. The trawl fishery for cod appears to be in good condition. Stocks are being maintained as interpreted from these data.

The combined Quillayute-Destruction Island area yields nine per cent of the cod catch in the ocean areas (Figure 22-B). This area is about the southern limit of the commercial fishing range of the cod. Only small poundages of cod are caught to the southward. Here effort has oscillated around 3,900 hours for five years. Poundage has increased from 1955 to 1958, and then decreased somewhat in 1959. Fishing success (C/E) increased from 1955 until 1957. It then decreased slightly in 1958, and remained level through 1959. From these data stocks of cod appear to be continuing in abundance. Here again, fishing success is about one-fifth that experienced by fishermen in Hecate Strait.

In Puget Sound (Figure 23) about 1.75 million pounds of Pacific cod were caught on an average over the study period. Fishing effort increased over

the period. Catch increased generally with a peak in 1958 and a decline in 1959. Success of fishing also increased somewhat, and this measure of availability reflected the 1958 peak of production. Although apparently stabilized, cod stocks have, like other species in the Sound, been driven to a low level. This is evidenced by the low (100 pound per hour) rate of catchability.

Sablefish (Blackcod)

Sablefish or blackcod ranks eighth in poundage and value among the trawl-caught species. This species is also exploited extensively by set line fishermen. Poundage records have often alternated high and low by years showing that market demand limits production when there is a large hold-over of frozen sablefish from a previous year.

The data from all areas, Table 8 and Figure 24, show generally decreasing effort, and except for a brief flurry in 1956, relatively level production and fishing success in this five-year period. Two factors render these data of little value in estimating the condition of the sablefish stocks. First and perhaps of greatest consequence is the fact that the catch by set line fishermen is large and should be considered simultaneously to analyze the effect of both fisheries upon the stocks. For example, in 1958 set liners took 76 per cent and the trawlers 24 per cent of the 1.5 million pounds of sablefish which were caught that year. Second, market limitations reduce the catch in some years. Consequently, the incidental catch of sablefish can usually supply the market demands; at times sablefish are discarded, especially small blackcod; but when demand is good fishermen seek out this species. They do not have to go very far afield as 95 per cent of the catch comes from the nearby areas, lower west Vancouver Island to Destruction Island.

Catch and effort bear little relation to each other in the area including Hecate Strait, Goose Island, and Cape Scott grounds shown in Figure 25-A.

Table 8 - Sablefish catch data from interviews extrapolated to the total landings

	1955	1956	1957	1958	1959	5-yr. ave.
HECATE STRAIT-GOOSE ISLAND and CAPE SCOTT						
	4 per cent of total					
Pounds	21,621	29,252	67,165	75,732	38,544	46,463
Hours	609	1,202	1,321	573	874	916
Lbs/hr.	36	24	51	132	44	51
Index lbs/hr.	100	67	142	367	82	
LOWER WEST VANCOUVER ISLAND						
	16 per cent of total ocean trawl catch					
Pounds	180,367	221,308	188,690	148,838	133,866	174,614
Hours	2,105	1,274	2,741	3,305	1,633	2,212
Lbs/hr.	86	174	69	45	82	79
Index lbs/hr.	100	202	80	52	95	
CAPE FLATTERY-UMATILLA						
	62 per cent of total ocean trawl catch					
Pounds	133,103	2,767,594	248,526	69,764	215,037	686,805
Hours	1,766	3,374	840	1,561	988	1,706
Lbs/hr.	75	820	296	45	218	403
Index lbs/hr.	100	1,093	395	60	291	
QUILLAYUTE and DESTRUCTION ISLAND						
	17 per cent of total ocean trawl catch					
Pounds	101,073	247,134	52,688	28,412	512,340	188,329
Hours	1,829	445	495	883	406	812
Lbs/hr.	55	555	106	32	1,262	232
Index lbs/hr.	100	1,009	193	58	2,295	
OCEAN TOTAL						
Pounds	442,666	3,266,456	562,367	342,324	920,678	1,106,898
Hours	6,606	6,318	5,536	6,723	4,336	5,904
Lbs/hr.	67	517	102	51	212	187
Index lbs/hr.	100	772	152	76	316	

Four per cent of the sablefish catch was taken in this combined area. Effort increased in 1956, catch increased slightly, and catch per effort decreased. Effort increased slightly in 1957, catch increased considerably, and C/E increased. The decrease in effort in 1958 was coupled with a slight increase in catch which produced a fair increase in fishing success. Then, in 1959, an increase in effort produced a decline in both catch and success of fishing. Ordinarily, this would mean that a fishery is cropping the fish at a maximum rate for sustaining the level of the sablefish populations in a given area. However, the low rate of fishing success, near or less than 100 pounds per hour indicates that sablefish

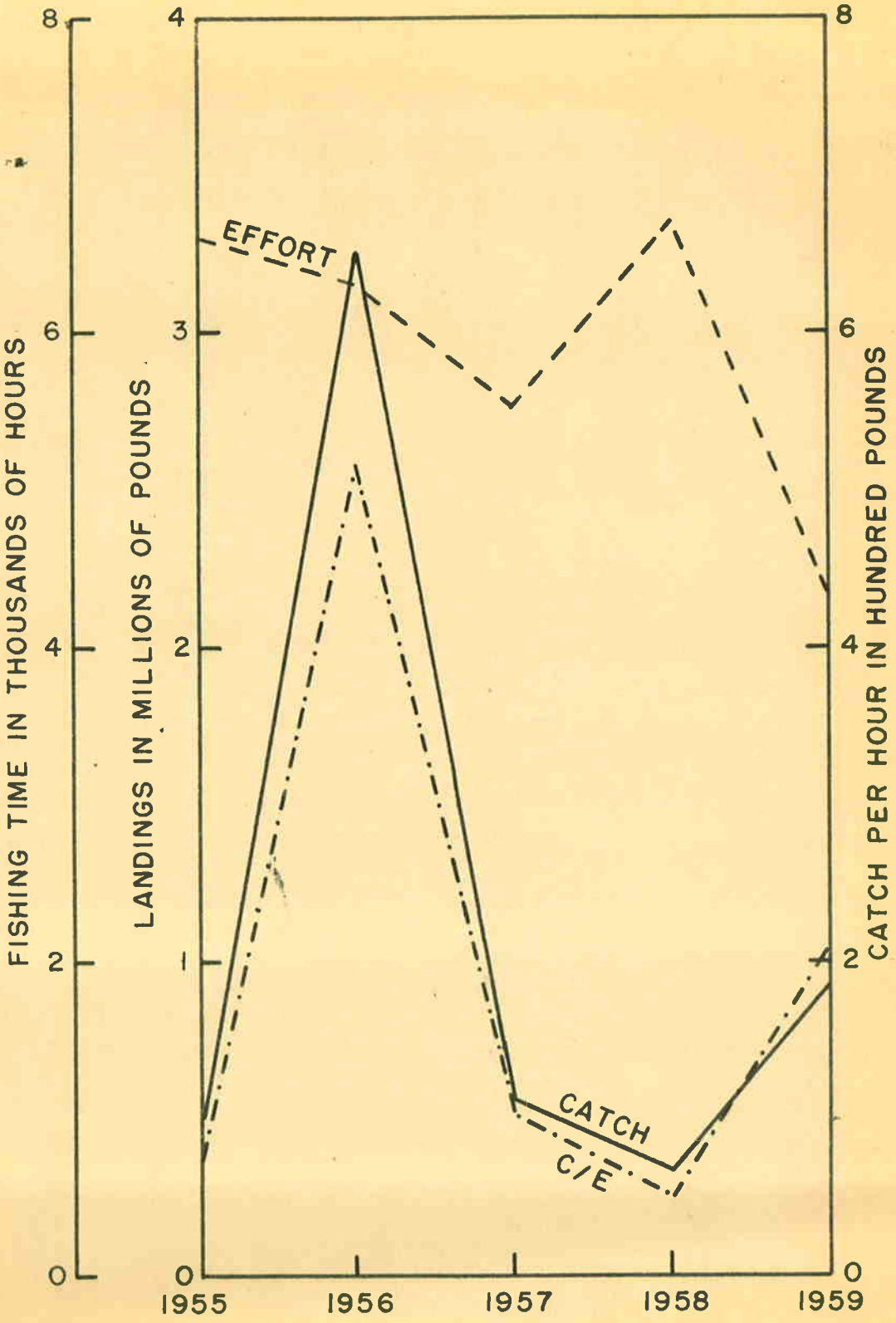


Figure 24 - Sablefish catch, calculated effort, and catch per hour from all ocean areas by year, 1955 through 1959.

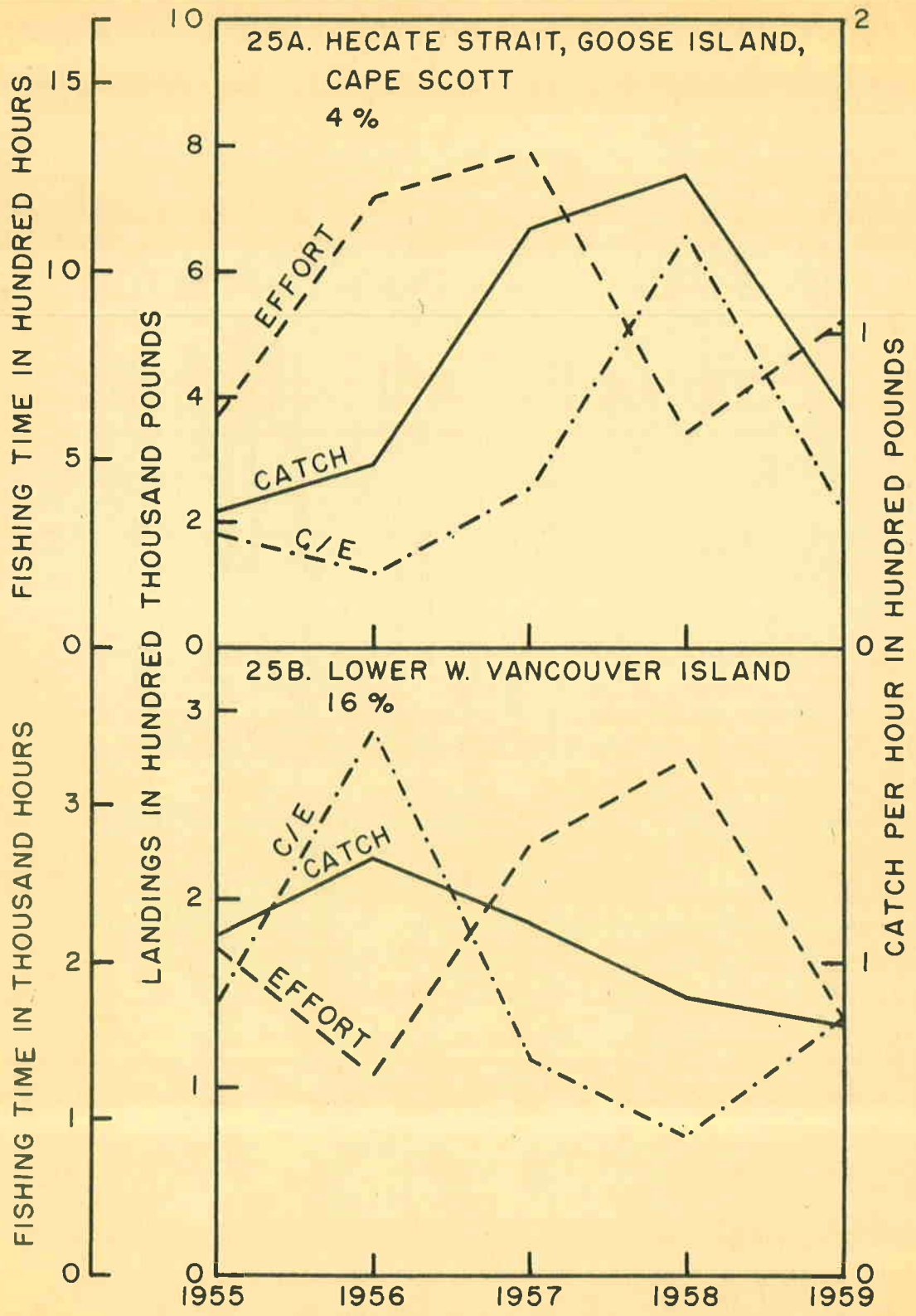


Figure 25 - Sablefish catch, calculated effort, and catch per hour from the Hecate Strait-Goose Island-Cape Scott and Lower West Coast of Vancouver Island areas by year, 1955 through 1959.

are caught incidentally to the fishing effort expended in search of other species as the fishing success for other species is much above this figure.

Sixteen per cent of the trawl catch of sablefish comes from the west coast of lower Vancouver Island, (Figure 25-B). Effort decreased in 1956 while catch and catch per hour both increased. Effort increased through 1958 and decreases occurred in catch and catch per hour. Then, in 1959 effort decreased, but catch decreased also with an increase in catch per hour which is difficult to interpret except to blame the incidental nature of the sablefish fishery.

The majority of the landings, 62 per cent, are taken in the Cape Flattery-Umatilla area, and the similarity of Figure 26-A to the total catch in Figure 24 is expected. Fluctuations are perhaps more exaggerated in the smaller area. Effort has decreased in the five years except during 1956. Catch is slightly increased as is fishing success. Fishing success or catch per hour is generally better here than in the more northerly areas which is the reverse situation than for most species. This indicates that fishermen are more inclined to fish exclusively for sablefish in this area, although much of the catch is incidental to Pacific Ocean perch, rockfish, and Dover sole.

Seventeen per cent of the sablefish catch is taken in the Quillayute to Destruction Island area shown in Figure 26-B. Here effort declined considerably from 1955 to 1956 and has not increased proportionately since. Catch was generally decreasing until 1959 when catch increased five times the 1955 level. Fishing success or C/E increased 23 times the 1955 rate. Many undersized sablefish are discarded while fishing in these areas at times during the year. The use of larger mesh nets ($4\frac{1}{2}$ inch) was of considerable benefit to this species in allowing the small fish to escape.

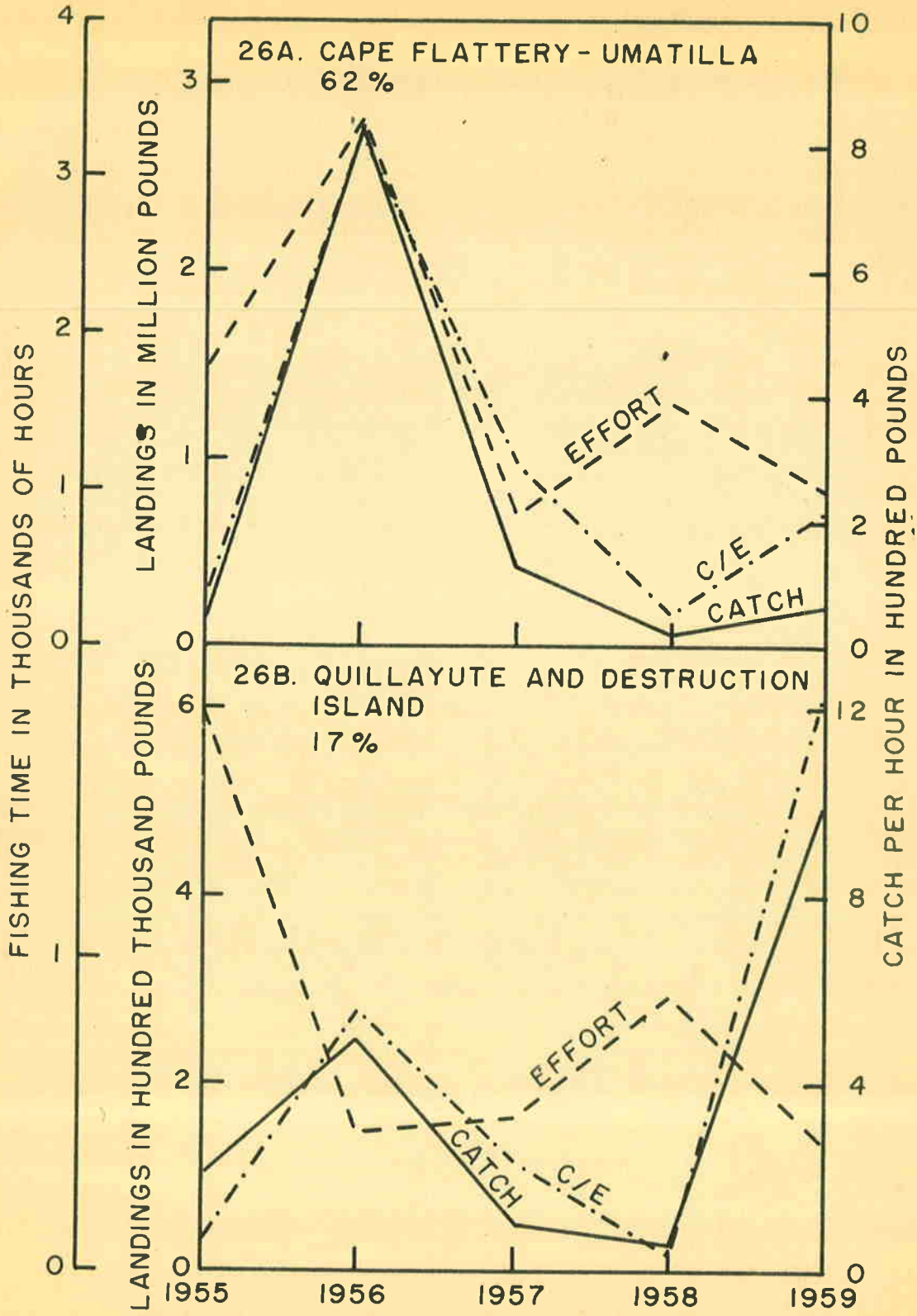


Figure 26 - Sablefish catch, calculated effort and catch per hour from the Cape Flattery-Umatilla and Quillayute-Destruction Island areas by year, 1955 through 1959.

Lingcod

About three-fourths of the total landings of lingcod are taken by trawl gear. These fish are also caught by troll, set line, hand line, set net, gill net, and drag seine. In the trawl fishery, lingcod ranks fifth in poundage and seventh in value. The catch of lingcod is taken incidentally to other species in most areas except on the 40-mile Bank where a thriving fishery exists from May through August. Thirty-nine per cent of the total catch averaged over this five-year period of study came from 40-mile Bank.

Total effort on lingcod, Figure 27 and Table 9, declined for four years but increased some in 1959. Poundage decreased for two years, but increased for the latter two years (1958 and 1959). Catch per unit of effort (pounds per hour) decreased in 1956, but rose steadily through 1959 which is a good indication.

As is usual, the areas considered separately present a differing set of circumstances. Lingcod are incidentally caught in Hecate Strait (5 per cent of the total, Figure 28-A). Effort has varied, poundage decreased, and fishing success decreased. The Goose Island area (Figure 28-B) only contributes 6 per cent to the total lingcod landings. Here effort decreased, catches declined and recovered, while catch per hour increased considerably during the last two years.

The Cape Scott area (Figure 29-A) contributes 14 per cent to the total lingcod landings. Fishing effort increased in 1956 and declined after that. The catch increased for two years, 1955 and 1956, then decreased. Fishing success increased in all four years although more slowly in the two later years, 1958 and 1959. Only four per cent of the lingcod were taken in the Esperanza area in the five year period (Figure 29-B), and all the data have generally declined. Seven per cent of the lingcod were taken in the Esteban area (Figure 30-A). Effort varied downward, catches dropped at first, but have

Table 9 - Lingcod catch data from interviews extrapolated to the total landings.

	1955	1956	1957	1958	1959	5-year ave.
HECATE STRAIT	5 per cent of the total ocean catch					
Pounds	404,047	123,090	146,909	63,568	115,522	170,627
Hours	1,676	1,301	1,477	1,014	1,590	1,412
Lbs/hr.	241	95	99	63	73	121
Index lbs/hr.	100	39	41	26	30	
GOOSE ISLAND	6 per cent of the total ocean catch					
Pounds	311,477	203,402	84,360	108,919	258,617	193,355
Hours	1,416	991	514	456	404	756
Lbs/hr.	220	205	164	239	641	256
Index lbs/hr.	100	93	75	109	291	
CAPE SCOTT	15 per cent of the total ocean catch					
Pounds	169,209	616,187	721,479	429,432	278,225	442,906
Hours	2,410	4,139	2,693	1,563	927	2,346
Lbs/hr.	70	149	268	275	300	189
Index lbs/hr.	100	213	383	393	429	
ESPERANZA	4 per cent of the total ocean catch					
Pounds	185,229	227,943	73,369	54,854	95,806	127,440
Hours	1,489	1,217	1,197	468	888	1,052
Lbs/hr.	124	187	61	117	108	121
Index lbs/hr.	100	151	49	94	87	
ESTEBAN	7 per cent of the total ocean catch					
Pounds	491,825	63,283	167,003	105,721	184,555	202,477
Hours	1,994	891	1,662	914	767	1,246
Lbs/hr.	247	71	100	116	241	163
Index lbs/hr.	100	29	40	47	98	
FORTY-MILE	39 per cent of the total ocean catch					
Pounds	606,305	734,548	912,478	1,063,730	2,799,718	1,223,356
Hours	668	1,416	1,367	1,067	4,079	1,719
Lbs/hr.	907	519	667	997	686	712
Index lbs/hr.	100	57	74	110	76	
CAPE FLATTERY	10 per cent of the total ocean catch					
Pounds	524,408	279,302	141,633	337,497	275,651	311,698
Hours	8,149	4,236	2,248	2,879	2,650	4,032
Lbs/hr.	64	66	63	117	104	77
Index lbs/hr.	100	103	98	183	163	
DESTRUCTION ISLAND	5 per cent of the total ocean catch					
Pounds	135,150	120,961	74,399	190,604	199,387	144,100
Hours	1,699	1,659	1,250	1,885	1,719	1,642
Lbs/hr.	80	73	60	101	116	88
Index lbs/hr.	100	91	75	126	145	
OCEAN TOTAL						
Pounds	3,356,637	2,718,004	2,458,721	2,620,069	4,374,764	3,105,639
Hours	22,175	19,851	14,219	11,722	14,155	16,424
Lbs/hr.	151	137	173	224	309	189
Index lbs/hr.	100	91	115	148	205	
PUGET SOUND						
Pounds	71,563	128,117	101,119	68,286	80,184	89,854
Hours	5,792	10,792	7,599	9,242	3,788	7,443
Lbs/hr.	12	12	13	7	21	12
Index lbs/hr.	100	100	108	58	175	

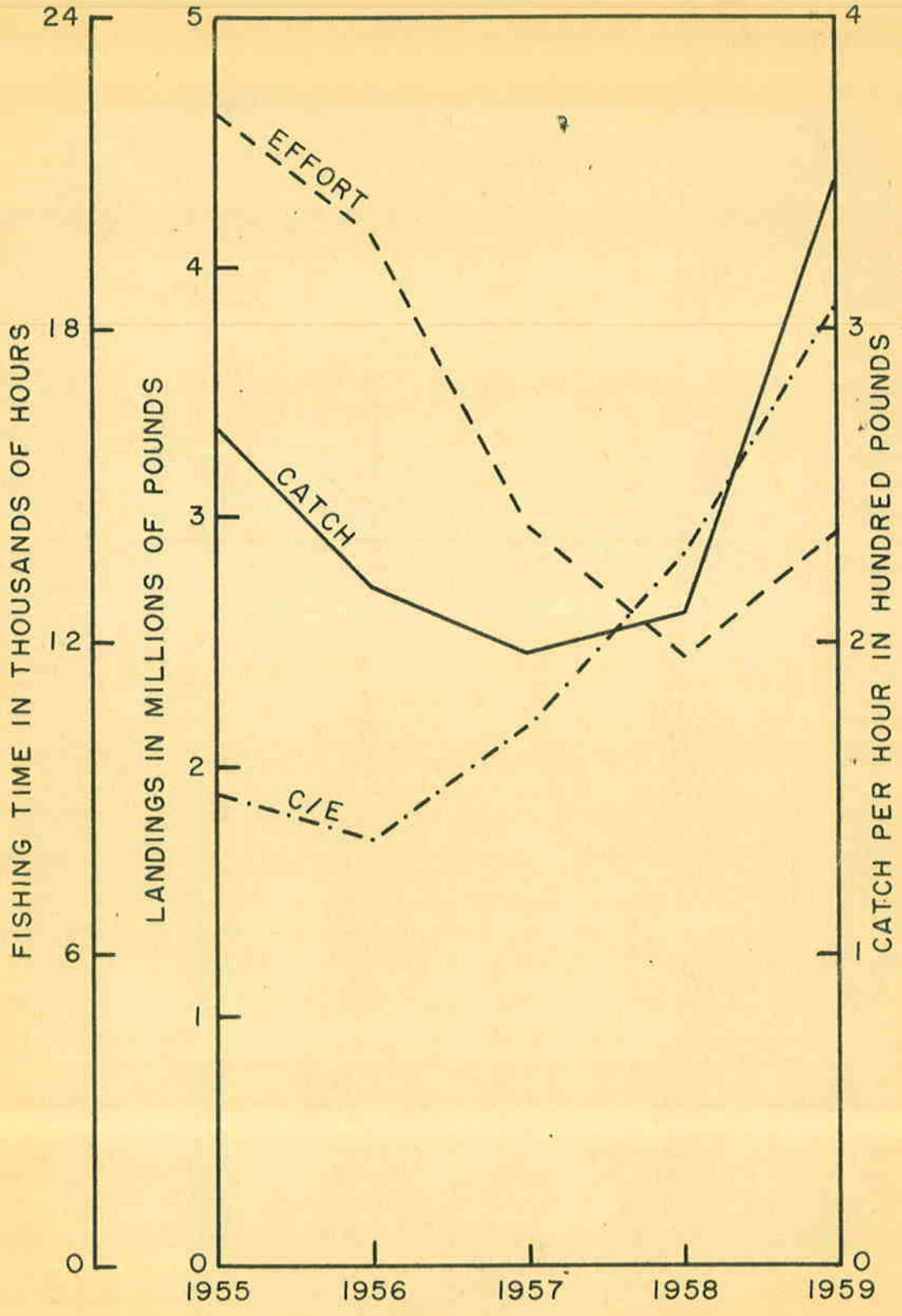


Figure 27 - Lingcod catch, calculated effort, and catch per hour from all ocean areas by year, 1955 through 1959.

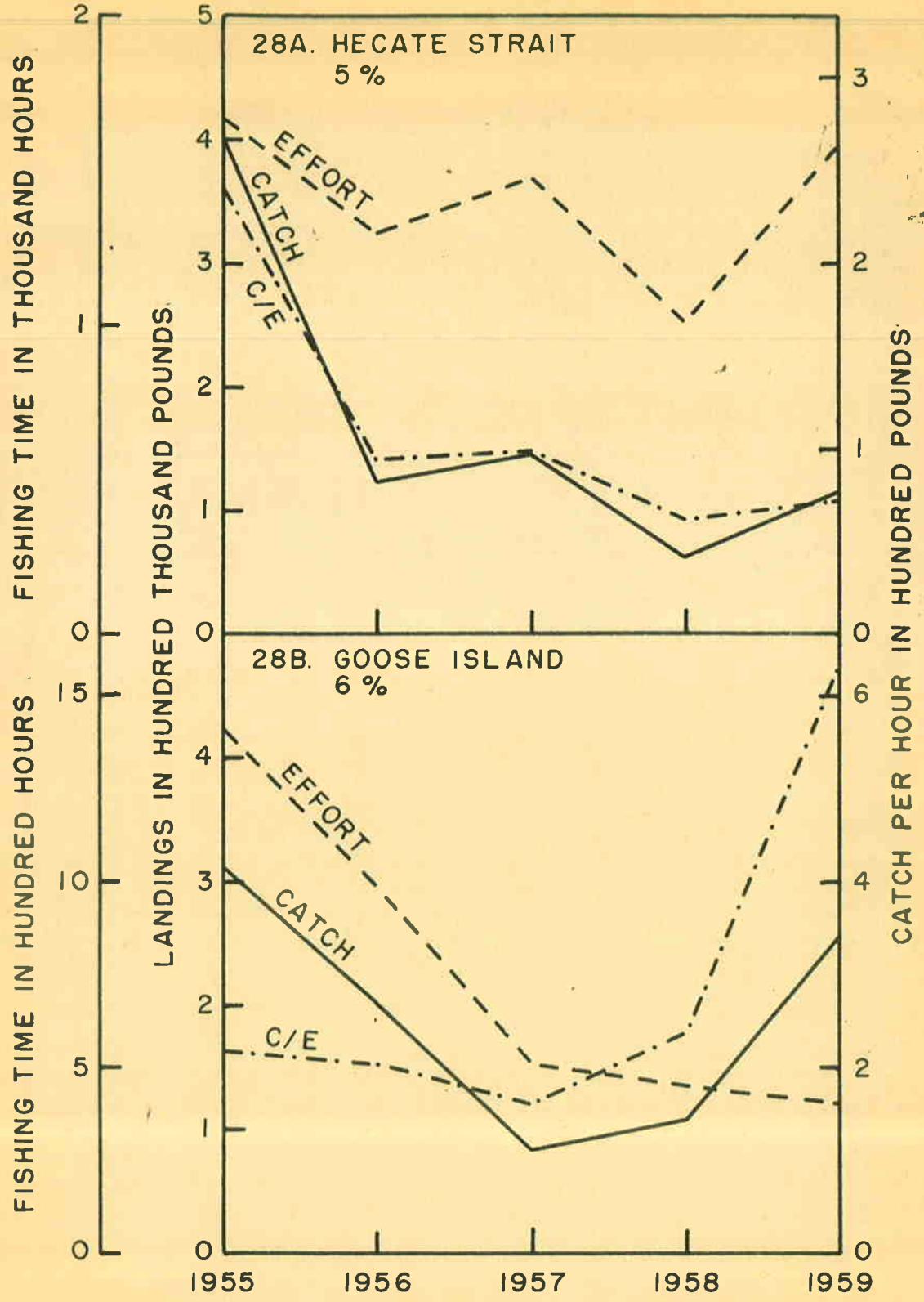


Figure 28 - Lingcod catch, calculated effort, and catch per hour from the Hecate Strait and Goose Island areas by year, 1955 through 1959.

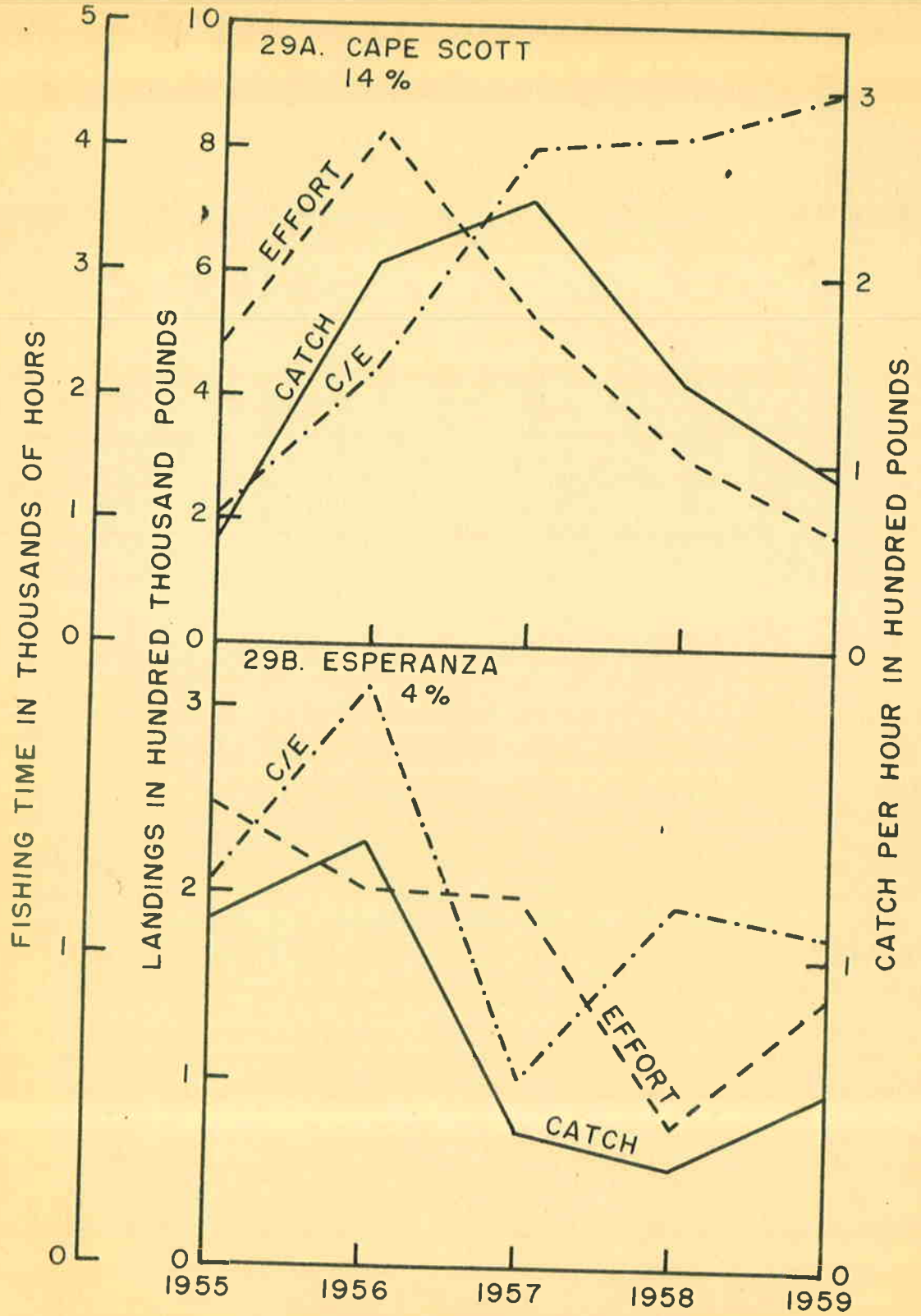


Figure 29 - Lingcod catch, calculated effort, and catch per hour from the Cape Scott and Esperanza areas by year, 1955 through 1959.

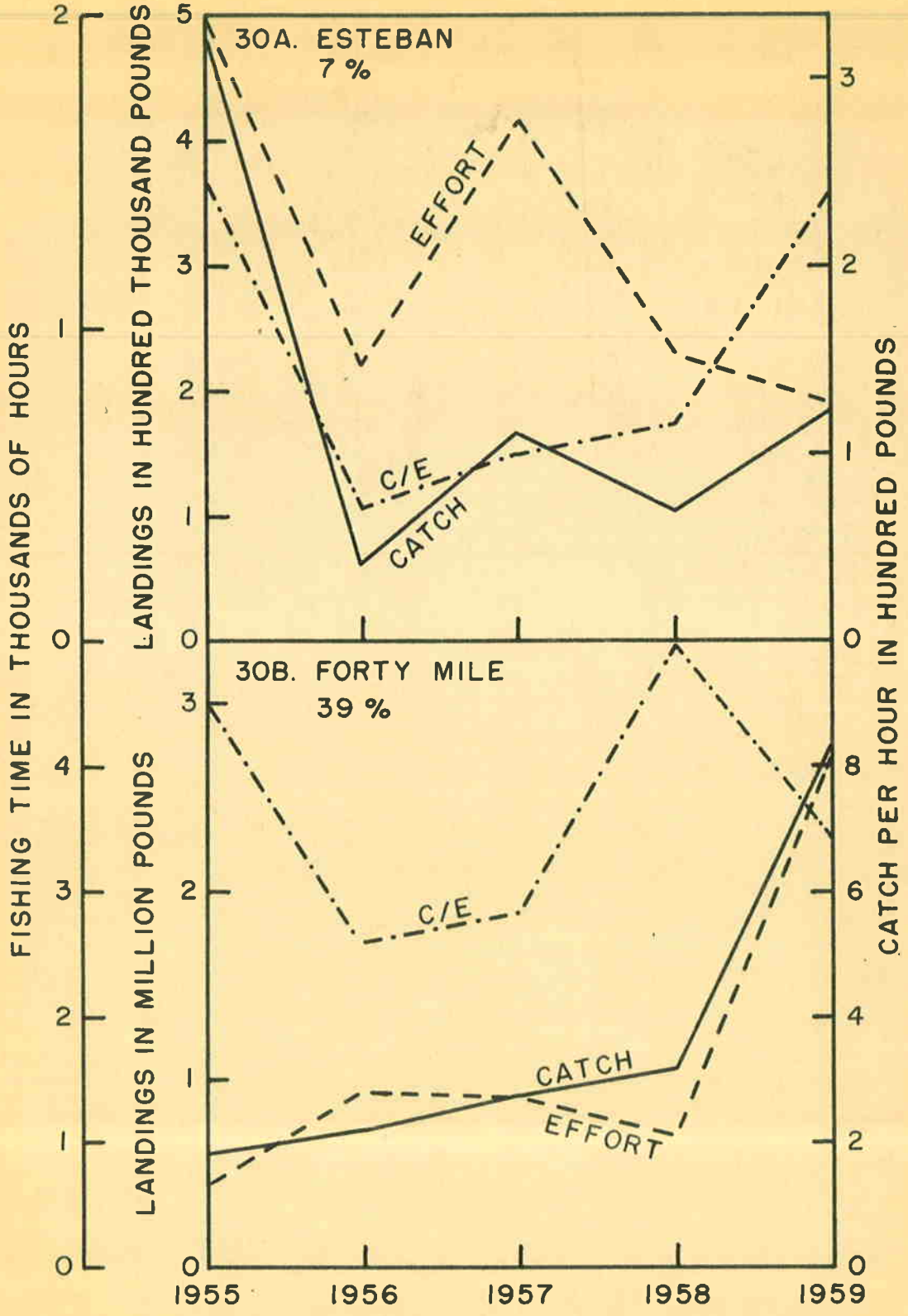


Figure 30 - Lingcod catch, calculated effort, and catch per hour from the Esteban and 40-mile Bank areas by year, 1955 through 1959.

recovered somewhat, and success decreased to a quarter of its 1955 value with a subsequent recovery in 1959 to nearly the 1955 level.

The 40-mile area, which produces more lingcod than any single area (Figure 30-B) has experienced a fourfold increase in effort, a twofold increase in catch, and a slight decrease in success of fishing. Most of the change occurred in 1959. The fluctuations in fishing success reflect availability as much as or more than abundance of fish in the case of lingcod, but the decline in 1959 should be watched closely for further decline, especially with the tremendous fishing effort that has been placed on these fish.

Lingcod catches are similar in both Cape Flattery (10 per cent) and Destruction Island (5 per cent, Figure 31). Effort decreased for two years (1956 and 1957), increased in 1958, and decreased again in 1959. Poundage followed effort in the two areas to some extent. Fishing success (catch per hour) remained about the same for three years (1955-1957) in the Cape area and then increased to a higher level for two years (1958 and 1959). Success decreased somewhat in the Destruction Island area in 1956 and 1957 and increased to a higher point in 1958 and 1959.

Puget Sound lingcod statistics have different trends than other Sound-caught species (Figure 32). After an increase in effort for three years, the effort dropped in 1959 to a point below the 1955 figure. Catch in pounds increased in 1956, decreased for two years to rise again in 1959. Catch per effort remained level from 1955 through 1957, dropped in 1958 and almost tripled in 1959. This seems encouraging until it is considered that these figures represent less than 100 pounds of fish per hour as compared to a peak of almost 1,000 pounds per hour on 40-mile Bank. The low fishing success found in Puget Sound would not economically support a commercial fishery in a more distant ocean area.

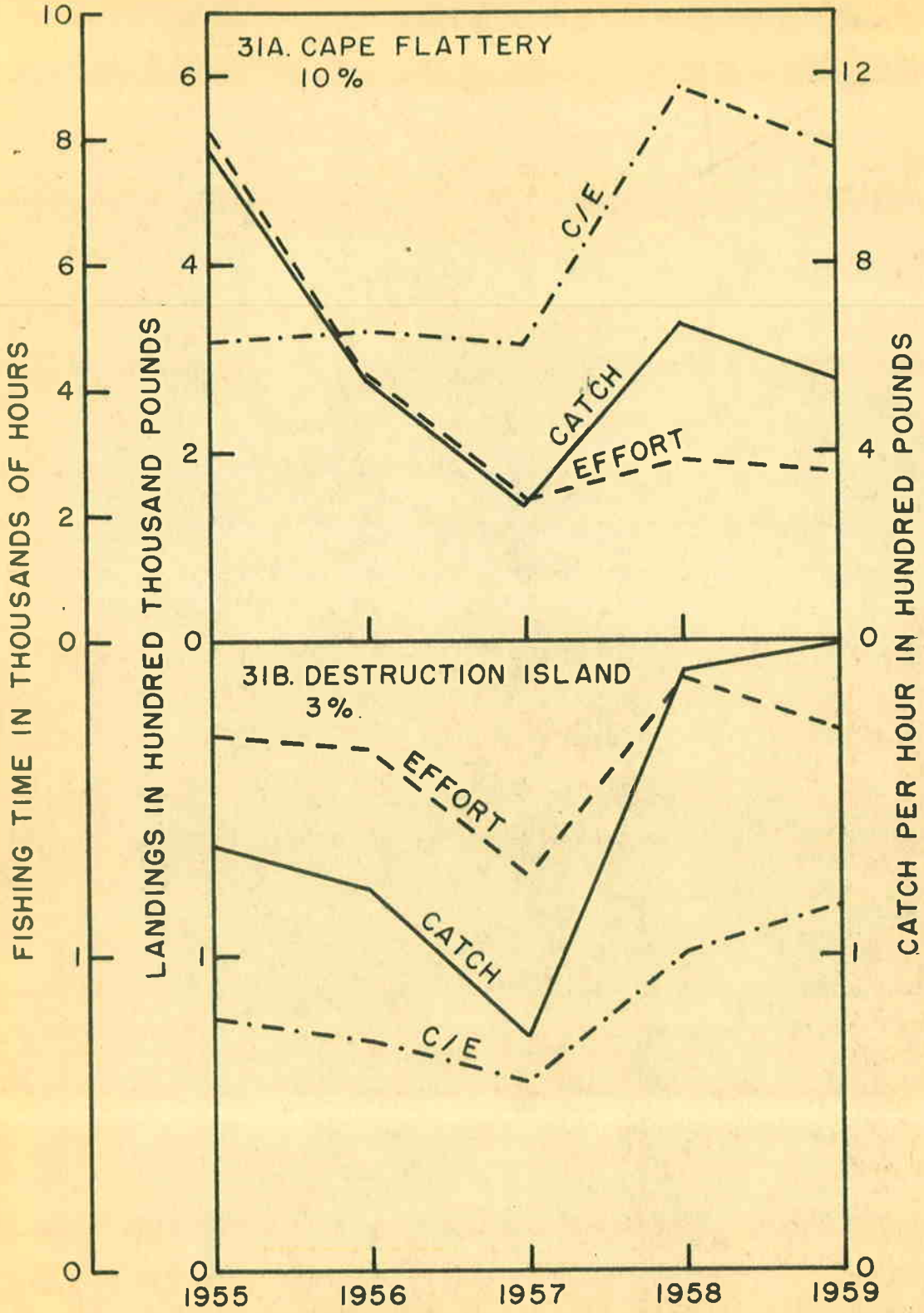


Figure 31 - Lingcod catch, calculated effort, and catch per hour from the Cape Flattery and Destruction Island areas by year, 1955 through 1959.

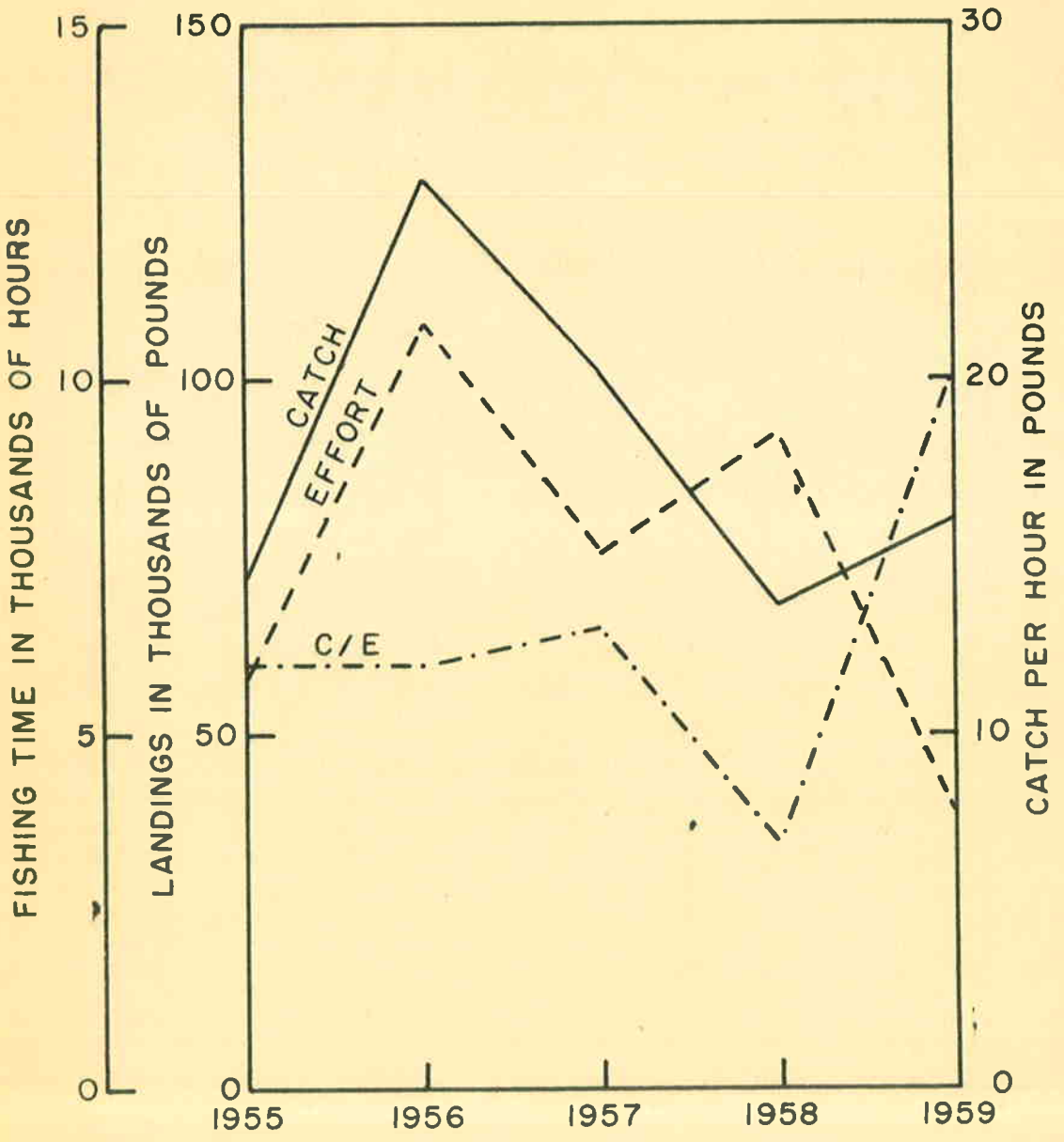


Figure 32 - Lingcod catch, calculated effort, and catch per hour from the Puget Sound area by year, 1955 through 1959.

Rockfish (except Pacific Ocean perch)

The rockfish group contains all commercially retained red and black rockfish except Pacific Ocean perch which is considered separately. The rockfish landings rank second in poundage and third in value among the trawl-caught species. Rockfish are also caught by troll, set net, hand line, and gill net gears. Trawlers land the bulk of the catch, however.

Fishing for rockfish is subject to limited market demand, and fishermen are asked almost constantly to limit their catch of these fish within reason or more frequently a specified poundage. A fisherman limited to no rockfish will avoid areas where these fish are to be found, if at all possible. If any rockfish are caught, and he cannot obtain permission by radio to keep them, the fish are discarded. With a small limit of 10,000 pounds, rockfish would be kept until this poundage was obtained, after which any rockfish would be discarded. With a larger limitation of 25,000 pounds or more, a fisherman would keep all incidental rockfish and probably fish for more. Due to market limitations, many pounds of rockfish are discarded each year. Unfortunately, no accurate measure is available of the actual discard.

Despite this gloomy aspect the total catch of rockfish is increasing after a decline in 1957 and 1958 (Table 10 and Figure 33). The number of fishing hours (effort) declined in 1956 and 1957, and then increased slightly in 1958 and 1959. Catch per hour (fishing success) has increased steadily in the last four years, 1956 to 1959.

The individual areas show varied statistics. Eleven per cent of the five-year average total catch of rockfish came from the Goose Island area (Figure 34-A). Poundage followed effort in a steady decline, while fishing success increased slightly. Twenty-one per cent of the average catch came from Cape Scott grounds (Figure 34-B). Effort increased in 1956, poundage decreased, and success decreased. Effort decreased in 1957, poundage decreased further, as did fishing success. Effort remained about the same during 1958 and 1959,

Table 10 - Rockfish catch data from interviews extrapolated to the total landings (excluding Pacific Ocean perch).

	1955	1956	1957	1958	1959	5-yr. ave.
GOOSE ISLAND	11 per cent of the total ocean trawl catch					
Pounds	792,780	653,477	628,956	413,434	306,483	599,026
Hours	2,231	2,134	1,797	991	696	1,570
Lbs/hr.	355	306	350	417	441	374
Index lbs/hr.	100	86	99	117	124	
CAPE SCOTT	21 per cent of the total ocean trawl catch					
Pounds	1,470,533	1,424,749	665,484	875,036	1,056,913	1,098,543
Hours	3,672	4,586	2,609	2,682	2,787	3,267
Lbs/hr.	400	310	255	326	379	334
Index lbs/hr.	100	78	64	82	95	
ESPERANZA-CAPE COOK	15 per cent of the total ocean trawl catch					
Pounds	781,182	1,013,632	932,579	459,666	802,928	797,997
Hours	2,014	1,935	1,758	959	1,567	1,647
Lbs/hr.	388	524	530	479	512	487
Index lbs/hr.	100	135	137	123	132	
ESTEBAN	12 per cent of the total ocean trawl catch					
Pounds	587,081	604,611	813,206	593,734	637,764	647,279
Hours	2,536	1,526	2,425	1,474	1,485	1,889
Lbs/hr.	231	396	335	403	429	359
Index lbs/hr.	100	171	145	174	186	
CAPE FLATTERY	25 per cent of the total ocean trawl catch					
Pounds	1,168,202	848,733	744,721	1,409,464	2,415,164	1,317,277
Hours	9,601	4,715	2,233	3,718	5,272	5,108
Lbs/hr.	122	180	334	379	458	295
Index lbs/hr.	100	148	274	311	375	
QUILLAYUTE-DESTRUCTION ISLAND	11 per cent of the total ocean trawl catch					
Pounds	485,548	910,620	182,330	984,861	453,867	603,445
Hours	3,623	4,038	1,950	3,701	2,688	3,200
Lbs/hr.	134	226	94	266	169	178
Index lbs/hr.	100	169	70	199	126	
OCEAN TOTAL						
Pounds	5,521,165	5,601,683	4,155,480	5,136,463	5,936,143	5,270,187
Hours	25,380	20,223	13,796	14,671	16,296	18,073
Lbs/hr.	218	277	301	350	364	302
Index lbs/hr.	100	127	138	161	170	
PUGET SOUND						
Pounds	62,314	93,339	99,005	73,946	80,032	81,727
Hours	3,431	4,167	5,122	4,024	4,301	4,209
Lbs/hr.	18	22	19	18	19	19
Index lbs/hr.	100	122	106	100	106	

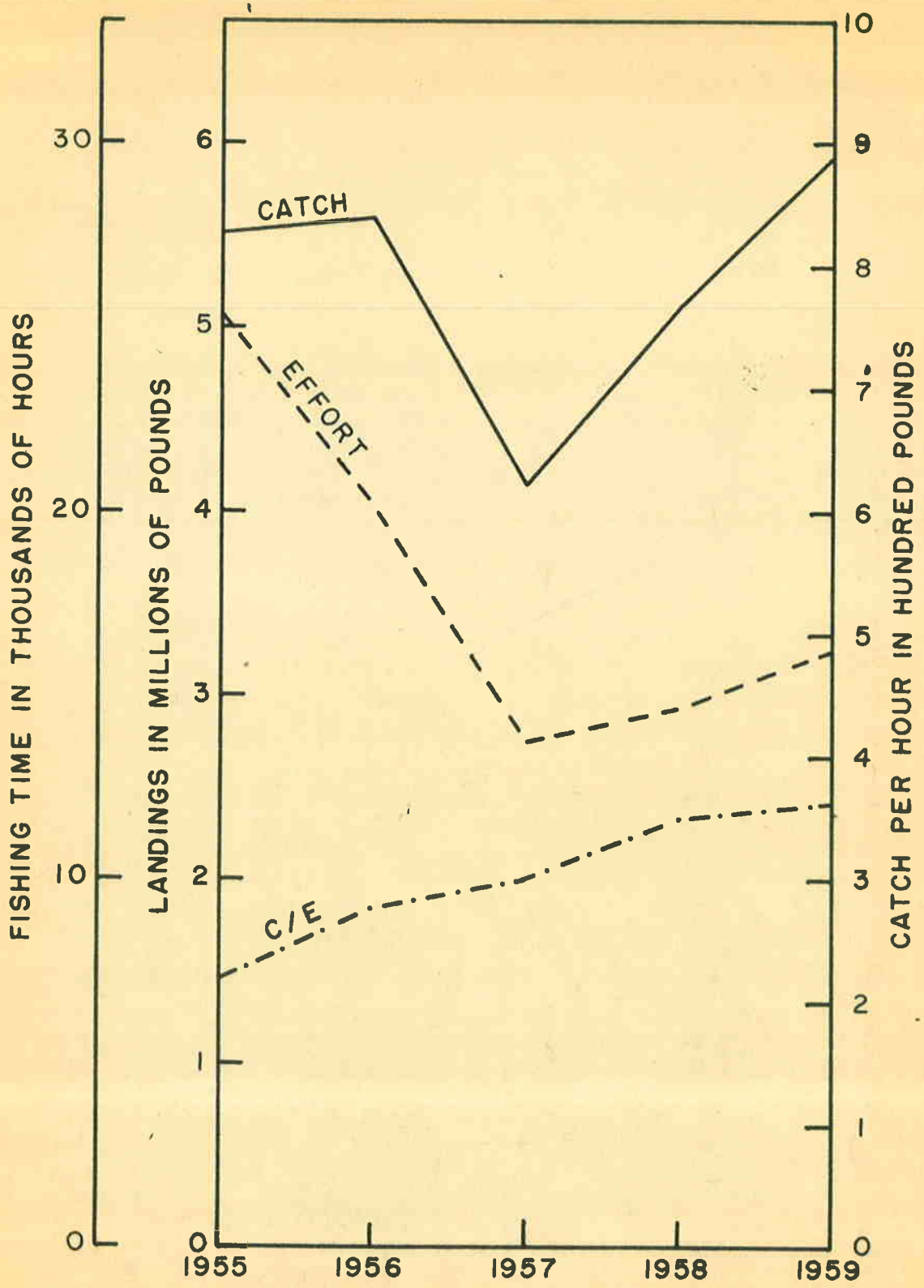


Figure 33 - Rockfish catch, calculated effort, and catch per hour from all ocean areas by year, 1955 through 1959.

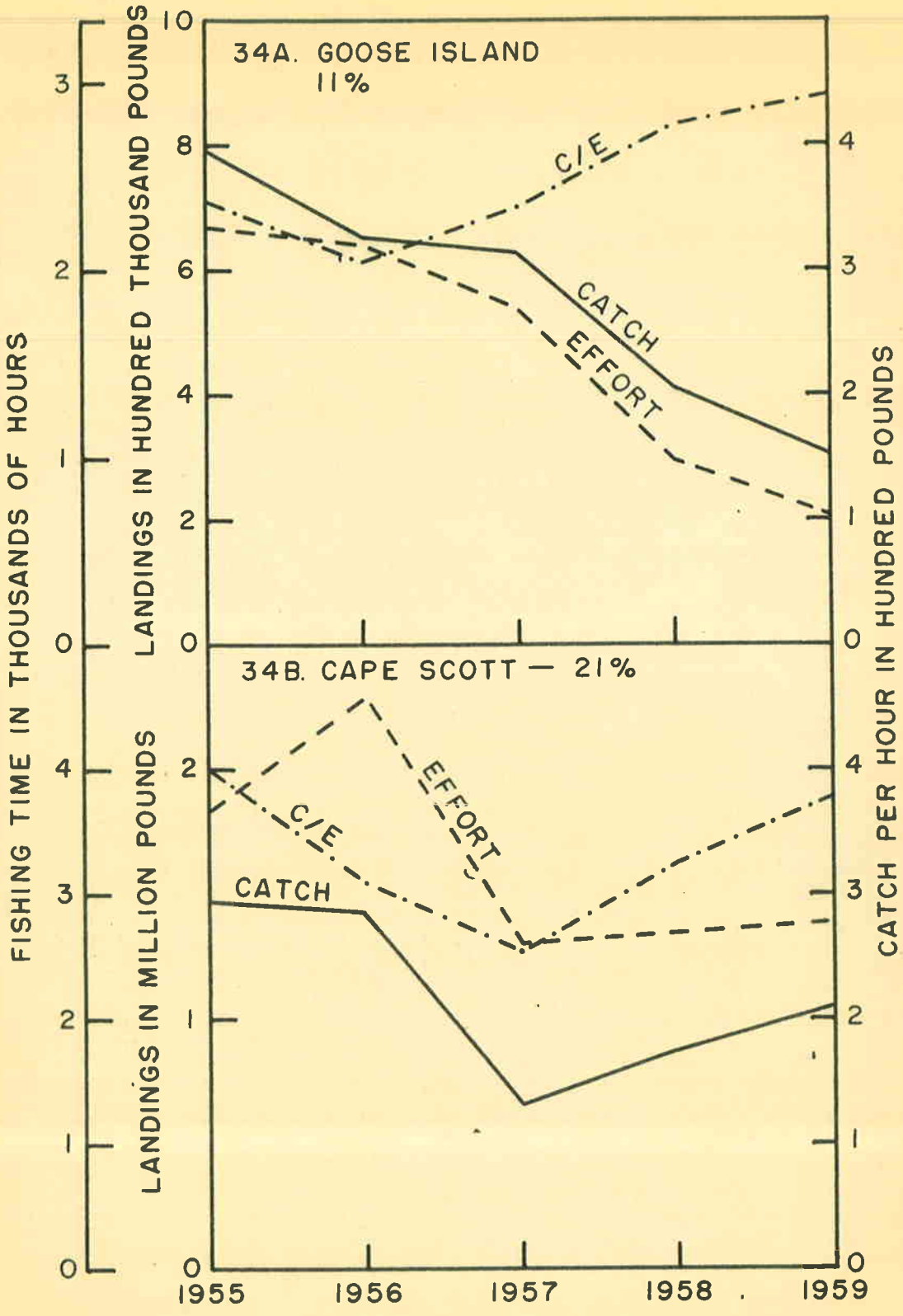


Figure 34 - Rockfish catch, calculated effort, and catch per hour from the Goose Island and Cape Scott areas by year, 1955 through 1959.

but poundage increased and fishing success increased. Rockfish were either more abundant in the Cape Scott area in 1958 and 1959, more readily available to the fishermen's nets, or new areas were exploited.

In Figure 35-A the Esperanza and Cape Cook catches of rockfish were combined for 15 per cent. The catch was largely from Esperanza. Effort decreased in three years, 1956, 1957, and 1958. Catch increased in 1956, but then followed the decrease in fishing effort in 1957 and 1958. Fishing success increased in 1956, leveled in 1957, and then decreased in 1958. During 1959 all three measures increased which indicates that rockfish are available in the Esperanza-Cape Cook region when needed.

The Esteban area supplied 12 per cent of the five-year average catch (Figure 35-B). Fishing was less intense in 1959 than it was in 1955, catch was slightly improved and fishing success was also improved.

The Cape Flattery area supported 25 per cent of the rockfish fishing (Figure 36-A). Over the five-year period the time spent fishing decreased, poundage caught increased, and fishing success increased fairly steadily. This improved situation can be attributed partially to the discovery of new fishing areas which is helpful in spreading fishing intensity over more area and, it is hoped, new stocks of rockfish.

The Quillayute and Destruction Island area catches were similar, and were, therefore, combined for this report (Figure 36-B). All three measures fluctuated together which indicates that the fish are often not available in these areas. Eleven per cent of the total rockfish catch is made here.

Rockfish catches in Puget Sound (Figure 37) have increased in the five-year period, 1955, to 1959. Fishing effort increased, but catch per hour remained at a low of nearly 20 pounds per hour of fishing. Perhaps this is all the inside waters are capable of producing.

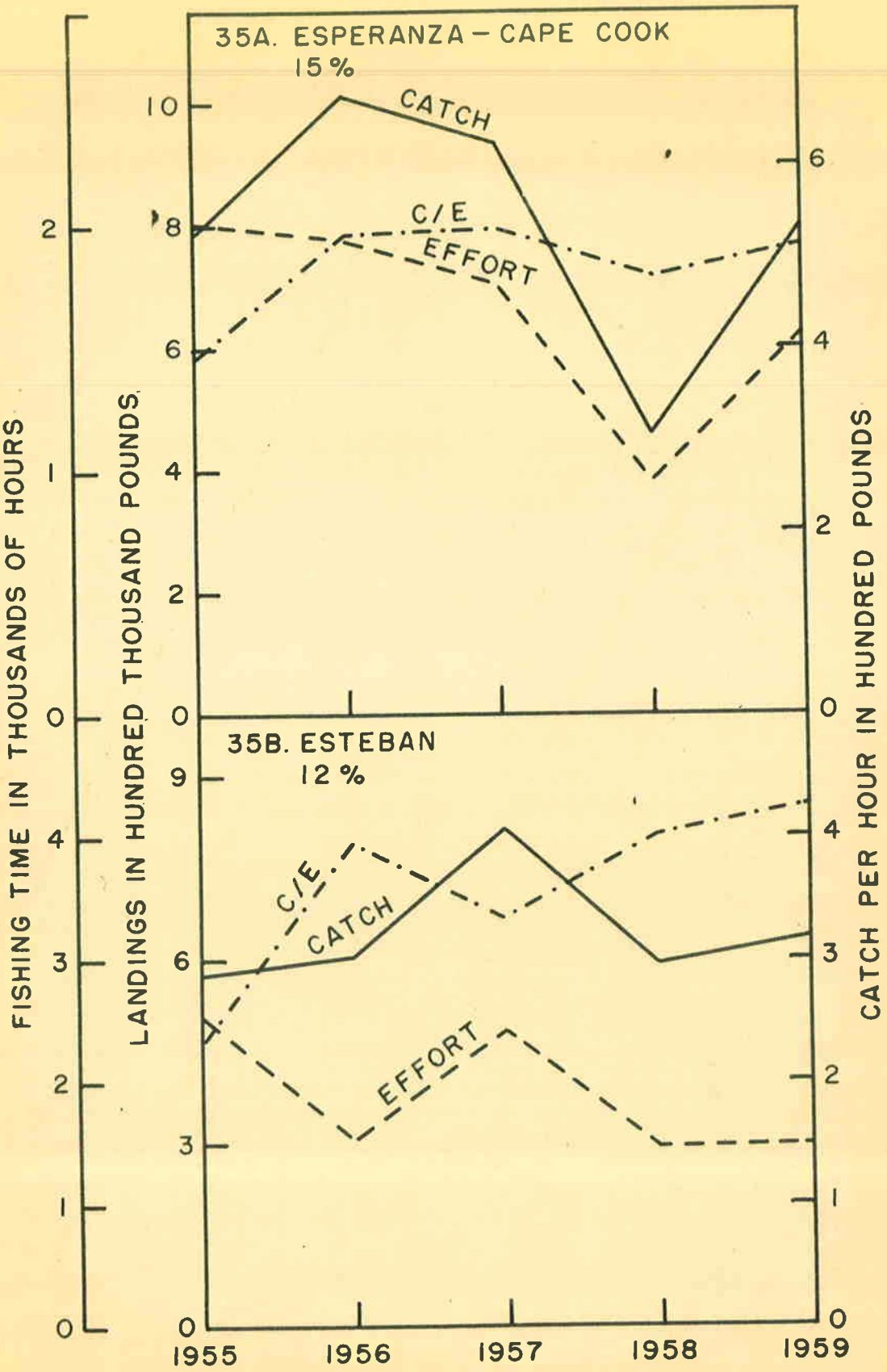


Figure 35 - Rockfish catch, calculated effort, and catch per hour from the Esperanza-Cape Cook and Esteban areas by year, 1955-through 1959.

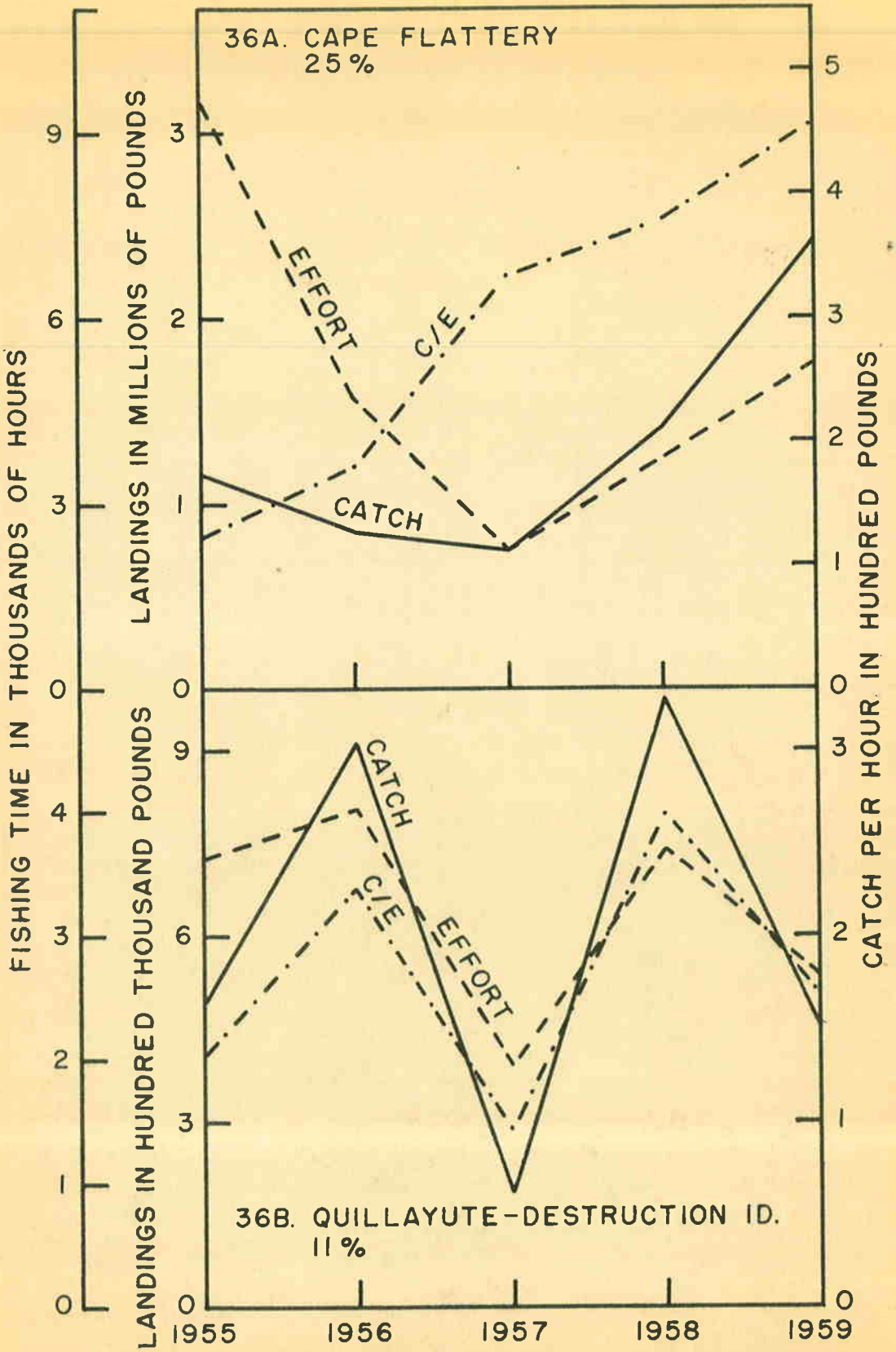


Figure 36 - Rockfish catch, calculated effort, and catch per hour from the Cape Flattery and Quillayute-Destruction Island areas by year, 1955 through 1959.

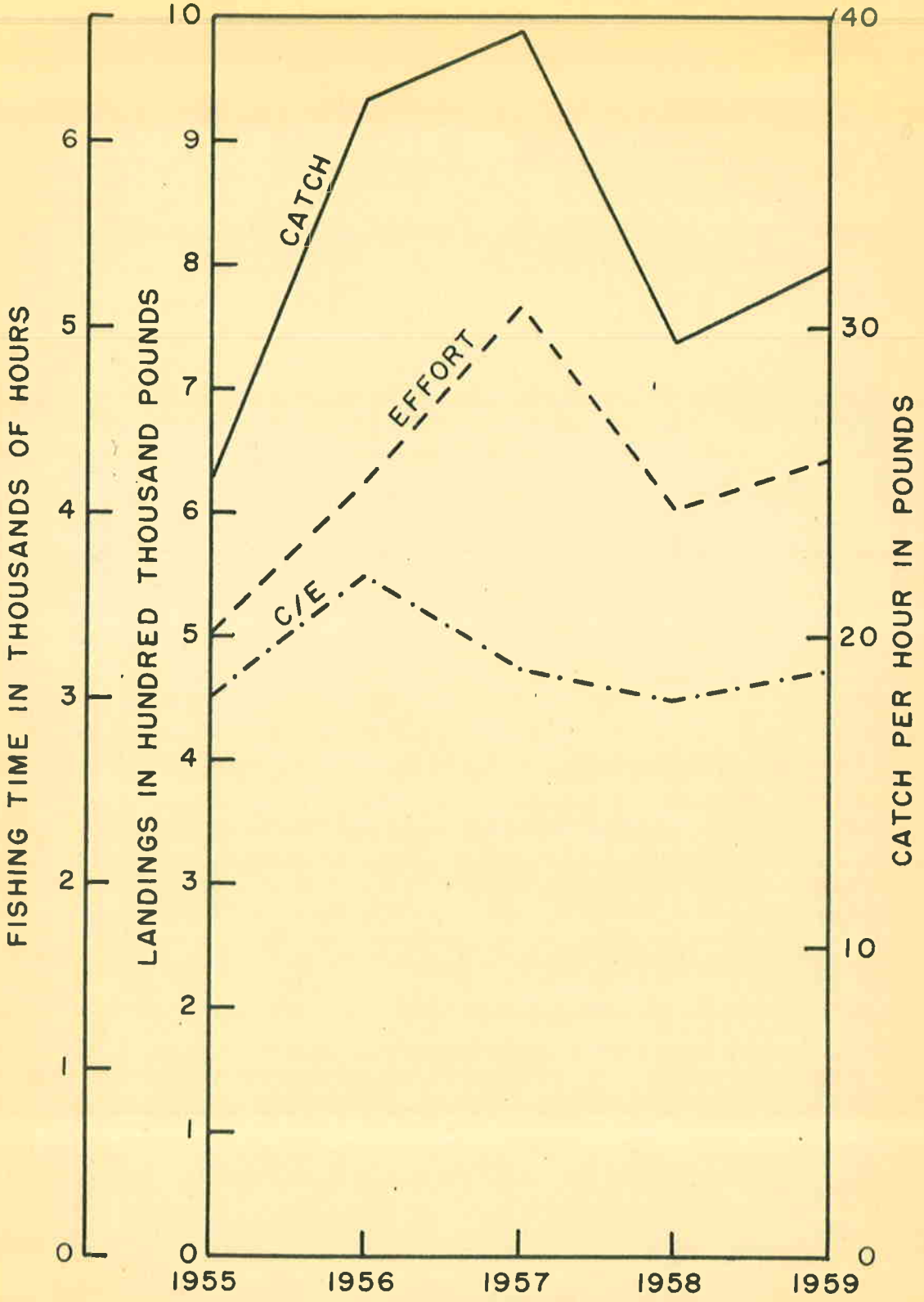


Figure 37 - Rockfish catch, calculated effort, and catch per hour from the Puget Sound area by year, 1955 through 1959.

Pacific Ocean Perch

The Pacific Ocean perch, which is not a perch but a species of the genus Sebastodes along with the other rockfish, is exploited at a smaller size for a special market of small fillets. This market was developed on the eastern coast of the United States using Sebastes marinus. Ocean perch, as it is called in Washington, ranked third in poundage and fifth in value during the 1955 through 1959 period of study, and was also subject to market limitations.

The total catch in all areas (none are caught in Puget Sound) showed no difficulties as catch and effort statistics fluctuated together fairly well. The catch per unit of effort has increased two-thirds in four years, (Figure 38 and Table 11).

In the Goose Island area (23 per cent of the catch in this period) effort and catch decreased, but success of fishing increased as shown in Figure 39-A. For the Cape Scott area, where 25 per cent of the perch are caught, all three statistics increased about threefold (Figure 39-B).

The Esperanza and Esteban areas (Figure 40-A) supplied 23 per cent of the catch in the five years, and although fishing time and catches decreased, fishing success in catch per hour was slightly improved. Most (three-quarters) of the catch was taken in the Esteban area.

Twenty-four per cent of the catch was made from Cape Flattery to Destruction Island where all three statistics remained about the same over the five years (Figure 40-B).

With the present writing, the Pacific Ocean perch populations appear to be maintaining themselves adequately. If effort should increase appreciably, stocks could be driven to lower numbers in the present areas of exploitation.

The age composition and recruitment of the perch stocks should be studied continually for signs of decreased abundance.

Table 11 - Pacific Ocean perch catch data from interviews extrapolated to the total landings.

	1955	1956	1957	1958	1959	5-yr. ave.
GOOSE ISLAND	23 per cent of the total catch					
Pounds	879,843	1,741,137	838,490	924,528	605,788	997,957
Hours	986	1,508	703	661	495	871
Lbs/hr.	892	1,154	1,193	1,398	1,223	1,146
Index lbs/hr.	100	129	134	157	137	
CAPE SCOTT	25 per cent of the total catch					
Pounds	341,744	876,241	624,985	445,274	3,180,103	1,093,669
Hours	530	1,129	947	569	2,132	1,061
Lbs/hr.	645	776	660	782	1,492	1,031
Index lbs/hr.	100	120	102	121	231	
ESPERANZA-ESTEBAN	23 per cent of the total catch					
Pounds	1,220,537	1,199,375	1,344,042	297,321	943,127	1,000,880
Hours	2,075	1,527	2,497	498	1,200	1,559
Lbs/hr.	588	785	538	597	786	642
Index lbs/hr.	100	134	91	102	134	
CAPE FLATTERY, QUILLAYUTE AND DESTRUCTION ISLAND	24 per cent of the total catch					
Pounds	991,013	903,110	1,161,262	997,302	1,035,271	1,017,591
Hours	1,855	1,502	1,361	1,505	1,445	1,534
Lbs/hr.	534	601	853	663	716	663
Index lbs/hr.	100	113	160	124	134	
OCEAN TOTAL						
Pounds	3,498,758	4,979,665	4,514,949	2,736,207	5,839,951	4,313,906
Hours	5,611	5,996	5,977	3,511	5,503	5,320
Lbs/hr.	624	831	755	779	1,061	811
Index lbs/hr.	100	133	121	125	170	

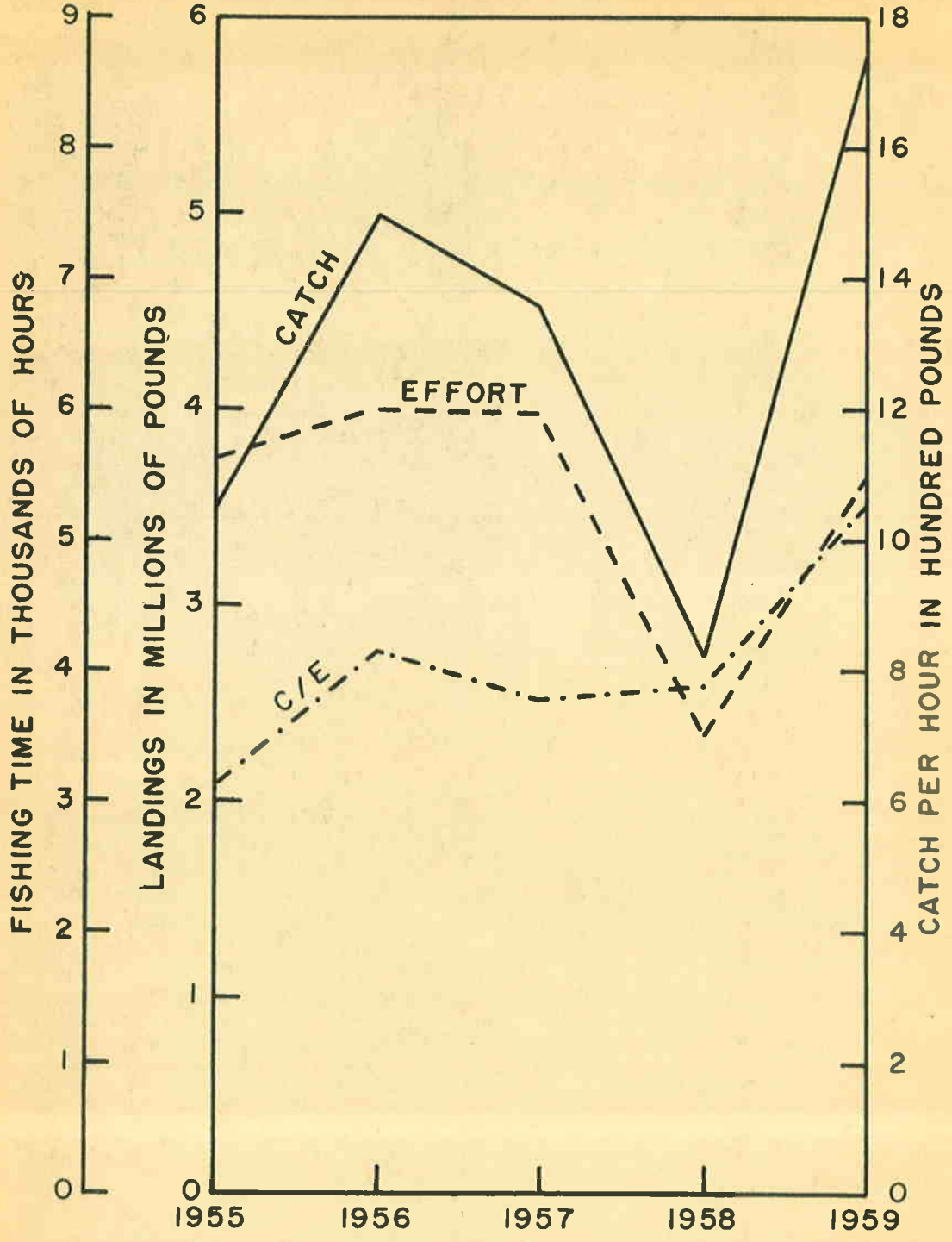


Figure 38 - Pacific Ocean perch catch, calculated effort, and catch per hour from all ocean areas by year, 1955 through 1959.

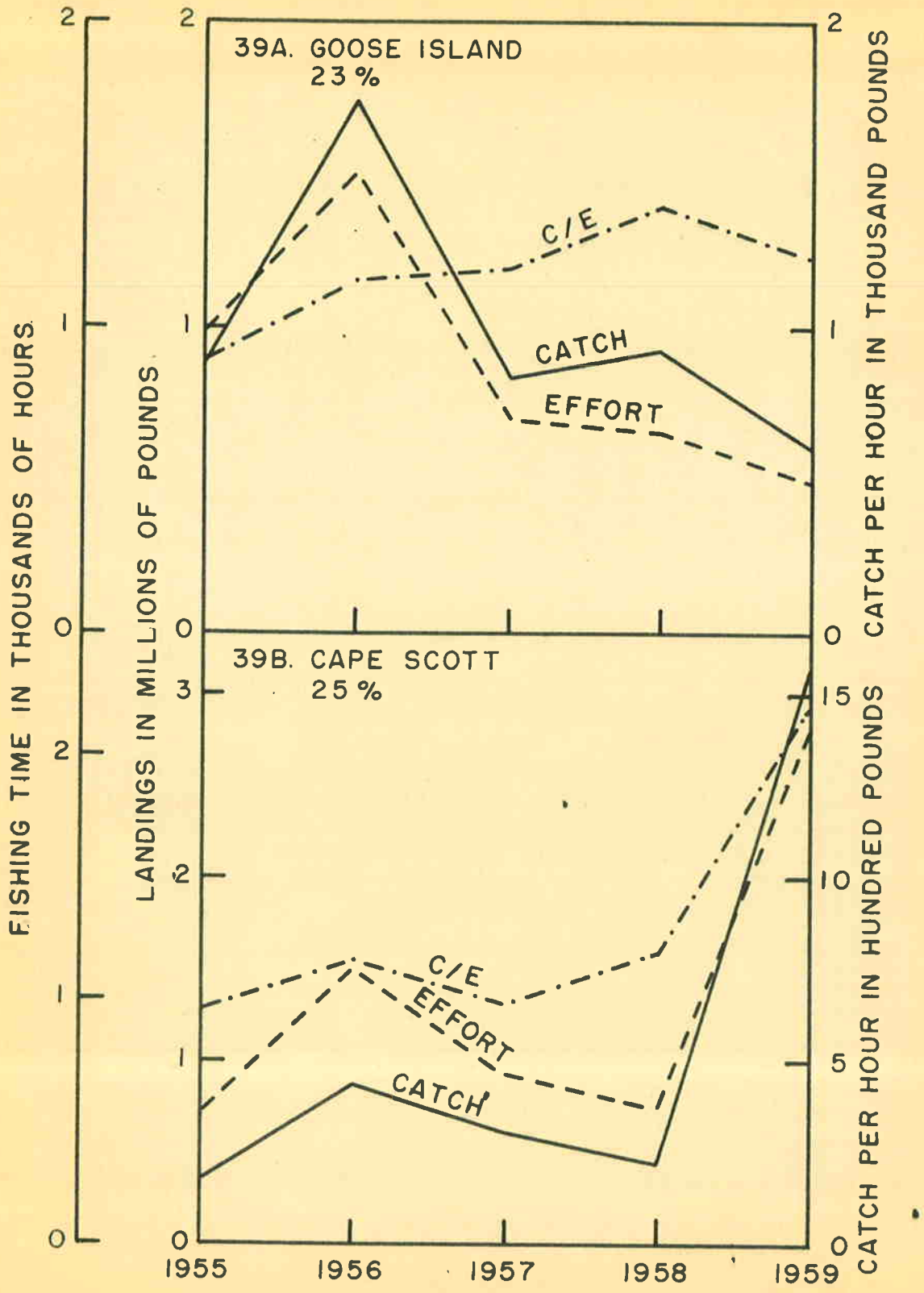


Figure 39 - Pacific Ocean perch catch, calculated effort, and catch per hour from the Goose Island and Cape Scott areas by year, 1955 through 1959.

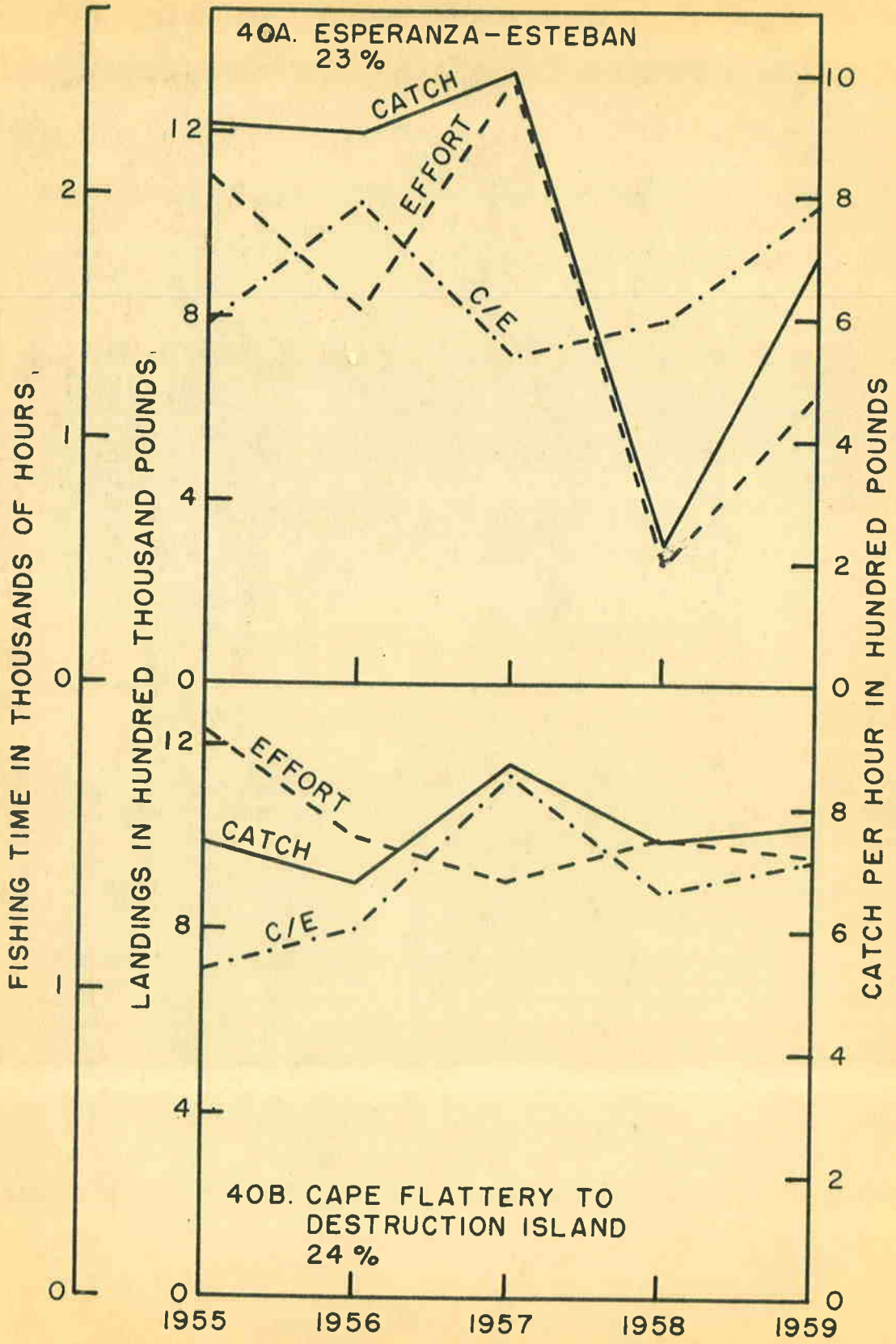


Figure 40 - Pacific Ocean perch catch, calculated effort, and catch per hour from the Esperanza-Esteban and Cape Flattery-Destruction Island areas by year, 1955 through 1959.

Discussion

Briefly summarizing the success of fishing as an index to fish abundance, the areas off the Washington Coast show more increases than decreases. Species in areas off Canada are barely being sustained with some species such as: English sole in Hecate Strait, rock sole in Hecate Strait and Goose Island gounds, and Pacific cod in Goose Island and Cape Scott showing declining trends. The grounds west of Vancouver Island show more decreases than increases.

It is difficult to explain the reason for the declining fishing success off the west coast of Vancouver Island with the improved fishing off the Washington Coast. The areas exploited by both fleets show about equal fishing success, although some species have declined. Evidently the better fishing off Canada attracted fishermen away from Washington allowing the latter area to improve.

Fishing success is low on most species caught in Puget Sound. Further study by area should be made in the Sound and steps taken to relieve the fishing pressure in the problem areas.

There are many factors involved which work to the benefit or detriment of the fishery, and these directly or indirectly affect the abundance of the stocks of fish.

(1) The limited market demand tends to decrease fishing pressure on the trawl-caught species. Demand varies during the year. In the late spring and summer months fresh halibut and salmon are on the markets, and trawl-caught species are less in demand. During fall and winter months demand increases for trawl-caught species as other fresh fish are less available. Demand for bottomfish peaks during the lenten period. Then too, the demand for bottomfish varies directly with the trends in meat prices.

(2) The use of large mesh ($4\frac{1}{2}$ inch) nets, heretofore, has been an important factor in maintaining the fishing success at the level shown during this period of study. Larger mesh allowed the small fish to survive which provided good recruitment of new fish into the fishery. The small mesh net ($3\frac{1}{2}$ inch), which catches more under-sized fish, has come into wider use in 1960. Obviously, a large proportion of the small fish will not survive being caught and re-leased. As a result, the recruitment of fish into the fishery will decline, thereby jeopardizing future catches by the trawl fishery.

(3) Discovery of new fishing areas within the larger areas has kept the fishing success from declining when these exploit new stocks of fish. For example, catches from the Cobb No. 9 tow, has affected Cape Flattery data in the last few years. If an area is being over-fished, fishing in new areas sustains the catch statistics at a high level until the new areas are depleted. The fishing will then collapse without warning. The condition of the older stocks is masked by the fishery for the new stocks.

(4) Unregulated fishing can remain successful provided there is adequate area over which the fishery can operate. This is a factor in the sustained fishing success of the Washington fleet. However, if too many fishermen enter the fishery, if areas are removed from the fishery, or if it becomes uneconomical to travel the long distances to some of the fishing grounds, the remaining grounds will become inadequate to support the present number of fishermen without good, enforceable regulations.

(5) Protection is given the fish stocks by the existence of large rocky areas on or near the fishing grounds. These provide sanctuary for the fish. Some species, such as petrale sole and lingcod, are believed to seek rocky areas at certain seasons. There are many rocky regions in or near the fishing grounds in most of the areas which could afford protection to some species of fish.

(6) Similar to the expansion of the fishery to new grounds is the expansion or shift of effort to new or different species. The increased catches of Dover sole in the northern areas and the increased catches of perch in many areas are examples.

(7) Other factors, such as: the decrease in fishing effort during price negotiations, the decrease in effort when fishermen quit trawling in the spring and summer, and the limitation of effort by regulation when fish are concentrated in the deep water areas, all trend to protect the stocks of fish. Also, when a fishery declines, the less experienced fishermen are forced to quit, effort is decreased and the stocks tend to recover.

(8) An increase in the value of the fish tends to attract more fishermen to the detriment of the fish stocks. This occurred with pilcards and salmon.

(9) Regulations were mentioned above, and they are the only real control available by which the number of fish can be sustained. Left to their own devices, more and more fishermen will enter a fishery until the increased effort drives stocks to such a low level of abundance that it becomes barely profitable to fish. The trawl fishery inside of Puget Sound is a good example. By limiting the fishing effort, the stocks can be increased to any desired level. It is conceivable that

the stocks within the Sound could be increased to such abundance that the present number of fishermen could catch the present poundage in a few days of fishing each week. It is then possible that more fishermen and vessels would be added to the fishery until the stocks were again depleted to the point where it would be barely profitable to fish for them.

There are two solutions to this problem: either limit the poundage caught by area as is done by the International Halibut Commission, or limit the number of licensed fishermen as is being considered in Canada.

Market Sampling

The trawl market-sampling program was comparatively light throughout the 1957-1959 period. This was primarily due to a manpower shortage which did not permit an extensive program to be undertaken.

Most of the field work consisted of taking length-frequency samples. Petrale sole from the Esteban Deep, English sole and true cod from Hecate Strait were the principal species sampled since they were being subjected to a heavy fishery in these areas. Throughout the past years, there has been a considerable number of length-frequency samples taken. However, due to the large number of species and areas involved in the trawl fishery, in very few cases is there a good record of length-frequency distributions for individual species by detailed areas over a substantial period of time.

Length-frequency distributions are often used in determining age and growth rates of fishes. This method alone is unsatisfactory for fishes involved in the trawl fishery. This is due to the large number of year classes of the various species present in the fishery and the overlapping sizes of these year classes.

In the future, it is hoped that an extensive age-sampling program can be initiated in coordination with the length-frequency sampling. In this way, a much better understanding can be obtained of the age groups of the various species comprising the fishery.

At the end of this section is a graphic summary of all the length frequency samples taken during 1957-1959, Figures 49 through 70.

The following are the results of the market sampling program by species.

True Cod (Gadus macrocephalus)

True cod sampled during 1957-1959 ranged from 43-86 centimeters, total length, with the females being slightly larger in size. True cod sampling was concentrated on the heavy Hecate Strait fishery and samples in April, 1957 and March, 1959 show a decrease in average size compared to April, 1956 (Figure 41).

Rockfish (Sebastodes sp.*)

A variety of species of the genus Sebastodes are caught by Washington trawlers. Principal species comprising the catch are orange rockfish (S. pinninger), yellowtail rockfish (S. flavidus), flagsnapper (S. rubrivinctus) and shortspine (S. brevispinis).

Due to the complexity of segregating the many different species comprising the rockfish catch, there was no market sampling of rockfish during this period.

Pacific Ocean Perch (Sebastodes alutus)

Pacific Ocean perch sampled during 1957-1959 ranged from 30-47 centimeters, total length. The females are generally larger than the males. The size range of perch is relatively small and it is thought these fish have a very slow growth rate.

*Excludes Sebastodes alutus.

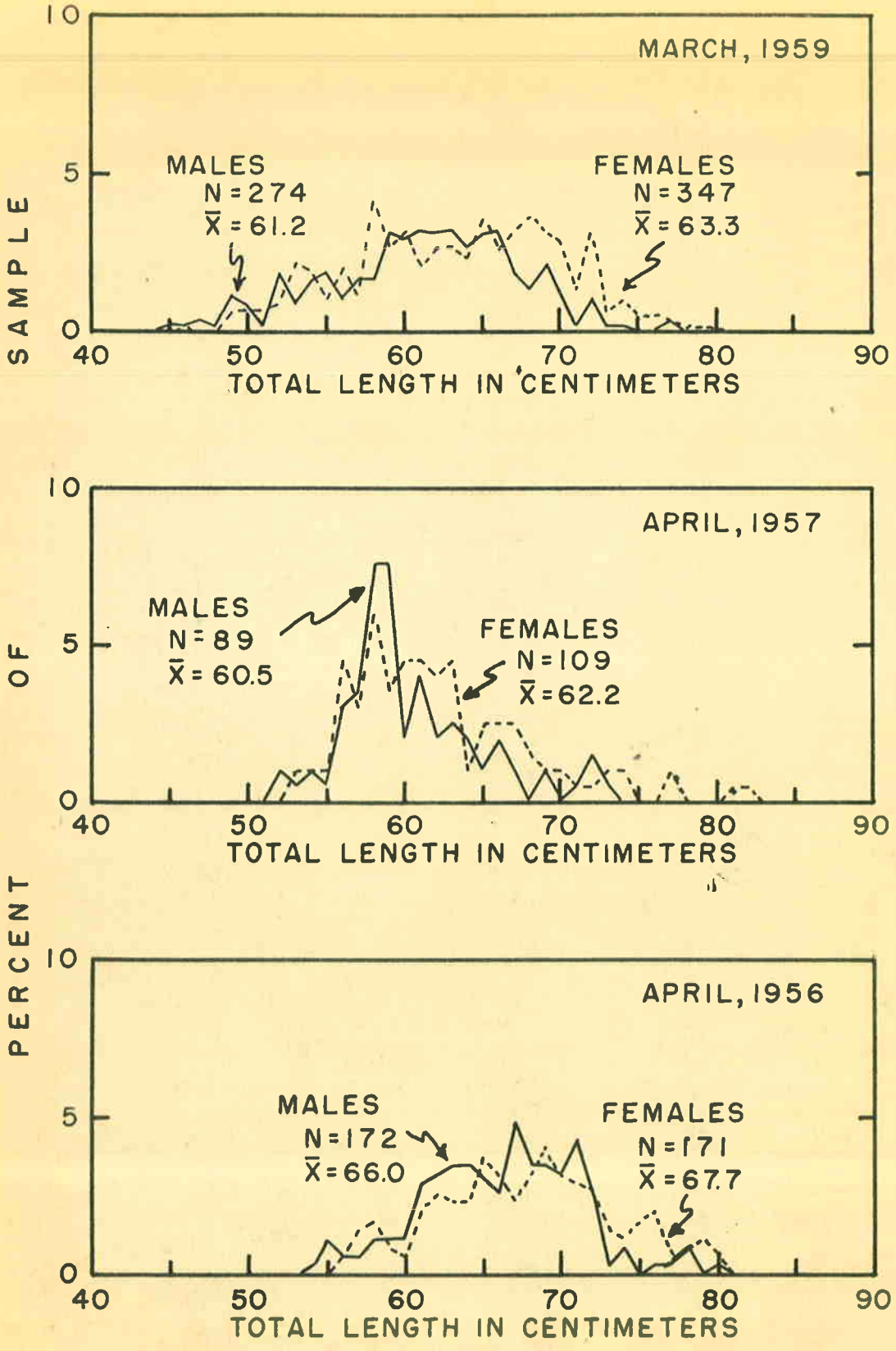


Figure 41 - Length frequency distribution of true cod caught in Hecate Strait in 37-60 fathoms.

In sampling Pacific Ocean perch, it has been found that small amounts of other species of red rockfish are mixed in with the perch catch. These species are S. rubrivinctus, S. diploproa, S. aleutianus and Sebastolobus alascanus.

Petrale Sole (Eopsetta jordani)

Petrale sole sampled during 1957-1958 ranged in total length from 30-62 centimeters.

Length frequency distributions of petrale sole caught off Esteban in 1954, 1957 and 1959 indicate the females are considerably larger than the males, and extend over a wider range of lengths (Figure 42).

In February, 1959, approximately 76 per cent of 157 female petrale sole examined from Esteban were either ripe, running ripe or spent (Table 12) indicating these fish are of a spawning population reaching its peak probably sometime in February. Only 13.38 per cent of the fish were immature.

Table 12 - Condition of female petrale sole caught off Esteban in 185 fathoms during February, 1959.

Running ripe	Ripe	Developing	Immature	Spent
14	100	16	21	6
8.92 per cent	63.69 per cent	10.19 per cent	13.38 per cent	3.82 per cent

Length frequencies of petrale sole from the heavily fished 40-mile area are shown for the years 1953, 1956, and 1958 (Figure 43).

Lingcod (Ophiodon elongatus)

Lengths of lingcod sampled from 40-mile Bank in June, 1957 ranged from 50-112 centimeters. The males are much smaller in size than the females with the largest male being only 81 centimeters.

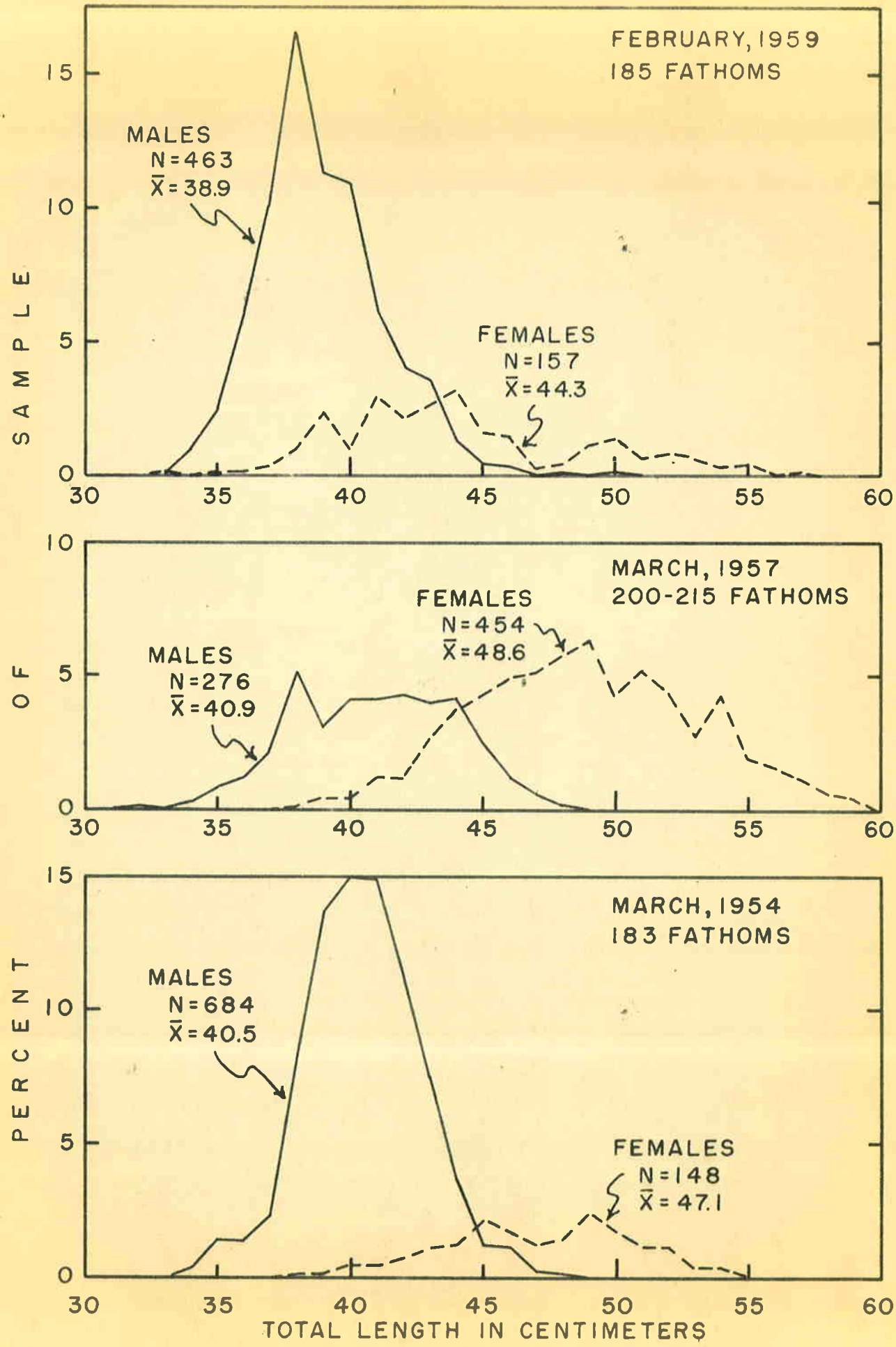


Figure 42 - Length frequency distribution of petrale sole caught off Esteban in 1954, 1957, and 1959.

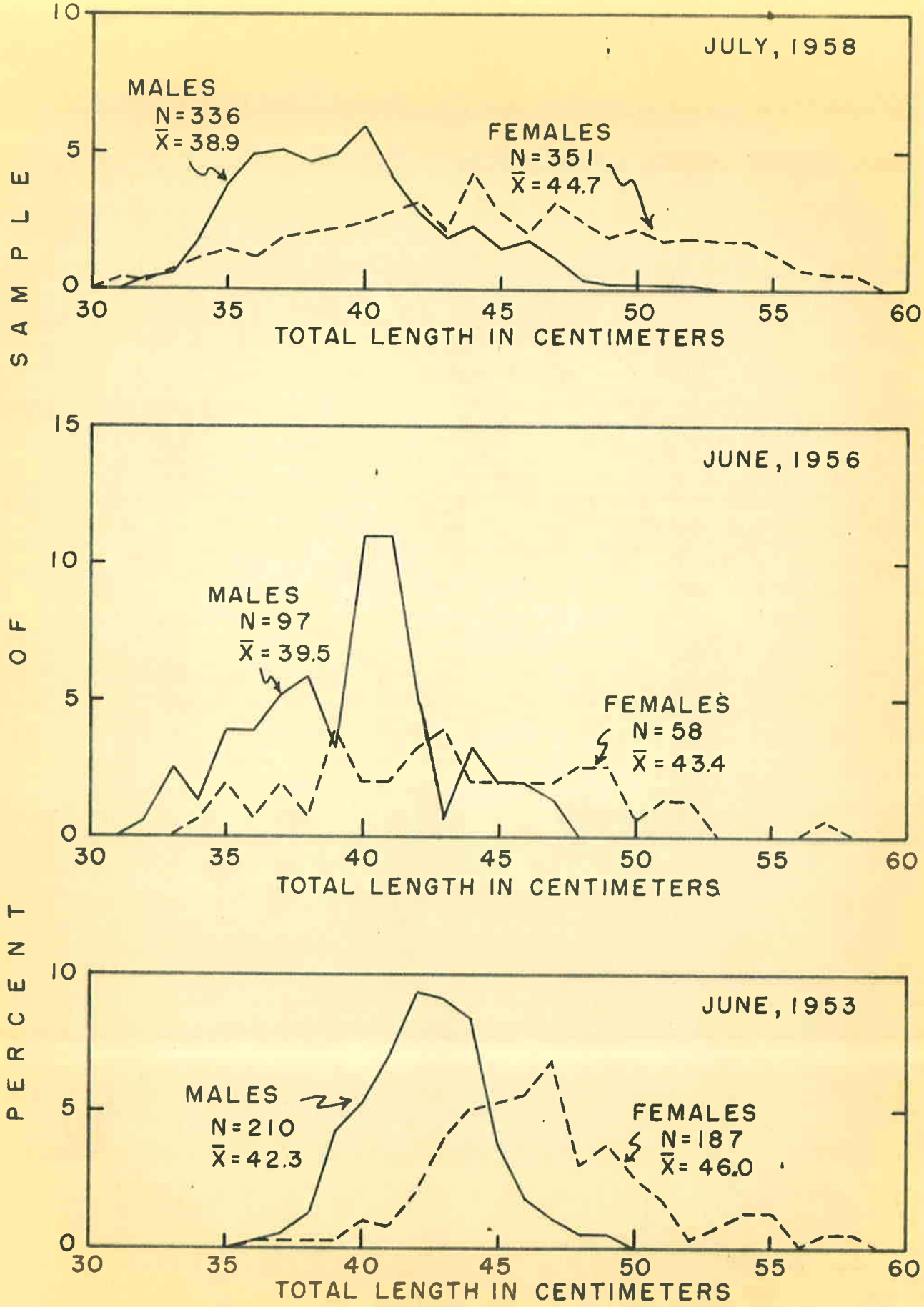


Figure 43 - Length frequency distribution of petrale sole caught on 40-mile Bank in 40-60 fathoms.

English Sole (Parophrys vetulus)

English sole sampled during 1957-1959 ranged in total length from 28-52 centimeters. Females comprised, by far, the largest proportion of the catches and are generally larger than the males.

The average lengths of English sole sampled from upper Hecate Strait did not seem to change significantly during the period from January 1954 to December-January 1958-1959 (Figure 44).

Age samples of 187 female English sole were taken during April of 1957. The interopercle bone was used for age classification. The most predominant age groups were 3 and 4-year olds, which comprised about 72 per cent of the sample (Figure 45). These fish were caught off Quillayute, an area which contributes a substantial portion of English sole landings caught off the Washington Coast.

Dover Sole (Microstomus pacificus)

Dover sole sampled in 1957-1959 ranged in total length from 29-65 centimeters with the females generally larger in size than the males. The average length of female Dover sole sampled in May, 1953, and April, 1959, from Cape Flattery has decreased (Figure 46).

Sablefish (Anoplopoma fimbria)

Length frequencies of 949 sablefish tagged in Holmes Harbor in May, 1959 indicate the presence of two-year classes (Figure 47). These are small and immature fish as indicated by their size. Commercial size fish are rarely taken in Puget Sound waters.

Flounder (Platichthys stellatus)

Flounder sampled during 1957-1959 ranged in length from 35-75 centimeters.

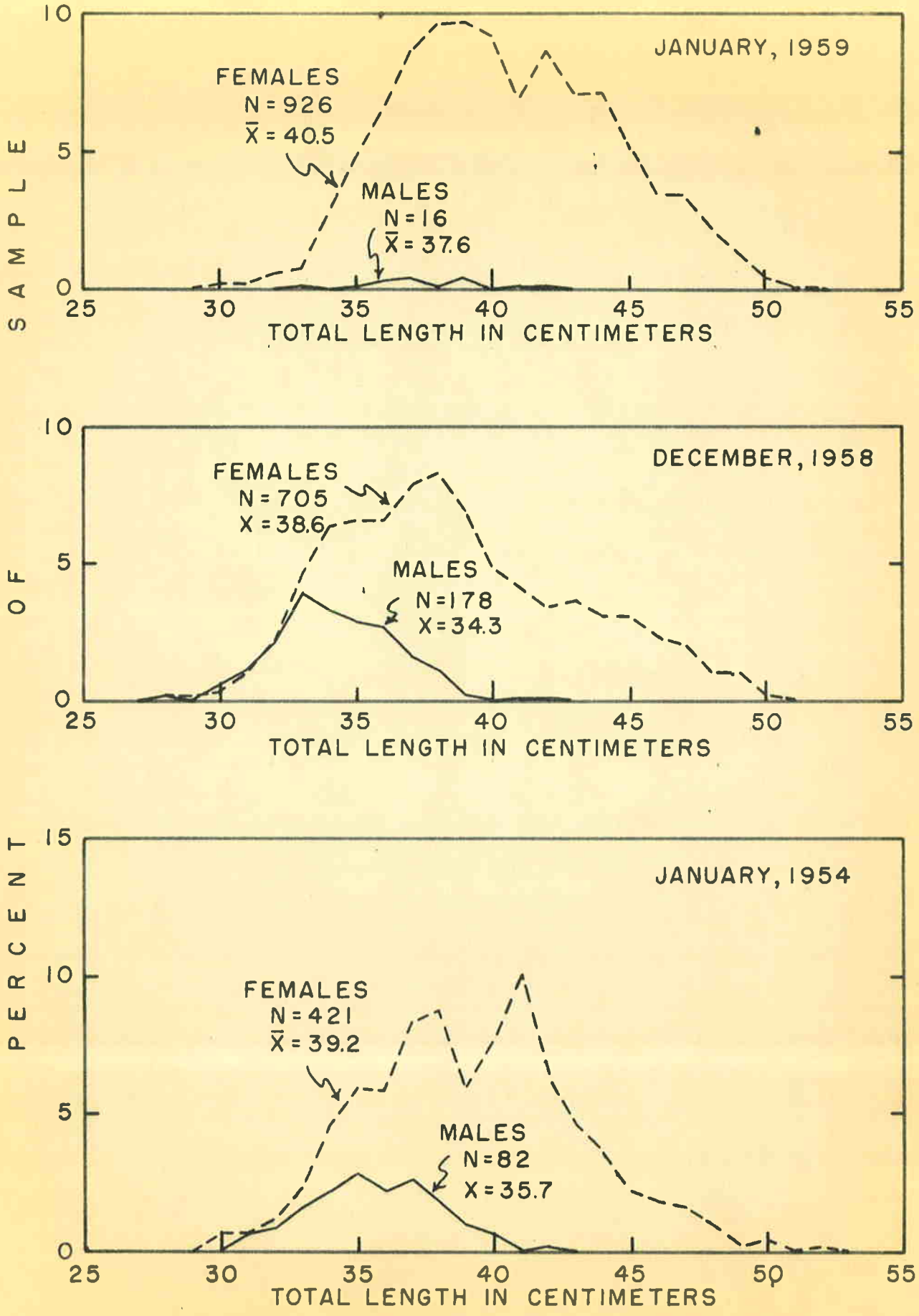


Figure 44 - Length frequency distribution of English sole caught in upper Hecate Strait in 29-55 fathoms.

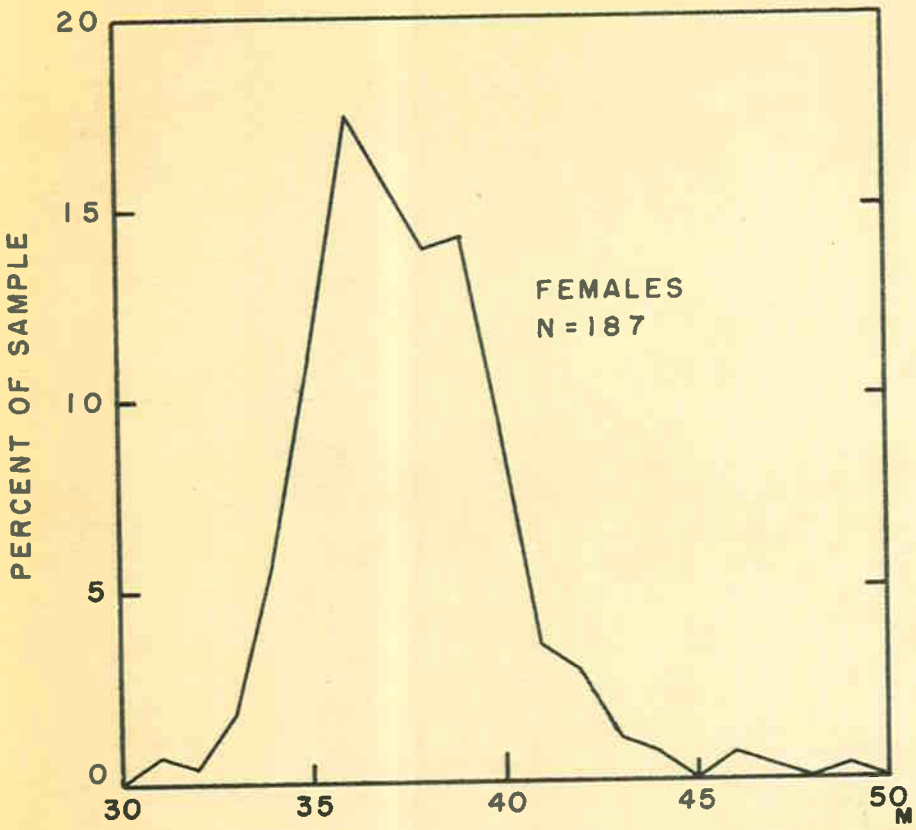


Figure 45-A. Length frequency distribution of English sole caught off Cape Flattery in 42-43 fathoms, April, 1957.

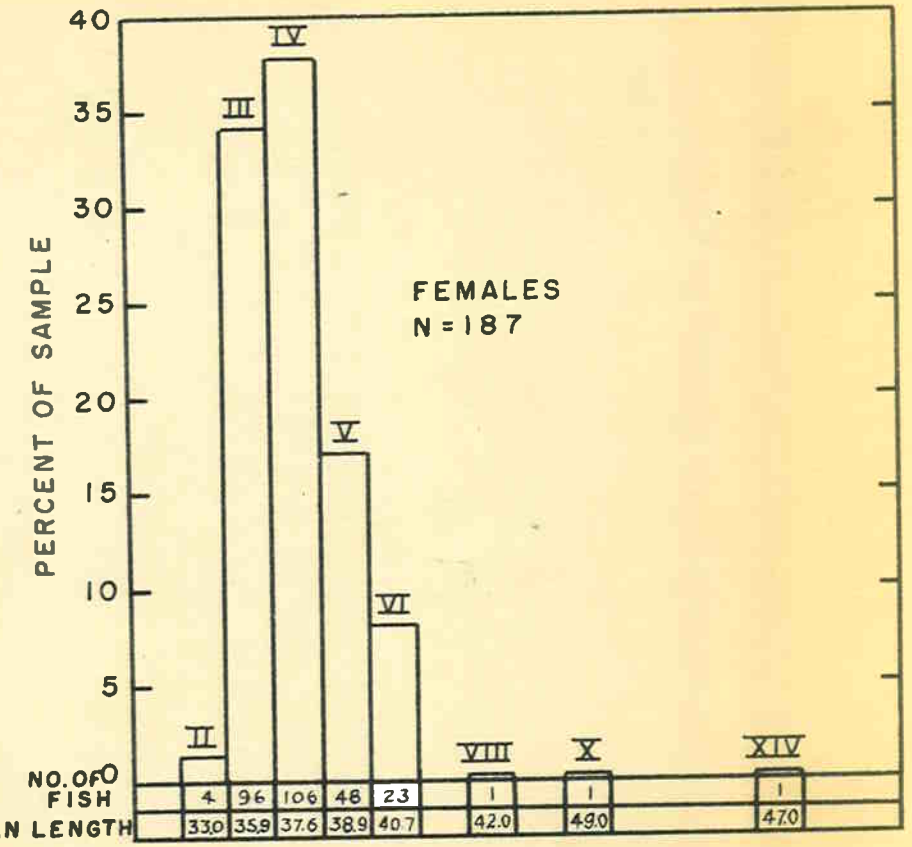
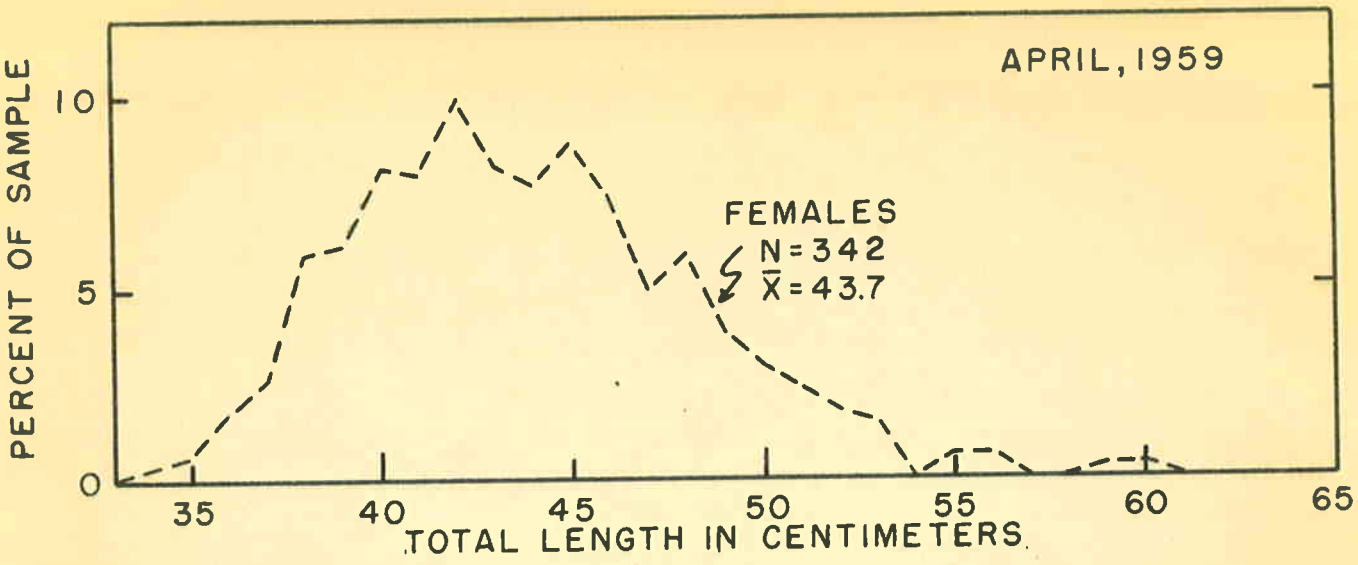


Figure 45-B. Percentage age composition in sample of English sole, Cape Flattery, 42-43 fathoms, April, 1957.



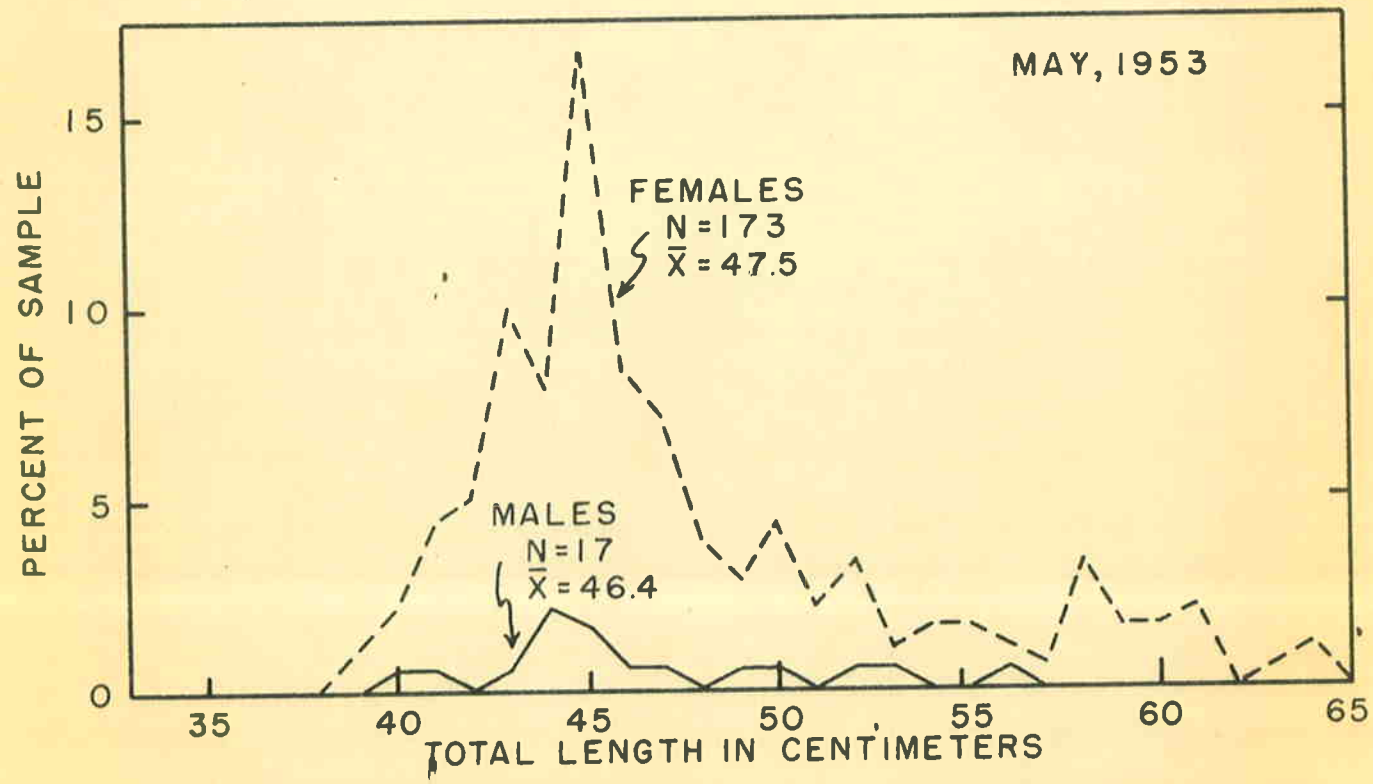


Figure 46 - Length frequency distribution of Dover sole caught off the "Spit" (Cape Flattery) in 145-150 fathoms.

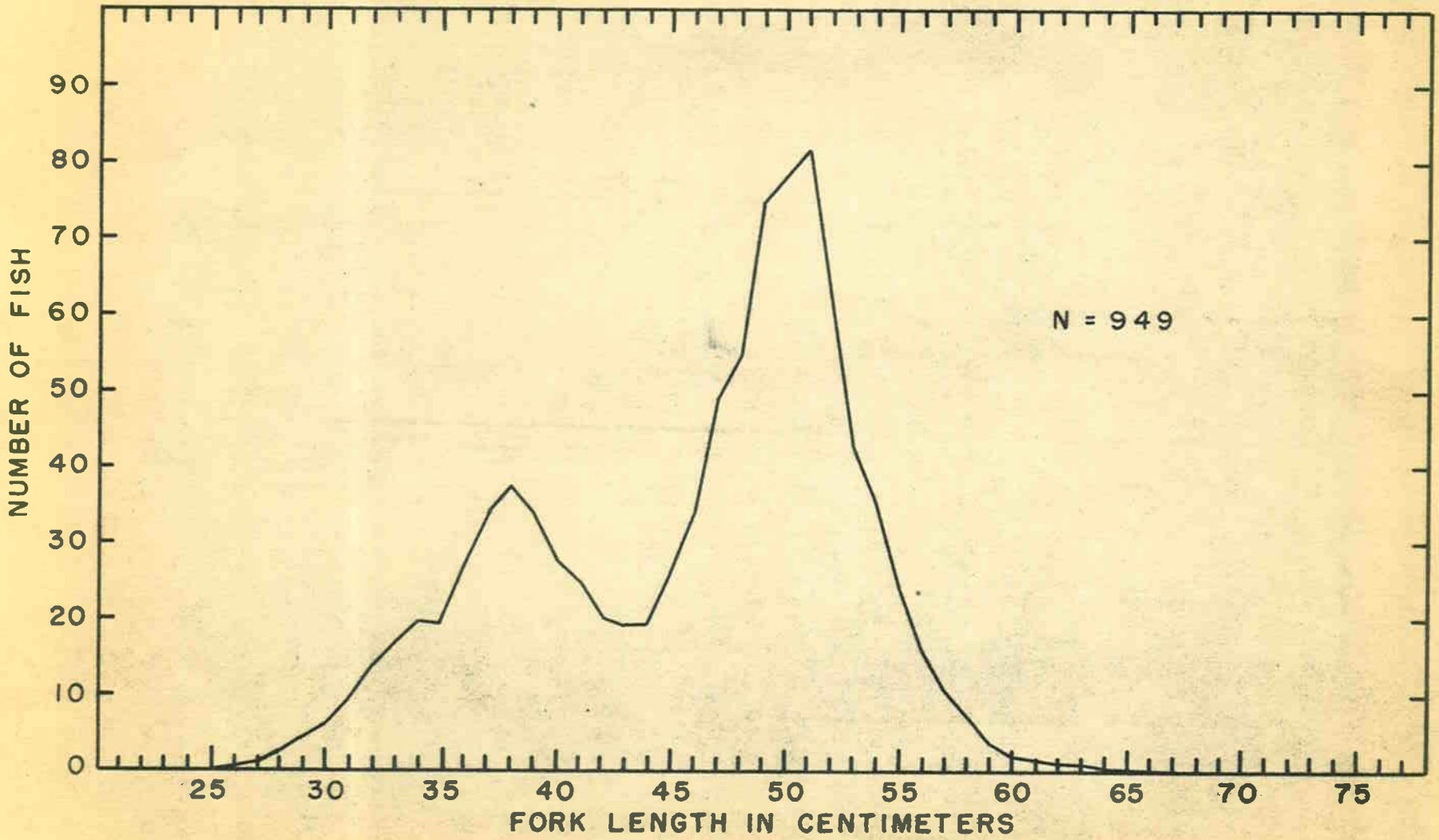


Figure 47. Length frequency of black cod, Holmes Harbor tagging, May, 1959 (Smoothed by 3's)

The flounders sampled from the Two Peaks (Hecate Strait) area were considerably larger in size than fish sampled from areas off the Washington Coast (Figure 48).

Rock Sole (Lepidopsetta bilineata)

A sample of rock sole from the Horseshoe Grounds (Hecate Strait) in October, 1957 ranged in length from 30-42 centimeters. The females are considerably larger than the males.

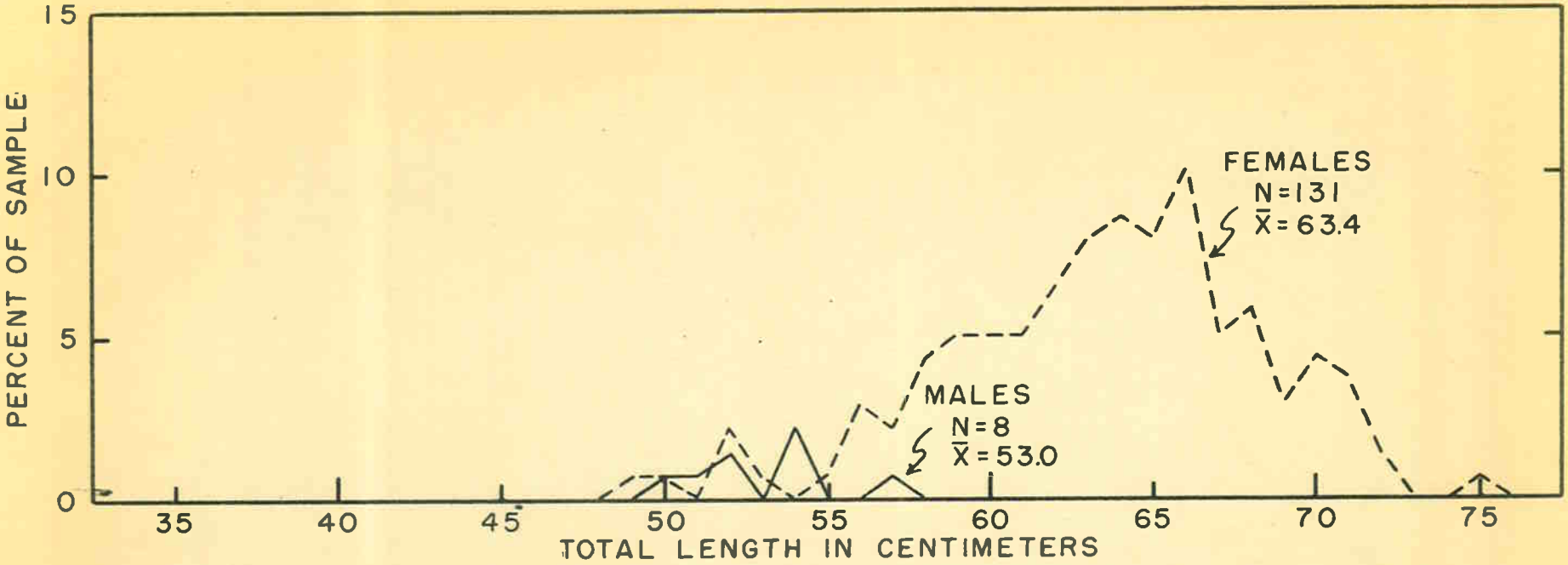


Figure 48-A. Length frequency distribution of starry flounder caught off Two Peaks (Hecate Strait) in 48 fathoms, October, 1958.

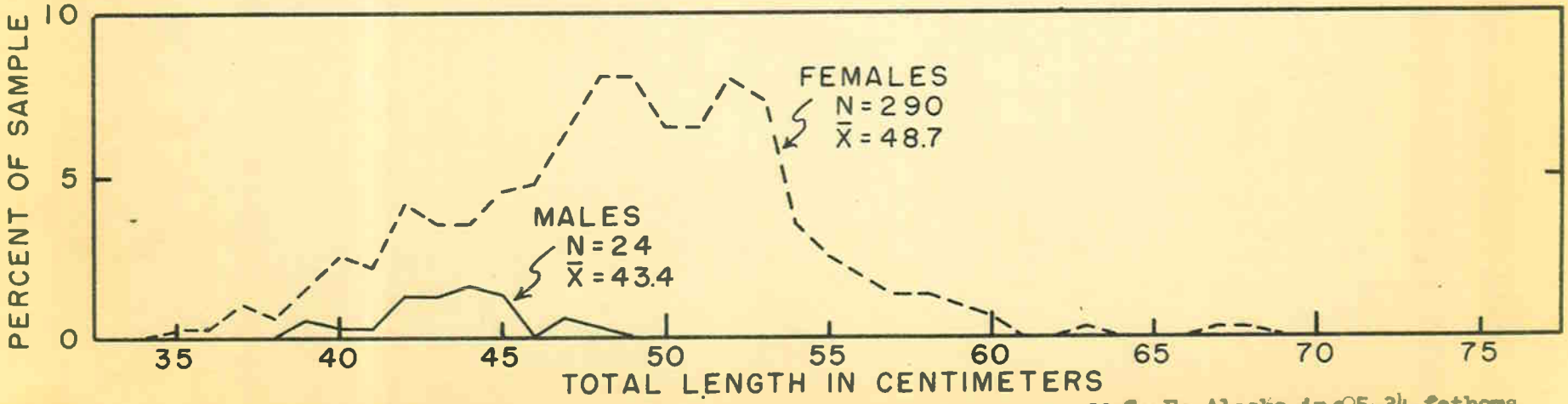


Figure 48-B. Length frequency distribution of starry flounder caught off S. E. Alaska in 25-34 fathoms, November, 1958.

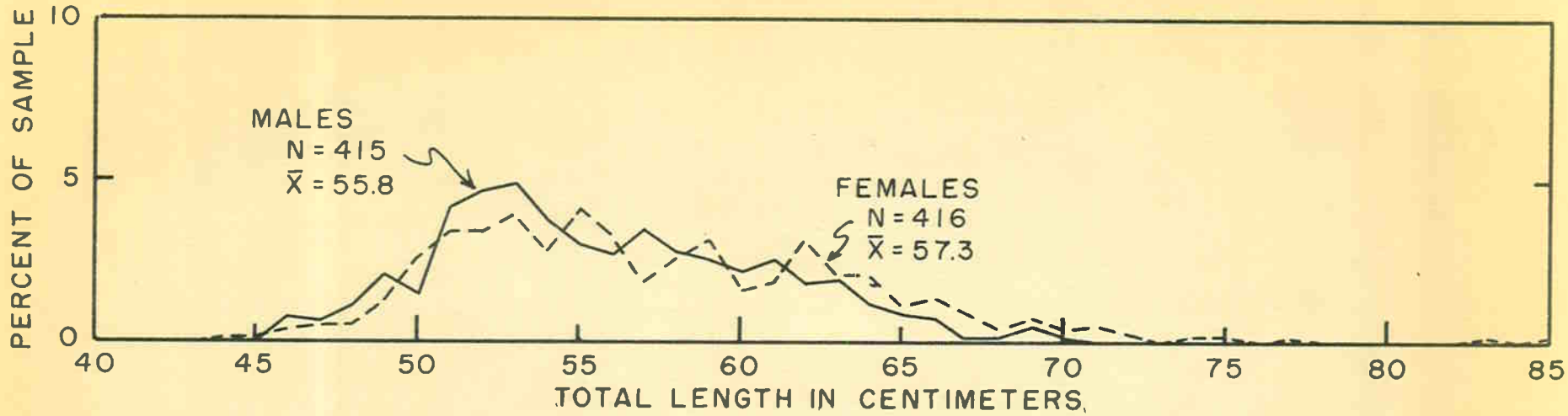


Figure 49-A. Length frequency distribution of true cod, Cape Scott, in 60-92 fathoms, June 26-July 1, 1957.

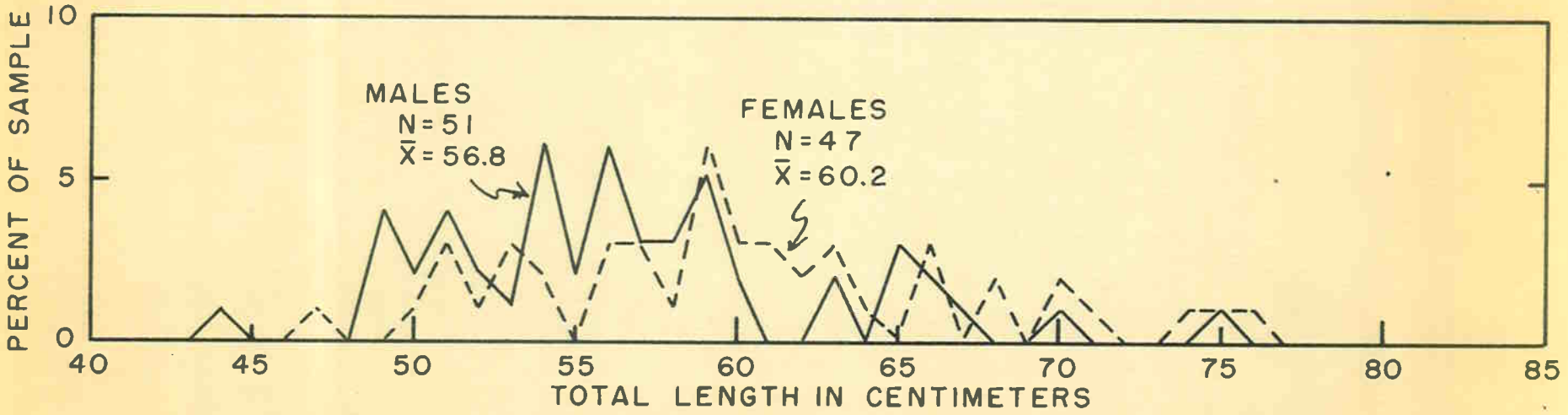


Figure 49-B. Length frequency distribution of true cod caught off Umatilla in 18-30 fathoms, June, 1957.

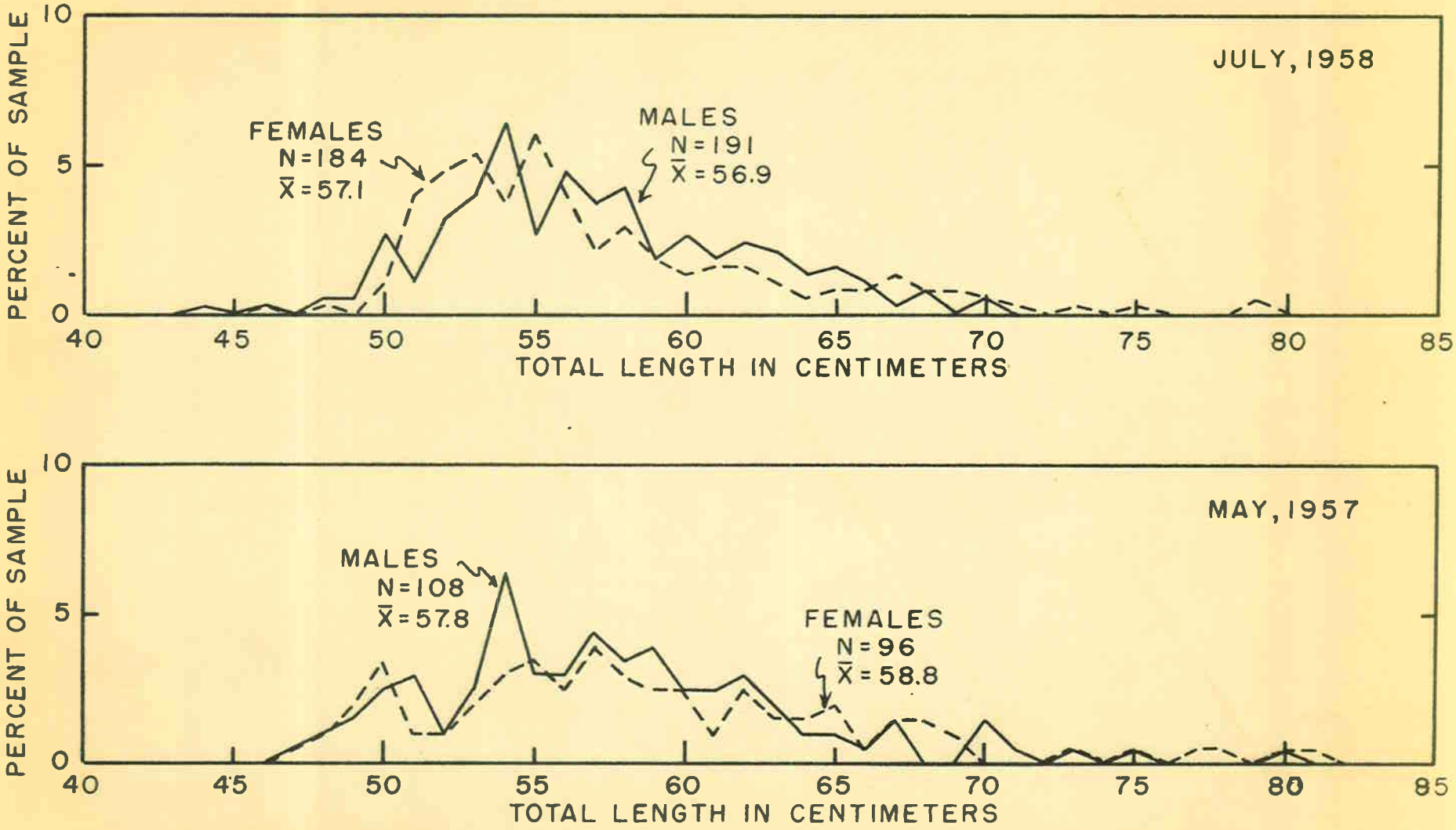


Figure 50 - Length frequency distribution of true cod, Hecate Strait in 43-57 fathoms.

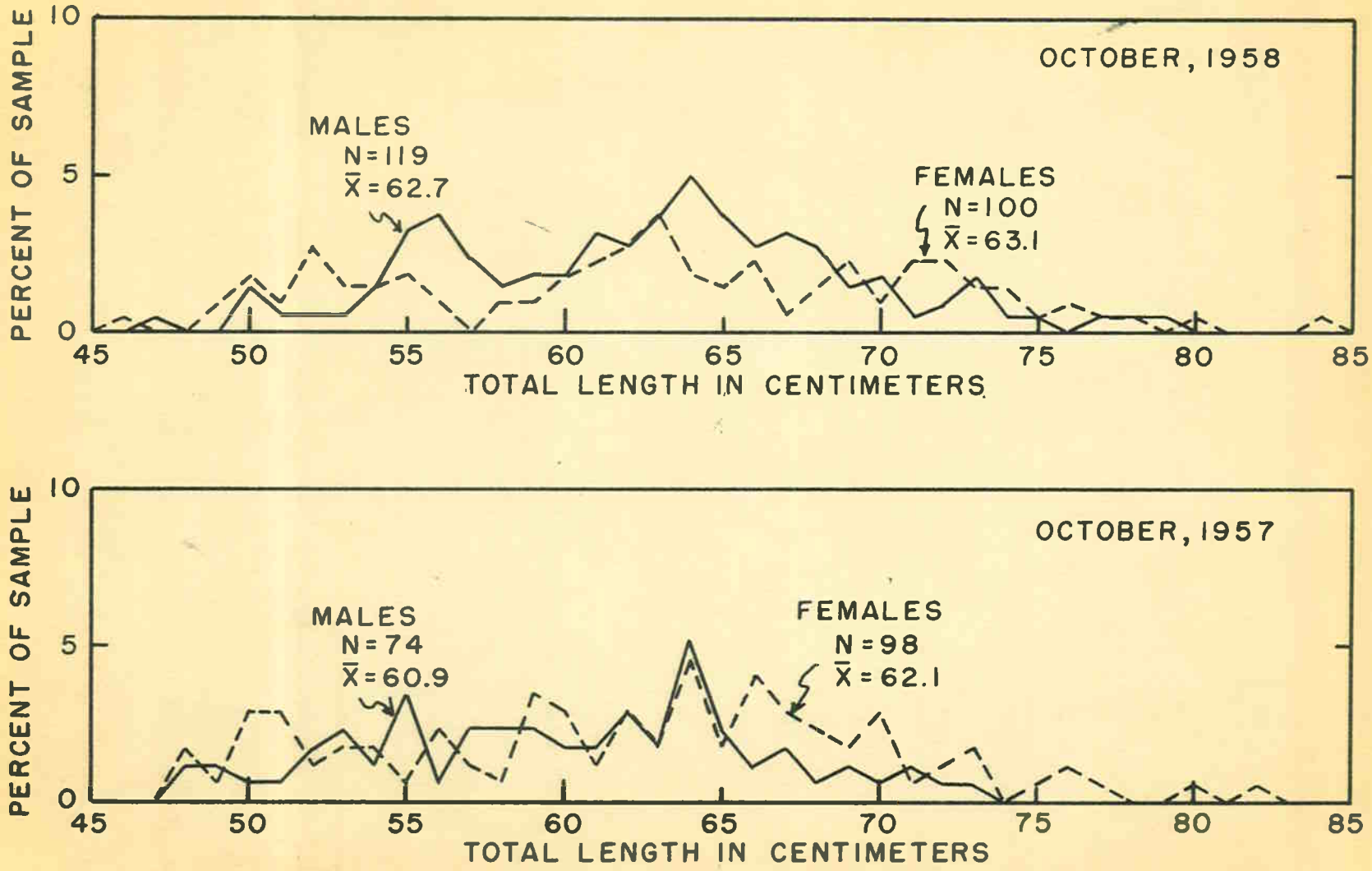


Figure 51 - Length frequency distribution of true cod, Hecate Strait, in 40-57 fathoms.

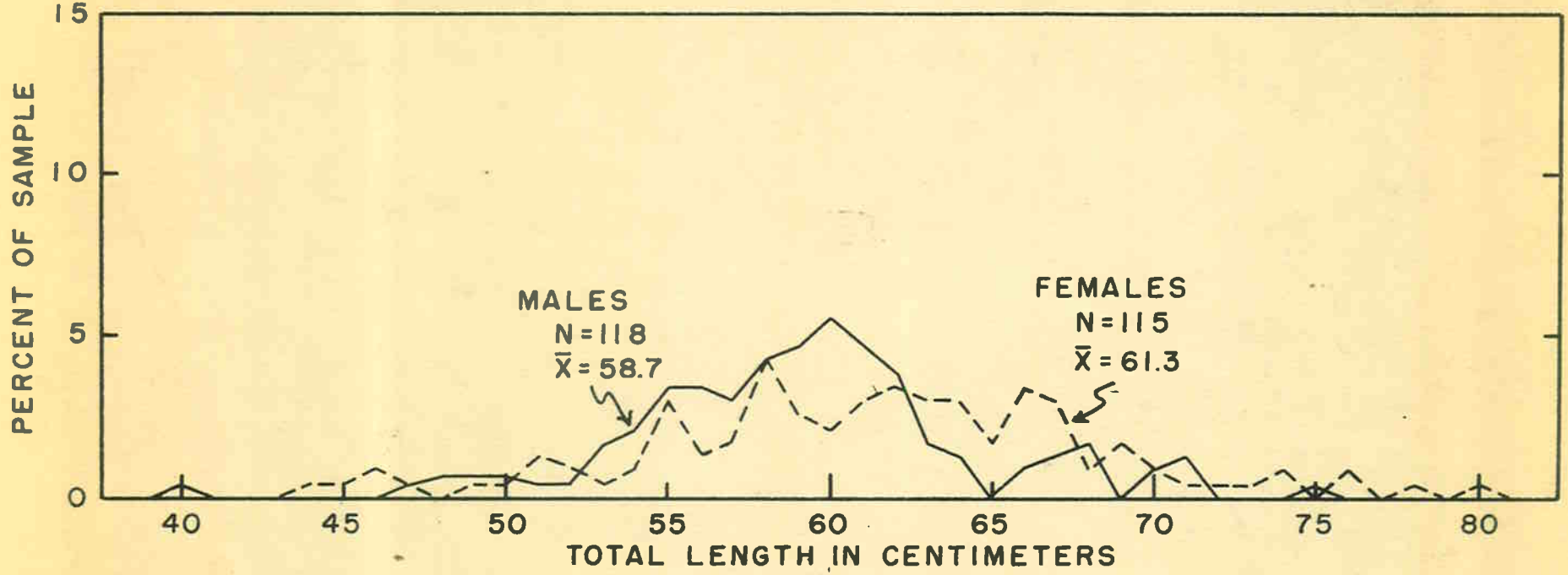


Figure 52 - Length frequency distribution of true cod, 40-Mile Bank, in 40 fathoms, October, 1958.

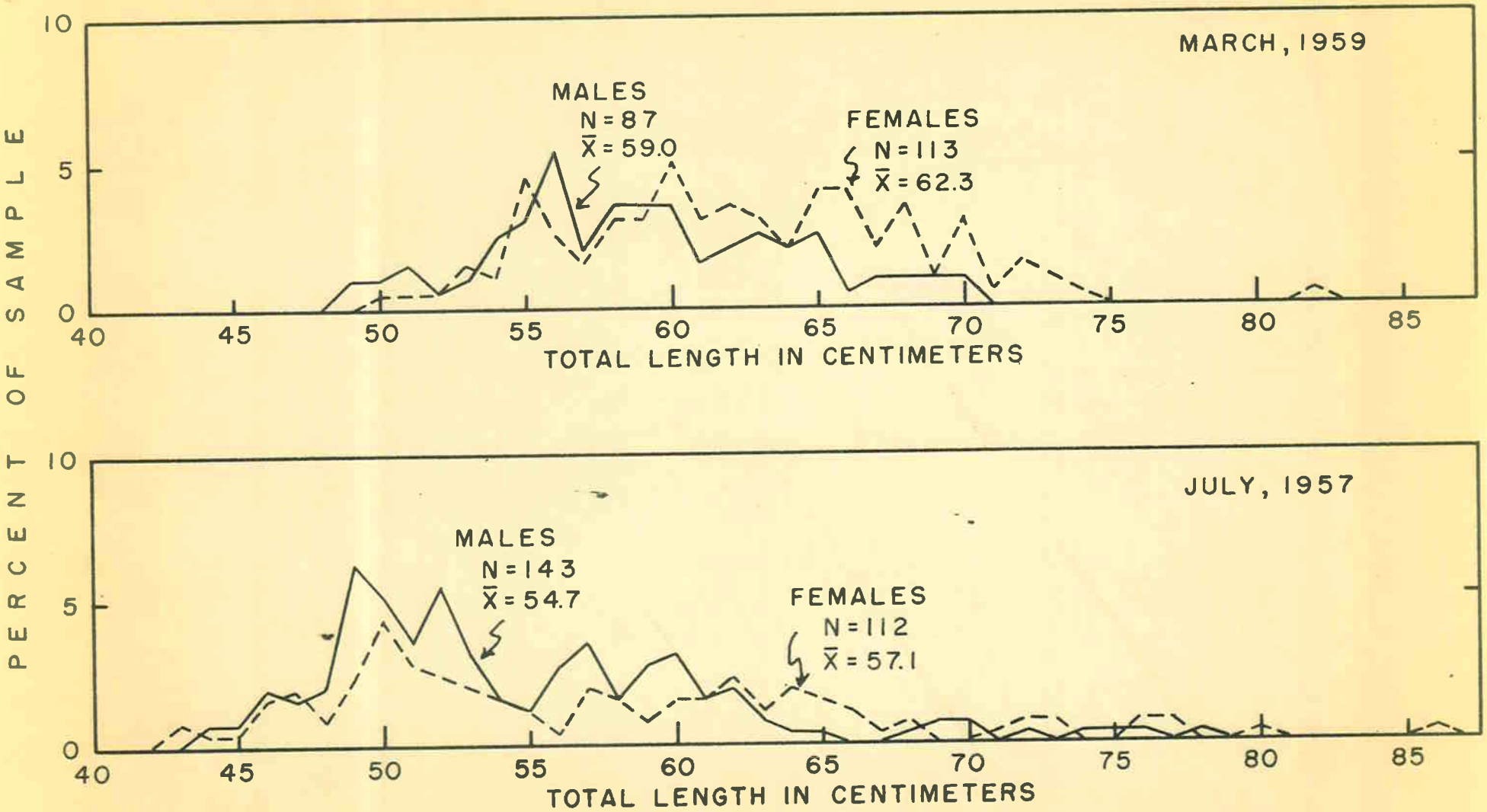


Figure 53 - Length frequency distribution of true cod caught off Cape Flattery-Umatilla in 57-68 fathoms.

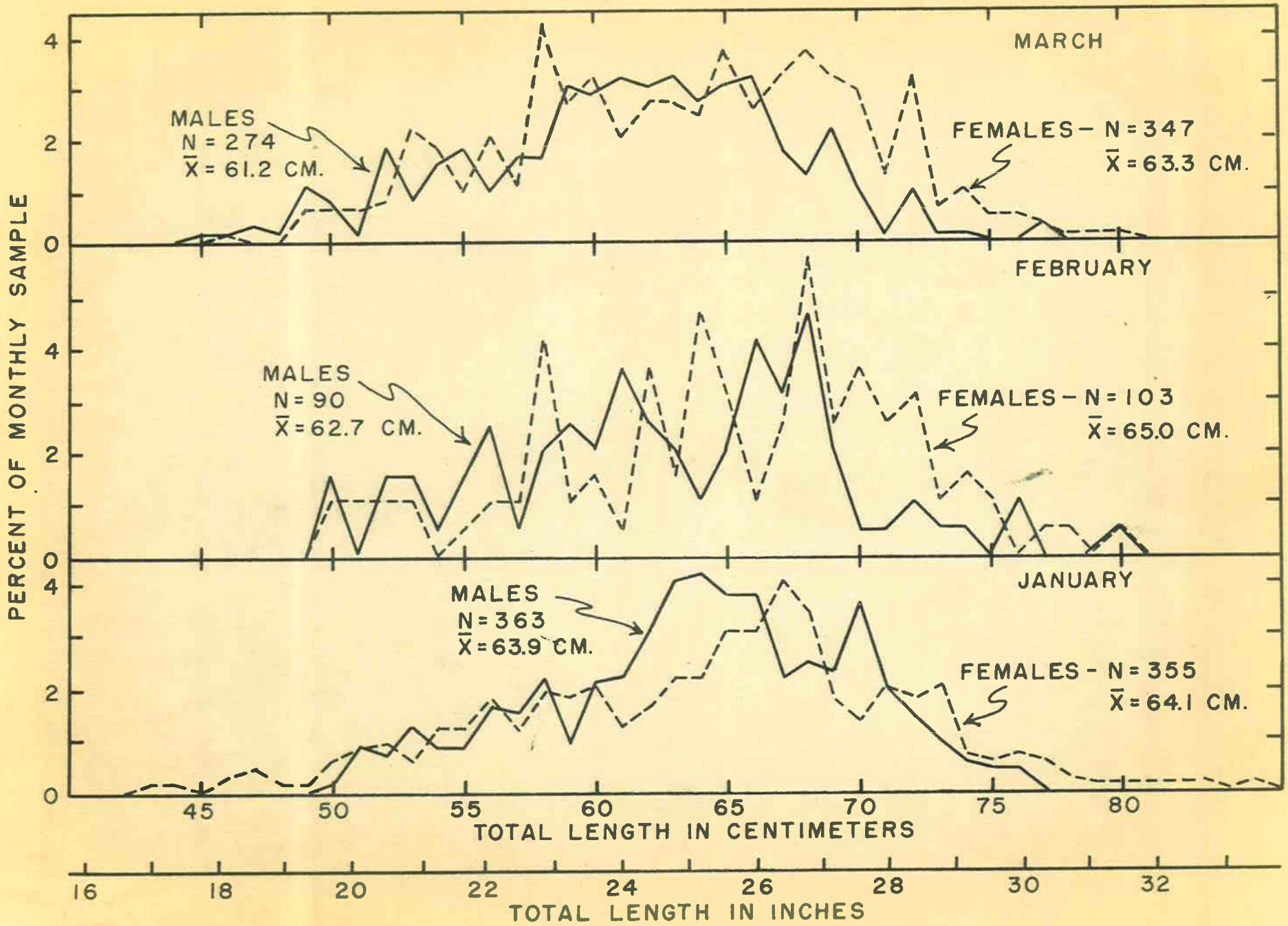


Figure 54. Length frequencies of true cod, Two Peaks and Bonilla in 36-70 fathoms, January, February, and March, 1959.

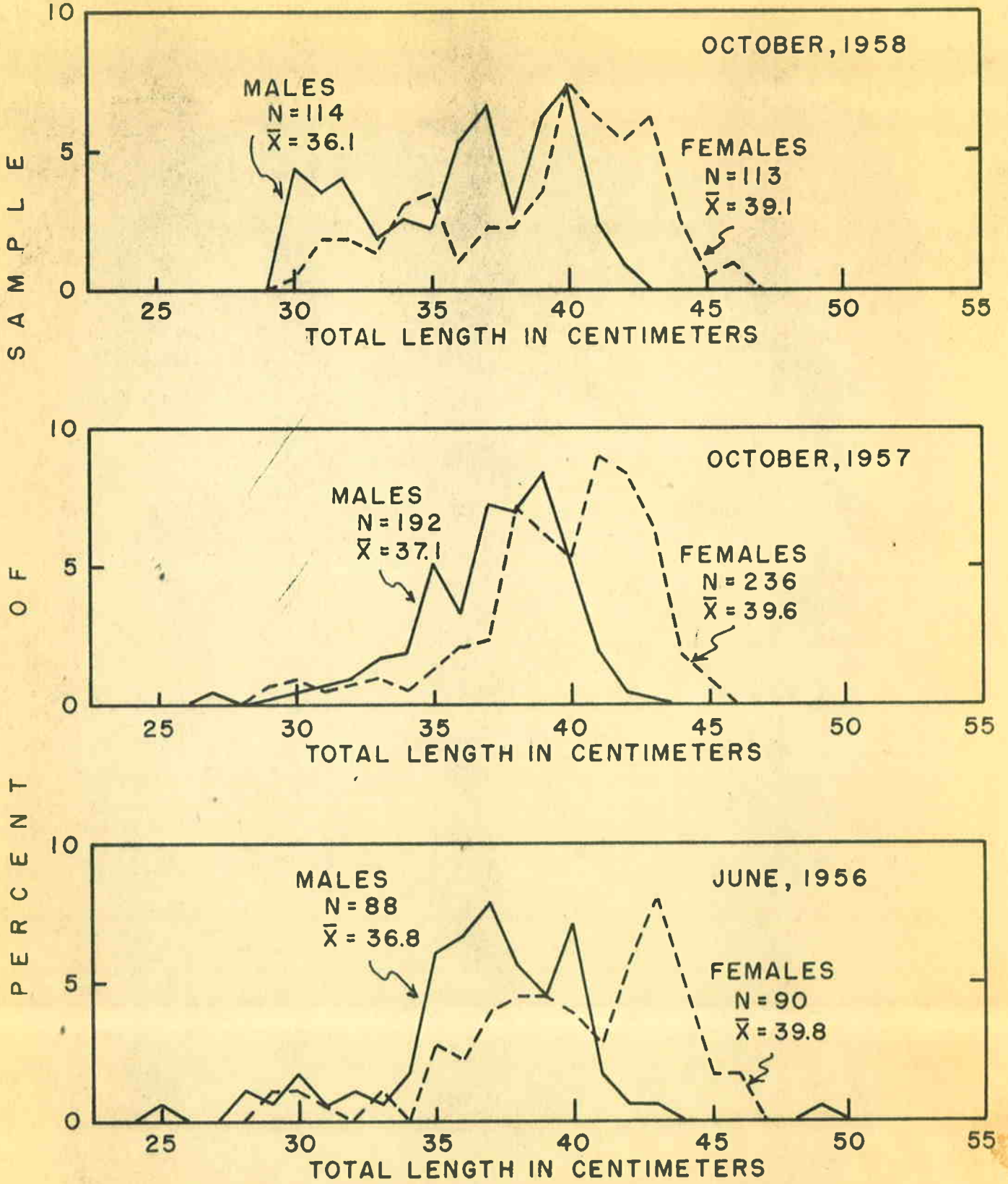


Figure 55 - Length frequency distribution of ocean perch caught on S. E. Edge (Goose Island) in 110-150 fathoms.

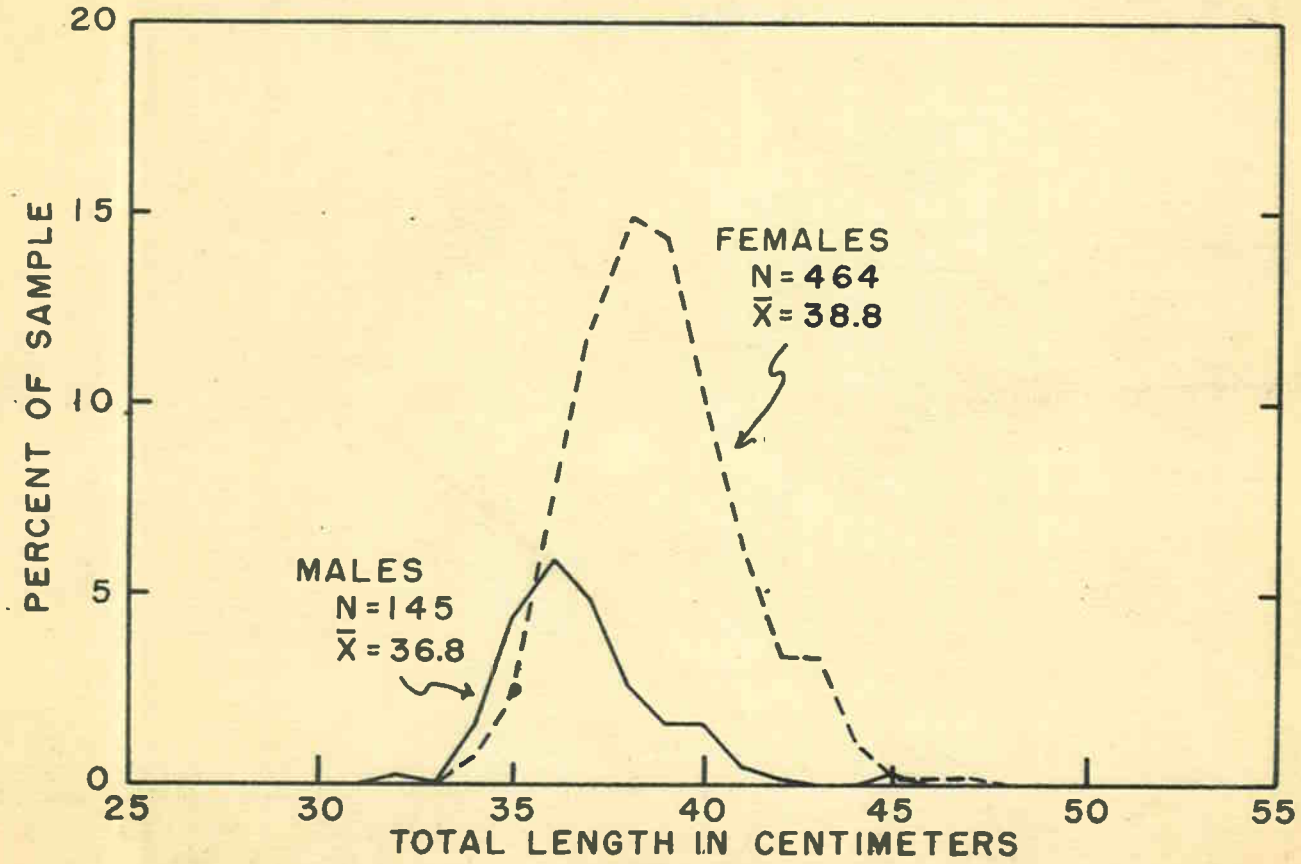


Figure 56 - Length frequency distribution of ocean perch caught off Esperanza in 150-160 fathoms, November, 1958.

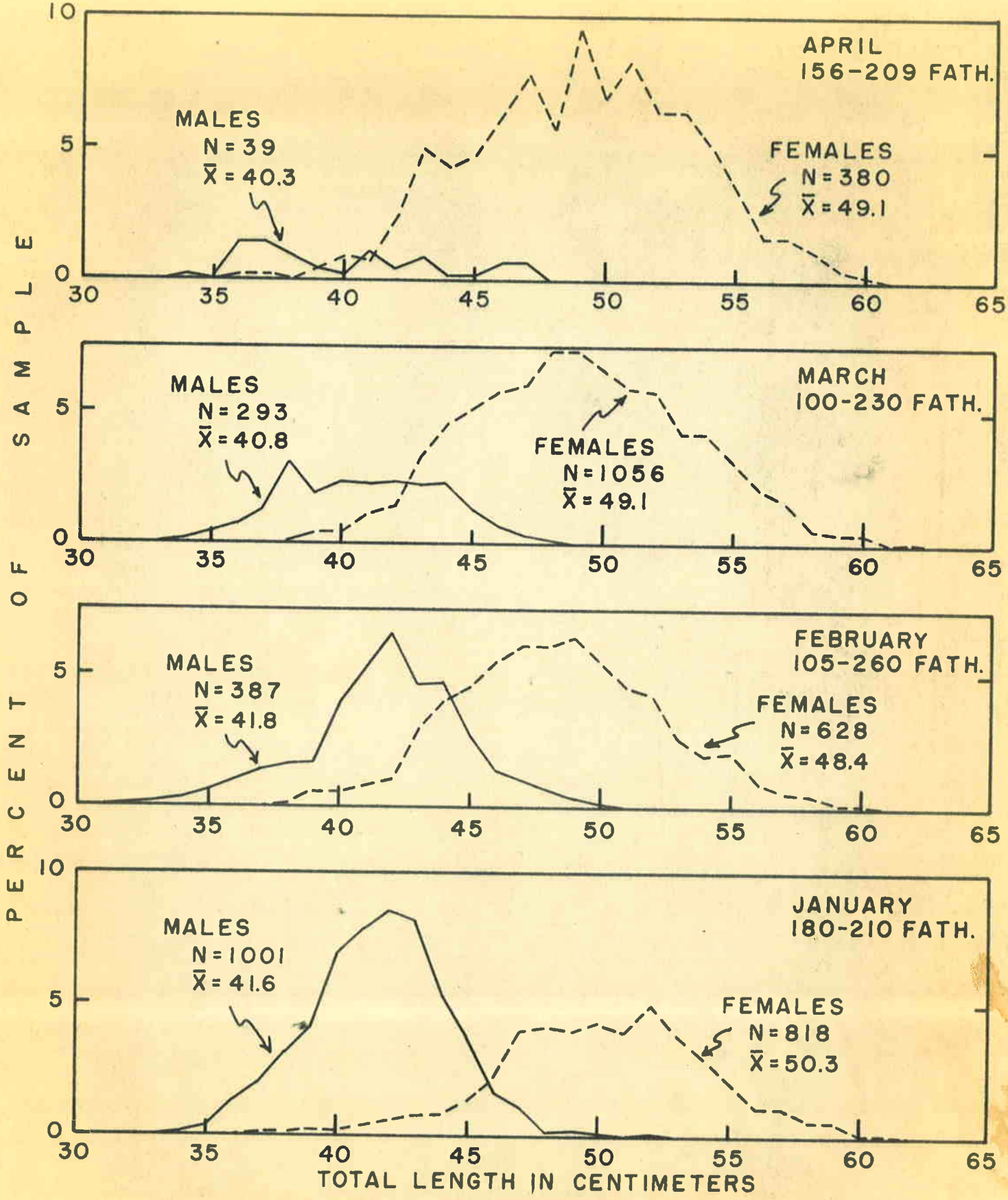


Figure 57 - Length frequency distribution of petrale sole, Esteban, 1957.

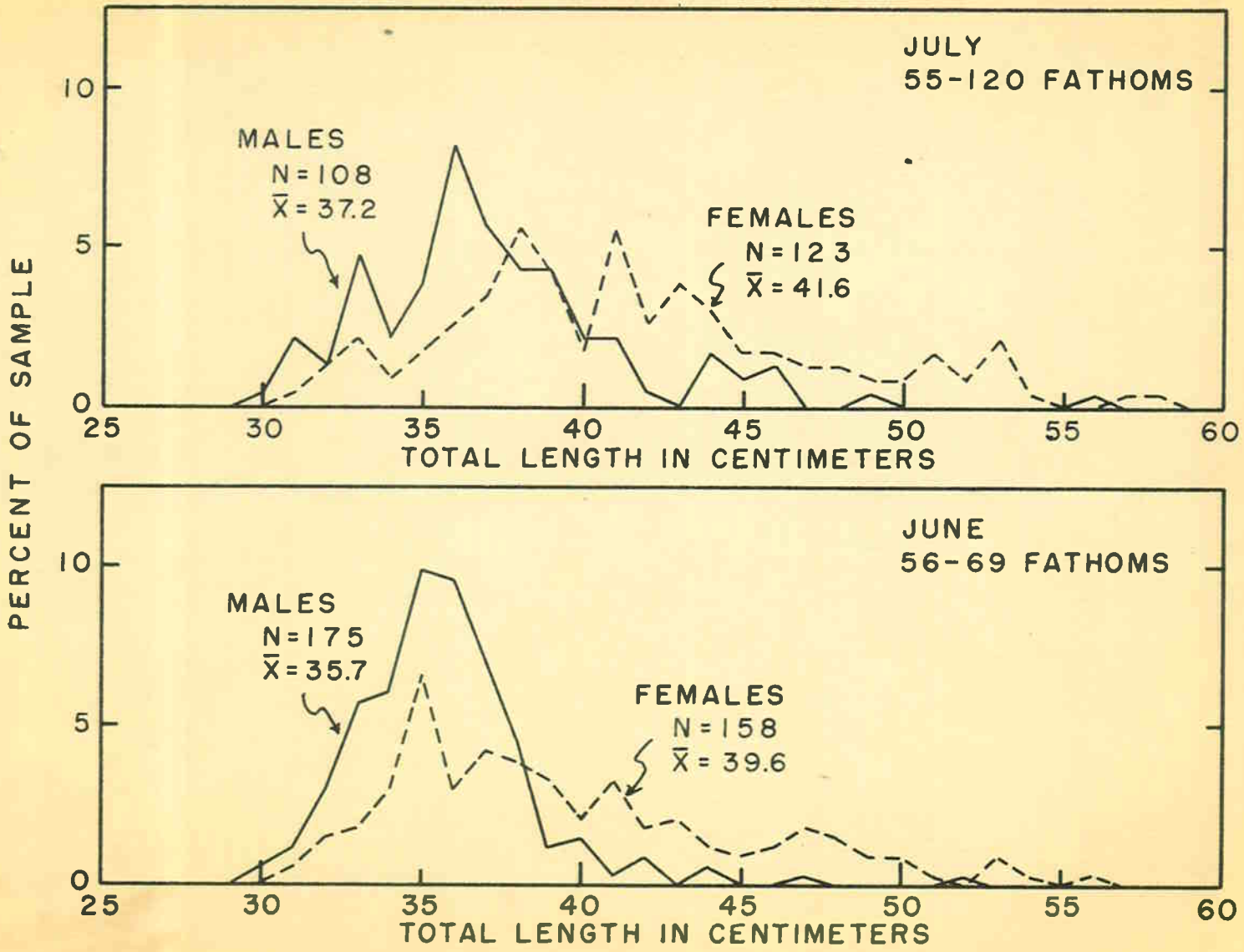


Figure 58 - Length frequency distribution of petrale sole, Cape Scott, 1957.

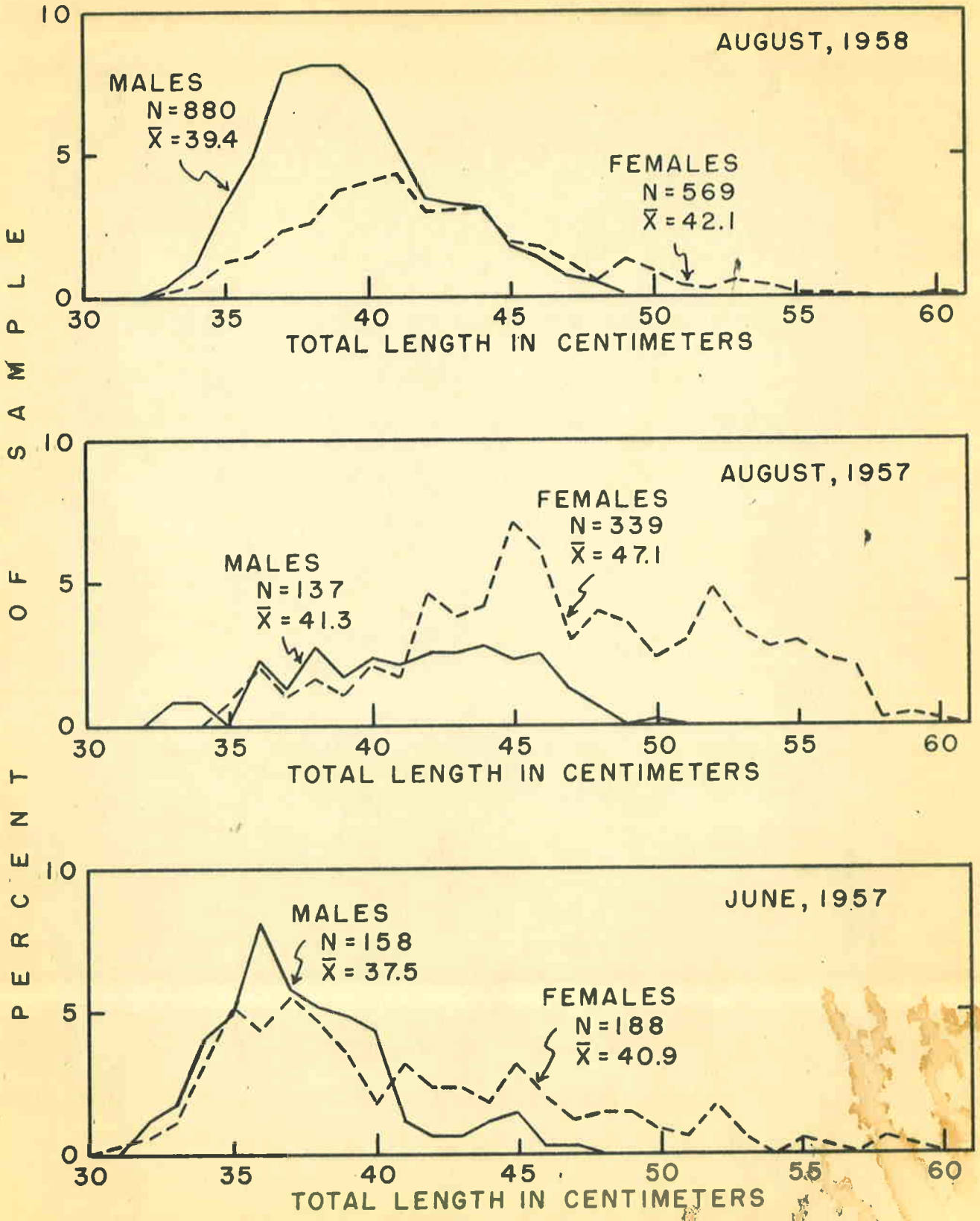
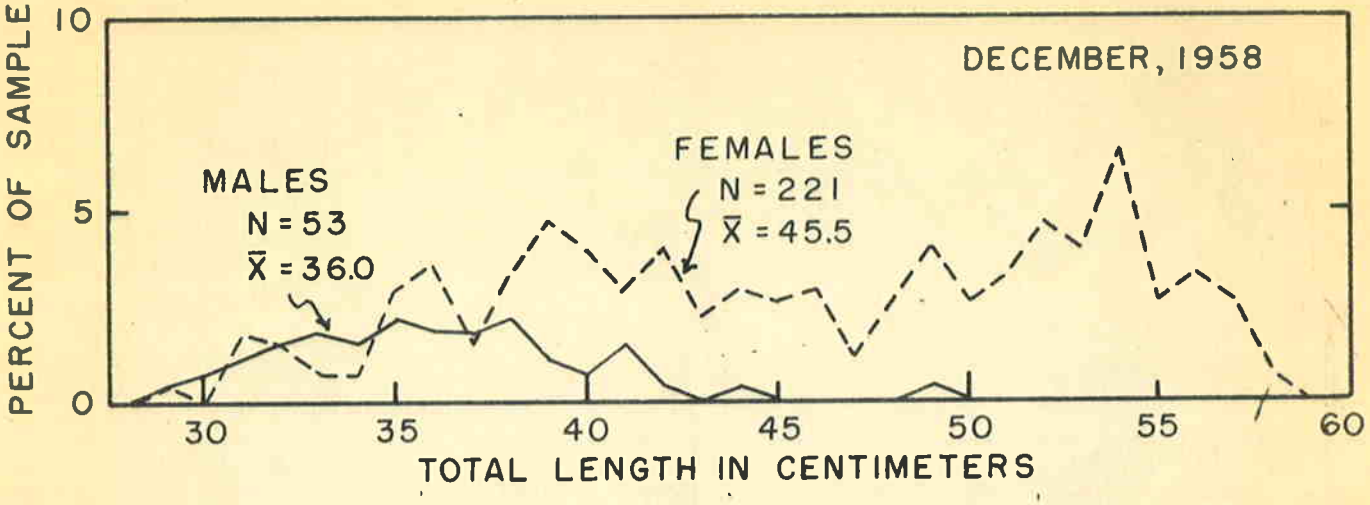


Figure 59 - Length frequency distribution of petrale sole, 40-mile Bank, 38-50 fathoms.



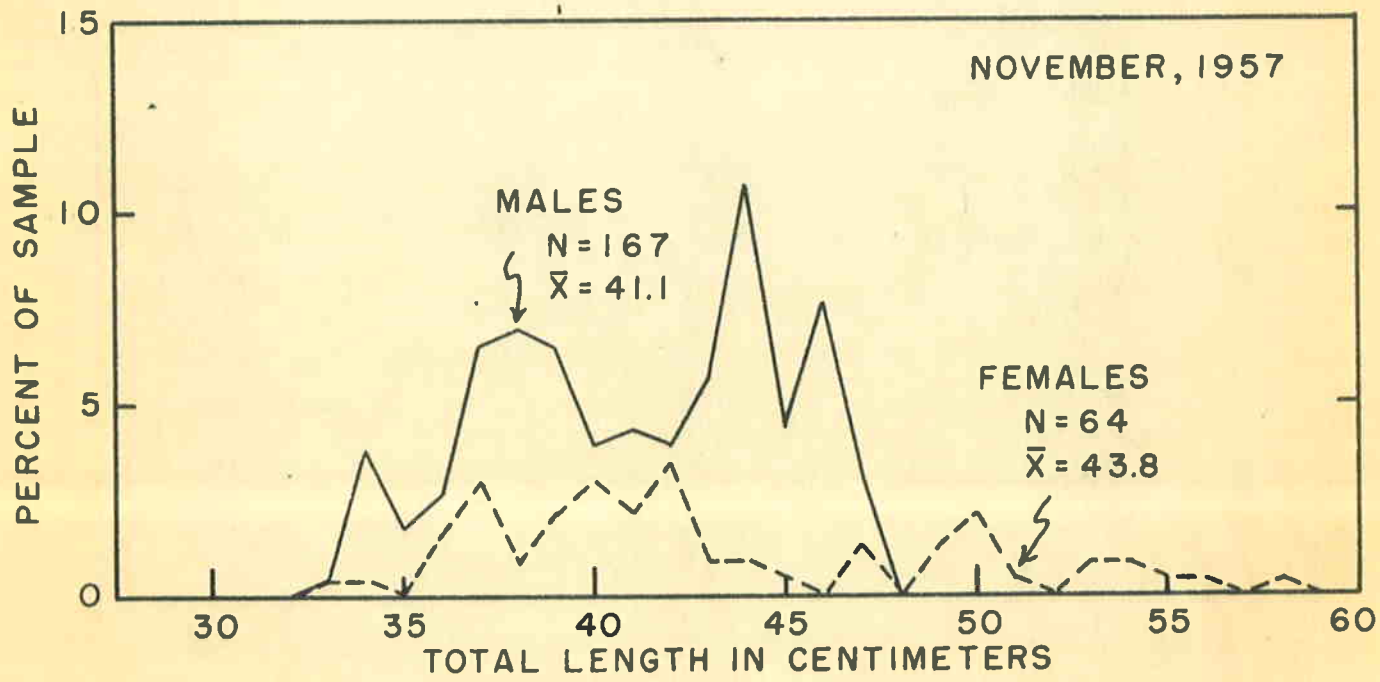


Figure 60 - Length frequency distribution of petrale sole, Bonilla Grounds, 48-58 fathoms.

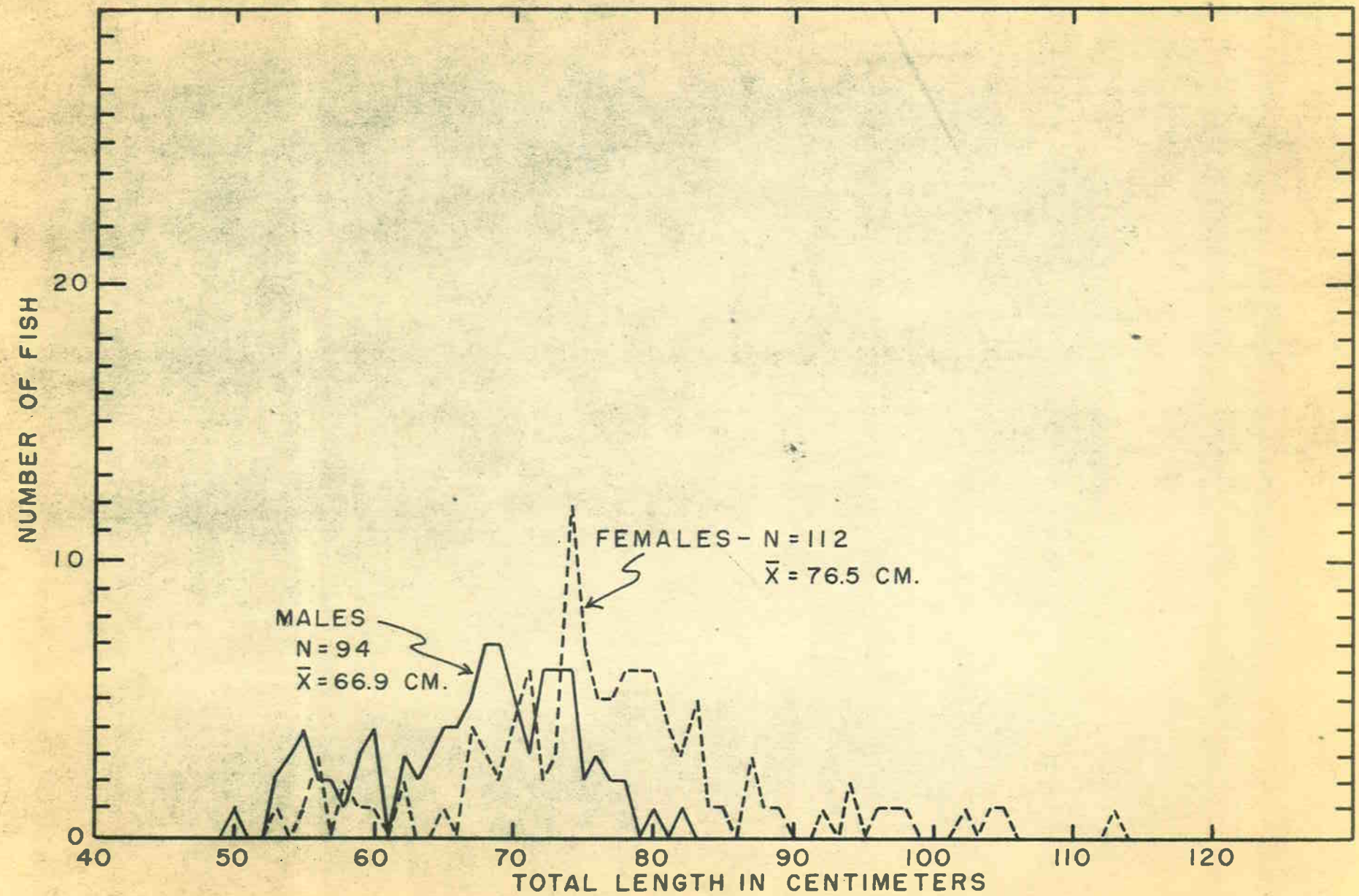


Figure 61. Length frequencies of ling cod, 40 Mile Bank in 40-43 fathoms, June, 1957.

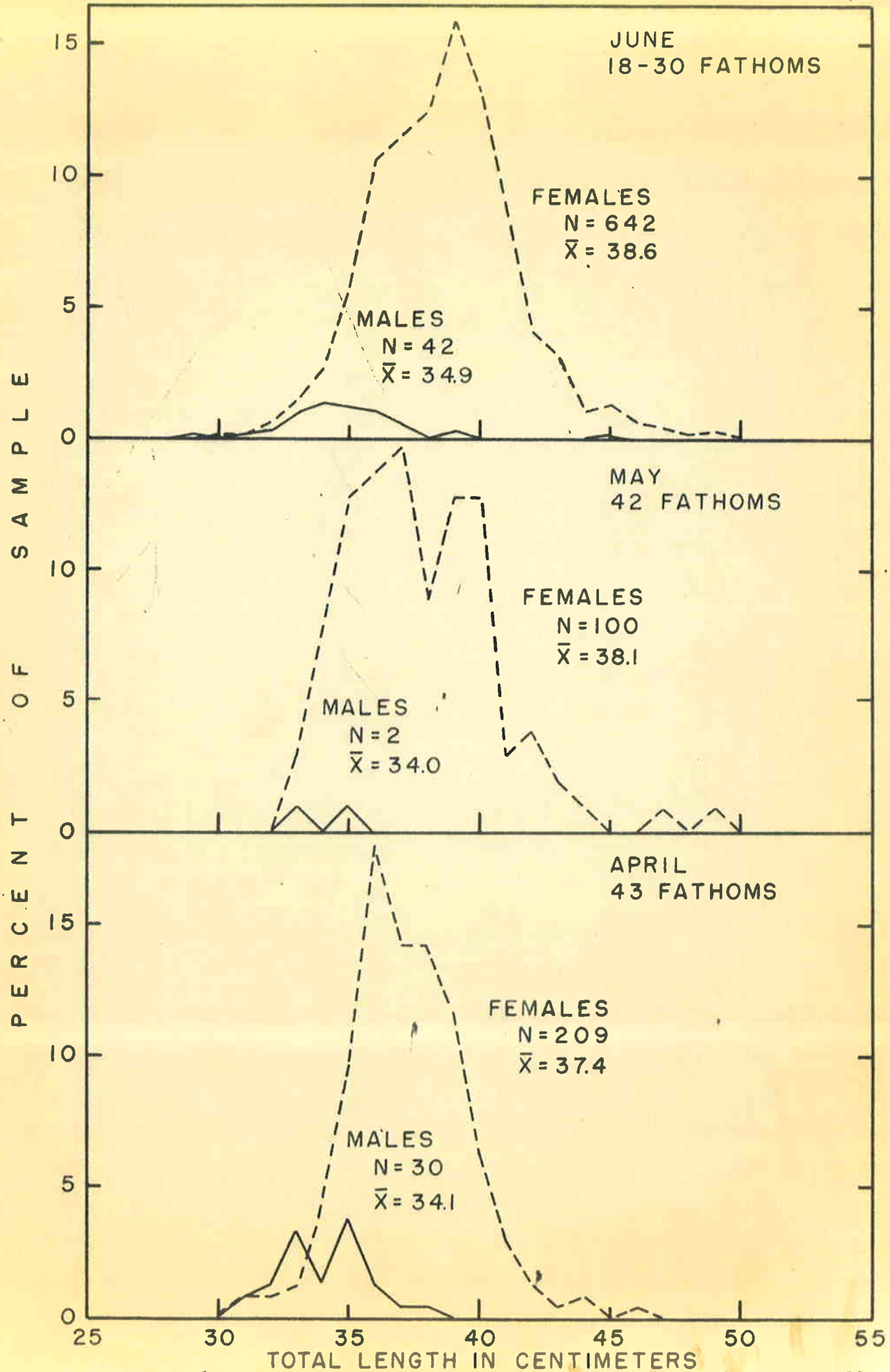


Figure 62 - Length frequency distribution of English sole caught off Cape Flattery-Umatilla, 1957.

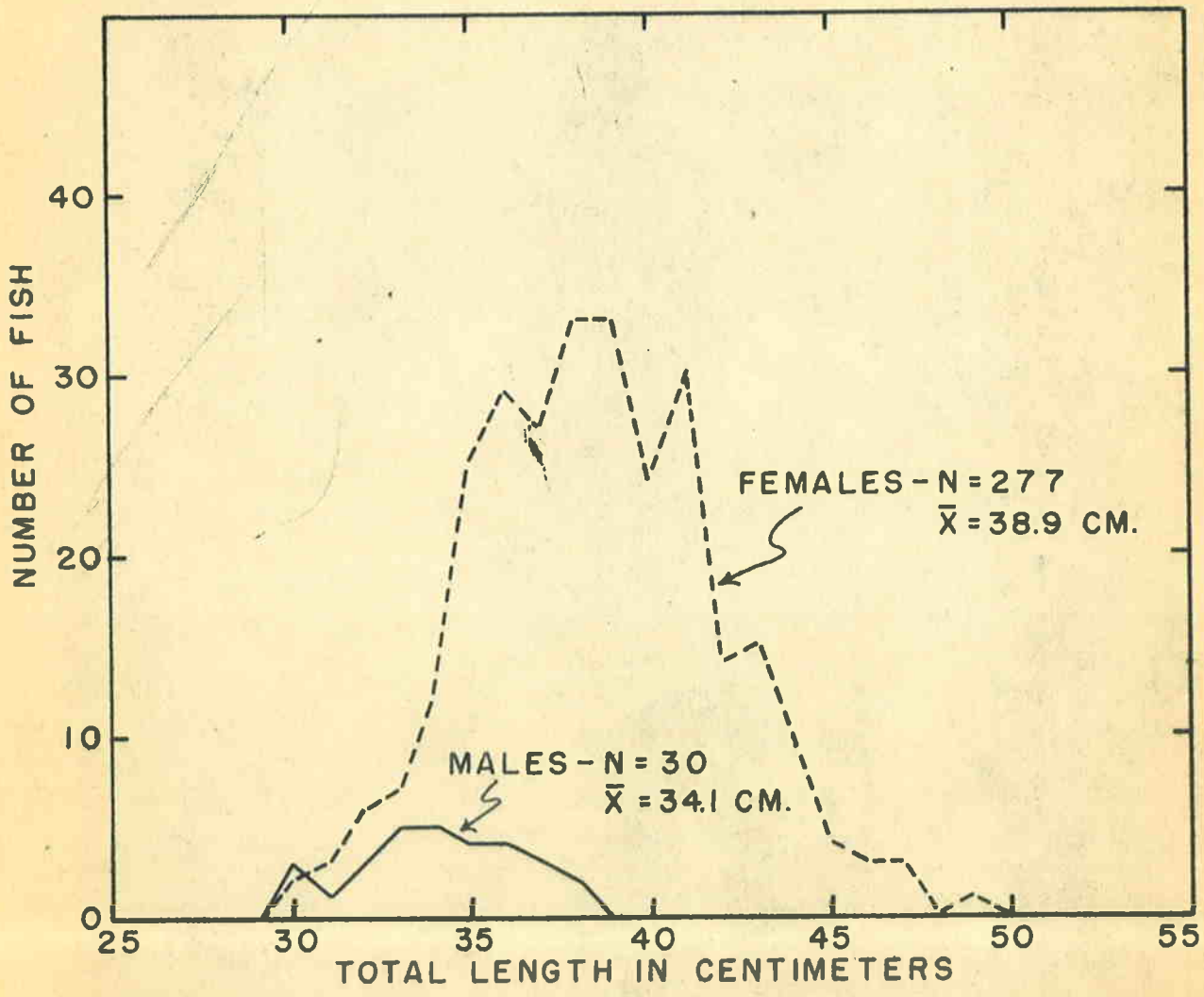


Figure 63. Length frequencies of English sole, Destruction Island, 48 fathoms, February, 1957.

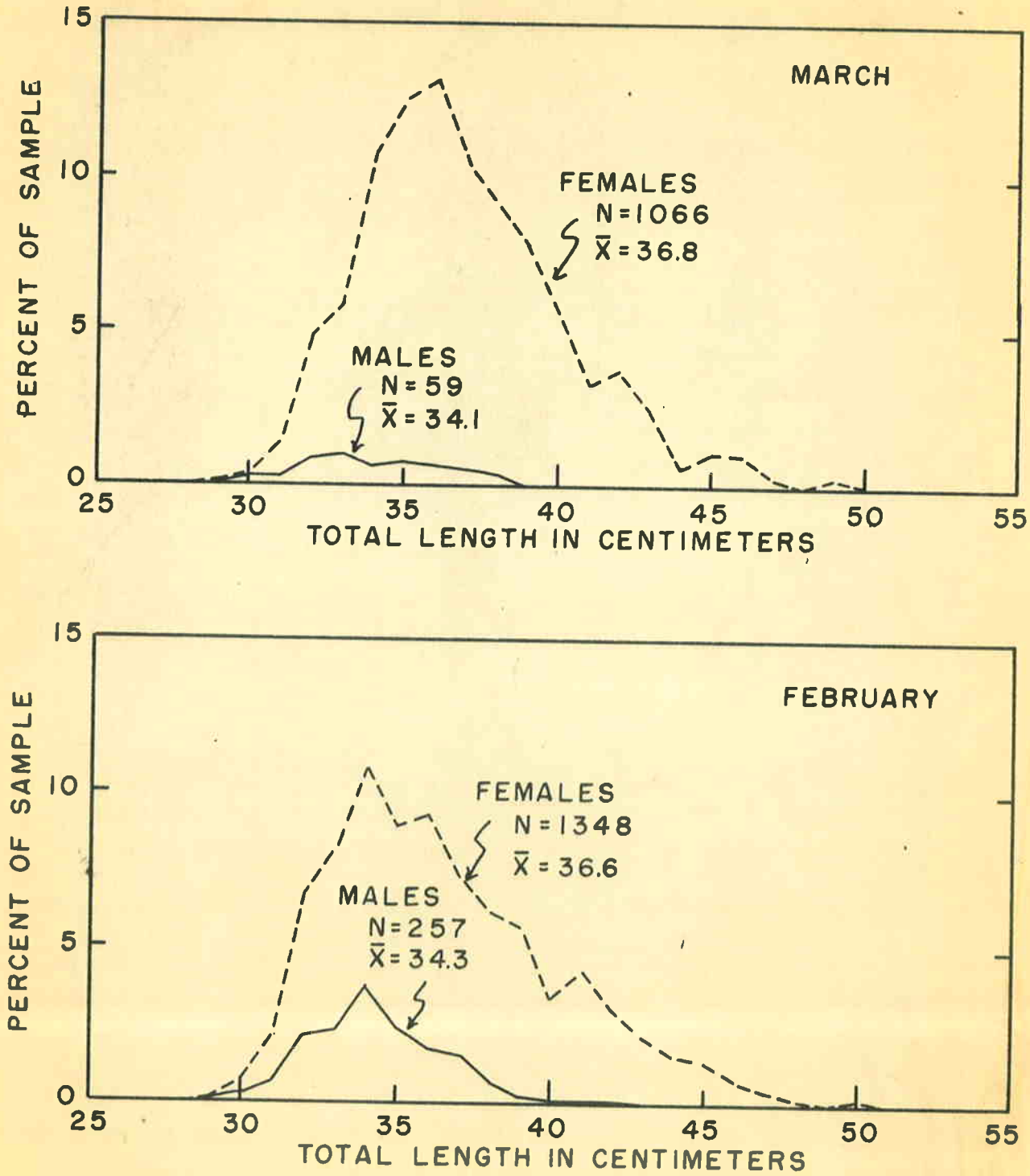
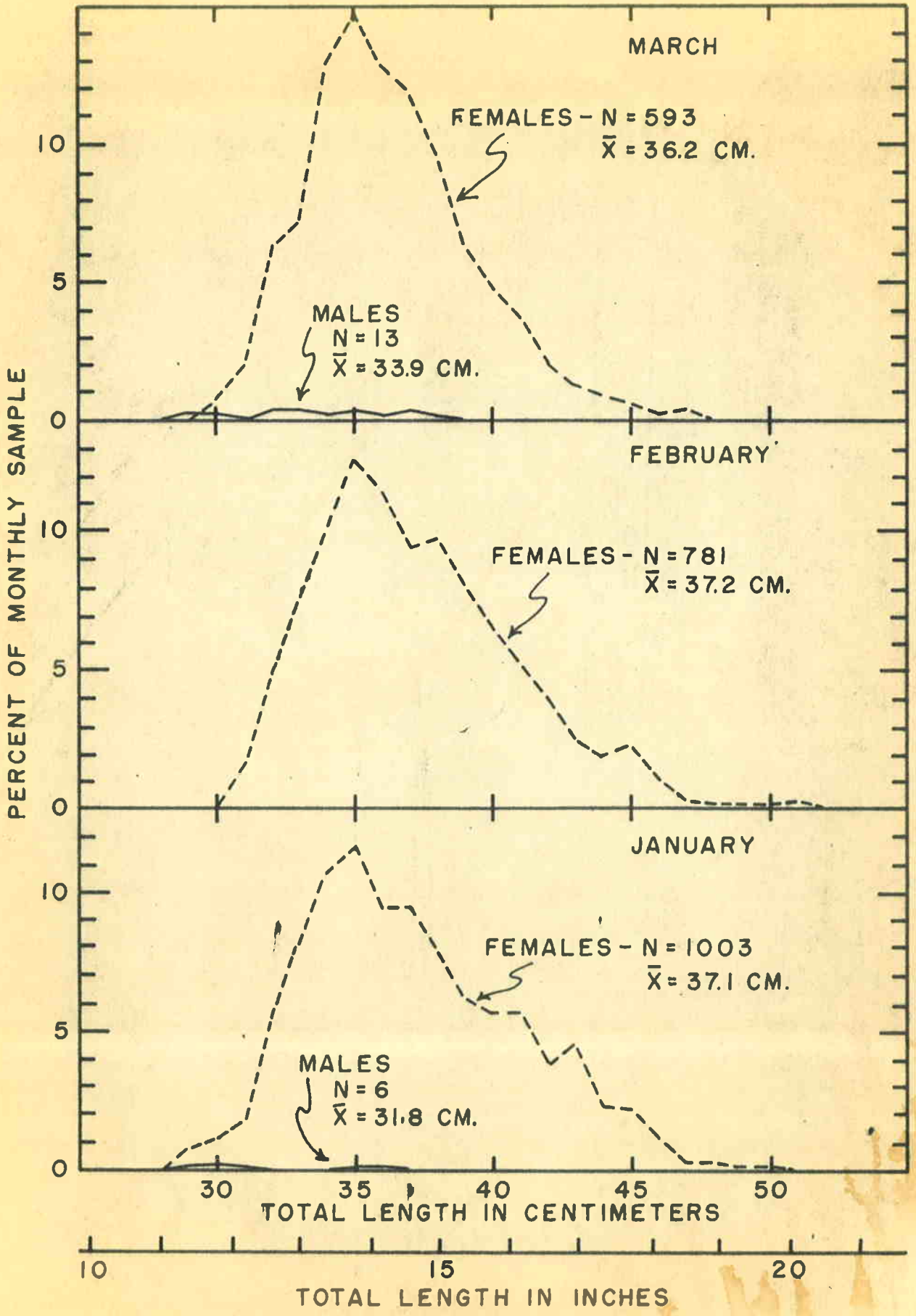


Figure 64 - Length frequency distribution of English sole caught in Hecate Strait in 38-59 fathoms, 1959.



Figures 65. Length frequencies of English sole, Destruction and Carroll Island in 57-65 fathoms, January, February, and March, 1959.

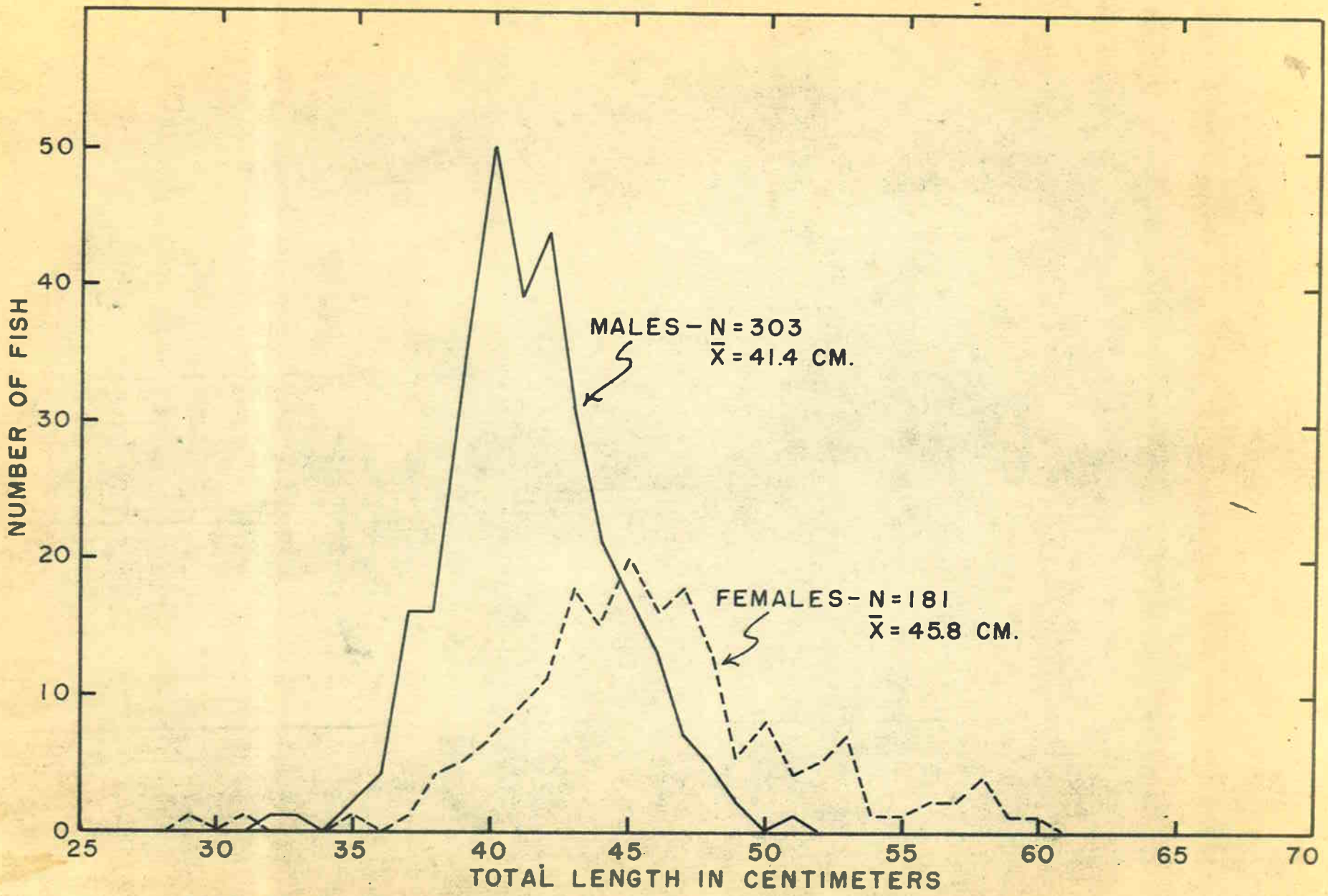


Figure 66. Length frequencies of Dover sole, 40 Mile Bank in 40 fathoms, June, 1957.

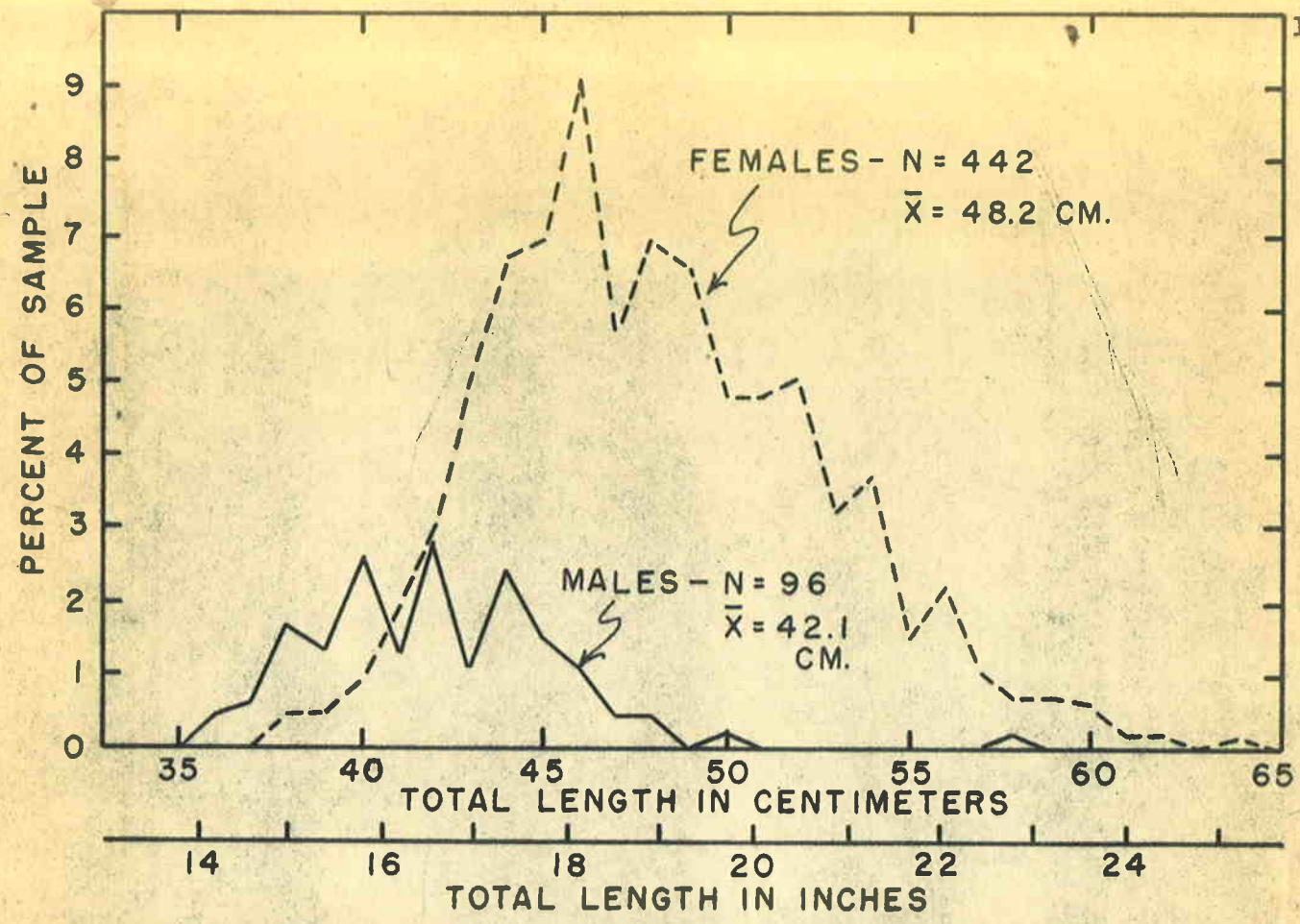


Figure 67-A. Length frequency distribution of Dover sole, Swiftsure Bank, in 105-110 fathoms, November, 1958.

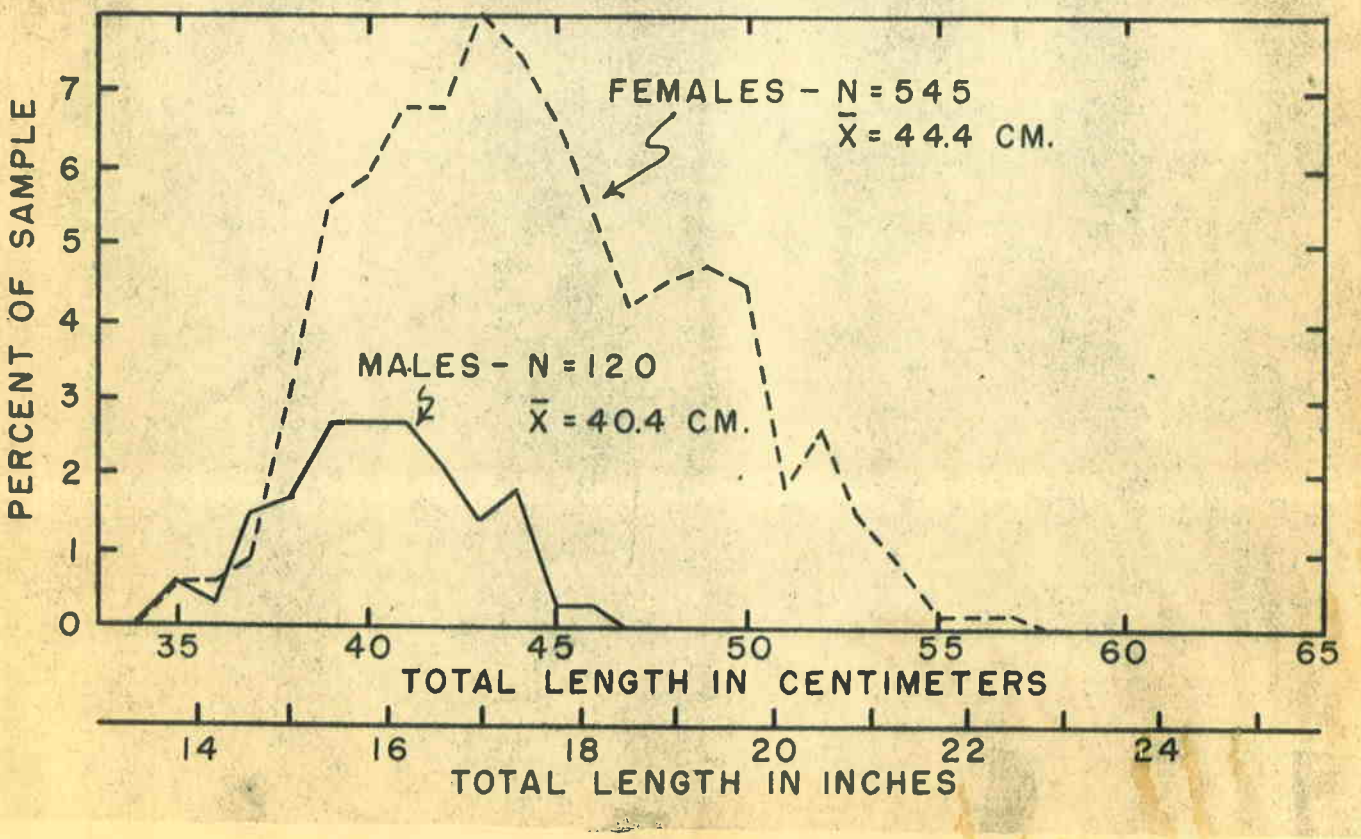


Figure 67-B. Length frequency distribution of Dover sole, Esteban, 80-115 fathoms, December, 1958.

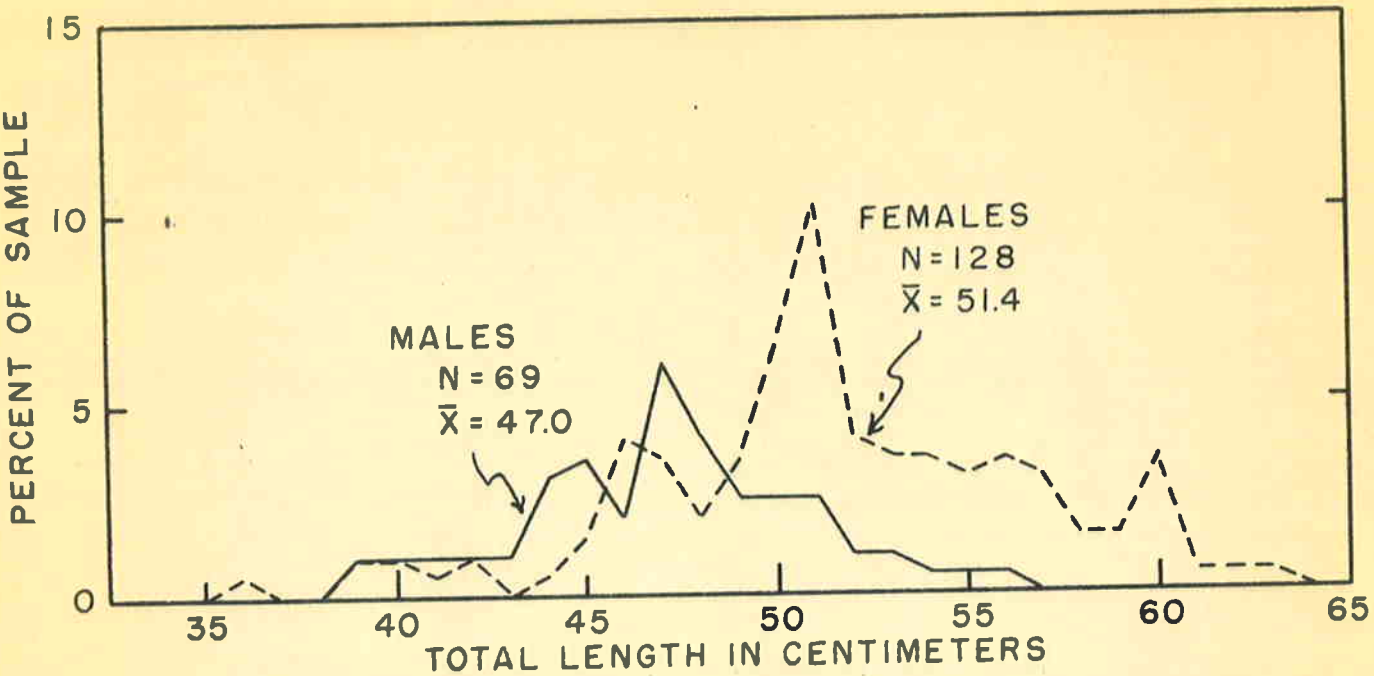


Figure 68-A. Length frequency distribution of starry flounder caught off Quillayute in 25 fathoms, July, 1957.

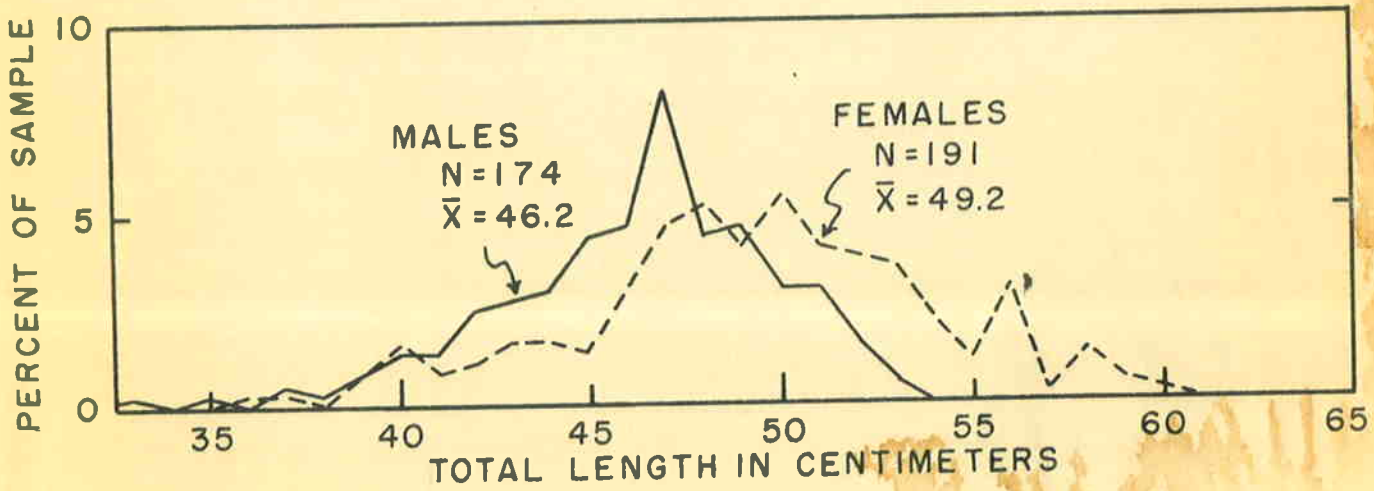


Figure 68-B. Length frequency distribution of starry flounder caught off the Columbia River (Area 17) in 27-28 fathoms, October, 1957.

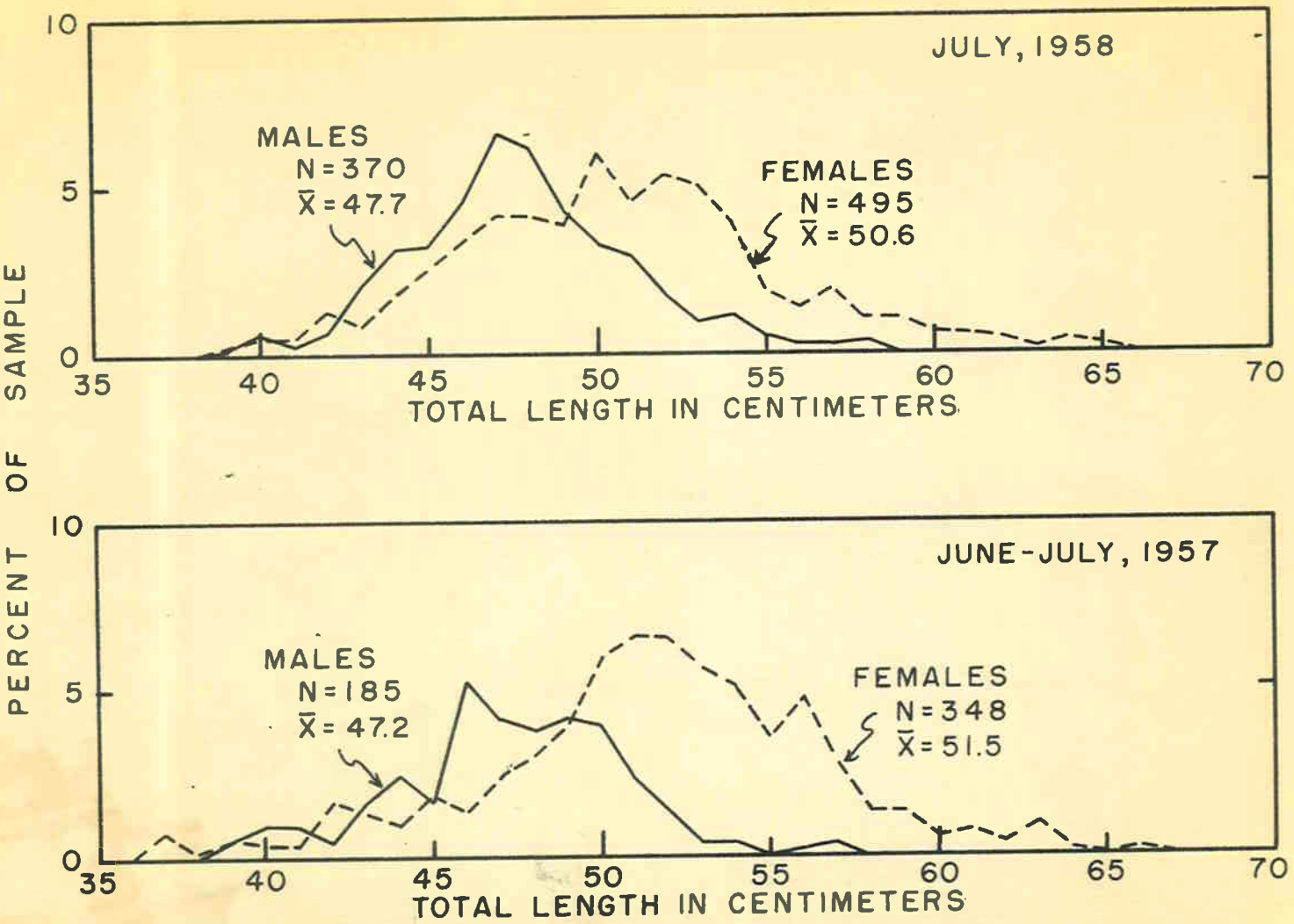


Figure 69 - Length frequency distribution of starry flounder caught off Umatilla in 18-30 fathoms.

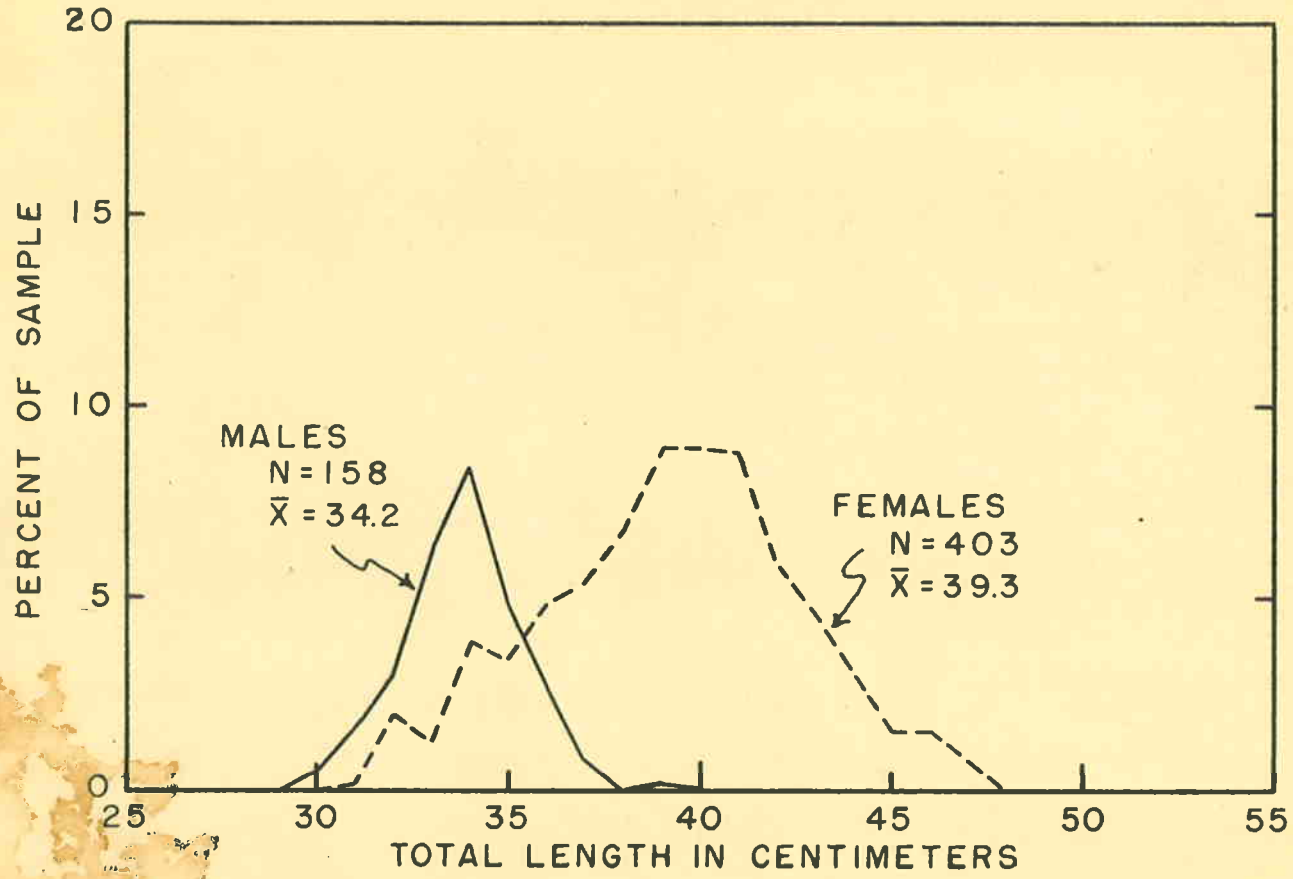


Figure 70 - Length frequency distribution of rock sole caught off the Horsehoe Grounds (Hecate Strait) in 47-50 fathoms, October, 1957.