Pattie

Research Report
on the
WASHINGTON TRAWL FISHERY
1962 - 1964

State of Washington
DEPARTMENT OF FISHERIES
Research Division

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INTRODUCTION

During the period of this report the trawl fishery or groundfish investigations have been conducted by three biologists and one technician. One of the biologists is also engaged in studies on the Puget Sound herring and smelt fisheries, which are reported on separately.

The objective of the groundfish research program is to acquire knowledge on the life histories of the various species that constitute the groundfish resource, and to apply this knowledge to achieve the greatest possible sustained production from this resource. To fulfill this objective, the relative abundance of the fish stocks is monitored continuously by the degree of success the fishermen experience in exploiting those stocks. This constitutes the "fishermen interview" program, and the catch statistics obtained in this program will be reported upon at length. Fish were tagged to identify individual stocks and to determine their migration patterns. Market samples are taken to determine age, length and sex compositions of the stocks and eventually it is hoped to obtain measures of survival rates of the various stocks or populations.

This sixth progress report on the trawl fishery is comprised principally of an analysis of catch statistics collected from fishermen over the past ten years. Prior progress reports on trawl investigations were prepared for 1954, 1955, 1956, 1957 through 1959, and 1960 through 1961.

The Washington trawl fleet is composed primarily of combination type fishing vessels. A few are halibut schooners that have been converted to trawling. Most of the vessels are of the purse seine type and are engaged in salmon fishing or packing during the summer salmon season. Washington trawl fishermen range from central Oregon to southeastern Alaska in their pursuit of groundfish. Most of their catch, however, is taken from Destruction Island off central Washington northward into Hecate Strait, British Columbia. Many species are taken in the

trawl nets, but this report will be concerned only with the ten species which make up the bulk of the commercial landings. Rockfish species (genus Sebastodes) are grouped for discussion except for Pacific Ocean perch.

TRENDS IN THE WASHINGTON TRAWL FLEET

Seasonal and Area Fishing Patterns

The total number of trawl vessels landing groundfish in 1962 through 1964 has remained nearly constant (Table 1). The turnover of individual boats comprising the fleet, however, is much higher.

Table 1. The number of boats participating in the Washington trawl fishery, 1962 through 1964.

Boat Designation	Year		
	1962	1963	1964
Outside(coastal)	55	52	43
Inside (Puget Sound)	38	35	43
Outside-Inside	15	23	23
Total No. of Boats	108	110	109

"Outside" boats are those landing fish from coastal waters, i.e., waters which lie outside or seaward of a line connecting Tatoosh Island with Bonilla Point at the entrance to the Strait of Juan de Fuca. This is in contrast to "inside" boats, which fish only in Puget Sound. Boats fishing both ocean and Puget Sound waters during the year are considered "outside-inside" boats. Some of the fishermen with boats in this latter category fish primarily outside waters, but make an occasional drag in Puget Sound while enroute to landing ports.

The number of trawlers in operation throughout the year varies considerably (Table 2). "Inside" fishermen fish heaviest in the winter and into early spring. A sharp decline in the number of "inside" boats occurs during the summer and early

Table 2. The number of trawl vessels participating in the Washington fishery by month, 1962 through 1964.

Year	Boats	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1962	Inside	26	30	20	19	18	10	6	5	9	14	19	26
	Outside	26	41	44	46	41	37	27	23	28	40	43	40
1963	Inside	32	30	30	31	30	16	7	6	14	18	24	28
	Outside	7	34	38	35	29	26	19	17	19	27	31	32
1964	Inside	28	28	28	24	19	15	6	3	9	17	21	27
	Outside	27	34	38	42	37	33	25	21	24	36	37	35

fall when a major portion of the inside fleet is fishing salmon. By late fall a rise in the number of "inside" trawlers is again noted. The success of the salmon season affects the time when the "inside" boats return to trawling.

Outside trawlers show a gradual decline in numbers during the summer months and again near the end of the year. During the summer, various agencies charter many of the larger outside vessels, and other outside fishermen discontinue trawling to fish salmon or halibut. The winter holiday season brings the entire outside fleet in by late December and a period of a week to several weeks may elapse before fishing is resumed. This allows for a certain amount of vacation, gear mending, boat repairs and price negotiating. A sharp decline to only 7 outside trawlers occurred in January 1963 as a result of a cooperative tie-up of outside fishermen involved in a dispute over fish prices. The winter storms occurring off the coast also contribute to the decline in outside fishing during January.

The seasonality of the trawl fleet can be demonstrated by the fact that in 1964 less than one half of the outside vessels fished 8 or more months and one half of the inside boats fished only 6 months (Table 3).

Table 3. Seasonality of Washington trawl vessels as determined by months in which one or more landings were made.

Inside Boats				Outside Boats			
Active Months	Number of Boats	Per Cent of Total	Per Cent Active (cumulative)	Active Months	Number of Boats	Per Cent of Total	Per Cent Active (cumulative)
12	3	7.0	7.0	12	3	7.0	7.0
11	2	4.7	11.7	11	7	16.3	23.3
10	4	9.3	21.0	10	4	9.3	32.6
9	5	11.6	32.6	9	2	4.7	37.3
8	1	2.3	34.9	8	5	11.6	48.9
7	5	11.6	46.5	7	6	13.9	62.8
6	2	4.7	51.2	6	4	9.3	72.1
5	4	9.3	60.5	5	1	2.3	74.4
4	6	13.9	74.4	4	4	9.3	83.7
3	5	11.6	86.0	3	4	9.3	93.0
2	3	7.0	93.0	2	1	2.3	95.3
1	3	7.0	100.0	1	2	4.7	100.0

The average number of days per trip and the average number of days fished per trip for outside fishermen is given by month for the 3 year period 1962-1964 in Figure 1. It can be seen from this representation that the average number of days spent fishing each trip ranges from a low of 5.3 days in October to a high of 6.8 days in April. Although the number of days fished per trip does not vary greatly, the length of time spent away from port does. Weather conditions are the main reason for this. For the years 1962 through 1964, outside fishermen averaged 11.3 days per trip during December with only 5.4 days spent fishing each trip. July and August had an average of only 8.6 days per trip with 5.8 and 5.7 days, respectively, spent fishing.

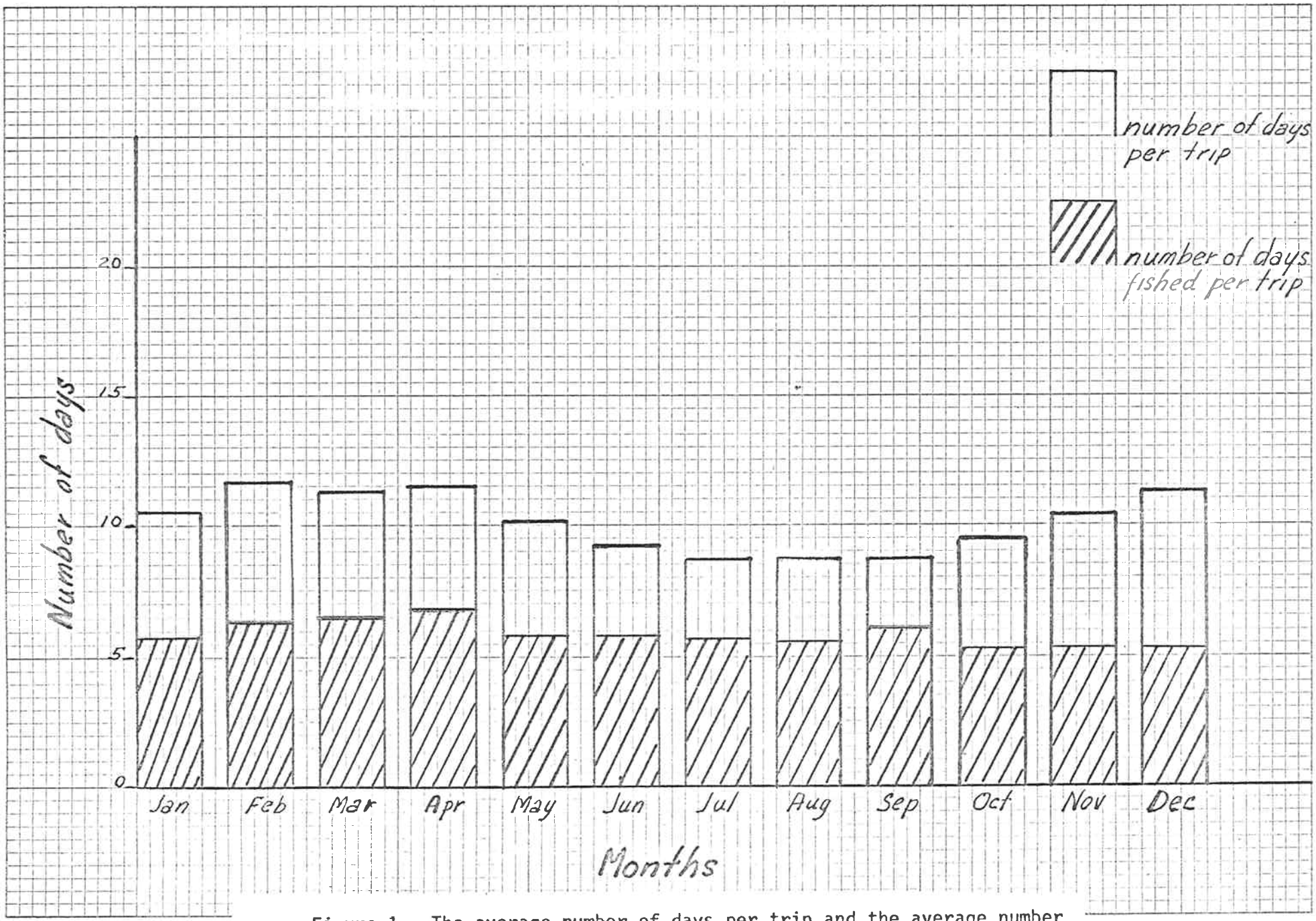

Figure 1. The average number of days per trip and the average number of days fished per trip for outside vessels, 1962-1964.

For inside boats, the average number of days fished each trip is approximately three for the Seattle fishermen, and one for those fishing out of the Bellingham area (Table 4). Since the northern Puget Sound fishing grounds are close to the landing ports, the fishermen at Blaine and Bellingham generally make daily trips and land their catch each evening. Seattle fishermen, who must travel greater distances to the grounds, in southern and central Puget Sound, regularly make trips lasting several days.

Table 4. Average number of days per trip for inside boats, 1962 through 1964.

Seattle Boats	Month	Bellingham Boats
4.0	January	1.3
5.1	February	1.2
6.6	March	1.0
3.9	April	1.0
2.0	May	1.1
1.0	June	1.0
1.0	July	1.1
1.0	August	1.1
1.4	September	1.0
1.6	October	1.1
2.6	November	1.1
3.3	December	1.2
3.2 Ave. No. of days/trip		1.2 Ave. No. of days/trip

Each year there are a number of fishermen who land over one million pounds of groundfish. Table 5 lists these trawlers which represent the "high-line" boats of the Washington trawl fleet.

Table 5. Trawlers making landings of more than one million pounds of bottomfish for years 1962-1964.

1962	1963	1964
1 Traveler	Traveler	Georgene
2 Georgene	New Washington	New Washington
3 Don Edwards	Georgene	Traveler
4 MarshaLynn	Morning Star	Nina B
5 McKinley	Don Edwards	Arthur H
6 Havana	Havana	Yaquina
7 Ann B	MarshaLynn	Ann B
8 Kodiak	Tordenskjold	
9 Tordenskjold	Ann B	
10 Nina B	McKinley	
11 Northern Light II	Paragon	
12 Guide	Nina B	
13 Tulip*	Western Flyer	
14 Coolidge II	Northern Light II	
15 Excell II		

*The M/V Tulip made all inside fishing trips in 1962.

In 1962, 15 fishermen, or 13.9 percent of the outside boats landed a million or more pounds of bottomfish. Fourteen or 12.7 percent in 1963 and seven or 6.4 percent in 1964 landed a million or more pounds.

The price received by fishermen for major species of bottomfish changed little during the three years covered in this report. A price of 10 cents per pound was paid for petrale sole in 1962. This price was raised to 11 cents in 1963 and has remained there since. Dover sole went from $6\frac{1}{4}$ cents per pound in 1962 to $6\frac{1}{2}$ cents per pound in 1963. The price paid for rockfish and Pacific Ocean perch fluctuates during the year. This is partially due to market demand. The

usual price received for Pacific Ocean perch and rockfish is 5 cents per pound, however, in 1964, after a major tie-up of the outside trawlers, a price of $5\frac{1}{2}$ cents per pound was paid the fishermen during January, February and March. This was followed by 5 cents per pound from April to October, and then $5\frac{1}{4}$ cents a pound during October, November and December.

Gear and Vessel Modifications

In the last ten years only one vessel, the "Northern Light II", was built specifically for trawl fishing. New boats entering into the Washington trawl fishery are converted purse seiners which were previously engaged in salmon fishing or in sardine fishing in California. Most of the presently active trawlers are constructed of wood although a few are of steel. Some of the vessels now engaged in the trawl fishery are 30-40 years old.

As the demand for groundfish enticed fishermen into the fishery, gear changes also became evident. In the beginning, some trawlers used a single mechanical winch with one wire (steel cable) which terminated in a bridle that held the otter boards and net in a fishing position. Other fishermen utilized double towing lines (Manila rope) to tow their doors and nets. The double lines were fished one on each side of the vessel, and a power capstan supplied the necessary force to the lines for pulling the fishing gear.

The single winch, towing wire, and Manila towing lines gave way to the double, mechanical, or hydraulic winch which is standard equipment aboard the trawlers today. The double winch is powered from the main engine, and each winch gives control over the towing wire which permits the gear to be fished at various depths.

Until mechanical and hydraulic net reels came into use, the conventional method of picking up the gear was to bring the otter boards up to the stanchions on each side of the stern where the boards were attached and released in order for the net to be brought aboard on the starboard (right) side of the vessel.

Picking up the net with block and tackle rigged to the main boom was time consuming since the length of the net required several "lifts" on the wings and main body before the cod end could be lifted aboard. It was also hazardous to the fishing crew during bad weather since the floats on the head rope of the net would swing back and forth with tremendous force each time the vessel rolled. With the use of the new reels, the safety margin to the crew increased because the wings and main body of the net could be rolled onto the reel before the catch in the cod end is brought aboard. The use of the reel lessened the danger in this phase of fishing activity, but increased it in another since fishermen with reels began fishing rougher weather.

The ideal trawler of today is one with complete hydraulic gear. Gradually, as the fishermen can absorb the cost, hydraulic systems such as the "Gearomatic", which works off of the main boom to pick up the net, and eliminates the manual handling of lines coupled to the power capstan, are replacing the gear driven winches and mechanical reels.

The otter boards or "doors", which function to keep the net spread open and in a fishing position while trawling, are being designed to give the net increased fishing efficiency. The first "doors" were approximately 4 feet high and 6 feet long and constructed of 2" x 12" planks confined in a strap-iron framework which was welded to a weighted "shoe" that kept them on the bottom and also protected them from being damaged by rocks and other debris. Such wooden doors are still used by small trawlers fishing in Puget Sound because of their relative low cost of construction. Most of the ocean vessels, however, presently use metal doors, usually of galvanized steel construction. Metal doors are preferred because they require minimum maintenance, are less cumbersome and dangerous to handle, and apparently fish the net more effectively than wooden doors.

In attempting to increase the towing power of their vessels and thereby their efficiency, many trawl fishermen have replaced the low speed, bulky power plants (engines) with high speed, compact engines of more horsepower. By moving

the bulkhead in the hold forward, many have also increased the carrying capacity of their vessels. This "stepped up" towing power allows fishermen to use larger nets, and nets equipped with "rollers" on the lead line. These rollers enable fishing in rocky areas that formerly could not be fished without damage to the net. The increase in vessel horsepower increased the fishability of the present trawlers, but did not boost the running speed proportionally because of hull design. Most repowered vessels have increased running speeds by 1 to 2 knots.

Electronic equipment found aboard the early trawlers usually consisted of a two-way radio, a fathometer, and on some vessels fishing ocean waters, a Loran set. Trawlers fishing inside waters and inshore ocean grounds usually depended on fathometer depth readings and headland points to position themselves on various known towing areas. As fishermen gradually moved further offshore, the Loran set became standard equipment. Loran, which enables fishermen to pinpoint their location, works in conjunction with certain radio frequencies projected from various Loran stations located on the mainland.

Radar first became available to fishermen at a cost warranting installation at the end of World War II, when surplus units were placed on the market. Subsequent development of commercial units placed it in a price range that was within the means of most fishermen. Present cost of a radar unit, plus installation, will vary from $3,000 - $6,000 or more, depending on the scanning range of the set. Nearly all boats of the trawl fleet, especially the outside trawlers, are now equipped with radar. In operation, the radar screen shows the position of the vessel in relation to objects (other vessels, land masses, buoys, etc.,) within the sets range.

Advances in the development of fathometers have brought forth recording echo sounders of varying degrees of sensitivity. These transmit sound waves downward from a transducer mounted on the keel of the vessel, and the returning waves, bounced back from the bottom, activate a recorder which produces an echogram on a special type of paper. Depending on the sensitivity of the machine, the echogram can show the depth of schools of fish or layers of plankton lying between the vessel and the bottom.

All boats in the trawl fleet carry echo sounders and the majority of these produce echograms. The simpler sounders will record dense schools of fish lying between the vessel and the bottom, but generally fail to reveal more diffuse schools and fish in direct contact with the bottom. White-line recorders, available in Simrad and Ekolite brand names, surmount these shortcomings but their high cost (to $6,000) has limited their adoption to the more progressive ocean fishing vessels.

REGULATION CHANGES

During the period 1962 through 1964, some minor changes in otter trawl regulations were made.

The previous method of determining the size of mesh of any net was the measurement of the distance between knots of each mesh when the net was stretched by hand using reasonable tension. Amending order No. 568 (4/25/63), subsection (d), of the general definitions provides that effective January 1, 1965, the size of a mesh of any net shall be the distance between the inside of one knot to the outside of the opposite vertical knot of one mesh when the mesh is stretched vertically, while wet, by using a tension of ten pounds on any three consecutive meshes, and then measuring the middle mesh of the three while under tension.

To enable the use of fishing gear constructed of nylon material required modification of General Order No. 480, Sect. 1 Subsection (o) to include, in the definition of legal otter trawl fishing gear, trawl nets constructed of synthetic rope.

Amending Order No. 479, Section 4, Subsection (d) of General Provisions stated that use of any electronic device in the commercial fishery to locate schools of food fish was unlawful except for herring. Amending Order No. 591, Section 4, Subsection (d) of General Provisions, took the restrictions off this use of such devices except in fishing for salmon.

A change in the petrale sole regulation was made in 1962. The former Order No. 480, Sect. 5, Subsection (e) made it unlawful from December 20 through April 15 to land or possess any petrale sole in the State other than the incidental catch not to exceed 3,000 lbs., or 8% of the food fish landed per boat trip, nor to exceed two trips per boat per month. Amending Order No. 564, Sect. 5, Subsection (e) changed the incidental catch quota to 6,000 lbs. per boat trip because the percentage tolerance created increased enforcement problems, and the Washington fishermen felt that the catch quota should be the same as permitted in Oregon, especially since Oregon trawlers were fishing off the Washington Coast for petrale sole. Closure dates were also changed by this order from December 20 through April 15 to December 23 through March 31.

ANALYSIS OF CATCH STATISTICS*

In 1953, a program of interviewing Washington trawl fishermen was initiated by department biologists to supplement the use of "fish receiving tickets" as a means of gathering data on the trawl catch. The study was intended to provide more detailed information on the time spent fishing in each area, the size of the catch in each area, the length of trips, the amounts of discarded fish, etc. This initial program is described by Dayton L. Alverson in "An appraisal of the fish ticket system in respect to the Washington otter-trawl fishery", Fisheries Research Papers, Volume 1, number 4, 1955. The program has continued without interruption and subsequent modifications are described in the department's Trawl Progress Report series. Among the more significant innovations was machine tabulation of the data. This reduced the chances of error inherent in hand tabulation, and provided for more permanent records.

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* The following method of analysis of the Washington trawl catch statistics was compiled by and represents the thoughts of E. K. Holmberg.

The 1960-1961 trawl progress report contained a thorough comparison of the Washington trawl statistical areas and the International Trawl statistical areas set up through the Pacific Marine Fisheries Commission. The only incongruity remaining between the two sets of statistical areas is the division between International Areas 2D and 3A. This line was placed at 46°40' by Oregon biologists. Our objection to this is that it lies across the Willapa Deep trawling ground. The original boundary coincided with the Astoria Canyon off the mouth of the Columbia River at 46°05' , and this is the more logical division from a fisheries management point of view as fishing takes place throughout the area except for the canyon. Washington catch data has historically, therefore, been divided at this point. Rather than make an unnatural division, it was agreed to combine Area 2D and 3A catches for PMFC treatment of the data. This combined area is fished primarily by Oregon trawlers.

It was agreed by the coastal states and Canada to exchange catch and effort statistics through PMFC in a "Trawl Data Series" report. The effort data in the PMFC Trawl Data Series is for all species in each area. This has been found to be meaningless in the analysis of abundance trends for any single species. The Data Series material has been useful, however, in determining the percent of the catch taken by Washington fishermen of a single species in a particular statistical area.

In this report, wherever applicable, use has been made of Thompson's method of comparing effort in number of hours spent fishing a particular species with the catch per hour of fishing. Dr. W. F. Thompson demonstrated that the reciprocal relationship observed between these factors in the Pacific halibut fishery was the effect of fishing upon the stock abundance.*

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* "The effect of fishing on stocks of Halibut in the Pacific," by William Francis Thompson, University of Washington Press, Seattle, 1950.

In the following data, the necessary circumstances are not always available to demonstrate this clearly. Nevertheless, for the purpose of this report, it will be assumed when a reciprocal relationship can be observed, that the case is analogous to that of the halibut fishery and the observed relationship is a reflection of the effect of fishing on stock abundance.

In the following analysis section, references will be made to the International Trawl Statistical areas also referred to as PMFC areas (Figure 2). Within these rather large regions, smaller Washington state statistical areas are also defined.

PETRALE SOLE

A review of tagging studies conducted on petrale sole indicate the Washington trawl fleet exploits at least two different stocks (Ketchen, K. and C. Forrester-Fish. Res. Bd. Can. Bull. No. 153). Fish of a "northern" stock are harvested in PMFC areas 3D northward into 5D, while fish of the "southern" stock are taken in PMFC area 3C southward to 2D.

The increasing use of loran readings by fishermen in defining areas of fishing resulted in the discovery that a large portion of the Esteban Deep spawning ground initially thought to lie entirely within PMFC Area 3D actually overlaps into PMFC Area 3C (Wash. Stat. Area 8). In past years, therefore, a part of the petrale sole catches from Esteban Deep were assigned to PMFC Area 3C. Since that time (1962) all petrale sole catches from Esteban Deep, from December through March have been assigned to Area 3D even though they may actually have occurred south into Area 3C. For the sake of consistency an attempt has been made to assign all the Esteban Deep catch data for these 4 months to Area 3D for all years covered in the report. As a result the petrale sole catch figures presented here will differ somewhat from those presented in previous progress reports.

Fig. 1.

Trawl Statistical Areas: Pacific Marine fisheries commission statistical areas (circled). Washington statistical areas (not circled).

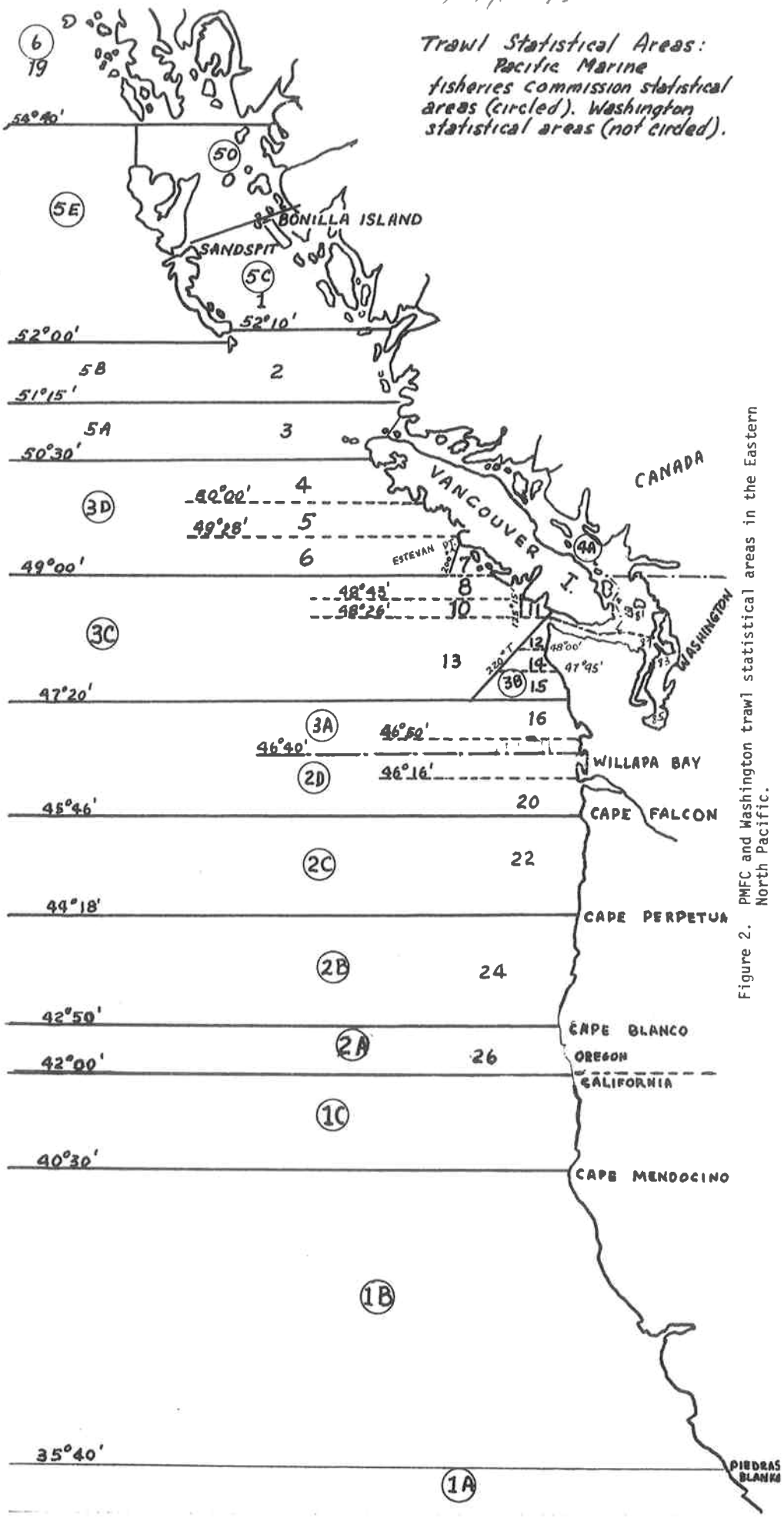


Figure 2. PMFC and Washington trawl statistical areas in the Eastern North Pacific.

"Northern" Petrale Sole Stocks

The catch data for petrale sole taken in PMFC Areas 3D, 5A, 5B, 5C and 5D represent the northern petrale sole stock. Table 6 summarizes these data for the ten year period 1955 to 1964, and Figure 3 presents the effort and catch per unit effort relationship for those years in a Thompson type graph. It can be seen from the latter that the "northern" stock appears to be producing at its former level of 2 million pounds annually.

Washington fishermen take approximately 46 percent of their total annual petrale catch from this stock, however, during 1964 it accounted for only 40 percent. This decline is attributed to a reduction in the fishing effort expended in the northern areas inhabited by this stock.

Table 6. Northern stock petrale sole landings from PMFC Areas 3D, 5A, 5B, 5C and 5D. (1000's of pounds)

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-Year Ave.
Total Landings	2278	1922	4118	1324	1331	959	1220	1940	2121	1881	1903
Wn. Landings	2009	1724	3593	852	937	430	763	1183	1378	1043	1391
Wn. Effort (hrs)	8785	10372	8677	6185	5419	3823	4702	7963	9651	6354	7193
Wn. (lbs/hr.)	229	166	414	138	173	112	162	149	143	164	193
(lbs/hr) index	119	86	215	72	90	58	84	77	74	85	100

Hecate Strait - PMFC Areas 5D and 5C

Hecate Strait is divided into two statistical areas but it will be considered here as one unit. About three fourths of the total Hecate Strait petrale catch is taken from the lower area (PMFC Area 5C). Table 7 presents the catch data for the period 1955 - 64. The ten year mean of the Washington catches, 78 thousand pounds, represents only about three percent of the total Washington catch of this species. The Canadian petrale catch in this area is significantly greater, averaging a quarter of a million pounds annually.

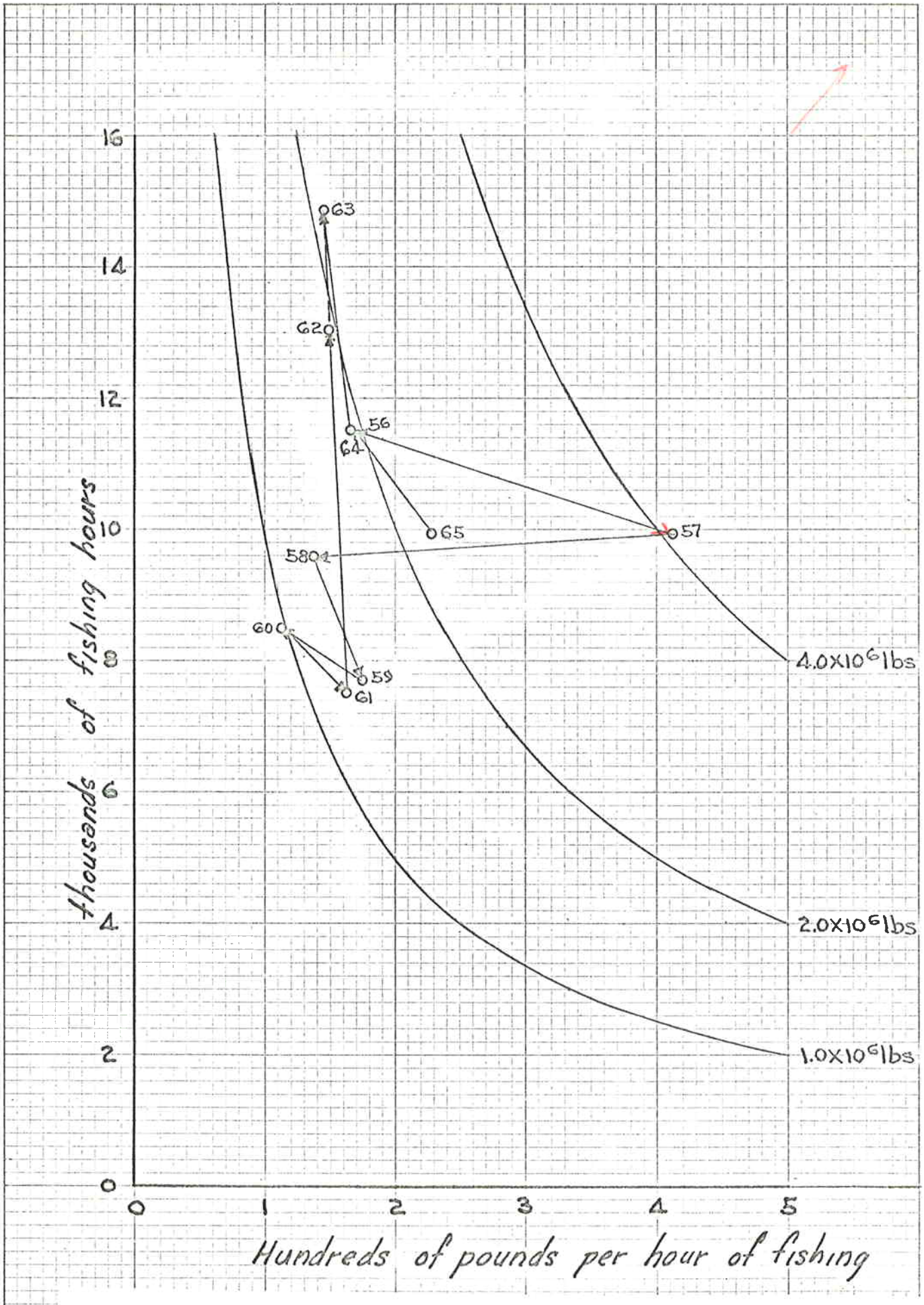


Figure 3. Relationship of catch per unit effort to effort for the "northern" petrale sole stocks.

Table 7. Landings of petrale sole from Hecate Strait in thousands of pounds.

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-year Ave.
Total Landings	207	117	477	377	478	266	224	363	181	360	316
Wn. Landings	163	47	159	80	226	21	11	46	25	44	78
Wn. Effort (hrs)	856	673	717	942	1196	243	80	107	353	373	554
Wn. lbs/hr.	190	83	222	85	189	85	136	52	72	118	141
(lbs/hr) index	135	59	157	60	134	60	96	37	51	84	100

Queen Charlotte Sound - PMFC Areas 5A and 5B

The Queen Charlotte Sound Area includes PMFC Areas 5B and 5A. Within these two PMFC areas lie both the Goose Island and the Cape Scott fishing grounds. Washington fishermen take about 17 percent of their total annual petrale sole landings from the Queen Charlotte Sound Area, mostly from the Cape Scott grounds.

Washington catches of petrale sole in this area were nearly a million pounds in early years of record, but, as shown in Table 8, decreased along with effort after 1956. Increased effort in 1962 failed to produce the former catch. This indicates that the species is not as available here as in former years. The effort expended during 1963, for example, was slightly less than that expended in 1955, but the catch in 1963 was about two-thirds that of 1955. The trend in the catch from this area generally is similar to that of Hecate Strait.

Table 8. Landings of petrale sole from Queen Charlotte Sound in thousands of pounds.

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-year Ave.
Total Landings	1018	1163	733	499	352	469	377	755	1184	928	718
Wn. Landings	987	1068	537	356	222	217	153	406	602	499	505
Wn. Effort (hrs)	4649	6587	3867	3082	2132	1734	1790	3066	4446	3418	3477
Wn. lbs/hr.	212	162	139	115	104	125	85	132	135	146	145
(lbs/hr) index	146	112	96	79	72	86	59	91	93	101	100

Upper West Coast of Vancouver Island - PMFC Area 3D

PMFC Area 3D yields an average of 26 percent of the total annual Washington landings of petrale sole. Eighty percent of this, however, is taken from Esteban Deep which, because of the special significance of its fishery, will be considered separately. Table 9 presents the catch data for PMFC Area 3D, exclusive of Esteban Deep.

Table 9. Landings of petrale sole from Upper West Coast of Vancouver Island excluding Esteban Deep, in thousands of pounds.

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-Year Ave.
Total Landings	432	177	234	285	351	129	154	228	68	131	212
Wn. Landings	238	144	223	253	338	97	134	175	62	36	163
Wn. Effort (hrs)	1745	1732	1161	1389	1320	1084	662	2096	786	334	1183
Wn. lbs/hr.	136	83	192	182	256	90	203	84	79	109	138
lbs/hr. index	99	60	139	132	186	65	147	61	57	79	100

Esteban Deep*

The Esteban Deep concentration of spawning petrale sole was discovered in the early 1950's by U.S. fishermen while exploiting Pacific Ocean perch. Tagging studies demonstrated the interrelationship of these fish with the summer inshore petrale sole fishery which was in a state of decline (Alverson, D. and B. Chatwin - Jour. Fish. Res. Bd. Can. 14 (6). Therefore, Canada, Washington and Oregon enacted a winter closed season on petrale sole (December 20-March 31), roughly coinciding with the period of their greatest concentration on the Esteban Deep ground. A tolerance poundage was included in the regulations to allow retention of incidentally caught petrale sole, and a limit of two trips per month was set. The latter restriction was subsequently dropped in Oregon.

*While Esteban Deep lies in both PMFC Areas 3D and 3C, its catch statistics are treated as though it was only in Area 3D.

At this writing, spawning petrale sole on the Esteban Deep ground are exploited entirely by Washington fishermen. Canadian vessels have been reported in the area during the spawning season, but were not observed fishing. Also there are no records of any Canadian landings from Esteban Deep.

Table 10 presents the catch data for the Esteban Deep ground for 1955-64. The large catch in 1957 indicates the vulnerability of the concentrated spawning population.

Table 10. Washington landings of petrale sole from Esteban Deep in thousands of pounds.

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-Year Ave.
Wn. Landings	621	465	2674	163	150	95	465	594	688	462	638
Wn. Effort(hrs)	1535	1389	2932	772	771	762	2170	2694	4066	2229	1931
Wn. lbs/hr.	405	335	912	211	195	124	214	221	169	208	330
(lbs/hr) index	123	102	276	64	59	38	65	67	51	63	100

The initial regulation began in 1958 and accounts for the abrupt decrease in the catch that year. During 1959 and 1960 an 8 percent tolerance poundage existed in Washington, which generally allowed landings from 6 to 10 thousand pounds of petrale sole. The increased catch during 1961 was made with the 8 percent tolerance poundage. The tolerance poundage was changed to a 3,000 pound limit in March, 1962, but the fishermen asked for and received a 6,000 pound limit per trip in November of that year. The further increases in the catch in 1962 and 1963 were at least partially a result of this increased limit.

The Esteban Deep petrale sole catch patterns are similar to those of the "northern" stock in general, i.e., both show declines following the large catches during 1957 with subsequent recovery in the early 1960's. The fact that each northern area tends to follow this pattern implies that stock fluctuation (recruitment) is involved as well as regulatory effects.

"Southern" petrale sole stock

The catch data for petrale sole taken in PMFC Areas 3C, 3B, 3A, and 2D are considered to be those of the southern petrale sole stock.

Canadian scientists have expressed concern about the declining catch per unit of effort for these stocks in the last few years. Figure 4 shows this decline with the increase in effort. The three million pound average catch line has been drawn in, and this line must be close to an equilibrium condition. Most of the landings are made in Area 3C.

Washington fishermen are obtaining a declining share of the petrale harvest as is shown in Table 11. The decline in 1964 landings partially resulted from the fact that several Washington fishermen sought a market for their fish in Oregon.

Table 11. Southern stock petrale sole landings from PMFC Areas 3C, 3B, 3A and 2D (1000's of pounds).

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-Yr. Ave.
Total Landings	-	2,092	2,423	2,269	3,222	3,462	4,203	3,650	3,459	2,848	3,070
Wn. Landings	979	1,157	1,105	1,314	2,116	2,040	2,738	1,805	1,556	1,102	1,591
Wn. Effort(hrs)	11,126	10,140	9,263	8,156	10,938	12,267	14,184	11,952	10,359	9,667	10,535
% Wn. Landings	-	55	46	58	66	59	65	49	45	39	52
Wn. lbs/hr.	88	114	119	161	193	166	193	151	150	114	151
(lbs/hr) index	58	75	79	107	128	110	128	100	99	75	100

A decline is expected in effort which should help these stocks recover their former abundance. Only a partial recovery can be expected because much of the catch is incidental to the fishery for other species.

S. W. Vancouver Island - PMFC Area 3C

This statistical area extends from the Esteban Point line (Wash. Area 7) southward to the Cape Flattery Spit boundary (Wash. Statistical Area 13). It includes the following areas mentioned here: Sydney Inlet, Ucluelet, Forty-Mile, Cape Flattery Spit, and the Swiftsure area.

Figure 5 compares effort with stock abundance as indicated by catch per hour data. The PMFC Data Series poundage was used, but the effort is that of the Washington fishermen (Table 12). The percent of the catch harvested by Wash-

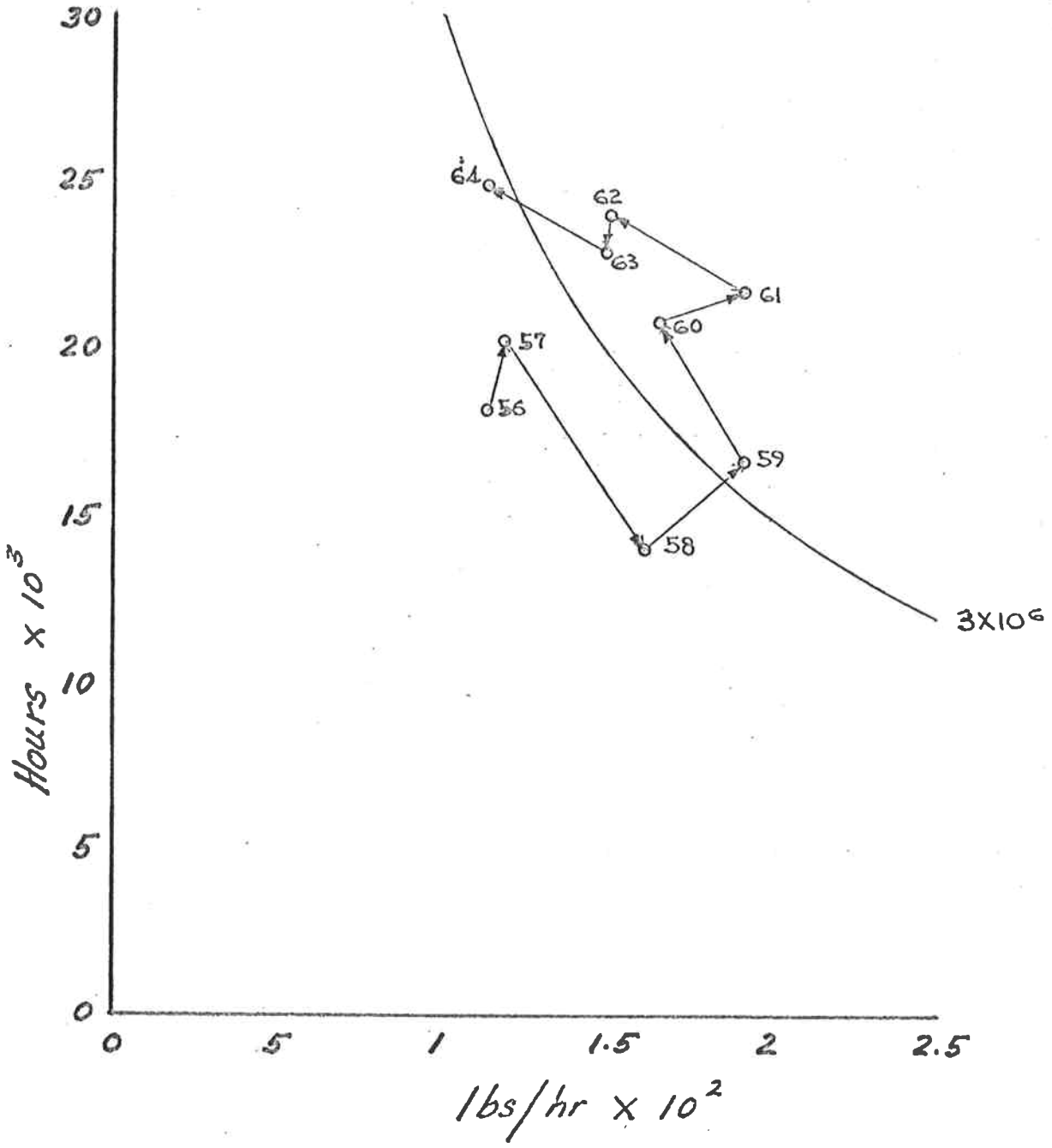


Figure 4. Relationship of catch per unit effort to effort for the "southern" petrale sole stocks.

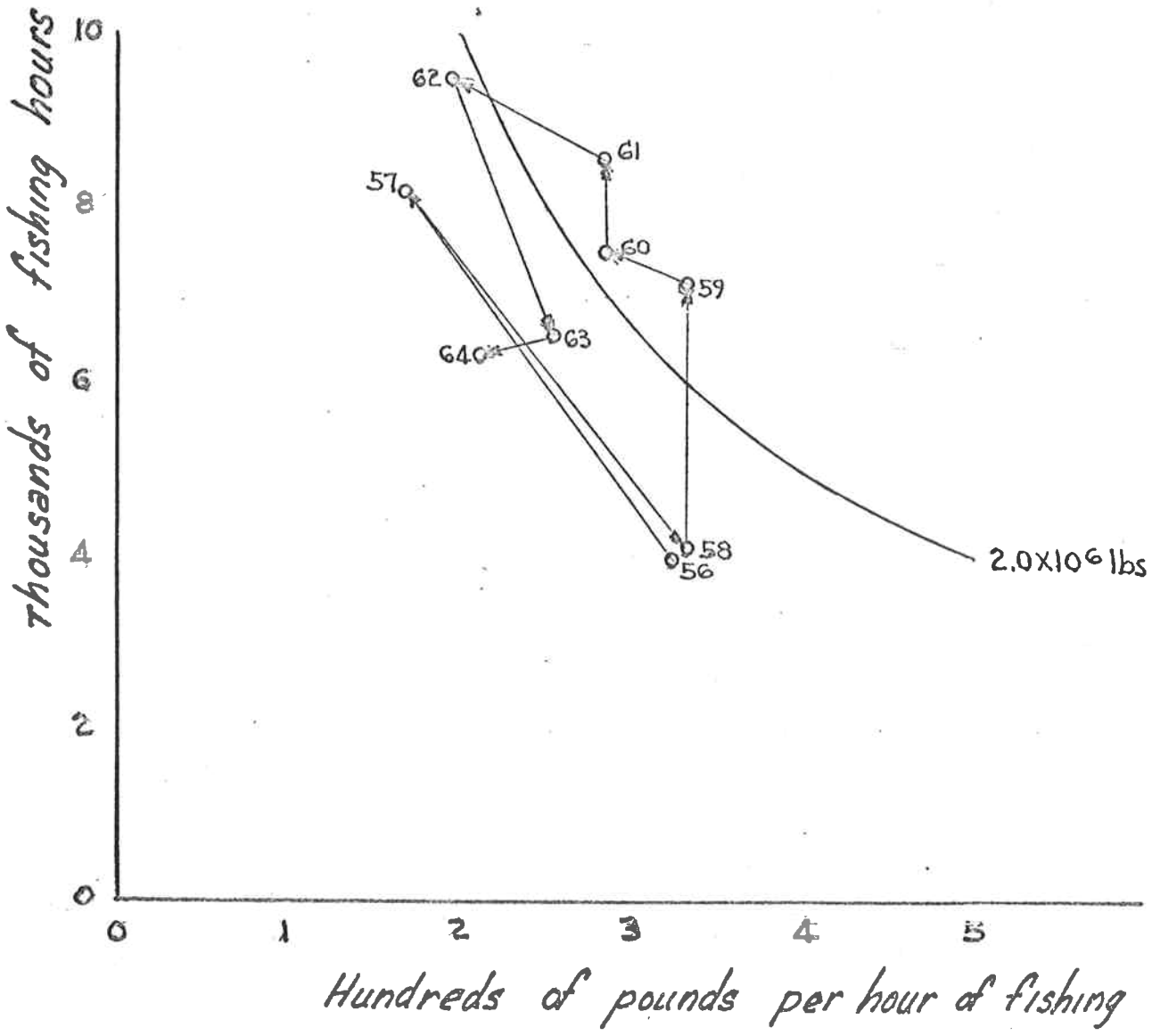


Figure 5. Relationship of catch per unit effort to effort for petrale sole from S. W. Vancouver Island.

ington fishermen for the nine years 1956 through 1964 was 67.5 per cent, and it ranged from 81 per cent during 1961 to 54 per cent during 1964. Fish did not appear available to the fishermen in early years of this record. A two-fold increase in effort during 1957 did not produce much increase in poundage, but the catch per unit declined in half. Over-exploitation took place during 1959, 1960, and 1961 with similar effort. A recovery began in 1962 and continued during 1963, but availability was poor again during 1964. It is considered significant that Canada subsidized the removal of dogfish during the years 1959, 1960, and 1961. Petrale sole will return to their former abundance and size in this area while they are protected by an increased population of dogfish. The conclusion is that a subsidy on dogfish would allow better, even over-exploitation of petrale sole in most of these areas.

Table 12. Landings of petrale sole from PMFC Area 3C (S.W. Vancouver Island) in thousands of pounds

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-Year Ave.
Total Landings	Not Avlb.	1288	1389	1343	2364	2146	2445	1876	1644	1322	1757
Wn. Landings	575	871	865	831	1806	1709	1982	1379	1144	708	1187
Wn. Effort (hrs)	3053	2695	5106	2508	5440	5985	6965	7002	4522	3360	4394
Wn. lbs/hr.	188	323	169	331	332	285	284	196	253	210	270
(lbs/hr) index	70	120	63	123	123	106	105	73	94	78	100

Sydney Inlet - Wash. Statistical Area #7

Sydney Inlet refers to the waters off the central west coast of Vancouver Island. Originally it included the area within 100 fathoms north and south of Esteban Point, and included catches northward and outside of Nootka Sound. Since the line was drawn 200° true from Esteban Point, it now includes the area from that line to 49° N. latitude. Most of the catch comes from waters off Lennard Island in the summer where petrale sole are caught incidentally with lingcod.

Washington data only are included in Table 13 because no breakdown is available of Canadian and Oregon landings from this area. Washington trawl fishermen take 6.7 per cent of their petrale sole from this area. Of the petrale sole taken from all of PMFC Area 3C by Washington fishermen, 12.6 per cent comes from Sydney Inlet. An average of 200,000 pounds of petrale sole a year was landed from this area during the last ten years. The catch of 1956 probably contained some Esteban Deep landings by mistake.

Table13. Washington landings of petrale sole from Sydney Inlet (1000's of lbs.).

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-Year Ave.
Landings	268	382	166	66	53	143	276	365	142	143	200
Effort (hrs)	1490	643	874	467	515	612	920	1282	705	508	802
lbs/hr	180	594	190	141	103	233	301	285	201	282	250
(lbs/hr) index	72	238	76	56	41	93	120	114	80	113	100

The fishery for petrale sole in this area as in all of Area 3C takes place from April to September of each year. The sole are mixed with lingcod, Pacific cod, and dogfish. The latter are often so abundant that fishermen are forced to fish for sole at night when the dogfish rise up off of the bottom.

Ucluelet (Wash. Area 8)

The Ucluelet area lies between 49° north latitude on the northern boundary and 48° 43' north latitude to the south. The petrale sole fishery in the Ucluelet area takes place largely from April through September with lingcod, Pacific cod, and dogfish. It also takes place in relatively shallow water, less than 50 fathoms. Washington fishermen take 2.6 per cent of all their petrale sole here, or about 5 per cent of what they take from the "southern" stock comes from the Ucluelet area (Table 14).

Table 14. Washington landings of petrale sole from the Ucluelet Area(1000's of lbs.)

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-Year Ave.
Landings	12	12	32	54	24	93	173	182	145	54	78
Effort (hrs)	236	204	147	62	55	440	609	758	497	245	325
lbs/hr	51	57	220	874	442	211	285	240	292	221	241
(lbs/hr) index	21	24	91	363	183	88	118	100	121	92	100

The above average results during 1958 and possibly 1959 indicate the inclusion of "Deep" catches. Discounting those years, the success of fishing as measured by lbs. per hour show the effect of the removal of dogfish by Canadian subsidy fishing during 1959 through 1961. As dogfish become more abundant here, the fishing for petrale sole will be lessened.

Forty-Mile Bank (Wash. Area 10)

This favorite fishing area lies within 48° 43' N. lat. on the north, 125° 15' W. long. on the east, 48° 26' N. lat. on the south and extends westward into the depths. The Canadian fishermen call this "Big Bank." Depths vary from 30 to 60 fathoms which includes a shallow area to the south called 40-Mile Finger. In the last few years fishermen seeking Pacific Ocean perch have started fishing the rocky westward area in 195-plus fathoms using rollers on the foot rope of their nets. The petrale sole are mixed with lingcod, dogfish, Pacific cod, halibut, and some rock sole. At times small sablefish become a nuisance to the fishermen. Petrale sole can be expected from Forty-Mile Bank from April through September of each year.

The importance of this area is shown by the fact that over the past ten years Washington fishermen have taken 19.3 per cent of their total petrale sole catch from this area (Table 15). Petrale sole landings here are incidental to a lingcod fishery. Therefore, the landings follow the exploitation of that fishery. Here, too, the abundance of dogfish influences the fishing effort. During the winter, fishermen are taking large size petrale with Pacific Ocean perch in deep water.

Table 15. Washington landings of petrale sole from Forty-Mile (1000's of lbs.)

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-Year Ave.
Landings	192	417	643	667	1481	781	389	331	600	287	579
Effort (hrs)	889	1492	1196	1107	3882	2989	1790	1509	1558	1182	1759
lbs/hr.	217	280	538	603	381	261	218	220	385	243	329
(lbs/hr) index	66	85	164	183	116	79	66	67	117	74	100

Cape Flattery Spit (Wash. Area 13)

This area lies west of a line drawn 220° true from the international boundary between Canada and the U.S. in the Strait of Juan de Fuca. It lies south of 48° 26' N. latitude.

The history of the petrale fishery in this area is varied and interesting. Dogfish are not thought to affect fishing effort. For the first five years of catch records, petrale sole were taken incidentally to other species: rockfish, Dover sole, and Pacific Ocean perch. Then a group of almost pure petrale was discovered in the late spring of 1960. Effort doubled and quadrupled in the following years. Catches increased eight fold. Fishing success trebled, but by 1964 only an occasional landing was made. Landings were made during late spring and summer months. The fish were not in the process of spawning. At first, it was thought that the fish captured during May were returning from a spawning area. However, as catches continued through August, it became obvious that this was not the situation. This was not thought to be an unexploited group of fish. The average size of these fish was not much different from the fish caught at Forty-Mile Bank, and fish tagged on the "Spit" were recovered later on Forty-Mile Bank as well as Swiftsure and Umatilla. Washington fishermen have taken 8 per cent of their petrale sole from the "Spit" over the last ten years (Table 16). For the "southern" stock 15 per cent has been taken from this area.

Table 16. Washington landings of petrale sole from the "Cape Flattery Spit" (1000's of lbs.)

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-Year Ave.
Landings	42	52	19	41	72	513	827	474	194	154	239
Effort (hrs)	136	208	187	694	734	1598	2376	3203	1600	1332	1207
lbs/hr	310	252	103	60	98	321	348	148	121	115	198
lbs/hr index	157	127	52	30	49	162	176	75	61	58	100

Swiftsure (Wash. Area 11)

The Swiftsure area is bounded on the north by 48° 43' N. lat., on the south by 48° 26' N. lat., on the west by 125° 15' W. long. and on the east by 124° 40' W. long. Although this is a relatively small area, the depths range from 36 fathoms off of Carmanah Point to over 100 fathoms in depth in the Juan de Fuca trench. Here again dogfish are a problem, and the years during which Canada subsidized the dogfish livers are obvious from the petrale sole landings records.

This area has been relatively unimportant to the Washington fishermen as they have taken only 3 per cent of their total petrale sole catch from Swiftsure during the ten year period (Table 17). This amounts to 5.7 per cent of their catch from the "southern" stock.

Table 17. Washington landings of petrale sole landings from the Swiftsure grounds (1000's of lbs.).

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-Year Ave.
Landings	60	8	4	2	175	178	315	26	62	69	90
Effort (hrs)	302	148	7	178	254	346	1270	250	162	93	301
lbs/hr.	200	57	619	13	691	516	248	103	386	748	300
(lbs/hr) index	67	19	206	4	230	172	83	34	129	249	100

Northern Washington Coast (PMFC Area 3B)

This is a relatively small, but heavily fished area off of the northern Washington coast. It is bounded on the north and west by a line which originates at the international boundary line between Canada and the U.S. in the Strait of Juan de Fuca and runs 220° true to 47° 20' N. latitude. The latter line forms the southern boundary of the area. Within this area are three smaller Washington statistical areas: Cape Flattery-Umatilla, Quillayute, and Destruction Island.

Petrale sole landings by Washington fishermen have averaged slightly more than a third of a million pounds annually for the ten year period 1955 through 1964 (Table 18). Washington fishermen account for about 90 per cent of the petrale sole taken from this area. They take 12 per cent of all their petrale, and 23 per cent of that from the "southern" stock from this area.

Petrale sole is taken here incidentally to English sole, Pacific cod, and rockfish. Dogfish are not too much of a problem to the fishermen in this area. The catch data fluctuate randomly as might be expected for a small segment of a population exploited throughout a larger area.

Table 18. Landings of petrale sole from PMFC Area 3B. N. Washington Coast (1000's of lbs.)

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-Year Ave.
Total Landings	-	252	240	508	271	379	714	361	409	434	396
Wn. Landings	377	236	212	420	250	328	683	337	367	393	360
Wn. Effort(hrs)	7975	7089	3948	5469	5290	6230	6976	4510	5684	6273	5944
Wn. lbs/hr.	47	33	54	77	47	53	98	75	65	63	61
(lbs/hr) index	77	54	89	126	77	87	161	123	107	103	100

About all that can be said for these data is that they do not show the same relation to the removal of dogfish that is indicated by the Area 3C data.

Southern Washington Coast: PMFC Area 2D-3A

This area lies between 47° 20' N. lat. and 45° 46' N. latitude. It is composed of three Washington statistical areas: Grays Harbor (47° 20' to 46° 50' N. lat.), Willapa Bay (46° 50' to 46° 05' N. lat.) and N. Oregon (46° 05' to 45° 45' N. lat.). Washington fishermen land a mere 5 per cent of the petrale sole caught in this area. The petrale sole landings are incidental to Pacific Ocean perch catches in the "Willapa Deep" which lies directly to the west off the Willapa buoy in 195 fathoms (46° 40' N. lat.). Dover sole are also caught near the Willapa Deep tow. Inshore in the summer, petrale are taken with lingcod, rockfish, and animal food mostly by Oregon fishermen. Washington data are too meager for the usual comparisons but it is given here for the record (Table 19).

Table 19. Landings of petrale sole from PMFC Area 3A-2D. S. Washington coast (1000's of lbs.).

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-Year Ave.
Total Landings	-	552	794	417	586	937	1044	1413	1406	1092	916
Wn. Landings	26	49	27	62	60	3	73	89	44	1	43
Wn. Effort (hrs)	98	356	209	179	208	52	243	440	153	34	197

ENGLISH SOLE

Hecate Strait

Although Washington fishermen take about 20 per cent of their ocean catch of English sole from Hecate Strait, Table 20 shows that their efforts in the area are too small to be indicative of the stock condition. Total production is below average, effort on the part of Washington fishermen is low, and the absence of the small-mesh Washington nets should result in increased stock abundance. This will not occur, however, if the Canadian fishermen reduce their mesh size from $4\frac{1}{4}$ inches and use smaller mesh to exploit these stocks. English sole are benefited more than any other commercially-used species by the use of mesh $4\frac{1}{4}$-inch (inside measure) or larger.

Table 20. Landings of English sole from Hecate Strait (1000's of lbs.)

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-Year Ave.
Total Landings	not avlb.	2106	1218	1528	2072	2530	1920	1013	900	957	1583
Wn. Landings	938	600	642	624	806	864	317	87	196	164	524
% Wn. Landings	-	28	53	41	39	34	17	9	22	17	33
Wn. Effort(hrs)	2554	2232	2295	2710	3990	1527	1460	493	1000	867	1913
Wn. lbs/hr.	367	269	280	230	202	566	217	176	196	189	274
lbs/hr index	134	98	102	84	74	207	79	64	72	69	100

N. Washington Coast

Washington fishermen land 74 per cent of their ocean catch of English sole from this area.

To understand the fluctuations of English sole landings, one needs to know the history of mesh regulation in Washington. In January of 1955, a $4\frac{1}{2}$-inch minimum mesh regulation went into effect. The fishermen were given two years to wear out their old, small $3\frac{1}{2}$-inch mesh nets. At that time mesh measurement was made between the knots. In other words, this meant that the opening of the mesh was required to be $4\frac{1}{2}$-inches while the mesh was stretched using reasonable tension. For the next two years the fishing effort for English sole in this area decreased over half for some unknown reason. There was probably a shift to other species as the small size of the English sole resulting from the continued use of small mesh would preclude large catches of this species with the larger mesh. An increase occurred in the fishing success or pounds caught per hour of fishing as shown both in Table 21 and Figure 6. The increase in fishing success during the first two years (1956 and 1957) is largely explained by the decrease in fishing effort. However, during 1958 and 1959 a remarkable increase in fishing success occurred with only a partial resumption of fishing effort.

Table 21. Landings of English sole from PMFC Area 3B (N. Washington Coast) (1000's of lbs.)

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-Yr Ave.
Total Landings	1986	1918	1417	2194	3173	2818	2203	1703	1803	1716	2081
Wn. Landings	1887	1914	1315	2180	3077	2631	2005	1553	1652	1624	1983
% Wn. Landings	95	100	93	99	97	93	91	91	92	95	95
Wn. Effort(hrs)	14,610	10,521	6043	7875	8597	10,301	9129	5875	7660	7820	8843
Wn. lbs/hr	129	182	218	277	358	254	220	264	216	208	224
lbs/hr index	58	81	97	124	160	113	98	118	96	93	100

The direction of this recovery indicates an increase in availability of fish to the fishery or an increase in recruitment. Two factors are involved. First, the decrease in effort and landings for two years allowed fish, that would have been caught, to grow, thereby raising the poundage when they were finally caught. Second, and more important, these were fish that were formerly caught by the small mesh and killed in the process of being squeezed as they were lifted aboard, or died on deck before they could be sorted out and thrown back. During the few years that large mesh was in use these fish were sorted by the large mesh and they were allowed to survive until they were large enough to be caught and kept as marketable-sized fish.

In early 1959, the fishermen complained that Pacific Ocean perch and dogfish gilled so badly in the large ($4\frac{1}{2}$-inch) mesh that it was almost impossible to fish for the perch or in areas with dogfish present. As this was a reasonable complaint and there was no alternative, the minimum mesh regulation was reduced to $3\frac{1}{2}$ inches. Dogfish have since become so numerous that fishermen do not dare fish in the areas where, or at times when dogfish can be expected to be caught. Also in January, 1963 the method of measuring mesh was modified to include one knot. Therefore, a $3\frac{1}{2}$-inch cod end constructed of 196 thread twine, which is commonly used, will measure 3 inches between the knots. The knot is one half inch long. A knot in 54 thread twine will measure three-eights of an inch. This hold for the nylon designation as well as cotton.

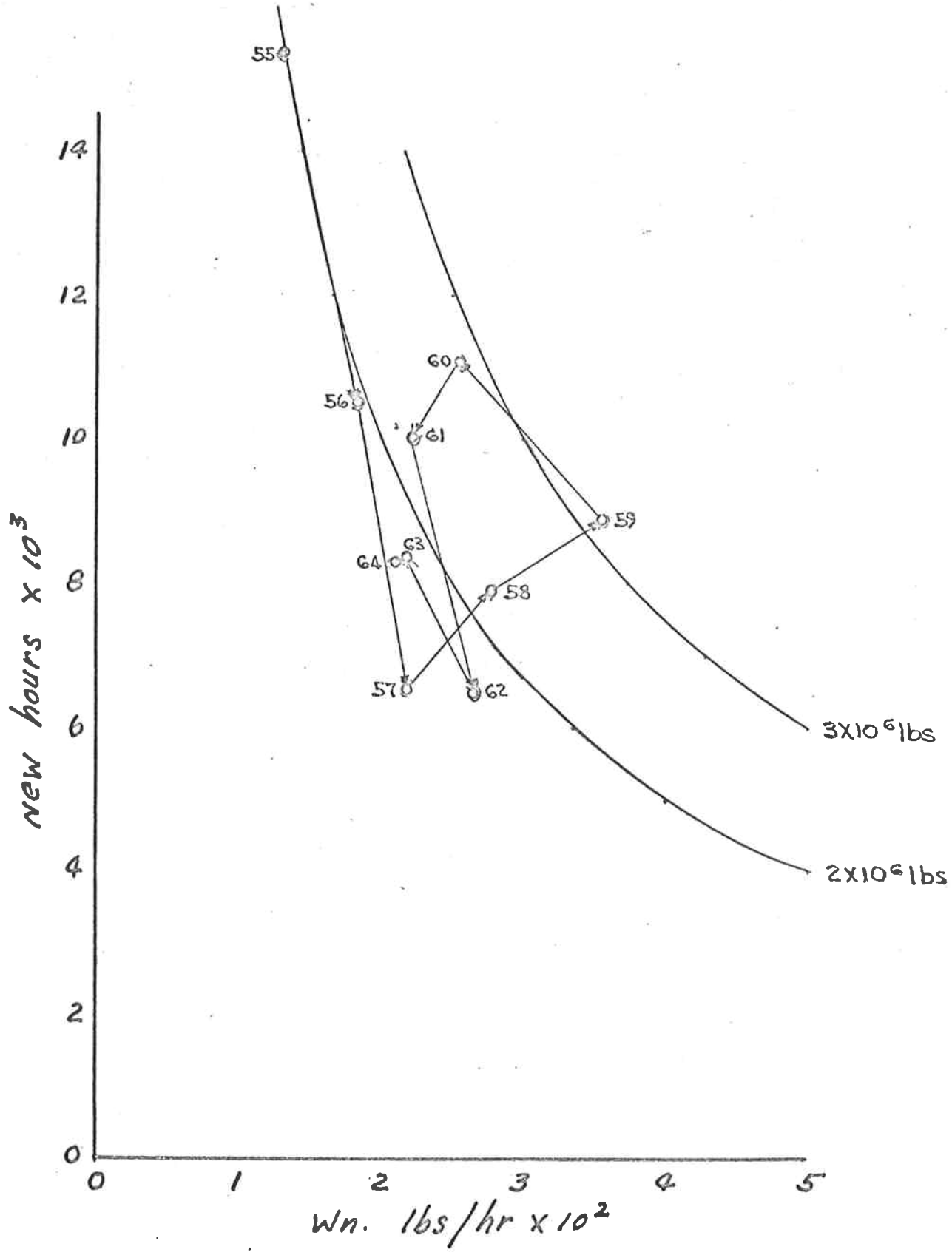


Figure 6. Relationship of catch per unit effort to effort for English sole - N. Washington Coast (3B).

During 1959 the fishermen enjoyed good English sole fishing using small-mesh nets. They had another fair year in 1960, but by 1962 stock abundance was back almost to the 1957 level, recruitment was low, and crews were again shoveling split after split of small sole overboard.

Area 3B is capable of producing 2.5 million pounds of English sole annually. All the fishermen have to do is use cod ends on their nets that have, at least, a $4\frac{1}{2}$-inch opening. The opening affects the escapability of the fish, and also takes into consideration the little anal spine with which each fish is equipped. This means that fishermen returning from fishing deeper water where they have been fishing for perch, rockfish, or Dover sole must remove the small-mesh cod end and replace it with a large-mesh cod end. The whole operation can be done in twenty or thirty minutes. But, the cod end will sort the sole for them while they drink coffee and play pinochle. Most of the catch will go into the hold, and within four years, if all cooperate, they will land, at least one million more pounds of English sole each year. At seven cents a pound, this comes to $70,000. Divide this among the 50 boats that are used to fish this area gives $1400 per boat per year. Canadians announced at the 1965 meetings that due to the perch gilling problem they were forced to reduce the minimum mesh size in offshore waters.

The analysis of the catch data would indicate that this is a sedentary population, however, tagging studies have shown that a portion of the population is capable of making extended migration. Only once were these fish tagged. This was on a Pacific cod tagging trip in July, 1956. The results have been summarized in the Thirteenth Annual Report of PMFC. Thirty per cent of the recoveries with locality information were taken outside of this area. Migrations were to the south as far as Trinidad Head, Calif., and most were taken during the winter months. In an Oregon experiment off Lookout Point, 32 per cent of the usable recoveries were from Area 3B. In a Canadian experiment off Victoria, B.C. an unknown but significant number of recoveries came from "Burma Road" which is located immediately S SW

of Cape Flattery.

Puget Sound Waters

The inland sea between Canada and the U.S. produces an average of 2 million pounds annually. Tagging experiments have shown intermixing of fish across the boundary line in the Gulf of Georgia. In this report Puget Sound refers to all state waters east of the Bonilla-Tatoosh line. The English sole within Puget Sound have divided themselves into four populations with very little intermixing. The northern population is located in the Strait of Georgia from the San Juan Islands to the mouth of the Fraser River. The central population is exploited from Edmonds up through Saratoga Passage into Penn Cove. The southern population is found in the bays and inlets south of the Tacoma Narrows. The western population is found in the Strait of Juan de Fuca around Protection Island, in Discovery Bay, and toward Port Angeles. These fish were tagged once, many years ago, but results were inconclusive. Each population will be treated separately here, and analysis of this catch will be by trip as an hourly breakdown was not initiated until 1963.

Northern Puget Sound

Northern Puget Sound or "Gulf of Georgia" as it is known by the industry is open to trawling the entire year. From September to May it is subjected to comparatively intense fishing pressure. About 20 to 24 trawlers fish each year. Trips are of daily duration.

Table 22 and Figure 7 show the catch statistics for English sole in northern Puget Sound. Beginning in 1945, effort was intense and fishing success in pounds caught per trip was low. In subsequent years, effort declined radically until 1955 when a low level of effort, a high in fishing success, and a high in stock abundance was reached. There may have been some distraction of effort toward the good true cod fishing from 1951 through 1953. There was no evidence of siphoning off of effort to cod fishing after 1953. In January, 1955 the minimum mesh

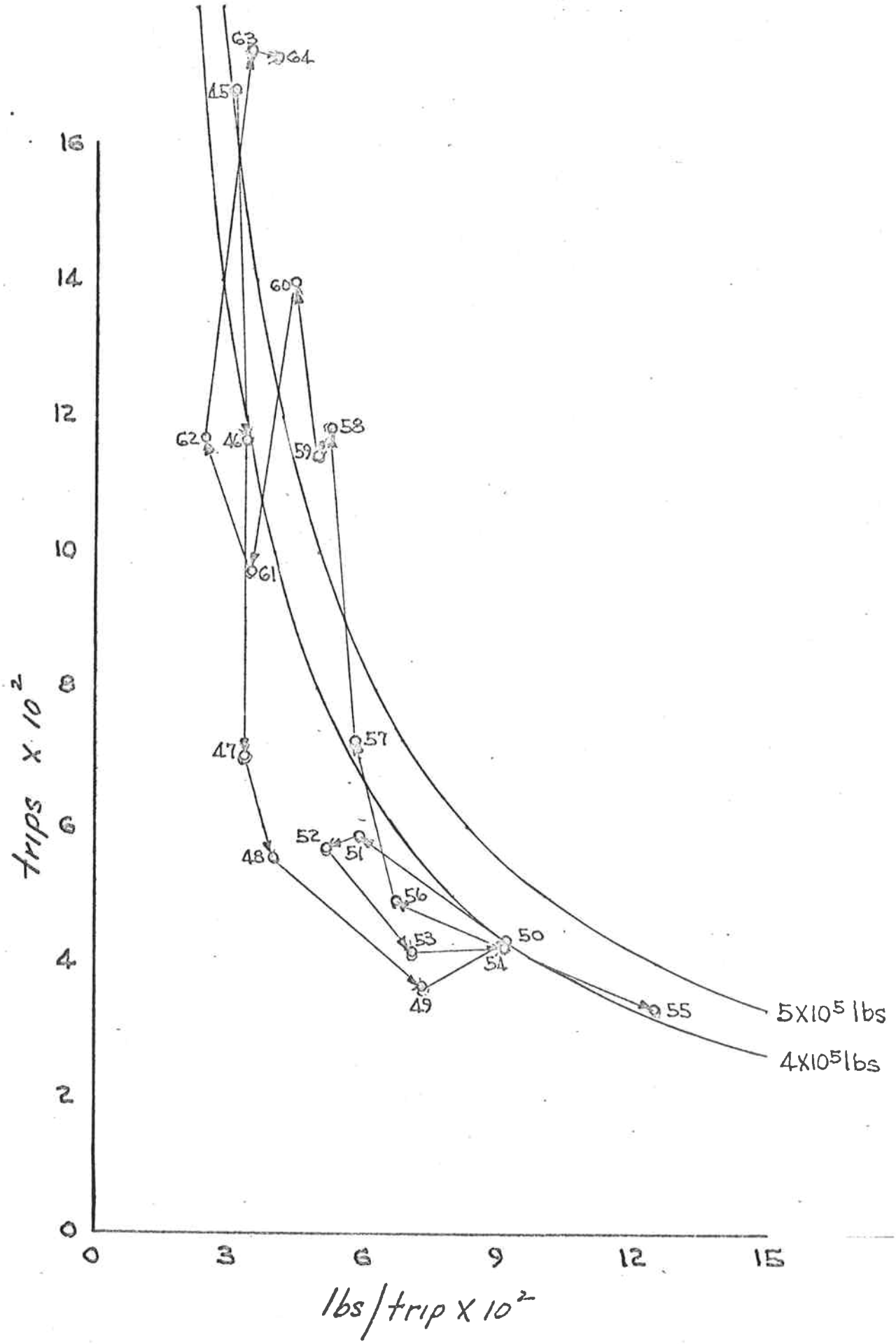


Figure 7. Relationship of catch per unit effort to effort for English sole - N. Puget Sound.

size regulation of $4\frac{1}{2}$ inches became effective, although fishermen were allowed two years to wear out their small mesh gear. Effort increased until 1960.

Table 22. Landings of English sole from N. Puget Sound.

Year	Pounds x10^3	Trips	lbs/trip	Year	Pounds x10^3	Trips	lbs/trip
1945	513	1677	306	1955	421	336	1253
1946	392	1169	335	1956	328	491	667
1947	251	702	357	1957	421	722	583
1948	221	553	400	1958	622	1182	526
1949	268	363	738	1959	566	1141	496
1950	396	431	919	1960	626	1399	447
1951	348	585	595	1961	338	975	346
1952	296	570	520	1962	287	1166	246
1953	294	415	709	1963	598	1739	344
1954	386	421	916	1964	696	1724	404

Landings also improved. The improvement was partially the result of under-fishing for several years, but the improvement was also the result of using large ($4\frac{1}{2}$-inch) mesh for several years. In fact, the pattern is similar to the pattern in Figure 6 for area 3B. The use of large mesh allows escapement and survival of small, unmarketable English sole. Unfortunately, the minimum mesh regulation was changed early in 1959 from $4\frac{1}{2}$-inch to $3\frac{1}{2}$-inch mesh. Mesh sizes discussed here are between the knots measurement. The reason for the change was to prevent excess gilling of Pacific Ocean perch and spiny dogfish in the $4\frac{1}{2}$-inch mesh. There are no Pacific Ocean perch within Puget Sound waters, and dogfish are not the problem that they are in the ocean waters. The regulation should not have been changed for state waters.

During 1961 and 1962 landings declined although the effort remained high. In January, 1962 the Canadian government regulation for a $4\frac{1}{2}$-inch minimum mesh size within the Strait of Georgia became effective. This is a between the knots measurement, and included the last seventy-five meshes of the net including the cod end. The rest of the net to be $4\frac{1}{4}$-inch mesh.

By 1963 and 1964 effort was greater than at any time within the recorded history of the fishery in the "Gulf" area. Landings were also near record levels, but the catch per hour was near the lowest levels. The record landings were partially the result of the low landings of 1961 and 1962 which allowed stocks to recuperate somewhat, and partially the benefit of the Canadian mesh regulation. It is safe to predict that without a minimum mesh regulation of, at least, 4 3/4 inches (including one knot) the fishing success per hour of fishing will remain low, and it will require an extreme amount of fishing effort to produce the present level of landings. Without the Pacific cod to maintain production, fishermen will find it uneconomical to maintain the present fishing pressure. In fact, we are in the same position we were in 1945, and we can expect the same reaction. Within four or five years production could decline to a level of 250,000 pounds. Using 4 3/4-inch mesh in the cod end only, we can expect a decline to 350,000 pounds with an increase and a leveling off at around the 500,000 pound level achieved in 1958 with large mesh. A conservative estimate of the benefit derived from the use of large mesh in the cod end would be 250,000 pounds. At 7 cents per pound, this is a savings of $21,000 per season or $1,050 apiece to each of the 20 trawlers used in fishing the area. The labor of shoveling small fish overboard would be done by the large mesh cod end. A cod end costs the fishermen about $50 apiece. California studies have shown that large mesh will catch more large fish than small mesh. Evidently large fish can avoid a net easily when the meshes of the cod end become blocked by fish.

In the last few years a Canadian market for mink food has developed. During 1964, 1,046,774 pounds of mink food was landed in northern Puget Sound. The landings were largely pollack or whiting (Theragra chalcogramma), although skate, hake, and other species were also present. Fishermen received 3 cents per pound for this product. This comes to $31,403.22. This catch will be decreased about 50 per cent by the use of 4 3/4-inch cod ends, which means that there will be a net gain of about $6,000 per season or $300 per boat after the stocks stabilize in about four years.

Central Puget Sound

The central population is subjected to fishing for varying periods of each year. Regulatory Area 4 is open to fishing from April 15 to February 15. Regulatory Area 3 is open from September 15 to February 15. The purpose of the first two months of the closure in Area 4 is to prevent the marketing of sole while they are in poor condition after spawning. Spawning occurs from December through February. The extended closure in Area 3 favors the fishermen that seine for salmon during the summer months.

Table 23 gives the gross catch statistics for central Puget Sound for the past twenty years. Much of the original mesh escapement research was accomplished on trawlers used in this area. The fishermen became convinced of the benefits of using large mesh by watching the experiments. They evidently persuaded their fellow fishermen likewise for large mesh ($4\frac{1}{4}$-inch) is presently in use by a majority of the fishermen exploiting this area.

Table 23. Landings of English sole from Central Puget Sound.

Year	Pounds x10^3	Trips	lbs/trip	Year	Pounds x10^3	Trips	lbs/trip
1945	208	318	655	1955	300	252	1191
1946	109	193	567	1956	525	365	1439
1947	152	212	719	1957	436	279	1564
1948	224	295	759	1958	561	334	1678
1949	193	192	1005	1959	549	435	1261
1950	200	185	1083	1960	584	435	1343
1951	431	341	1265	1961	537	280	1919
1952	551	311	1771	1962	559	242	2312
1953	587	343	1712	1963	765	291	2631
1954	415	292	1420	1964	704	319	2206

Figure 8 was prepared from the data of Table 23, but these data contain one flaw that shadows any interpretation of them. The flaw is that the length of a trip may vary from one day to a week in duration. Therefore, the time spent fishing is not comparable. Unfortunately, there are no other data with which to analyze these stocks. The ratio of daily to weekly trips will not vary greatly from year to year, but over the twenty year period the ratio is probably significant. An interpretation will be made, but the shortcoming will be considered.

From 1945 through 1950 the fluctuations of the annual statistics suggest daily trips from an underfished stock. It is suspected that the fishermen seldom left the Everett area. The increase in effort in 1951 and the increase in catch per unit of effort in both 1951 and 1952 are typical of changes in availability. Either more weekly trips were made, or new stocks were exploited, or recruitment increased. The reverse shift from 1953 through 1955 indicates decreased availability of fish for the exact opposite reasons just given. By 1958, the situation

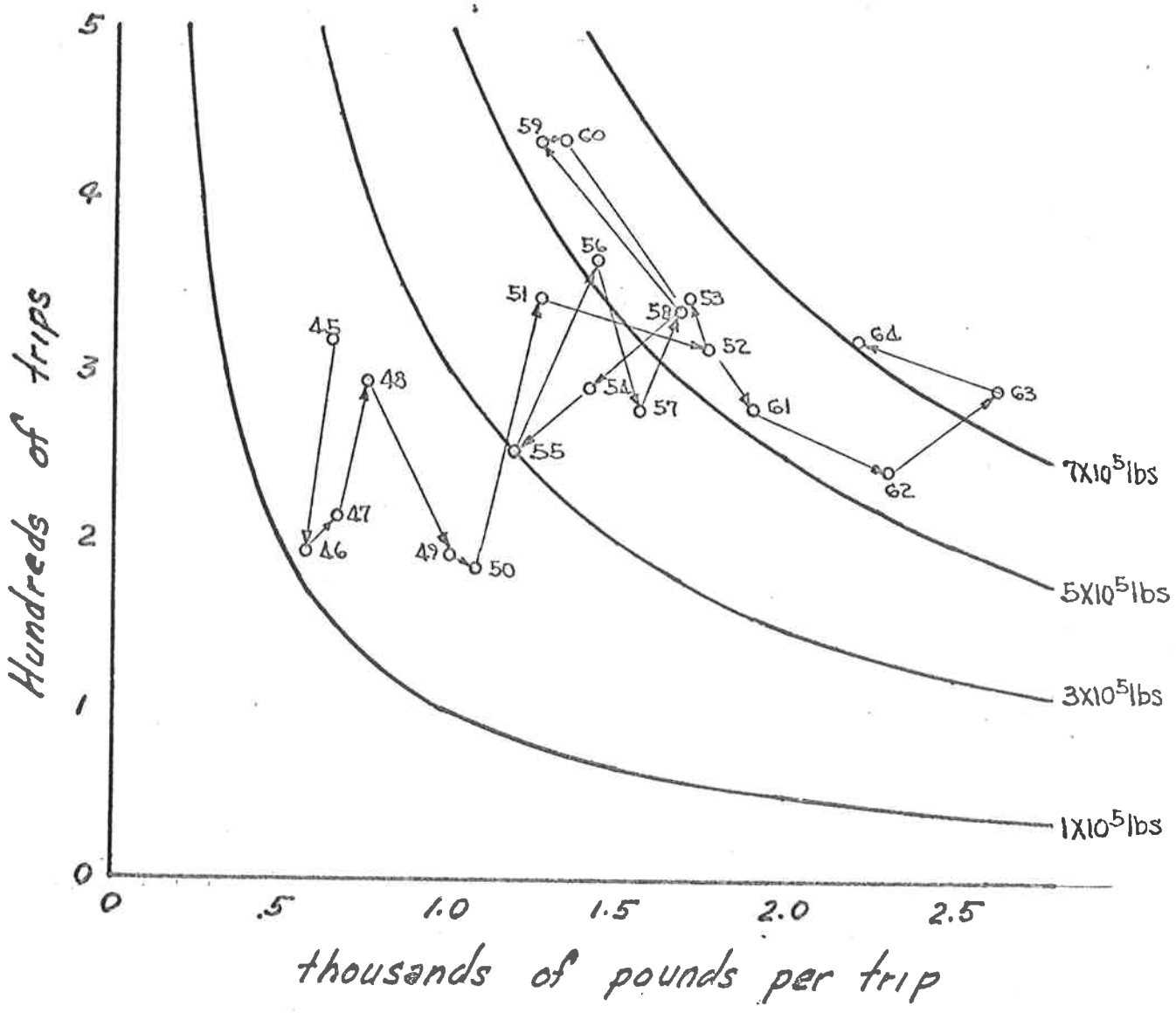


Figure 8. Relationship of catch per unit effort to effort for English sole - central Puget Sound.

had returned to the 1952-1953 level, and the pattern from 1958 through 1962 are characteristic of a fishery that is intense enough to affect stock abundance. In other words, increases in effort cause a decline in catch per unit of effort, and declining effort causes increase in catch per unit. There is no evidence of over-fishing. The shift to a higher level of availability in the 1963-1964 period means more new fish in the stocks. No new areas were discovered, length of trip has not changed radically, size of mesh has decreased if it has changed at all. Future fluctuations will indicate whether over-fishing is involved as the catch level will decline.

The University of Washington, School of Fisheries personnel conducted a tagging study and made age composition studies in about 1957 or 1958 which was interpreted by them to indicate that up until 1958 there was no evidence of over-fishing of the central Puget Sound English sole population. This material appears in a thesis by Sayed El-Sayed "English sole population dynamics in northern Puget Sound."

Southern Puget Sound

Briefly, this area constitutes all of the waters open to trawling south of Pt. Defiance. Such names as: Case Inlet, Carr Inlet, Nisqually Reach, Pickering Pass, and Johnson Point are found recorded in fishermen's logbooks. Many inlets, such as: Budd, Totten, Eld, and Hammersley are closed to trawling, but these reportedly abound with spiny dogfish shark. In December 1953, many areas were reopened to trawl fishing in south Puget Sound. The entire area is closed to trawling from April 1 to November 30 of each year.

Table 24 and Figure 9 give the catch statistics and show their relationship. During 1954 and 1955 most trips were thought to be of one day's duration, but since that time trips have been of nearly a week's duration. Equilibrium appears to exist near the 600,000 pound level. As effort declines, fishing success has improved for the remaining fishermen. Stocks appear to be maintaining themselves.

Table 24. Landings of English sole from southern Puget Sound.

Year	Pounds x10^3	Trips	lbs/trip	Year	Pounds x10^3	Trips	lbs/trip
1954	93	48	1937	1960	645	60	10,746
1955	50	27	1840	1961	353	37	9542
1956	681	70	9732	1962	438	34	12,895
1957	567	68	8345	1963	394	29	13,579
1958	521	59	8826	1964	543	39	13,926
1959	248	28	8861				

This stock is parasitized by Philometra americana, a nematode worm, and the fish are used entirely for mink feed. When the fishery area was enlarged, it was hoped that the removal of part of the stock would lessen the parasitism. But, while fishing has resulted in diminishing the size of the fish, the parasites remain of the same size. This has the effect of making the parasitism appear worse. Fishermen find so few nonparasitized fish now that they do not attempt to sort their catches. Fishing takes place largely in Case and Carr Inlets and the latter had fish heavily parasitized in early studies.

Western Puget Sound

Fishermen trawling the Strait of Juan de Fuca make trips of a week or more in duration. The possible migrations of this stock are imperfectly known. Early tagging experiments gave inconclusive information. A Canadian fishery is pursued on the north side of the strait, and sizable fisheries for English sole take place outside of Cape Flattery and in the Strait of Georgia.

Table 25 shows a tabulation of the landing statistics, and Figure 10 relates effort with catch per trip. Trips are mostly of a week in duration. There was a reciprocal relationship between sole and cod fishing until about 1956, but since then landings of these species have fluctuated similarly. The fishery is relatively small, and the graph does not indicate that the fishery is affecting the

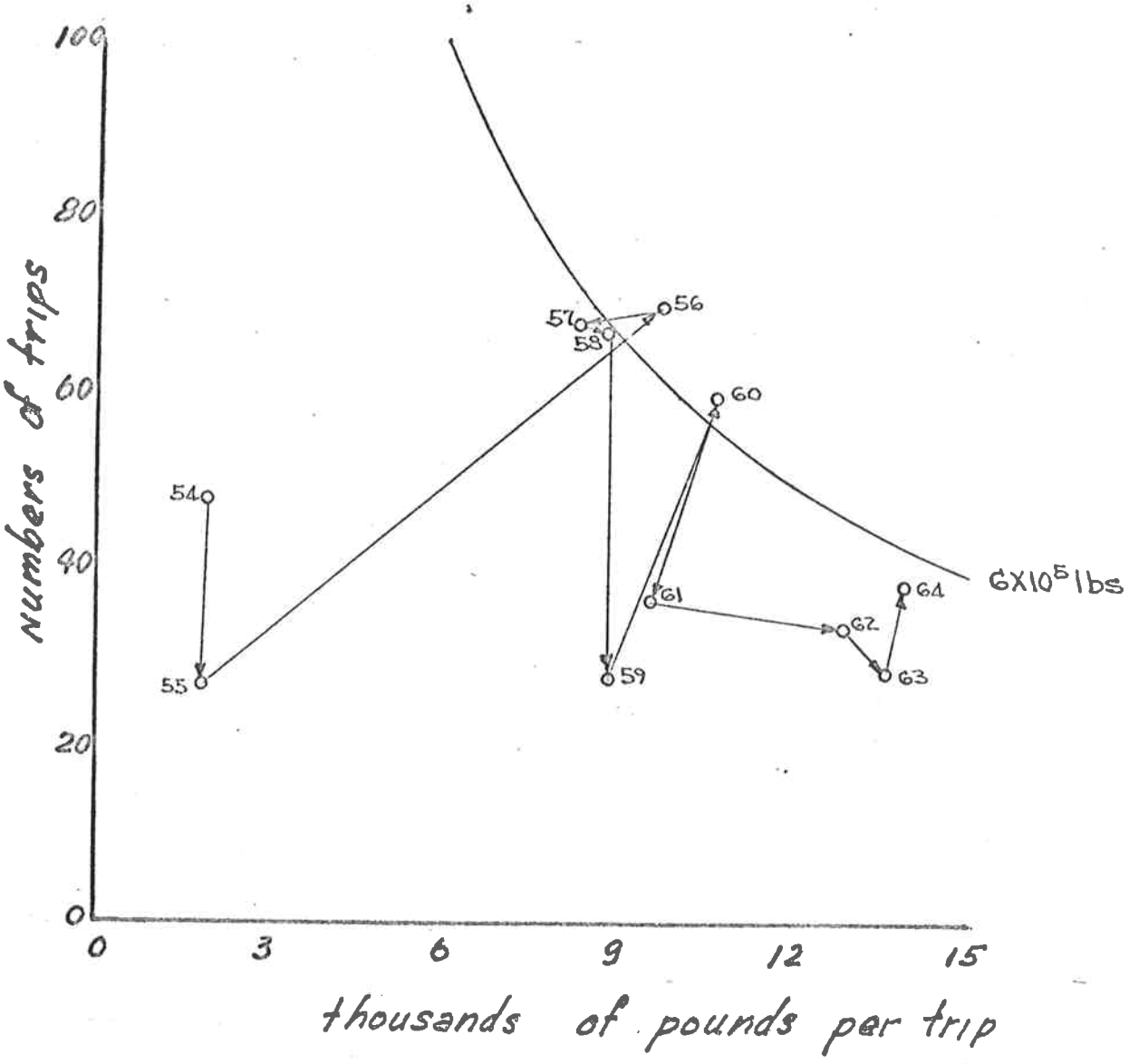


Figure 9. Relationship of catch per unit effort to effort for English sole - southern Puget Sound.

abundance of the stock. Either the stock is under-fished or this stock is part of a larger stock which is being exploited in another area. In the latter situation, a tagging study should be conducted to determine the identity and origin of this stock.

Table 25. Landings of English sole from western Puget Sound.

Year	Pounds x10^3	Trips	lbs/trip	Year	Pounds x10^3	Trips	lbs/trip
1948	55	29	1880	1957	68	53	1275
1949	25	10	2501	1958	175	104	1687
1950	81	16	5069	1959	140	69	2022
1951	66	32	2053	1960	74	28	2631
1952	40	46	866	1961	134	67	1997
1953	60	49	1223	1962	225	77	2923
1954	173	55	3148	1963	100	48	2092
1955	168	53	3164	1964	130	60	2171
1956	35	30	1157				

DOVER SOLE

Hecate Strait

One per cent of the total coastwide catch of Dover sole was taken by Washington trawlers in Upper Hecate Strait during 1964 (Table 26).

Table 26. Landings of Dover sole from Hecate Strait (1000's of lbs.).

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-Year Ave.
Total Landings	-	245	197	146	192	225	42	70	50	178	149
Wn. Landings	39	45	-	56	173	177	3	5	10	2	51
% Wn. Landings	-	18	-	38	90	79	7	7	20	1	34
Wn. Effort (hrs)	168	251	-	126	334	213	15	17	34	80	124
Wn. lbs/hr.	232	179	-	442	516	831	218	293	297	28	411
(lbs/hr) index	56	44	-	108	126	202	53	71	72	7	100

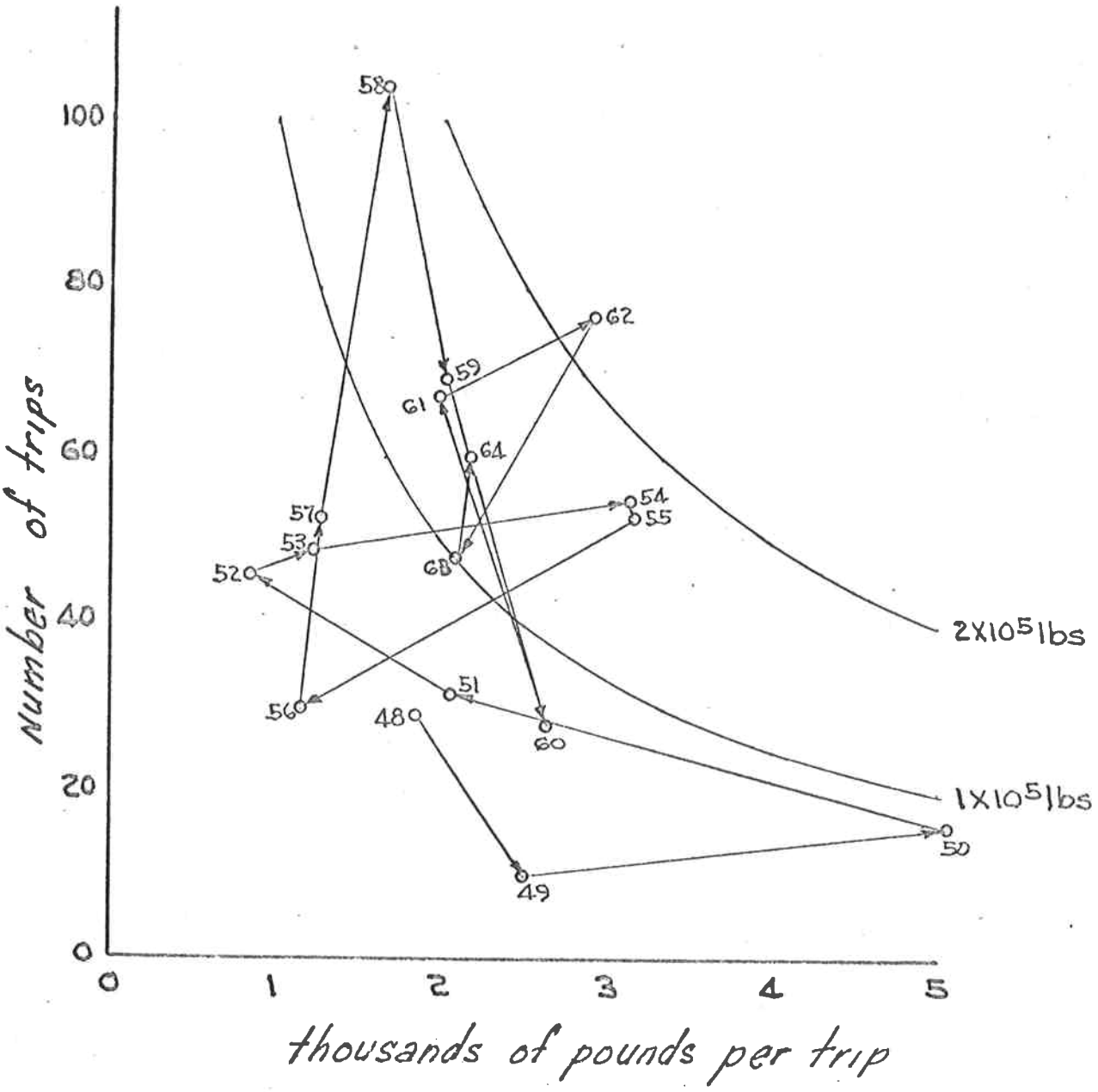


Figure 10. Relationship of catch per unit effort to effort for English sole - western Puget Sound.

The Dover sole landings of both Canadian and U.S. fishermen in this area appear to be incidental to other species. At least, no trend is evident. California and Oregon fishermen account for 86 per cent of the Dover sole landings on the coast.

Queen Charlotte Sound

During 1964, about five per cent of the coastwide landings of Dover sole came from areas within Queen Charlotte Sound.

Washington fishermen account for 95 per cent of the Dover sole landed from this area as shown in Table 27. They take about 15 per cent of their entire ocean catch from Queen Charlotte Sound. Figure 11 shows increasing effort with catch per unit also increasing which indicates under-fishing. Fishermen are probably turning their attention more to this previously incidentally caught species.

Table 27. Landings of Dover sole from Queen Charlotte Sound (1000's of lbs.).

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-Year Ave.
Total Landings	-	541	229	257	212	490	343	395	654	841	440
Wn. Landings	112	528	225	229	207	434	332	375	637	814	420
% Wn. Landings	-	98	98	89	98	89	97	95	97	97	95
Wn. Effort (hrs)	629	2654	1128	686	1157	1759	1515	1542	2476	3078	1662
Wn. lbs/hr	178	199	200	333	179	247	219	243	257	264	234
lbs/hr index	76	85	85	142	76	106	94	104	110	113	100

Upper West Coast Vancouver Island

Although Dover sole caught from this area contribute only 1.7 per cent to the coastwide landings, Washington fishermen take 26 per cent of their ocean catch in this area.

The PMFC Data Series figures are included for consistency, but there are discrepancies which are all our own as the bulk of the landings are made by Washington fishermen. Areas have been shifted from the early years to conform to petrale sole

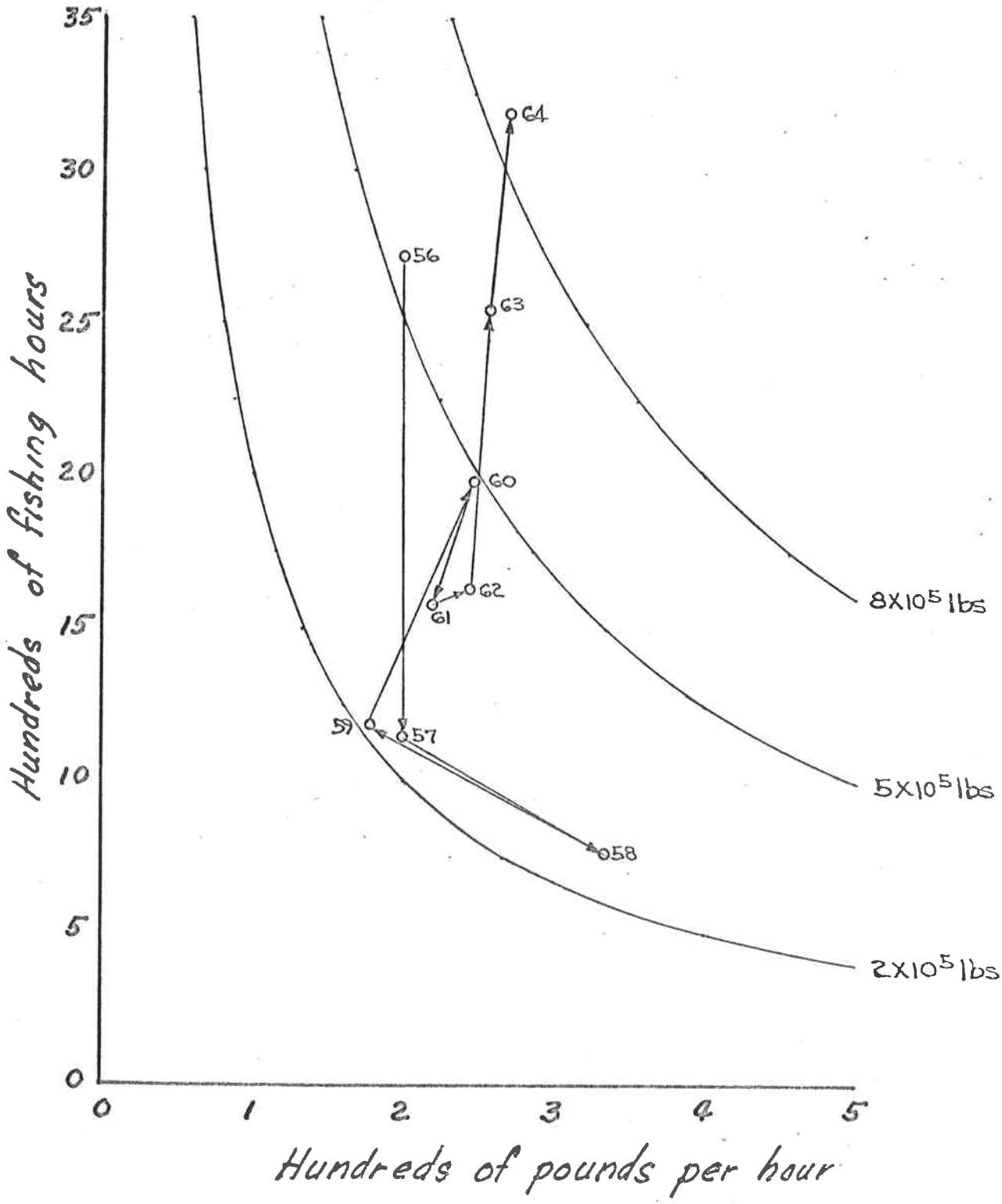


Figure 11. Relationship of catch per unit effort to effort for Dover sole - Queen Charlotte Sound.

requirements and not necessarily Dover sole biology. A re-examination should be made of every landing, and a retabulation made of the Dover sole data from the entire area from Cape Cook to Cape Flattery. The 1958 data were redone, but obviously some errors were included.

The bulk of the catch from this area is taken near Esteban Deep. Exploitation began in the early 1950's. The first two years are characteristic of early exploitation. There is an indication of an equilibrium condition at about the 600,000 pound level (Table 28). Figure 12 is composed of Washington data only, but Washington fishermen account for about 95 per cent of the landings.

Table 28. Landings of Dover sole from Upper Vancouver Island (1000's of lbs.).

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-Year Ave.
Total Landings	-	39	69	66	184	101	530	830	324	296	271
Wn. Landings	999	1329	519	531	736	613	528	825	322	289	669
Wn. Effort (hrs)	2104	1667	2526	1194	1786	1204	1645	2861	1069	882	1694
Wn. lbs/hr.	475	797	206	444	412	509	321	289	301	328	395
lbs/hr .index	120	202	52	112	104	129	81	73	76	83	100

Lower Vancouver Island

During 1964, only two per cent of the coastwide landings of Dover sole were taken off of the lower west coast of Vancouver Island. La Perouse Spit was added to this area in 1958 and from 1960 to the present. The expanded landings since 1960 resulted from the discovery of new fishable areas (Table 29).

Table 29. Landings of Dover sole from Lower Vancouver Island (1000's of lbs.).

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-Year Ave.
Total Landings	not avlb	1424	578	1344	647	1167	745	1173	649	331	895
Wn. Landings	18	74	48	345	86	611	705	1157	580	285	391
Wn. Effort(hrs)	99	499	246	736	186	1829	2868	4756	2975	1384	1558
Wn. lbs/hr.	178	147	195	469	460	334	246	243	195	206	251
lbs/hr index	71	59	78	187	183	133	98	97	78	82	100

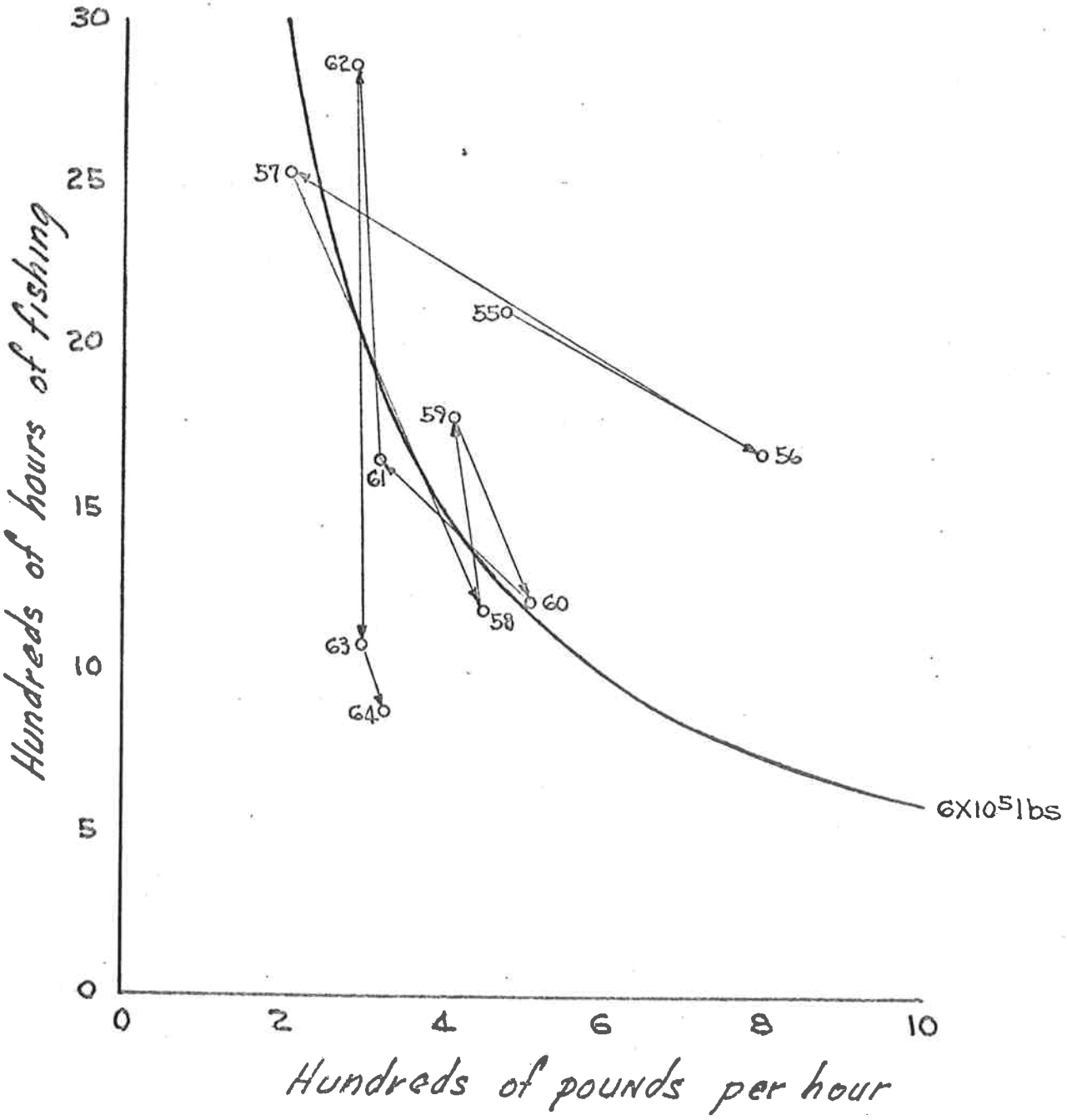


Figure 12. Relationship of catch per unit effort to effort for Dover sole - Upper Vancouver Island.

Over the ten year period, Washington fishermen have taken 15 per cent of their ocean-caught Dover sole from this area. The PMFC Data Series data suffers similarly here as it did in the upper area. The Washington landings represent 94 per cent of the total exploitation which is representative of the fishing in the area.

Only in 1962 is there evidence of overfishing. Data are inadequate to locate an equilibrium level, but the 700,000 pound line entered in Figure 13 is a conservative estimate.

Northern Washington Coast

Washington fishermen land 42 per cent of their ocean catch from this area, but this is only 2.6 per cent of the coastwide total (Table 30).

Table 30. Landings of Dover sole from N. Washington Coast (1000's of lbs.).

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-Year Ave.
Total Landings	not avlb	1782	676	885	1056	1715	1172	724	1316	447	1086
Wn. Landings	2052	1639	646	654	1008	1620	1070	680	1224	323	985
Wn. hrs.	6659	4664	2310	3117	2360	3834	4664	3547	3138	3089	3738
Wn. lbs/hr.	308	351	279	210	427	423	229	192	390	105	292
lbs/hr index	105	120	96	72	146	145	78	66	134	36	100

The Washington landings constitute about 91 per cent of the total landings from this area (3B). These have been used in Figure 14. The early years of great effort and large landings indicate the beginnings of market acceptability as the Dover sole appeared to be subjected to over-fishing almost from the start. Actually, Dover sole were marketed from about 1950. The one million pound line is approximately the equilibrium production for this area.

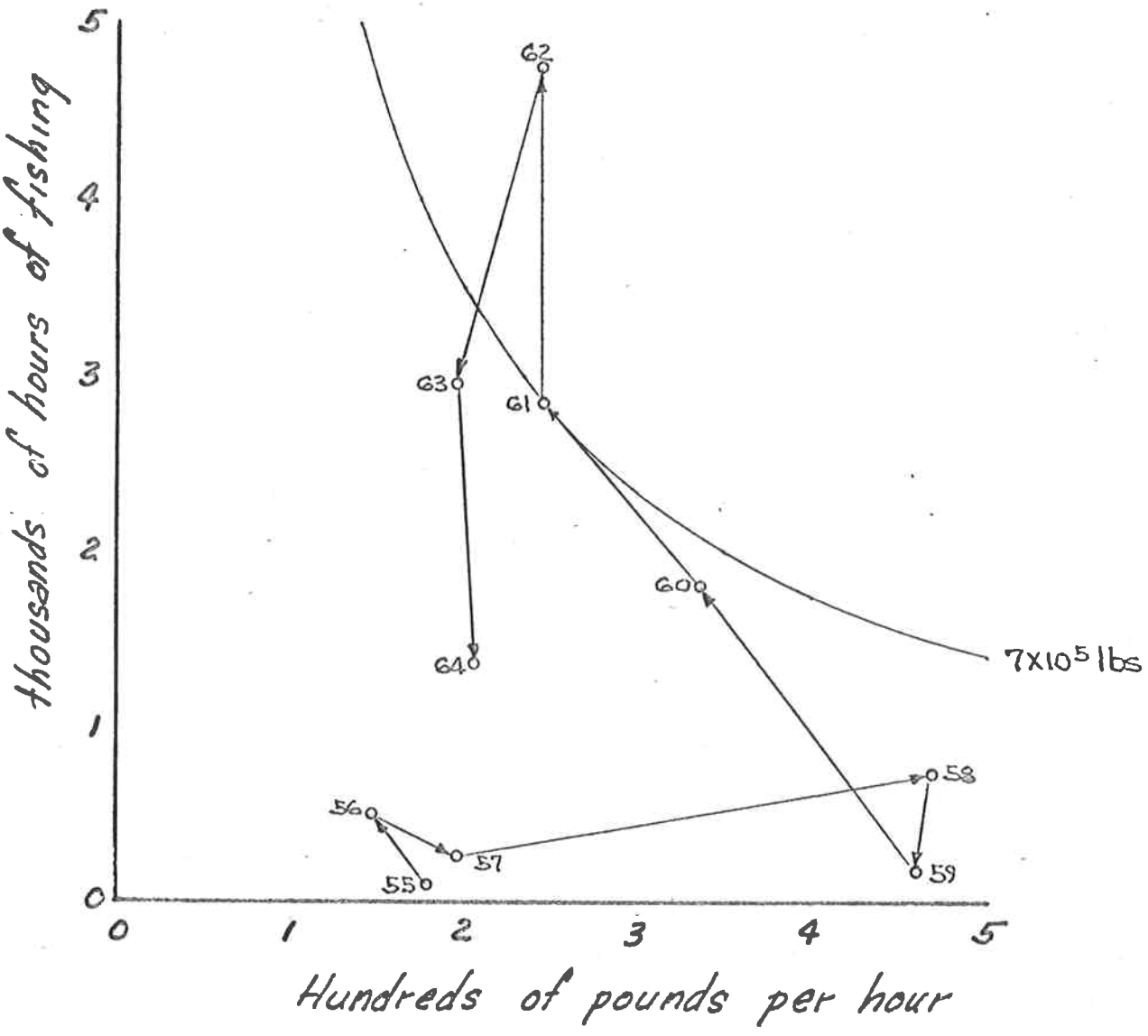


Figure 13. Relationship of catch per unit effort to effort for Dover sole - Lower Vancouver Island.

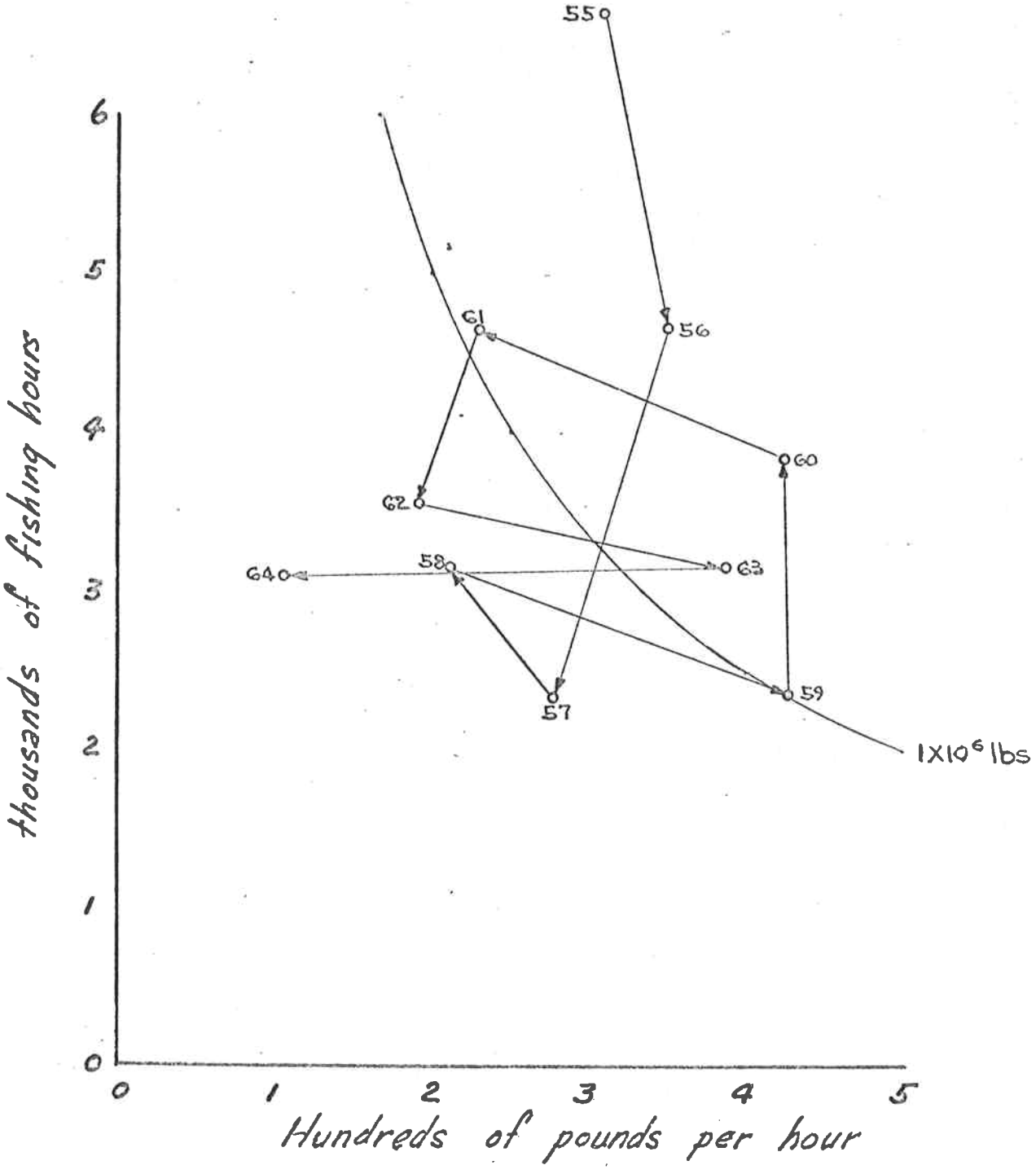


Figure 14. Relationship of catch per unit effort to effort for Dover sole - northern Washington Coast (Wn. Data only).

Central Puget Sound

The Dover sole in the Everett area are rapidly approaching extinction. As late as 1956, 93,000 pounds were landed here. Now fishermen regard them as an oddity when they appear in their catch. Dover sole must be vulnerable to the intense English sole fishery which is the principal species exploited in the Everett area.

The catch data for Dover sole is subject to the same error described for English sole. That is the trip unit of effort is subject to variation between years. However, Dover sole data given in Table 31 and Figure 15 shows a tendency to shorter length of trip which is the opposite of the trend shown by the English sole data. The Dover sole data, therefore, can only indicate extinction for this species in this area.

Table 31. Landings of Dover sole in Central Puget Sound.

Year	Pounds	Trips	lbs/trip	Year	Pounds	Trips	lbs/trip
1951	5710	32	178	1958	54,587	84	650
1952	6522	9	725	1959	11,048	9	1228
1953	5648	32	176	1960	1850	3	617
1954	16,165	107	151	1961	15,427	18	857
1955	49,945	100	499	1962	14,640	14	1046
1956	93,025	165	564	1963	7704	9	856
1957	51,505	66	780	1964	640	3	213

Over-fishing may have occurred during 1956. The 50,000 pound level indicates close to equilibrium conditions. The decline during 1959 should have brought about a recovery in stock abundance, but none was forthcoming. Stocks are being driven to zero or extinction. Other studies on Dover sole indicate that the average age in the landings is about nine years. Therefore, a factor affecting the reproductive cycle would have occurred nine or ten years previous to a lack

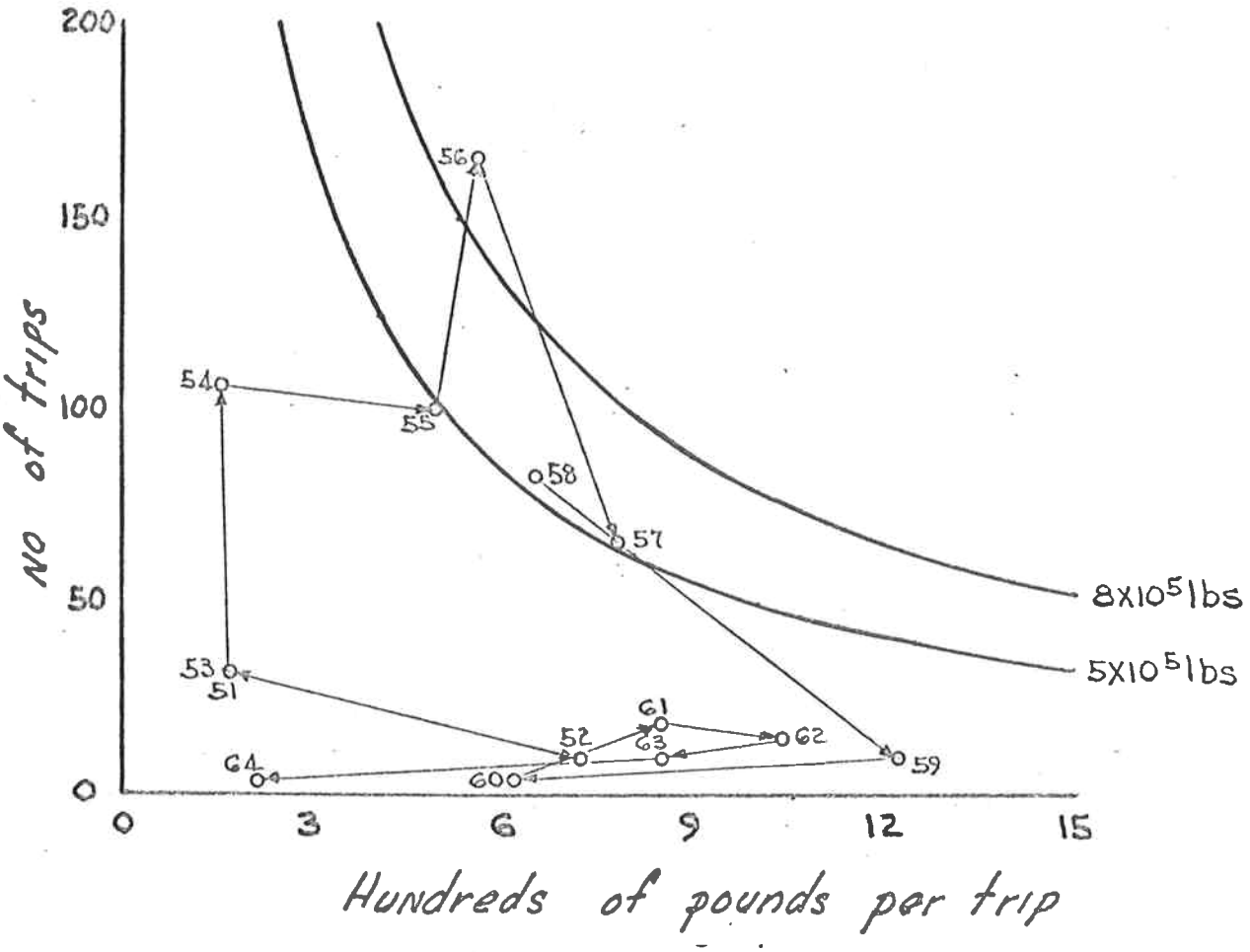


Figure 15. Relationship of catch per unit effort to effort for Dover sole - central Puget Sound.

of response of the stock to recover. During or about 1950, the environment must have become adverse for survival of Dover sole.

ROCK SOLE

Hecate Strait

Washington fishermen take only a minor percentage of the rock sole catch in Hecate Strait when compared to the Canadian landings. The total catch for years 1955-1964 appear in Table 32.

Table 32. Landings of Rock sole from Hecate Strait (1000's of lbs.)

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-Year Ave.
Total Landings	not avlb.	2558	2538	2770	918	2485	1641	1827	1938	1638	2035
Wn. Landings	448	260	88	193	204	230	36	98	38	16	165
% Wn. Landings	-	10	3	7	22	9	2	5	2	1	8

Queen Charlotte Sound

About three quarters of the Washington landings came from the Goose Island grounds (Queen Charlotte Sound) during 1964 (Table 33).

Table 33. Landings of Rock sole from Queen Charlotte Sound (1000's of lbs.).

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-Year Ave.
Total Landings	not avlb.	1892	1581	1940	1227	1986	1439	1603	1495	1407	1619
Wn. Landings	397	360	130	207	181	414	409	463	638	734	393
% Wn. Landings	-	19	8	11	15	21	28	29	43	52	24
Wn. hrs.	1227	2878	1101	925	662	1562	1155	2026	2846	2664	1705
Wn. lbs/hr.	323	125	118	223	273	265	354	228	224	276	231
(lbs/hr) index	140	54	51	97	118	115	153	99	97	120	100

Washington fishermen land an average of 24 per cent of the total rock sole landings in this vast area. Rock sole are largely taken with petrale sole, lingcod,

Pacific cod, and rockfish, although the landings of rock sole may often exceed those of the other individual species. This accounts for the high original effort. Stocks appear to be regulating themselves, however, if large quantities were discovered the graph could project upward and to the right in future years (Figure 16).

West Coast of Vancouver Island

Landings of rock sole average about a quarter of a million pounds here annually. They are taken incidental to petrale sole, lingcod, and Pacific cod in shallower depths, less than 100 fathoms, during the late spring to early autumn months.

Puget Sound

In Puget Sound rock sole are taken largely in the Strait of Juan de Fuca and Admiralty Inlet. They are taken incidental to Pacific cod and rockfish.

STARRY FLOUNDER

S.E. Alaska

There are three main areas located in outside, or ocean waters, which produce commercial quantities of starry flounder. The area farthest north is S. E. Alaska. The waters of this area are separated from those to the south, by the Alaskan boundary at lat. 54° 40'. All waters north of this line designate S.E. Alaska. Over the ten year period, 1955-1964, thirty-two per cent of the ocean total poundage of starry flounder taken by Washington fishermen came from S.E. Alaska (Table 34). An average of 233 thousand pounds were captured there annually. Starry flounder is the principle species trawled in these waters. Only a few vessels journey to this northern area annually to trawl for this species. The hours trawled vary considerably each year, but average around 175 hours. Catches average nearly 13 hundred pounds per hour.

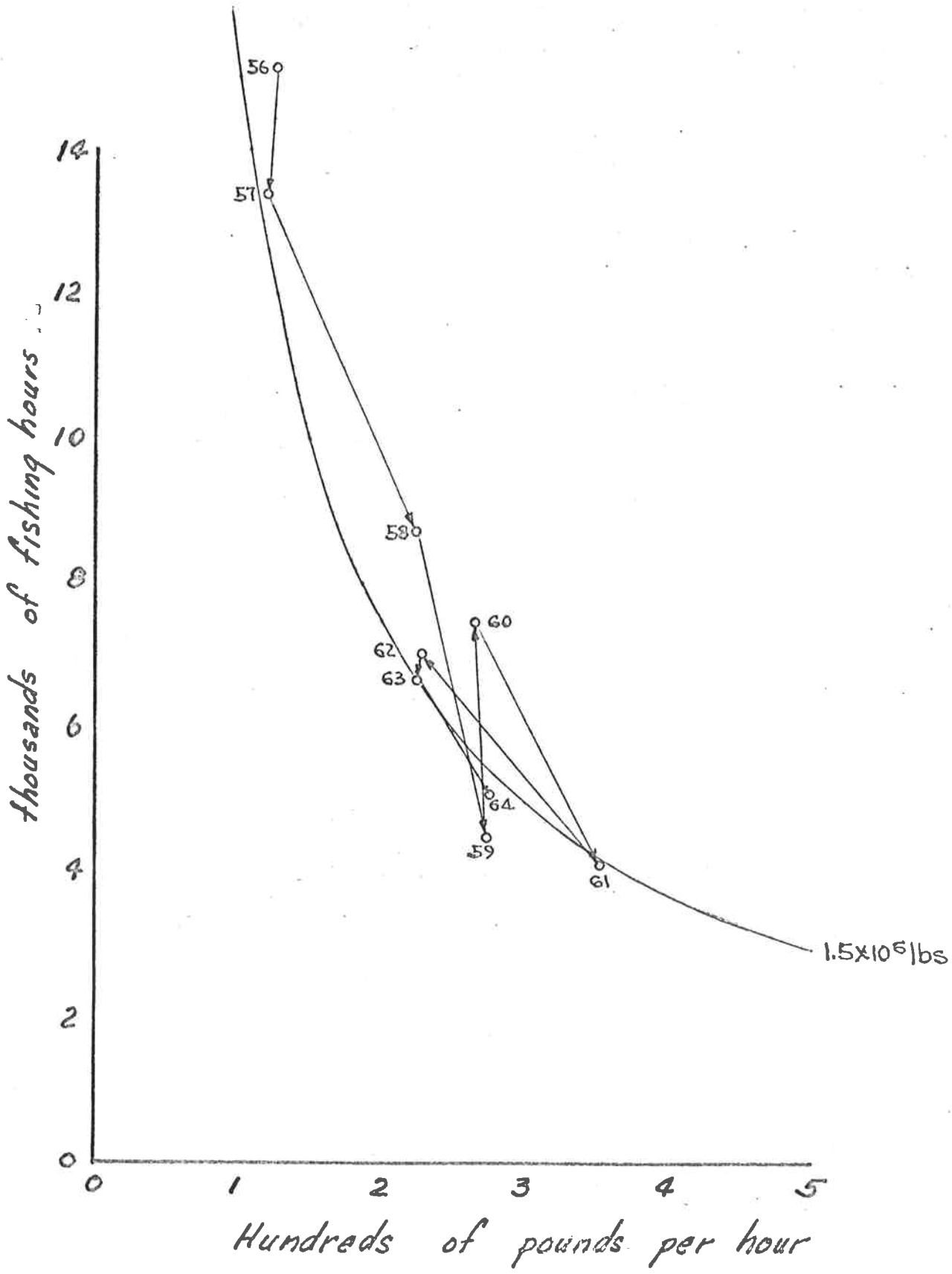


Figure 16. Relationship of catch per unit of effort to effort for rock sole - Queen Charlotte Sound.

Table 34. Washington landings of starry flounder from S. E. Alaska (1000's of lbs.).

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-Year Ave.
Wn. Landings	667	309	174	24	98	177	357	174	38	307	233
Wn. Effort (hrs)	470	185	73	36	65	130	245	287	41	213	175
Wn. lbs/hr.	1418	1669	2390	657	1501	1364	1458	606	938	1444	1332
(lbs/hr) index	106	125	179	49	113	102	109	45	70	108	100

Figure 17 shows the wide fluctuations of the S.E. Alaskan flounder stocks. The first three years of data (1955 through 1957) show declining effort but an increase in fishing success. This would indicate that stocks are highly vulnerable, and, without past records to prove otherwise, the fishery evidently removed most of the stock. Some recovery occurred during 1958, 1959 and 1960. Over-exploitation took place again in 1961 with declines repeated during 1962 and 1963. Stocks were up again in 1964. The oscillatory pattern is not clear, but equilibrium must be near the 250 thousand pound level drawn in the graph.

Hecate Strait

The flounder fishery in Hecate Strait has experienced almost complete failure since 1961. Until that time the fishery was taking 249 thousand pounds of flounder there annually. Effort nearly tripled in 1961, and a catch of only 67 pounds per hour resulted (Table 35). Washington accounted for 54 per cent of the total U.S.-Canadian catch of flounder that year. Until this time Washington fishermen accounted for 91 per cent of the flounder catches in Hecate Strait, and they averaged 19 per cent of their ocean total poundage of flounder from this area.

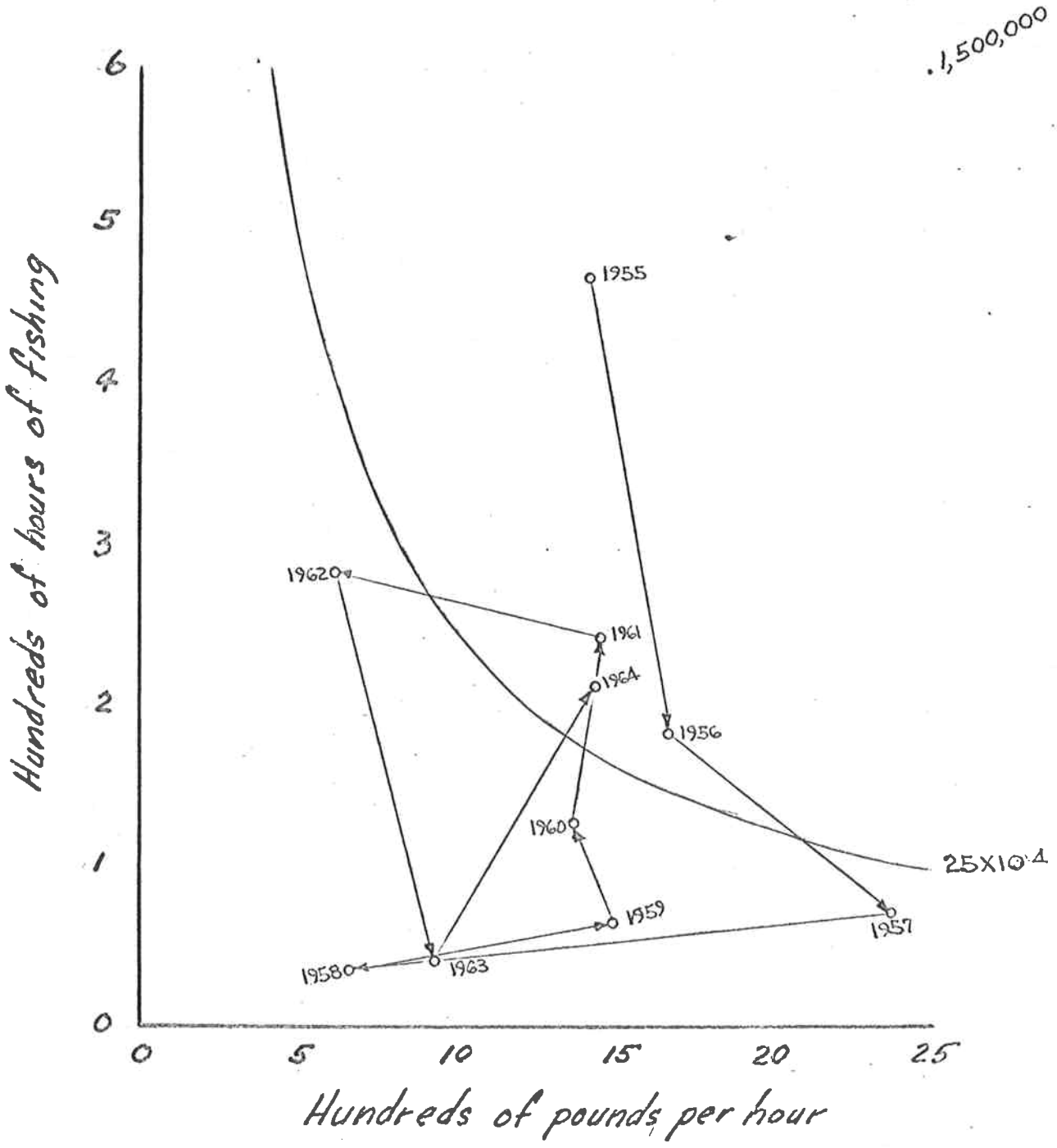


Figure 17. Relationship of catch per unit effort to effort for starry flounder - S. E. Alaska.

Table 35. Landings of starry flounder from Hecate Strait (1000's of lbs.).

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-Year Ave.
Total Landings	114	137	178	220	488	296	168	63	96	39	187
Wn. Landings	98	130	164	193	472	238	91	4	1	6	140
% Wn. Landings	86	95	92	88	97	80	54	6	1	15	75
Wn. hrs.	477	425	264	788	642	739	1354	282	13	115	510
Wn. lbs/hr.	206	305	621	245	735	322	67	14	80	50	274
(lbs/hr) index	75	111	227	89	268	118	24	5	29	18	100

The failure of this fishery has caused fishermen to leave the shallower flounder grounds in search of more productive species. It is hoped that this decreased fishing intensity will enable the flounder population to establish itself once again. The annual yield level of Hecate Strait flounder was around three hundred thousand pounds between 1956 and 1960 (Figure 18).

N. Washington Coast

Flounder caught off the northern coast of Washington have averaged nearly 48 per cent of Washington's ocean total catch for the 10 year period, 1955-1964. An annual average catch of 347 thousand pounds occurred during that period (Table 36).

Table 36. Landings of starry flounder from N. Washington Coast (1000's of lbs.).

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-Year Ave.
Total Landings	490	903	664	228	126	51	228	356	421	130	345
Wn. Landings	490	903	660	228	85	49	206	338	401	108	347
Wn. Effort (hrs)	3670	2443	4194	1441	978	963	2057	1976	3379	1708	2281
Wn. lbs/hr.	133	369	157	158	87	51	100	171	119	63	152
(lbs/hr) index	88	243	103	104	57	34	66	113	78	41	100

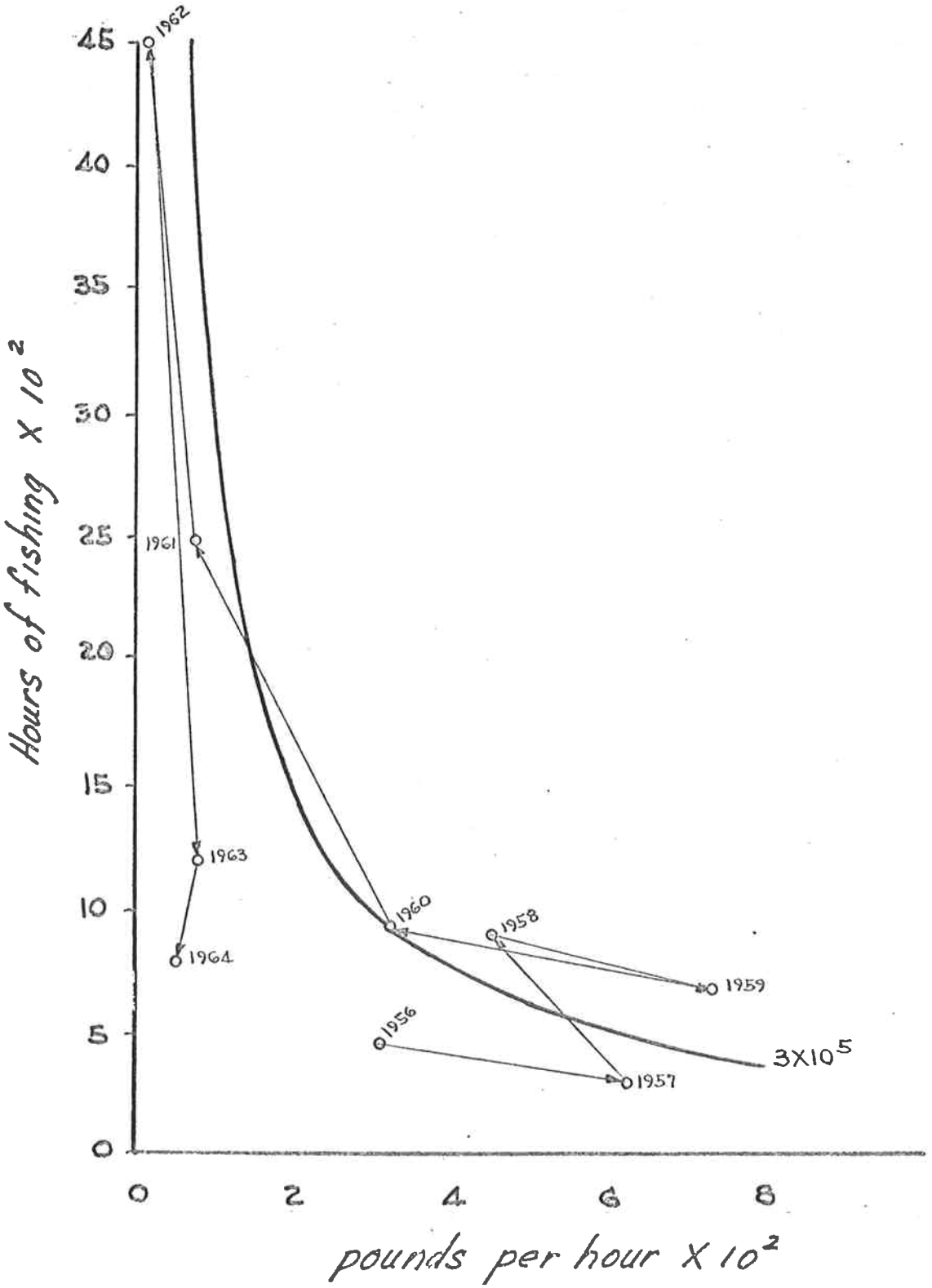


Figure 18. Relationship of catch per unit effort to effort for starry flounder - Hecate Strait.

Spawning usually occurs from January to March in depths shallower than 50 fathoms. Fishing is done most frequently in waters deeper than 50 fathoms, with the exception, that during the spawning season the trawlers move into shallower waters to catch this species while its population is most concentrated. Another consideration that must be made is that market demand is usually less for flounder than for other species of sole. Demand must have been good during the first three years of record, 1955 through 1957. However, stocks were either depleted or less available during 1958 as the decrease in effort did not result in improved fishing success. There was a definite lack of interest in flounder fishing on the part of the fishermen during 1959 and 1960. Landings were fair in 1962 and 1963, but a decline occurred again in 1964. Under the present circumstances the 300 thousand pound level appears to be an adequate exploitation rate (Figure 19).

Northern Puget Sound

Northern Puget Sound is the most productive inside area for starry flounder catches. Nearly 50 per cent of the Puget Sound flounder landings come from this region. An annual average of over 175 thousand pounds has been trawled here during the 21 years from 1944 to 1964 (Table 37). The depths which the flounder frequent are shallower than those most generally fished. Flounder are caught incidental to English sole and true cod, except when catches of these species are low and when they move into the shallow water with flounder. When sole and true cod are not abundant, the trawlers move shallower to fish for flounder.

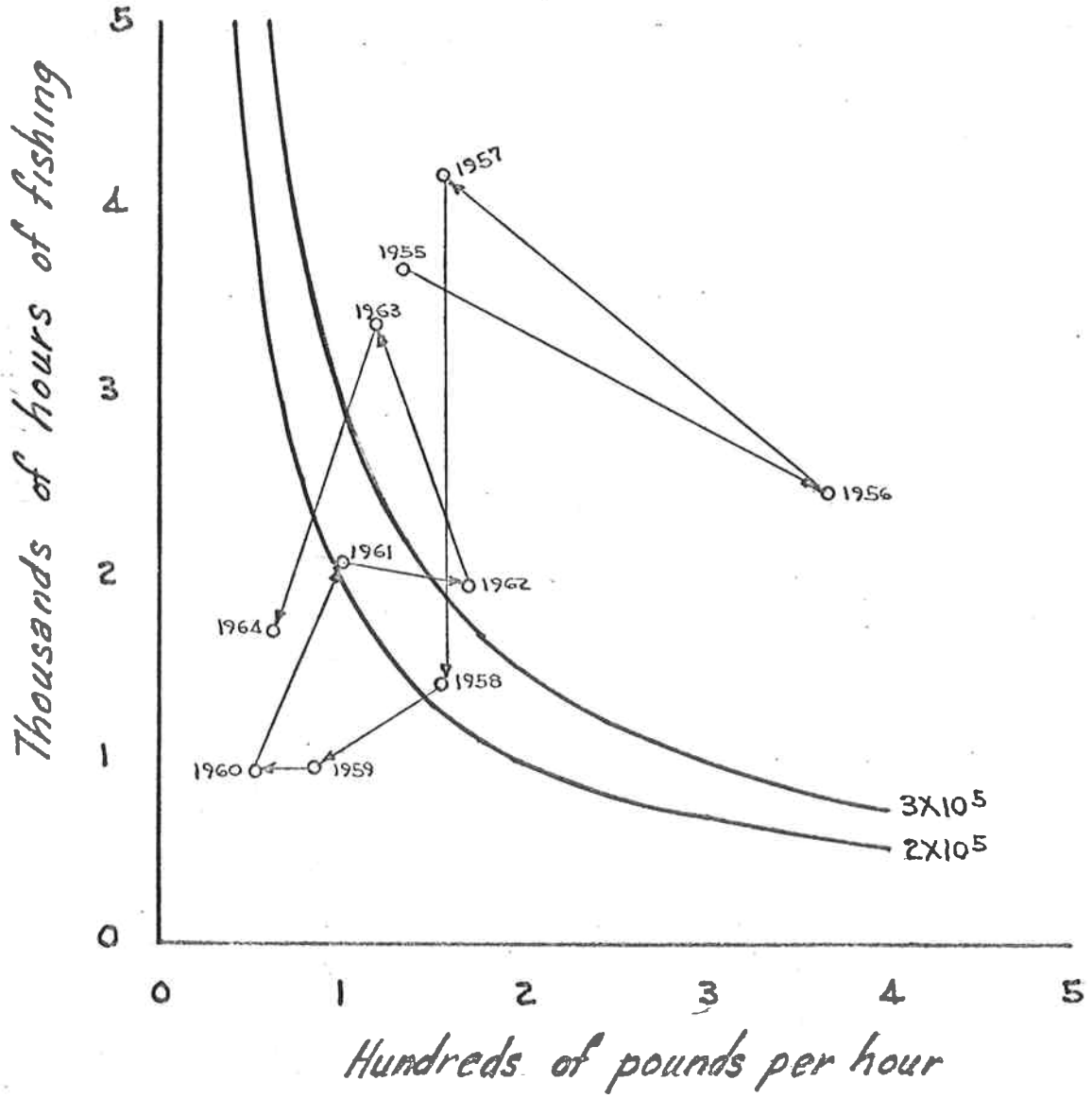


Figure 19. Relationship of catch per unit effort to effort for starry flounder - Cape Flattery to Destruction Island (Wash. data only)

Table 37. Landings of starry flounder from North Puget Sound.

Year	Pounds	Trips	lbs/trip	Year	Pounds	Trips	lbs/trip
1944	166,896	490	341	1954	81,845	147	557
1945	203,801	653	312	1955	159,733	155	1,031
1946	43,257	158	274	1956	127,932	221	579
1947	81,307	134	607	1957	177,453	300	592
1948	81,348	154	528	1958	330,222	501	659
1949	56,329	110	512	1959	74,494	228	327
1950	208,825	139	1,502	1960	363,320	570	637
1951	228,211	288	792	1961	282,754	479	590
1952	133,166	278	479	1962	195,774	308	636
1953	155,329	231	672	1963	325,926	551	592
				1964	250,586	553	453

It is difficult to analyze the flounder population in this area because of the shifting availability. However, the consensus is that this is an underfished population. The Thompson graph of northern Puget Sound flounder has three annual yields levels. The first is for 75 thousand pounds and includes the years 1946 to 1949 (Figure 20). The increased catch per hour in 1950 was followed by increased fishing effort with another yield level around 150 thousand pounds, covering 1950 to 1957. Fishing intensity has since shown considerable fluctuation, however, it has increased on the average and the catch per trip has remained such that the third annual yield level is around 250 thousand pounds for the years 1958-1964. Therefore, it can be said that increased fishing effort has not diminished the flounder stock in this area. An annual average of nearly 550 pounds per trip has been trawled over the past 21 years. Trips are usually of one day's duration in this area.

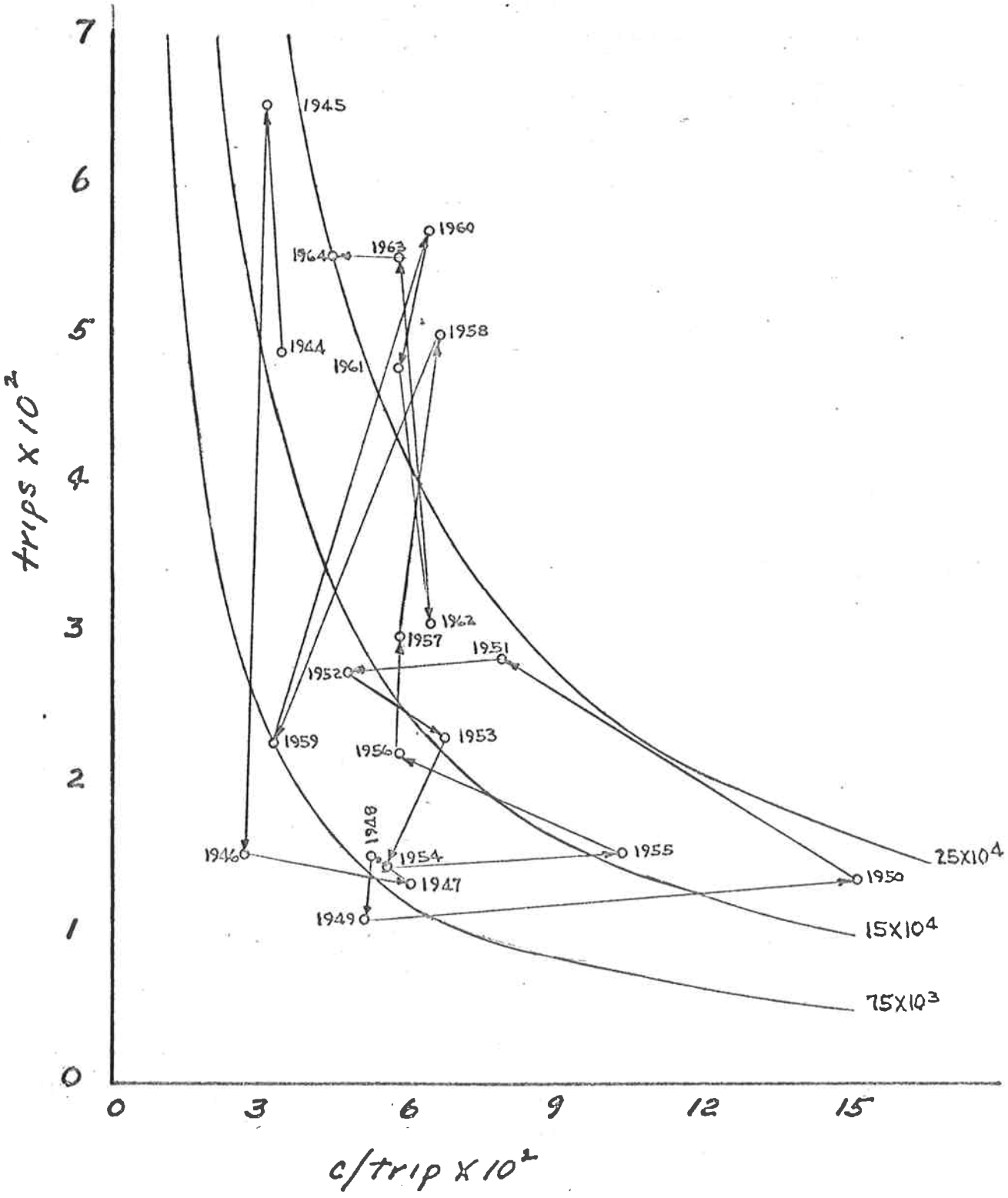


Figure 20. Relationship of catch per unit effort to effort for starry flounder - northern Puget Sound.

Bellingham Bay

The flounder population in Bellingham Bay has remained fairly stable over the 21 year period, 1944-1964 (Table 38). Almost 17 per cent of the flounder landings in Puget Sound come from Bellingham Bay. Numbers of fishing trips have declined from the high years of 1944 to 1948. Trips were lowest from 1949-1958, and since then, they have increased slightly. The annual yield level for Bellingham Bay flounder is equal to what it was in earlier years, around 75 thousand pounds (Figure 21). This is up from a level of 50 thousand pounds (not shown on the Thompson graph) during 1949-1958.

Table 38. Landings of starry flounder from Bellingham Bay.

Year	Pounds	Trips	lbs/trip	Year	Pounds	Trips	lbs/trip
1944	33,573	142	236	1954	33,105	52	637
1945	78,413	344	228	1955	44,843	64	701
1946	117,804	366	322	1956	44,891	74	607
1947	63,385	168	377	1957	38,200	41	932
1948	65,733	225	292	1958	51,946	58	896
1949	31,397	108	291	1959	54,108	82	660
1950	21,695	56	387	1960	61,520	133	463
1951	46,360	73	635	1961	79,861	133	600
1952	53,085	86	617	1962	117,244	143	820
1953	108,938	74	1,472	1963	49,424	62	797
				1964	44,480	87	511

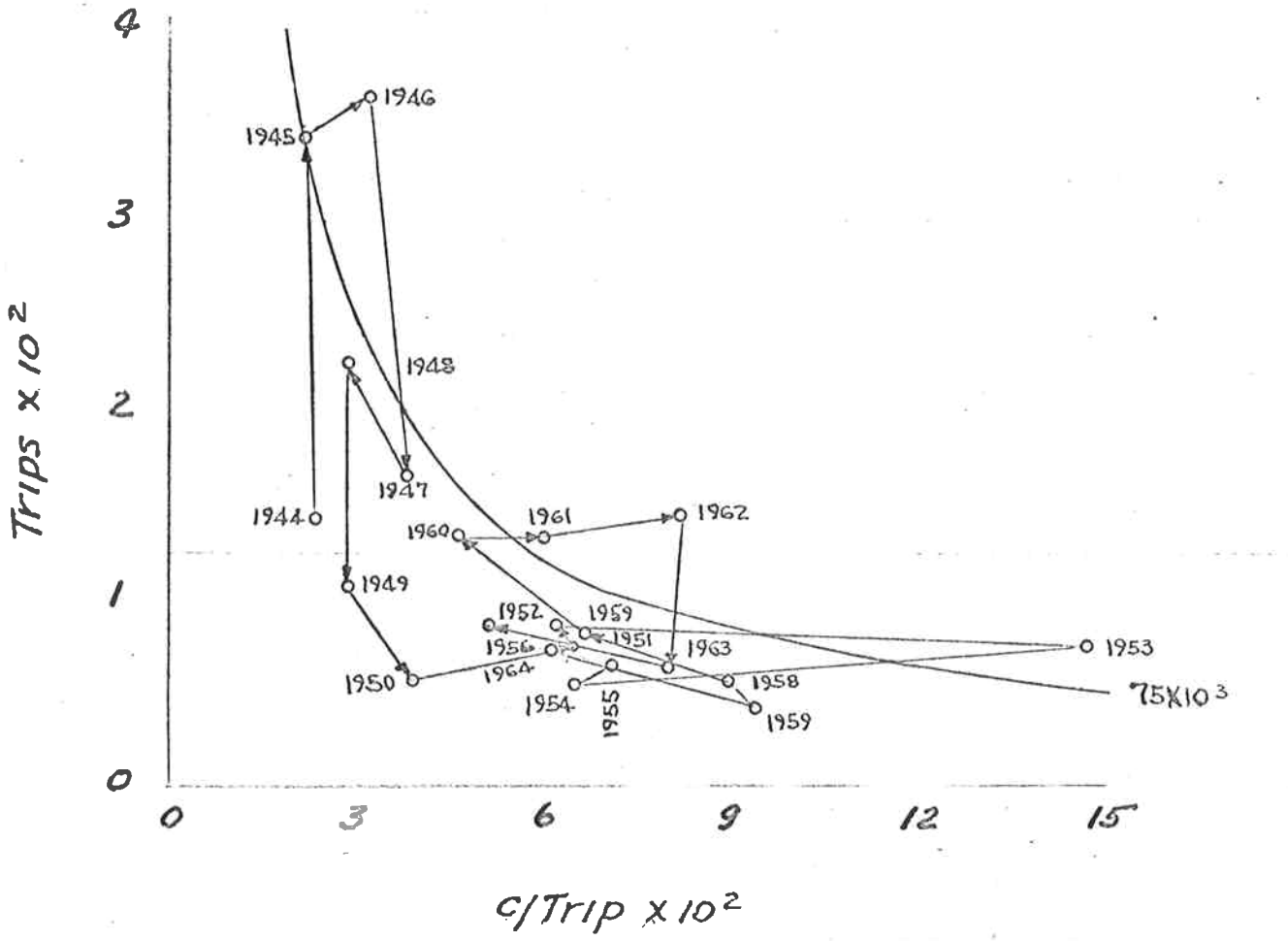


Figure 21. Relationship of catch per unit effort to effort for starry flounder - Bellingham Bay.

Central Puget Sound

Flounder from Central Puget Sound are quite similar to northern Puget Sound flounder in that their availability is dependent upon the fishery moving into shallow water. There are many areas in Central Puget Sound, however, that are shallow enough that flounder, sole and true cod are all caught at the same time.

Over the past 21 years there has been an annual average of 85 thousand pounds of flounder trawled in Central Puget Sound (Table 39). Over 24 per cent of all inside flounder comes from this area. The annual yield level of this species at present is close to 90 thousand pounds.

Table 39. Landings of starry flounder from Central Puget Sound.

Year	Pounds	Trips	lbs/trip	Year	Pounds	Trips	lbs/trip
1944	90,634	133	681	1954	69,703	41	1,700
1945	118,429	173	685	1955	48,726	38	1,282
1946	64,204	80	803	1956	93,705	54	1,735
1947	38,065	52	732	1957	43,530	35	1,244
1948	88,382	137	645	1958	20,256	16	1,266
1949	80,458	95	847	1959	52,304	27	1,937
1950	158,791	149	1,066	1960	132,301	96	1,378
1951	142,322	216	659	1961	90,090	45	2,002
1952	44,735	87	514	1962	83,482	54	1,546
1953	87,208	83	1,051	1963	195,788	79	2,478
				1964	48,823	43	1,135

Figure 22 has a distinct shift from a high range of effort to a low range of effort and better fishing success. This is thought to represent a change of trip length from daily trips to a mixture of daily and weekly trips that prevails at present. Actually more effort is expended now to land similar poundages. Unfortunately, the records are not complete enough to verify this supposition.

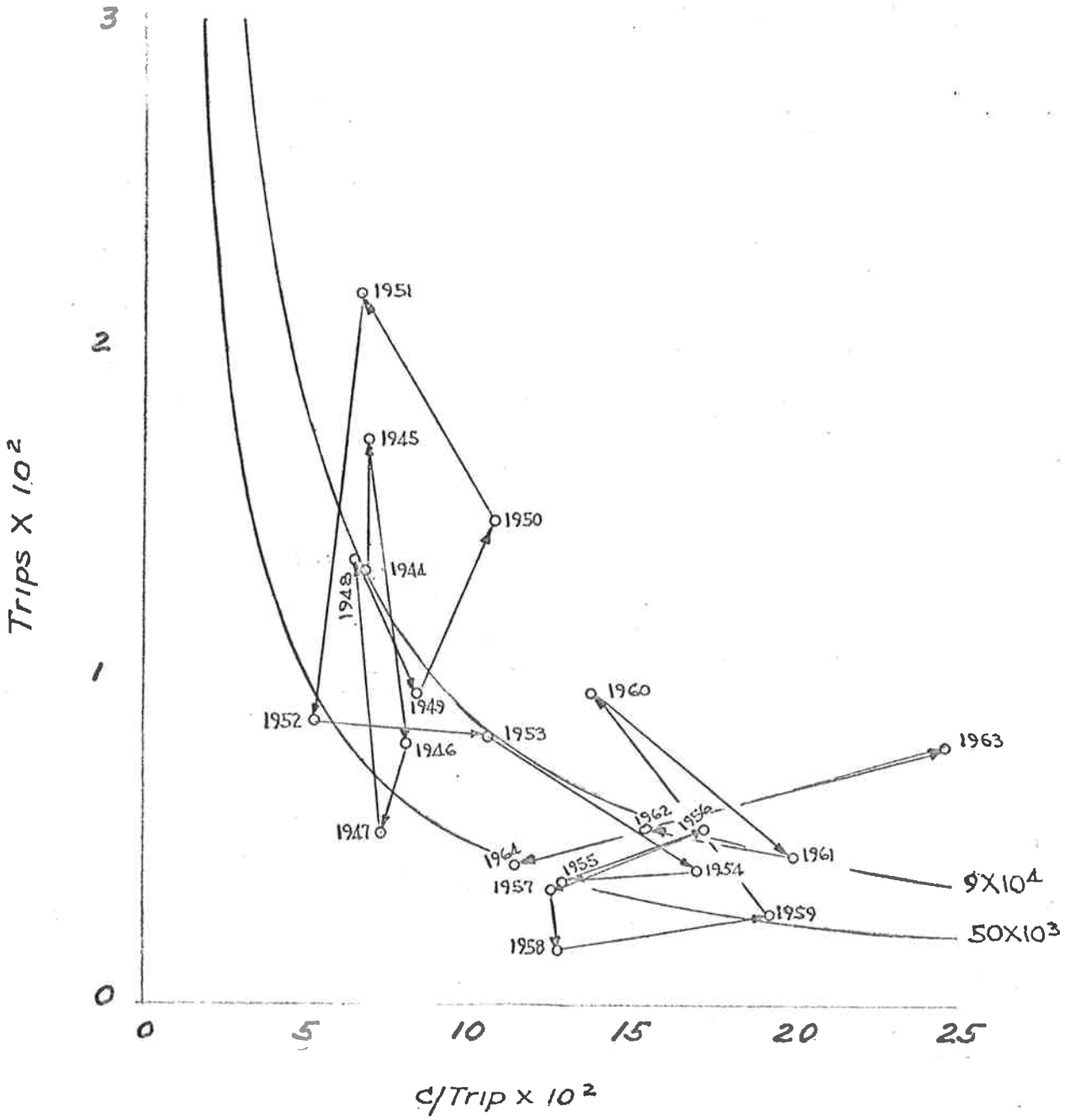


Figure 22. Relationship of catch per unit effort to effort for starry flounder - central Puget Sound.

Western Puget Sound

Only 4 per cent of the total Puget Sound flounder catch comes from West Puget Sound. An annual average of 12,500 pounds has been trawled there since 1944 (Table 40). Availability is certainly the important factor in this area. Catches of flounder are incidental to true cod and English sole landings in this area.

Table 40. Landings of starry flounder from West Puget Sound.

Year	Pounds	Trips	lbs/trip	Year	Pounds	Trips	lbs/trip
1944	20,455	4	5,114	1954	7,752	15	517
1945	1,410	3	470	1955	19,754	22	898
1946	463	3	154	1956	1,816	6	303
1947	25,994	30	866	1957	1,220	6	203
1948	2,205	7	315	1958	17,455	19	919
1949	360	1	360	1959	19,725	18	1,096
1950	22,510	9	2,501	1960	6,495	5	1,299
1951	7,501	19	395	1961	21,780	19	1,146
1952	1,041	8	130	1962	40,907	31	1,320
1953	14,685	24	612	1963	4,265	8	533
				1964	25,301	13	1,946

Fluctuations in fishing effort were too extreme, although much less change occurred with the catch per effort. The most productive years were 1950 and 1964. The annual yield level for flounder in this area is around 10 thousand pounds. The fishery, however, does not reflect the true flounder population in West Puget Sound.

Southern Puget Sound

Complete data is available for the South Puget Sound area only from 1952 to present. Nearly 8 per cent of Puget Sound flounder landings comes from this area. The catches of flounder are incidental to the wormy English sole landings which are fished in shallow depths where flounder are available. An average of 28 thousand pounds of flounder was trawled during the 13 years from 1952 through 1964 (Table 41).

Table 41. Landings of starry flounder from South Puget Sound.

Year	Pounds	Trips	lbs/trip	Year	Pounds	Trips	lbs/trip
1952	295	2	148	1958	49,870	39	1,279
1953	39,918	22	1,814	1959	8,551	17	503
1954	47,817	27	1,771	1960	76,278	46	1,658
1955	2,475	7	354	1961	40,162	31	1,296
1956	18,417	31	594	1962	26,538	29	915
1957	20,059	44	456	1963	21,260	24	886
				1964	11,147	29	384

PACIFIC COD

Hecate Strait

The importance of this species and this area is shown by the fact that it has produced an average of 6.8 million pounds of true cod over the ten year period of 1955 through 1964 (Table 42). Washington fishermen during this period landed 35 per cent of their ocean-caught cod from this area. They accounted for 73 per cent of the true cod landings there during 1955, but their share of the total U.S.-Canadian catch has waned to 5 per cent during 1962 and 9 per cent during 1964. Over the ten year period their average percent of the catch was only 35 per cent. The area can be divided into upper and lower areas. Most (79 per cent) of the cod was taken in upper Hecate Strait.

Thompson type relation between catch and catch per unit effort has been omitted as no conclusions could be drawn from it. Washington landings in recent years are too small a proportion of the total catch to be significant, and other factors such as water temperatures are thought to affect cod abundance.

Table 42. Catch statistics for Pacific cod in Hecate Strait (1000's of lbs.).

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-Year Ave.
Total Landings	4817	3271	5113	11,468	11,298	5202	3562	3724	6454	11,525	6846
Wn. Landings	3498	1500	2802	5056	6544	1361	833	177	970	1005	2375
% Wn. Landings	73	46	55	44	58	26	23	5	15	9	35
Wn. Effort (hrs)	2659	1824	2424	2619	4677	1945	1206	463	955	902	1967
Wn. lbs/hr	1315	822	1156	1931	1399	700	691	383	1016	1115	1207
(lbs/hr) index	109	68	96	160	116	58	57	32	84	92	100

Pacific cod found along our coast are near the southern extremity of their range. Therefore, the average sea water temperatures for June, July and August were compared with fishing success (catch per hour) three years later. Three year olds are the dominant age group in the landings, as a general rule, and, if survival of the young of the year are affected by temperature, it would require three years to show in the landings. An inverse relationship exists as shown in Figure 23. Many factors affect both the temperature data, and the numbers of fish caught. Slightly less correlation was found with a four year lag of temperatures. This can be explained by the fact that four year olds are about as numerous as three year olds in the landings. If the two age classes could be grouped, a better relationship would probably be found. The Washington catch per hour rate was better related than the combined Canadian and Washington landings which shows that the catch per hour is more representative of the stock abundance. Market demand slowed in Washington when landings decreased, and evidently were slower than the Canadian markets to react when cod were again available. Much of the

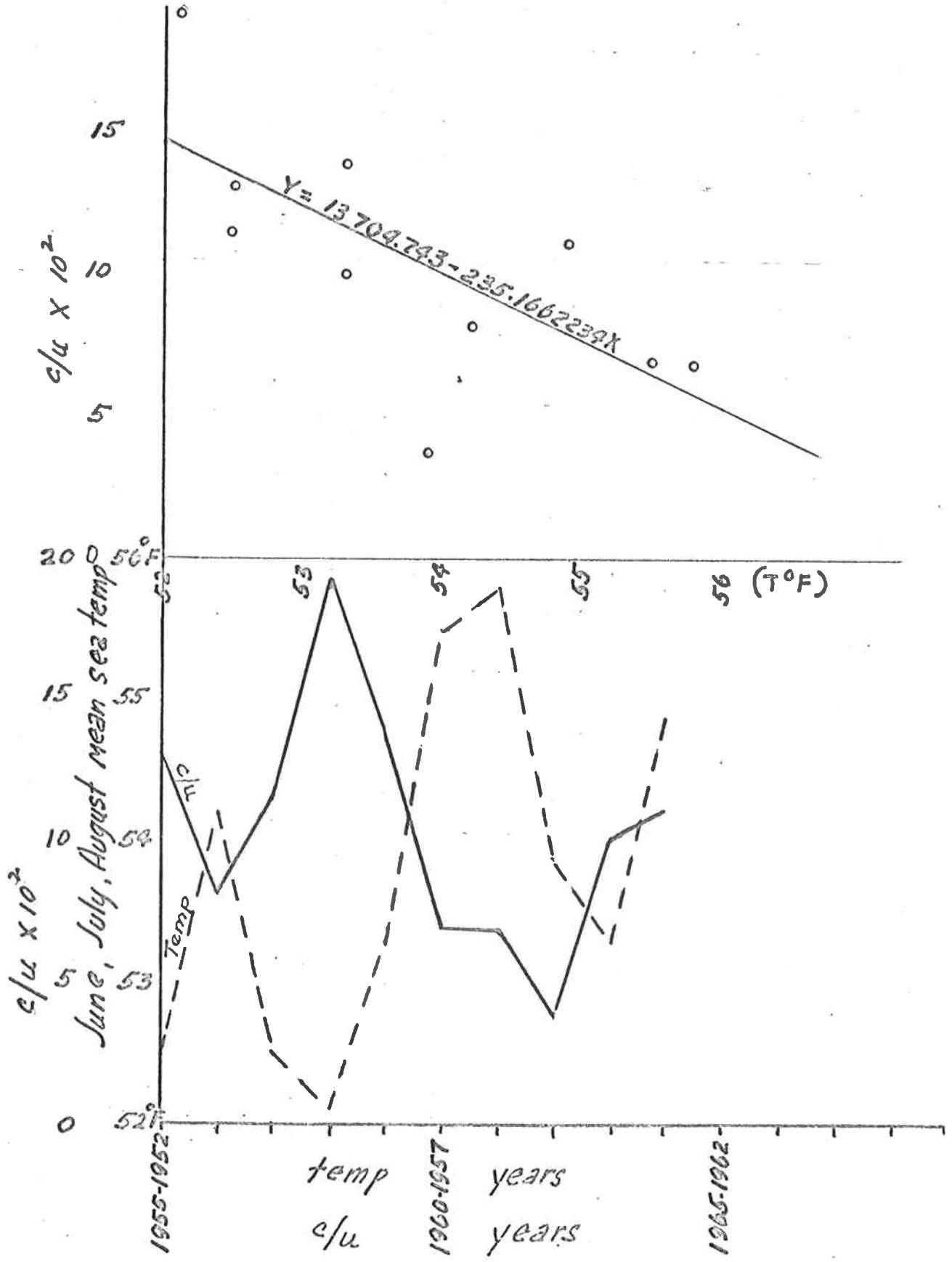


Figure 23. Hecate Strait C/E (Wn.) Triple Island. June-August Mean sea

cod is used in fish sticks. There is some relationship (+0.48) between warmer water temperatures and better catches. This would mean that it is possible that cod are not to be found in their usual habitat during colder water years. Dr. K. Ketchen of the Fisheries Research Board of Canada has suggested the February to April period for study in this regard, but less relationship was found. Maximum temperatures and the number of days of 9° C (48.2° F) or warmer were studied, but no threshold effect was found.

Queen Charlotte Sound

Washington fishermen land 15.5 per cent of their ocean-caught cod from this area. Slightly more are taken from the Cape Scott side of the grounds. Combined landings from this area have averaged about 2.5 million pounds over the ten year period of 1955 through 1964. Cod are usually taken incidentally to other species (petrale, lingcod, and rockfish) in this area. The effort of the Washington fishermen has not waned to the extent that it has in the Hecate Strait area.

The catch statistics for Pacific cod taken in Queen Charlotte Sound are listed in Table 43. Canadian seawater temperatures from Pine Island were compared with the catch per hour by Washington fishermen from Queen Charlotte Sound (Figure 24). For the ten year period, Pine Island temperatures averaged 4.5° colder than Triple Island during the June, July, and August season. Evidently Pine Island is rather remote from the cod habitat. A slight relationship is evident, but it is rather severe in that at 52° F a negative catch per unit can be expected. The records of other more exposed stations should be studied if a better relationship is desired.

Table 43. Catch statistics for Pacific cod in Queen Charlotte Sound (1000's of lbs.).

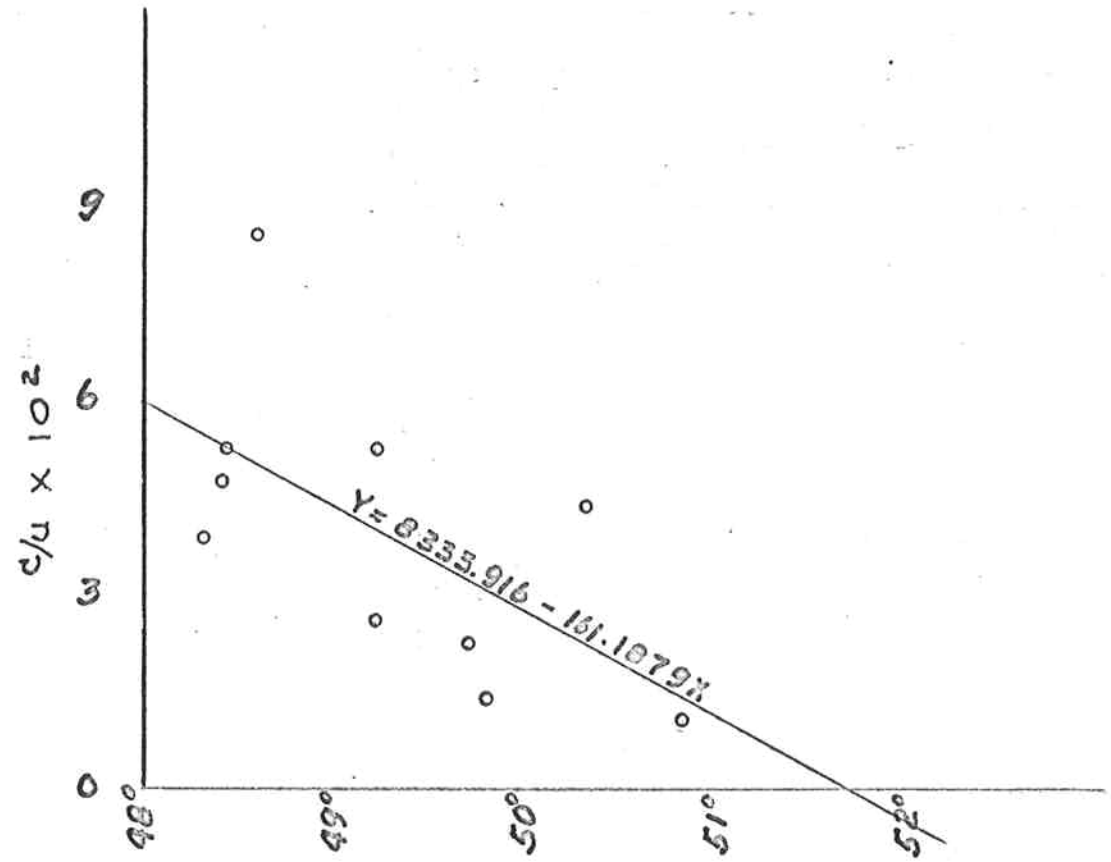
Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-Year Ave.
Total Landings	2535	3866	6050	2597	2087	1364	529	931	1492	2810	2426
Wn. Landings	2380	3164	3610	1527	714	496	186	380	1145	1554	1516
% Wn. Landings	94	82	60	59	34	36	35	41	76	55	62
Wn. hrs.	5005	5992	4226	2888	1836	2185	1815	2813	4387	3567	3471
Wn. lbs/hr.	476	528	854	529	389	227	103	135	261	436	437
(lbs/hr) index	109	121	195	121	89	52	24	31	60	100	100

West Coast of Vancouver Island

The combined landings of Canadian, Washington, and some Oregon fishermen averaged about 2.2 million pounds during the ten year period of 1955 through 1964 (Table 44). The majority of the catches are made at the "Firing Range," "Cabbage Patch," and Forty-Mile Bank or "Big Bank" as the latter is known to Canadian fishermen. A small percentage of cod landings come from the adjacent Esteban-Esperanza area. The Washington fishermen account for 47 per cent of the cod landings from this area, but these landings are only 15.5 per cent of the cod landings from all oceanic areas.

Table 44. Catch statistics for Pacific cod off W. Coast Vancouver Island (1000's of lbs.).

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-Year Ave.
Total Landings	2558	3234	4002	1875	2000	1402	926	1396	2756	2728	2228
Wn. Landings	2262	1688	1548	595	1104	807	325	577	1101	454	1046
% Wn. Landings	88	52	39	32	55	58	35	41	40	17	47
Wn. hrs.	5598	4248	3942	2322	4511	5147	3968	4509	4014	2114	4037
Wn. lbs/hr.	404	397	393	256	245	157	82	128	274	215	259
(lbs/hr) index	156	153	152	99	95	61	32	49	106	83	100



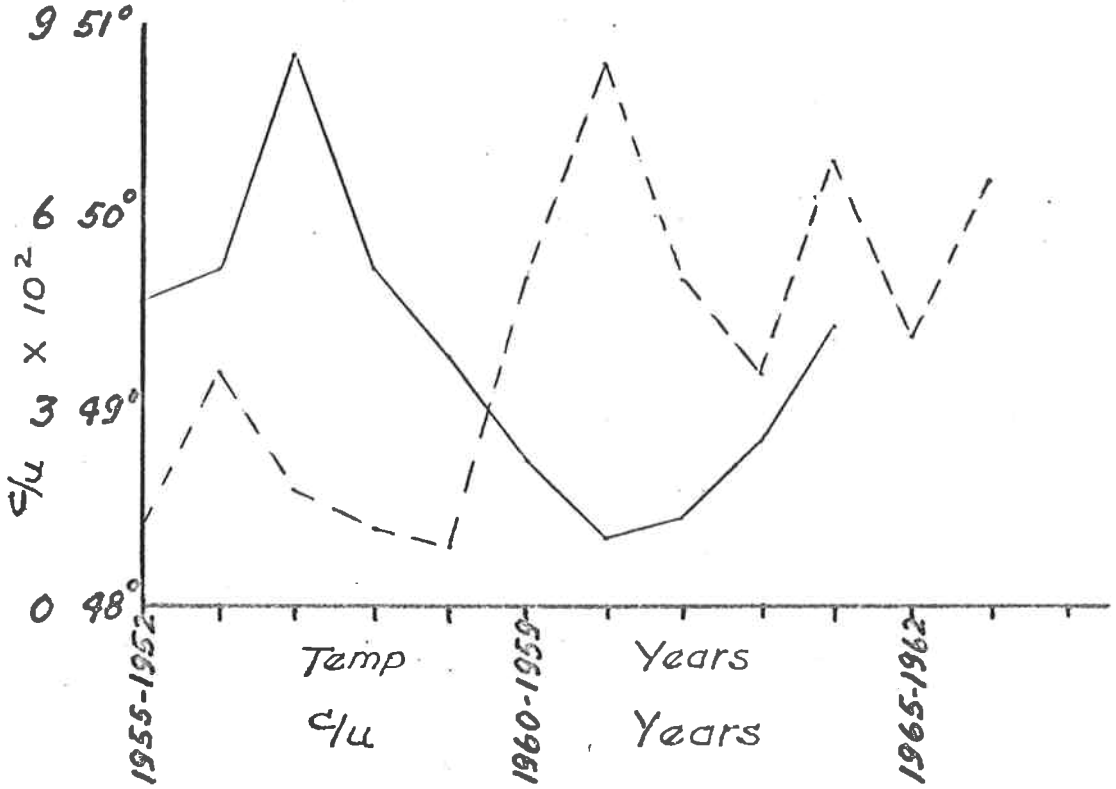


Figure 24. Queen Charlotte Sound Wn (C/E) and Pine Island Mean June, July and August sea temp. lagged 3 yrs.

The graph in Figure 25 reflects largely fluctuations in availability of cod to the fishery. Starting from 1955 to 1957, effort increased, but catch per hour remained fairly steady showing more poundage available to the fishermen. There was a tremendous decrease in availability during 1958 which lasted until 1962 despite increased effort on the part of the fishermen. From 1961 to 1963 availability increased and was maintained during 1964. If the fishery was affecting stock abundance the 1963 level would not have occurred without a radical reduction in effort to, at least, 6,000 hours of fishing.

Figure 26 displays the temperature and fishing success relationship, which is the poorest found thus far. Conditions should be ideal for comparison. The fishery is in close proximity, and the station is fairly well exposed to changing oceanic conditions. The decline in abundance in 1958 occurred simultaneously with the peak in temperature. Perhaps there is a shift in habitat along the coast which makes the fish nonavailable. Here again, Canadian scientists say that there was a lack of recruitment of young fish into the fishery.

N. Washington Coast

Washington fishermen take 98 per cent of the cod landed from this area, although this amounts to only 26 per cent of the total ocean catch of true cod. The area produced an average of 1.8 million pounds per year in the last ten years (Table 45). Although cod have wandered to Piedras Blancas near San Francisco, this Washington area represents the southern limit of a commercial fishery.

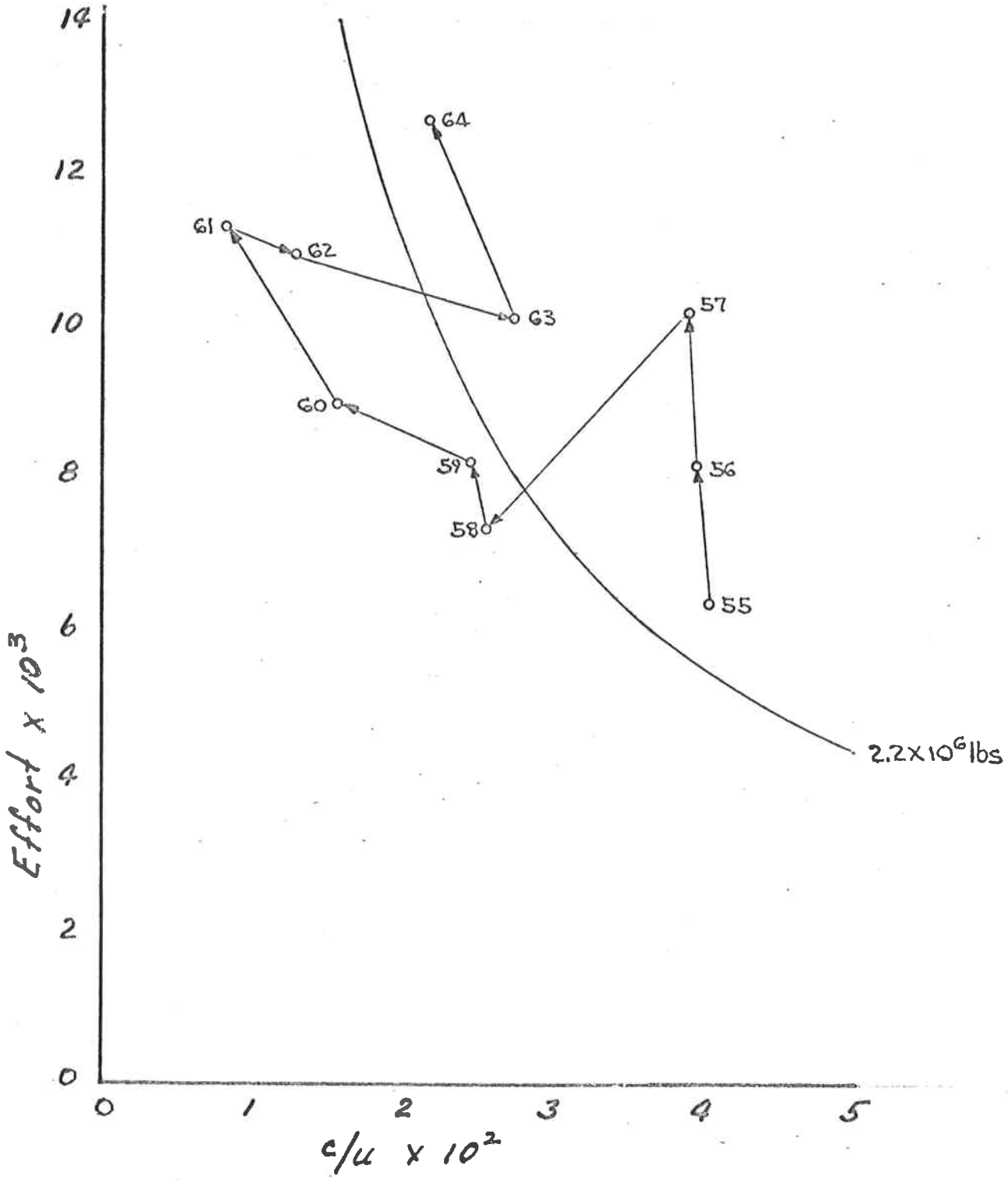


Figure 25. Relationship of catch per unit effort to effort for Pacific cod - W. coast Vancouver Island.

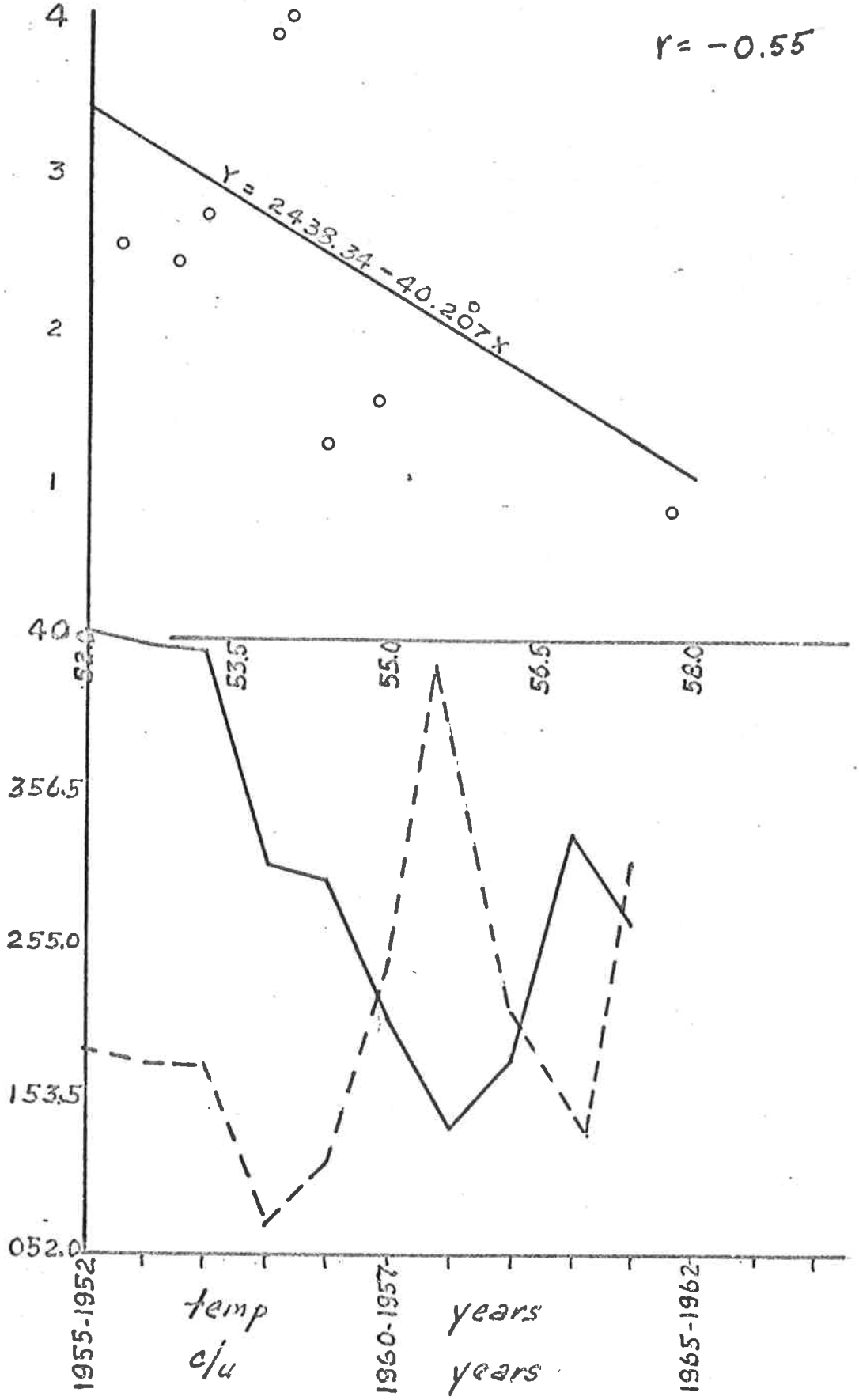


Figure 26. W. Coast Vancouver Island Wn C/E vs Amphitrite Pt. June, July, and August Mean sea temp. lagged 3 yrs.

Table 45. Catch statistics for Pacific cod off N. Washington Coast (1000's of lbs.)

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-Year Ave.
Total Landings	3599	1993	1585	2599	2955	1618	771	581	1184	1406	1822
Wn. Landings	3528	1989	1557	2541	2855	1571	751	525	1140	1343	1780
% Wn. Landings	98	100	98	98	97	97	97	90	96	96	98
Wn. Effort (hrs)	13,883	9883	6032	8698	7782	10,066	7457	5543	7251	7340	8393
Wn. lbs/hr.	254	201	258	292	367	156	101	95	157	183	212
(lbs/hr) index	120	95	122	138	173	74	48	45	74	86	100

Pacific cod are landed incidental to other species in this area, such as English sole, lingcod, and rockfish.

About all the graph in Figure 27 shows is that the area was capable of producing 3.5 million pounds in 1955. The ten year average line of 1.8 million pounds was added for interest, and it does not represent an equilibrium condition. The periods of 1956 to 1958 and 1960 to 1964 could be mistaken for the effect of the fishery on the stocks. However, because of the high natural mortality rate of these fish, which was determined by Canadian studies, it is known that stock fluctuations are the result of changes in stock availability to the fishery.

Figure 28 was prepared showing the relationship between catch per hour and the mean sea temperatures during June, July, and August at Amphitrite Point, B.C. three years earlier. The relationship produced a correlation of -0.67 which is better than the -0.55 found for the segment of the fishery off the west coast of Vancouver Island and the same temperatures. The same degree of correlation (-0.67) was produced by the temperatures in one year compared to fishing success four years later. This is taken to mean that fish of the same year class are affected by summer temperatures in their first year. Unfortunately, the ages of cod in the catch are determinable only by length frequency modes in the size distribution of the landings. If the three and four year fish could be grouped by year class, it is expected that an improved relationship with temperature could be found.

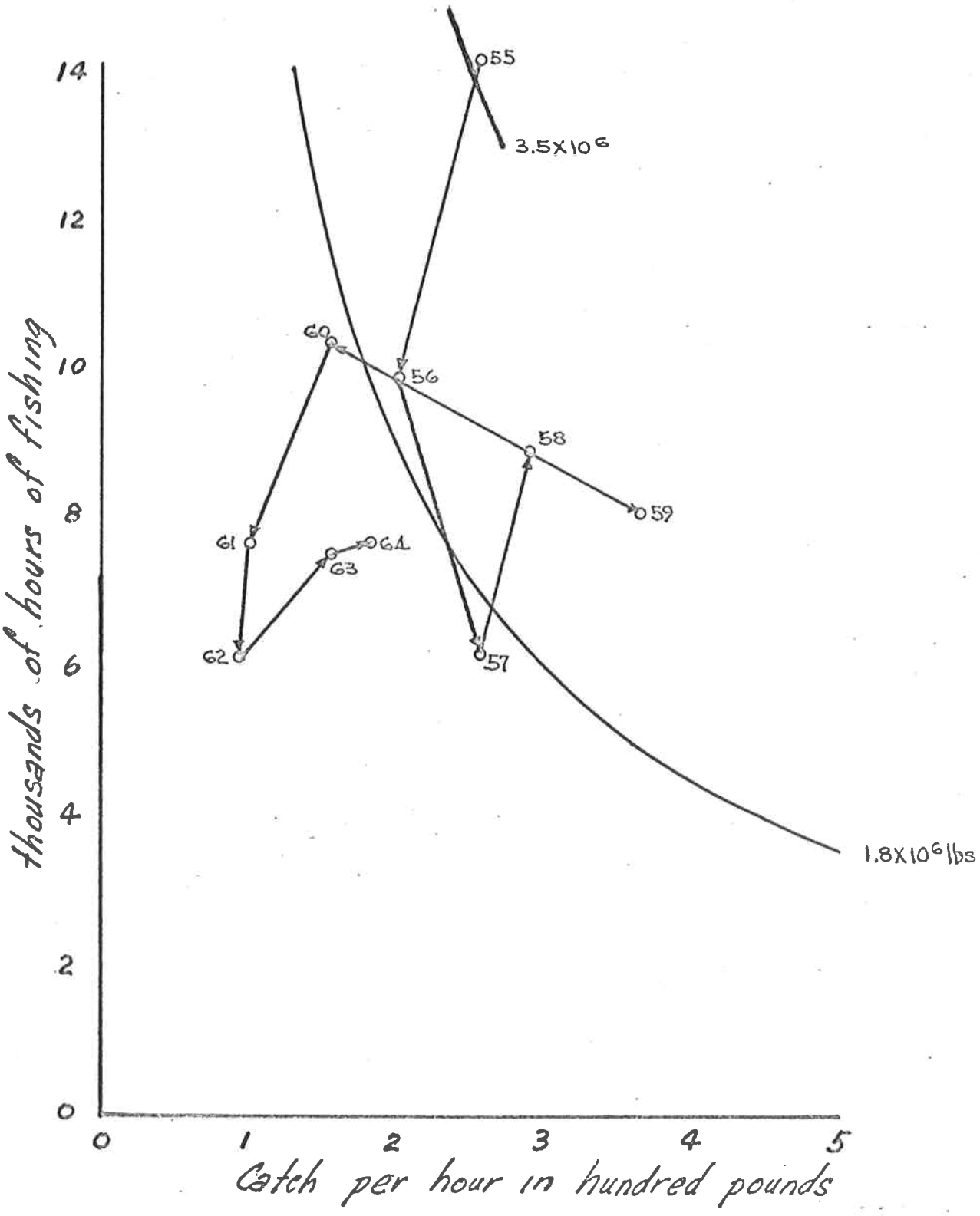


Figure 27. Relationship of catch per unit effort to effort for Pacific cod - N. Washington (3B).

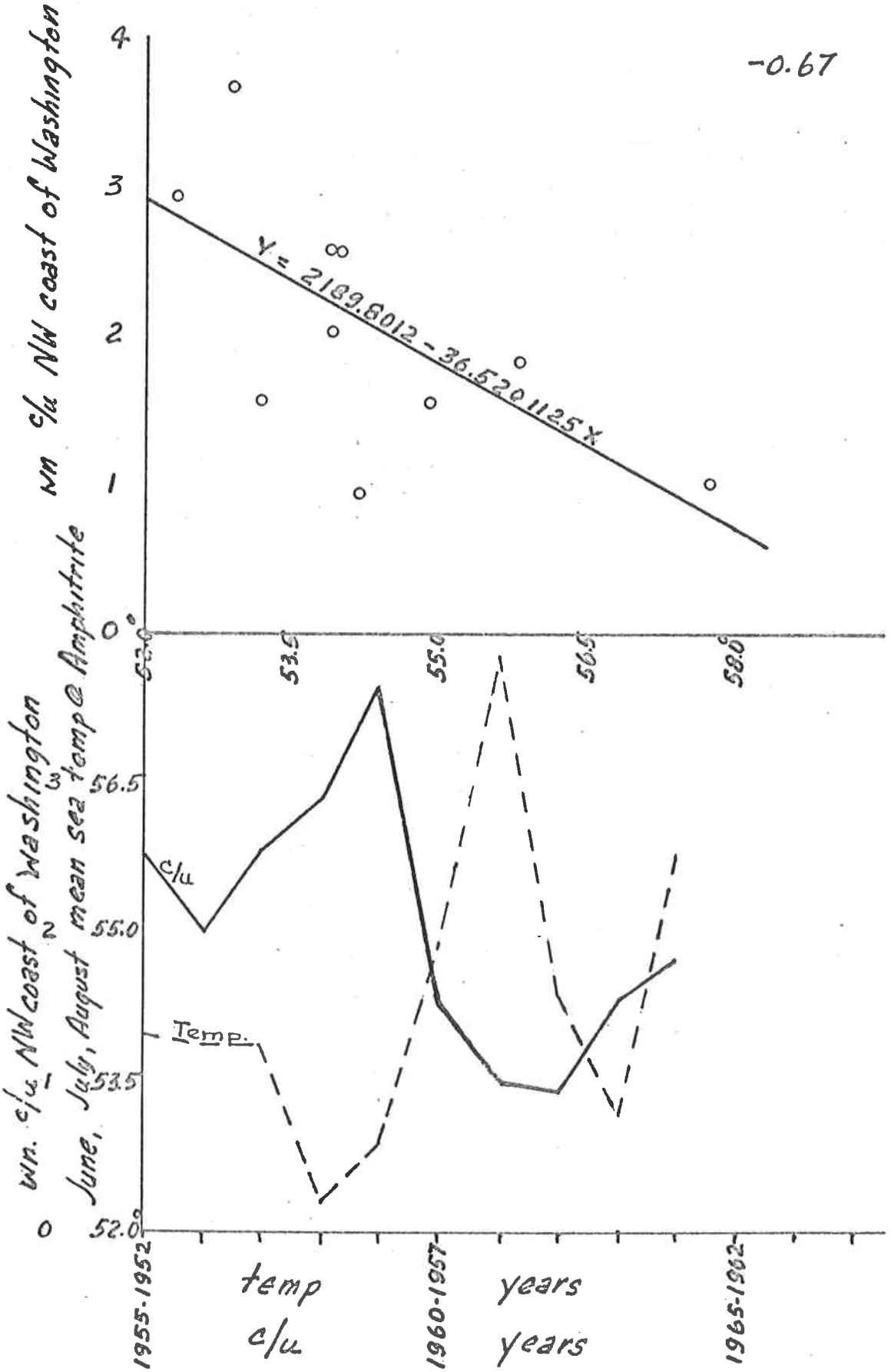


Figure 28. Relationship of Wn. catch per hour off N. Wn. Coast and June, July, August mean sea temp. at Amphitrite P. lagged 3 yrs.

The graph also shows that cod stocks in this area (3B) peaked in 1959, a year later than in most other areas. Recovery also seemed delayed when compared to stocks of other areas.

In all fairness it should be pointed out that throughout most of this period sea water temperatures have been relatively cold. The variability has been large for the cold region of the data. More observations are needed for warmer water temperatures. Perhaps it was fortunate that a decline occurred following the single warm period. The amount of variability that will develop from further warm water observations cannot be conjectured upon from these data. It is fortunate that the Canadians had the foresight to collect the sea water temperatures, and it is hoped that they continue. No comparable continuous data are available.

Puget Sound and Gulf of Georgia

Again the Puget Sound area is used in the broad sense to include all waters East of the Bonilla - Tatoosh line, and the liberty is taken to include Canadian landings in the total poundage, and in the study of the relationship between sea water temperatures and the landings. Most of the discussion will concern the Washington true cod fishery.

During the ten year period Washington landings equaled the Canadian on the average (Table 46). Washington landings were less during early years, but have surpassed the Canadian in later years.

Table 46. Catch statistics for Pacific cod in Puget Sound (1000's of lbs.)

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-Yr Ave.
Total Landings	2965	2330	5365	3771	3876	2533	1732	2450	3352	3353	2940
Wn. Landings	934	1127	1689	2389	1701	891	832	1397	1866	1782	1461
% Wn. Landings	32	48	31	63	44	35	48	57	56	53	50
Wn. hrs.	12,345	13,508	18,927	18,902	19,309	19,919	12,974	11,333	13,028	19,515	15,976
Wn. lbs/hr.	76	83	89	126	88	45	64	123	143	91	91
(lbs/hr) index	84	91	98	138	97	49	70	135	157	100	100

Figure 29 graphs the fishing success and effort. The year to year variations from 1955 to 1959 reflect changes in availability, but from 1960 to 1964 the reactions are typical of the effect of a stock recovery from being over-fished. The line at 1.5 million pounds would represent an equilibrium condition. However, we know that stocks are subjected to great natural mortality, and one contributing factor is sea water temperature conditions in the first summer of a fish's life. Because of a high natural mortality the maximum fishing effort should be maintained. Present regulations in Washington limit fishing effort.

More than half of the true cod landings in Puget Sound come from the Strait of Georgia area, and another third come from the Strait of Juan de Fuca. Those landed from the central area are from Admiralty Inlet. The identity of separate Puget Sound stocks is unknown.

A -0.68 correlation was found between the combined statistical areas 4A and 4B landings, and summer mean sea temperatures at Race Rocks, but only -0.36 was obtained for 21 years of Washington landings and temperatures from the same station (Figure 30).

LINGCOD

Hecate Strait

In some years the effort of Washington trawl fishermen on lingcod has been but a small proportion of the total fishing effort expended in this area (Table 47). There are unknown, but significant catches of lingcod taken on other gears, such as troll, set line, and hand line. No data are exchanged for the catches by these gears, but they should be considered in any analysis of catch.

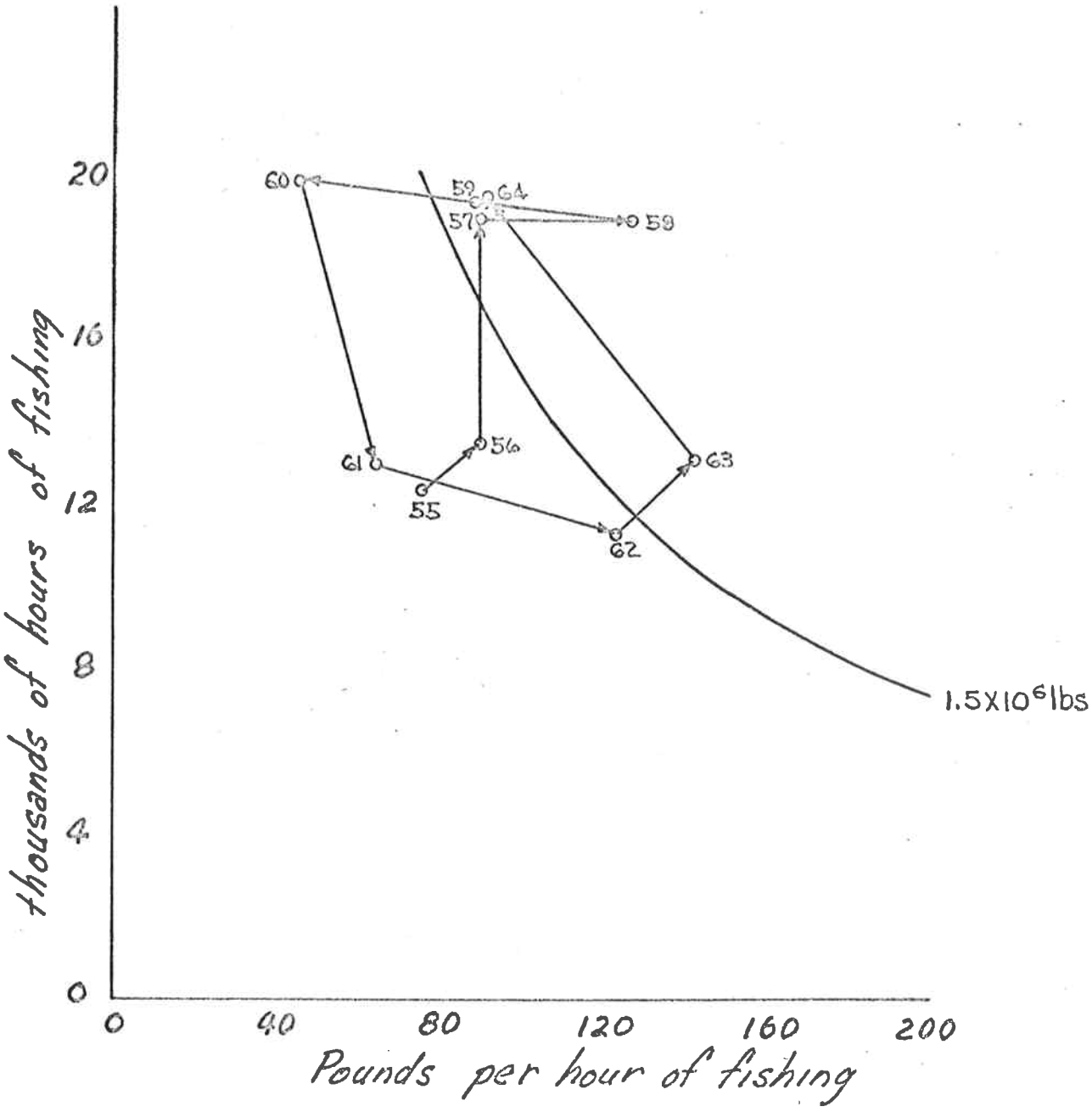


Figure 29. Relationship of catch per unit effort to effort for Pacific cod - Puget Sound.

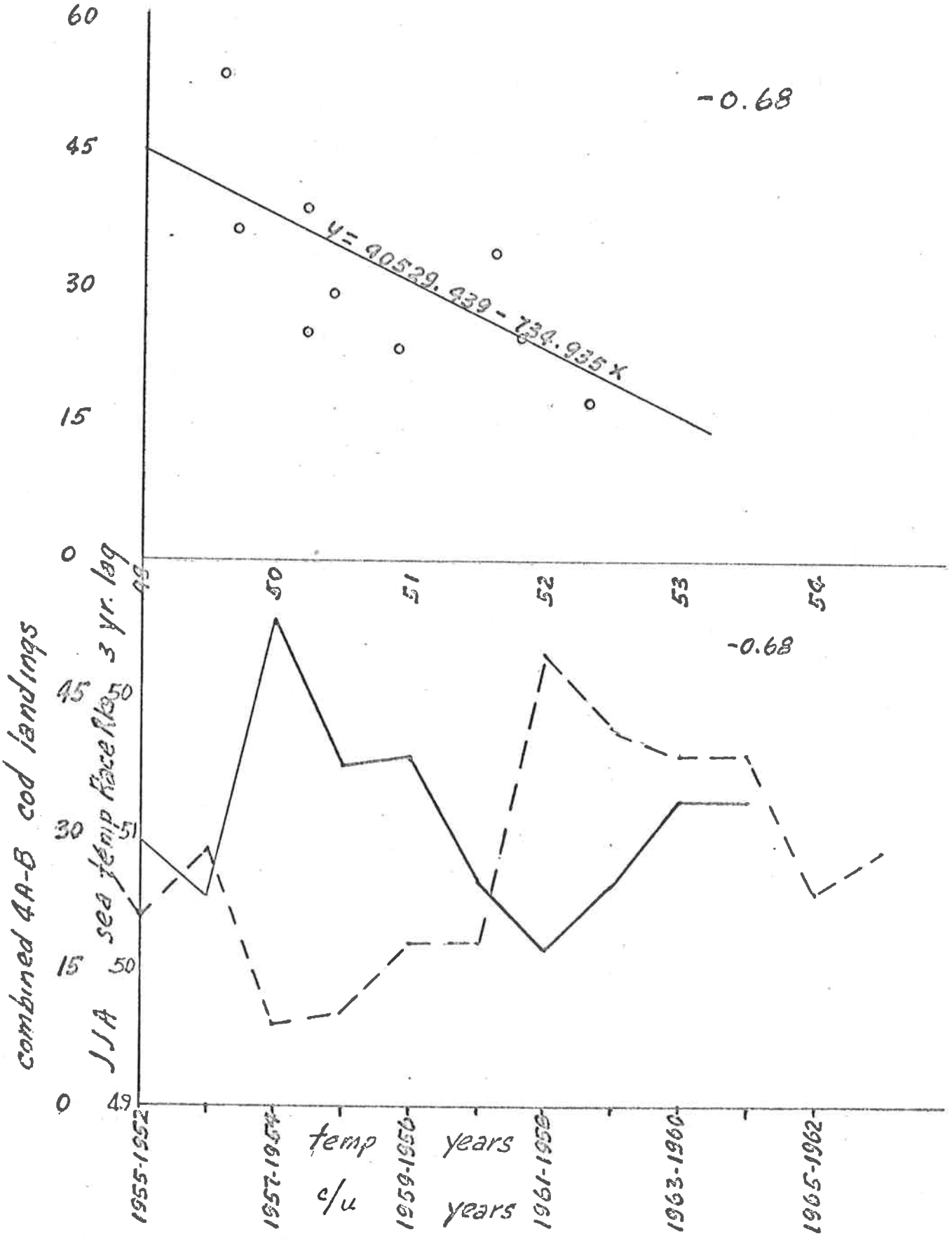


Figure 30. Relationship of combined Canadian and Washington Puget Sound Pacific cod landings and June, July, August mean sea temp. at Race Rocks lagged 3 yrs.

Table 47. Catch statistics for lingcod from Hecate Strait (1000's of lbs.).

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-Year Ave.
Total Landings	497	205	284	165	259	256	211	250	322	473	292
Wn. Landings	392	118	152	86	127	75	73	29	64	50	117
% Wn. Landings	79	58	54	52	49	29	35	12	20	11	40
Wn. hrs.	1838	1217	1605	1541	1891	594	1051	432	596	657	1142
Wn. lbs/hr.	213	97	95	56	67	126	70	67	107	76	102
(lbs/hr) index	209	95	93	55	66	124	69	66	105	75	100

Washington fishermen have taken only 3.5 per cent of their ocean landings of lingcod from Hecate Strait over the ten year period. A graph of the effort compared to the catch per hour is included with reluctance for fear that it might be misinterpreted (Figure 31). An equilibrium at about 250 thousand pounds is indicated but the good landings during 1955, 1963, and 1964 also indicate that the area is capable of greater production. Without the landings and effort by the fisheries using other gear, no conclusions can be made. Perhaps the best years for the trawlers were the years when less poundage was taken by other gears.

Slightly over half (58%) of the Washington catch comes from upper Hecate Strait. According to the PMFC Data Series, the southern or lower Hecate Strait area is out producing the upper or northern area. Seventy per cent of the Hecate Strait lingcod catch was taken in the lower area during 1964.

Queen Charlotte Sound

Washington trawl fishermen have averaged slightly over half of the landings made by trawlers in Queen Charlotte Sound in the last ten years (Table 48). Here again lingcod are taken by trollers, set liners, and hand-liners, but the catch by other gears must not be significant as the graph of catch and effort indicates an effect of the trawl fishery on the abundance of the lingcod stocks. Almost 22 per cent of the ocean landings of lingcod by Washington fishermen were taken from this area from 1955-1964.

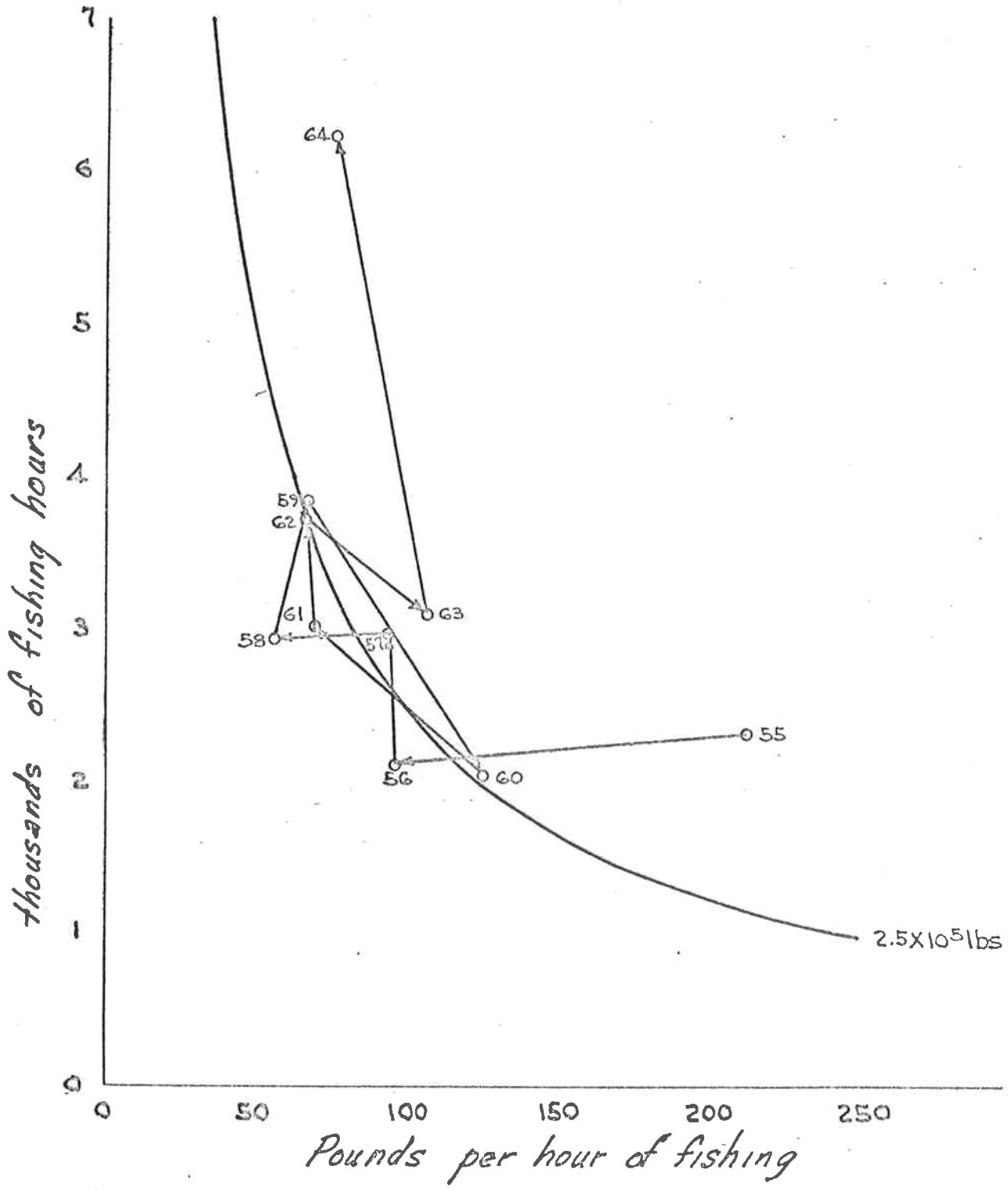


Figure 31. Relationship of catch per unit effort to effort for lingcod - Hecate Strait.

Table 48. Catch statistics for lingcod from Queen Charlotte Sound (1000's lbs.).

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-Year Ave.
Total Landings	557	1323	1328	1261	1369	1450	1567	2068	1416	1515	1385
Wn. Landings	472	808	765	579	527	775	733	976	882	695	721
% Wn. Landings	85	61	58	46	38	53	47	47	62	46	52
Wn. hrs.	4102	5282	3448	2499	1450	2679	2190	3362	4068	3657	3274
Wn. lbs/hr.	115	153	222	232	364	289	335	290	217	190	220
(lbs/hr) index	52	70	101	105	165	131	152	132	97	86	100

The fishing success effort curve in Figure 32 almost draws its own line at the 1.4 million pound level. However, both in 1960 and in 1963 there were increased landings in the following years which is taken to indicate that landings in the prior years were less than equilibrium. The area should produce at least 1.8 million pounds annually to the trawlers, but, as in Hecate Strait, there are other fisheries (troll, set line, and hand-line) also landing lingcod from this area.

The catch is fairly evenly split between the Goose Island grounds (49%) and the Cape Scott grounds (51%). This varies with the years, however.

West Coast Vancouver Island

Fifty-eight per cent of the Washington oceanic landings of lingcod come from this large area. Within this area, almost sixty per cent of these landings are made at Forty-Mile Bank. In fact, here, and at Sydney Inlet or Lennard Island grounds, lingcod is the primary species the fishermen are usually pursuing. Petrale, rockfish, and Pacific cod are incidental to the lingcod fishery. Washington fishermen have accounted for 61 per cent of the landings in this area during the 1955 to 1964 period (Table 49).

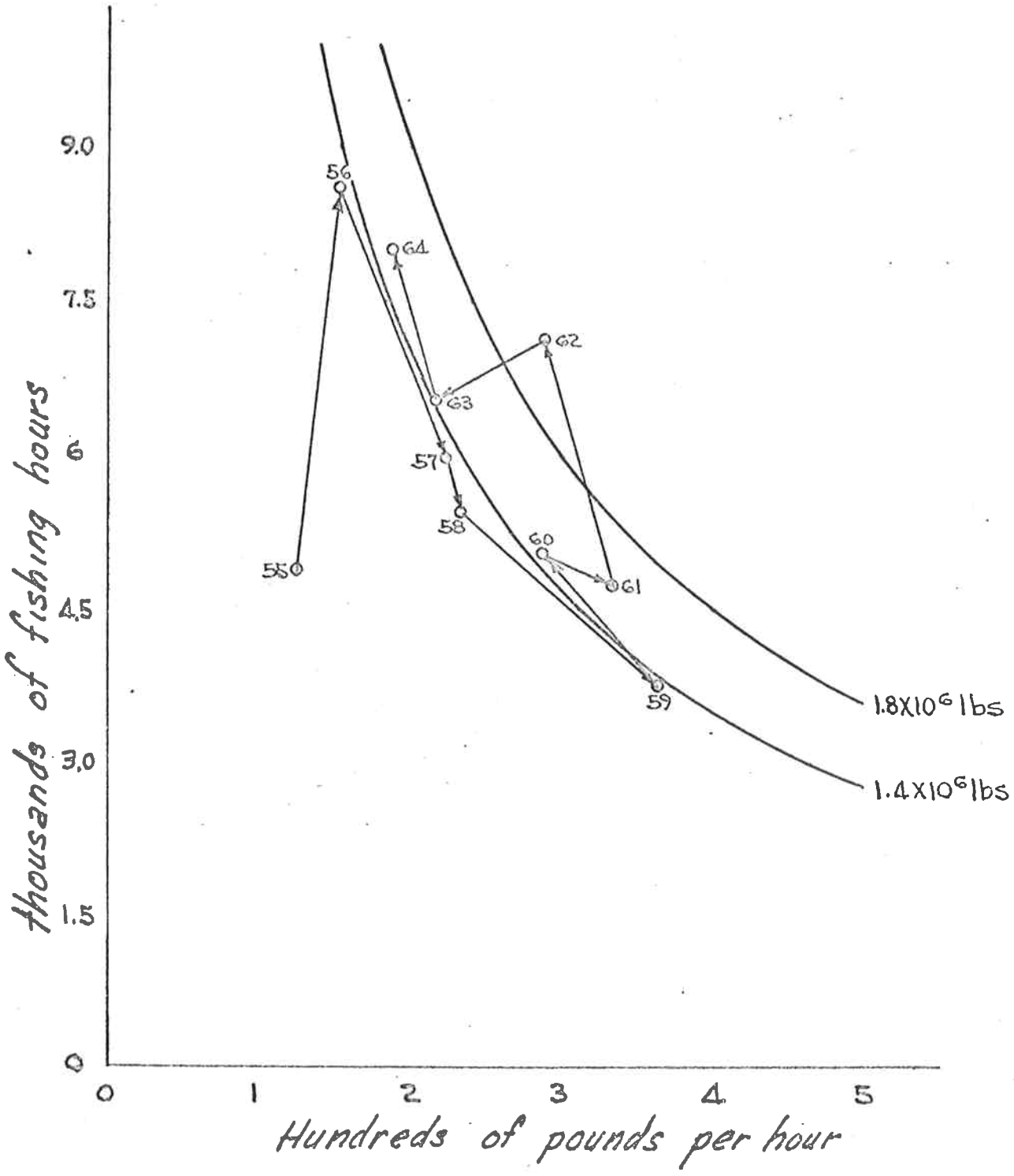


Figure 32. Relationship of catch per unit effort to effort for lingcod - Queen Charlotte Sound.

Table 49. Catch statistics for lingcod from the West Coast Vancouver Island (1000's of lbs.).

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-Year Ave.
Total Landings	3059	2907	2646	2549	3985	4307	4787	2592	1677	3106	3162
Wn. Landings	1664	1165	1222	1251	3163	3171	3072	1910	1048	1547	1921
% Wn. Landings	54	40	46	49	79	74	64	74	62	50	61
Wn. Effort (hrs)	5276	4402	4725	3575	6684	7595	8812	9124	6152	3098	5944
Wn. lbs/hr.	315	265	259	350	473	417	349	209	170	500	323
(lbs/hr) index	98	82	80	108	146	129	108	65	53	155	100

Figure 33 shows another classical case of the effect of a fishery on a stock of fish. It is interesting to note that the original oscillation started at a lower level of availability. The fishermen were probably not exploiting as many individual stocks of fish as they are at present. The line drawn at 3.2 million pounds represents the ten year average approximately. It is known that lingcod are taken from this area by trolling, hand line, and set line, but the amounts are not available. Trawling must account for the largest segment, or the relationship would only show random variations. All landings and all effort should be available before any management quotas, or regulations are imposed. Management could reduce the wide oscillations demonstrated here, but it would not add a pound of fish to the average.

N. Washington Coast

Washington fishermen take about 95 per cent of the lingcod landed from this area (Table 50). They are assisted by both Canadian and Oregon fishermen. Lingcod are taken incidentally to English sole, Pacific cod, rockfish, and petrale sole in this area. Landings of lingcod from this area constitute but 16 per cent of the oceanic catch of Washington fishermen.

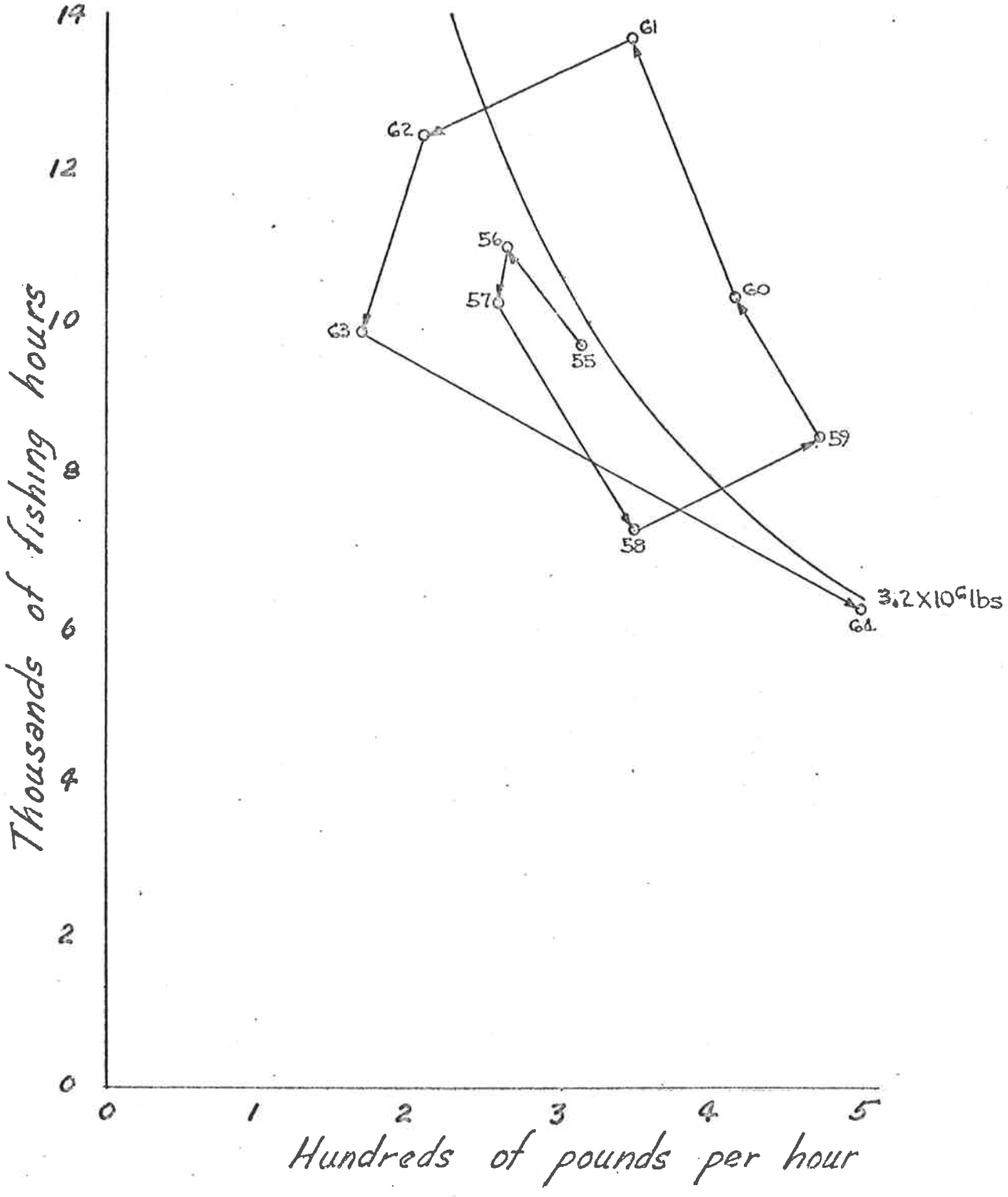


Figure 33. Relationship of catch per unit effort to effort for lingcod - W. Coast Vancouver Island.

Table 50. Catch statistics for lingcod from N. Washington Coast (1000's of lbs.).

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-Year Ave.
Total Landings	(831)	611	284	650	577	644	769	343	364	542	562
Wn. Landings	823	607	277	629	542	626	734	327	337	437	534
% Wn. Landings	(99)	99	98	97	94	97	95	95	93	81	95
Wn. Effort (hrs)	12,767	8680	4767	6812	6060	9630	8164	5634	5227	6394	7414
Wn. lbs/hr.	64	70	58	92	90	65	90	58	64	68	72
(lbs/hr) index	89	97	81	128	125	90	125	81	89	94	100

Figure 34 has been included, but the year to year variations are random in nature. This is thought to result from the incidental character of the trawl fishery. The 560,000 pound line is the 10-year average.

Puget Sound

Trawling produces an average of about 77 thousand pounds of lingcod annually throughout Puget Sound. The trawl landings, and efforts do not reflect stock abundance, but these are included in Table 51 for the sake of continuity.

Table 51. Washington catch statistics for lingcod in Puget Sound.

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-Yr Ave.
Pounds	71,563	91,459	101,119	68,286	80,384	47,356	108,059	79,647	44,301	79,362	77,154
Hours	6,135	8,914	9,149	12,225	3,813	4,502	6,488	3,517	3,282	7,326	6,535
lbs/hr.	12	10	11	6	21	11	17	23	14	11	12
(lbs/hr) index	100	83	92	50	175	92	142	192	117	92	100

A few of the trollers have complained about the conditions of the lingcod fishery around Hein Bank in western Puget Sound. A study was made of the catches by all gears. Trollers take 88 per cent of the catch on the average. Table 52 and Figure 35 have been prepared using the number of troll trips as the effort.

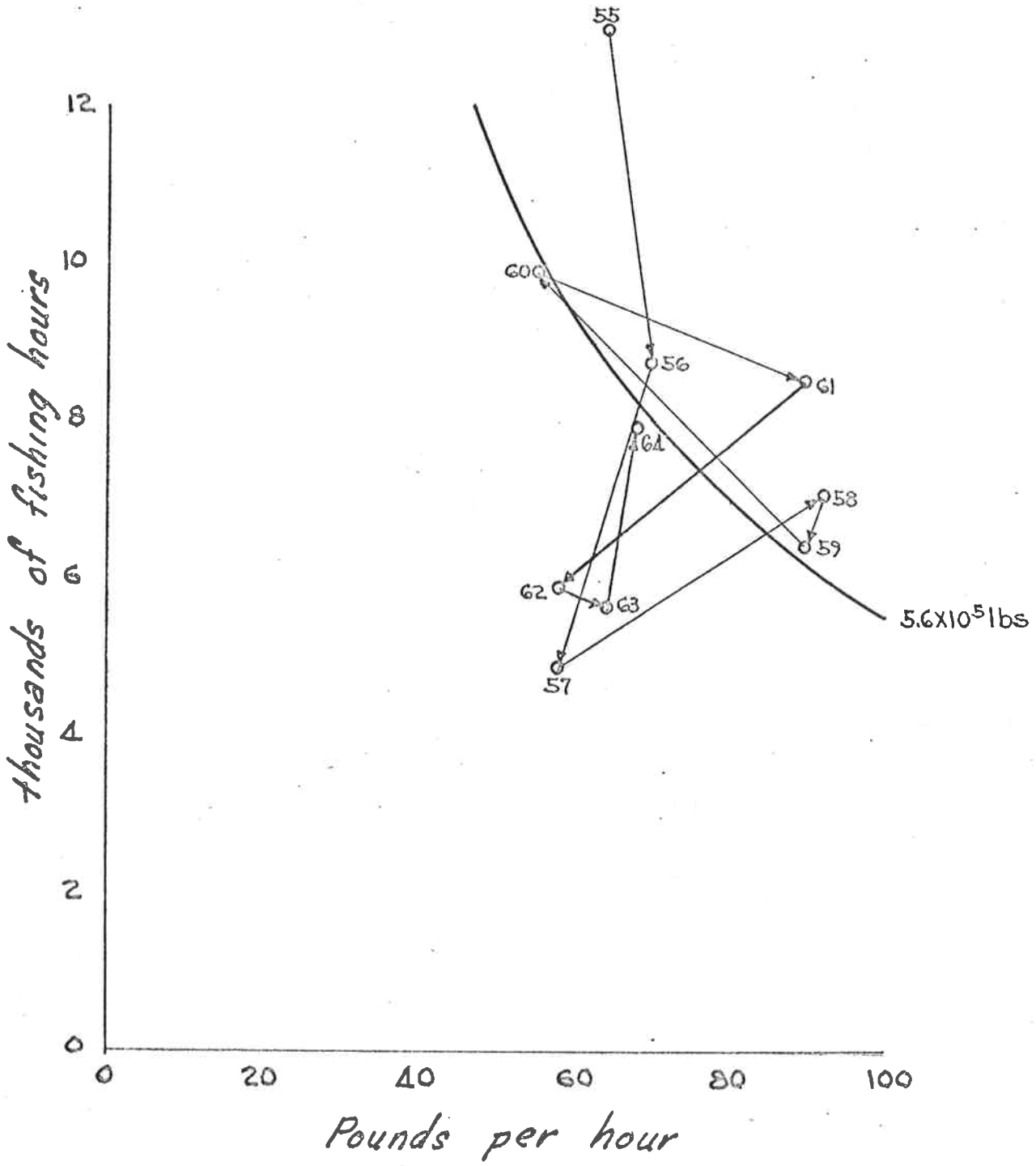


Figure 34. Relationship of catch per unit effort to effort for lingcod - N. Washington Coast.

Table 52. Catch statistics for lingcod W. Puget Sound by all gear using the effort from trolling (1000's of lbs.).

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-Year Ave.
Total Landings	78	85	127	283	280	332	413	286	176	189	225
Troll Landings	68	64	80	249	257	326	372	242	158	171	199
No. troll trips	134	77	111	429	728	734	930	589	427	360	452
lbs/trip	504	830	725	579	353	444	400	411	370	475	440

According to Figure 35, the stocks are not in too serious condition. During 1955, 1956, and 1957 the stocks appear to have been under-utilized. During 1958 and 1959 fishing pressures were nearly average. Only during 1960, and especially in 1961 was there over-exploitation. Stocks now (1962 through 1964) seem to be recovering from being over-fished. A return to higher levels can be expected. The area is capable of producing between 280 and 300 thousand pounds of lingcod annually to all gear. Biologically it would be advantageous to protect lingcod during their spawning season when the male guards the eggs and is very vulnerable to capture because of his pugnacity in that role. Spawning can occur from mid-March through mid-May. A large proportion of the catch (ca. 20%) is taken during this period as can be extrapolated from Table 53.

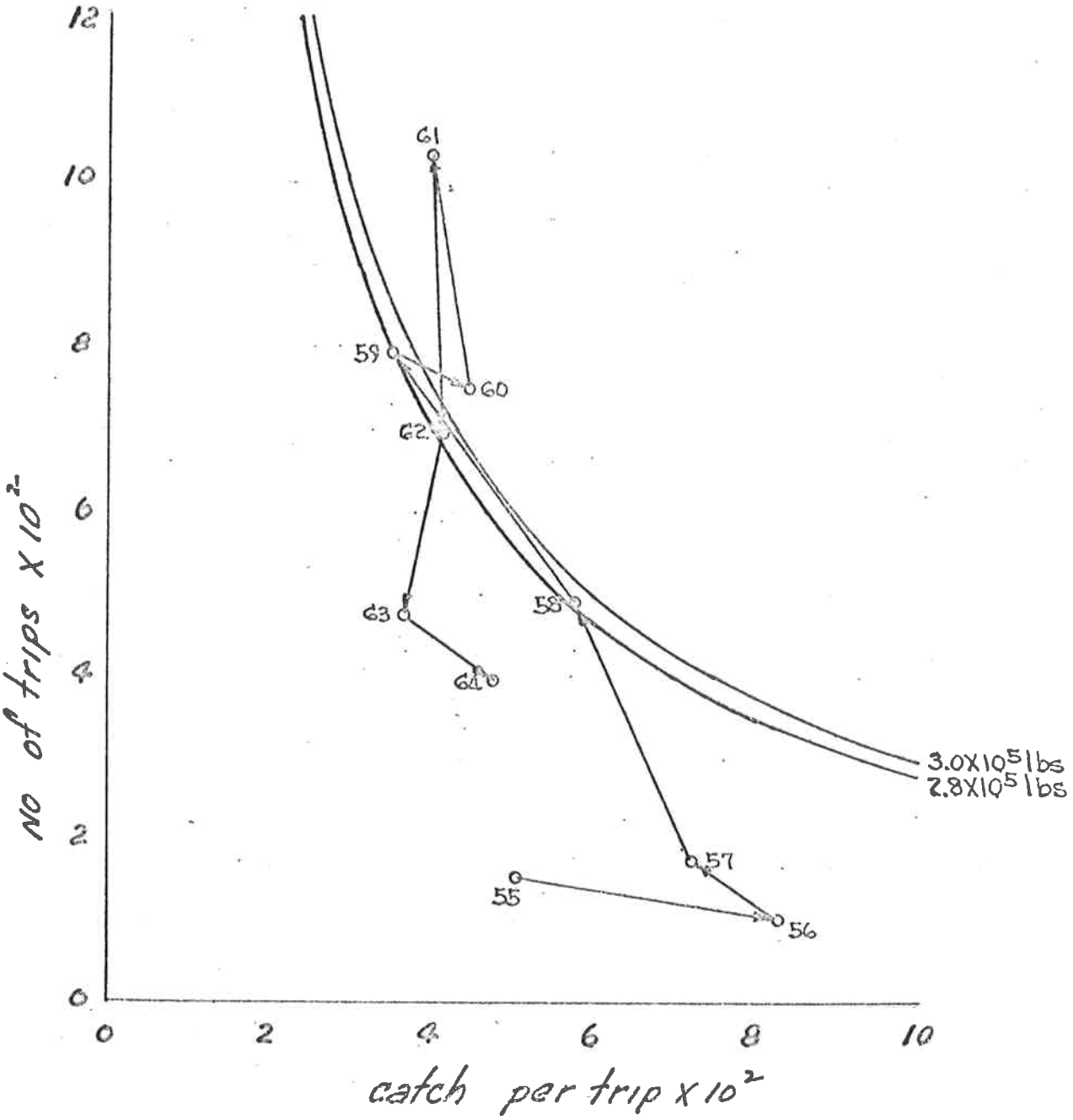


Figure 35. Lingcod - western Puget Sound Troll catch per unit of effort data.

Table 53. Total commercial lingcod landings by month, per cent of catch and catch per trip for troll fishermen in W. Puget Sound.

	Total Pounds (000's)	Troll Landings	Per cent of troll catch by Month	Total Trips (all gears)	lbs/trip
Jan.	14	12	7	30	384
Feb.	18	16	8	48	326
Mar.	30	26	13	70	373
Apr.	22	19	10	41	466
May	23	21	10	37	562
June	14	14	6	24	568
July	10	9	4	26	354
Aug.	9	8	4	21	401
Sept.	11	10	5	16	635
Oct.	21	19	9	33	587
Nov.	27	25	12	55	461
Dec.	26	19	12	51	383
Totals	225	198	100	452	440

According to this table effort increases just prior to the spawning season, and fishing success is improving from the February low at this time. Effort is least when fishing success is best which indicates possible competition between gear. Recommended management is for a closed season between March 15 and May 15 of each year, and a seasonal quota of 300 thousand pounds. Both the season and the quota to apply to all types of fishing gear. There would be a minimum of interference with the trawl fishery for Pacific cod during this period. Actually, the trawlers do not take many spawning lingcod from the rocky spawning areas.

SABLEFISH

Hecate Strait

Landings of sablefish from Hecate Strait by Canadian and Washington trawlers are minimal. The average for the nine years, 1956 through 1964 is 41 thousand pounds. Interest is increasing, however, as shown in Table 54.

Table 54. Catch statistics for sablefish - Hecate Strait (1000's of lbs.)

Year	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-Year Ave.
Total Landings	2	8	4	6	42	22	58	79	148	41
Wn. Landings	-	-	-	3	24	-	-	2	1	3

This interest, however, is on the part of the Canadian fishermen as only 1200 pounds were landed in Washington from Hecate Strait during 1964. The 3 thousand pounds of sablefish taken by Washington fishermen represents 0.3 per cent of the 1,011,025 pound average taken in all ocean areas annually over the ten-year period (1955 through 1964).

Queen Charlotte Sound

Washington fishermen acquire about 5 per cent of their black cod from the Goose Island-Cape Scott areas. On the average 68 per cent of the catch in this area comes from the Goose Island side, although during 1959 most of the catch was reported from Cape Scott. All of the catch is incidental to other species. Here again the catch and effort are given to preserve continuity (Table 55).

Table 55. Catch statistics for sablefish - Queen Charlotte Sound (1000's of lbs.).

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-Year Ave.
Total Landings	22	42	92	29	42	66	37	49	83	123	59
Wn. Landings	21	30	87	16	38	53	35	40	65	87	47
% Wn. Landings	95	71	95	55	90	80	95	82	78	71	80
Wn. Effort (hrs)	531	1619	1493	192	722	1122	1042	1164	1916	2891	1269
Wn. lbs/hr.	40	19	58	83	52	47	34	34	34	30	37
(lbs/hr) index	108	51	157	224	141	127	92	92	92	81	100

All of the Washington effort data include every hour during which a species is reported caught, and this accounts for the large number of hours fished. It is estimated that to have any information for sablefish a sort would have to be made using all catches composed of 5 per cent or less of this species. Fishermen at the present writing do not seek sablefish specifically in the Queen Charlotte Sound area. Figure 36, a Thompson type graph, could have been eliminated except that the large poundages taken during 1963 and 1964 with only slight decrease in fishing success show that the stocks can stand greater fishing pressure. From observation it has been noted that the fishermen usually save only the larger (5 lb. dressed) fish when fishing this area. Also from observations aboard fishing vessels, most of the smaller (1 to 3 lb. round) black cod do not survive being caught and are usually dead when returned to the water. This is also borne out by the poor recovery of tagged black cod in almost every experiment. There is a minimum size limit on black cod which will be discussed in the section on the S.W. coast of Vancouver Island where many small blackcod are taken at times. The 59 thousand pound line drawn into the figure is simply the ten-year average of the total poundage taken in this area.

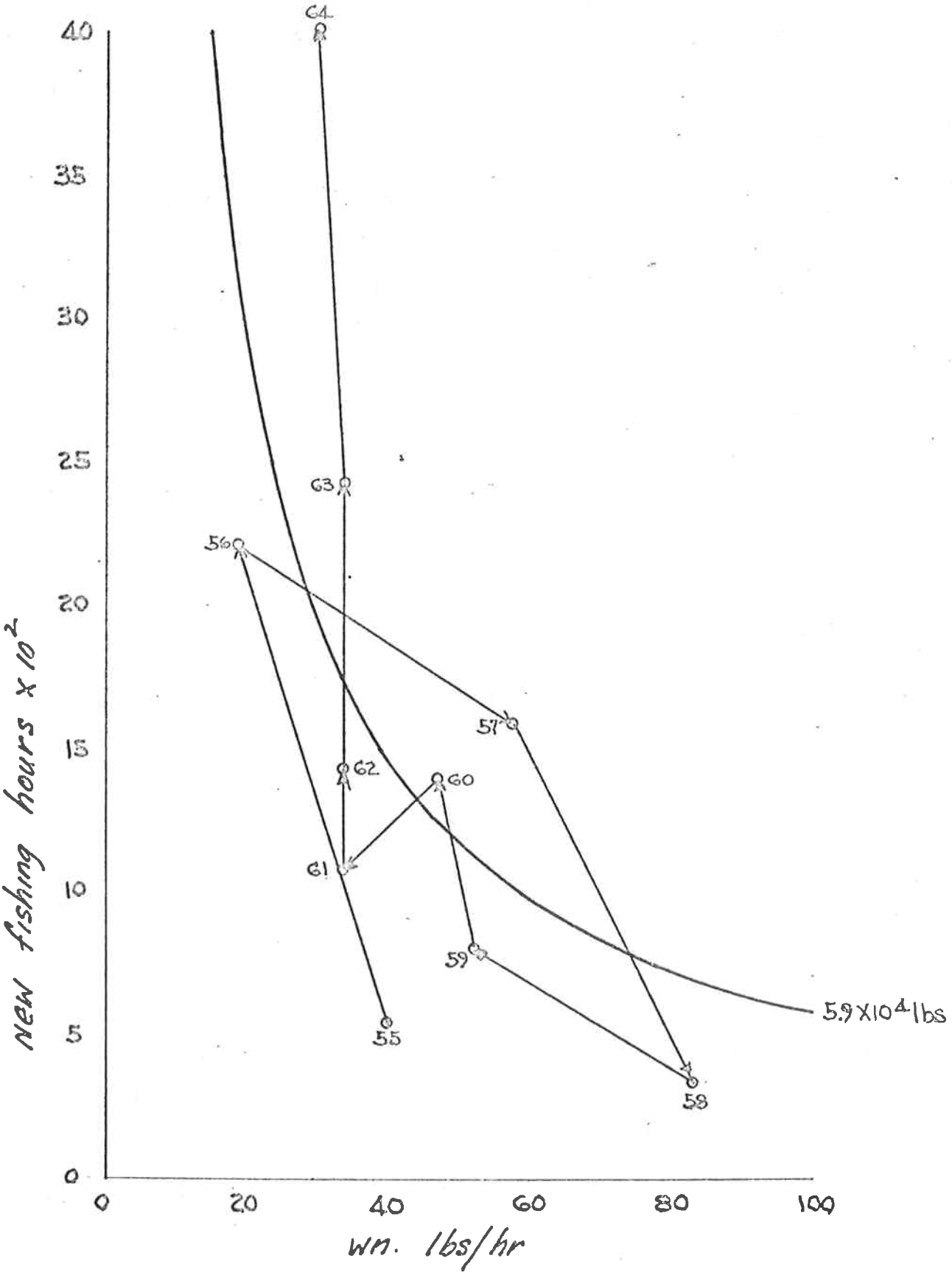


Figure 36. Relationship of catch per unit effort to effort for sablefish - Queen Charlotte Sound.

N. W. Coast Vancouver Island

Washington fishermen do not fish specifically for sablefish in this area, but a few large fish are usually saved from the catches of Pacific Ocean perch, rockfish, Dover sole and, in winter, petrale sole. In fact, the Esteban Deep fishery produces a large share of the poundage given in Table 56.

Table 56. Catch statistics for Sablefish - N.W. Coast Vancouver Island (1000's of lbs.)

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-Year Ave.
Total Landings	87	75	85	53	69	49	120	173	53	43	81
Wn. Landings	87	75	85	53	69	42	119	173	53	39	79
% Wn. Landings	100	100	100	100	100	85	98	100	99	91	98
Wn. Effort (hrs)	1347	1095	1434	959	1160	895	2323	2396	1845	803	1426
Wn. lbs/hr.	64	69	60	55	60	47	51	72	29	48	56
(lbs/hr) index	114	123	107	98	107	84	91	129	52	86	100

The landings from this area by Washington fishermen represent but about 8 per cent of their total oceanic catch. Figure 37 is made up largely of random deviations, although the decrease during 1963 and 1964 after two years of increased effort and catch is typical of an over-fishing reaction. However, it is thought to be a lack of interest on the part of the fishermen to save sablefish from the catch.

Sablefish landings fluctuate with market demand, and the latter is affected by many factors; the halibut landings, the sablefish landings by set-liners, the frozen fish holdings, the salmon mild cure pack, etc. In most of these graphs the higher landings during 1961 or 1962 are followed by lower landings during 1963 and 1964.

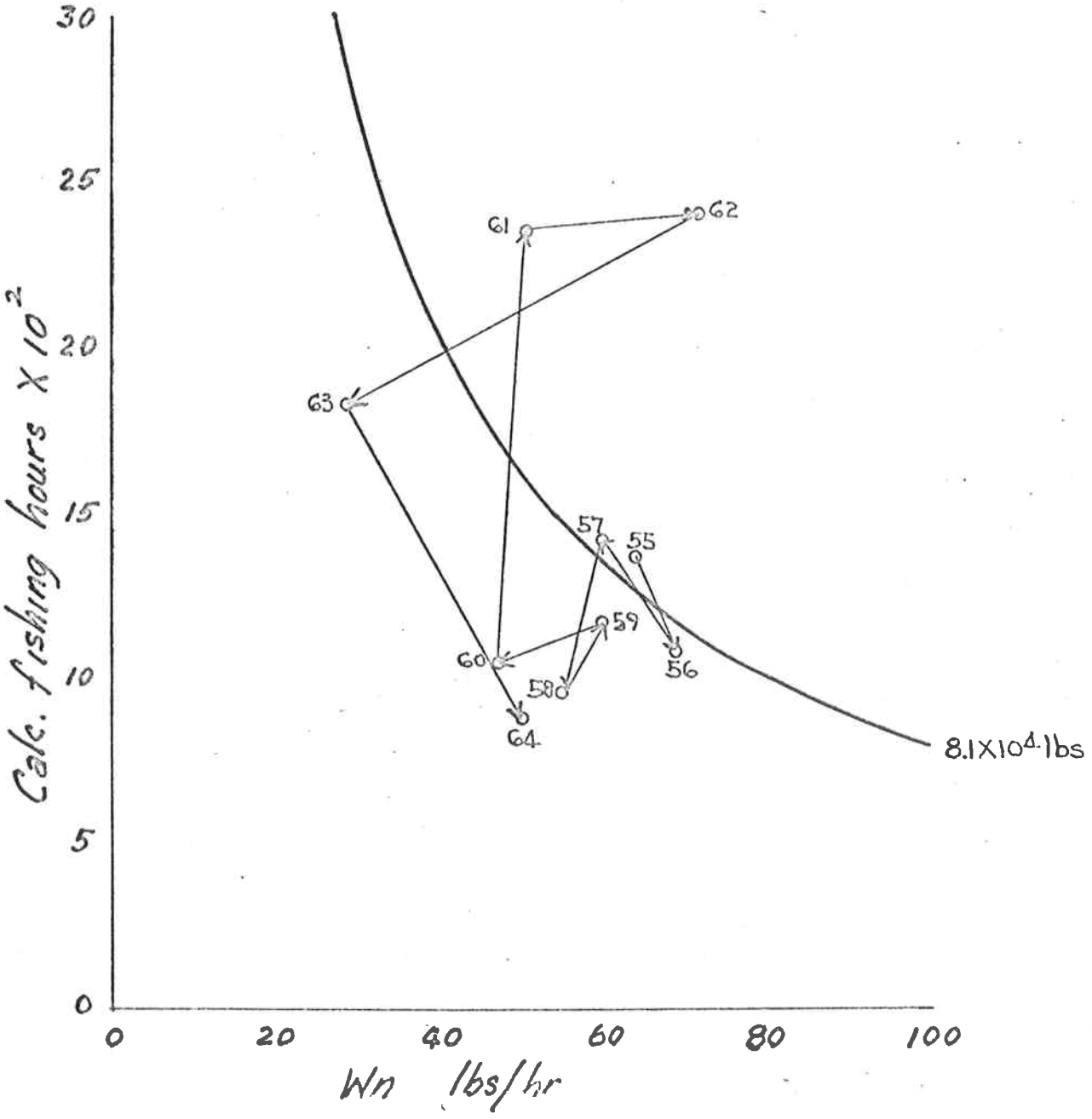


Figure 37. Relationship of catch per unit effort to effort for sablefish - N. W. Coast Vancouver Island.

S. W. Coast Vancouver Island

This large area produced 22 per cent of the annual average Washington trawl landings for the ten-year period 1955 through 1964. About a quarter of a million pounds are taken annually, but the amount has varied widely from 733 thousand pounds in 1956 to 52 thousand pounds in 1964. Of course, the landings by trawlers are far exceeded by the set-line landings. Trawlers take black cod about 3-4 pounds in size, but the average size in the set-line catch is between 7-8 pounds. Size of fish varies, however, with depth of trawling. The black cod caught over 200 fathoms in depth will compare with the size taken on set-line gear. PMFC Bulletin No. 3 was devoted to sablefish, and it contains most of what is known about this species. Bell and Pruter's analysis of the set-line fishery has been kept current and is reported upon in the section for sablefish - N. Washington coast.

The stock identity of black cod is not known because of the poor success with tagging experiments. There could be a single population from Cape Elizabeth to Cape Cook.

Small mesh trawl nets (less than $4\frac{1}{2}$-inch including one knot) take many small (1-3 lb. round) sablefish at times in certain areas. The set-line fishermen made quite an effort during the early 1950's to restrict the trawling of black cod for fear of depletion by the trawlers. They failed to gain control, but as an outgrowth of this, a 3 lb. dressed minimum size was enacted by Canada and most states, including Washington where the minimum is still in existence as 17 inches from insertion of the dorsal fin to the end of the tail.

The landings in Table 57 and depicted in the Thompson type graph, Figure 38 represent about 17 per cent of the poundage taken from Cape Elizabeth to Amphitrite Point. The graph reflects the condition of the stocks which is over-exploited. But the fishery is not influencing the condition of the stocks. For instance, during 1963 and 1964 the effort decreased but there was no corresponding increase in catch per hour. There is a great amount of small three pound fish available

to the trawlers which they can exploit if the market will accept it. This accounts for the apparent good fishing success during 1956 and 1960. At a $3\frac{1}{2}$ pound average, the catch during 1956 would represent the removal of about 2.8 million fish.

Table 57. Catch statistics for sablefish from S.W. Coast of Vancouver Island 1000's of lbs.)

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-Year Ave.
Total Landings	129	799	229	340	243	484	372	398	132	125	325
Wn. Landings	106	733	140	165	132	391	189	227	104	52	224
% Wn. Landings	82	92	61	49	54	81	51	57	79	42	69
Wn. Effort (hrs)	1660	2421	1697	3492	1233	2618	2982	5031	2545	1740	2542
Wn. lbs/hr.	64	303	83	47	107	149	63	45	41	30	88
(lbs/hr) index	73	344	94	53	122	169	72	51	47	34	100

N. Washington Coast

About 65 per cent of the landings of black cod by Washington fishermen come from this area (Table 58). Much of this is small (3 to 4 pound round) fish as was mentioned in the other sections.

Table 58. Catch statistics for sablefish from N. Washington Coast (1000's of lbs.).

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-Year Ave.
Total Landings	226	2427	248	157	679	452	177	1919	332	98	671
Wn. Landings	226	2427	248	89	677	451	177	1914	320	91	662
% Wn. Landings	100	100	100	57	100	100	100	100	96	93	99
Wn. Effort (hrs)	3812	2818	1214	2450	928	2687	2488	2831	2123	1588	2293
Wn. lbs/hr.	59	861	204	36	730	168	71	676	151	58	289
(lbs/hr) index	20	298	71	12	253	58	25	234	52	20	100

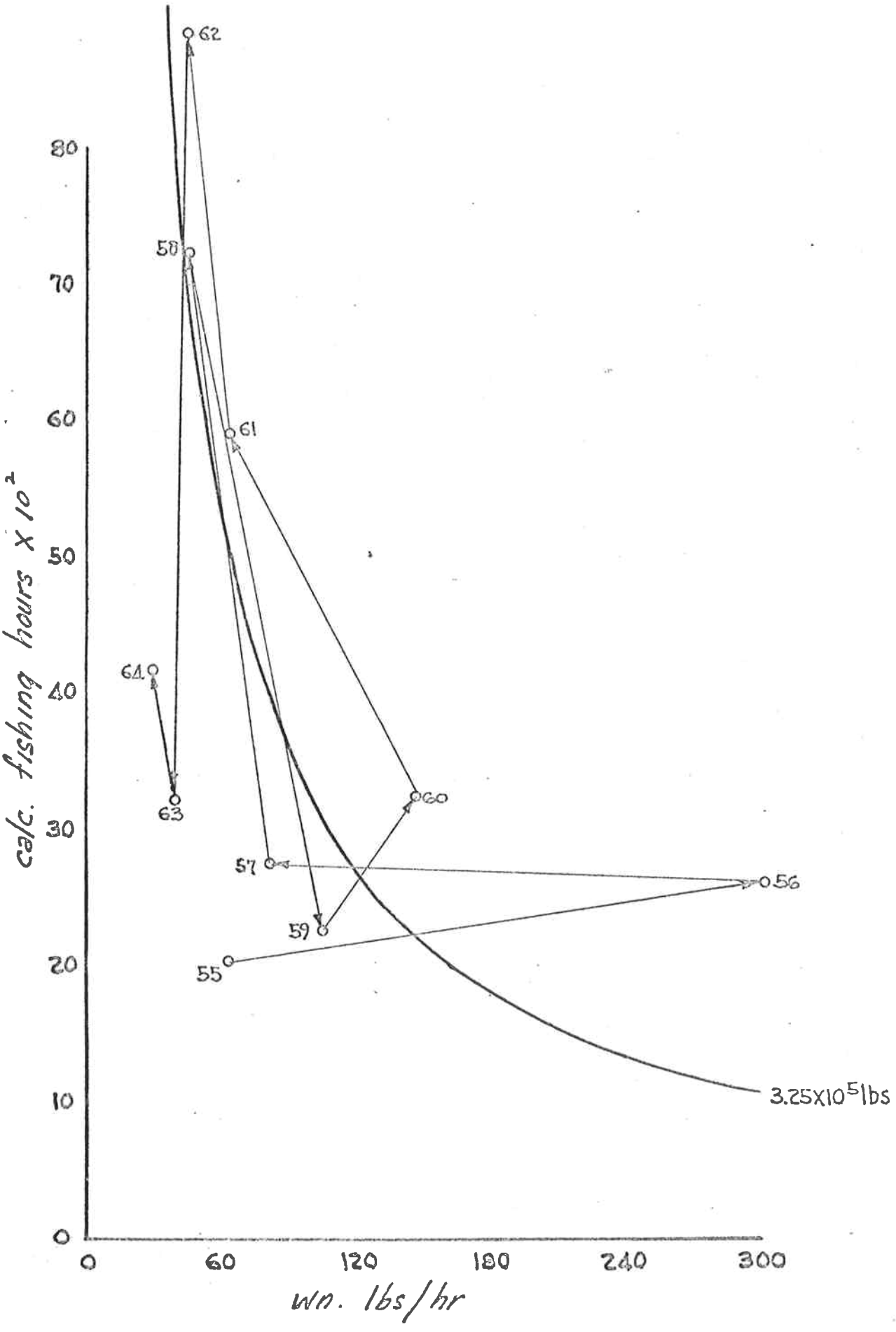


Figure 38. Relationship of catch per unit effort to effort for sablefish - S. W. Coast Vancouver Island.

Figure 39 is prepared from the above data. It shows that trawling is capable of producing 2 million pounds when small fish are taken, but declines to the 300,000 pound level when the catch is principally the larger fish which are taken incidentally to perch and Dover sole in deeper water.

The data in Table 59 are a continuation of Bell and Pruter's study in PMFC Bulletin No. 3. We have attempted to follow their procedures. Canadian set-line catches are not included, and it is not known whether the original data included these or not. The omission of these data would not change the results significantly.

The area of study by Bell and Pruter is from Cape Elizabeth to Amphitrite Point, and includes the halibut fishing areas 050 and 060. This corresponds well with PMFC Area 3B, but it only includes about the southern half of PMFC Area 3C.

Figure 40 has been prepared following Thompson's method of depicting the halibut data. According to Smith's 1936 "Report on the Puget Sound Otter Trawl Investigations" the high seas trawl fishery started during 1933. It shouldn't have had much affect upon stocks of black cod for several years. Figure 40 shows that the set-line fishery alone, however, had overfished black cod prior to that date. Bell and Pruter blamed market demand for the decline, but this graph shows that even in years of low fishing effort, the stocks could not recover. Therefore, equilibrium yield is less than the average set-line catch between 1917 and 1935 which is about 1.7 million pounds.

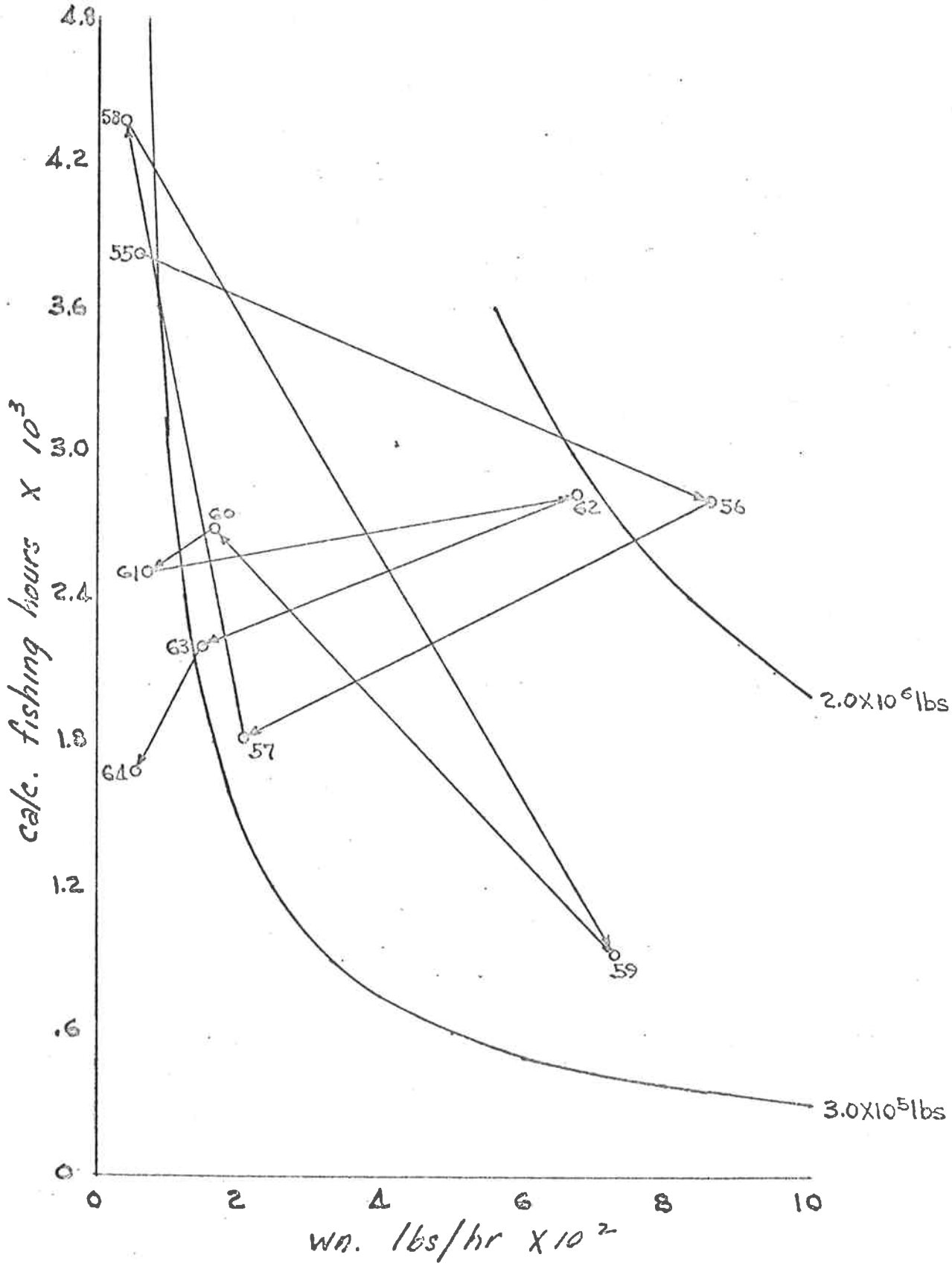


Figure 39. Relationship of catch per unit effort to effort for sablefish - N. Washington Coast.

Table 59. Total landings of Cape Flattery sablefish in thousands of pounds, catch per skate in pounds, and calculated number of skates fished 1952 to 1964.

Year	Landings	Catch per Skate	Calc. No. of Skates
1952	1584	55.7	28,438
1953	1406	55.8	25,197
1954	1326	51.0	26,000
1955	1490	52.5	28,381
1956	3814	60.2	63,355
1957	2326	63.7	36,515
1958	983	69.0	14,246
1959	1782	65.7	27,123
1960	2951	61.9	47,674
1961	1478	59.8	24,716
1962	1894	65.5	28,916
1963	1086	71.1	15,274
1964	1278	65.6	19,482

The black cod stocks have no resiliency in that when landings declined to or below the one million pound level there was no corresponding increase in catch success to indicate an increase in stock abundance. The point remains that the set-line fishery alone forced the stock abundance to the 60-70 pound per hour level where it has remained ever since. Effort can range from 15,000 to 32,500 hours, and landings can range from 1.0 million to 2.5 million pounds with no effect upon stock abundance. However, trawling was blamed for this condition, and during 1955 two regulations were imposed which should have abetted sablefish stocks if trawling were to blame. One regulation was a three pound minimum size limit (17 inches between the front of the first dorsal fin and the end of the tail). The other was the $4\frac{1}{2}$-inch (inside measure) minimum trawl mesh regulation which was reduced to $3\frac{1}{2}$-inches in 1959. Figure 41 shows the slight increase in catch per skate during this period, but the increase hardly shows in Figure 42 which is a Thompson type graph of the same data in analog form. Only twice has the catch per skate approached the 75 pound per skate level, once in 1942 (73.8) and again in 1963. The only difference that can be ascribed to these years are the large removals of dogfish shark that occurred during or just prior

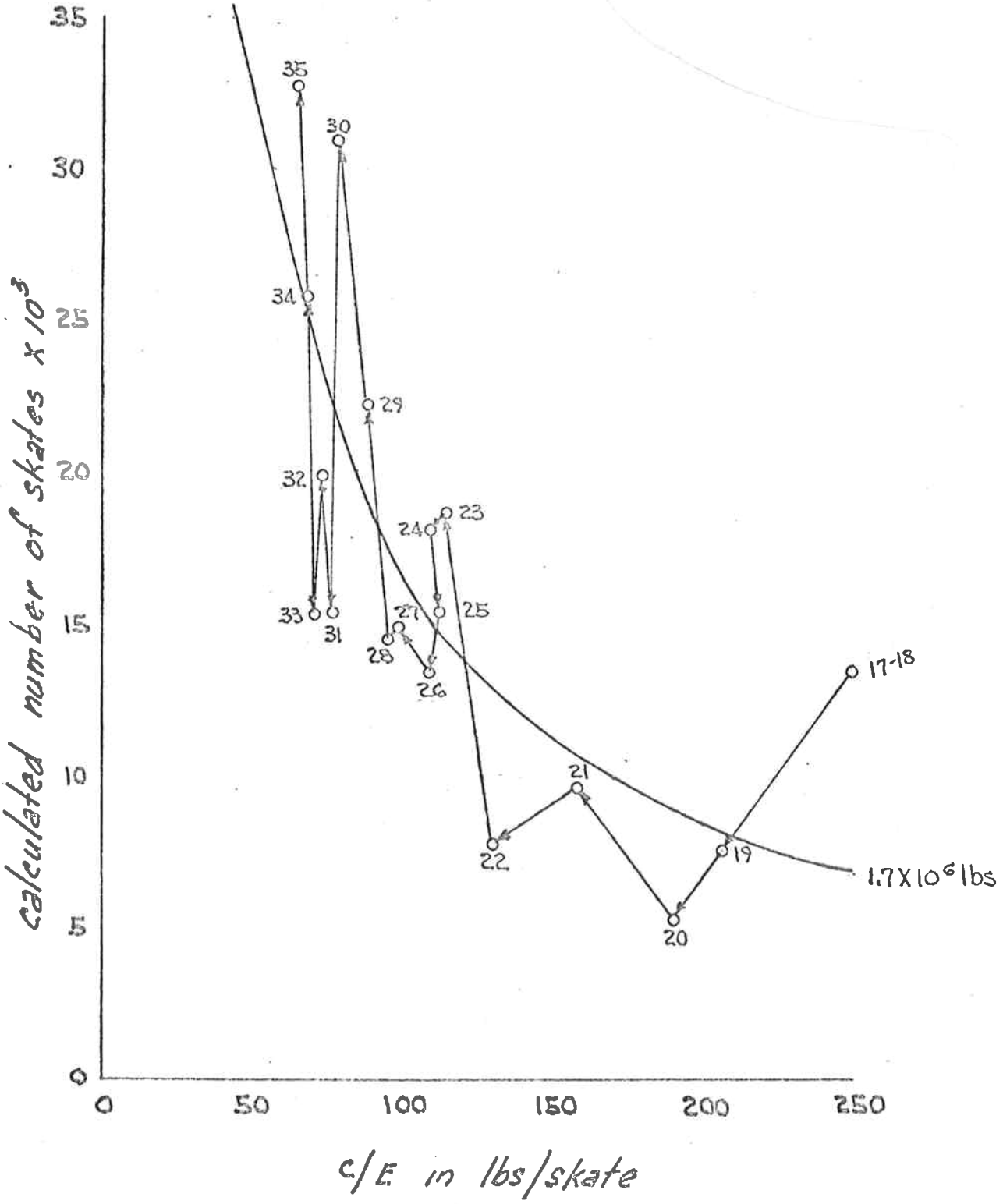


Figure 40. Relationship of catch per unit effort to effort for set line caught sablefish - Cape Elizabeth to Amphitrite Point, 1917-1935.

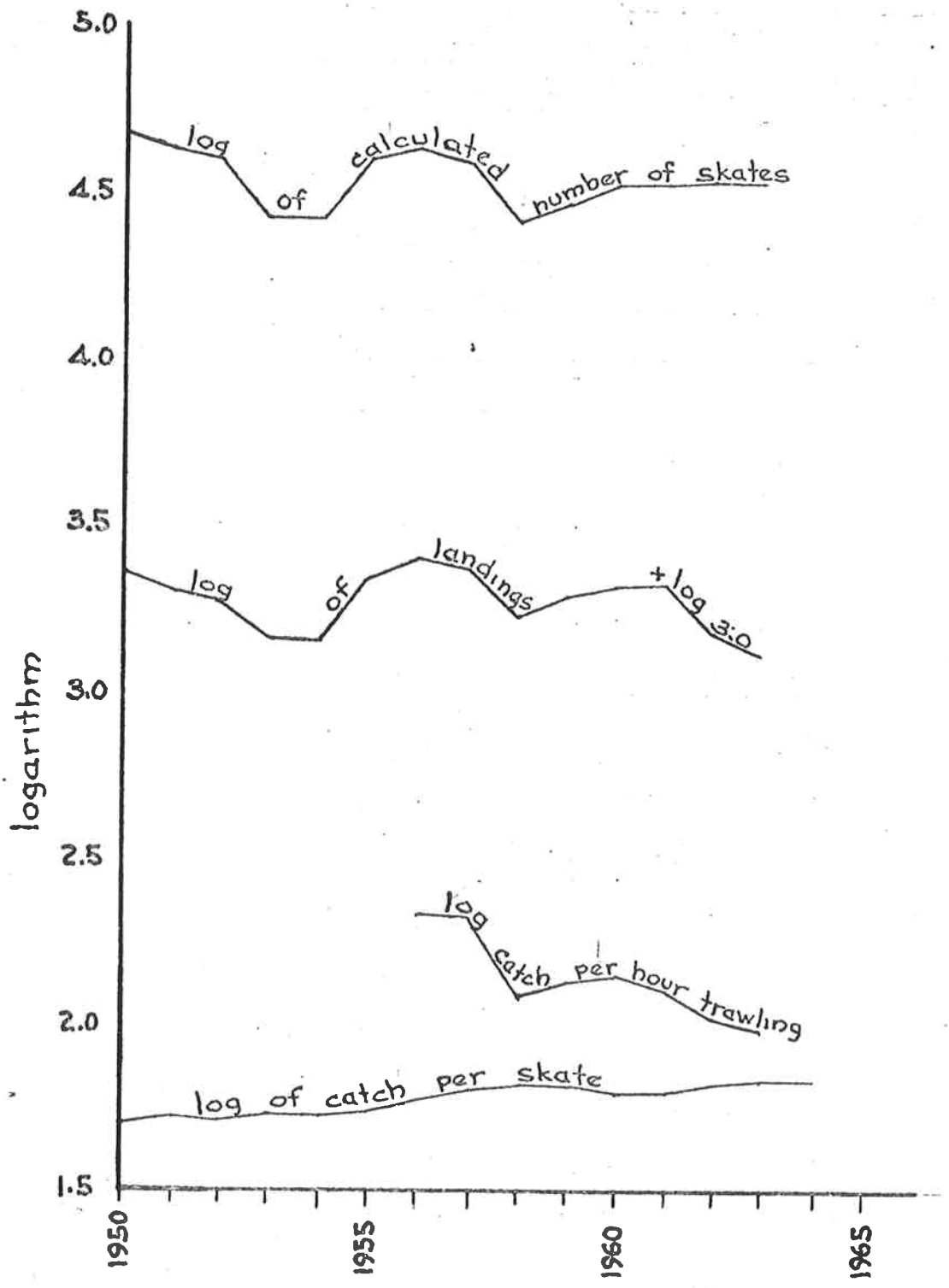


Figure 41. Logarithms of (smoothed by 3's) landings of sablefish, catch per skate and calculated number of skates by Washington set line and trawl fishermen in the Cape Flattery area.

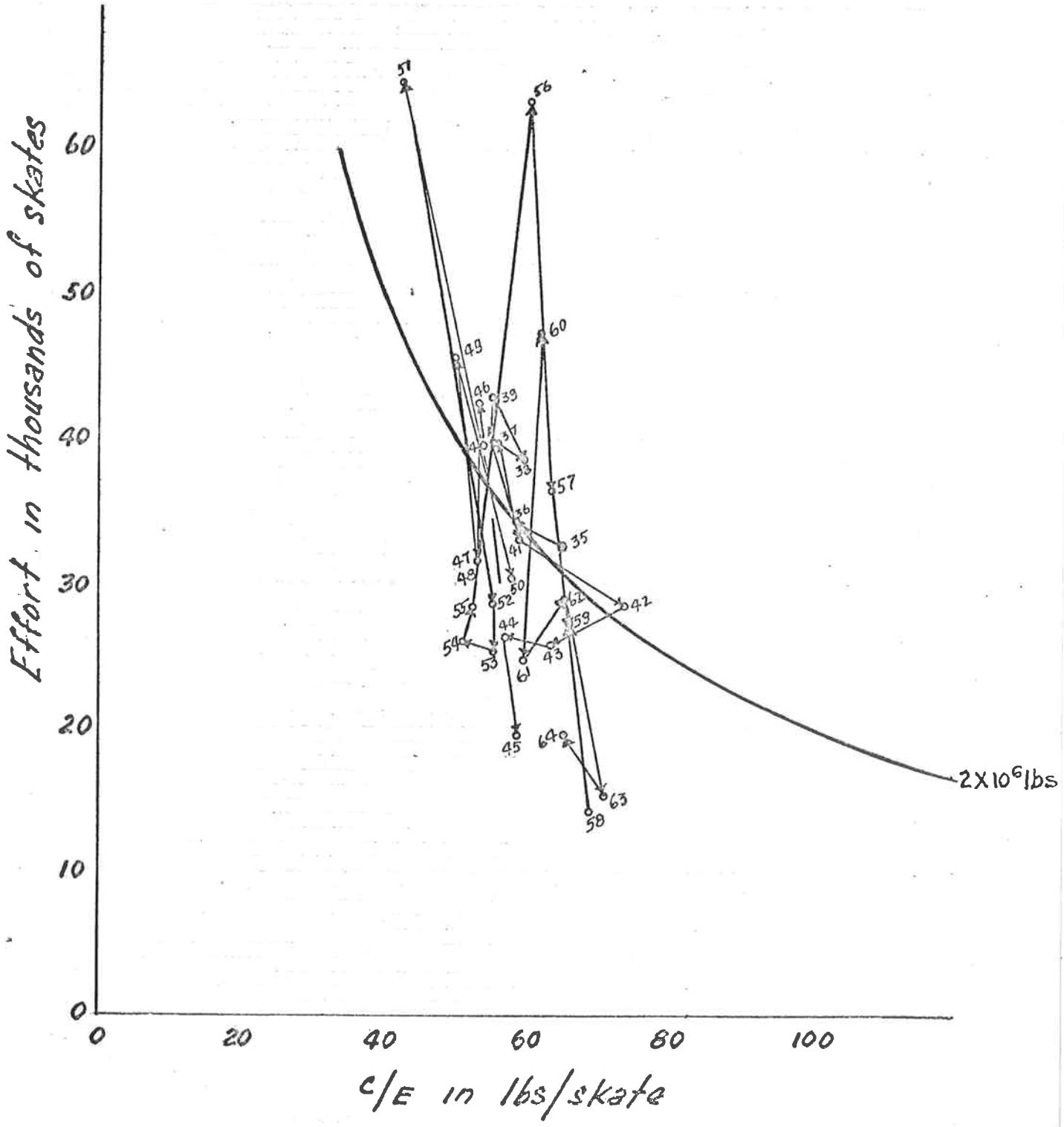


Figure 42. Blackcod combined set line and otter trawl effort compared to catch per skate 1949 through 1961.

to these years. Predation by the tons of dogfish shark in this area on the small black cod coupled with the mortality by small-mesh trawl nets must have an effect on black cod stocks. The wide fluctuations in effort and catch per skate indicates that the fisheries no longer affect stock abundance. In fact, the landings in 1956 were 71 per cent trawl caught for 3.3 million pounds, a figure attained by set-line gear only in the first years on a virgin fishery. The difference in potential catch about 700,000 pounds or (x 4 lbs) 2.8 million fish is indicative of the mortality suffered by the young fish in attaining the average size in the set-line fishery (ca $4\frac{1}{2}$ lbs.). A loss of 700,000 pounds is incurred by not harvesting these fish at a smaller size in the trawl fishery, and by allowing many to die in the process of attaining the size at which they will be harvested by the set-line fishery. It is recommended that the minimum size limit on sablefish be eliminated. There isn't any point in reducing the limit to 2 pounds. The market will decide the acceptable size. The main point in elimination is that most trawl caught sablefish are dead when they are brought aboard, and except for fertilizing the grounds, they should be retained. It was hoped that the minimum size limit would cause fishermen to avoid areas which abound in small fish, but if there are enough marketable-sized fish available they will shovel tons of small fish to get the good ones.

Sablefish are not taken commercially in Puget Sound.

ROCKFISH

Hecate Strait

Although Washington fishermen take a good proportion of the total rockfish landings from this area, their fishing effort is apparently too meager to affect the stock abundance (Table 60). Rockfish are taken here incidentally to sole and true cod, and fishermen do not specifically fish for rockfish. When and if

fishermen do seek out rockfish, it is expected that the stocks in this area can produce more than the present average of 93 thousand pounds annually.

Table 60. Catch statistics for rockfish from Hecate Strait (1000's of lbs.).

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-Year Ave.
Total Landings	139	65	57	61	129	81	66	158	64	107	93
Wn. Landings	122	50	23	31	85	58	22	54	36	53	53
% Wn. Landings	88	77	41	50	66	72	33	34	56	49	57
Wn. Effort (hrs)	1132	248	331	412	713	420	582	224	372	619	505
Wn. lbs/hr.	108	202	69	75	119	138	38	241	97	86	105
(lbs/hr) index	103	192	66	71	113	131	36	230	92	82	100

The Hecate Strait catch is only 0.9 per cent of the ocean catch for Washington, although 2.7 per cent of the effort is expended here.

Queen Charlotte Sound

During the ten year period, 1955 through 1964, 31 per cent of the ocean catch of rockfish by Washington fishermen has been taken in the Queen Charlotte Sound area. Slightly more comes from the Cape Scott grounds than from the Goose Island side, but this varies between years. Table 61 shows that Washington fishermen still take a large percentage of the rockfish production from this area.

Table 61. Catch statistics for rockfish from Queen Charlotte Sound (1000's of lbs.).

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-Year Ave.
Total Landings	2348	2206	1449	1459	1834	1069	1590	3311	3249	2617	2113
Wn. Landings	2205	2121	1313	1442	1338	993	1473	2854	3020	2052	1881
% Wn. Landings	94	96	91	99	73	93	93	86	93	78	89
Wn. Effort (hrs)	5866	7112	4501	4733	3403	2896	2943	3855	6012	5256	4658
Wn. lbs/hr.	376	298	292	305	393	343	500	740	502	390	404
(lbs/hr) index	93	74	72	75	97	85	124	183	124	97	100

Figure 43 is a Thompson type representation of the catch and effort data, and it is a good example of the effect of a fishery on the abundance of a population. Many investigators hide behind the market demand fluctuations when required to interpret the variations in landings, especially for rockfish as load limits are usually imposed upon this group first of all. Also the rockfish catch is composed of several species in any one area. In spite of all this, the rockfish landings from Queen Charlotte Sound present an almost classical example. Landings were moderate during 1955 and 1956, effort was relatively great, and the catch in pounds per hour was relatively low for this area during this period. Effort decreased (1957-1961) either from lack of success in fishing or from decreased market demand, which is not important. It is important that while effort was low the stocks increased so that when effort increased again, catch per hour also increased. This in turn produced greater landings (1962). During 1963, a further increase in effort resulted in a decline in catch per hour, although landings remained about the same. Then, in 1964, still further increase in effort brought decreases in catch per hour, and in landings. The difference in poundage level between that of 1955-1956 and 1963-1964 could represent acceptance of new species by the market. Evidently species composition has been relatively stable during this period as any shift could confuse the pattern. We have witnessed one complete cycle in the abundance fluctuation of the Queen Charlotte Sound rockfish stocks. Another feature of the fishery to consider is that, although rockfish are caught by almost every other type of fishing gear, trawl fishing accounts for the largest proportion of the landings. Finally, the fishing areas have remained fairly constant through this period. Rockfish are considered to be sedentary in habit, and any shift of fishing area could subject new stocks to the fishery. This should shift the annual fluctuations in the Thompson type graph upward and to the right, i.e., a higher level of landings. Washington fishermen expend 24.5 per cent of their effort fishing rockfish in this area.

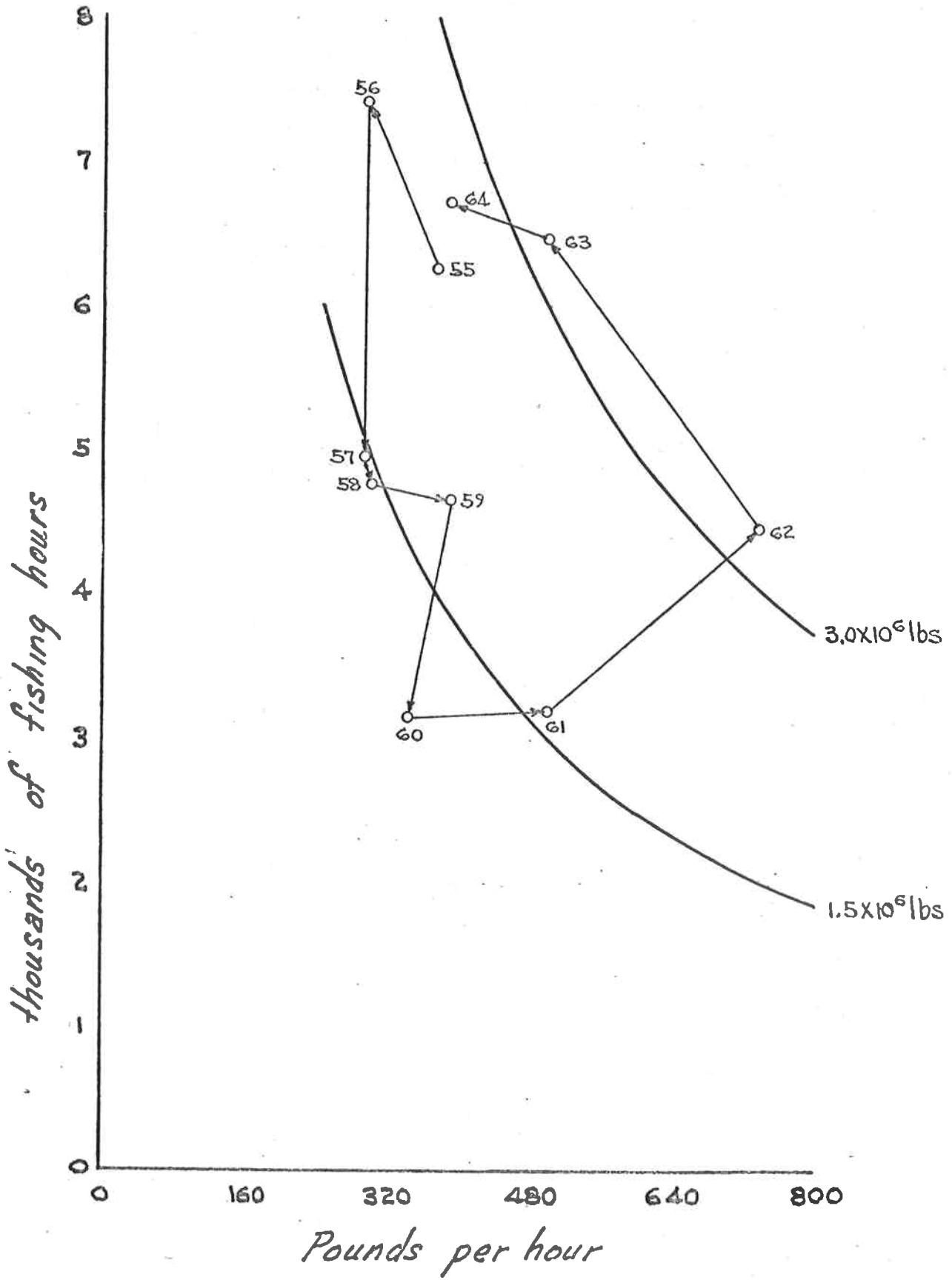


Figure 43. Relationship of catch per unit effort to effort for rockfish - Queen Charlotte Sound.

N. W. Coast of Vancouver Island

Few Canadians venture along this rocky, formidable coast. The quantity of all fish is insufficient to attract them. The upper end of this stretch, at least, is more of a traveling area for Washington fishermen on their way to and from the Queen Charlotte Sound and Hecate Strait area. With fewer fishermen traveling to the northern grounds via this route, effort, especially during 1964, has declined appreciably (Table 62). Grounds available to trawling vary from fairly good near Nootka Sound to a few known drags among the rocks to the northward. The fishermen that fished the Nootka area have been less active in recent years. Rockfish are taken with lingcod, petrale sole, Dover sole, and Pacific Ocean perch. Only in a few of the more northerly areas can pure catches of rockfish be obtained.

Table 62. Catch statistics for rockfish - N.W. Vancouver Island (1000's of lbs.).

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-Year Ave.
Total Landings	1226	1343	1441	982	1207	826	1536	2458	1863	768	1365
Wn. Landings	1213	1340	1440	981	1207	811	1507	2413	1861	754	1353
% Wn. Landings	99	100	100	100	100	98	98	98	100	98	99
Wn. Effort (hrs)	4215	2406	3312	2873	2567	1385	2920	4817	2974	1218	2879
Wn. lbs/hr.	288	557	435	341	470	585	516	501	626	620	470
(lbs/hr) index	61	119	93	73	100	125	110	107	133	132	100

The Thompson graph in Figure 44 is less classic than that for the Queen Charlotte Sound area. From 1955 through 1961, landings oscillated around the 1.3 million pound level. Either new areas were discovered or new species taken to raise the fishing to the 2.0 million pound level during 1962 and 1963. The decline in effort during 1963 and 1964 appears to be a lack of interest on the part of the fishermen rather than a decline in stock abundance. Fishing for rockfish

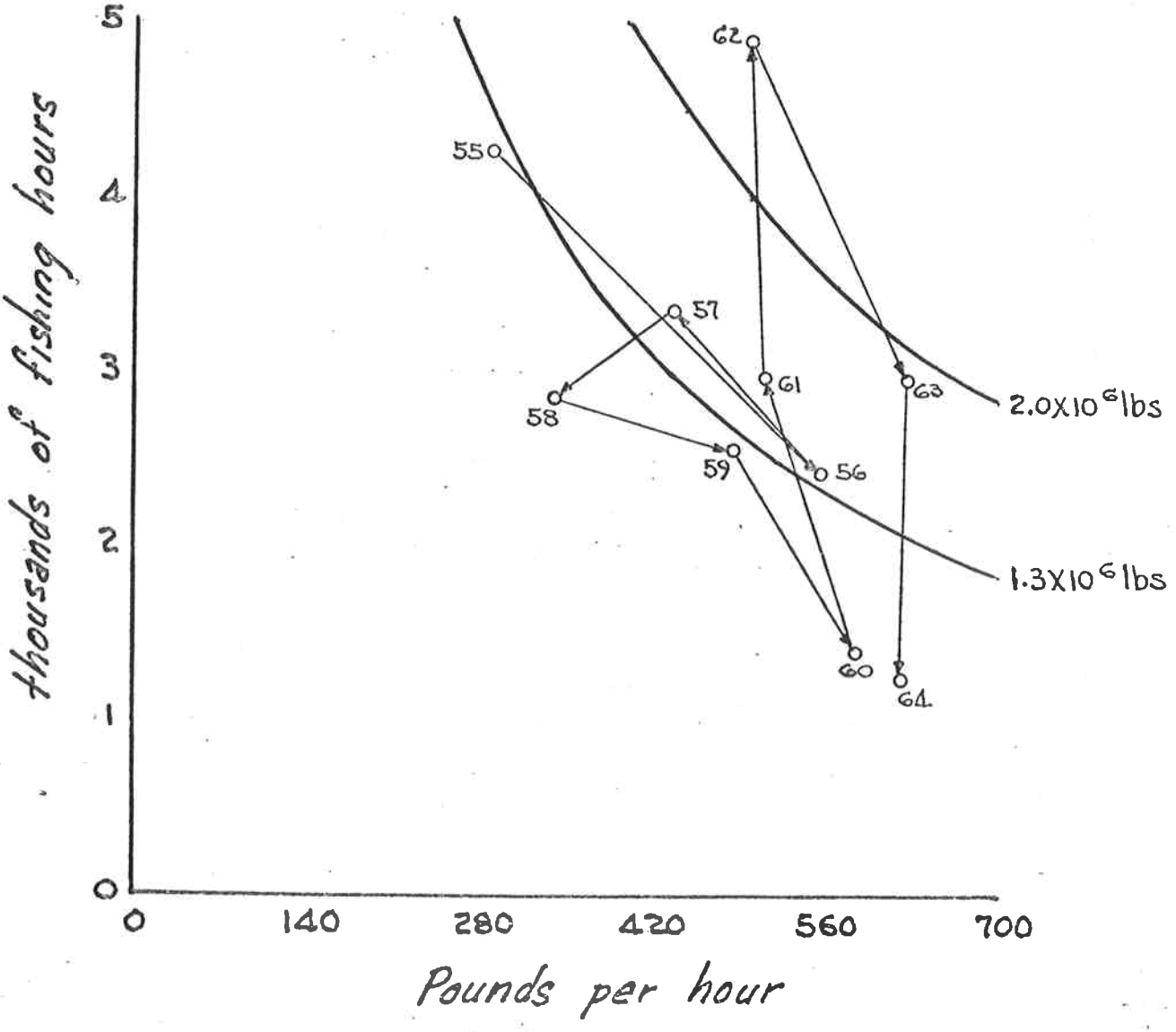


Figure 44. Relationship of catch per unit effort to effort for rockfish - N. W. Coast Vancouver Island.

should remain good in this area, and there are undoubtedly more areas and stocks of rockfish to be discovered along this stretch of coast. Although fishermen of Washington only spend 15 per cent of their rockfish effort in this area, 22.5 per cent of their landings occur here.

S.W. Vancouver Island

This is an extensive area, and many stocks are involved. S. brevispinus, S. pinniger, S. flavidus, S. paucispinis, and S. crameri are taken in varying proportion dependent upon the locality. Washington fishermen spend about 17 per cent of their effort for rockfish within this area, and they take 23.5 per cent of their ocean-caught rockfish here.

The initial fishery for rockfish on "The Spit" in 1958 is obvious both in the Table 63 and the Thompson type graph, Figure 45. There has been a gradual acceptance of more species also. S. paucispinis and S. flavidus (green) were always discarded a few years ago. Now S. auriculatus, the brown rockfish is about the only one that is consistently discarded because of its soft flesh and poor keeping qualities. Many are discarded because of their small size: S. saxicola, S. zacentrus, and S. helvimaculatus to name a few.

Table 63. Catch statistics for rockfish from S.W. coast Vancouver Island (1000's of lbs.)

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-Year Ave.
Total Landings	369	309	405	1145	1935	2366	2429	2979	1332	1263	1453
Wn. Landings	303	283	383	1051	1906	2333	2384	2943	1304	1212	1410
% Wn. Landings	82	92	95	92	99	99	98	99	98	96	97
Wn. hrs.	1062	1866	1353	2013	3020	4324	5674	7263	4001	2449	3303
Wn. lbs/hr.	286	151	283	522	631	540	420	405	326	495	427
(lbs/hr) index	67	35	66	122	148	126	98	95	76	116	100

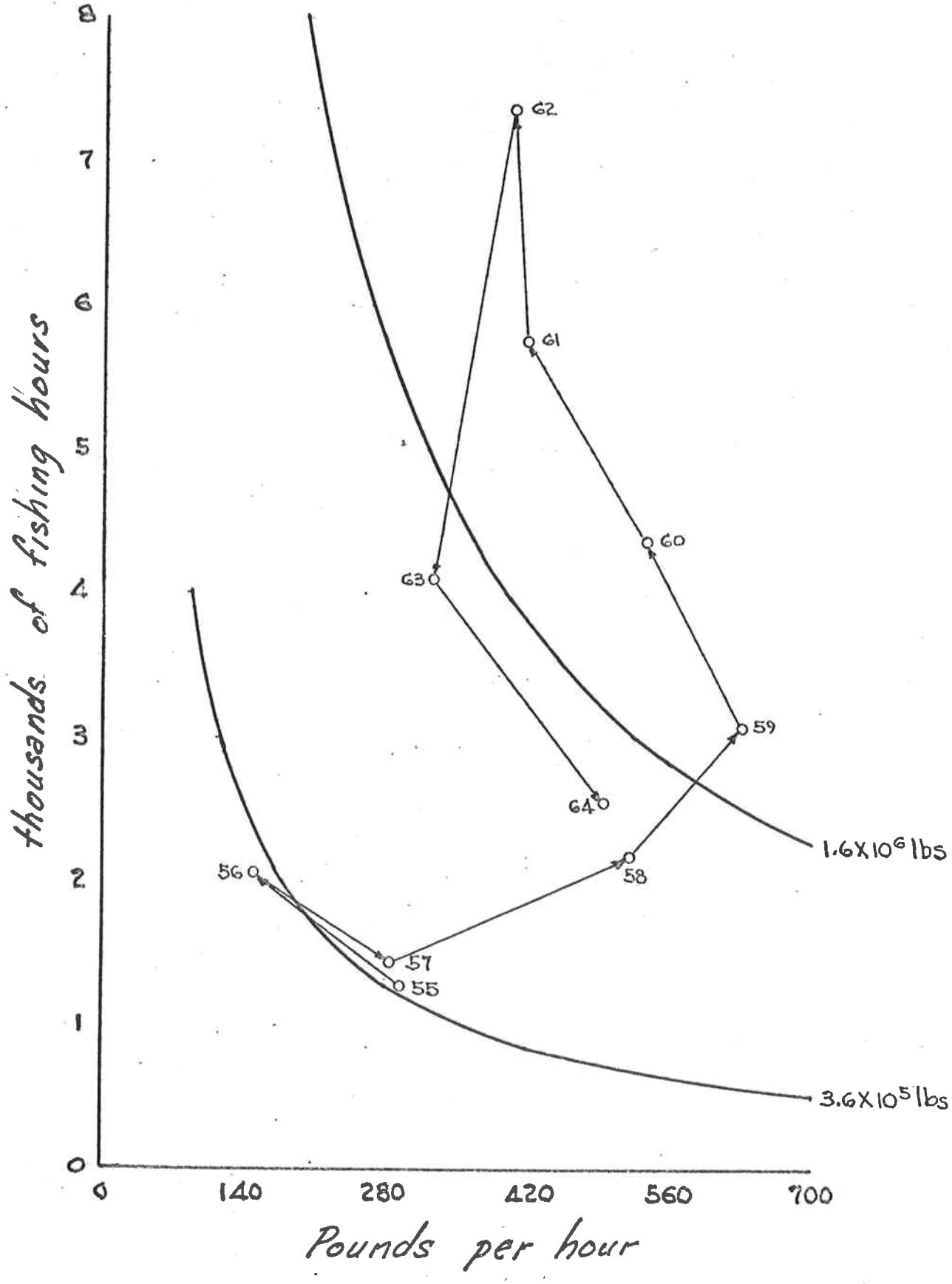


Figure 45. Relationship of catch per unit effort to effort for rockfish - S. W. Coast Vancouver Island.

Figure 45 shows that the area other than La Perouse Spit supports a small fishery of about 3.6 thousand pounds which is evident during 1955, 1956 and 1957. The fishery also expanded all along the continental slope for Pacific Ocean perch primarily, but a good proportion of rockfish is taken with the perch. The year 1962 is puzzling in that a great amount of fishing effort was expended on what should have been a new stock, but the effort faded during 1963, and the stock was not available to the fishery. Nearly 3 million pounds were landed during 1962, and it doesn't seem possible that a stock could be exhausted so quickly.

N. Washington Coast

During World War II, there were over 30 million pounds of rockfish landed annually along the entire coast. During 1945, Washington landings alone were over 25 million pounds, but this couldn't last, and Washington landings in the last ten years have averaged 6.6 million pounds. Fishermen didn't venture too far from home during the war years. So it is assumed that the Washington coastal area produced a great proportion of those comparatively large landings. Coastwide landings during 1964 were 17 million pounds with California the big producer of 7 million pounds.

Rockfish are comparatively slow growing. Aging the fish by the annuli on the scales shows that rockfish and perch usually attain marketable size in their seventh year. Therefore, local stocks will not maintain a high fishing rate for very many years, and stocks could be irreparably damaged. The "Cobb No. 9" tow is a good example. This spot produced millions of pounds of Pacific Ocean perch and rockfish. Fishermen still try a tow there once in a while, but they don't make a second tow which means that they caught under a thousand pounds of all species. Most fishermen are not satisfied with less than a thousand pounds of marketable species per tow.

Washington fishermen expend almost 40 per cent of their effort in this area (Table 64). From Duncan Rock southward is known as "Burma Road", although rockfish are largely taken from Umatilla Reef southward in deeper water. "Burma Road" has produced well throughout the years, however. Twenty per cent of all ocean-caught rockfish landed by Washingtonians are taken off the N. Washington coast.

Table 64. Catch statistics for rockfish from N. Washington Coast (1000's of lbs.).

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-Year Ave.
Total Landings	(1686)	1800	885	1523	1358	1080	1072	923	1079	1286	1266
Wn. Landings	1652	1769	884	1440	1320	1036	1008	820	983	1167	1208
% Wn. Landings	(98)	98	100	95	97	96	94	89	91	91	95
Wn. hrs.	13,761	8992	4093	8258	7071	7546	7627	5182	6119	7260	7591
Wn. lbs/hr.	120	197	216	174	187	143	132	158	161	161	159
(lbs/hr) index	75	124	136	109	118	90	83	99	101	101	100

Figure 46 is a poor representation of a Thompson type graph. The Cape Flattery "Spit" was included in this area in earlier years, and it was a hand sort to separate it out. It looks suspiciously as though the first three years contain a good proportion of fishing from the "Spit." The million pound line is drawn in for reference. If we were to hazard a guess at an equilibrium line, it would probably come between 1.25 and 1.5 million pounds. The incidental nature of the rockfish fishery in this area causes fishing to show a poor relationship with stock abundance. Rockfish are caught incidental to Pacific Ocean perch, Dover sole, lingcod, and about every other species of lesser extent. A great variety of species are taken in this area.

S. Washington Coast

Table 65 has been prepared from the PMFC Data Series, but it can be seen that Washington's portion is too limited to carry the analysis any further.

Table 65. Catch statistics for rockfish from S. Washington Coast (1000's of lbs.).

Year	1956	1957	1958	1959	1960	1961	1962	1963	1964	9-Year Ave.
Total Landings	1347	2598	3010	2123	2504	2189	4907	2814	2951	2716
Wn. Landings	39	88	124	78	14	89	254	84	141	94
% Wn. Landings	3	3	4	4	2	4	5	3	5	3

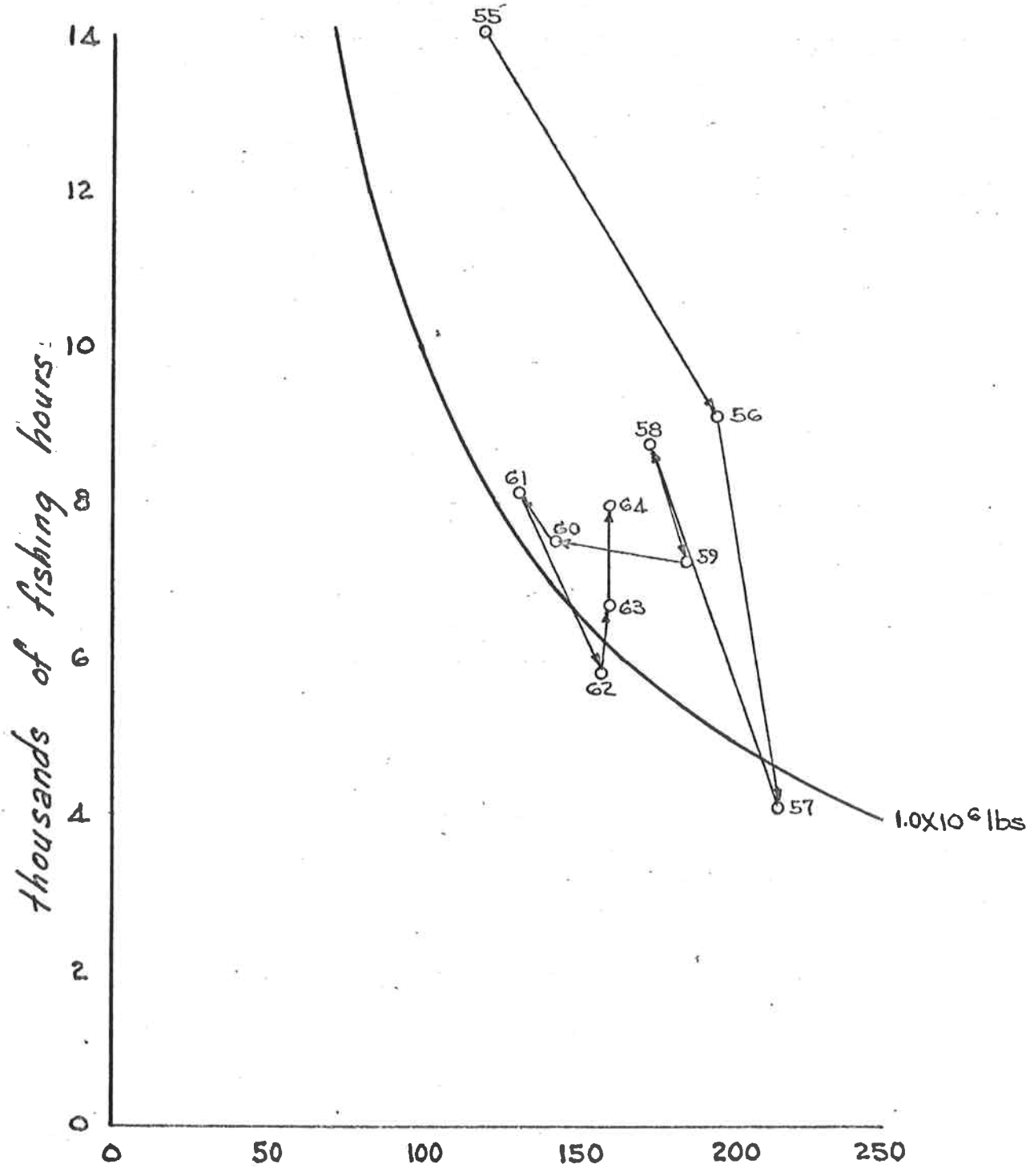


Figure 46. Relationship of catch per unit effort to effort for rockfish - N. Washington Coast.

Puget Sound

Within Puget Sound waters the principal species taken by trawling are S. caurinus copper rockfish, S. maliger quillback, and S. pinniger orange rockfish. Populations are scattered throughout Puget Sound. The central area is most productive followed by the southern area and the western area. Landings average less than one hundred thousand pounds annually which is rather insignificant(Table 66).

Table 66. Catch statistics for rockfish in Puget Sound (1000's of lbs.)

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-Year Ave.
Landings	62	93	99	74	89	118	75	77	176	128	99
Effort (hrs)	4550	8291	4723	5015	5082	8042	5467	3934	3761	6019	5488
lbs/hr.	14	11	21	15	18	15	14	20	47	21	18
(lbs/hr) index	78	61	117	83	100	83	78	111	261	117	100

Figure 47 shows that an equilibrium level must exist at slightly above 100,000 pounds. The low catches in the early years are thought to be a lack of demand. Fishermen did not fish specifically for rockfish.

PACIFIC OCEAN PERCH

Hecate Strait

Fishing for Pacific Ocean perch in the Hecate Strait area is hardly worth mentioning. A few are caught incidentally with other species. These are mostly from Lower Hecate Strait. There is the possibility that these catches were logged incorrectly by the fishermen. Many fishermen consider themselves in Hecate Strait when they round Cape Scott.

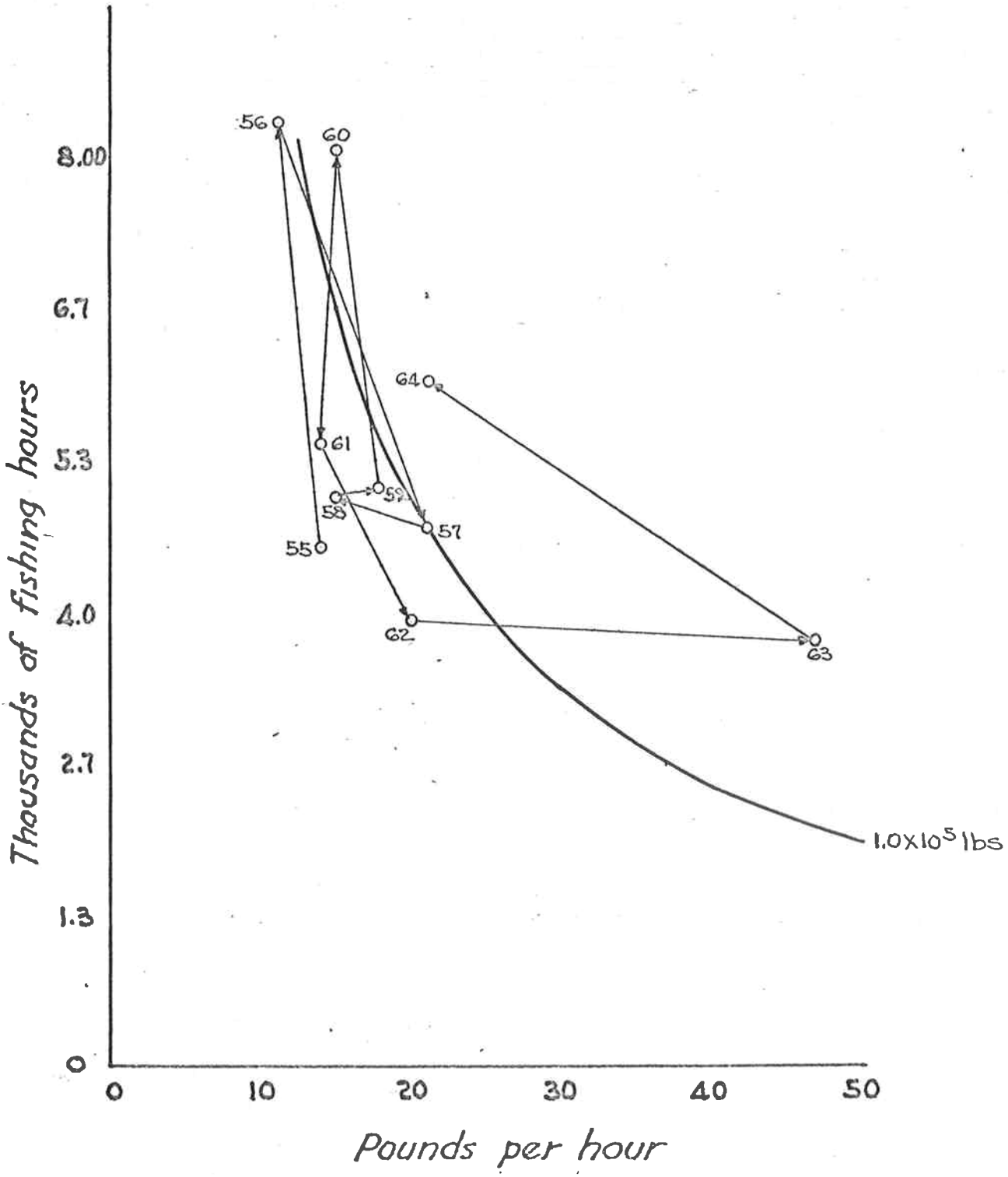


Figure 47. Relationship of catch per unit effort to effort for rockfish - Puget Sound waters.

The Washington poundage represents one per cent of the total perch landings in Washington, and the effort is less than one per cent of the effort expended by Washington fishermen in fishing for this species (Table 67).

Table 67. Catch statistics for Pacific Ocean perch from Hecate Strait (1000's of lbs.).

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-Year Ave.
Total Landings	8	169	471	41	5	65	1	-	59	41	86
Wn. Landings	3	140	467	32	5	65	1	-	56	29	80
% Wn. Landings	42	83	99	77	100	100	100	-	95	71	93
Wn. Effort (hrs)	58	59	302	40	4	53	33	-	52	29	63

Queen Charlotte Sound

Significant landings of Pacific Ocean perch are made from this area by Washington fishermen (Table 68). Their landings amount to 44 per cent of the total catch, although only 29 per cent of their perch fishing is done here. Perch are taken in the trench that separates the Goose Island grounds from the Cape Scott area. The Cape Scott side extends out to the Triangle Island area.

Table 68. Catch statistics for Pacific Ocean perch from Queen Charlotte Sound (1000's of lbs.).

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-Year Ave.
Total Landings	1265	2720	1669	2052	4218	3701	2643	4051	8184	7731	3823
Wn. Landings	1242	2410	1474	1358	3673	2914	2383	2881	7191	6664	3219
% Wn. Landings	98	89	88	66	87	79	90	71	88	86	84
Wn. Effort (hrs)	1603	2463	1629	1269	2477	2294	1676	1976	3877	4137	2340
Wn. lbs/hr.	775	978	905	1070	1483	1270	1422	1458	1855	1611	1376
(lbs/hr) index	56	71	66	78	108	92	103	106	135	117	100

Figure 48 is a Thompson type graph of fishing effort against catch per unit as the latter reflects stock abundance. For perch, however, the fishery has not, at least until 1963, affected stock abundance. The following table of total perch landings for Washington shows the trend (Table 69). Except for stocks near Cape Flattery, the fishermen have not exploited perch to the extent that they have other species of bottomfish. Oregon fishermen have concentrated on perch fishing for a greater number of years. There are still virgin stocks off central Oregon. The Canadians have fished perch to a lesser degree than we have.

Table 69. Washington landings of Pacific Ocean perch from all areas (millions of lbs.)

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-Year Ave.
Landings	3.5	5.0	4.5	2.7	5.8	6.1	7.9	11.4	15.6	11.2	7.4

The poundage levels in Figure 48 represent levels of expansion. Until there is more evidence that the fishery is affecting stock abundance, we will not know how much the Queen Charlotte area can produce. It is over 8 million pounds annually.

N.W. Coast Vancouver Island

This area is largely dominated by the Washington fishermen who catch about 17 per cent of their Pacific Ocean perch here with the expenditure of about 22 per cent of their perch fishing effort (Table 70).

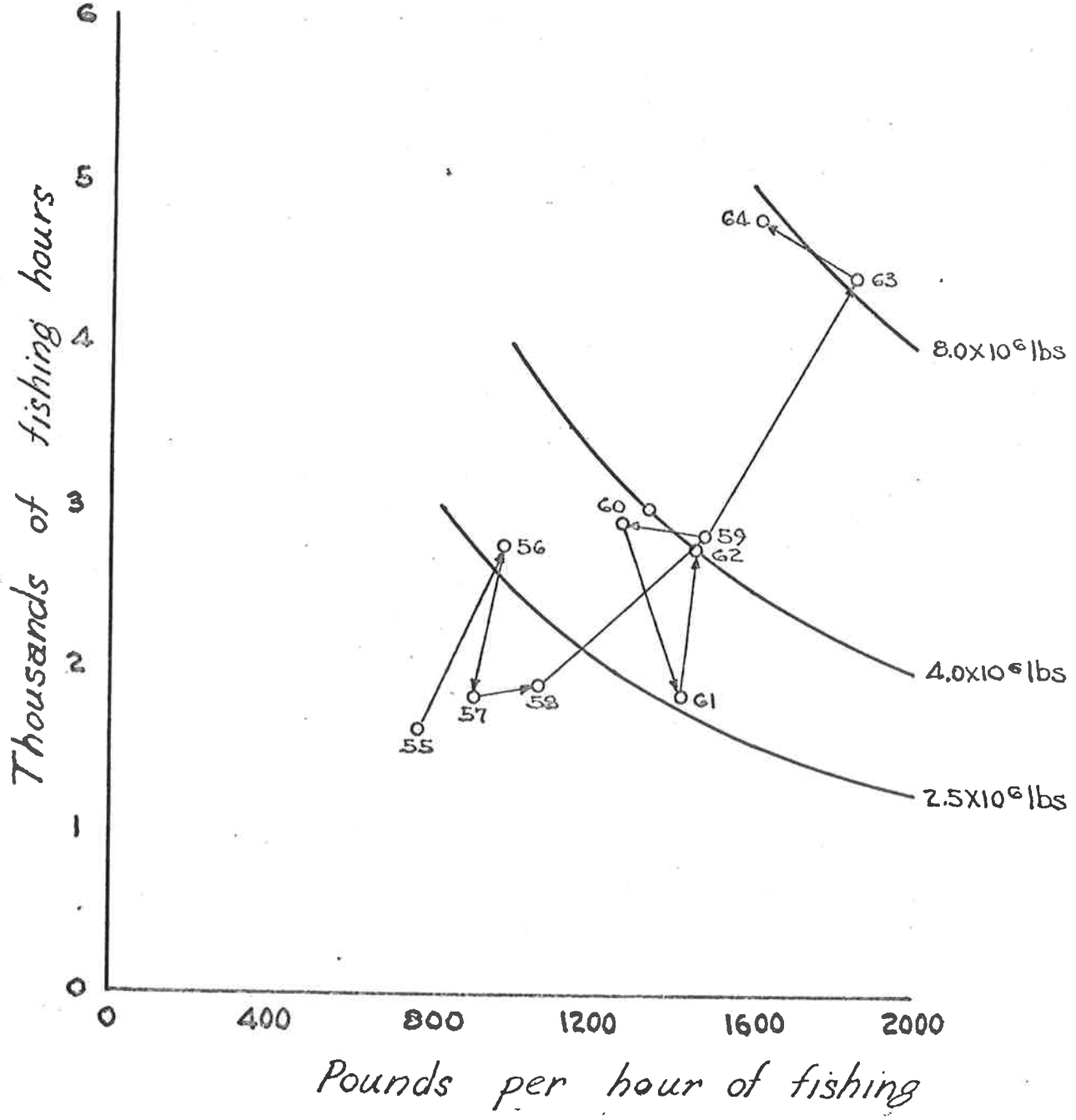


Figure 48. Relationship of catch per unit effort to effort for Pacific Ocean perch - Queen Charlotte Sound.

Table 70. Catch statistics for Pacific Ocean perch from N.W. Coast Vancouver Island (1000's of lbs.).

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-Year Ave.
Total Landings	1276	1285	1300	298	993	449	2091	2089	1781	966	1253
Wn. Landings	1276	1284	1300	298	993	334	2082	2082	1781	962	1239
% Wn. Landings	100	100	100	100	100	74	100	100	100	100	99
Wn. Effort (hrs)	2271	1768	2345	496	1292	520	2559	2973	2283	1284	1779
Wn. lbs/hr.	562	726	554	600	768	642	814	700	780	749	696
(lbs/hr) index	81	104	80	86	110	92	117	101	112	108	100

Figure 49 is a Thompson type graph for this species and area. The graph reflects the same expansion of the perch market. It is hard to believe that the decline during 1963 and 1964 was the result of overfishing during 1961 and 1962. Rather, it is suspected that fishermen by-passed this area to fish Queen Charlotte Sound, and this decline is a lack of effort on the part of the fishermen.

S. W. Vancouver Island

For convenience, the PMFC area divisions have been followed in these discussions. The PMFC areas were based upon the distribution of petrale sole. They do not necessarily apply to any of the other species. When, and if, the distribution of Pacific Ocean perch is known, this area will probably contain several subpopulations. In fact, the present statistics indicate this.

Washington fishermen dominate the fishery in this area, and they take about 25 per cent of their perch catch here and expend 25 per cent of their effort (Table 71).

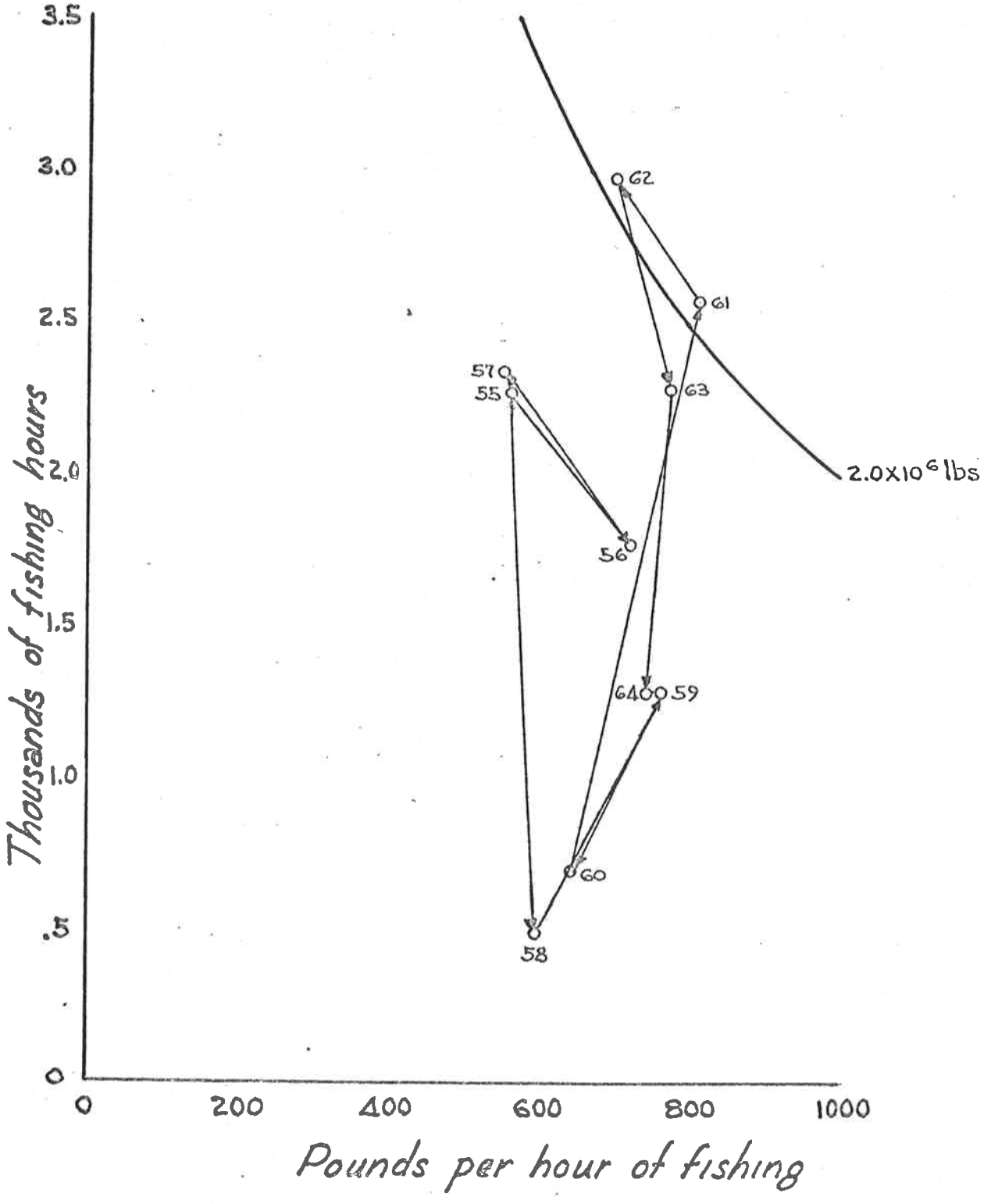


Figure 49. Relationship of catch per unit effort to effort for Pacific Ocean perch - N. W. Vancouver Island.

Table 71. Catch statistics for Pacific Ocean perch for S. W. Vancouver Island (1000's of lbs.).

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-Year Ave.
Total Landings	233	525	646	608	558	1572	1605	4723	5407	2717	1859
Wn. Landings	233	525	646	608	558	1430	1602	4723	5397	2564	1829
% Wn. Landings	100	100	100	100	100	91	100	100	100	94	98
Wn. Effort (hrs)	189	698	662	922	618	2334	2441	5434	4628	2509	2044
Wn. lbs/hr.	1234	752	975	660	902	613	656	869	1166	1022	895
(lbs/hr) index	138	84	109	74	101	69	73	97	130	114	100

The Thompson type graph in Figure 50 shows the expansion of the perch fishery as mentioned for other areas, but the difference here is that the expansion here was into new grounds. The use of rollers or bobbins in the last few years aided in this expansion. From 1955 through 1959, perch fishing was largely carried out in areas such as: La Perouse Spit, Swiftsure (100 fms.), and Ucluelet (100 fms.). The latter is actually the extension of Esteban Deep. Perch fishing is at a minimum during summer months in this area. During 1960, the Bureau of Commercial Fisheries used the research vessel "John N. Cobb" to explore a region west of Forty-Mile Bank where good concentrations of perch were found. Then with the use of rollers on their nets, fishermen expanded this area further. Now perch are exploited from the southern end of La Perouse Spit almost without a break northward to Esperanza. The decline in 1964 can only be explained by a lessening of market demand. The area is thought to be capable of producing 5 million pounds annually.

During 1964, Russian fishing vessels were observed on the perch fishing areas, and it was predicted at the various meetings that the abundance of fish here would attract foreign fishing fleets.

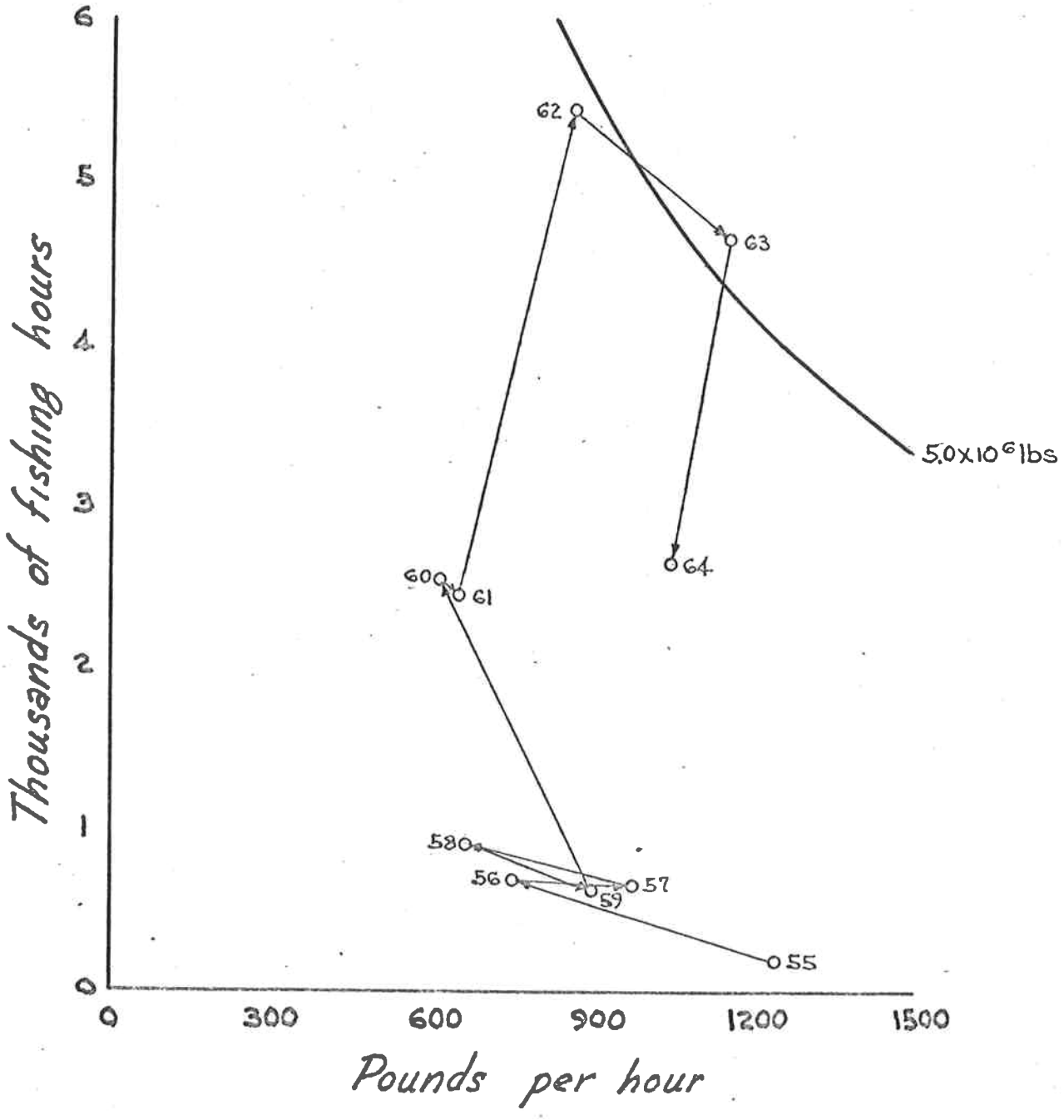


Figure 50. Relationship of catch per unit effort to effort for Pacific Ocean perch - S. W. Vancouver Island.

N. Washington Coast

Washington fishermen spend about 22 per cent of their Pacific Ocean perch fishing effort from Umatilla reef to the Destruction Island area, but they only take about 13 per cent of their perch catch here. Table 72 shows that Washington fishermen account for an average of about 84 per cent of the perch catch from the area.

Table 72. Catch statistics for Pacific Ocean perch from N. Washington Coast (1000's of lbs.).

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-Year Ave.
Total Landings	not avlb	579	597	587	582	1451	1782	1691	1338	1827	1159
Wn. Landings	743	570	569	417	578	1320	1753	1656	1168	994	977
% Wn. Landings	-	98	95	71	99	91	98	98	87	54	84
Wn. Effort (hrs)	1777	1214	1780	848	922	3402	2556	2546	1777	1359	1818
Wn. lbs/hr.	418	469	320	492	627	388	686	651	657	731	537
(lbs/hr) index	78	87	60	92	117	72	128	121	122	136	100

Figure 51 is a Thompson type relationship of the data in Table 72 with the exception of the year 1955 which are Washington data only (Oregon data not available). From 1955 through 1959, the graph is almost a classic picture of a fishery affecting the abundance of a stock at around the 600,000 pound level or slightly less. But, when the demand increased, the same stocks are now producing at about the 1.5 million pound level, or slightly more. There is no sign of depletion, or over-fishing even at this fishing intensity. It is known that catches have decreased in specific areas such as : the "Cobb No. 9 tow" and the "spit" tows which are now included in the S. W. Vancouver Island area.

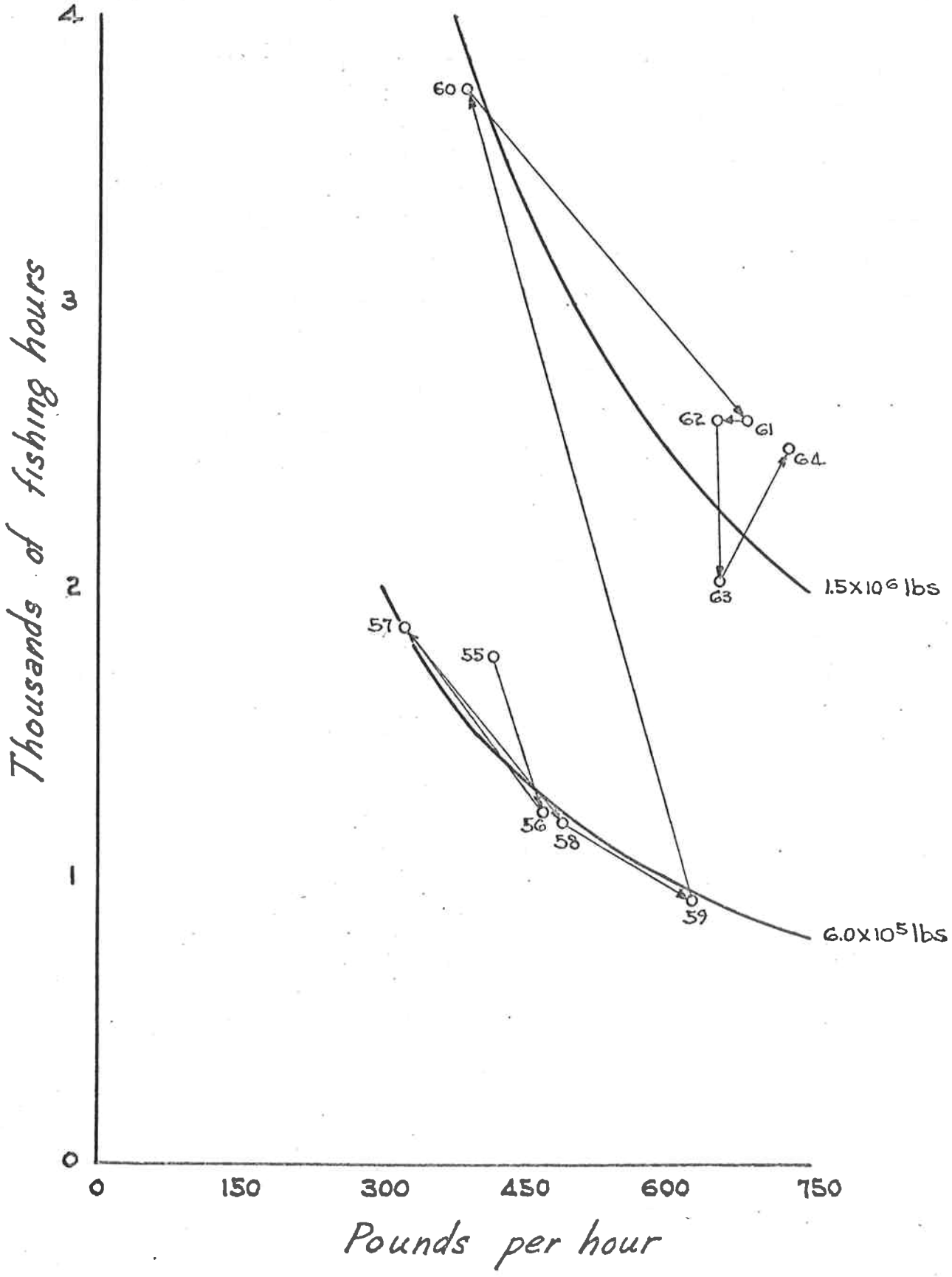


Figure 51. Relationship of catch per unit effort to effort for Pacific Ocean perch - N. W. Washington Coast.

S. Washington Coast

This area extends from south of Destruction Island to Tillamook Head which is south of the Columbia River mouth. Oregon fishermen exploit the area more than the Washington fishermen. Washington markets prefer Pacific Ocean perch of at least 14 inches in total length, and the perch in the exploited areas within this region average less than 14 inches. For this reason the Washington fishermen avoid this region. Washington fishermen take 1.7 per cent of the 1.8 million pound average harvested here annually. This represents 0.4 per cent of Washington perch landings, and 0.8 per cent of the perch fishing effort. This data is too meager to analyze further.

Table 73. Catch statistics for Pacific Ocean perch from S. Washington Coast (1000's of lbs.).

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	10-Year Ave.
Total Landings	not avlb	845	1808	1129	621	1053	2019	2862	3289	2342	1774
Wn. Landings	1	7	32	26	34	-	50	91	23	32	29
Wn. Effort (hrs)	2	18	35	91	145	-	62	240	46	33	67

TAGGING STUDIES

Groundfish tagging experiments during 1962-1964 were limited to two. Petrale sole were tagged in the Willapa Deep in 1962 and English sole were tagged in Puget Sound in 1964.

Petrale sole

During February 1962, 4,461 petrale sole, Eopsetta jordani, were tagged with dart tags, and released in the Willapa Deep off the Washington Coast. These fish have been captured by trawlers from California, Oregon, Washington and British Columbia. From the time of tagging through 1965, 177 or 4% of the total number of fish tagged and released have been recovered. Most of the tag recoveries were made from the tagging site northward to the lower west coast of Vancouver Island. The southern most recovery was off Eureka, California.

English sole

During 1964, studies to determine migratory habits, growth and mortality rates of English sole in Puget Sound were undertaken. Three thousand, four hundred and forty-seven fish were tagged and released. One thousand, eight hundred and eighty-eight of these releases, consisting of 958 Petersen disc tagged and 930 dart tagged fish, were made in Possession Sound. The remaining 1,559 tag releases were made at Alden Bank in the Strait of Georgia, and consisted of 753 Petersen disc tagged and 806 dart tagged fish.

A review of recovery data shows that during 1964 a total of 147 tags (4.3%) were returned. In 1965, 248 tags were returned. The total tag returns from both tagging areas through 1965 is 395 or 11.5%. Disc tag returns are far greater than dart tag returns.

Tagged fish were recovered in Everett Bay and Coupeville from the English sole tagged and released in Possession Sound. Returns from English sole tagged at Alden Bank indicate that these fish exhibit tendencies to make extensive

migrations. Six tagged English sole were recovered by Canadian trawlers fishing off the mouth of the Fraser River. One disc tagged fish was caught at Umatilla off the Washington Coast, and one dart tag return was from the Ten-Mile Creek area off the southern Oregon coast.

The preliminary data on returns indicates that the English sole tagged and released in Possession Sound are characterized by minor in-sound migratory tendencies, while those released at Alden Bank are characterized by stronger migratory tendencies resulting in a degree of intermingling of these fish into "Canadian" waters of the Gulf of Georgia, and through the Strait of Juan de Fuca.

BIOLOGICAL SAMPLING

In attempting to provide length, weight, age, and sex composition data on various trawl caught species landed by the trawl fleet, 83 biological samples were collected during the three years covered by this report. These samples include both port samples and samples collected at sea aboard tagging vessels. Unfortunately much of these data remain in raw form due to a combination of limited personnel, personnel turnover and the resulting lack of adequate time for analyzation.

Samples were taken of seven species: petrale sole, English sole, Dover sole, Pacific Ocean perch, Pacific cod, lingcod, and sablefish (blackcod) (Table 74).

Table 74. Biological samples taken during the three year period 1962-1964.

Sample Number	Sampling Date	Washington Statistical Area	Depth of Capture (fathoms)	Number in Sample	Source of Sample	Data Collected			
						Length	Weight	Sex	Age
				Petrale Sole					
1	2/17-23/62	17	170-210	4,500	Tagging	yes	no	yes	no
2	2-24-62	15	145-180	57	Tagging	yes	no	yes	no
3	12-16-63	6	185	100	market	yes	yes	yes	yes (O)
4	12-16-63	6	185	69	market	yes	no	yes	no
5	12-23-63	6	100	100	market	yes	yes	yes	yes (O)
6	12-23-63	6	100	193	market	yes	no	yes	no
7	2-26-64	6	155-185	200	market	yes	no	yes	yes (O)
8	3-9-64	6	195-226	100	market	yes	yes	yes	yes (O)
9	3-9-64	6	195-226	100	market	yes	no	yes	no
10	6-12-64	7	32-46	46	boat	yes	no	no	no
11	6-12-64	7	32-46	100	boat	yes	no	no	no
12	6-12-64	10	38-44	103	boat	yes	no	no	no
13	8-17-64	10	36-38	200	market	yes	no	yes	yes (O)
14	8-20-64	10	38-40	218	market	yes	no	no	no
15	8-20-64	10	38-40	105	market	yes	no	yes	no
16	8-25-64	10	40	244	market	yes	no	no	no
17	12-10-64	6	(?)	100	market	yes	yes	yes	yes (O)
18	12-10-64	6	(?)	23	market	yes	yes	yes	no
				English sole					
1	1-25-62	0	45-55	100	market	yes	no	yes	yes (I)
2	1-29-62	85	14-30	20	market	yes	no	yes	yes (I)
3	1-29-62	85	14-30	245	market	yes	no	no	no
4	2-1-63	85	9-35	86	market	yes	yes	yes	no
5	2-1-63	85	9-35	100	market	yes	yes	yes	yes (I)
6	2-8-63	85	15-24	306	market	yes	yes	yes	no
7	2-8-63	85	15-24	112	market	yes	yes	yes	yes (I)
8	4-11-63	81	(?)	99	market	yes	no	no	yes (I)
9	4-24-63	83	15-115	101	boat	yes	no	no	yes (I)
10	5-13-63	81	(?)	100	market	yes	no	no	yes (I)
11	6-27-63	81	15-30	99	market	yes	no	no	yes (I)
12	9-25-63	83	15-105	100	market	yes	no	no	yes (I)

Table 74. (continued) Biological samples taken during the three year period 1962-1964.

Sample Number	Sampling Date	Washington Statistical Area	Depth of Capture (fathoms)	Number in Sample	Source of Sample	Data Collected			
						Length	Weight	Sex	Age
				English sole (cont'd)					
13	9-30-63	81	29-52	101	market	yes	no	no	yes (I)
14	10-6-63	81	(?)	100	market	yes	no	no	yes (I)
15	10-21-63	81	(?)	100	market	yes	no	no	yes (I)
16	10-31-63	81	30-120	100	market	no	no	no	yes (I)
17	11-8-63	83	15-115	100	boat	yes	no	no	yes (I)
18	12-9-63	81	(?)	125	market	yes	no	no	yes (I)
19	12-20-63	83	10-90	193	boat	yes	no	no	yes (I)
20	1-8-64	81	(?)	205	boat	no	no	no	yes (I)
21	1-16-64	83	55-110	125	market	yes	no	no	yes (I)
22	2-19-64	81	10-55	200	market	no	no	no	yes (I)
23	5-1-64	83	15-100	153	market	no	no	no	yes (I)
24	5-4-64	81	25-55	150	market	no	no	no	yes (I)
25	6-5-64	83	57-115	110	market	no	no	no	yes (I)
26	10-15-64	81	30	100	market	yes	yes	yes	yes (I)
27	10-27-64	81	50-120	99	market	yes	yes	yes	yes (I)
28	11-19-64	81	30-50	100	market	yes	yes	yes	yes (I)
29	12-14-64	81 & 87	24-65	100	market	yes	yes	yes	yes (I)
				Dover sole					
1	5-17-62	6	137-275	367	market	yes	no	yes	no
2	11-20-63 11-21-63	12	105-115	286	market	yes	yes	yes	yes (S)and(O)
3	6-8-64	5	80-83 or 115-165 (?)	30	boat	yes	no	no	no
				Pacific Ocean perch					
1	2-16-62 to 2-27-62	13	145-155 (?)	22	boat	yes (?)	no	yes	yes (S)
2	5-17-62	6	137-275	41	(?)	yes	no	yes	yes (S)
3	9-19-62	13	150	100	(?)	yes	no	yes	yes (S)
4	9-24-62	13	(?)	100	(?)	no	no	no	yes (S)
5	10-31-62	13	115-160	100 (?)	(?)	yes	yes	yes	yes (S)
6	1-28-63	6	205	122	market	yes	yes	yes	yes (S)*

Table 74. (continued) Biological samples taken during the three year period 1962-1964.

Sample Number	Sampling Date	Washington Statistical Area	Depth of Capture (fathoms)	Number in Sample	Source of Sample	Data Collected			
						Length	Weight	Sex	Age
				Pacific Ocean perch (cont'd)					
7	10-9-63	10	85-90	140	market	yes	yes	yes	yes (S)*
8	10-22-63	3	105-135	133	market	yes	yes	yes	yes (S)*
9	10-31-63	13	105-145	119	market	yes	yes	yes	yes (S)*
10	2-10-64	8	160-190	100	market	yes	yes	yes	no
11	6-8-64	5	155-165	30	boat	yes	no	yes	yes (S)
12	6-9-64	3	120	32	boat	yes	no	no	no
13	6-9-64	2	90-95	50	boat	yes	no	yes	yes (S)
14	6-10-64	2	90-95	53	boat	yes	no	yes	yes (S)
15	6-10-64	2	90-95	100	boat	yes	no	yes	no
16	6-12-64	10	(?)	50	boat	yes	no	yes	no
				Lingcod					
1	7-23-62	2 or 8 (?)	(?)	202	(?)	yes	yes	no	no
2	6-13-64	10	38-44	114	boat	yes	no	no	no
				Pacific cod					
1	3-28-62	81	(?)	645	market	yes	no	no	no
2	4-5-62	81	(?)	565	market	yes	no	no	no
3	11-8-62	81	(?)	207	market	yes	yes	yes	no
4	11-28-62	81	(?)	136	market	yes	yes	yes	no
5	1-16-63	81	(?)	220	market	yes	yes	yes	no
6	2-19-63	81	(?)	160	market	yes	yes	yes	no
7	4-11-63	81	(?)	200	market	yes	yes	yes	no
8	5-13-63	81	(?)	146	(?)	yes	yes	yes	no
9	10-7-63	81	22	124	market	yes	yes	yes	no
10	12-5-63	81	15-18	114	market	yes	yes	yes	no
11	1-8-64	81	(?)	61	market	yes	yes	yes	no
12	2-24-64	81	(?)	144	market	yes	yes	yes	no
13	3-18-64	81	(?)	233	market	yes	yes	yes	no

Table 74. (continued) Biological samples taken during the three year period 1962-1964.

Sample Number	Sampling Date	Washington Statistical Area	Depth of Capture (fathoms)	Number in Sample	Source of Sample	Data Collected			
						Length	Weight	Sex	Age
				Sablefish					
1	2-20-62 to 2-23-62	15	145-180	136 (?)	boat	yes	no	no	no
2	2-24-62	17	170-210	13	boat	yes	no	no	no
3	3-11-63	14	(?)	13	market	yes	yes	no	no
4	4-29-63	11	42-44	17	market	yes	yes	no	no

Notations: (O) = based on otoliths
(I) = based on interopercles
(?) = uncertain or unknown
(S) = based on scales
* = 100 fish only in age subsample

INTERNATIONAL TRAWL COMMITTEE

During 1959, the International Conference on "Coordination of Fisheries Regulations" between Canada and the United States established a Trawl Fishery Committee to deal with international problems pertaining to the investigation and regulation of the trawl fisheries which are of mutual interest to the U. S. and Canada. The parent Trawl Committee in turn set up a Technical Subcommittee which consists of scientific representatives of the various agencies involved. The functions of the Technical Subcommittee have been to review the efficacy of existing regulations, to review proposed regulation changes before implemented, to recommend the continuance or further development of current research programs, and to exchange information on the status of bottomfish stocks of mutual concern. It is in the last function that the subcommittee has been most active. Meetings of the Technical Subcommittee were attended during 1962-1964 and the results are contained in the annual "Reports of the Technical Subcommittee of the International Trawl Fishery Committee."

The subcommittee usually meets in June, and a report of its findings is prepared for the use of the parent committee which usually meets just prior to the PMFC meeting in the fall. However, the International Trawl Committee is entirely separate from PMFC, and it differs from PMFC in that it officially involves Canada. No monies are involved. Agencies pay their own expenses.

PACIFIC MARINE FISHERIES COMMISSION

PMFC is composed of the three coastal states and Idaho. Alaska was invited to join, but so far has only acted as an observer. Membership in PMFC costs each state proportionately to the value of its commercial fisheries. Expenses account for most of the funds. There has been monies available for publications recently. Status and special reports on the coastal fisheries, including trawl, are made at an annual meeting where resolutions are the main order of business. If funds are

sufficient, a biologist meeting is also held in the spring where recommendations from the technical staff are considered.

Notes on Giant Squid Moroteuthis robusta (Dall) Verrill Trawled off the Southwest Coast of Vancouver Island, Canada

Bradley H. Pattie

During the first four months of 1965 several large squid were received by the Washington Department of Fisheries for identification. The squid had been captured by otter-trawl gear off the southwest coast of Vancouver Island, Canada. All of the squid were captured in the area between lat. 49° 5' N, long. 126° 53' W and lat. 48° 47' N, long. 126° 25' W. The area where each cephalopod was trawled is further described in Table 1. United States Coast and Geodetic Survey Loran rate, and depth in fathoms are used to define the location of capture for each squid.

The specimens were identified as Moroteuthis robusta (Dall) Verrill, 1876. The identification was made on the basis of the following morphological features; (1) the large size, (2) the lack of nuchal folds on the dorsal back of the head, (3) the presence of hooks on the tentacular clubs, (4) two rows of suckers only (no hooks) on the sessile arms, and (5) the solid cartilaginous cone terminating the posterior end of the gladius (Sasaki, 1929). Detailed descriptions of M. robusta are also given by Berry (1910) and Phillips (1933).

Table 1.--Locations where five specimens of Moroteuthis robusta were trawled in 1965.

Specimen number	General Area	2H5 Loran	Depth in fathoms	Date Caught
1	Southwest coast of Vancouver Island	1800	185	Jan. 1965
2	"	1750	220	March 5, 1965
3	"	1700	175	April 3, 1965
4	"	2000	160	April 4, 1965
5	"	1800	185	April 9, 1965

Specimen number 1 was captured in January 1965 by the trawler Arthur H at a depth of 185 fathoms. Its dorsal mantle length was 86 cm (2.8 ft). Both tentacular arms (the longest) were missing so the total length was calculated at around 244 cm (8 ft).

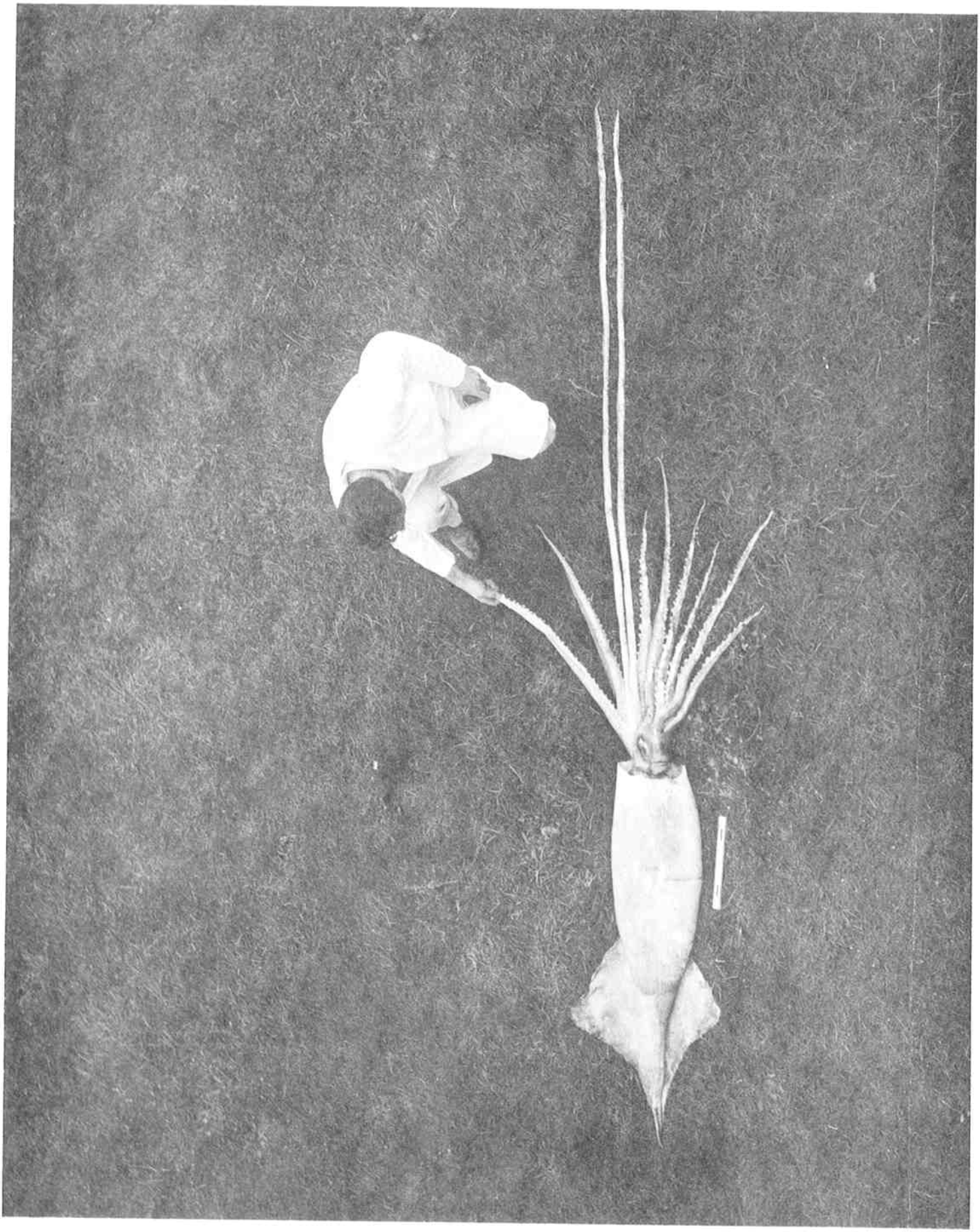
Specimen number 2 was caught on March 5, 1965 by the trawler Ann B. This squid was trawled from a depth of 220 fathoms. It had a dorsal mantle length of 125 cm (4.1 ft) and a total length of 335 cm (11 ft).

Specimen number 3, shown in Figure 1, was also trawled by the Ann B, on April 3, 1965. It weighed 47.5 pounds, had a dorsal mantle length of 129 cm (4.2 ft) and a total length of 352 cm (11.5 ft).

Specimen number 4 was caught by the trawler Morning Star in 160 fathoms on April 4, 1965. The dorsal mantle length was 113 cm (3.7 ft).

Specimen number 5 was caught by the trawler Yaquina. This squid was from a depth of 185 fathoms on April 9, 1965. Only parts of the last two specimens were received for identification. These parts, however, were definitely from M. robusta.

Figure 1.--The largest of five specimens of M. robusta trawled off the southwest coast of Vancouver Island, B.C. Ventral aspect, except for the head which is turned 90 degrees to the right. The left ventral arm is being held.



The largest specimen of M. robusta reported in literature was around 427 cm (14 ft), recorded by Dall (1873). This squid was found on the beach at Unalaska Island, Alaska. The second largest specimen, reported by Van Hyning and Magill (1964), measured nearly 396 cm (13 ft) in overall length. It was trawled off the southern Washington Coast.

Certain body measurements from specimens number 2, 3, and 5 are shown in Table 2. The measurements of the beak were taken from the left sides of the two horny jaws which comprise this hard part. The numerous segments of the jaws were measured and labeled as described by ~~Volsbe, et. al~~ (1962).

Specimen number 1 was given to Mr. Clifford Fiscus of the Bureau of Commercial Fisheries to add to his collection of cephalopods. The beak, radula, tentacular clubs, several sessile arms, the gladius and its solid terminal cone were preserved from specimens number 2, 3, and 5. These parts are being stored by the Washington Department of Fisheries for future reference.

It is the indication from past reports that M. robusta are common in Pacific waters. They have been reported in areas along the eastern Pacific Coast from California to Alaska. These giant squid are uncommonly found, however, because the depths which they inhabit are beyond the limits of fishing gear capable of catching them.

There is no market for this species, and earlier attempts to establish one were not successful (Smith, 1963). Although the flesh of this animal is quite appealing, it is not good to eat. Samples of the clean, white meat were taken from the mantle and arms of two specimens and cooked by two methods; (1) breading and frying in cooking oil, and (2) boiling in unsalted water. Both methods, however, failed to disguise the strong, salty flavor of the flesh. Smith (1963) also mentions them as unpalatable.

Table 2.--Measurements of three specimens of Moroteuthis robusta.

Description	Second Specimen	Third Specimen	Fifth Specimen
Total length, including tentacles	3,353 mm	3,520 mm	
Length of longest tentacle	1,980	2,110	
Dorsal mantle length	1,250	1,290	
Length of fin	622	680	
Length of terminal cone	256	288	
Thickness " "	32.8	34.2	
Width " "	30.9	30.3	
Right tentacular club:			
Length of adhesive pad	38.4	35.1	36.2 mm
Width " " "	16.9	15.9	17.3
Left tentacular club:			
Length of adhesive pad		37.2	37.7
Width " " "		15.9	18.0
Upper jaw: Tip of rostrum to most extreme posterior tip of palatal part	62.1 mm	59.8 mm	
Anterior margin of wing to posterior tip of palatal part	55.4	52.7	
Tip of rostrum to dorsal posterior edge of frontal part	Broken	45.5	
Dorsal posterior edge of frontal part to lower most margin of palatal part	44.4	43.7	
Opening across the anterior edges of wings	6.2	6.5	
Lower jaw: Tip of rostrum to the most ventral posterior margin of gular part	B	30.4	
Tip of rostrum to extreme posterior edge of gular part	r	42.6	
Posterior edge of gular part to ventral tip of mental part	o	36.6	
Tip of rostrum to ventral tip of mental part		11.6	
Ventral tip of mental part to extreme edge of wing	k	44.5	
Ventral margin of gular part to the dorsal tip of same	e	25.2	
Opening of lower jaw, just above the cutting edge	n	10.3	

The sperm whale Physeter catodon is a chief predator of M. robusta. Stomach contents of these whales show that the giant squid is a frequent part of their diet. The remains of M. robusta have been found in sperm whales caught in waters off the northwest coast of Vancouver Island, Canada (Pike, 1950) and also from California waters (Rice, 1963). Squid beaks are often the only undigested remains found in stomach contents of whales. The size and shape of these horny jaws are sometimes the only means to the identity of the species of squid (or octopus) to which they belong.

ACKNOWLEDGEMENT

I would like to thank Mr. Clifford Fiscus for his help in identifying the original specimen, and for his suggesting some important materials on this species. My appreciation to Ed Holmberg for his encouragement in writing this article. A special thanks to the fishermen who turned specimens of M. robusta over to the Department of Fisheries:

Mr. Ivar Reinholdtsen, Captain of the M/V Arthur H

Mr. Wilhelm Jensen, Captain of the M/V Ann B

Mr. Lars Svege, Captain of the M/V Morning Star

Mr. Erling Jacobsen, Captain of the M/V Yaquina

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