THE SUNKEN GILL-NET FISHERY, AND AN ANALYSIS OF THE AVAILABILITY OF THE DOG-FISH (*Squalus suckleyi* Girard) AND THE SOUP-FIN SHARK (*Galeorhinus galeus* Linnaeus) IN BRITISH COLUMBIA WATERS FROM 1943 TO 1946.

BY

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ABSTRACT

As the requirements for vitamin "A" increased during World War II, the livers from the Pacific coast dog-fish (Squalus suckleyi) and the soup-fin shark (Galeorhinus galeus) became one of the principal sources of vitamin "A". Under the pressure of a high and increasing fishing intensity, the catch of these two sharks in British Columbia has dropped greatly during the years following 1944.

Changes in the availability or relative abundance of the dog-fish and soup-fin shark caught in Hecate strait and the dog-fish caught off Barkley sound on the west coast of Vancouver island were determined from the analysis of the individual tally slips or fish receipts of each fishermen's landing of the livers from these two sharks caught by sunken gill-nets.

Methods employed in the analysis of the data to determine the availability, included the analysis of the total landings of the livers from each area under investigation; the average boat catches per month; and average boat catches per trip per month. The method of link relatives is used in the analysis and the catch per unit of effort off Barkley sound is determined.

The availability or relative abundance of the dog-fish in Hecate strait was found to decline from 1943 to 1945 with a slight increase during 1946.

The availability of the soup-fin shark was found to decline greatly from 1944 to 1946. In the year 1946, the soup-fin shark fishery in Hecate strait was almost a failure.

The decline in the availability of the dog-fish and the

drop in the average vitamin "A" per gram of liver oil is closely related to the removal or possible depletion of the older age classes from the population.

On the west coast of Vancouver island, off Barkley sound the index of return per unit of effort (one sunken gill-net 75 fathoms long fishing over a period of 24 hours) indicated that the availability of the dog-fish has increased in each year since 1944.

The sunken gill-nets (7 inch stretched mesh) were found to select dog-fish greater than 76 cm. in length. Small dog-fish of no commercial value (less than 76 cm.) tend to pass through the meshes.

I. INTRODUCTION

The production of oil from the livers of the dog-fish (Squalus suckleyi Girard) was one of the earliest fishing activities carried on in British Columbia. This oil was used mainly for lighting and lubricating purposes. With the discovery of vitamin "A" in the livers of the dog-fish, a very significant and important use for these livers was disclosed. The vitamin "A" content of the soup-fin shark (Galeorhinus galeus Linnaeus) was found to be even greater than that in the livers of the dog-fish. As the demands and requirements for vitamin "A" increased during World War II, the Pacific coast dog-fish and soup-fin shark livers became one of the principal sources.

For the past few years the soup-fin shark has been the major source in the production of vitamin "A" supply in the United States (Ripley 1946). The catch, however, dropped so seriously in American waters that the soup-fin shark was replaced by the dog-fish.

In British Columbia there has been a fairly intensive fishery for the soup-fin shark during recent years. At the same time the intensity of the dog-fish fishery has increased greatly until it now ranks with the important fisheries in British Columbia. As a result of the high and increasing fishing intensity, the catch of the dog-fish and soup-fin shark has dropped greatly in the years following 1944.

It has seemed unlikely that a sufficient and stable stock could be maintained at this high level of exploitation but adequate information concerning the stock has been lacking. The abundance of any stock which is exploited by man, must be known before the rate of exploitation may be determined. The maximum rate of exploitation or the optimum yield must also be determined so that a stable and productive population may be maintained for future utilization.

A. The Problem

An investigation was undertaken to determine the changes in the availability or relative abundance of the dog-fish and soup-fin shark caught in Hecate strait and off Barkley sound on the west coast of Vancouver island.

Changes in the availability were determined from the analysis of individual tally slips or fish receipts of each fisherman's landing of the livers of these two sharks caught by sunken gill-net boats and recorded by the industry. The analysis of these data to determine the availability, include:

1. the total catch of livers from each area under investigation;
2. the average catch per boat per month;
3. the average catch per trip per boat per month;
4. the average catch per boat per month and the average catch per trip per boat per month for each year as a whole;
5. the index of the average catch per boat per month, and the index of the average catch per trip per

boat per month as determined by the method of link relatives;

6. comparison of the average catch per boat per month for the same sunken gill-net boats fishing in adjacent years;
7. the index of the total catch of the same sunken gill-net boats fishing in adjacent years as determined by the method of link relatives;
8. the catch per-unit-of-fishing effort.

A knowledge of the history of the fishery and a detailed description of the early and modern sunken gill-net fishing methods are pertinent to an understanding of the problem.

B. Description and Distribution of Each Species.

1. The Dog-fish (Squalus suckleyi)

The dog-fish (Fig. 1) is a member of the family Squalidae, which includes another member in British Columbia waters, the sleeper shark (Somniosus microcephalus). Dog-fish attain a size of slightly over five feet. The head is flattened dorso-ventrally and the mouth is ventral in position. It has five gill openings anterior to the pectoral fins, and a large spiracle close behind the eye. The two dorsal fins are each preceded by a large spine. There is no anal fin. Small placoid scales cover the gray to light brown dorsal surface and the dirty white ventral surface.

Girard was the first to describe the dog-fish in 1854 and according to Clemens and Wilby (1946) it was first recorded

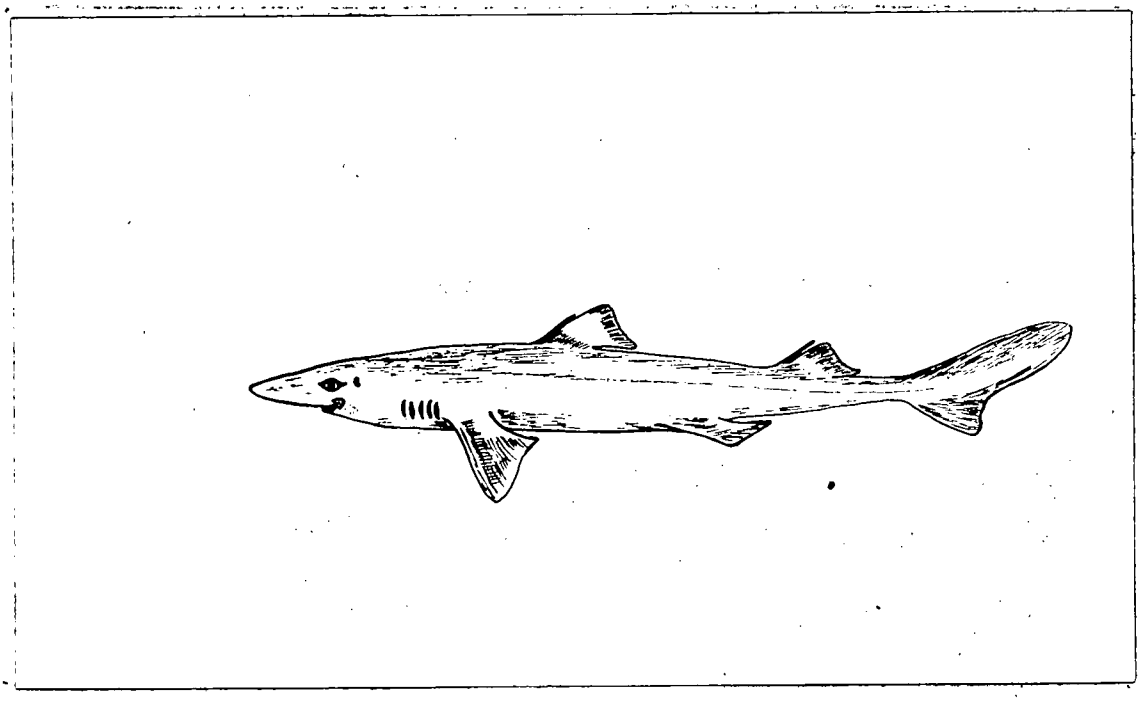

Fig. 1

Sketch of Dog-fish. Squalus suckleyi (Girard)

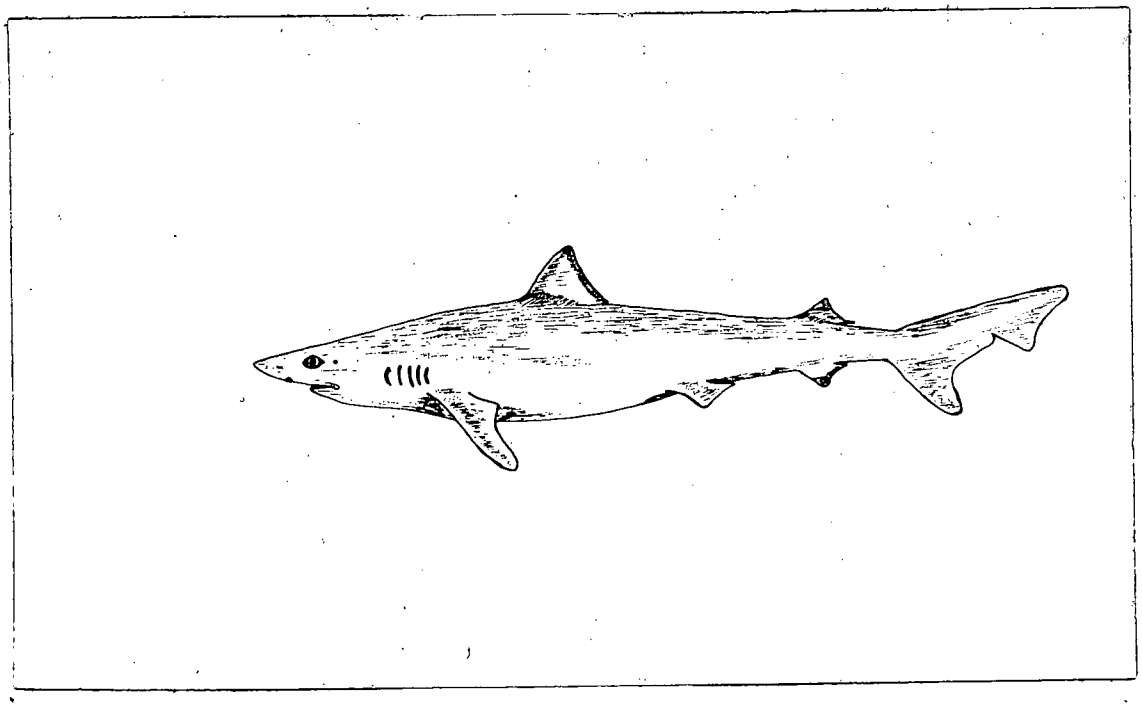

Fig. 2

Sketch of Soup-fin shark. Galeorhinus galeus (Linnaeus)

in British Columbia by J. K. Lord in 1866 as Acanthius suckleyi.

The words gray-fish and dog-fish are synonomous, both to the commercial fisherman and to the industry.

The range of this species is from southern California to northwestern Alaska.

2. The Soup-fin Shark (Galeorhinus galeus)

This shark is one of the two members of the family Carcharinidae found in British Columbia. The other member is the blue shark (Prionace glauca). The soup-fin shark (Fig. 2) attains a size of slightly over six feet. Its head is depressed and the snout extends well beyond the ventral mouth opening. The fifth and last gill opening is located above the shortened pectoral fin, and the spiracle, situated behind the eye, is small. An anal fin is present. No spines precede the two dorsal fins. The caudal fin is considerably shorter than the rest of the body and is deeply notched, forming a large lobule on the upper lobe of the fin. There are no lateral keels on the caudal peduncle. Small placoid scales cover the surface of the body. The colour is dark gray to dark blue on the dorsal surface, often with a purplish tinge, becoming paler to a dusky white on the ventral surface.

The soup-fin shark was first described by Linnaeus in 1758, and, according to Clemens and Wilby (1946) was first recorded from British Columbia in 1891. Publications from California still list and refer to this species as Galeorhinus zyopterus (Ripley 1946).

The range is from southern California to northwestern Alaska.

II. HISTORY OF THE DOG-FISH FISHERY IN BRITISH COLUMBIA

A. Production of Oil from the Livers of the Dog-fish.

Oil extracted from the livers of the dog-fish ranks as one of the earliest products of the fishing industry in British Columbia. Lord (1866) noted that the Pacific coast Indians extracted the clear oil from the fatty livers by heat and pressure for their domestic uses. A few years later the production of dog-fish liver oil gave employment to a large number of persons along the seaboard of the Province, opening a valuable industry to both the native fisherman and the European. Anderson (1877) estimated the outlay necessary for two men to commence operations to fish dog-fish, as follows:

Boat, with oars and sail $60.00

Try-pot $18.00

1,000 yards manilla rope, 1 3/4 in.

600 J.P. cod-hooks, No. 3, per cwt., $1.50

6 doz. cod-lines.

Oil casks at six cents per gallon.

A net, for catching herring for bait, cost from $150 to $200 and was used in common by many fishermen in the same neighbourhood.

The annual yield to the fisherman was estimated at from 40 to 150 barrels of oil. Each barrel contained approximately 30 to 40 gallons of oil. This oil was valued at forty cents a gallon in Victoria.

Large quantities of oil were consumed for lubricating

and lighting purposes in the extensive saw-mills at Burrard inlet, in the coal-mines at Nanaimo and Departure bay and by numerous steamers and sailing vessels frequenting these waters (Anderson 1877).

Two of the light stations on this coast burned dog-fish oil exclusively. The oil was claimed to give a luminous and brilliant light and, besides, was cheaper than any other oil that could be imported during this period (Cooper 1874).

During the spring of 1877 an establishment employing white fishermen was formed on the Queen Charlotte islands for collecting dog-fish oil (Anderson 1878), but two years later the Skidegate Oil Company largely employed Indian labour secured from the villages around them (Anderson 1880).

The livers of the dog-fish (the only part of the shark processed in 1879) were first steamed in large vessels, in which the oil collected at the top. After separation, the oil was again subjected in another vessel to a certain degree of heat, thus dissipating very minute water particles. This refined oil was sealed in five gallon cans, two of which were packed in a case for shipment to ready markets (Anderson 1880).

The quality of dog-fish oil could not be excelled for lubricating purposes at this time. In April 1881 the best quality liver oil was used on the "H.M.S. Rocket" as a lubricating oil for the engines, and it was found that the dog-fish oil was superior to the vegetable oils from Rangoon, used on Her Majesty's ships (Anderson 1882).

Carcasses of the "piked dog-fish", as the dog-fish was more commonly called then, were not used as a source of oil

to any great extent. In 1880 two qualities of oil were procured from the dog-fish at the refinery on the Queen Charlotte islands; one oil of superior quality was refined from the livers alone, and the other from the carcasses of the fish (Anderson 1882).

Sometimes the Indians attempted to extract the oil from the carcasses of the dog-fish in a very primitive fashion. After cleaning the fish, they would cut them into pieces, boil them in vats, place them in large tubs, and the squaws would press the oil out by tramping with their feet. This made a very inferior oil which was mostly used for dressing skins, and for greasing skidways on logging roads (Mowat 1888).

At this time British Columbia was not permitted to share the privileges of the Washington Treaty, and a very heavy duty was placed on the highly prized dog-fish oil, almost preventing its export to the United States. A limited quantity of oil was exported to China, Honolulu, and to many manufacturing firms in the United States (Anderson 1884). Since the export market of oil was very limited, commercial fishing for the dog-fish almost ceased and, as a result, a reduction occurred in the number of gallons of oil produced (see Table II).

B. Destruction of Fishing Gear and Food Fish by the Dog-fish

With the reduction in fishing effort, dog-fish appeared to increase in numbers in coastwise waters, and became a source of great annoyance to fishermen in other branches of the fishing industry. It was claimed that the dog-fish would

not only cut the fish lines but would also eat the fish on the hooks, leaving only the heads (Mowat 1887). In spite of these claims by the fishermen, the British Columbia Fishery Commission (1893) recommended that the system prevailing along the coast of killing vast numbers of dog-fish, for the use of the livers for oil purposes only, should be discontinued unless the bodies of the dog-fish could be utilized in the same manner. To help alleviate some of the complaints from many fishermen who deplored the dog-fish as a pest because it destroyed valuable food fish, the Dominion Fisheries Commission of British Columbia (1908) recommended that the dog-fish carcasses be marketed as a fresh fish. This product has appeared on the market at various times under such trade names as "whitefish", "ocean whitefish", and "flake".

Taylor (1916) reported that the dog-fish had become a more serious menace to the fisheries than the hair seal and the sea-lion. One of the reasons that the dog-fish had increased their numbers was probably due to replacement of dog-fish liver oil for lighting purposes by calcium carbide.

It was not until the years 1916-18 that the dog-fish on the Pacific coast were caught in large quantities for export to the fresh fish market. The name "gray-fish" was given to the dog-fish marketed as fresh fish and nearly the whole catch was exported to the United States. This market disappeared after the cessation of hostilities of World War I.

Although great numbers of whole dog-fish were utilized as cattle and chicken food (Cunningham 1920), the dog-fish continued to work havoc with the fishermen's nets. The British

Columbia Fisheries Commission of 1922 (1923) strongly recommended, therefore, that the utilization of this pest by reduction plants be encouraged in some way, either by financial or other assistance, and that there be no restriction whatsoever placed on the catching of dog-fish. The Commission also recommended, after further investigation, that a bounty should be paid for the catching of such fish if necessary.

Motherwell (1923) considered that the Fordney-McCumber tariff hindered the market of dog-fish products from the Canadian establishments, since the tariff afforded protection to American fishermen. The tariff thus limited the Canadian fishermen in attempting to rid the waters of this pest.

C. Introduction of Orientals to the Dog-fish Fishery

During 1923 the number of licences previously issued to Orientals was reduced considerably in the salmon and cod fisheries. Since no restriction was placed on the number of hook and line dog-fish licences given to Orientals, many Japanese turned to this industry. Thus, there was a gradual increase in the number of Oriental fishermen (see Table I). At the same time the low price of $3 to $4 per ton for dog-fish discouraged many white fishermen from entering this fishery.

D. Valuation of the Dog-fish and Dog-fish livers.

It was not until 1938 that the number of fishermen engaged in the dog-fish fishery increased substantially. In this year 488 licences were operating, as compared to only 161

Table I

List of Dog-fish licences Issued and Operating in British Columbia from 1922 to 1946.

	White	Indian	Others*	Cancelled	Total
1922					1
1923	25	3	54		82
1924					143
1925					166
1926					177
1927					237
1928	219	11	191		421
1929	149	35	238	3	422
1930	90	2	228		320
1931	32		213		245
1932	9		123	2	134
1933	9		65		74
1934	31	1	120		152
1935	23	1	88		112
1936	43		81		124
1937	56	11	94		161
1938	169	20	299		488
1939	95	12	258		365
1940	164	2	239	1	406
1941	357	121	419	1	898
1942	1,026	208		1	1,235
1943	1,807	242			2,049
1944	2,745	320	1**		3,066
1945	2,031	135	4**		2,170
1946					1,405

* Mostly Japanese fishermen.
** British subjects of Chinese origin.

in the previous year (see Table I). The number of licences issued continued to increase as the price of the livers and the whole fish continued to rise. Livers rose from 6 cents per lb. in 1937, to 16 cents in 1942, to 25 cents in 1943, and to 34 cents per lb. in 1944. The price of whole dog-fish increased from $6 per ton in 1937, to $8 in 1940 and to $70 per ton in 1943. The dog-fish livers are bought "on test" at present, that is the livers are tested for the potency of vitamin "A" before the fishing industry pays for the livers from the fishermen.

E. Present Uses of Dog-fish Liver Oil and Body Oil.

Although Brocklesby (1927) determined the vitamin "A" content of the liver oil in 1927 and the vitamin "D" content in 1929 (Brocklesby 1929), it was not until World War II that this discovery became very important when new sources of vitamin "A" were needed. The livers of the dog-fish became increasingly important as a new source of vitamin "A" in 1943 when the dog-fish, with a market value of 2.7 million dollars, stood in third place among British Columbia fish and seventh in the Canadian list.

The dog-fish liver oil is used extensively as a blending oil in the preparation of poultry oils. In 1932, at the Pacific Fisheries Experimental Station, a medicinal oil "Thalattol" was developed. This oil contains the necessary vitamin "A" and vitamin "D" from high-grade dog-fish liver oil and pilchard oil. For a number of years this medicinal oil has been supplied

to the Dominion Indian Department for distribution to its wards in British Columbia, Saskatchewan, and the Northwest Territories (Swain 1944).

Brocklesby (1941) relates that both the liver oil and body oils can be used in the leather trades and also in insecticide sprays for codling-moth control and for tree banding. He also mentions that the body oil and the lower grades of liver oil and mixed oils of the dog-fish, have been used in steel tempering and in the manufacture of sheep and cattle dips. The meal from the dog-fish is a valuable fertilizer because of its high nitrogen content.

III. THE SUNKEN GILL-NET FISHERY IN BRITISH COLUMBIA

A. The Early Sunken Gill-net Fishery.

In the early 1920's representations were made to the Department of Fisheries by the Japanese and other fishermen for the use of old sockeye nets to capture the dog-fish. These discarded linen nets were the first sunken gill-nets to be used in capturing dog-fish. A number of graycod and red snappers were also tangled in the nets. These nets were in continuous operation throughout the year in the Gulf of Georgia by the Orientals and a small number of white fishermen until April 28, 1939.* In this year the first restrictions were imposed and, thereby, fishing for dog-fish was prohibited in an area around Pylades Channel (Fig. 3). Further legislation prohibited fishermen from catching dog-fish with sunken gill-nets from the 1st of November in each year to the 31st of March in the following year.** Fishermen using sunken gill-nets were not numerous in comparison with those fishing with the conventional long-line gear, which could be operated throughout the year without any restrictions. In early 1942, when the cotton sunken gill-net was introduced into British Columbia and the power drum on the gill-net boats used for lifting such nets from the

* (Order in Council, April 28, 1939), Special Fishery Regulations for the Province of British Columbia, 1939.

** (Order in Council, September 25, 1940), Special Fishery Regulations for the Province of British Columbia, 1941.

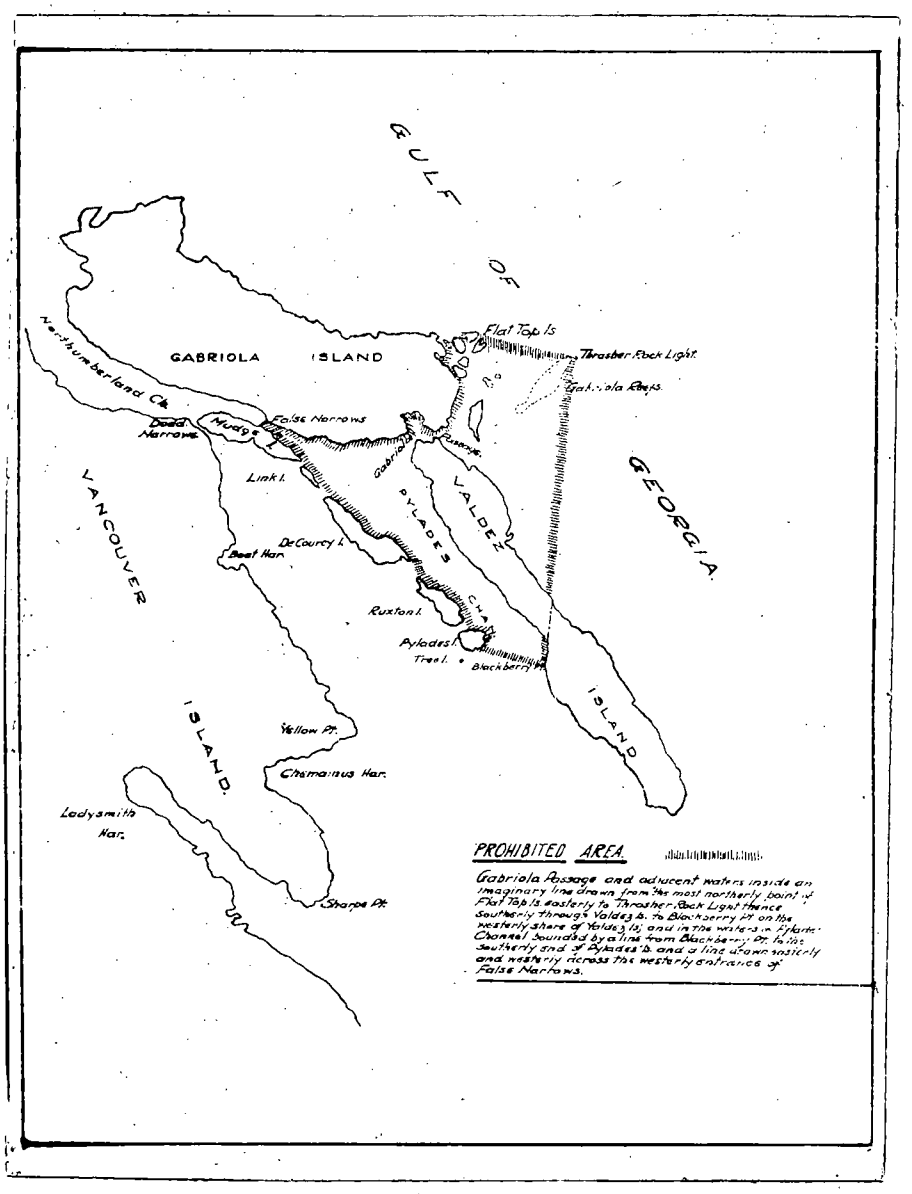

Fig. 3

Prohibited area for sunken gill-nets in the Strait of Georgia, 1939.

sea bottom was perfected, the sunken gill-net fishery became an important part of British Columbia's fishing industry.

B. The Modern Sunken Gill-net Fishery.

1. Description of Gear and Fishing Methods

a. Boats

There is a considerable range in the size and the equipment of the boats used in catching dog-fish and soup-fin shark. They range from the small salmon gill-net boats to the larger vessels used in the salmon purse-seine, the trawling and the halibut fisheries. Despite the diversity in sizes, the boats may be grouped into two size classes which may for purposes of description be called small and large.

(1) Small Boats

The small boats are essentially the salmon gill-net boats equipped with a rotating drum for lifting their nets. The boats range from 28 feet to 34 feet in length, 7 feet to 9 feet in beam and 3 tons to 6 tons in weight. Gasoline marine engines of various designs and manufacture, ranging from 7 to 115 horse-power, supply the motive power. There is sleeping accommodation for one or two men in the bow. Many boats do not carry a dinghy but some have just enough room to carry one fastened along the side or on top of the small cabin.

A port view of a typical small sunken gill-net boat is shown in Fig. 4.

(2) Large Boats

The larger vessels range in length from 45 to 55 feet, with beams from 10 to 16 feet, and tonnages

Fig. 4

A typical small sunken gill-net boat.

Fig. 5

The drum of a small sunken gill-net boat.

from 10 to 25. Although a few of the larger vessels are powered by gasoline engines, most of them are driven by diesel engines with horse-power ratings of 60 to 165. Sleeping accommodation for a crew of four to six men is provided for by tiered bunks below the deck in the bow. Usually the captain sleeps in the pilot house or wheel-house on the deck. A row boat may be carried on the port side, lashed to the railing on the pilot-house, or it may be secured above the pilot-house (Fig. 8).

b. Drum and Rollers.

The drums are constructed of wood of a size suitable to the individual boat. They range from 3 to 4 feet in diameter and about 4 feet along the axis. Some of the larger drums are constructed of steel but these drums are not in common use among the fishing fleet. The wooden drum in use today is shown in Fig. 5.

The drum is turned by a shaft leading from the engine through a series of chain drives and a transmission system to a gear drive mounted on the axle of the drum. An old automotive clutch geared from the engine was the first transmission system used to supply the motive power for the gill-net drum. Many are still in use by the smaller boats. One fisherman is able to control the speed of the rotating drum and remove the dog-fish from the net as the latter is lifted over the stern of the boat.

On the stern of the boat is mounted a "V" roller (Fig. 6) which prevents the net from becoming entangled in the propeller. It also acts as a guide in keeping the net in the correct plane when the net is wound on the drum.

Fig. 6

The "V" roller on the stern of a small sunken gill-net boat.

Fig. 7

A dog-fish coming over the bow roller of a larger sunken gill-net boat in Hecate strait.

Some of the larger boats are equipped with bow rollers (Fig. 7), which enable the vessels to lift the nets in rougher seas. These are not power driven as were the bow rollers of the Columbia river gill-net and "diver-net" boats (Anon 1931).

c. Nets

The sunken gill-net for dog-fish is made of cotton web with a stretched mesh size of 6 1/2 or 7 inches. Mesh size is almost invariably 7 inches at the present time, but both 6 1/2 and 7 inch mesh nets were used by some fishermen in 1943 and 1944. Each net is about 50 fathoms long although some of the first nets constructed in British Columbia were as long as 75 fathoms. The depth of the net is 25 meshes or about 14 feet.

Webbing is marketed to the wholesale dealer in bales containing 910 fathoms of white cotton web, weighing about 273 pounds. The wholesale merchant treats the white web with a solution of "tanbark" referred to as "cutch" which protects the web from bacterial decay. The cost is 5 1/2 cents per pound of web to the fisherman. Nets that are treated with "Cuprinol" (Anon. 1940) are said to remain wet for long periods of time without risk of bacterial decay or overheating. Many fishermen treat the web with "cutch" or "tanbark" extracts from one of several oriental woods. Similar extracts are made from oak bark, hemlock bark, japonica, or quebracho (Firth and Carlson 1944).

Specifications of the dog-fish web are as follows:

Twine Size	Mesh Size inches	Depth in Meshes	Length of Bale fathoms
12 thread	6 1/2	25	900
15 thread	7	25	910

The price of dog-fish web to the fisherman was 57 cents per lb. per bale in 1945, 62 1/2 cents in 1946, and $1.10 per lb. per bale in 1947.

Some fishermen carry a few fathoms of the larger mesh size webbing for catching soup-fin sharks. Specifications of the soup-fin shark web are as follows:

Twine Size	Mesh Size inches	Depth in Meshes	Length of Bale fathoms
21 thread	10	24	500
24 thread	10	22	500

Nets are hung on the "cork line" of 1/2 or 5/8 inch manilla or sisal rope. Proper fullness of the web is important in the nets. Too much or too little web may affect the wearing quality, as well as the efficiency of the net. Sunken nets as a general rule are hung on the one-half (1/2) basis; that is, a net of 100 fa. stretched measurement will be only 50 fa. long when hung on the "cork line" (Fig. 10). The nets are hung with cotton hanging twine, usually 36 thread, but running to 54 thread or heavier, depending on the preference of individual fishermen.

d. Glass Ball Floats.

The glass ball floats most commonly used on sunken gill-nets are 4 1/2 inches in diameter although 5 and

6 inch glass balls have been used. Buoyancy of the 4 1/2 inch size is rated at 15 oz. with the 5-inch ball floating 23 oz. and the 6-inch diameter doubling this buoyancy to 46 oz. (Anon. 1943). Spacing of the glass balls along the "cork-line" varies somewhat with preference of the fisherman. Usually they are placed about 1 1/2 fathoms apart for the 4 1/2 inch size (Fig. 10).

The glass balls are "trapped" in "covers" (Fig. 11) made of tarred seine web of 1-inch mesh. Sometimes this is done by lacing pieces of tarred web of the proper dimensions into a partial sack and, when the glass ball is inserted, the pouch is then completed with close lacing. Another method, which is widely used, is the knitting of web about the glass ball in diamond-shaped meshes or in square meshes of becket twine.

Before the glass ball float was fully developed on this continent, a suitable float for submerged fishing presented a problem. The float must be able to withstand high water pressure without breaking or becoming water-logged and must be easily handled. Cedar floats treated with hot paraffin, coal tar, pine tar, or linseed oil were used in some experiments with "diver set-nets" (Anon. 1942) in catching soup-fin sharks off the Columbia river and in the submerged gill-net fishery in Alaska for king crabs (Carlson 1942). A satisfactory float was found to be the empty "stubby" beer bottle, with a buoyancy of approximately 7 ounces when sealed with standard lacquered metal caps with cork disk inner lining. It was during the summer of 1940 that J. T. Barnaby, U. S. Fish and Wildlife Service, constructed a submerged tangle net in which the

Fig. 8

The captain on the bridge is scouting for his marker pole, indicating position of the sunken gill-net in Hecate strait.

Fig. 9

A marker pole and buoy "scotchman" in Hecate strait.

"stubby" beer bottles were first used as floats (Carlson 1942).

e. Lead Line.

The lead weights on the "lead line" keep the net in place on the sea bottom while the glass floats keep it upright in the water. The lead line is 1/2-inch or 5/8-inch rope with 4 oz. lead weights strung along the rope and the weighting is such that the buoyancy of the glass ball floats is definitely overcome. About one pound of lead is placed on each fathom of lead line (Figs. 10 and 11).

f. Buoy Lines, Buoys, and Anchors.

An anchor bridle from 4 to 6 fathoms long is formed at the end of the "string" of nets from the "cork line" and the "lead line". These, when joined, form an "eye" or a small loop. The anchor is attached to the "eye" by the anchor line of 21 thread sisal rope from 1 to 2 fathoms long. The dory anchor weighing from 45 to 75 pounds holds the net on the sea bottom against the actions of the tidal currents. The buoy line extends from the anchor to the buoy and marker pole on the surface of the water (Fig. 10).

2. Fishing Methods.

From three to five nets are joined into one "string" or a "gang" (Whitehead 1930) of nets, and fished as one unit of 150 to 250 fathoms in length. In setting a net (Fig. 10), a marker pole (Fig. 9) and buoy are first put out, then the buoy line with the anchor attached follows. The boat moves ahead under power with the direction of the tide, while the net is payed out from the rotating drum. Another marker pole and

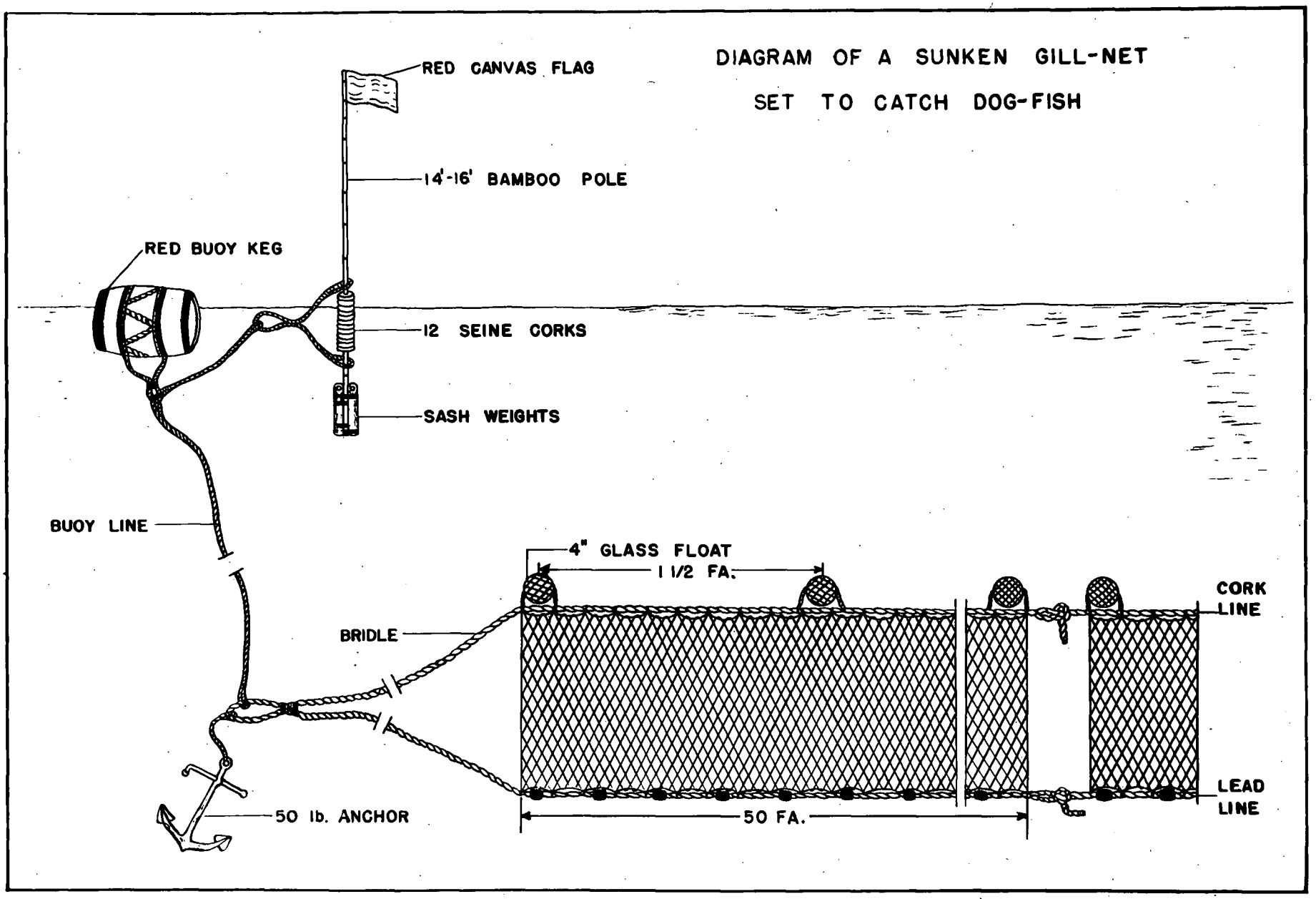
DIAGRAM OF A SUNKEN GILL-NET
SET TO CATCH DOG-FISH
RED CANVAS FLAG
14'-16' BAMBOO POLE
RED BUOY KEG
12 SEINE CORKS
SASH WEIGHTS
BUOY LINE
4" GLASS FLOAT
1 1/2 FA.
CORK LINE
BRIDLE
LEAD LINE
50 lb. ANCHOR
50 FA.

Fig. 10

buoy is attached to the other end of the net. A "string" of nets is usually left in the water from 12 to 24 hours. Upon returning to the fishing grounds the fisherman lifts the marker and buoy into the boat and fastens the buoy line to a loop of rope on the axle of the drum. The buoy line and the net are now lifted from the sea bottom by the rotating drum. The speed of the rotating drum is governed by the clutch mounted nearby. It may take from 1 to 2 hours to lift a "string" of nets, depending on the weather and the number of dog-fish caught in the net. A "string" of nets is reset on the same grounds if a good catch has been made, otherwise grounds are sought where better fishing has been reported. The dog-fish and other species of fish (see Fig. 11 and Fig. 13) are picked out of the net as they come over the stern roller in the small boats or the bow roller in the large boats.

Fig. 7, shows a dog-fish coming over the bow roller of one of the larger boats and in Figs. 11 and 13, the fisherman is removing the dog-fish from the net on the same boat.

After fishing operations the boats enter sheltered bays where the livers are removed from the dog-fish into 40 pound capacity tins. The carcasses are thrown over-board. They are not discarded on the fishing grounds as the Canadian fisherman believe the latter will become fouled, thus preventing further catches. The American otter trawl fleet, however, operating in Hecate strait, discard all the carcasses on the fishing grounds. International fishing regulations prohibit these vessels from trawling within three miles of the shoreline but they are permitted to seek the shelter of a Canadian port during a storm.

Fig. 11

"Picking" a ♀ dog-fish from the gill-net. Note the female dog-fish on deck and the rock sole caught in the mesh.

Fig. 12

Winding the sunken gill-net on the drum of a large boat.

In Hecate strait the length of a trip may be from 1 to 7 days, depending upon the weather and the number of dog-fish or soup-fin shark caught. On the west coast of Vancouver island, off Barkley sound, the boats return to the fishing camp every evening to market the dog-fish livers and other fresh fish caught.

The fishing camps in Skidegate inlet at Queen Charlotte City are shown in Fig. 14. The camp is a large scow with a store and an ice-house for freezing the livers and fresh fish.

3. Care of the Nets.

Each week the nets are mended and cleaned in a solution of copper sulphate to prolong their usefulness. Generally, 25 to 40 pounds of copper sulphate (bluestone) are dissolved in about 29 gallons of water (Firth and Carlson 1944). Exact proportions are seldom used, the strength being determined by the colour of the solution. The bluestone is placed in a burlap sack and worked through the water in a large wooden tank, then the nets are immersed in the solution. After bluestoning, the nets must be washed in water as the solution is acidic and will itself rot the nets. The scow in the background of Fig. 14, contains bluestone tanks and drying racks for the nets.

C. Other Species of Fish Caught by Sunken Gill-nets.

1. In Hecate Strait.

Although the 7-inch mesh net was designed to capture dog-fish, other species of fish are taken on the gear. A number of soles are taken but these along with gray cod,

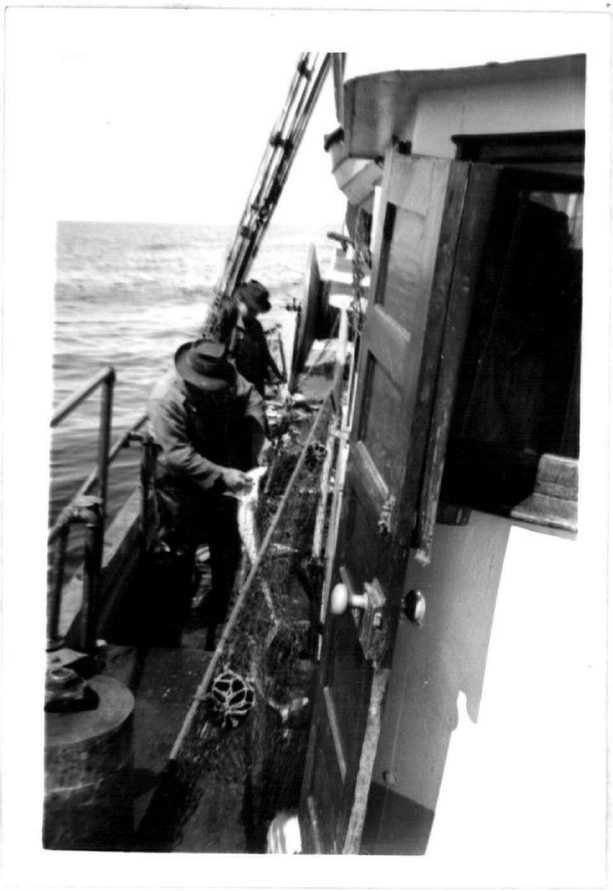

Fig. 13

"Picking" dog-fish from the sunken gill-net of a large boat in Hecate strait.

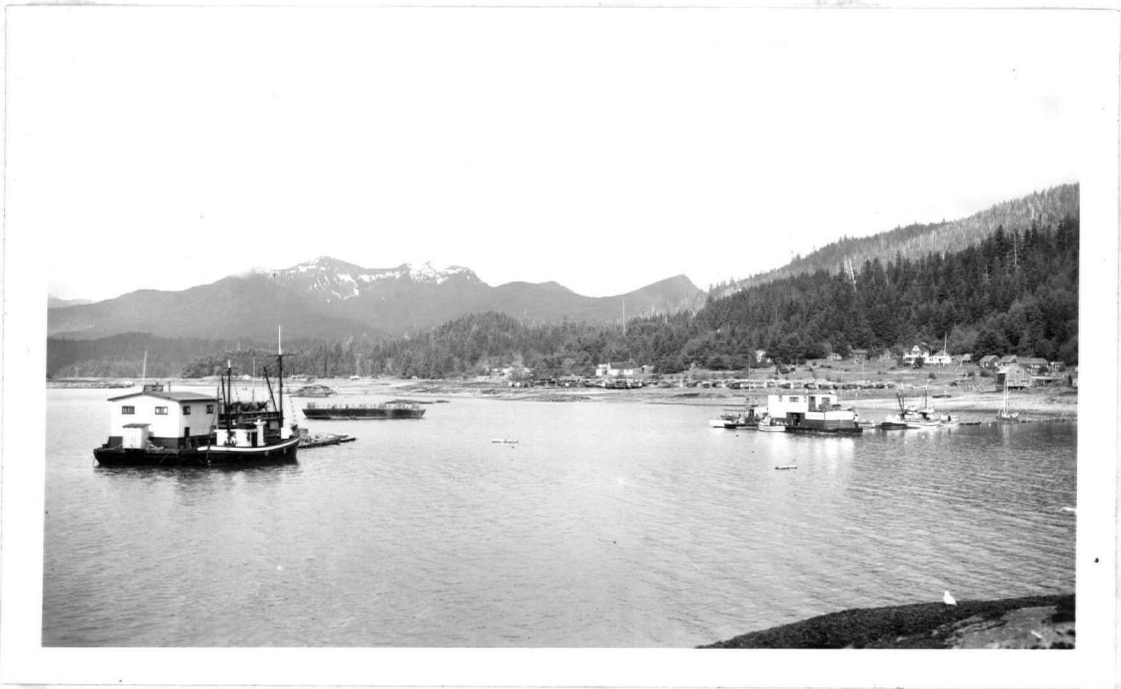

Fig. 14

Two fishing camps in Skidegate inlet, Queen Charlotte islands. Note bluestone tanks on a scow in the center background.

skate, halibut and others are usually returned to the sea because there is not a ready market for them in this area. Occasionally a few lingcod and blackcod are caught an are marketed along with their livers.

On June 18, 1946, the following numbers of fish were noted to be caught by 5 "strings" or a total of 25 sunken gill-nets. The nets were set in 14 fathoms, off Skidegate bar in Hecate strait.

butter sole	(Isopsetta isolepis)	166
sand sole	(Psettichthys melanostictus)	125
rock sole	(Lepidopsetta bilineata)	38
gray cod	(Gadus macrocephalus)	13
halibut	(Hippoglossus stenolepis)	1
dog-fish	female	457
	male	57

Other sets were observed on different boats fishing in this area and similar catches were recorded.

2. East Coast of Vancouver Island.

The sunken gill-net proved to be very effective in capturing large numbers of lingcod (Ophidon elongatus) in the strait of Georgia, when set on the lingcod reefs. On June 9, 1942*, fishermen using gill-nets, set-nets, and sunken gill-nets were prohibited from marketing lingcod caught by such gear.

* (Order in Council, June 9, 1942, P.C. 4877), Special Fishery Regulations for the Province of British Columbia, 1942.

On May 26, 1944, a special set was made on a lingcod reef, 300 fa. east of Pinnacle point near Departure bay. The "string" of nets, 300 fa. long with a mesh size of 6 1/2 inches, had been set in 50 fa. of water for only 12 hours and when lifted the writer observed the following number of lingcod captured:

lingcod (male) ..... 56 (13 alive)

lingcod (female) ..... 76 (43 alive)

Only 5 male and 6 female dog-fish were caught.

It was estimated that nearly 2,000 pounds of lingcod (averaging 15 lbs. each) were taken from this sunken gill-net.

It is evident that if this fishery were intensified, these sunken gill-nets could deplete in a short time many of the lingcod banks in the gulf of Georgia.

By the Order in Council of July 7, 1944**, sunken gill-nets were prohibited from operating in all the coastal waters of British Columbia after December 16, 1944. This order was later amended on April 16, 1945*** to apply only to the gulf of Georgia and certain other fishing localities.

3. West Coast of Vancouver Island.

On the mud bottom of the waters off Barkley sound lingcod and sable-fish or black cod (Anoplopoma fimbria) are

** (Order in Council July 7, 1944, P.C. 5207), Special Fishery Regulations for the Province of British Columbia, 1944.

*** (Order in Council April 16, 1945, P.C. 2649; O.C. February 28, 1946, P.C. 736; O.C. April 18, 1946, P.C. 1525), Special Fishery Regulations for the Province of British Columbia, 1946.

caught in the sunken gill-nets along with dog-fish in sufficient quantity to be readily marketed. Nets set in certain areas may have lingcod and black cod tangled in the web one day and when set in the same area on other occasions neither species may be caught.

The following species and their numbers were recorded from 10 different sets made by boats fishing off Barkley sound in June, 1944:

Hag-fish (Polistotrema stoutii)	2
Dog-fish (Squalus suckleyi)	1,028*
Big skate (Raja binoculata)	1
Rat-fish (Hydrolagus colliei)	175**
Spring salmon (Oncorhynchus tshawytscha)	6
Gray cod (Gadus macrocephalus)	1
Bocaccio (Sebastodes paucispinis)	5
Yellow-tailed rock-fish (Sebastodes flavidus)	3
Sebastodes spp.	3
Lingcod (Ophiodon elongatus)	62
Sable-fish (Black cod)(Anoplopoma fimbria)	4
Long-jaw flounder (Atheresthes stomias)	245**
Halibut (Hippoglossus stenolepis)	2
Brill (Eopsetta jordani)	52
Crabs (Cancer magister)	1

* This is an estimated number, based upon counted random samples of dog-fish livers of known weights and the total weight of all the dog-fish livers.

** This number is in part estimated.

The following species of fish were recorded from different landings in Barkley sound; soup-fin shark (Galeorhinus galeus), green sturgeon (Acipenser medirostris), pilchard (Sardinops caerulea), herring (Clupea pallasii), coho salmon (Oncorhynchus kisutch), hake (Merluccius productus), red-striped rock-fish (Sebastodes proriger), flat-head sole (Hippoglossoides elassodon), rock sole (Lepidopsetta bilineata), lemon sole (Parophrys vetulus), wolf-eel (Anarrhichthys ocellatus), wry-mouth

(Delolepis giganteus).

It was observed off Barkley sound that the hag-fish (Polistotrema stoutii) will eat the livers from the dog-fish when the nets are left in the water for more than 12 hours. The writer has removed as many as four hag-fish from the body cavity of a single dog-fish.

D. Selectivity of the Sunken Gill-net.

The sunken gill-net has not only proven an effective means of capturing dog-fish but it also tends to select the length of the dog-fish; small ones tend to pass through the webbing, thus eliminating those of no commercial value. Male dog-fish less than 76 cm. long contain so little vitamin "A" that they are of no appreciable value. Few female dog-fish are mature at 76 cm. and only about 50 percent of males become mature at this size.

Length-Frequency Distribution of Dog-fish Caught by Sunken Gill-nets and by Otter Trawls

Figures 15 and 16 illustrate the length-frequency distributions of dog-fish caught in sunken gill-nets off Barkley sound during the months of June and August respectively, in 1944. During these two months a greater percentage of males than females was taken. Fig. 17 illustrates the length-frequency distribution of dog-fish caught by sunken gill-nets in Hecate strait during June 1946. A greater percentage of female dog-fish were caught by the sunken gill-nets during this period in Hecate strait. Figures 18 and 19 illustrate the

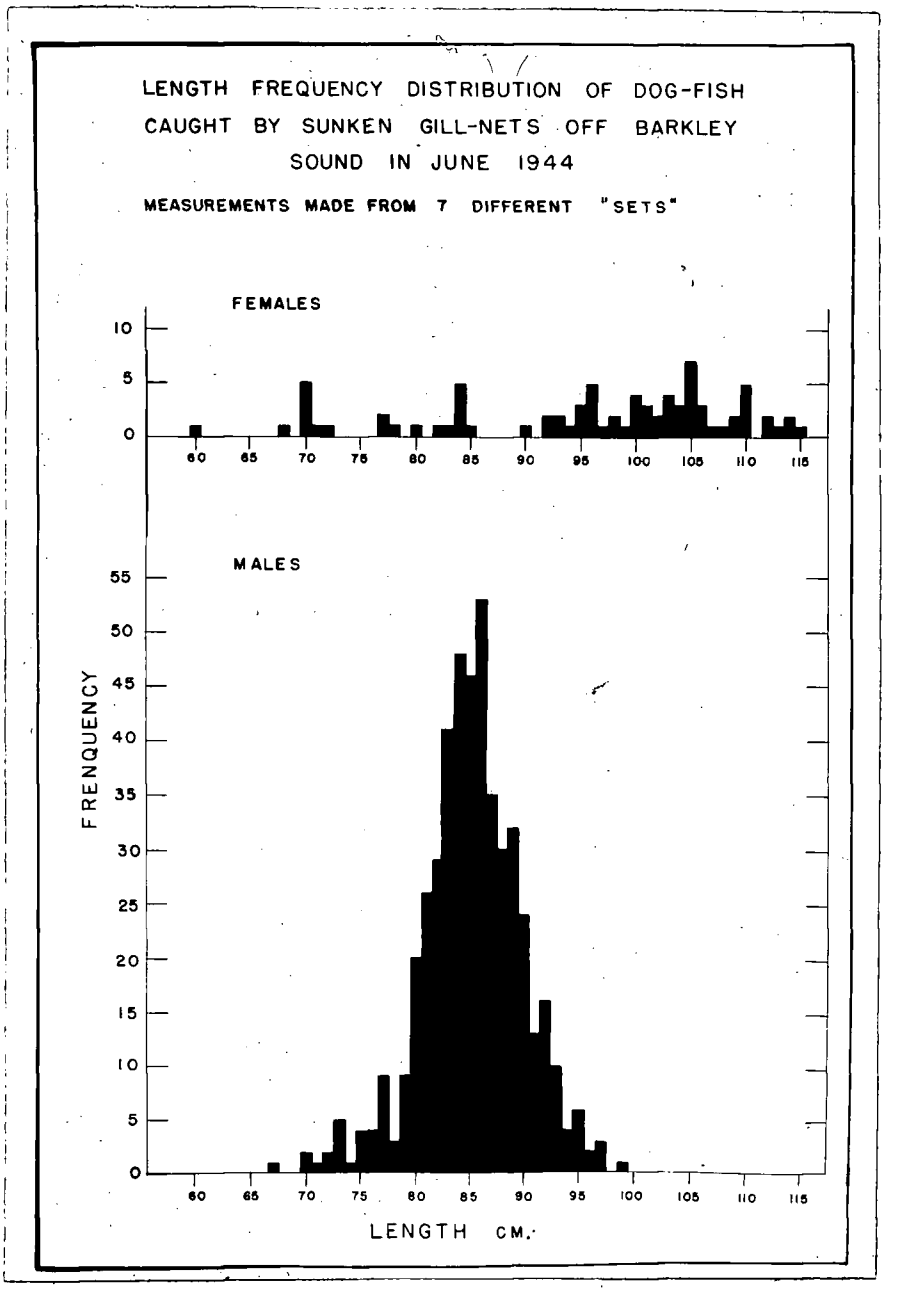
LENGTH FREQUENCY DISTRIBUTION OF DOG-FISH
CAUGHT BY SUNKEN GILL-NETS OFF BARKLEY
SOUND IN JUNE 1944
MEASUREMENTS MADE FROM 7 DIFFERENT "SETS"
FEMALES
10
5
0
60 65 70 75 80 85 90 95 100 105 110 115
MALES
55
50
45
40
35
30
25
20
15
10
5
0
FRENQUENCY
60 65 70 75 80 85 90 95 100 105 110 115
LENGTH CM.

Fig. 15

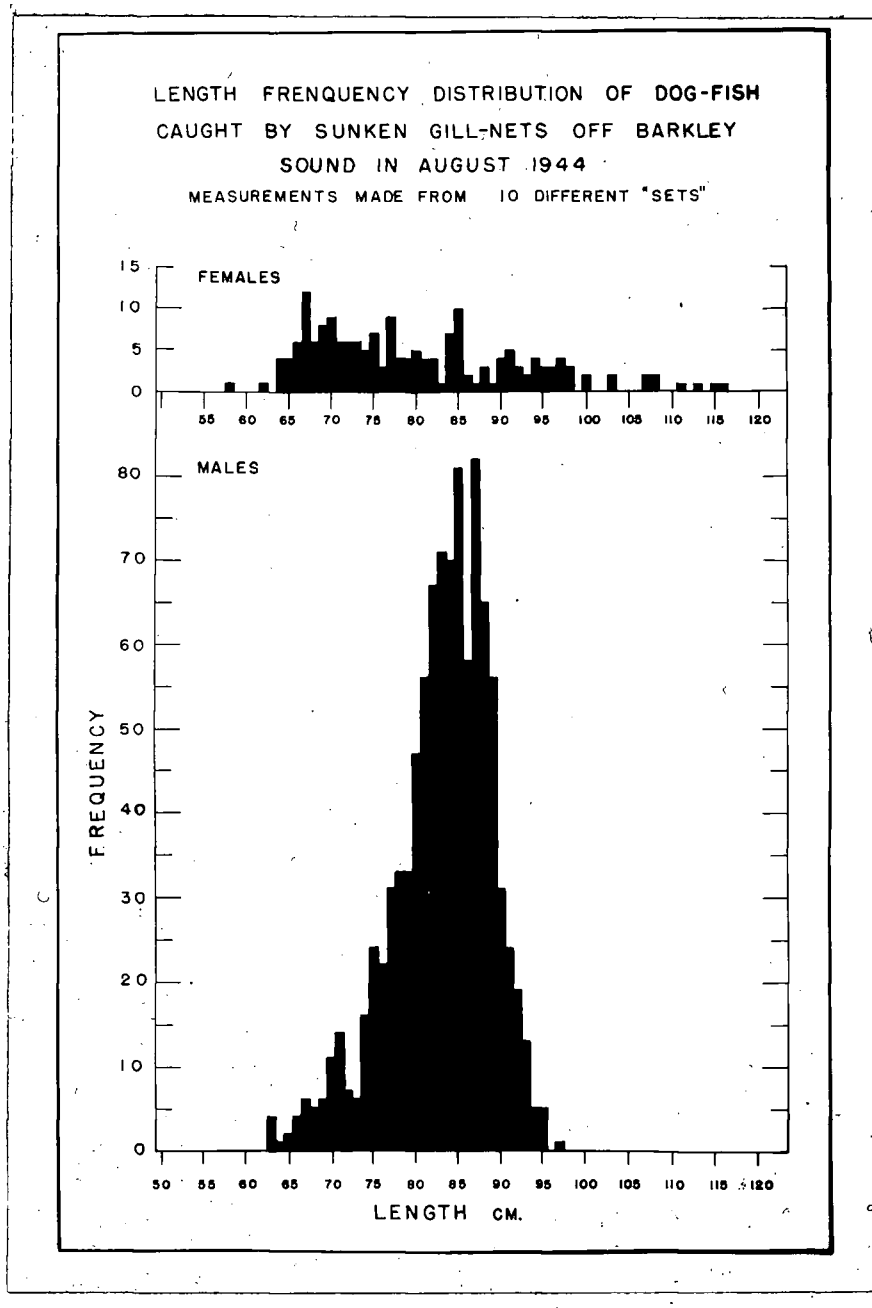
LENGTH FRENQUENCY DISTRIBUTION OF DOG-FISH
CAUGHT BY SUNKEN GILL-NETS OFF BARKLEY
SOUND IN AUGUST 1944
MEASUREMENTS MADE FROM 10 DIFFERENT "SETS"
FEMALES
MALES
FREQUENCY
LENGTH CM.

Fig. 16

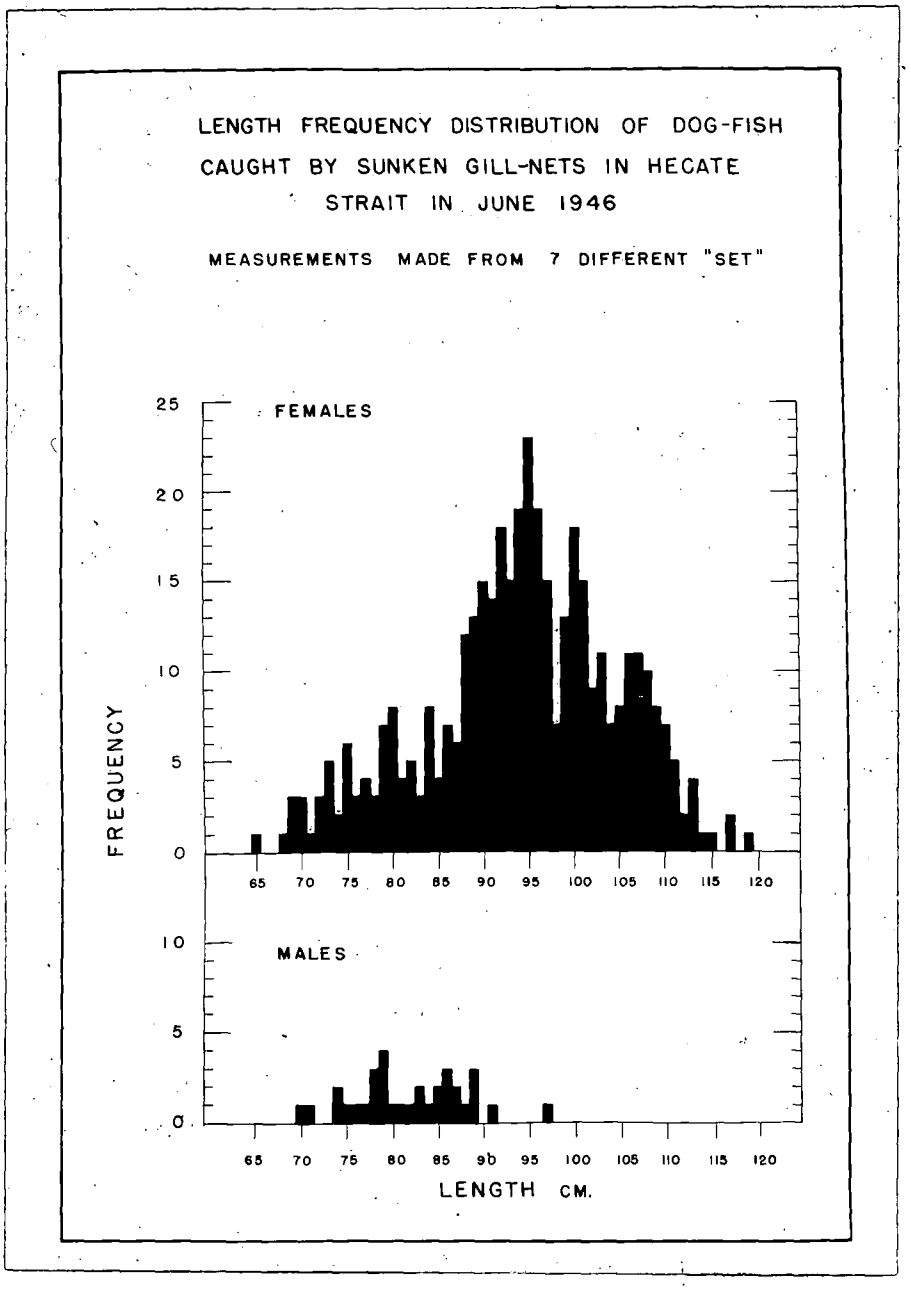
LENGTH FREQUENCY DISTRIBUTION OF DOG-FISH
CAUGHT BY SUNKEN GILL-NETS IN HECATE
STRAIT IN JUNE 1946
MEASUREMENTS MADE FROM 7 DIFFERENT "SET"
FEMALES
MALES
FREQUENCY
25
20
15
10
5
0
10
5
0
65 70 75 80 85 90 95 100 105 110 115 120
65 70 75 80 85 90 95 100 105 110 115 120
LENGTH CM.

Fig. 17

length-frequency distributions of dog-fish caught by sunken gill-nets and otter trawls respectively off the west coast of Vancouver island. The dog-fish caught by the sunken gill-nets (Fig. 18) were caught off Barkley sound while those caught by the otter trawls (Fig. 19) were taken only 10 miles northward, off Florencia island and Amphitrite point. Figures 15, 16, 17, and 18 show that the sunken gill-nets tend to select the larger dog-fish over 76 cm. which have liver of significant commercial value while, Fig. 19 illustrates the large number of otter trawl caught dog-fish that are less than 76 cm. which are of no appreciable value. It is evident that the otter trawl does not select the dog-fish when fishing on the sea bottom and thus also catches large individuals when they are present on the trawling grounds.

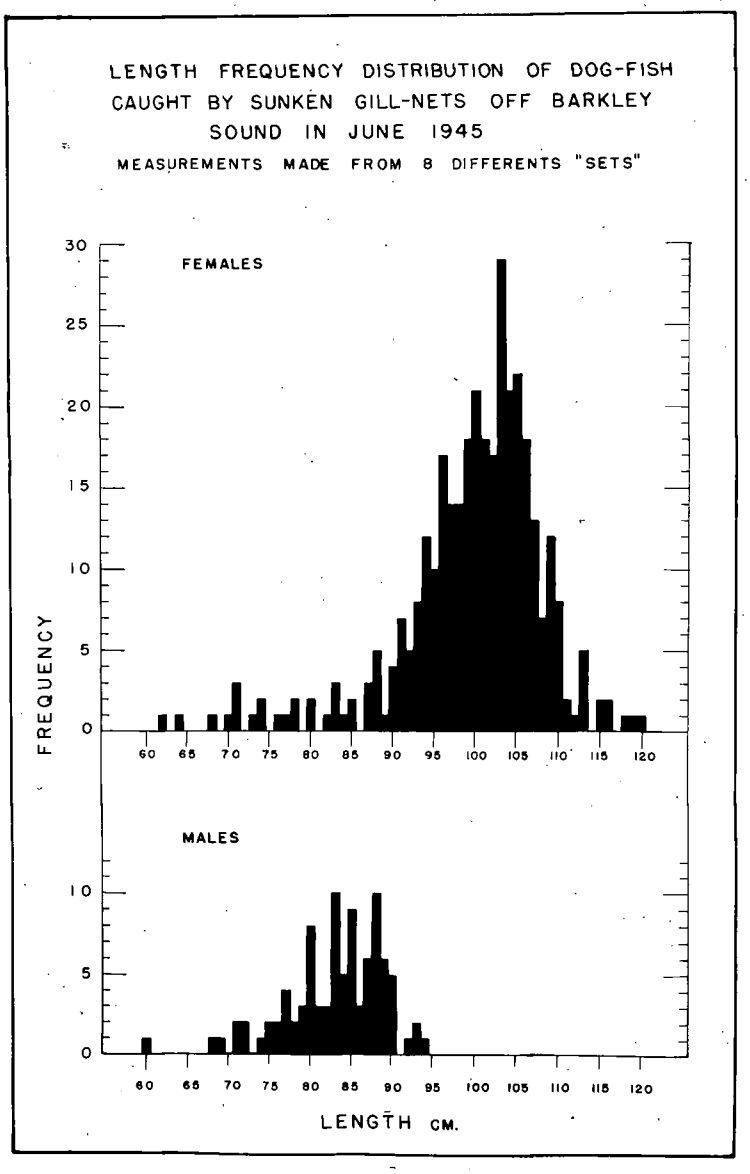
LENGTH FREQUENCY DISTRIBUTION OF DOG-FISH
CAUGHT BY SUNKEN GILL-NETS OFF BARKLEY
SOUND IN JUNE 1945
MEASUREMENTS MADE FROM 8 DIFFERENTS "SETS"
FEMALES
MALES
FREQUENCY
LENGTH CM.
30
25
20
15
10
5
0
60 65 70 75 80 85 90 95 100 105 110 115 120

Fig. 18

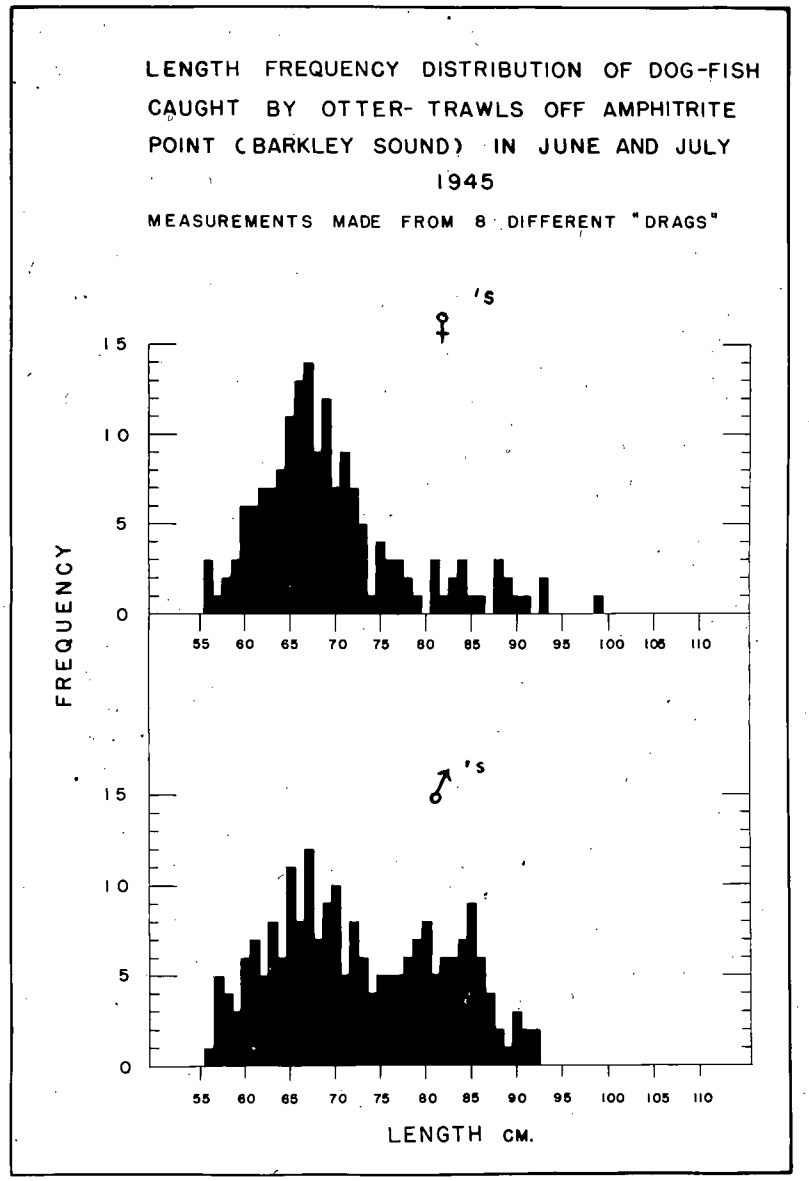
LENGTH FREQUENCY DISTRIBUTION OF DOG-FISH CAUGHT BY OTTER- TRAWLS OFF AMPHITRITE POINT (BARKLEY SOUND) IN JUNE AND JULY 1945
MEASUREMENTS MADE FROM 8 DIFFERENT "DRAGS"
♀'s
♂'s
FREQUENCY
0
5
10
15
55 60 65 70 75 80 85 90 95 100 105 110
LENGTH CM.

Fig. 19

IV. TOTAL CATCH STATISTICS OF THE DOG-FISH AND SOUP-FIN SHARK IN BRITISH COLUMBIA

Total catch statistics are of value wherever a mass of data exists and wherever those facts can be expressed quantitatively in a form suitable for analysis. Catch statistics of a commercial fishery help to constitute a scientific background for fishery regulations and management. Intelligent management cannot be conducted without statistics. The catch, which is indicated by quantitative units, varies from year to year and the quantitative units form a means of expressing the economic condition of the fishery. Total catch statistics may indicate the changes, if any, in the abundance of fish on the grounds, but usually are too involved to reveal the existing state of abundance of a commercially exploited fishery population.

The annual production and value of dog-fish liver oil and body oil from 1876 to 1945 are given in Table II. From 1879 to 1887 a record was kept of the production of refined dog-fish liver oil. Separate catch statistics for the production of liver and body oil were not kept again until the year 1940. The commercial development of refined dog-fish liver oil in British Columbia was first centered on the Queen Charlotte islands at Skidegate, where production of liver oil and body oil continued for a number of years. Before 1900, a small amount of seal and porpoise oil was included in the total amount of dog-fish liver and body oil produced.

The amount of dog-fish liver and body oil produced in

Table II

Production of Dog-fish Liver oil and Body oil from 1876 to 1945.

	Dog-fish Liver and Body Oil		Refined Dog-fish Liver Oil	
	Gallons	Value $	Gallons	Value $
1876	50,124	25,024.00		
1877	115,495	46,198.00		
1878	150,516	60,206.40		
1879	104,475	41,790.00	12,780	1,500.00
1880	119,362	47,744.80	20,000	11,000.00
1881	142,240	56,896.00	27,000	14,850.00
1882	196,407	78,562.80	37,000	20,350.00
1883	217,419	86,967.60	40,000	22,000.00
1884	10,000	3,500.00	45,000	24,800.00
1885	22,200	5,550.00	40,000	20,000.00
1886	25,000	10,000.00	20,000	10,000.00
1887	40,000	16,000.00	67,500	33,750.00
1888	64,345	32,172.50		
1889	141,420	70,710.00		
1890	162,264	81,132.00		
1891	249,500	124,750.00		
1892	259,554	129.046.20		
1893	172,250	68,900.00		
1894	143,000	57,200.00		
1895	135,000	54,000.00		
1896	61,500	24,600.00		
1897	95,500	28,650.00		
1898	124,525	37,357.00		
1899	145,200	43,560.00		
1900	128,100	35,227.50		
1901	152,100	45,630.00		
1902	161,950	56,682.50		
1903	223,550	78,242.50		
1904	192,750	67,462.50		
1905	175,990	61,596.50		
1906	125,265	43,842.00		
1907	116,640	40,474.00		
1908	142,480	56,646.00		
1909	209,950	64,122.50		
1910	77,240	26,767.00		
1911	75,550	24,262.00		
1912	85,826	29,075.00		
1913	144,050	46,690.00		
1914	41,249	12,481.00		
1915	33,565	12,363.00		
1916	7,505			
1917	44,820	23,892.00		
1918	53,383	53,383.00		
1919	54,954	35,097.00		

Table II

	Dog-fish Liver and Body Oil		Refined Dog-fish Liver Oil.	
	Gallons	Value $	Gallons	Value $
1920	55,669	31,155.00		
1921	44,700	7,110.00		
1922	75,461	22,655.00		
1923	180,318	64,696.00		
1924	241,376	88,855.00		
1925	354,853			
1926	217,150			
1927	375,130	138,180.00		
1928	411,208	119,120.00		
1929	459,575	122,513.00		
1930	114,558	22,229.00		
1931	170,271	19,362.00		
1932	35,147	4,629.00		
1933	117,600	13,170.00		
1934	203,930	25,205.00		
1935	122,380	23,744.00		
1936	164,643	34,745.00		
1937	124,464	28,074.00		
1938	113,360	18,802.00		
1939	130,044	38,177.00		

	Dog-fish Body Oil		Dog-fish Liver Oil	
	Gallons	Value $	Gallons	Value $
1940	95,484	20,997.00	64,269	84,405.00
1941	71,582	29,569.00	212,175	531,355.00

	Dog-fish Body Oil		Dog-fish Liver Oil	
	lb.	Value $	lb.	Value $
1942	433,667	31,135	2,802,277	1,178,242.00
1943	334,696	16,756	3,509,213	2,028,875.00
1944	163,103	8,263	4,909,808	3,661,131.00
1945			3,880,483	2,337,267.00

	Dog-fish Body Oil	Dog-fish Body Oil
	Gallons*	Gallons*
1942	390,300	2,538,863
1943	301,226	3,179,347
1944	146,793	4,448,286
1945		3,515,663

* Sp. gr. of Dog-fish Liver Oil at 25°C. = 0.906

British Columbia was relatively constant from 1877 to 1940, with the exception of minor fluctuations. A drop in production of oil ensued following the outbreak of World War I. With the "boom" years which followed (1927 to 1929) an increase in effort, indicated by the increase in the number of licences, resulted in a decided increase in total production (Table II). During the decade that followed the output returned to its former level of production.

Until 1941 the demand for dog-fish liver and body oil never attained a magnitude of importance. During this year the need for vitamin "A", which is stored in the liver of the dog-fish, became very apparent and the dog-fish assumed a degree of importance with a resulting sudden influx of fishermen to this fishery (Table I). The output of liver oil soared to unprecendented heights during the four years following 1941 (Table II). In 1942 the amount of liver oil and body oil produced was recorded in pounds. These figures have been converted into gallons for comparison with the previous years.

After the oil has been removed from the body of the dog-fish the remainder after processing is marketed as meal and fertilizer (Table III). The production of body oil ceased after 1944. Since the dog-fish were caught only for their livers after this year the carcasses were discarded.

Some fresh dog-fish have been marketed in certain years (Table IV), but the fresh fish has not met the general approval of the fresh fish market. The quantity of whole dog-fish caught and landed in British Columbia from 1916 to 1944 is presented in Table IV.

Table III

Production of Dog-fish Meal and Fertilizer from 1892 to 1944.

	Dog-fish Meal and Fertilizer	
	Tons	Value $
1892	15	375.00
1893	15	375.00
1894	30	600.00
1895	15	375.00
1896	50	1,000.00
1897		
1898	200	6,000.00
1899	550	16,500.00
1900	200	6,000.00
1901	300	9,000.00
1902	150	4,500.00
1903	1,060	31,800.00
1904	607	18,210.00
1905	872	26,160.00
1906	140	3,570.00
1907	1,294	32,362.50
1908	84	2,352.00
1909	487	13,636.00
1910	266	700.00
1911		
1912	150	5,097.00
1913	1,649	59,254.00
1914	1,244	47,432.00
1915	953	36,477.00
1916		
1917	1,220	70,164.00
1918	1,802	18,198.00

	Dog-fish Meal and Fertilizer	
	Tons	Value $
1919	1,800	19,756.00
1920	466	39,147.00
1921	489	27,010.00
1922	911	48,926.00
1923	823	43,447.00
1924	1,709	94,303.00
1925	2,468	
1926	1,752	
1927	2,512	145,449.00
1928	3,658	
1929	3,626	173,254.00
1930	899	45,165.00
1931	1,010	34,869.00
1932	264	7,018.00
1933	786	23,580.00
1934	1,135	39,510.00
1935	768	22,924.00
1936	1,065	34,906.00
1937	833	26,740.00
1938	1,262	42,807.00
1939	925	36,322.00
1940	1,285	63,210.00
1941	1,051	69,062.00
1942	914	60,872.00
1943	708	41,857.00
1944	330	21,136.00

Table IV

Quantity of Dog-fish (whole fish) Caught and Landed in British Columbia from 1916 to 1944

	Weight Landed cwt.	Value $	Marketed	
			Fresh cwt.	Value $
1916	5,460	1,911	5,460	1,911*
1917	11,200	4,480	11,200	4,480*
1918	59,194	29,607	59,194	29,607*
1919	50,920	17,822		
1920	15,000	4,550		
1921	52,560	12,998		
1922	40,240	10,085		
1923	48,640	12,812		
1924	74,000	23,150		
1925	74,040	22,212		
1926	78,380	23,514		
1927	112,700	39,445		
1928	230,557	80,694		
1929	259,540	90,839		
1930	98,680	30,372		
1931	112,348	22,929		
1932	28,020	4,203		
1933	79,609	13,789		
1934	117,020	21,921		
1935	76,800	15,360		
1936	116,140	26,309	340	68
1937	113,220	32,428	3,920	1,274
1938	159,690	27,087	45,951	2,310
1939	114,816	23,888		
1940	141,350	57,236		
1941	142,999	100,965	5,843	13,117
1942	100,540	12,055		
1943	78,924	9,865		
1944	24,339	25,606		

* Exported to the United States

Fig. 20 illustrates the total landings of dog-fish livers for British Columbia from 1937 to 1946. The value of the livers and the average price per pound paid to the fishermen is given in Table V. The catch of the dog-fish dropped greatly in the years following 1944 as indicated by the quantity of livers landed, (Fig. 20). This drop in total catch indicated that the high fishing intensity was possibly exploiting the dog-fish beyond the limits of a stable and productive level.

Although the soup-fin shark is not nearly as abundant as the dog-fish in British Columbia waters, its livers provide a substantial part of the vitamin "A" supply. The vitamin "A" content of the soup-fin shark livers is even greater than that in the livers of the dog-fish.

Fig. 21 illustrates the total landings of soup-fin shark livers in British Columbia from 1940 to 1946. There was a marked drop in the landings of livers during the years 1945 and 1946. The value of the soup-fin shark livers and the marketed value of the liver oil is given in Table VI.

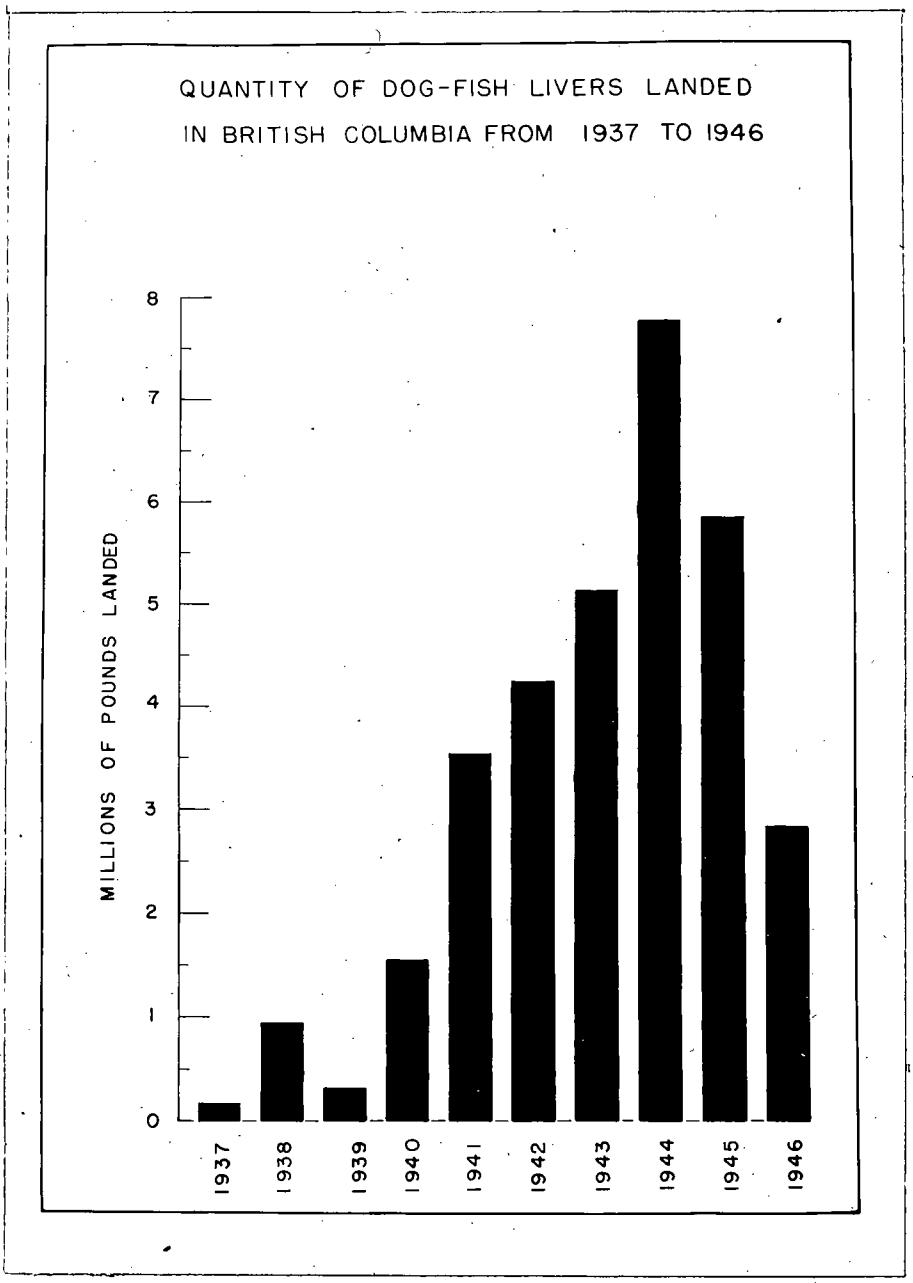
QUANTITY OF DOG-FISH LIVERS LANDED
IN BRITISH COLUMBIA FROM 1937 TO 1946
MILLIONS OF POUNDS LANDED
0
1
2
3
4
5
6
7
8
1937
1938
1939
1940
1941
1942
1943
1944
1945
1946

Fig. 20

Table V

Quantity and Value of Dog-fish Livers
Landed in British Columbia from 1937 to 1946.

	Weight Landed lb.	Value $	Average Price ¢ to Fishermen per lb.
1937	178,900*	10,702°	6
1938	933,300**	49,271°	6
1939	308,047***	19,063°	6
1940	1,566,500	86,192	6
1941	3,552,576	331,737	9
1942	4,241,256	688,040	16
1943	5,121,186	1,344,858	25
1944	7,769,564	2,661,573	34
1945	5,821,849	1,833,210	31
1946	2,844,217	888,075?	32.5

* All livers exported.

** All livers exported with the exception of a small proportion used by local chemical and fishery companies in experimental work.

*** Figure estimated from Vitamin Oil Production plus quantity exported.

° Marketed values of livers only.

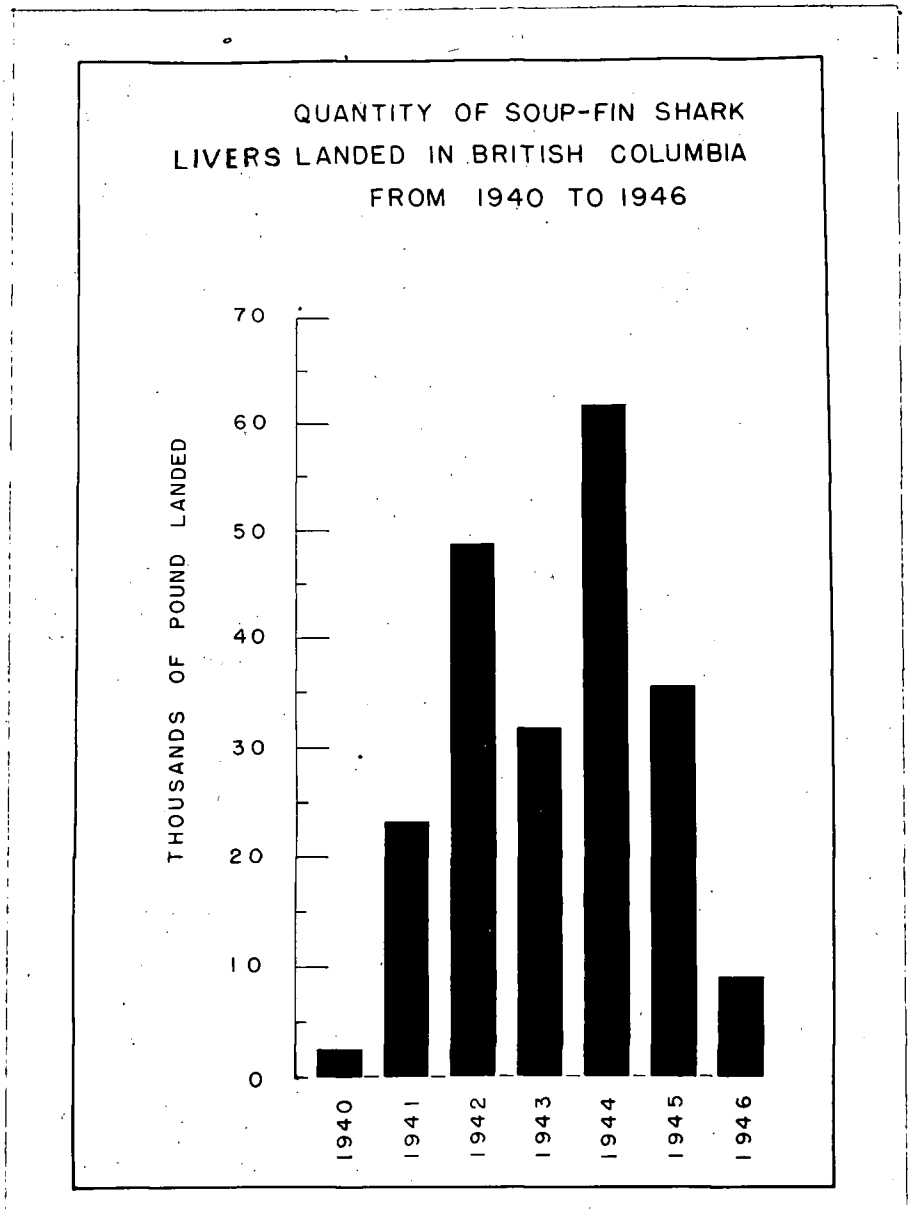
QUANTITY OF SOUP-FIN SHARK
LIVERS LANDED IN BRITISH COLUMBIA
FROM 1940 TO 1946
THOUSANDS OF POUND LANDED
70
60
50
40
30
20
10
0
1940
1941
1942
1943
1944
1945
1946

Fig. 21

Table VI

Quantity of Soup-fin Shark Livers Landed in British Columbia with Marketed values of the Livers and Liver Oil.

	Weight Landed lb.	Value $		Liver Oil Marketed	
		Landed	Marketed	lb.	value
1940	2,600	1,090	2,094	700	1,400
1941	23,191	51,509	68,122	10,266	23,262
1942	48,768	136,137	168,596	18,375	126,461
1943	31,922	86,300	99,931	12,926	78,886
1944	61,510	218,337	300,641	34,690	288,436
1945	35,341	140,103	168,702	20,967	162,154
1946	9,005	23,973	37,186	5,005	32,870

V. DESCRIPTION AND ANALYSIS OF THE AVAILABILITY OF THE DOG-FISH AND SOUP-FIN SHARK

A. Selection and Source of Data.

Before an analysis of the availability of the dog-fish and soup-fin shark may be accomplished, adequate catch statistics must be available. For analyses it is necessary to know the individual landings of livers from all, or nearly all the fishermen, and the locality of each catch. In British Columbia, neither the Dominion nor the Provincial Fisheries Department collect catch statistics that are adequate for an analysis of the availability and abundance of commercially important fishes caught in these waters.

In the State of California, the Division of Fish and Game have for many years had a clearer picture of the fishery problems because of the nature of the recorded data. In 1931 (Conner 1937) the collection of complete and informative biological statistics was inaugurated. The California Division of Fish and Game have what is known as the "pink ticket" system of collecting statistics. Fish receipts, or tally slips are made in triplicate, on forms supplied by the Division of Fish and Game. One copy covering each sale goes to the fisherman, one to the fish buyer, and the third or "pink ticket" to the Division. The Division then transfers the data from the receipt or "pink ticket" to special cards which are sorted and recorded in almost any desirable form, by electrically operated Hollerith tabulating machines (Conner 1935).

For the analysis in this study it therefore became necessary to collect such data from the fishing industry and to tabulate it. The data were collected from the individual tally slips, or fish receipts, of the dog-fish and soup-fin shark liver landings from all parts of the British Columbia coast, wherever records were to be found. It is not essential to have a complete record of every landing made from each area under study. In undertaking an analysis of availability, completeness in data adds to the accuracy of the investigation. Each tally slip or fish receipt indicates the date, place of sale, the dealer's name, the fisherman's name, the name of the boat, weight and value of the dog-fish and soup-fin shark livers landed, as well as the weights of the varieties of fresh fish landed. The data on these receipts were then compiled on special forms, listing the fisherman's name and boat, and the locality where the fish were caught.

B. Estimating Changes in the Availability and Abundance of Fish Populations.

Exploitation of any virgin fishery tends to change the abundance of the fish population on which it depends. Effective fisheries administration depends upon knowledge of the extent of the exploitation and its course. In general, direct measures of fish populations are not feasible, but relative estimates can be obtained from analyses of fisheries statistics. As a rule, such statistics are most useful when they include detailed accounts of the amount of fishing effort and localities

fished. In most fisheries, total catch is too involved with the amount of fishing effort to reflect well the changes in the abundance of fish on the grounds. Knowledge of fishing costs is useful in interpreting fishery production figures.

In order to obtain fishery statistics in the most useful form, pilot house record books have been used in the herring (Tester 1945), the pilchard, and the halibut fisheries on the pacific coast. Some fishermen on sunken gill-net boats keep pilot house record books of their own.

As a rule, calculations of return per unit of fishing effort is one of the most valuable indices of availability and abundance. Should the amount of effort that is used, vary from year to year, catch per unit of effort may not be used directly to indicate the relative abundance or availability, without considering the actual amount of effort used in successive years. Conclusions can be distorted by cumulative and unassessable changes in the quality of the effort. The theoretical relationship of catch per unit effort to abundance and rate of exploitation has been discussed by Ricker (1940).

The return per-unit-of-effort has been used in the halibut investigations (Thompson, Dunlop, and Bell 1931, Thompson and Bell 1934), and in the study of the depletion of the black cod by Bell and Gharrett (1945). The index used in these studies was the "catch per-skate". The "catch per-seine-day" has been used by Tester (1945) in the herring fishery; the catch "per-boat-week", the "catch per-boat-per-night", by Silliman and Clark (1945), and "catch per-lunar month" (Clark 1939) in the pilchard fishery investigation. Rousefell and Kelez

(1938) use the "catch per-seven-day period per boat of 30-39 net tons as in index of the availability for the salmon fishery.

C. Meaning of Availability and Abundance.

In this study of the dog-fish and soup-fin shark, "availability" will refer to the relative amount of the dog-fish and soup-fin shark in the waters of British Columbia subjected to the sunken gill-net fishery. Availability in this sense does not mean abundance. The dog-fish and soup-fin sharks may be abundant, that is, the actual numbers of these sharks may be in great quantities in the waters but they may not be available to the sunken gill-nets. Availability, therefore, is a relative term applying only to that part of the total population within the horizontal and vertical range of the sunken gill-nets and moving around actively enough to become emmeshed in them.

In the analysis of catch statistics from Hecate strait, the unit of effort is the average boat catch per month of dog-fish and soup-fin shark livers, independent of the number of nets fished. Should there be a decline in the average catch per boat from year to year, even though there is an increase in the number of nets fished per boat, it will certainly indicate a decline in the availability of the dog-fish and soup-fin shark.

On the west coast of Vancouver island, off Barkley sound more detailed information of the effort expended by the fishermen in catching the dog-fish was available for the period of

time under investigation. In this area catch per sunken gill-net (75 fathoms) per day (24 hours) will be used in determining the availability of the dog-fish.

D. Analysis of the Catch Records of Dog-fish Livers Landed by Sunken Gill-net Boats Fishing in Hecate Strait.

1. The Total Landings of Livers by Sunken Gill-net Boats.

In Hecate strait (Fig. 22), the sunken gill-net fishery commences in May and usually terminates at the end of October. Fig. 23 illustrates the decided increase in total catch from 1943 to 1944. In 1946 the total catch was only half the amount landed in 1944. About 24 per cent of all the dog-fish livers landed in British Columbia in 1944 was caught by sunken gill-net boats fishing in Hecate strait from May until October. During the same months in 1945 and 1946, sunken gill-net boats in Hecate strait caught 30 per cent and 32 per cent respectively of the total catch landed in British Columbia. During 1945 there was nearly double the number of sunken gill-net boats fishing in Hecate strait (Table 7) as there was in 1944, but the total weight of livers landed by the boats was slightly lower in 1945 than in 1944. Poor weather conditions during the summer months of 1945 hindered the fishing effort of some of the smaller boats, thus contributing to the smaller catch.

Fig. 24 illustrates the total catch of dog-fish livers for each month from 1943 to 1946. The largest catches were made during the months of June and July in 1944 and 1945. In 1946 the months of greatest total catches were in June and

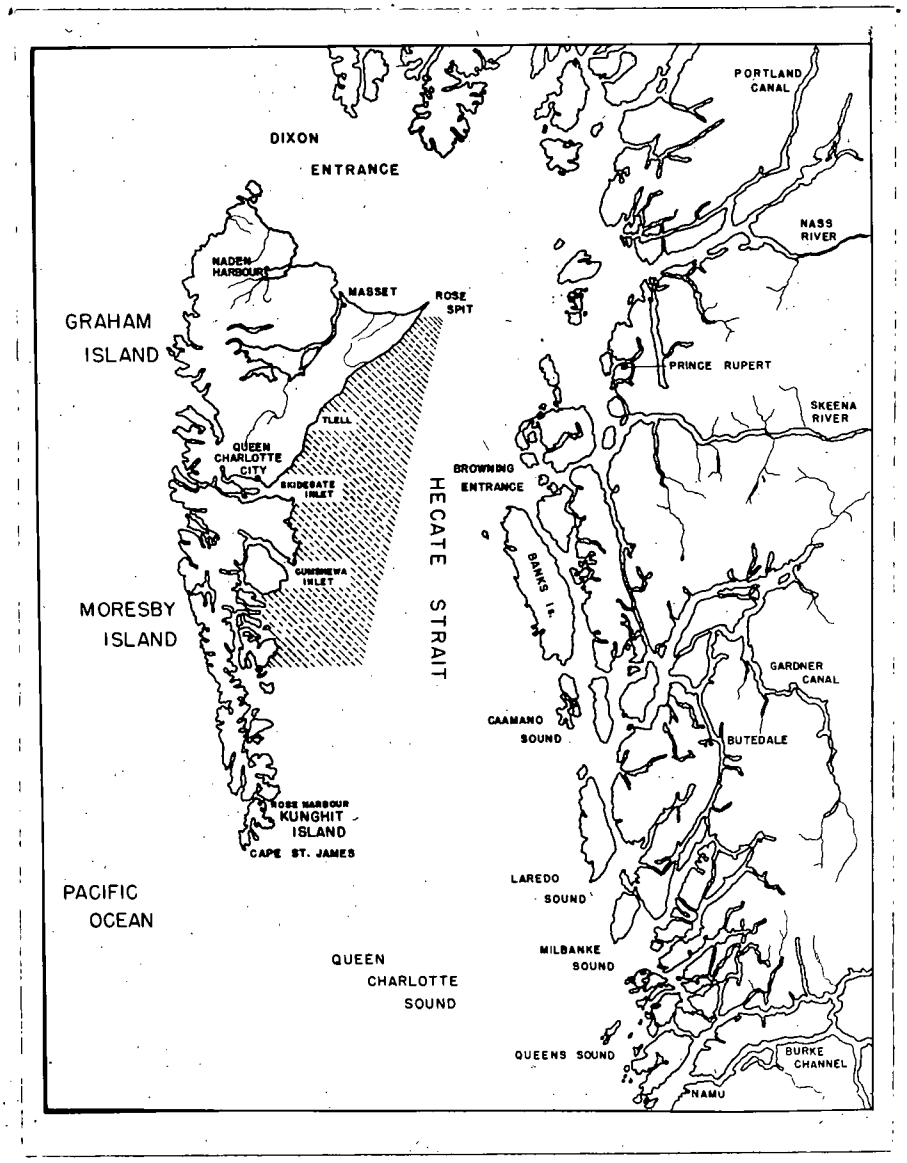

Fig. 22

The shaded area indicates the general fishing grounds for the sunken gill-nets in Hecate strait.

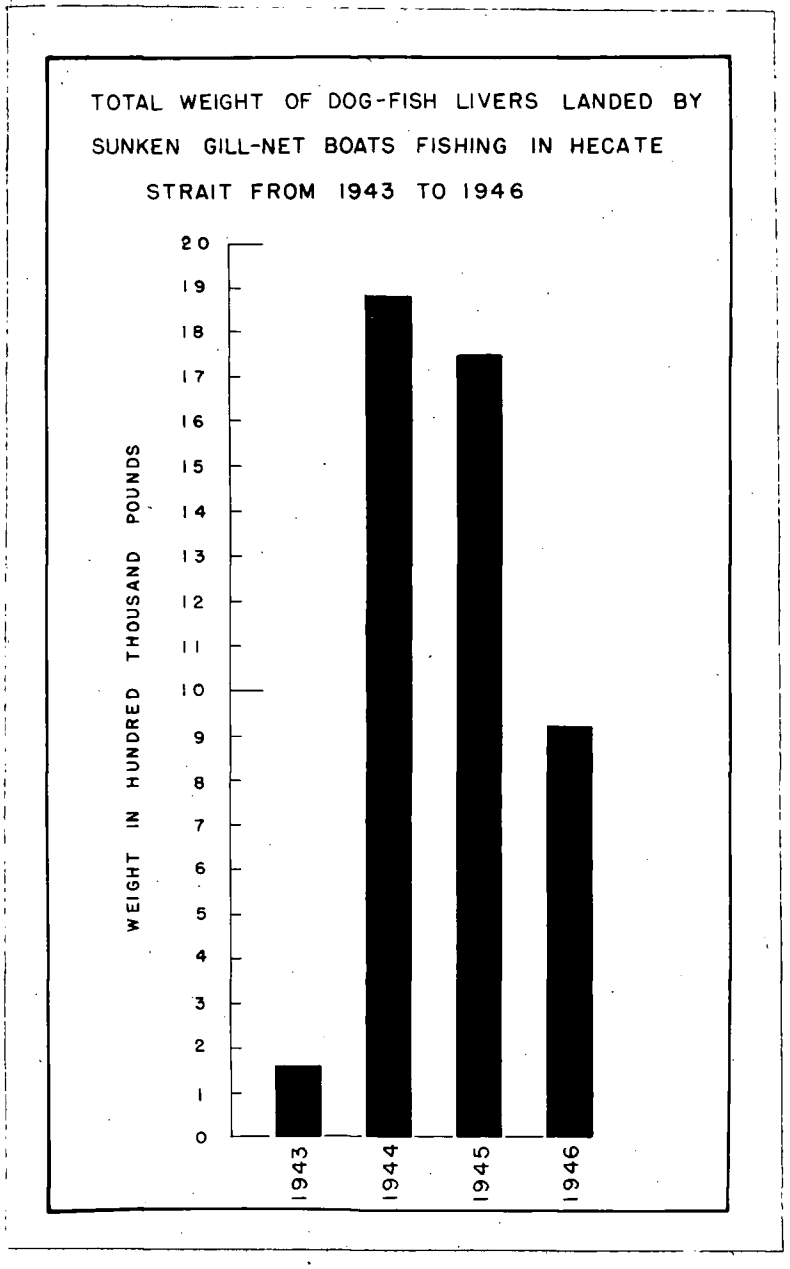
TOTAL WEIGHT OF DOG-FISH LIVERS LANDED BY SUNKEN GILL-NET BOATS FISHING IN HECATE STRAIT FROM 1943 TO 1946
WEIGHT IN HUNDRED THOUSAND POUNDS
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
1943
1944
1945
1946

Fig. 23

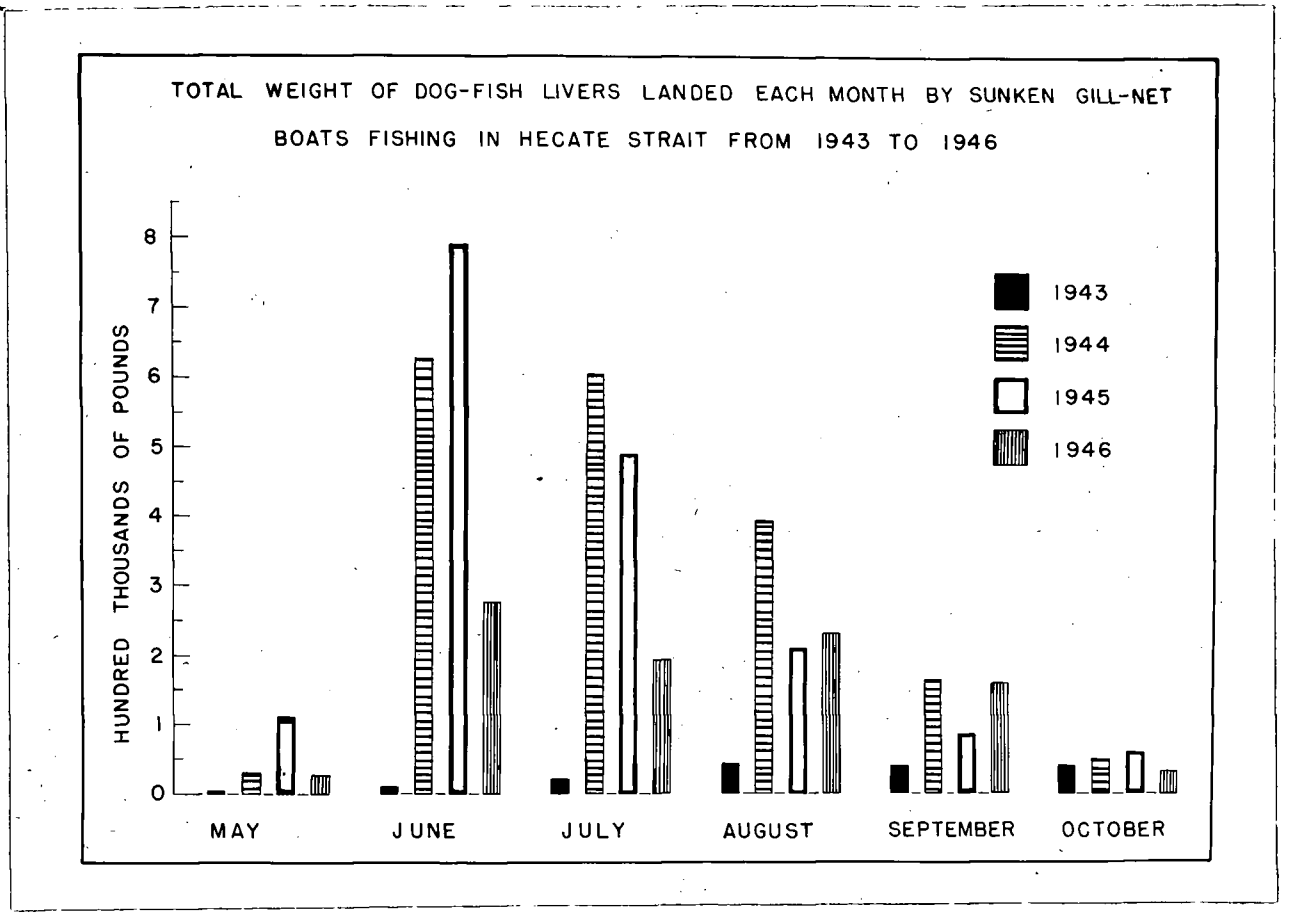
TOTAL WEIGHT OF DOG-FISH LIVERS LANDED EACH MONTH BY SUNKEN GILL-NET BOATS FISHING IN HECATE STRAIT FROM 1943 TO 1946
HUNDRED THOUSANDS OF POUNDS
0
1
2
3
4
5
6
7
8
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
1943
1944
1945
1946

Fig. 24

August.

2. The Average Catch per Boat per Month.

When the average catch per month is used as an index of availability, changes in the number of fishing days per trip are discontinued. For example:- two boats fished twenty days in a month, and each boat caught the same amount of fish each day. One boat lands its catch every day, and the other boat every fifth day. The catch per trip of the boat that landed its catch every five days is four times greater than the boat that landed its catch every day but the catch at the end of the month is the same for each boat. The data from both the large and small boats are used, because the number of days per trip made by each class of boat is discounted.

The average catch per boat per month and the average catch per boat per trip per month both give indices of availability. Both of these two methods of analysis of catch statistics have been used in availability studies of the white sea bass (Cynoscion nobilis) of California (Whitehead 1930); the striped bass (Roccus lineatus) of California (Craig 1930), Clark 1933); the bluefin tuna (Thunnus thynnus), (Whitehead 1931); and the California halibut (Paralichthys californicus) (Clark 1931).

Fig. 25 illustrates the average catch per boat per month for the years 1943 to 1946. This method of analysis indicates the dog-fish were most available during the month of August in 1943 and 1946. In 1944 and 1945 the dog-fish were most available during the month of June. The year 1945 shows a

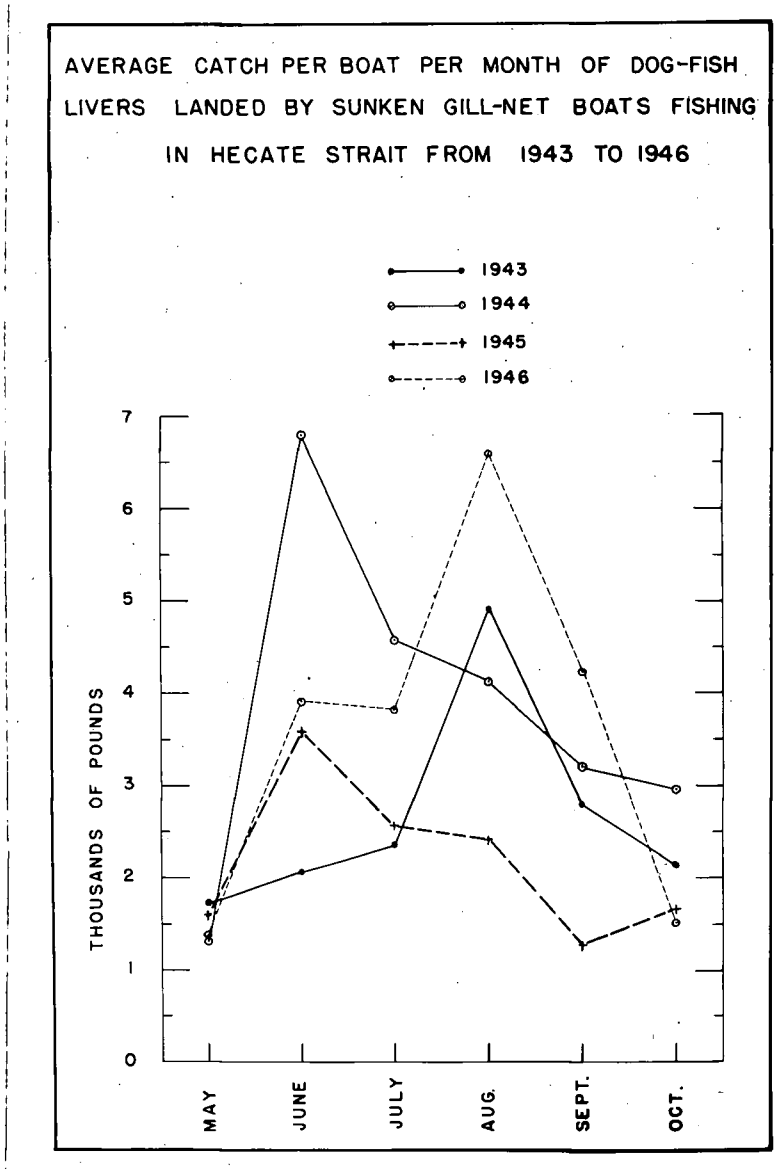
AVERAGE CATCH PER BOAT PER MONTH OF DOG-FISH LIVERS LANDED BY SUNKEN GILL-NET BOATS FISHING IN HECATE STRAIT FROM 1943 TO 1946
1943
1944
1945
1946
THOUSANDS OF POUNDS
0
1
2
3
4
5
6
7
MAY
JUNE
JULY
AUG.
SEPT.
OCT.

Fig. 25

decided drop in the availability from 1944, while in the year 1946 the availability increased over the previous year. The sources of error in this graph are discussed later in the text.

3. The Average Catch per Trip per Boat per Month.

The average catch per trip per boat is determined by dividing the monthly catch of all the boats by the number of trips that all the boats made in each particular month. The comparison between the methods of using the average catch per boat per month and the average catch per trip per boat by months is made to indicate the effect of the longer trips in each successive year. It is seen (Table VII) that there has been a general drop in the average number of trips per month since 1943, except during the months of June in 1944, and the months of August and September in 1946.

Like the other method (Fig. 25) of analysis Fig. 26 indicates the availability of the dog-fish to be greatest during the month of August in 1943 and 1946. The year 1945 shows a decided drop in the availability compared with 1944.

4. The Average Catch per Boat per Month and the Average Catch per Trip per Boat per Month for Each Year as a Whole.

Fig. 27 illustrates the weighted average catch per boat per month and the weighted average catch per trip per boat per month. The average catch is weighted by the different number of boats fishing each month and the changes in the number of trips made for each month. Although the average catch per boat per month dropped greatly during 1945, the average catch

Table VII

The Average Number of Trips per Boat per Month made by Sunken Gill-net Boats Fishing in Hecate Strait from 1943 to 1946.

	1943	1944	1945	1946
May	2	2.92	1.30	1.50
June	4	4.72	3.80	3.07
July	4.80	3.58	3.32	3.41
August	4.67	3.84	3.44	4.48
September	3.93	3.24	2.00	4.66
October	5.32	3.71	3.00	2.75
Average No. of Trips Each Year	4.61	3.84	3.14	3.44

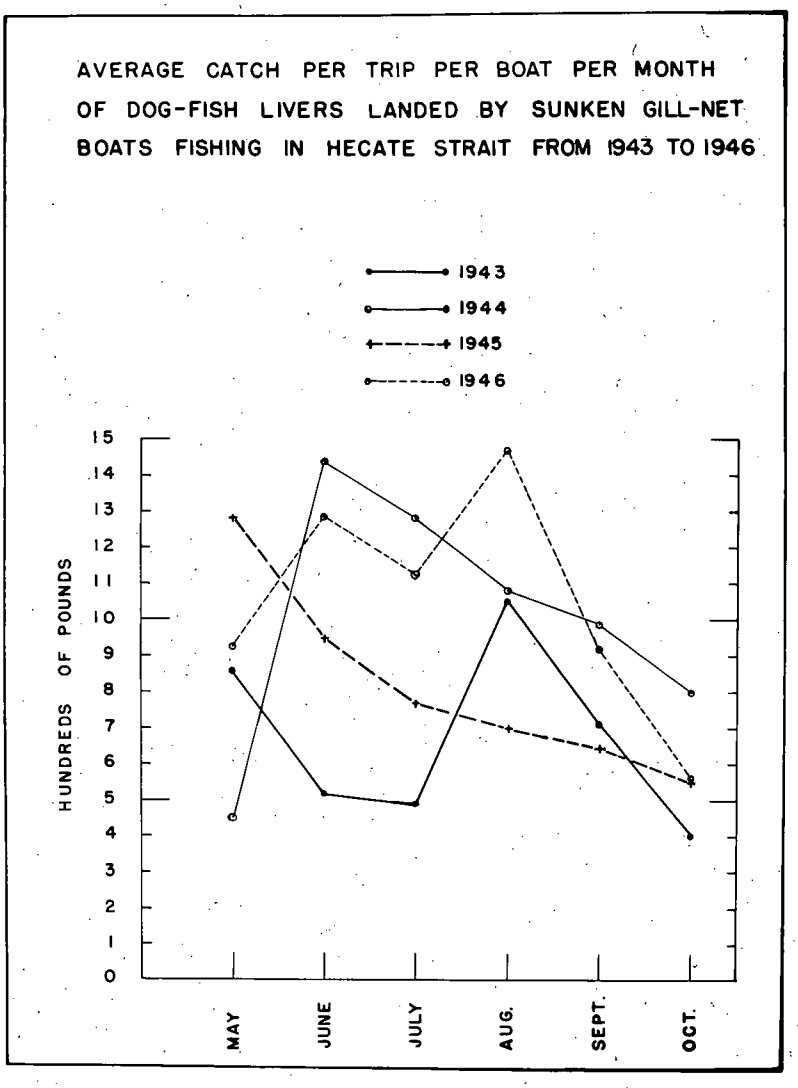
AVERAGE CATCH PER TRIP PER BOAT PER MONTH
OF DOG-FISH LIVERS LANDED BY SUNKEN GILL-NET
BOATS FISHING IN HECATE STRAIT FROM 1943 TO 1946
1943
1944
1945
1946
HUNDREDS OF POUNDS
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
MAY
JUNE
JULY
AUG.
SEPT.
OCT.

Fig. 26

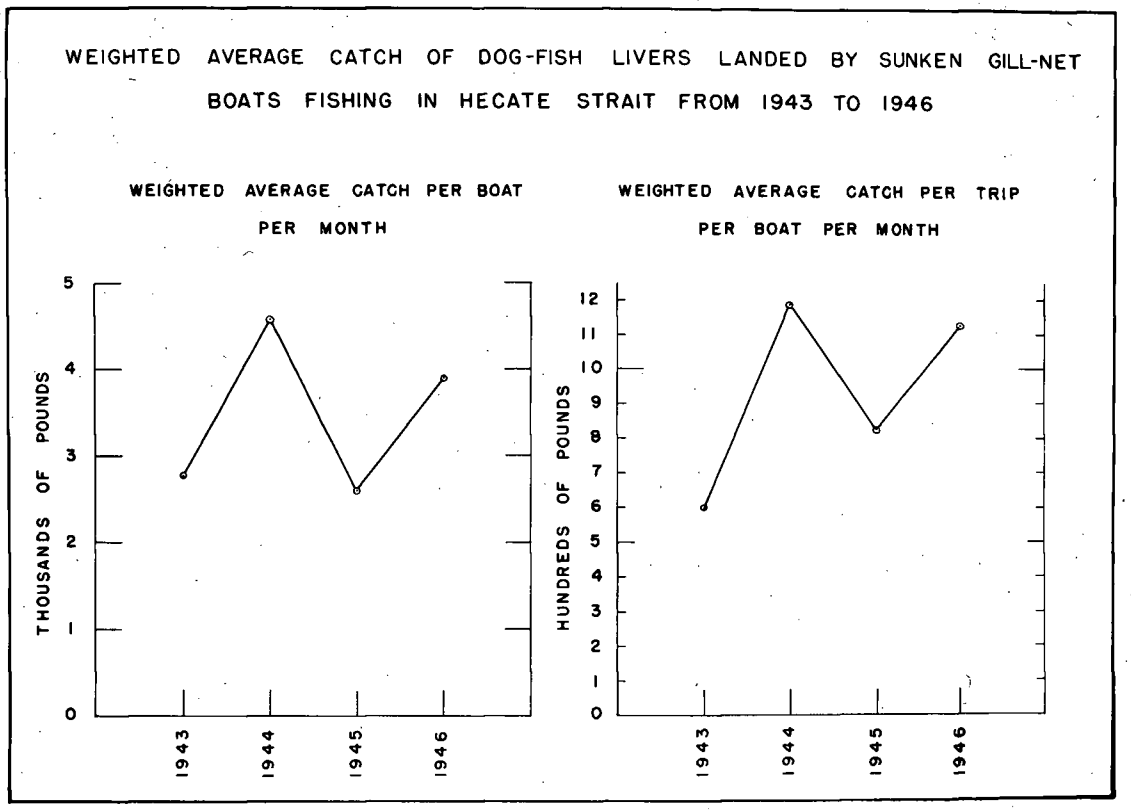
WEIGHTED AVERAGE CATCH OF DOG-FISH LIVERS LANDED BY SUNKEN GILL-NET BOATS FISHING IN HECATE STRAIT FROM 1943 TO 1946
WEIGHTED AVERAGE CATCH PER BOAT PER MONTH
THOUSANDS OF POUNDS
0
1
2
3
4
5
1943
1944
1945
1946
WEIGHTED AVERAGE CATCH PER TRIP PER BOAT PER MONTH
HUNDREDS OF POUNDS
0
1
2
3
4
5
6
7
8
9
10
11
12
1943
1944
1945
1946

Fig. 27

per trip per boat dropped only slightly. These two graphs indicate lower availability during the years 1943 and 1945 and an increase in the availability during 1946.

The graphs in Fig. 27 give a somewhat distorted picture of the actual conditions. Consider the following situation:- A limited population in a certain locality is being fished with a fixed amount of gear. If the number of boats and gear is doubled, the total catch would not double because of competition among the increased gear. It is probable that each boat in operation would catch less fish than if only the smaller number were operating. Such a situation occurred in Hecate strait from 1943 to 1945. During 1946 the number of sunken gill-net boats fishing in Hecate strait was much less than in 1945 (Table 7). There are many cumulative factors which would tend to increase the average boat catch in 1946. Some of these factors may be discussed. The general drop in the average number of trips per month since 1943 could indicate a greater amount of effort expended by the fishermen before a landing of dog-fish livers was made. This would tend to increase the average catch per trip per boat per month. Some of the men on the larger boats may have had more resolution and experience to fish in bad weather in 1946. This would increase their average monthly landings of dog-fish livers. These possibilities, coupled with a rising value of the dog-fish and soup-fin shark livers would tend to keep the fishermen on the fishing grounds for longer periods.

5. The Index of the Average Catch per Boat per Month and the Index of the Average Catch per Trip per Boat per Month as Determined by the Method of Link Relatives.

Link relatives are determined by comparing the catch in one month, with the catch in the same month in the previous year, or in each successive year. In the analysis presented here, the year 1943, was used as the base year. Each month of this year was compared with the same months in each of the successive years. Chaddock (1925) describes this method of analysis in detail, and it has been used in the analysis of boat catches in the California halibut fishery (Clark 1931).

For example:- if 8, 12, 6, and 3 are the values of the average catch per boat per month in the successive years 1943 to 1946; the relative for the second year, 1944, using the first year (1943), as a base, is 12 ÷ 8 = 1.50; the third relative is 6 ÷ 12 = 0.50, and the fourth relative for the year 1946 would be 3 ÷ 6 = 0.50. These relatives must now be linked together by what is termed the chain relative. The first year of the series, 1943, is the base year, and is therefore 100 percent. The chain relative for 1944 would be 100 multiplied by 1.50 = 150 percent; the chain relative for 1945 would be 150 x 0.50 = 75 percent; and the chain relative for 1946 would be 0.75 x 0.5 = 37 1/2 percent. The chain relative for the years 1944 to 1946 would then be 1.5, 0.75, and 0.375.

In Figs. 28 and 29 the indices show that the availability of the dog-fish in Hecate strait was greatest in 1944 for the months of June, July, and October. In the month of May, 1945,

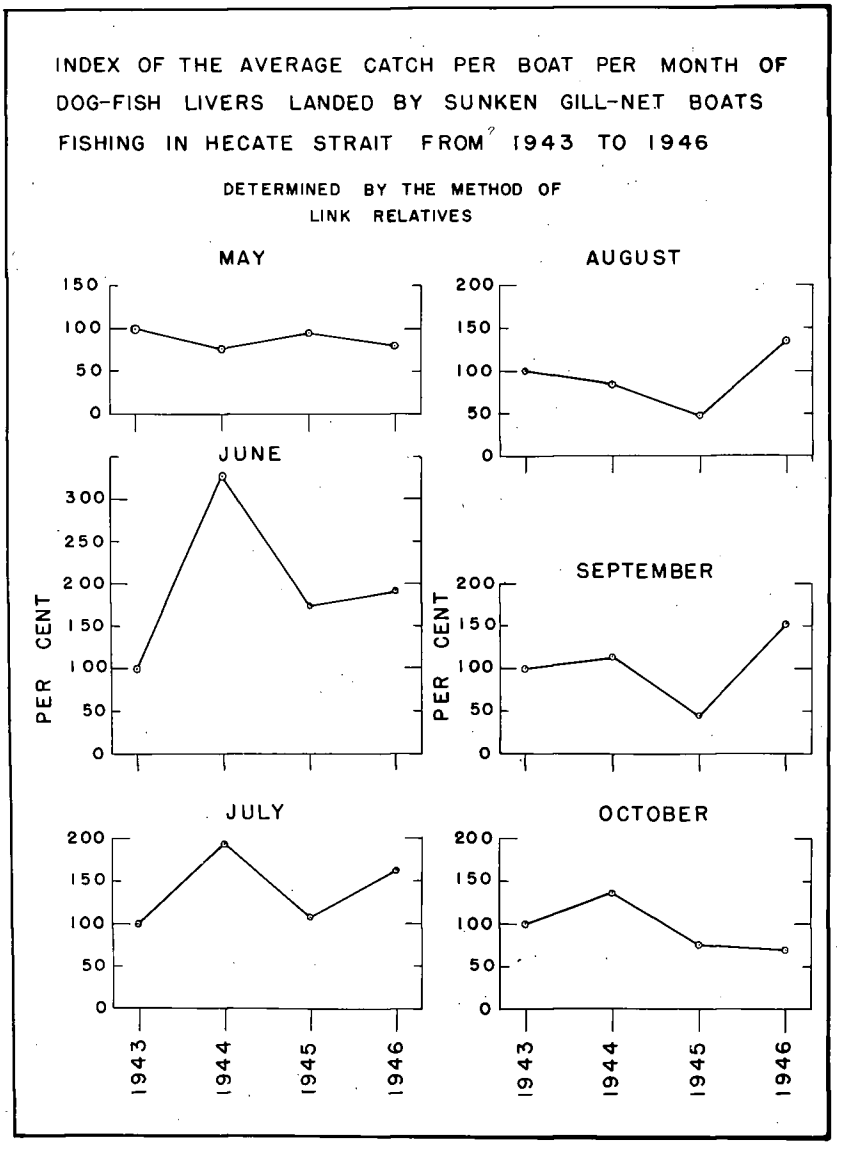
INDEX OF THE AVERAGE CATCH PER BOAT PER MONTH OF DOG-FISH LIVERS LANDED BY SUNKEN GILL-NET BOATS FISHING IN HECATE STRAIT FROM 1943 TO 1946
DETERMINED BY THE METHOD OF LINK RELATIVES
MAY
AUGUST
JUNE
SEPTEMBER
JULY
OCTOBER
PER CENT
PER CENT
0
50
100
150
200
250
300
1943
1944
1945
1946

Fig. 28

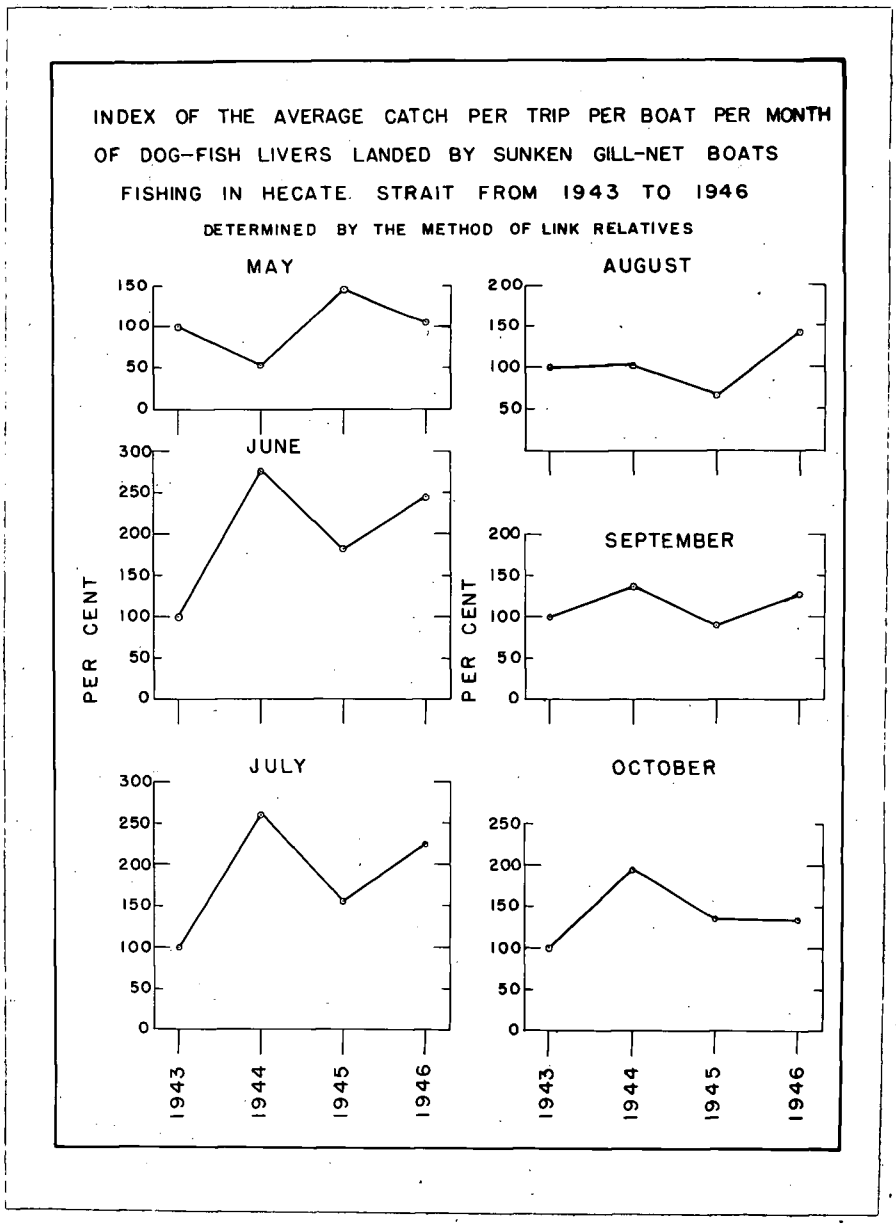
INDEX OF THE AVERAGE CATCH PER TRIP PER BOAT PER MONTH
OF DOG-FISH LIVERS LANDED BY SUNKEN GILL-NET BOATS
FISHING IN HECATE STRAIT FROM 1943 TO 1946
DETERMINED BY THE METHOD OF LINK RELATIVES
MAY
AUGUST
JUNE
SEPTEMBER
JULY
OCTOBER
PER CENT
PER CENT
1943
1944
1945
1946

Fig. 29

the availability index rises when compared with May 1944, indicating a possible early movement of dog-fish in Hecate strait for that year. The index remained high during June but fell very sharply for the rest of the year, depicting the poor catches which were made by the sunken gill-net boats during that year.

In 1946 the index of the average catch per boat per month and the average catch per trip per boat per month increased for the months of June, July, August, and September. The index of the average catch per boat per month and the average catch per trip per boat per month increased abruptly during the months of August and September. This agrees with increased in the average catch per boat per month and the average catch per trip per boat per month for this year, 1946, as shown in Figs. 25 and 26.

When the years as a whole are compared with each other (Fig. 30), the index also shows that the availability was greatest in 1944 and that the year 1946, shows a definite increase in availability over the previous year. Less competition between gear and improved weather conditions would probably increase the yield of the boat catches during some of the months in 1946 when compared with 1945.

6. Comparison of the Average Catch per Boat per Month for the Same Sunken Gill-net Boats Fishing in Adjacent Years.

This method of estimating availability has been employed in various fishery investigations. It makes some

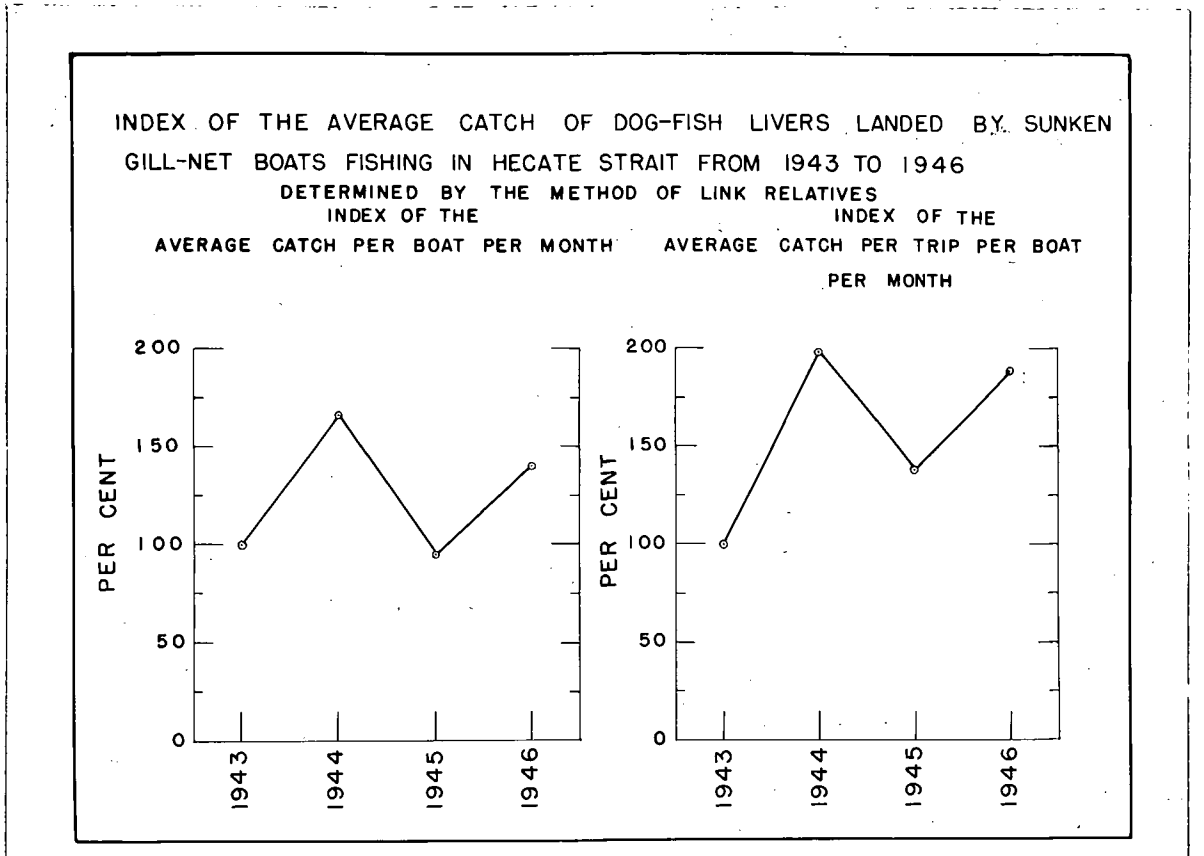
INDEX OF THE AVERAGE CATCH OF DOG-FISH LIVERS LANDED BY SUNKEN GILL-NET BOATS FISHING IN HECATE STRAIT FROM 1943 TO 1946
DETERMINED BY THE METHOD OF LINK RELATIVES
INDEX OF THE AVERAGE CATCH PER BOAT PER MONTH
INDEX OF THE AVERAGE CATCH PER TRIP PER BOAT PER MONTH
PER CENT
200
150
100
50
0
1943
1944
1945
1946

Fig. 30

allowance for the increase in the fishing effort (the increase in the average number of nets per boat) that occurs in each successive year. Information obtained from a number of fishermen along the coast revealed that the number of nets each sunken gill-net boat used increased gradually in each successive year from 1943 to 1946. It has been roughly estimated that the number of nets per boat in 1946 has doubled since 1943. This means that the effort expended by each fisherman in 1946 was much greater than in 1943.

The boats fishing in 1943 were compared with the same boats fishing in 1944; boats fishing in 1944 were compared with the same boats fishing in 1945, and the same comparison was made for the years 1945-46. The increase in the number of nets per boat between two successive years is not nearly as great as the increase over a four year period. Each boat will also reach an optimum number of nets with which to fish. This method of comparing only the same boats fishing in adjacent years, tends to equalize the effect of the increase, or decrease, in the number of nets per boat from 1943 to 1946. However, the increasing number of nets over the fleet will produce a cumulative error no less than by other methods.

In Fig. 31 the average catch of dog-fish livers per boat per month landed by the same boats fishing in the years 1943-44, indicates the comparitively high availability in 1943, when the fishery with sunken gill-nets in Hecate strait commenced. This information has not been borne out fully by any of the other methods of analysis.

When the years 1944-45 are compared (Fig. 32) availability

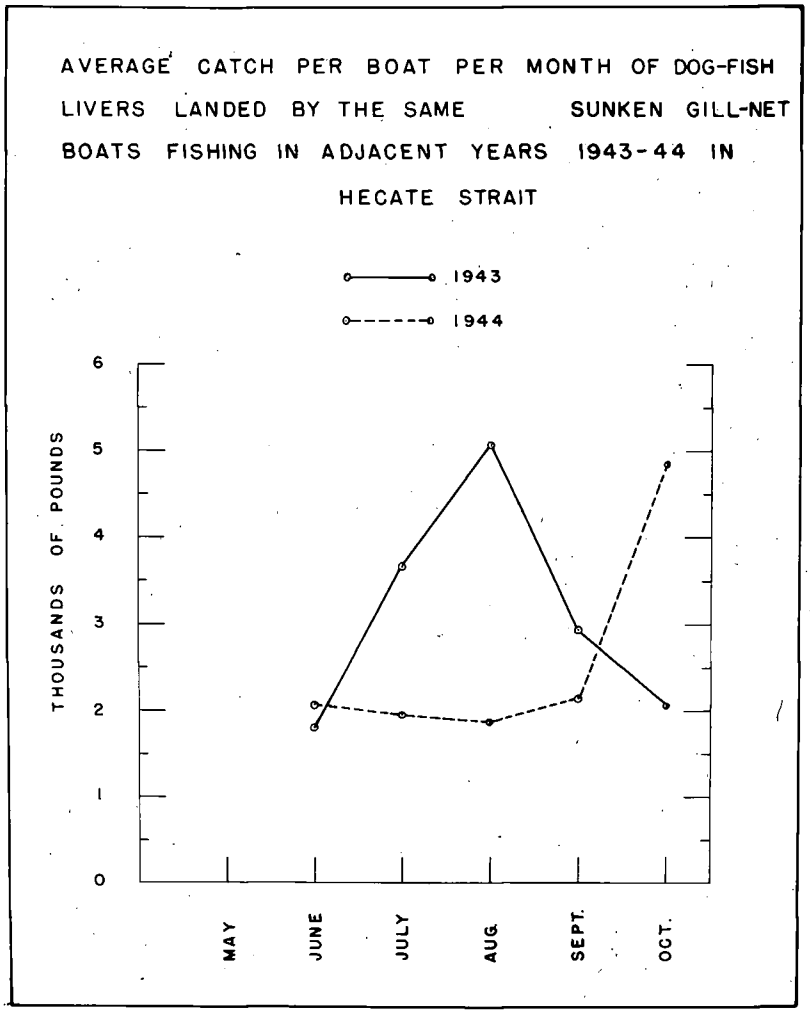
AVERAGE CATCH PER BOAT PER MONTH OF DOG-FISH LIVERS LANDED BY THE SAME SUNKEN GILL-NET BOATS FISHING IN ADJACENT YEARS 1943-44 IN HECATE STRAIT
1943
1944
THOUSANDS OF POUNDS
0
1
2
3
4
5
6
MAY
JUNE
JULY
AUG.
SEPT.
OCT.

Fig. 31

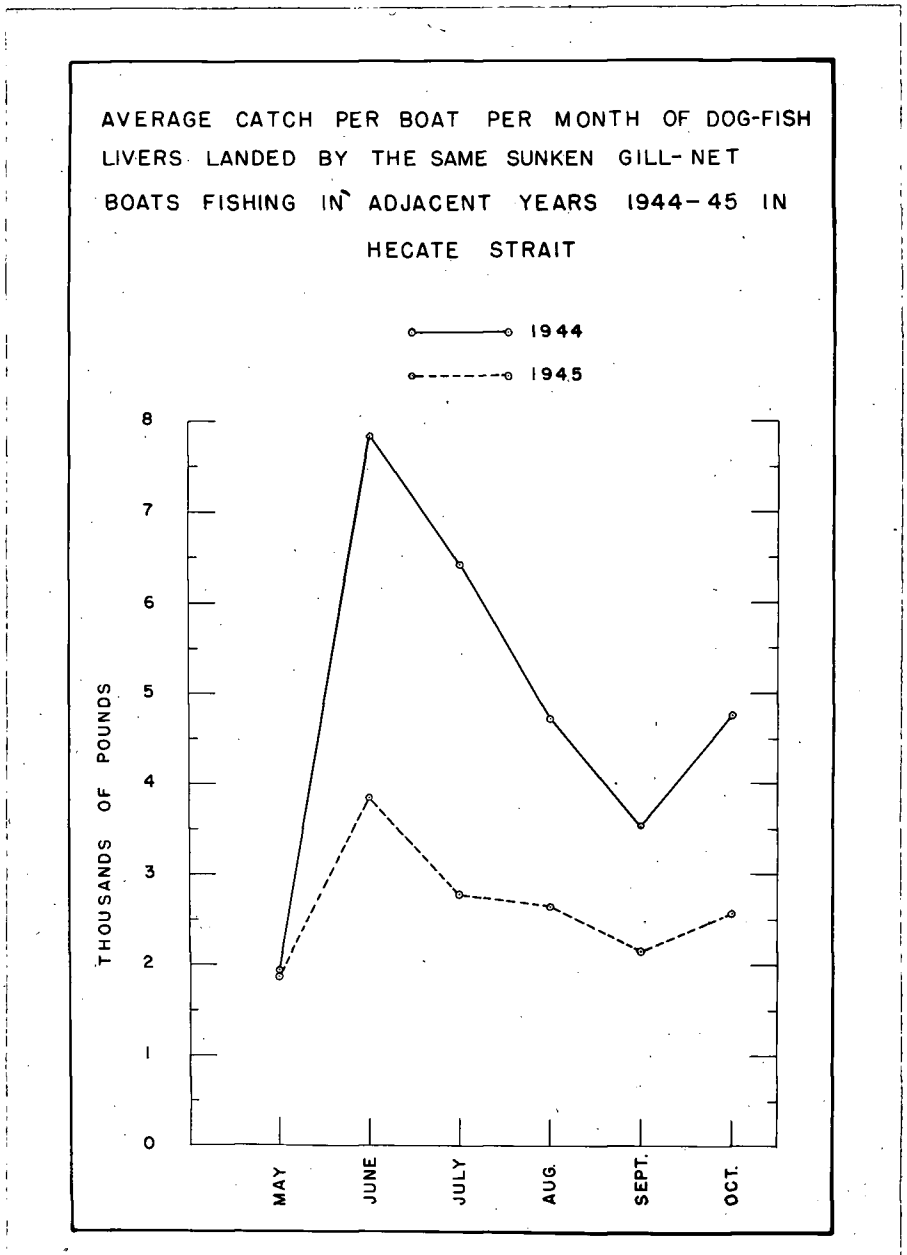
AVERAGE CATCH PER BOAT PER MONTH OF DOG-FISH LIVERS LANDED BY THE SAME SUNKEN GILL-NET BOATS FISHING IN ADJACENT YEARS 1944-45 IN HECATE STRAIT
1944
1945
THOUSANDS OF POUNDS
0
1
2
3
4
5
6
7
8
MAY
JUNE
JULY
AUG.
SEPT.
OCT.

Fig. 32

is greatest in the earlier year, 1944. Fig. 32 also shows that the availability in 1945 was greatest in the month of June and then falls off sharply in the following months.

During 1946 the number of boats fishing for dog-fish in Hecate strait was reduced by almost two-thirds the number fishing in 1945. This would indicate that the average catch per boat in 1946 could exceed the average boat catch in 1945. This situation occurred during the months of June, July, August, and September (Fig. 25).

Fig. 33 illustrates the average catch per boat per month for the same boats fishing in the years 1945-46. The boat catch increased abruptly in the month of August, 1946, but the average boat catches for the other months almost paralleled the catches made in the previous year. This sudden increase in the availability of the dog-fish in August, 1946, is probably closely related with the varied mass movements of dog-fish in Hecate strait. The abrupt increase in availability during August, 1946 as shown in Fig. 33 is also indicated in Figs. 25 and 26.

7. The Index of the Total Landings of Dog-fish Livers Made by the Same Sunken Gill-net Boats Fishing in Adjacent Years as Determined by the Method of Link Relatives.

The index calculated from the total catch per month from the same boats fishing in adjacent years, and the index calculated from the average catch per boat per month from the same boats fishing in adjacent years would be identical. Only

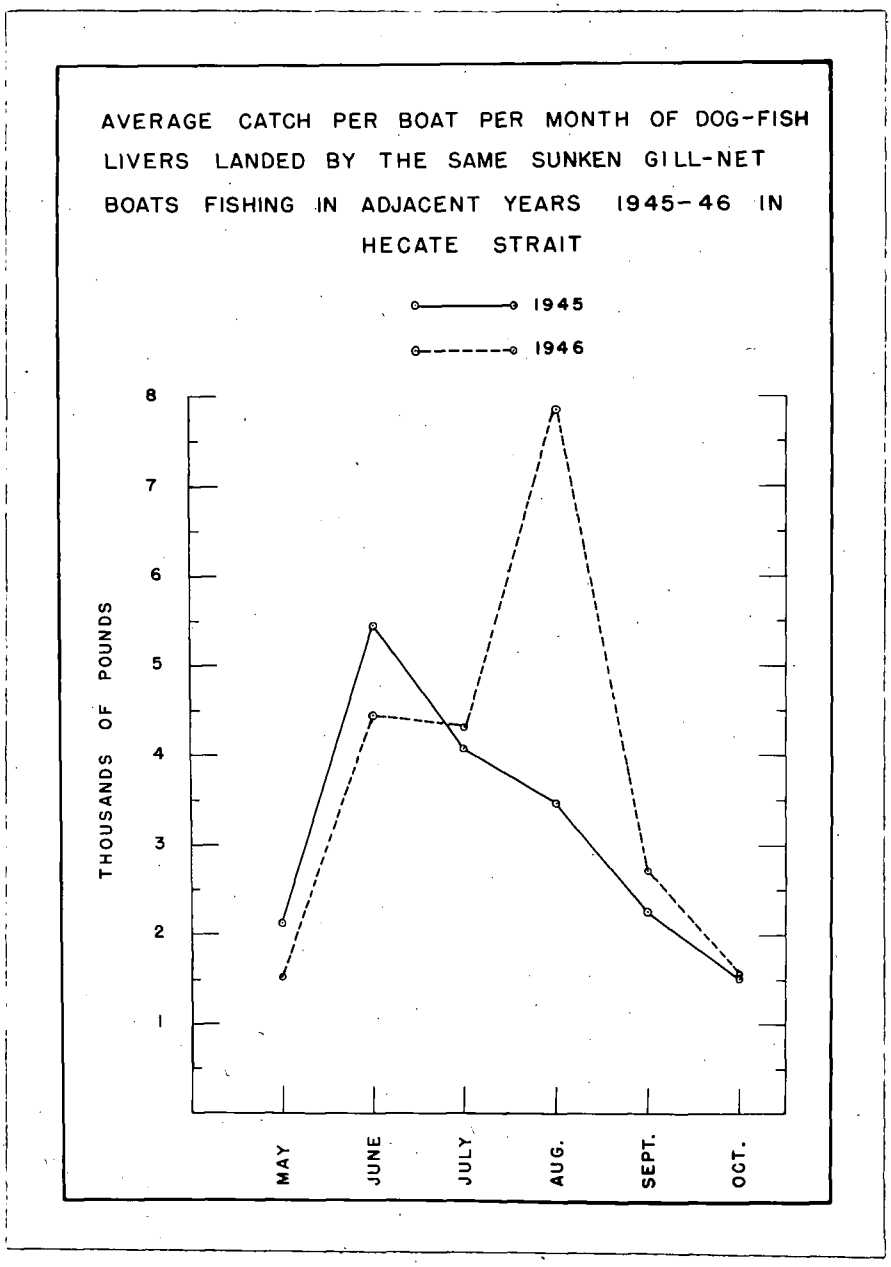
AVERAGE CATCH PER BOAT PER MONTH OF DOG-FISH LIVERS LANDED BY THE SAME SUNKEN GILL-NET BOATS FISHING IN ADJACENT YEARS 1945-46 IN HECATE STRAIT
1945
1946
THOUSANDS OF POUNDS
8
7
6
5
4
3
2
1
MAY
JUNE
JULY
AUG.
SEPT.
OCT.

Fig. 33

the same number of boats are compared in each month between two successive years. It would simply mean dividing the total catch of any month in 1943 and the total catch of the same month in 1944 by a common denominator.

The index of the total landings of dog-fish livers each month made by the same sunken gill-net boats fishing in adjacent years (Fig. 34), differs in many details from the index of the average catch per boat per month (Fig. 28), and the average catch per trip per boat per month (Fig. 29). The indices in Fig. 34 give a clearer picture of the availability in 1943, when the sunken gill-net fishery commenced in Hecate strait. It would seem probable that the abundance, or the total number of dog-fish must have been greater in 1943 than during the following years, when enormous numbers of this species were taken from the British Columbia waters. Fig. 34 shows that the availability of dog-fish in Hecate strait varies from year to year, and does not always follow the same course at the same time each year. The abundance is represented in part by the relative abundance or availability calculated from the analyses of boat catches. Although very large numbers of dog-fish were removed from Hecate strait in 1944 and 1945, Figures 28, 29, and 34 indicate an increase in availability during the months of August and September in 1946.

When the total landings of dog-fish livers from the same sunken gill-net boats fishing in adjacent years are linked together by the method of chain relatives, a more accurate and clearer picture of the availability of the dog-fish in Hecate strait, from 1943 to 1946, is demonstrated (Fig. 35). The

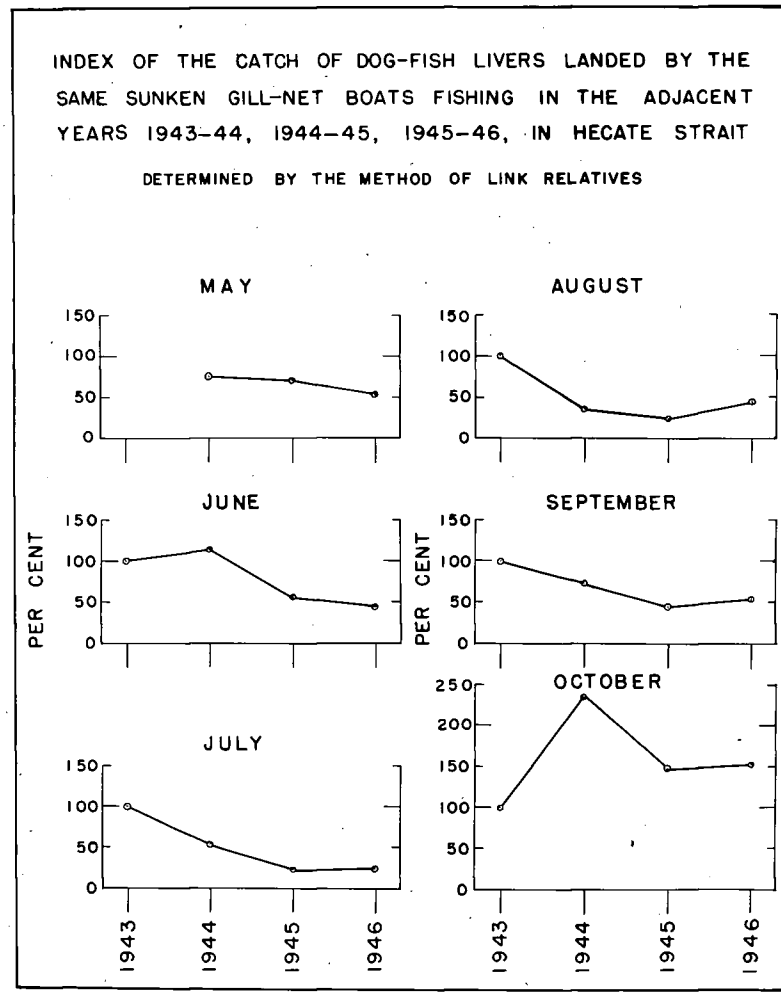
INDEX OF THE CATCH OF DOG-FISH LIVERS LANDED BY THE SAME SUNKEN GILL-NET BOATS FISHING IN THE ADJACENT YEARS 1943-44, 1944-45, 1945-46, IN HECATE STRAIT
DETERMINED BY THE METHOD OF LINK RELATIVES
MAY
AUGUST
JUNE
SEPTEMBER
JULY
OCTOBER
PER CENT
PER CENT
150
100
50
0
250
200
1943
1944
1945
1946

Fig. 34

INDEX OF THE TOTAL CATCH OF DOG-FISH LIVERS LANDED BY THE SAME SUNKEN GILL-NET BOATS FISHING IN THE ADJACENT YEARS 1943-44, 1944-45, 1945-46 IN HECATE STRAIT

DETERMINED BY THE METHOD OF LINK RELATIVES

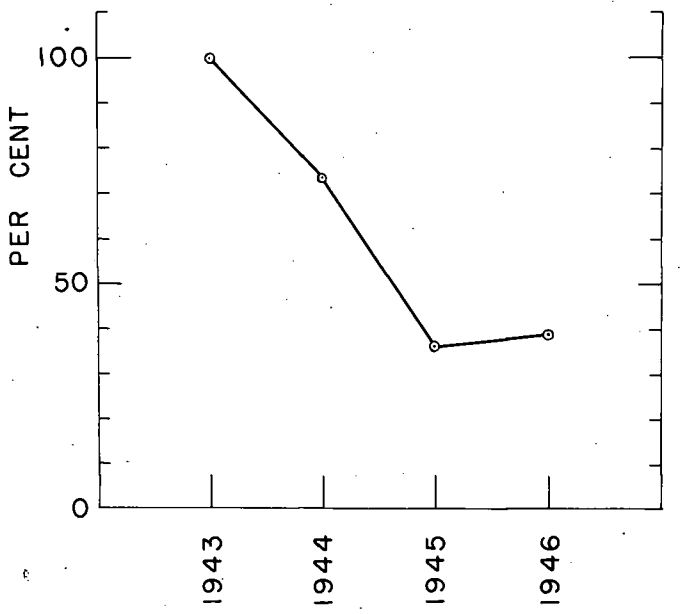

Fig. 35

index of the availability (Fig. 35) drops from the year 1943 to 1945, and then increases slightly in 1946.

E. Analysis of the Catch Records of Soup-fin Shark Livers Landed by Sunken Gill-net Boats Fishing in Hecate Strait.

The catch statistics of the soup-fin shark are analysed by the same methods employed in the analysis of the dog-fish statistics.

1. The Total Landings of Livers by Sunken Gill-net Boats.

The total landings of soup-fin shark livers for each year are graphed in Fig. 36. The total landings for the year 1944 represent the absolute minimum, since some of the records from one company were missing for that year. In spite of this, 1944 represents the year of the greatest landings of soup-fin shark livers from Hecate strait. The year 1944 also represented the year of the greatest landings of soup-fin shark livers for the Province. In the years 1943 and 1944 about 40 per cent of all the soup-fin shark livers landed in British Columbia were caught by sunken gill-net boats fishing from May to October inclusive, in Hecate strait. The sunken gill-net boats landed 45 per cent and 40 per cent of the total landings for the Province in the years 1945 and 1946 respectively.

Table VIII lists the total weights of soup-fin shark livers landed each month by sunken gill-net boats fishing in Hecate strait from 1943 to 1946. The months of the greatest landings in the year 1943 were August and September. July was the peak

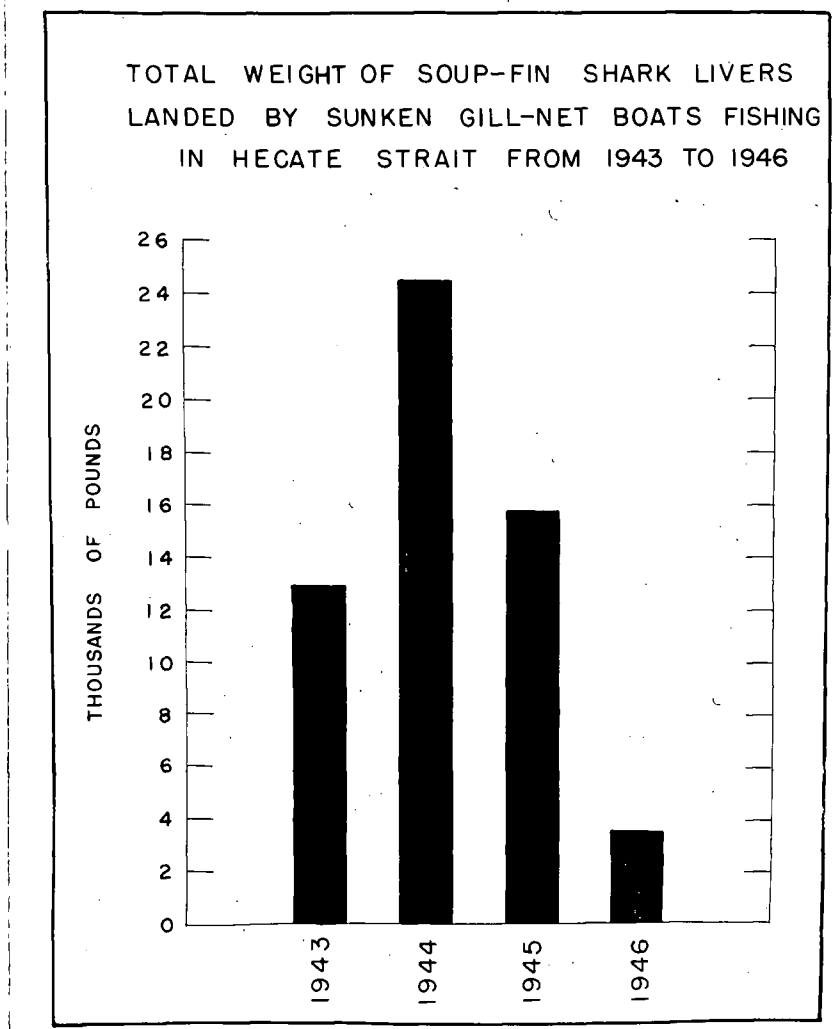
TOTAL WEIGHT OF SOUP-FIN SHARK LIVERS
LANDED BY SUNKEN GILL-NET BOATS FISHING
IN HECATE STRAIT FROM 1943 TO 1946
THOUSANDS OF POUNDS
26
24
22
20
18
16
14
12
10
8
6
4
2
0
1943
1944
1945
1946

Fig. 36

Table VIII

Total Weight (lb.) of Soup-fin Shark Livers landed each Month by Sunken Gill-net Boats from Hecate Strait, from 1943 to 1946.

	1943	1944	1945	1946
May	----	61	4	2
June	40	4,147	3,219	752
July	1,027	13,732	9,795	2,071
August	6,256	5,857	2,329	480
September	4,525	445	254	208
October	310	8	165	3
Total	13,058	24,250	15,766	3,516
Weighted average catch per boat per month	225.14	66.44	23.57	14.90

month in each of the three years, 1944, 1945, and 1946.

2. The Average Catch per Boat per Month.

Fig. 37 illustrates the average catch per boat decreasing from 1943 to 1946. Although more soup-fin shark livers were landed in the year 1944, the availability dropped considerably below the previous year for a short period during the months of August and September. The graph indicates the month of August as the month of greatest availability for the year 1943. In 1944, 1945, and 1946 the month of July was the month of the greatest average catch per boat.

3. The Average Catch per Trip per Boat per Month.

The average catch per trip per boat per month (Fig. 38) almost follows the same representative pattern as depicted in Fig. 37. In the year 1945, Fig. 38 shows the availability was greatest in the month of August, whereas Fig. 37 shows that the availability was greatest in the month of July. This difference is only very slight when the small amount of livers landed is considered.

4. The Average Catch per Boat per Month and the Average Catch per Trip per Boat per Month for Each Year as a Whole.

Fig. 39 illustrates the continued drop in the availability of the soup-fin shark from 1943 to 1946. The availability calculated from the average catch per boat per month

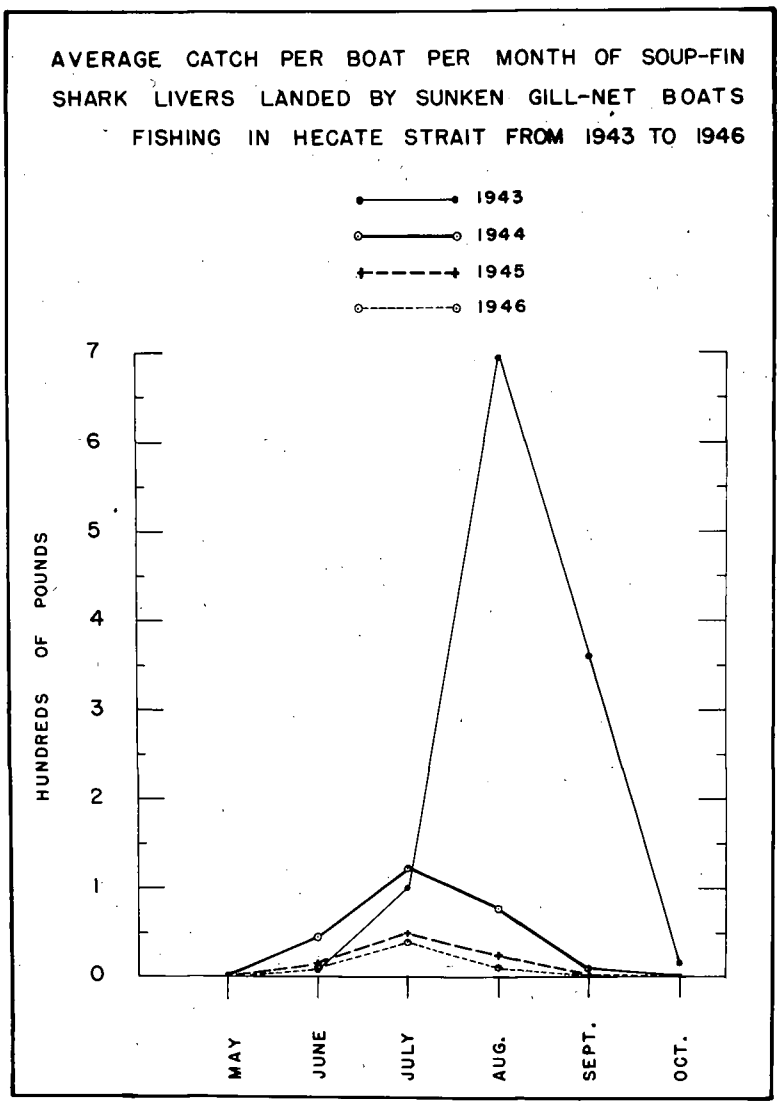
AVERAGE CATCH PER BOAT PER MONTH OF SOUP-FIN SHARK LIVERS LANDED BY SUNKEN GILL-NET BOATS FISHING IN HECATE STRAIT FROM 1943 TO 1946
1943
1944
1945
1946
HUNDREDS OF POUNDS
0
1
2
3
4
5
6
7
MAY
JUNE
JULY
AUG.
SEPT.
OCT.

Fig. 37

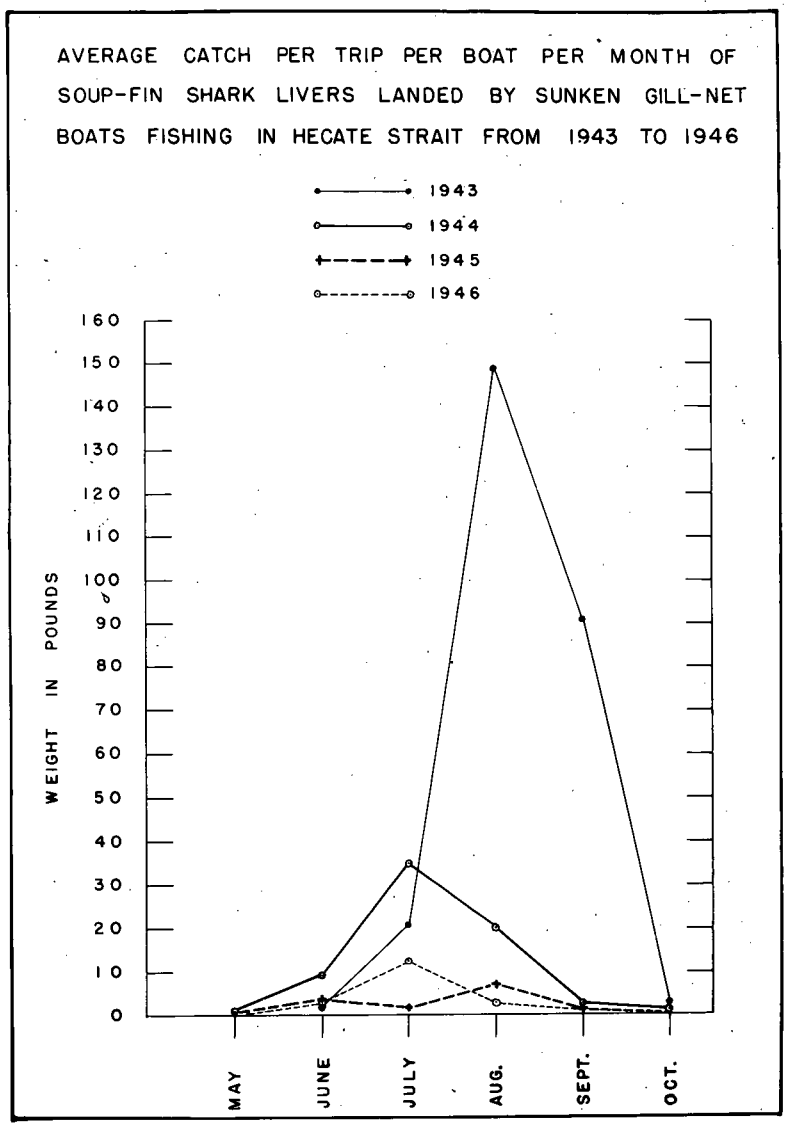
AVERAGE CATCH PER TRIP PER BOAT PER MONTH OF SOUP-FIN SHARK LIVERS LANDED BY SUNKEN GILL-NET BOATS FISHING IN HECATE STRAIT FROM 1943 TO 1946
1943
1944
1945
1946
WEIGHT IN POUNDS
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
MAY
JUNE
JULY
AUG.
SEPT.
OCT.

Fig. 38

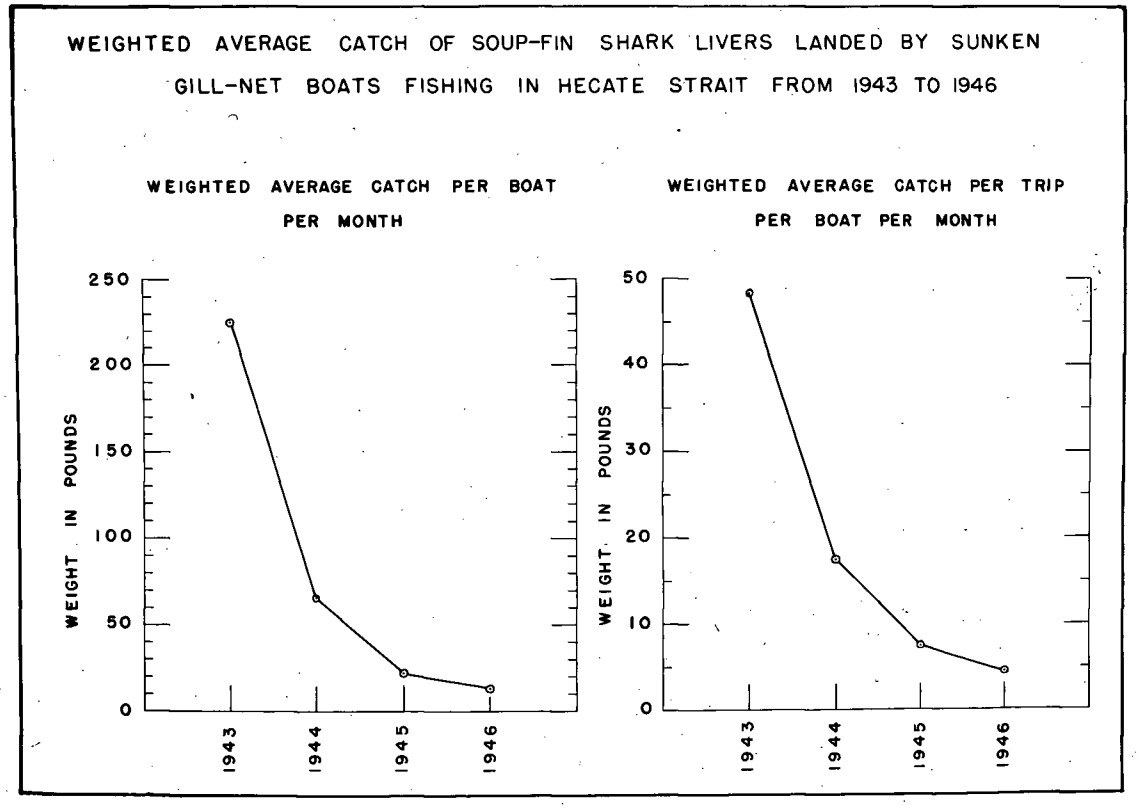
WEIGHTED AVERAGE CATCH OF SOUP-FIN SHARK LIVERS LANDED BY SUNKEN GILL-NET BOATS FISHING IN HECATE STRAIT FROM 1943 TO 1946
WEIGHTED AVERAGE CATCH PER BOAT PER MONTH
WEIGHT IN POUNDS
250
200
150
100
50
0
1943
1944
1945
1946
WEIGHTED AVERAGE CATCH PER TRIP PER BOAT PER MONTH
WEIGHT IN POUNDS
50
40
30
20
10
0
1943
1944
1945
1946

Fig. 39

and the average catch per trip per boat per month both illustrate the marked decline from 1943 to 1946. The availability for the years 1945 and 1946 is extremely low when compared with the year 1943.

5. The Index of the Average Catch per Boat per Month and the Average Catch per Trip per Boat per Month, as Determined by the Method of Link Relatives.

The two graphical presentations of the availability (Figures 40 and 41) are very similar. Both of these figures demonstrate the sudden increase in the availability for June 1944 and the increase in the availability for July 1944, when compared with July 1943. In the years 1945 and 1946 the availability dropped to a very low degree.

The index of the average catch per boat per month and the index of the average catch per trip per boat per month for each year as a whole (Fig. 42) indicates a decided drop in availability from 1943 to 1946.

6. Comparison of the Average Catch per Boat per month for the Same sunken Gill-net Boats Fishing in Adjacent Years.

This method of analysis demonstrates that the average catch per boat per month increased sharply for all months in 1944 when compared with the months in 1943 (Fig. 43). This result, illustrated in Fig. 43, is partly the reverse of the results illustrating the average catch per boat per month (Fig. 37) and the average catch per trip per boat per month (Fig. 38).

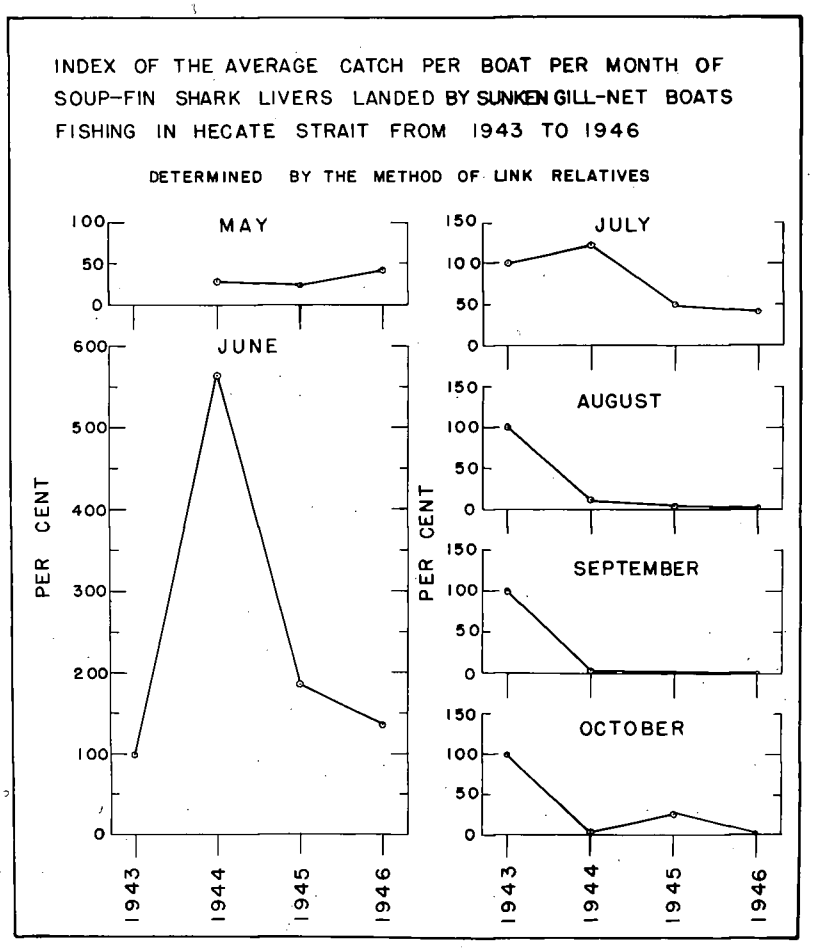
INDEX OF THE AVERAGE CATCH PER BOAT PER MONTH OF SOUP-FIN SHARK LIVERS LANDED BY SUNKEN GILL-NET BOATS FISHING IN HECATE STRAIT FROM 1943 TO 1946
DETERMINED BY THE METHOD OF LINK RELATIVES
PER CENT
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
1943
1944
1945
1946

Fig. 40

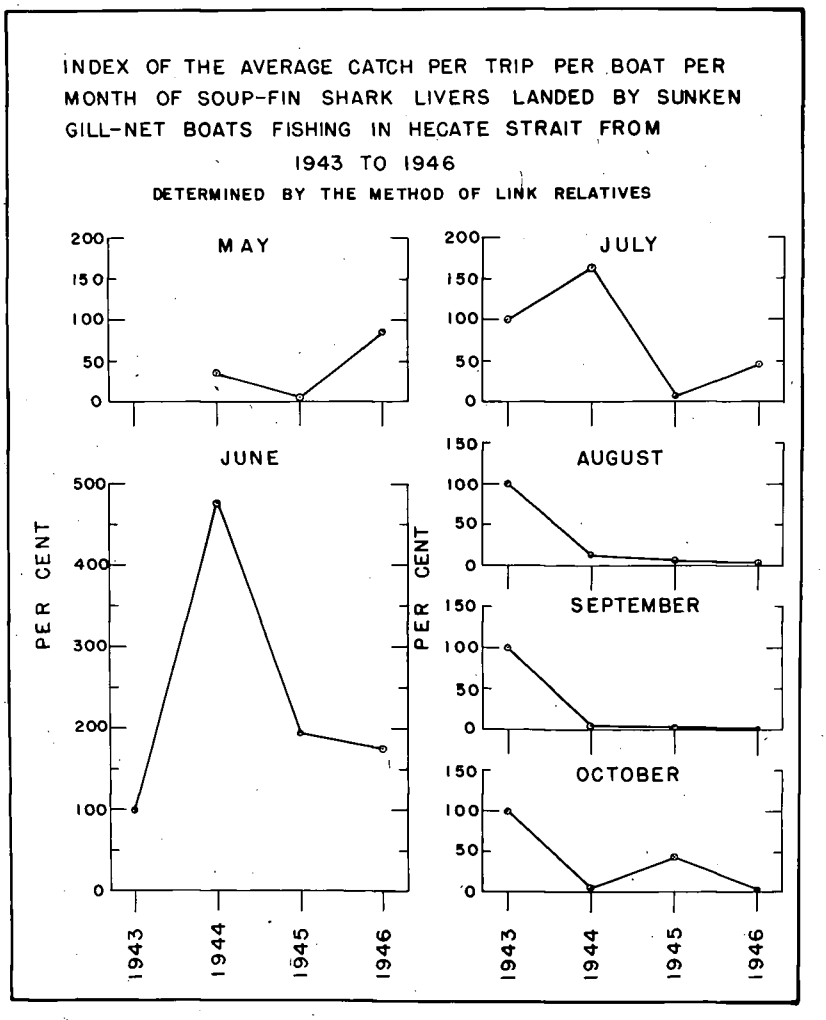
INDEX OF THE AVERAGE CATCH PER TRIP PER BOAT PER MONTH OF SOUP-FIN SHARK LIVERS LANDED BY SUNKEN GILL-NET BOATS FISHING IN HECATE STRAIT FROM 1943 TO 1946
DETERMINED BY THE METHOD OF LINK RELATIVES
MAY
JULY
JUNE
AUGUST
SEPTEMBER
OCTOBER
PER CENT
PER CENT
0
50
100
150
200
300
400
500
1943
1944
1945
1946

Fig.-41

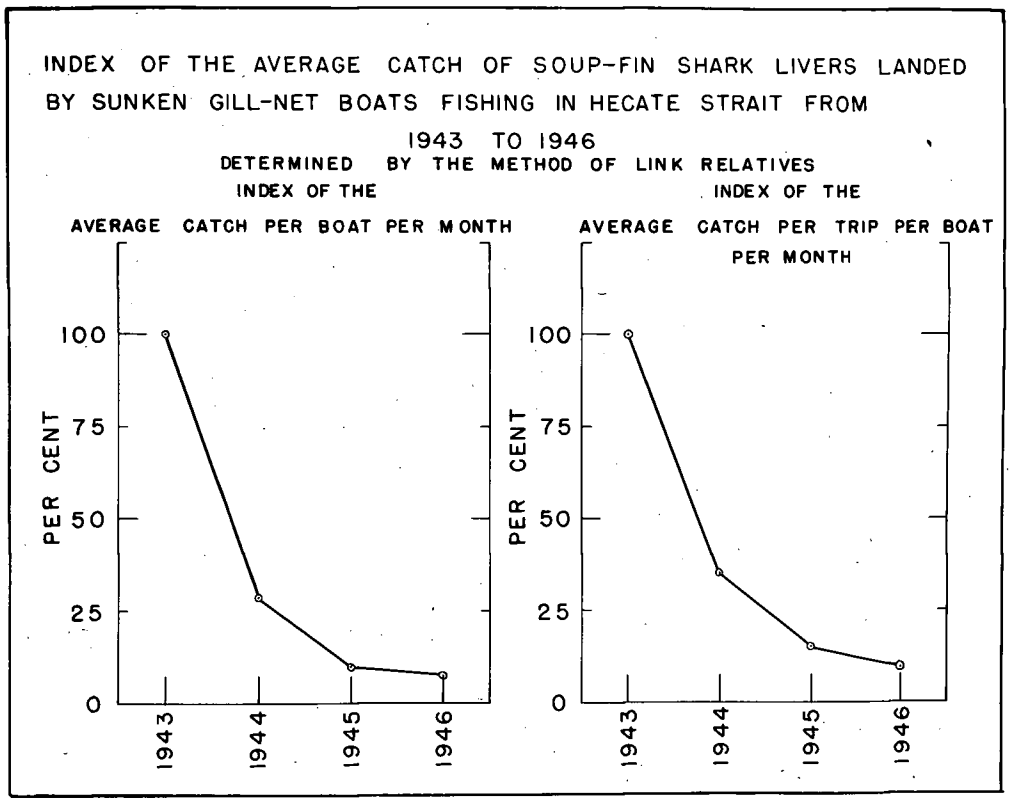
INDEX OF THE AVERAGE CATCH OF SOUP-FIN SHARK LIVERS LANDED BY SUNKEN GILL-NET BOATS FISHING IN HECATE STRAIT FROM 1943 TO 1946
DETERMINED BY THE METHOD OF LINK RELATIVES
INDEX OF THE AVERAGE CATCH PER BOAT PER MONTH
INDEX OF THE AVERAGE CATCH PER TRIP PER BOAT PER MONTH
PER CENT
100
75
50
25
0
1943
1944
1945
1946

Fig. 42

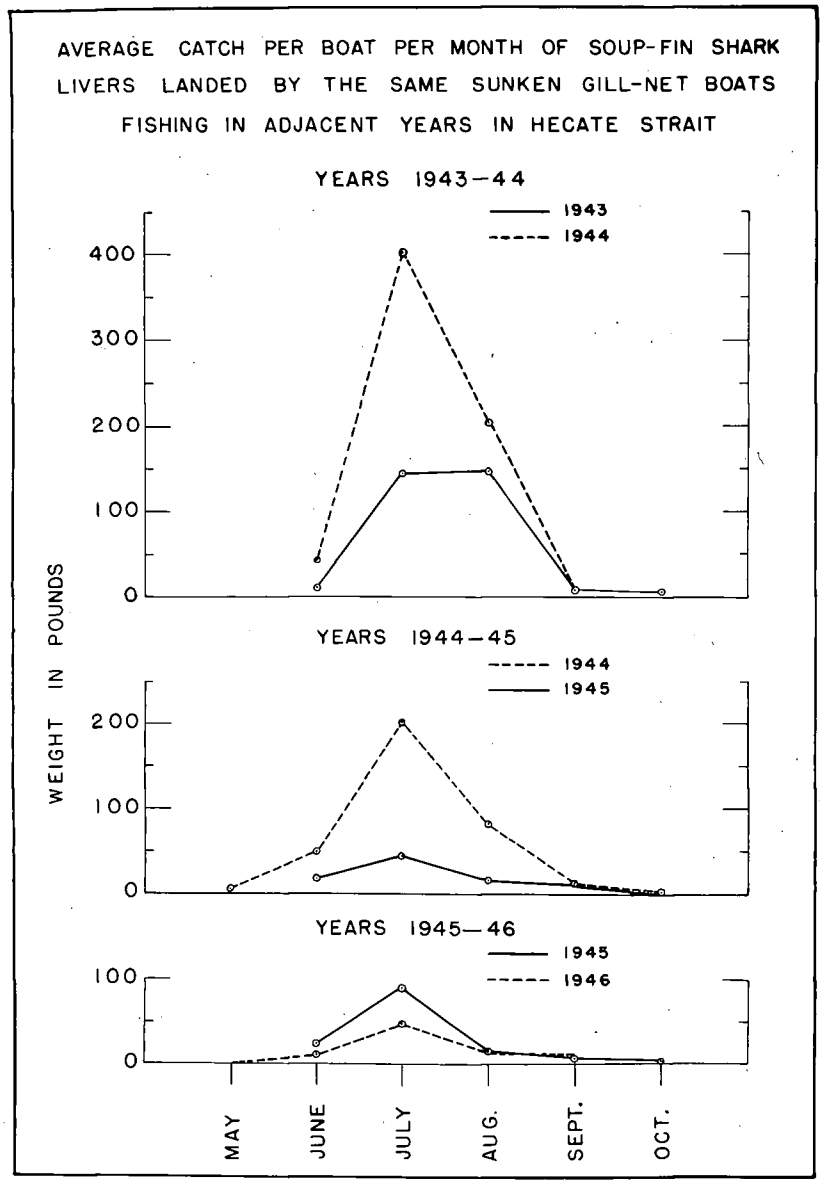
AVERAGE CATCH PER BOAT PER MONTH OF SOUP-FIN SHARK LIVERS LANDED BY THE SAME SUNKEN GILL-NET BOATS FISHING IN ADJACENT YEARS IN HECATE STRAIT
YEARS 1943—44
1943
1944
400
300
200
100
0
WEIGHT IN POUNDS
YEARS 1944—45
1944
1945
200
100
0
YEARS 1945—46
1945
1946
100
0
MAY
JUNE
JULY
AUG.
SEPT.
OCT.

Fig. 43

Figures 37 and 38 picture the availability to be greater for the months of July and August in 1943.

When the months of the years 1944-45 and the years 1945-46 are compared, the average catch per boat per month landed by the same boats fishing in these adjacent years falls steadily with each successive year. In 1946 the availability became so low that the soup-fin shark fishery almost disappeared from Hecate strait.

7. The Index of the Total Landings of Soup-fin Shark Livers made by the Same Sunken Gill-net Boats Fishing in Adjacent Years, as Determined by the Method of Relatives.

The indices graphed in Fig. 44 check fairly closely for all months, except September, with the indices graphed in Figures 40 and 41. Figures 40 and 41 illustrate the picture for all the boats fishing in Hecate strait while Fig. 44 illustrates the picture of the availability for the same boats fishing in adjacent years. Fig. 44 indicates an increase in the availability of the soup-fin shark in September 1946 when compared with September 1945; and an increase in availability in September 1945 when compared with September 1943.

Fig. 45 illustrates the average catch of soup-fin shark livers, per month for each year as a whole, landed by the same boats fishing in adjacent years in Hecate strait. The index rises abruptly in 1944, when compared with the base year 1943. The index of availability falls just as abruptly in 1945 and reaches a low index in 1946.

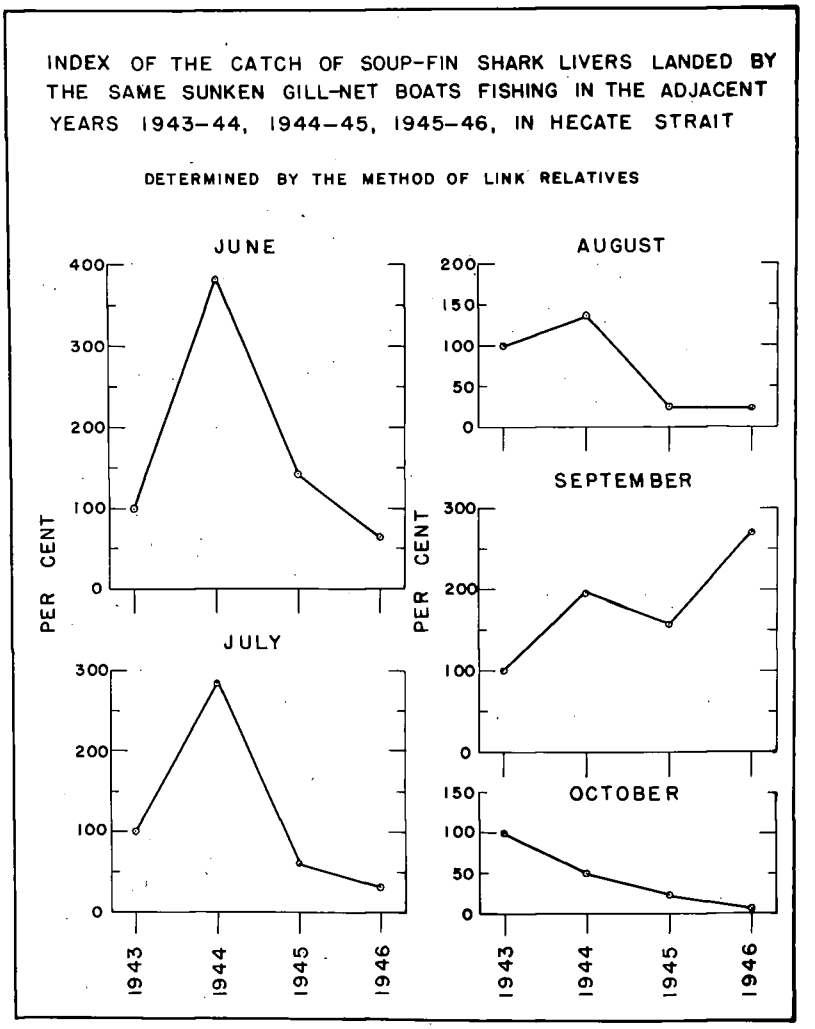
INDEX OF THE CATCH OF SOUP-FIN SHARK LIVERS LANDED BY THE SAME SUNKEN GILL-NET BOATS FISHING IN THE ADJACENT YEARS 1943-44, 1944-45, 1945-46, IN HECATE STRAIT
DETERMINED BY THE METHOD OF LINK RELATIVES
JUNE
AUGUST
SEPTEMBER
JULY
OCTOBER
PER CENT
PER CENT
400
300
200
100
0
200
150
100
50
0
300
200
100
0
300
200
100
0
150
100
50
0
1943
1944
1945
1946
1943
1944
1945
1946

Fig. 44

INDEX OF THE TOTAL CATCH OF SOUP-FIN SHARK LIVERS LANDED BY THE SAME SUNKEN GILL-NET BOATS FISHING IN THE ADJACENT YEARS 1943–44, 1944–45, 1945–46, IN HECATE STRAIT

DETERMINED BY THE METHOD OF LINK RELATIVES

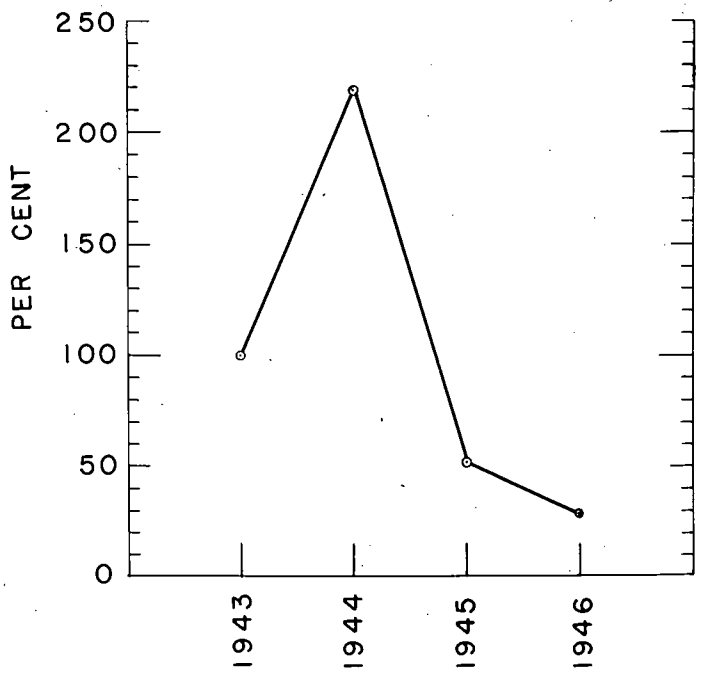

Fig. 45

F. Summary, Discussion, and Conclusions of the Results of the Analysis of the Data from Hecate Strait.

A number of methods of analysing the catch records of the dog-fish and soup-fin shark livers landed by sunken gill-net boats in Hecate strait has been presented. The methods of analysis of the availability have been treated in order of complexity, from the general variations of the increase and decrease in total catch statistics, to the more searching and valid methods of estimating availability. The graphical illustrations have been used to replace wordy descriptions of discussing availability by each method of analysis.

From information gathered in the field and by detailed surveys of the precise area of capture of the dog-fish by individual boats during each month, it was found that the dog-fish migrates into Hecate strait from the north each year. Evidence of this is shown by changes in the periods of availability for the different months in each year. When the dog-fish reach and enter Hecate strait they are partly restricted in their direction of movements by the barriers on both sides of the strait. The dog-fish become bunched, and tend to travel in very large schools, thus increasing their vulnerability to capture by fishing gear. In the late summer of 1943, the first year when sunken gill-nets were used in Hecate strait, the fishermen's boat catches were large and the distance the fishermen travelled to set their nets was not great. These fishermen were probably fishing only a small part of the actual population of the dog-fish in Hecate strait at that time, or of the

population which had been in Hecate strait. In the year 1944, an intensified fishery occurred as a result of the large catches of dog-fish during the later summer months in 1943. Large numbers of American trawlers entered Hecate strait in 1944 and the total landings of dog-fish and soup-fin shark livers was the largest in the history of British Columbia. The large catches raise doubts as to what quantity of dog-fish and soup-fin shark can be taken from the fishery and yet leave a sufficient number of the species to propagate. In the year 1945, availability of the dog-fish and soup-fin shark dropped so abruptly that many fishermen considered the fishery in that year almost a failure. The number of sunken gill-nets used in 1945 almost doubled the number that was used in 1944. The dog-fish entering Hecate strait in 1945 were not only confronted by an extemely large barrier of sunken gill-nets but an increased number of otter-trawls. This increase in the number of boats reduced the average catch per boat when compared with the previous year. Undoubtedly the increased competition between gear and the poor weather conditions during the summer months in 1945 were two detrimental factors influencing the catch.

In 1946 the number of fishermen entering the fishery in Hecate strait declined. The dog-fish which entered the strait in 1946 were not subjected to the intensive fishery that occurred in the previous years. The availability increased slightly in 1946 during the months of August, September, and October. This may indicate a later period of migration for the dog-fish when compared with the previous years.

From the analyses of the catch records of sunken gill-net

boats, it is now evident that the fishable population of dog-fish which enters Hecate strait should only be subjected to a fishery by a limited number of boats and gear. This is an economic conclusion, not a biological one. The analyses of the catch records indicate a definite decline in abundance of the dog-fish in Hecate strait but it is not possible to state that this constitutes depletion. The problem needs at least one more season of investigation. A definite decision is therefore reserved because of the influence of two important factors which have not been studied sufficiently to give conclusive results. These two factors are:-

1. the changes in the total amount of effort.
2. the influence of hydrographic conditions.

In addition to the decline in availability of dog-fish and the total landings of livers from Hecate strait from 1944 to 1946 there has been a noticeable decline in the vitamin "A" potency of the dog-fish livers from 1944 to 1947. The average vitamin "A" potency (in USP units per gram of liver oil) of livers from dog-fish caught in the same area in Hecate strait by sunken gill-nets has declined with each succeeding year since 1944. The decline in the vitamin "A" potency of the livers has been of great concern to the fishermen and the fishing industry. It means that the total poundage of livers from dog-fish caught in Hecate strait in 1947 would represent a lower stock of vitamin "A" for the same weight of livers recovered from dog-fish caught by the same gear and in the same area as in 1944.

The decline in potency of vitamin "A" is indicated in

Table IX. The average number of USP units per gram of liver oil were tested from livers removed from dog-fish caught only by sunken gill-nets in Hecate strait near the Queen Charlotte islands (shaded area Fig. 22). Livers tested for vitamin "A" in table IX were landed from the beginning of May until the end of October in each year. This decline in potency of vitamin "A" is both an economic problem and a biological one. The economic problem is particularly concerned with the decline in the potency of vitamin "A" per pound of liver landed. The biological problem is concerned with the relationship between the decline in the availability of the dog-fish in Hecate strait and the decline in potency of vitamin "A" in the livers. What has brought about this decline in average potency of livers from Hecate strait?

Certain facts concerning the relationship between the vitamin "A" concentration per liver and the physical characteristics of the dog-fish are well known. Vitamin "A" concentration of the liver oil and percentage of oil in the liver are positively correlated with the length. There is also a close association with sexual maturity of the dog-fish and the vitamin "A" concentration of the livers. Livers from immature dog-fish contain only a small percentage of vitamin "A" found in the livers of the larger fish. Fish with dark livers appear to mature earlier than dog-fish of the same size and sex with light coloured livers. It is known that the darker livers generally average higher in vitamin "A" concentration than the lighter coloured livers and that the largest male and female dog-fish have livers darker in colour than the smaller fish of either sex. Further,

Table IX

The average number of USP units per gram of liver oil determined from the livers of the dog-fish taken from dog-fish that were caught only by sunken gill-nets in Hecate strait near the Queen Charlotte islands from 1944 to 1947.

	Average number of USP units per gram of liver oil*	Total poundage of dog-fish livers analysed
1944	14,648	148,191
1945	13,183	514,000
1946	9,784	446,448
1947	9,075	572,486

* These figures were determined from daily liver oil analyses made available by the fishing industry which included as many separate landings of dog-fish livers as possible.

there is a seasonal variation in the liver potency as for example--dog-fish of the same size and sex, have livers which produce a greater liver potency in the winter than in the summer. In general it has been found that for dog-fish of the same sex, large fish, as compared with small fish, have a greater ratio of liver weight to body weight; darker livers; more oil per liver; liver and liver oil of a higher potency; more vitamin "A" per liver.

Since the larger dog-fish contain a higher concentration of vitamin "A" than the smaller dog-fish, the decline in vitamin "A" of livers removed from dog-fish caught in Hecate strait by sunken gill-nets could be attributed to the removal of the larger dog-fish or the movement of these larger fish from the grounds. This would suggest that the decline in availability of dog-fish caught in sunken gill-nets in Hecate strait is closely related to removal or possible depletion of the older age classes of dog-fish from the population.

Sanford and Bonham (1946) indicate that age is probably the determining factor in vitamin "A" production in the liver independent of the length of the dog-fish. They found that within a length frequency category that there was an inverse relationship between liver colour and the average posterior spine length of the dog-fish. It was assumed that for fish of the same size and sex that the dog-fish with the darker livers are probably the older since their blunt spines would have been subjected to wear for a longer time. Their observations showed that the difference in the length of the spine was most noticeable among the larger fish, where specimens of the same size

might have differed considerably in rate of growth. This would indicate that the darkest livers with the highest vitamin "A" concentration are found in the dog-fish which grow the slowest.

A question arises. Why was the drop in the availability of the soup-fin shark more pronounced than the drop in the availability of the dog-fish?

There may be two reasons:

1. The soup-fin shark is more vulnerable to capture by the sunken gill-nets than the dog-fish.

or

2. The soup-fin shark has been subjected to an intense fishery in the United States for a number of years. Thus when the intensity of fishing for this species suddenly increased over the whole of the migratory range, the availability of the soup-fin shark would suddenly drop in the localities which represent the limits of its migratory range. Foerster (1945) reported the possible movement of soup-fin sharks from California to British Columbia when a female soup-fin shark tagged in California waters was captured inside Bajo reef, Nootka sound, on the west coast of Vancouver island.

G. Analysis of the Catch Records of Dog-fish Livers, Landed by Sunken Gill-net Boats Fishing off Barkley Sound on the West Coast of Vancouver Island, from 1944 to 1946.

1. The Total Landings of Dog-fish Livers by Sunken Gill-net Boats.

The histogram (Fig. 47) illustrates the total catch of dog-fish livers landed by sunken gill-net boats fishing off Barkley sound (Fig. 46), from 1944 to 1946. Catch statistics for 1943 were not available. The largest catch of dog-fish livers was made in 1944.

Fig. 48 illustrates the total landings of dog-fish livers each month from 1944 to 1946. The greatest landings of dog-fish livers were made in the month of June in each year.

2. Catch per Unit of Effort.

The fishery for dog-fish off Barkley sound differs from that in Hecate strait, in that each boat's catch is landed every day. The fishing companies have camps on the outer islands of Barkley sound, and at Bamfield, Ucluelet, and Kildonan (Fig. 46). The fishing grounds are only about 1 hour to 2 hours travelling time from the fishing camps.

In the computation of the intensity of fishing effort a "unit" must be established and the amount of fishing time must be included in the calculation of this unit. For this survey the "unit of effort" is defined as one sunken gill-net (75 fathoms) fishing over a period of 24 hours. The number of units of fishing effort was calculated for each fisherman's daily catch, and the index of return per unit of fishing effort for each fisherman's catch was determined by dividing the daily catch by the number of units of fishing effort. There was a

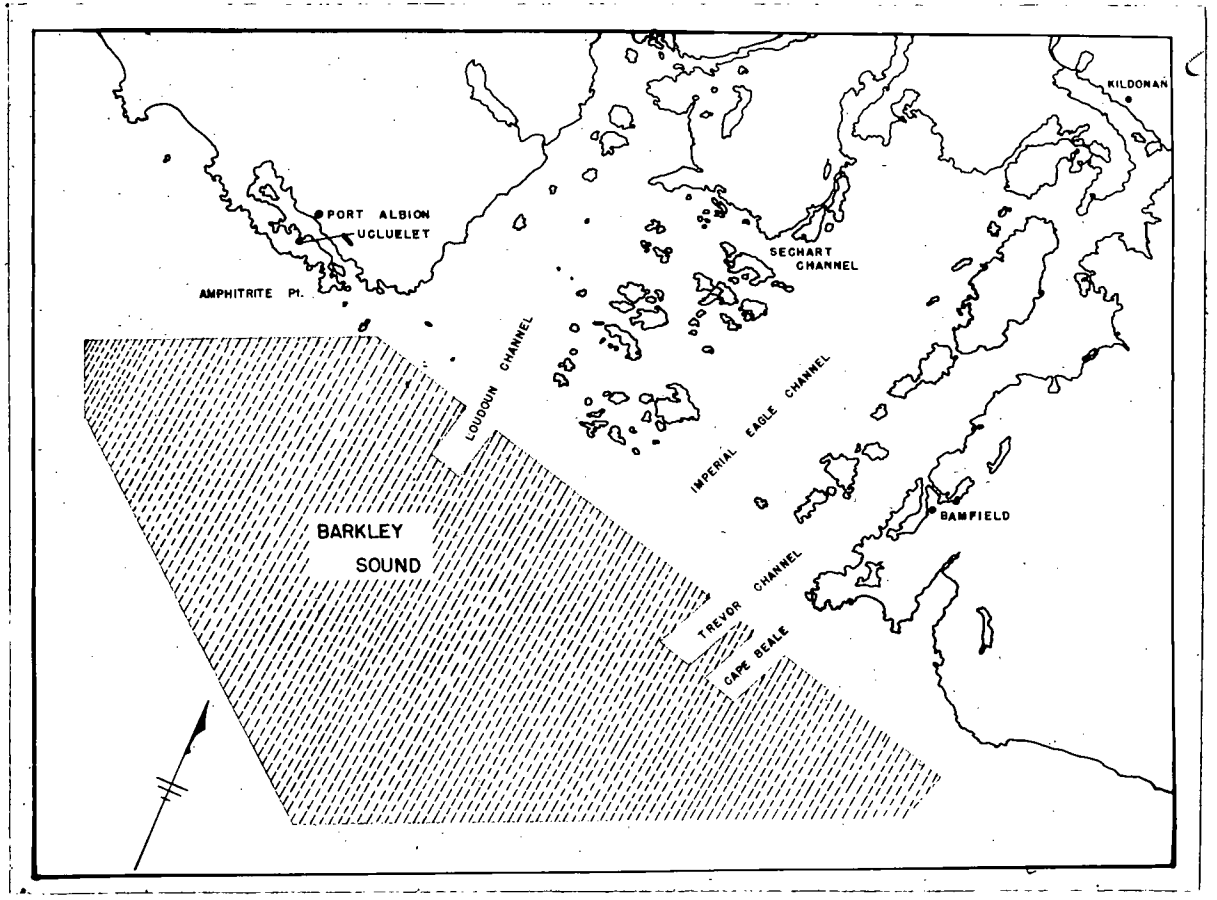

Fig. 46

The shaded area indicates the general fishing grounds for the sunken gill-nets off Barkley sound, on the west coast of Vancouver island.

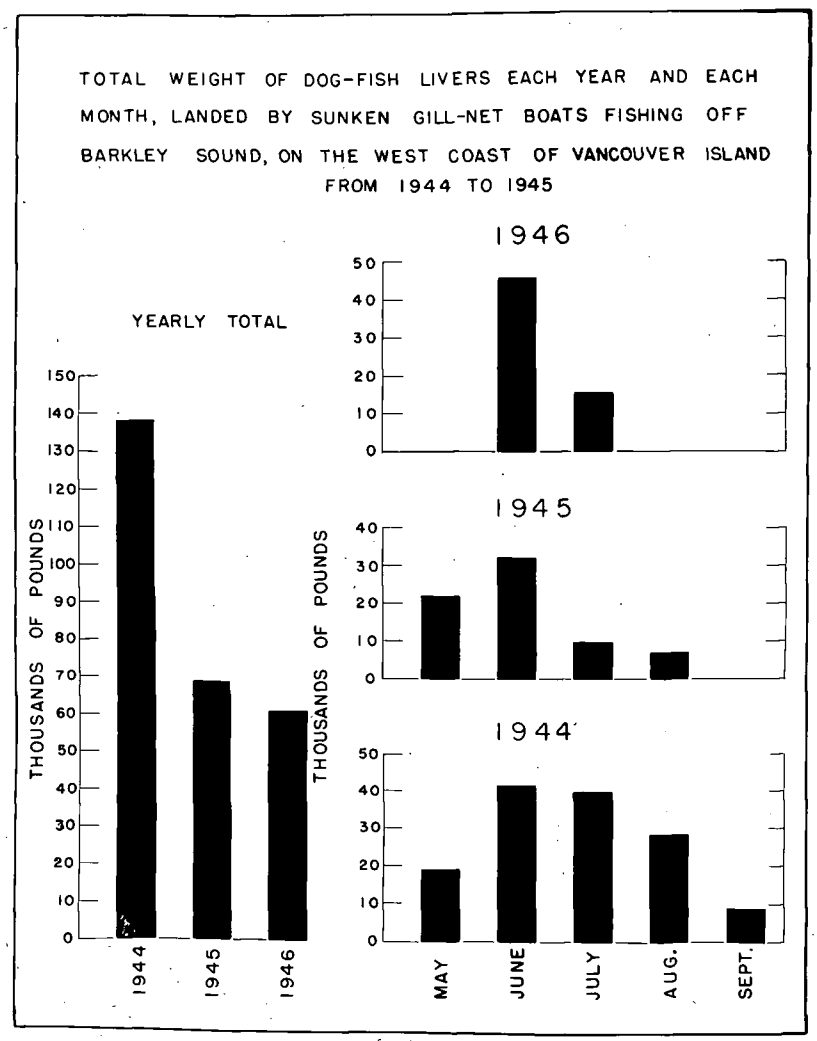
TOTAL WEIGHT OF DOG-FISH LIVERS EACH YEAR AND EACH MONTH, LANDED BY SUNKEN GILL-NET BOATS FISHING OFF BARKLEY SOUND, ON THE WEST COAST OF VANCOUVER ISLAND FROM 1944 TO 1945
YEARLY TOTAL
THOUSANDS OF POUNDS
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1944
1945
1946
1946
1945
1944
THOUSANDS OF POUNDS
50
40
30
20
10
0
MAY
JUNE
JULY
AUG.
SEPT.

Fig. 47

Fig. 48

slight increase in the actual number of nets per boat each year but the length of the net was found to decrease slightly each year, according to each fisherman's individual preference. This index of return per unit of fishing effort forms a basis for comparing the monthly and yearly landings of dog-fish livers. The index can thus be used to formulate the monthly and yearly availability of the dog-fish.

In the month of June, the index of return per unit of fishing effort for the dog-fish is greatest for the years 1944 and 1946 (Fig. 49). Fig. 49 also illustrates that the availability of the dog-fish has increased in each succeeding year since 1944. There may be a slight error in the index of return per unit of fishing effort for 1946, since no allowance is made for the improvement in handling the gear.

3. Average Catch per Boat per Month.

The average catch per boat per month is much lower off Barkley sound when compared with the average catch per boat per month in Hecate strait (Tables X and 9) but the average catch per boat per month off Barkley sound increased from 1944 to 1946. This is just the reverse of the situation found by analyses of catch records from Hecate strait.

H. Summary, Discussion, and Conclusions of the Results of the Analysis of the Data from Barkley sound and Hecate strait.

Either of the two factors or a combination of the following two factors could initiate a movement of dog-fish off the British

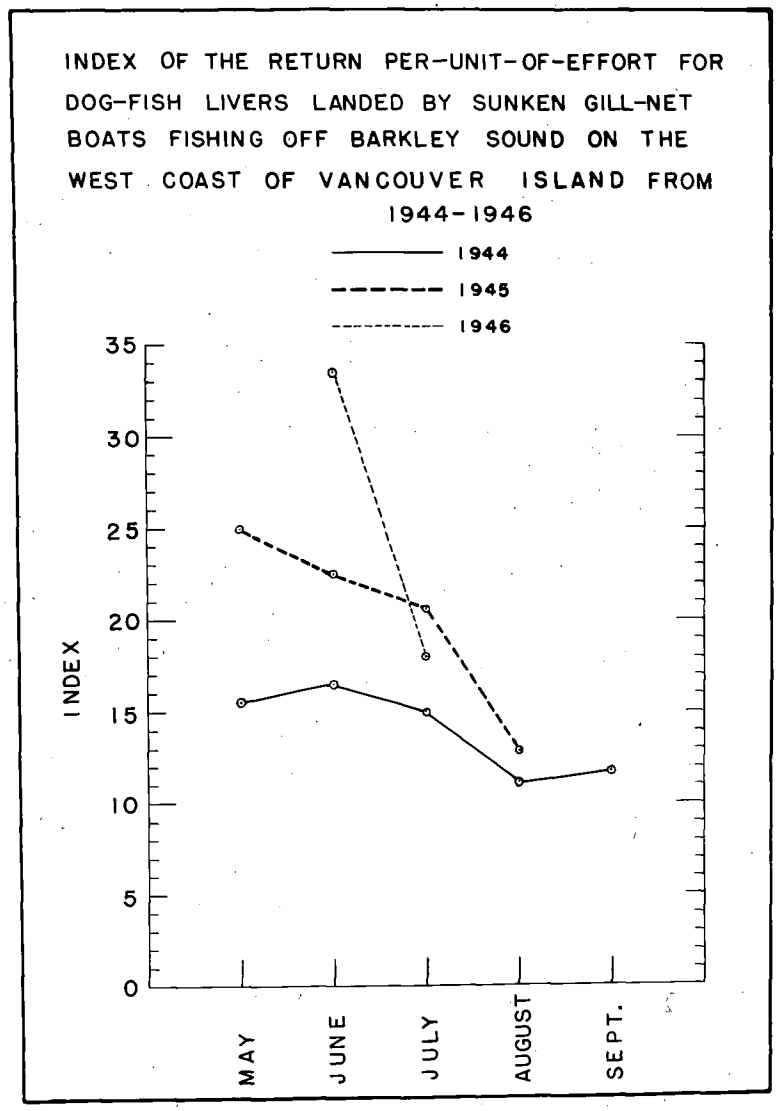
INDEX OF THE RETURN PER-UNIT-OF-EFFORT FOR DOG-FISH LIVERS LANDED BY SUNKEN GILL-NET BOATS FISHING OFF BARKLEY SOUND ON THE WEST COAST OF VANCOUVER ISLAND FROM 1944-1946
1944
1945
1946
INDEX
35
30
25
20
15
10
5
0
MAY
JUNE
JULY
AUGUST
SEPT.

Fig.. 49

Table X

Average Catch (lb.) per Boat per Month of Dog-fish Livers landed by Sunken Gill-net Boats fishing off Barkley Sound on the West Coast of Vancouver Island, from 1944 to 1946

	1944	1945	1946
May	970.2	1,580.2	
June	1,342.2	2,160.4	2,691.1
July	1,284.4	1,549.3	1,198.7
August	1,196.1	1,222.0	
September	694.6		
Weighted average catch per boat per month	1,164.4	1,724.9	2,044.4

Columbia coast are:-

1. a migration in search of food.

2. a migration induced by sexual conditions.

Both of these factors are governed by hydrographic conditions which control the direction, speed, and seasonal fluctuations of their movements.

In 1944 the abundance of the dog-fish was high enough to maintain a successful fishery, both off the west coast of Vancouver island and in Hecate strait. In 1945 the availability of dog-fish dropped greatly in Hecate strait but increased off the west coast of Vancouver island. In 1946 the oceanographic conditions were such that the migration of the available population of dog-fish for the sunken gill-net fishery in Hecate strait did not occur until the months of August and September. The decrease in the return per unit of effort for dog-fish, in the month of July 1946 off Barkley sound (Fig. 49) may be the first indication of the possible movement of dog-fish from the west coast of Vancouver island into Hecate strait.

It is suggested that the greater numbers of the limited population of dog-fish tended to remain off the west coast of Vancouver island with each succeeding year and that the sudden increase in the availability of dog-fish in Hecate strait in the months of August and September in 1946, may have been the result of the movement of the dog-fish from the west coast of Vancouver island into Hecate strait by the southern entrance and not by the northern entrance. In former years the dog-fish have migrated into Hecate strait by the northern entrance around Rose spit. Evidence of this southern migration into Hecate

strait was indicated by the first large catches of dog-fish by otter-trawls, south of Cumshewa inlet, and later by the sunken gill-nets off Skidegate inlet and Tlell.

The success of the dog-fish fishery in Hecate strait almost parallels the Canadian pilchard fishery off the west coast of Vancouver island. The Canadian pilchard fishery is dependent upon the largest pilchards which make a northward migration each summer from the California coastal waters (Hart 1938). As the pilchards off the California coast grow older with each succeeding year, the northward migration is extended. Since the larger fish go farther, they take a longer time to return to California waters, thus they become subjected to the Canadian fishery.

The success of the dog-fish fishery for the sunken gill-nets in Hecate strait has largely depended in the past upon the older age classes of dog-fish which have migrated into this area. The increase in the availability of dog-fish off the west coast of Vancouver island, would indicate that the oceanographic conditions were not suitable for the migration of the dog-fish into Hecate strait in 1945 and the first three months of the fishery in 1946. As the older age classes of dog-fish are removed from the fishery the tendency for the dog-fish to migrate into Hecate strait would become limited. The numbers of younger dog-fish would be limited in their range of migration into Hecate strait but they would still tend to remain off the west coast of Vancouver island.

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VIII. APPENDIX

Table 1

Length Frequency Distributions of Dog-fish Caught by Sunken Gill-nets off Barkley Sound in June, 1944.
Measurements made from 7 different "sets".

Length (cm.)	No. of Males	Length (cm.)	No. of Males	Length (cm.)	No. of Females	Length (cm.	No. of Females
60	1	89	32	60	1	89	
61		90	24	61		90	1
62		91	13	62		91	
63		92	16	63		92	2
64		93	10	64		93	2
65		94	4	65		94	1
66		95	6	66		95	3
67		96	2	67		96	5
68		97	3	68	1	97	1
69		98		69		98	2
70	2	99	1	70	5	99	1
71	1	100		71	1	100	4
72	2	101		72	1	101	3
73	5	102		73		102	2
74	1	103		74		103	4
75	4	104		75		104	3
76	4	105		76		105	7
77	9	106		77	2	106	3
78	3	107		78	1	107	1
79	9	108		79		108	1
80	20	109		80	1	109	2
81	26	110		81		110	5
82	29	111		82	1	111	
83	41	112		83	1	112	2
84	48	113		84	5	113	1
85	46	114		85	1	114	2
86	53	115		86		115	1
87	35	116		87	1	116	
88	30			88			

Total 480 ♂ Total 81 ♀

Table 2

Length Frequency Distributions of Dog-fish Caught by Sunken Gill-nets off Barkley Sound in August 1944.
Measurements made from 10 different "sets".

Length (cm.)	No. of Males	Length (cm.)	No. of Males	Length (cm.)	No. of Females	Length (cm.) F	No. of Females
58		87	82	58	1	87	1
59		88	65	59		88	3
60		89	56	60		89	1
61		90	31	61		90	4
62		91	24	62	1	91	5
63	4	92	19	63		92	3
64	1	93	13	64	4	93	2
65	2	94	5	65	4	94	4
66	4	95	5	66	6	95	3
67	6	96		67	12	96	3
68	5	97	1	68	6	97	4
69	6	98		69	8	98	3
70	11	99		70	9	99	
71	14	100		71	6	100	2
72	7	101		72	6	101	
73	6	102		73	6	102	
74	16	103		74	5	103	2
75	24	104		75	7	104	
76	22	105		76	3	105	
77	31	106		77	9	106	
78	33	107		78	4	107	2
79	33	108		79	4	108	2
80	47	109		80	5	109	
81	56	110		81	4	110	
82	67	111		82	4	111	1
83	71	112		83	1	112	
84	70	113		84	7	113	1
85	81	114		85	10	114	
86	58	115		86	2	115	1
						116	1

Total 976 ♂ Total 182 ♀

Table 3

Length Frequency Distribution of Dog-fish Caught by Sunken Gill-nets in Hecate Strait in June 1946.
Measurements made from 7 different "sets".

Length (cm.)	No. of Males	Length (cm.)	No. of Males	Length (cm.)	No. of Females	Length (cm.)	No. of Females
65		93		65	1	93	15
66		94		66		94	19
67		95		67		95	23
68		96		68	1	96	19
69		97	1	69	3	97	15
70	1	98		70	3	98	7
71	1	99		71	1	99	13
72		100		72	3	100	18
73		101		73	5	101	15
74	2	102		74	2	102	9
75	1	103		75	6	103	11
76	1	104		76	3	104	7
77	1	105		77	4	105	8
78	3	106		78	3	106	11
79	4	107		79	7	107	11
80	1	108		80	8	108	10
81	1	109		81	4	109	8
82	1	110		82	5	110	7
83	2	111		83	3	111	5
84	1	112		84	8	112	2
85	2	113		85	4	113	4
86	3	114		86	7	114	1
87	2	115		87	6	115	1
88	1	116		88	12	116	
89	3	117		89	13	117	2
90		118		90	15	118	
91	1	119		91	14	119	1
92		120		92	18	120	

Total 33 ♂ Total 401 ♀

Table 4

Length Frequency Distributions of Dog-fish Caught by Sunken Gill-nets off Barkley Sound in June 1945.
Measurements made from 8 different "sets".

Length (cm.)	No. of Males	Length (cm.)	No. of Males	Length (cm.)	No. of Females	Length (cm.)	No. of Females
60	1	91		60		91	7
61		92	1	61		92	5
62		93	2	62	1	93	8
63		94	1	63		94	12
64		95		64	1	95	10
65		96		65		96	17
66		97		66		97	14
67		98		67		98	14
68	1	99		68	1	99	18
69	1	100		69		100	21
70		101		70	1	101	18
71	2	102		71	3	102	17
72		103		72		103	29
73		104		73	1	104	21
74	1	105		74	2	105	22
75	2	106		75		106	18
76	2	107		76	1	107	13
77	4	108		77	1	108	7
78	2	109		78	2	109	12
79	3	110		79		110	8
80	8	111		80	2	111	2
81	3	112		81		112	1
82	3	113		82	1	113	5
83	10	114		83	3	114	
84	5	115		84	1	115	2
85	9	116		85	2	116	2
86	3	117		86		117	
87	6	118		87	3	118	1
88	10	119		88	5	119	1
89	6	120		89	1	120	1
90	5			90	4		
	Total 93 ♂				Total 342 ♀		

Table 5

Length Frequency Distribution of Dog-fish caught by Otter Trawls off Amphitrite Point (Barkley Sound) in June and July 1945.

Length (cm.)	No. of Males	Length (cm.)	No. of Males	Length (cm.)	No. of Females	Length (cm.)	No. of Females
55		76	5	55		76	3
56	1	77	5	56	3	77	3
57	5	78	6	57	1	78	2
58	4	79	7	58	2	79	1
59	3	80	8	59	3	80	
60	6	81	5	60	6	81	3
61	7	82	6	61	6	82	1
62	5	83	6	62	7	83	2
63	8	84	7	63	7	84	3
64	6	85	9	64	8	85	1
65	11	86	6	65	11	86	1
66	8	87	4	66	13	87	
67	12	88	2	67	14	88	3
68	7	89	1	68	9	89	2
69	9	90	3	69	12	90	1
70	10	91	2	70	7	91	1
71	5	92	2	71	9	92	
72	8	93		72	7	93	2
73	6	94		73	5	94	
74	4	95		74	1	95	
75	5			75	4		

Total 214 ♂

Total 165 ♀

Table 6a

Daily Landings of Dog-fish and Soup-fin Shark Livers Caught in Hecate Strait by Sunken Gill-net Boats (from available data).

	May 1943			May 1944			May 1945			May 1946		
	Weight of Dog-fish Livers lb.	Weight of Soup-fin Shark Livers lb.	No. of Trips	Weight of Dog-fish Livers lb.	Weight of Soup-fin Shark Livers lb.	No. of Trips	Weight of Dog-fish Livers lb.	Weight of Soup-fin Shark Livers lb.	No. of Trips	Weight of Dog-fish Livers lb.	Weight of Soup-fin Shark Livers lb.	No. of Trips
1												
2												
3				679		2						
4												
5												
6												
7										24		1
8												
9												
10				2,201		2						
11												
12				3,647		3						
13				566		2						
14				456		2						
15				995		2				57		1
16				664		2						
17				163		1				301		2
18				1,092		4						
19				390		1				86		1
20				2,609	2	6	4,158		1	164		1
21				793		3	750		1			
22				431	22	3	1,620		4	98		1
23				2,638	10	4	435		2	742		2
24				2,763		7	48		1			
25	600		1	2,016		5	6,118		9			
26				909	4	2	9,610	1	10	408		1
27				166		1	12,315		8	4,927		4
28	1,120		1	766		3	9,010		6			
29				2,136	13	6	41,743	3	27	5,891	2	3
30				3,562	10	7	14,250		13	5,519		6
31				3,687		5	13,978		8	9,555		7
Total	1,720		2	33,329	61	73	114,035	4	90	27,772	2	30
	No. Boats 1			No. Boats 25			No. Boats 69			No. Boats 20		

Table 6b

Daily Landings of Dog-fish and Soup-fin Shark Livers Caught in Hecate Strait by Sunken Gill-net Boats (from available data).

	June 1943			June 1944			June 1945			June 1946		
	Weight of Dog-fish Livers lb.	Weight of Soup-fin Shark Livers lb.	No. of Trips	Weight of Dog-fish Livers lb.	Weight of Soup-fin Shark Livers lb.	No. of Trips	Weight of Dog-fish Livers lb.	Weight of Soup-fin Shark Livers lb.	No. of Trips	Weight of Dog-fish Livers lb.	Weight of Soup-fin Shark Livers lb.	No. of Trips
1				17,085	2	15	27,278	19	43	5,101	7	5
2				19,843	10	15	21,763	5	14	2,214		2
3	2,022	6	1	16,581	5	20	3,766		9	6,222		2
4				4,005		8	20,237		12			
5				19,611	83	20	29,092	13	20	248		1
6	210		1	7,478			37,008	25	34	12,256	12	9
7				28,442	70	21	64,828	24	43	17,007		4
8				10,616	5	15	52,129	5	37	12,873		9
9				20,248	63	9	17,562	22	18	1,343		3
10	1,021		2	23,163	38	20	5,040	72	11	1,368		4
11	758	2	2	8,297		10	22,110	7	22	12,664	5	12
12	727		1	19,764	39	11	17,225	6	37	28,721	8	15
13				8,505	28	6	11,827	14	24	4,847	45	8
14	368		1	22,502	43	10	19,860	5	26	2,934		4
15	1,571	5	3	24,652	65	11	22,003	154	28	1,450	90	3
16	727	12	3	51,154	153	24	24,179	28	31	17,053	4	9
17				24,820	138	15	11,284	8	18	21,867	4	18
18				18,119	175	10	18,315	64	38	2,140	8	3
19				16,326	60	15	24,301	40	23	11,412	112	8
20	80		1	19,624	186	15	16,585	182	16	16,310	84	14
21	220		1	12,187	220	9	16,448	153	35	14,146	44	14
22				13,668	173	11	25,272	279	28	7,212	11	6
23				22,188	214	10	57,054	365	33	2,012	60	4
24	558		1	16,830	140	15	14,238	86	23	10,285	32	8
25	1,120		2	16,140	148	10	17,674	177	26	14,622	61	11
26	201	15	1	16,545	262	10	24,597	228	38	9,450	33	10
27				50,003	420	28	28,758	148	29	13,769	70	10
28				30,211	372	21	27,416	407	19	12,366	19	9
29				10,433	222	11	44,584	355	42	6,996	33	7
30				57,363	813	27	57,614	328	48	6,741	10	3
Total.	10,386	40	20	626,404	4,147	434	780,047	3,219	825	275,629	752	215
	No. Boats 5			No. Boats 92			No. Boats 217			No. Boats 70		

Table 6c

Daily Landings of Dog-fish and Soup-fin Shark Livers Caught in Hecate Strait by Sunken Gill-net Boats (from available data).

	July 1943			July 1944			July 1945			July 1946		
	Weight of Dog-fish Livers lb.	Weight of Soup-fin Shark Livers lb.	No. of Trips	Weight of Dog-fish Livers lb.	Weight of Soup-fin Shark Livers lb.	No. of Trips	Weight of Dog-fish Livers lb.	Weight of Soup-fin Shark Livers lb.	No. of Trips	Weight of Dog-fish Livers lb.	Weight of Soup-fin Shark Livers lb.	No. of Trips
1	198		1	18,054	129	11	3,116	15	14	4,736	17	3
2				18,123	460	13	12,292	81	15	1,227	4	4
3	835		1	23,813	363	15	23,648	196	24	11,961	50	8
4	160		1	27,333	674	23	29,753	238	33	10,140	32	6
5				7,037	166	10	18,002	509	29	523	4	2
6				49,946	286	16	48,707	779	37	749	16	1
7				13,087	276	9	23,056	463	35	8,666	85	9
8				15,297	446	14	22,757	688	34	12,538	128	8
9	56	4	1	16,497	38	8	37,218	457	29	3,565	25	7
10	118	7	1	13,716	23	8	18,678	303	28	1,653		3
11	598	81	2	28,035	283	16	13,981	296	25	3,737	45	4
12	1,093	144	4	9,467	29	9	15,145	371	18	2,161	26	3
13	1,326	98	2	20,724	349	10	13,777	301	13	7,445	300	6
14	1,874	136	3	2,430	14	5	15,051	472	24	615	4	1
15	799	43	3	14,358	88	9	8,603	299	18	13,302	169	7
16	764	19	2	23,258	116	16	13,588	179	25	11,320	102	8
17	199	9	1	24,369	966	17	24,956	521	34	20,583	176	14
18	85		1	11,433	34	13	16,224	530	33	1,694	138	3
19	222		1	24,010	358	26	21,910	673	31	1,210	5	4
20	1,000	6	3	16,508	470	16	24,947	605	13	1,011	32	2
21	66		1	14,039	1,109	9	17,239	256	9	2,847	68	5
22	353	13	1	11,652	303	7	4,565	465	8	3,751	168	6
23	2,453	41	5	6,906	408	12	7,706	164	15	7,179	86	5
24	403	9	1	19,501	430	17	2,566	89	12	8,976	37	8
25	3,306	118	2	15,338	308	16	10,192	117	17	8,046	58	7
26	96		1	11,147	348	10	10,652	188	7	5,930	81	6
27	403		2	11,911	1,179	18	8,710	151	13	4,964	12	5
28				8,607	1,252	9	6,364	98	11	3,014	36	3
29	4,514	276	2	8,941	739	8	9,280	164	9	11,498	88	9
30	627	15	3	8,834	914	10	1,348	59	7	10,821	79	7
31	2,152	8	3	11,356	1,174	14	4,771	68	10	2,449		3
Total	23,700	1,027	48	505,827	13,732	394	488,802	9,795	630	188,311	2,071	167
	No. Boats 10			No. Boats 110			No. Boats 190			No. Boats 49		

Table 6d

Daily Landings of Dog-fish and Soup-fin Shark Livers Caught in Hecate Strait by Sunken Gill-net Boats (from available data).

	August 1943			August 1944			August 1945			August 1946		
	Weight of Dog-fish Livers lb.	Weight of Soup-fin Shark Livers lb.	No. of Trips	Weight of Dog-fish Livers lb.	Weight of Soup-fin Shark Livers lb.	No. of Trips	Weight of Dog-fish Livers lb.	Weight of Soup-fin Shark Livers lb.	No. of Trips	Weight of Dog-fish Livers lb.	Weight of Soup-fin Shark Livers lb.	No. of Trips
1	1,056	9	3	12,658	1,154	18	9,656	175	17	852		4
2	4,023	240	1	9,043	129	11	12,814	672	15	15,958	21	11
3	4,187	48	2	18,018	804	21	5,599	110	7	9,649	18	5
4	820		1	26,188	380	18	14,740	99	13			
5				12,426	158	17	5,124	18	13	19,675	19	9
6	2,948	146	3	8,544	260	8	20,898	271	17	2,709	4	4
7	3,470	766	2	12,584	228	12	8,294	31	11	10,668	86	6
8	1,333	82	3	16,153	106	9	13,415	50	14	3,101	5	4
9	2,340	83	2	3,660	32	4	8,703	124	12	12,592	3	7
10	98		1	12,969	492	13	5,344	61	8	12,666	31	11
11	148		1	10,089	152	8	6,084	31	4	4,143	23	3
12	4,619	27	2	13,614	158	12	2,169	2	8	16,977	2	6
13	1,288	12	2	3,000		1	5,758	52	19	6,736		4
14	1,388	652	2	4,636	243	6	7,678	31	11	1,611	14	6
15	263		2	18,943	318	11	9,416	23	12	15,841	45	11
16	3,473	6	2	11,742	65	8	7,383	9	14	4,467	5	3
17	450	234	1	15,358	153	12	4,263	71	7	4,245	11	4
18				6,553	110	8	2,312	6	8	28,378	7	6
19				25,212	177	15	4,578	27	9	2,768	8	4
20				12,633	165	10	14,327	107	12	13,720	39	12
21	59	208	1	5,556	141	6	9,518	143	10			
22		110		14,090	111	11	7,039	15	14			
23	1,499	6	2	3,000		1	4,418	52	10	74		1
24	125		1	4,267	39	8	7,980	26	12	6,094	3	7
25	4,951	45	3	7,606	76	3	2,867	5	5	1,471	2	2
26	1,240	2,028	2	2,020	20	7	11,143	23	11	2,035	10	3
27	61	16	1	1,239	16	3	349	3	3	5,943	37	6
28				10,823	34	10	3,450	48	7	10,500	6	5
29	2,409	513	1	4,818	73	9	57		2	4,644	5	3
30	1,976	1,025	1	3,423	24	6	658	22	2	1,059	3	2
31				5,315	39	6	3,329	22	6	12,474	73	8
Total	44,224	6,256	42	316,180	5,857	292	219,363	2,329	313	231,050	480	157
	No. Boats 9			No. Boats 76			No. Boats 91			No. Boats 35		

Table 6e

Daily Landings of Dog-fish and Soup-fin Shark Livers Caught in Hecate Strait by Sunken Gill-net Boats (from available data).

	September 1943			September 1944			September 1945			September 1946		
	Weight of Dog-fish Livers lb.	Weight of Soup-fin Shark Livers lb.	No. of Trips	Weight of Dog-fish Livers lb.	Weight of Soup-fin Shark Livers lb.	No. of Trips	Weight of Dog-fish Livers lb.	Weight of Soup-fin Shark Livers lb.	No. of Trips	Weight of Dog-fish Livers lb.	Weight of Soup-fin Shark Livers lb.	No. of Trips
1	2,653		4	19,699	72	14	998		4	1,057		2
2	1,492	158	2	9,326	70	10	12,208	41	9	1,956	26	4
3	2,011		2	2,153	28	5				1,943	32	5
4	30		1	2,508	7	3	7,090	33	7	1,279	2	2
5				11,410	61	8	2,303	19	5	7,823		7
6	3,351	868	3	3,673	62	3	7,017	23	11	21,095	14	11
7	93		1	6,409	8	6	779		4	3,552	15	3
8	1,435	342	2	12,133	19	6	1,293	41	9	7,257	31	6
9	1,045		2	8,213	29	10	1,803	3	5	14,377	11	11
10	3,618	2,967	4	5,150	23	8	6,234	11	6	18,350	20	14
11	3,225		2	7,184		8	5,804	9	8	1,591		5
12	568		1	642		1	4,188	24	6	6,411		4
13	133		1	7,946		4	2,083	7	3	425		1
14	3,982	491	3	10,564	7	7	9,049		4	1,653	6	7
15				1,737		3	1,100	1	2	234		1
16				2,796	6	6	876		2	2,561		4
17	733		3	2,325	5	2	1,745	7	3	23,852	7	24
18	2,735		3	1,995		3	7,265	23	7	4,645		5
19				1,327	3	4	3,386	2	6	486		1
20	1,628		2	811		3	1,326		3	1,703	32	2
21	80		1	2,809		5				999		2
22	1,686	12	2				605		2	793		1
23	618	7	2	864		2	41		1	1,785		3
24	1,150		2	1,251		2	327		2	4,826		7
25	1,395		3	6,821	14	5	1,103	10	5	3,116		7
26	1,274		2	1,597		4	39		1	6,663		18
27	1,512	21	4	859		2	186		2	4,962		7
28	556	47	2	6,338	6	4	1,263		5	5,252		5
29	4,395	13	3	5,352	24	7	88		1	7,181	6	3
30	721	499	2	805		1	1,821		5	3,630	6	5
Total	42,119	5,425	59	144,697	445	146	82,020	254	128	161,457	208	177
	No. Boats 15			No. Boats 45			No. Boats 64			No. Boats 38		

Table 6f

Daily Landings of Dog-fish and Soup-fin Shark Livers Caught in Hecate Strait by Sunken Gill-net Boats (from available data).

	October 1943			October 1944			October 1945			October 1946		
	Weight of Dog-fish Livers lb.	Weight of Soup-fin Shark Livers lb.	No. of Trips	Weight of Dog-fish Livers lb.	Weight of Soup-fin Shark Livers lb.	No. of Trips	Weight of Dog-fish Livers lb.	Weight of Soup-fin Shark Livers lb.	No. of Trips	Weight of Dog-fish Livers lb.	Weight of Soup-fin Shark Livers lb.	No. of Trips
1	564	18	2	3,688		3	1,138		3	3,428		11
2	1,984	150	3	4,927		1				1,320		4
3	2,042	23	6	748		2	1,202		3			
4	2,204	13	6	1,956		5	853	2	5	1,877		3
5	4,009		5				4,550		3	100	3	1
6	2,781	10	6	535		1	4,479	3	6	482		1
7	5,486	65	8	649		2	1,440	4	2	1,065		1
8	1,933		4				4,126	26	5	6,728		4
9	2,367		4	2,270		3	4,020	7	5	1,842		3
10				414		1	5,371		4	2,121		3
11	863		3	2,941		3	1,938		5	1,361		1
12	2,099	24	5	3,373		3	4,350		2	2,860		3
13				2,348		3	1,419		3			
14				1,319		3						
15	1,328		5	264		1	1,424		6	213		2
16	3,291		3	2,464	8	4	2,360		5	900		2
17	1,047		3	7,358		4	752		1	4,927		9
18	937		5	1,864		3	1,804		3	144		2
19	2,202		7	4,523		2	1,270	123	5	660		1
20	602		2	242		1	5,587		8	367		2
21	101		1	1,085		2	192		2	78		1
22	921		3	640		2	2,541		2			
23	1,934		6	2,832		3	187		2	2,568		3
24	168		1	1,000		2	357		5			
25	261		2				766		1	2,007		2
26	396		3	656		3	93		2	1,080		4
27	330		2				4,615		3			
28	132		1	385		3	860		7	465		2
29							2,837		6	84		1
30	194	7	1				643		5			
31	1,213		4	2,215		3	2,396		5			
Total	41,389	310	101	50,696	8	63	63,664	165	114	36,677	3	66
	No. Boats 19			No. Boats 17			No. Boats 38			No. Boats 24		

Table 7

Total Weight (lb.) of Dog-fish Livers Landed each Month by Sunken Gill-net Boats from Hecate Strait from 1943 to 1946. The number of boats landing dog-fish livers each month is indicated in brackets below the weight.

	1943	1944	1945	1946
May	1,720 (1)	33,329 (25)	114,035 (69)	27,772 (20)
June	10,386 (5)	626,404 (92)	780,047 (217)	275,629 (70)
July	23,700 (10)	505,827 (110)	488,802 (190)	188,311 (49)
August	44,224 (9)	316,180 (76)	219,363 (91)	231,050 (35)
September	42,119 (15)	144,697 (45)	82,020 (64)	161,457 (38)
October	41,389 (19)	50,696 (17)	63,664 (38)	36,677 (24)
Total	163,538 (59)	1,677,133 (365)	1,747,931 (669)	920,896 (236)
Weighted Average catch per boat per month.	2,772	4,595	2,613	3,902

Table 8

Total Weight (lb.) of Dog-fish Livers landed each Month by Sunken Gill-net Boats from Hecate Strait, from 1943 to 1946. The number of trips per boat per month is indicated in brackets below the weight.

	1943	1944	1945	1946
May	1,720 (2)	33,329 (73)	114,035 (90)	27,772 (30)
June	10,386 (20)	626,404 (434)	780,047 (825)	275,629 (215)
July	23,700 (48)	505,827 (394)	488,802 (630)	188,311 (167)
August	44,224 (42)	316,180 (292)	219,363 (313)	231,050 (157)
September	42,119 (59)	144,697 (146)	82,020 (128)	161,457 (177)
October	41,389 (101)	50,696 (63)	63,664 (114)	36,677 (66)
Total	163,538 (272)	1,677,133 (1,402)	1,747,931 (2,100)	920,896 (812)
Weighted Average catch per trip per boat per month	601	1,196	832	1,134

Table 9

Average Catch (lb.) per Boat per Month of Dog-fish Livers landed by Sunken Gill-net Boats from Hecate Strait, from 1943 to 1946.

	1943	1944	1945	1946
May	1,720	1,333.2	1,652.7	1,388.6
June	2,077.2	6,808.7	3,594.7	3,937.6
July	2,370.	4,598.4	2,572.6	3,843.1
August	4,913.8	4,160.3	2,410.6	6,601.4
September	2,807.9	3,215.5	1,281.6	4,248.9
October	2,178.4	2,982.1	1,675.4	1,528.2
Weighted average catch per boat per month	2,771.8	4,594.9	2,612.7	3,902.1

Table 10

Average Catch (lb.) per Trip per Boat per Month of Dog-fish Livers landed by Sunken Gill-net Boats from Hecate Strait, from 1943 to 1946.

	1943	1944	1945	1946
May	860.0	456.6	1,267.1	925.7
June	519.3	1,443.3	945.5	1,282.0
July	493.7	1,283.8	775.9	1,127.6
August	1,052.9	1,082.8	700.8	1,471.7
September	713.9	991.1	640.8	912.2
October	409.8	804.7	558.5	555.7
Weighted average catch per trip per boat per month	601.2	1,196.2	832.3	1,134.1

Table 11

Index of the Average Catch per Boat per Month of Dog-fish Livers landed by Sunken Gill-net Boats from Hecate Strait, from 1943 to 1946.

Determined by the method of link relatives.

	1943	1944	1945	1946
May	1.0	0.77	0.95	0.80
June	1.0	3.28	1.74	1.91
July	1.0	1.94	1.09	1.62
August	1.0	0.85	0.49	1.35
September	1.0	1.14	0.46	1.51
October	1.0	1.37	0.77	0.70

Index for Each Year.	1.0	1.66	0.95	1.4

Table 12

Index of the Average Catch per Trip per Boat per Month of Dog-fish Livers landed by Sunken Gill-net Boats from Hecate Strait, from 1943 to 1946

Determined by the method of link relatives.

	1943	1944	1945	1946
May	1.0	0.53	1.47	1.07
June	1.0	2.78	1.81	2.46
July	1.0	2.60	1.56	2.26
August	1.0	1.03	0.67	1.41
September	1.0	1.39	0.90	1.28
October	1.0	1.96	1.35	1.34

Index for Each Year.	1.0	1.99	1.38	1.88

Table 13

Monthly Landings of Dog-fish Livers landed by the same Sunken Gill-net Boats, Fishing in adjacent years in Hecate Strait.

	1943						1944					
	May	June	July	August	September	October	May	June	July	August	September	October
Weight of Dog-fish Livers (lb.)		3,615	18,417	20,389	8,803	6,162		4,136	9,918	7,474	6,452	14,548
Number of boats		2	5	4	3	3		2	5	4	3	3
Average Catch per boat (lb.)		1,808	3,683	5,097	2,934	2,054		2,068	1,984	1,869	2,151	4,849

	1944						1945					
	May	June	July	August	September	October	May	June	July	August	September	October
Weight of Dog-fish Livers (lb.)	19,735	438,750	333,569	108,536	24,776	16,305	18,894	215,960	145,533	60,746	15,157	10,301
Number of boats	10	56	52	23	7	4	10	56	52	23	7	4
Average Catch per boat (lb.)	1,974	7,835	6,415	4,719	3,539	4,076	1,889	3,856	2,799	2,641	2,165	2,575

	1945						1946					
	May	June	July	August	September	October	May	June	July	August	September	October
Weight of Dog-fish Livers (lb.)	19,129	290,371	159,376	65,964	34,005	15,166	14,586	235,831	168,685	149,424	40,668	15,547
Number of Boats	9	53	39	19	15	10	9	53	39	19	15	10
Average Catch per boat (lb.)	2,125	5,478	4,087	3,472	2,267	1,517	1,621	4,450	4,325	7,864	2,711	1,555

Table 14

Index of the Catch of Dog-fish Livers landed by the same Sunken Gill-net Boats Fishing in adjacent years, 1943-44, 1944-45, 1945-46, in Hecate Strait.

Determined by the method of link relatives.

	1943	1944	1945	1946
May	---	0.741	0.709	0.540
June	1.0	1.144	0.563	0.457
July	1.0	0.538	0.235	0.249
August	1.0	0.367	0.205	0.464
September	1.0	0.733	0.449	0.537
October	1.0	2.360	1.491	1.528

Index each year	1.0	0.741	0.367	0.392

Table 15

Total Weight (lb.) of Soup-fin Shark Livers landed each Month by Sunken Gill-net Boats from Hecate Strait, from 1943 to 1946.
The number of boats landing soup-fin shark livers each month is indicated in brackets below the weight.

	1943	1944	1945	1946
May	---- (1)	61 (25)	4 (69)	2 (20)
June	40 (5)	4,147 (92)	3,219 (217)	752 (70)
July	1,027 (10)	13,732 (110)	9,795 (190)	2,071 (49)
August	6,256 (9)	5,857 (76)	2,329 (91)	480 (35)
September	4,525 (15)	445 (45)	254 (64)	208 (38)
October	310 (19)	8 (17)	165 (38)	3 (24)
Total	13,058 (59)	24,250 (365)	15,766 (669)	3,516 (236)
Weighted average catch per boat per month	225.14	66.44	23.57	14.90

Table 16

Total Weight (lb.) of Soup-fin Shark Livers landed each Month by Sunken Gill-net Boats from Hecate Strait, from 1943 to 1946.
The number of trips per boat per month is indicated in brackets below the weight

	1943	1944	1945	1946
May	---- (2)	61 (73)	4 (90)	2 (30)
June	40 (20)	4,147 (434)	3,219 (825)	752 (215)
July	1,027 (48)	13,732 (394)	9,795 (630)	2,071 (167)
August	6,256 (42)	5,857 (292)	2,329 (313)	480 (157)
September	5,425 (59)	445 (146)	254 (128)	208 (177)
October	310 (101)	8 (63)	165 (114)	3 (66)
Total	13,058 (270)	24,250 (1,402)	15,766 (2,100)	3,516 (812)
Weighted average per trip per boat per month	48.36	17.30	7.51	4.33

Table 17

Average Catch (lb.) per Boat per Month of Soup-fin Shark Livers landed by Sunken Gill-net Boats from Hecate Strait, from 1943 to 1946.

	1943	1944	1945	1946
May		2.44	0.06	0.1
June	8.00	45.07	14.83	10.74
July	102.7	124.84	51.55	42.26
August	695.11	77.06	25.59	13.71
September	361.67	9.89	3.97	5.47
October	16.31	0.47	4.34	0.12

Weighted average catch per boat per month	225.14	66.44	23.57	14.90

Table 18

Average Catch (lb.) per Trip per Boat per Month of Soup-fin Shark Livers landed by Sunken Gill-net Boats from Hecate Strait, from 1943 to 1946

	1943	1944	1945	1946
May		0.84	0.04	0.07
June	2.00	9.55	3.90	3.50
July	21.40	34.85	1.55	12.40
August	148.95	20.06	7.44	3.08
September	91.94	3.05	1.98	1.18
October	3.07	0.13	1.45	0.04
Weighted average catch per trip per boat per month	48.36	17.30	7.51	4.33

Table 19

Index of the Average Catch per Boat per Month of Soup-fin Shark Livers landed by Sunken Gill-net Boats from Hecate Strait, from 1943 to 1946

Determined by the method of link relatives.

	1943	1944	1945	1946
May	---	0.295	0.25	0.42
June	1.0	5.63	1.86	1.34
July	1.0	1.22	0.50	0.41
August	1.0	0.11	0.04	0.02
September	1.0	0.03	0.01	0.01
October	1.0	0.03	0.28	0.01

Index for each year	1.0	0.295	0.105	0.07

Table 20

Index of the Average Catch per Trip per Boat per Month of Soup-fin Shark Livers landed by Sunken Gill-net Boats from Hecate Strait, from 1943 to 1946.

Determined by the method of link relatives.

	1943	1944	1945	1946
May	---	0.357	0.05	0.87
June	1.0	4.77	1.96	1.76
July	1.0	1.63	0.06	0.48
August	1.0	0.13	0.05	0.02
September	1.0	0.03	0.02	0.01
October	1.0	0.04	0.45	0.01

Index for each year.	1.0	0.357	0.155	0.09

Table 21

Monthly Landings of Soup-fin Shark Livers landed by the same Sunken Gill-net Boats Fishing in adjacent Years in Hecate Strait

	1943						1944					
	May	June	July	August	September	October	May	June	July	August	September	October
Weight of Soup-fin Shark Livers (lb.)	---	22	724	591	19	14	---	84	2,056	814	37	---
Number of Boats	---	2	5	4	3	3	---	2	5	4	3	3
Average Catch per boat (lb.)	---	11	145	148	6	5	---	42	411	204	12	---

	1944						1945					
	May	June	July	August	September	October	May	June	July	August	September	October
Weight of Soup-fin Shark Livers (lb.)	39	2,762	10,530	1,874	86	8	---	1,028	2,250	339	70	2
Number of Boats	10	56	52	23	7	4	10	56	52	23	7	4
Average Catch per boat (lb.)	4	49	203	81	12	2	---	18	43	15	10	0.5

	1945						1946					
	May	June	July	August	September	October	May	June	July	August	September	October
Weight of Soup-fin Shark Livers (lb.)	---	1,248	3,459	304	85	34	2	572	1,848	271	145	---
Number of Boats	9	53	39	19	15	10	9	53	39	19	15	10
Average Catch per boat (lb.)	---	24	89	16	6	3	0.2	11	47	14	10	---

Table 22

Index of the Catch of Soup-fin Shark Livers landed by the same Sunken Gill-net Boats Fishing in Adjacent Years, 1943-44, 1944-45, 1945-46, in Hecate Strait.

Determined by the method of link relatives.

	1943	1944	1945	1946
May	----	----	----	----
June	1.0	3.818	1.420	0.650
July	1.0	2.840	0.608	0.325
August	1.0	1.377	0.249	0.222
September	1.0	1.947	1.585	2.704
October	1.0	0.500	0.250	0.70

Index each year	1.0	2.183	0.526	0.291

Table 23a

Daily Landings of Dog-fish Livers Caught off Barkley Sound by Sunken Gill-net Boats (from available data).

	May 1944		May 1945	
	Weight of Dog-fish Livers lb.	Number of Trips	Weight of Dog-fish Livers lb.	Number of Trips
1	657	4	126	3
2	224	1	357	3
3	365	7	1,418	5
4	94	4	276	3
5	202	6	2	1
6	27	1	2,460	23
7	360	5	58	8
8	1,074	4	20	5
9	847	5	64	2
10				
11				
12				
13			48	1
14				
15			192	4
16	155	1	101	3
17				
18			1,051	8
19	900	7	1,415	6
20	318	7	678	6
21	1,176	9	607	5
22	764	11	1,974	4
23	871	10	1,883	5
24	819	9	2,504	7
25	1,278	10	909	4
26	3,032	12	2,526	8
27	1,828	13	2,012	6
28	880	11	1,142	5
29	1,581	14	300	1
30	1,159	17		
31	793	11		
Total	19,404	179	22,123	126

Table 23b

Daily Landings of Dog-fish Livers
Caught off Barkley Sound by Sunken Gill-net Boats
(from available data).

	June 1944		June 1945		June 1946	
	Weight of Dog-fish Livers lb.	Number of Trips	Weight of Dog-fish Livers lb.	Number of Trips	Weight of Dog-fish Livers lb.	Number of Trips
1	237	5	4,108	18		
2	555	8	888	7		
3	76	2	650	6	1,079	5
4	734	9	1,229	6	4,325	11
5	264	5	1,186	8	1,566	9
6	929	5	2,966	12	951	13
7	176	2	2,427	8	363	6
8	2,292	15	1,462	9	1,140	11
9	2,737	20	296	4	2,628	11
10	2,471	14	28	1	2,112	11
11	1,786	10	110	2	3,707	11
12	2,965	15	1,889	7	3,402	11
13	2,660	19	102	1	4,890	10
14	1,724	16	2,111	9	3,180	11
15	1,326	11	1,260	7		
16	1,846	16	897	7	2,261	12
17	1,912	17	534	7	1,035	9
18	1,914	15	104	2	1,373	10
19	2,123	17	1,062	7	455	2
20	1,489	17	142	5	112	1
21	587	17	106	1		
22	372	10	866	10	5,742	17
23	987	14	921	9	3,544	10
24	390	7	873	8	664	1
25	228	7			355	2
26	715	11			261	5
27	889	8	1,513	7		
28	2,864	13	1,596	9	604	6
29	2,805	14	469	9		
30	1,556	13	441	6		
Total	41,609	352	30,246	192	45,749	195

Table 23c

Daily Landings of Dog-fish Livers
Caught off Barkley Sound by Sunken Gill-net Boats
(from available data)

	July 1944		July 1945		July 1946	
	Weight of Dog-fish Livers lb.	Number of Trips	Weight of Dog-fish Livers lb.	Number of Trips	Weight of Dog-fish Livers lb.	Number of Trips
1	2,376	16	369	4	2,813	8
2	639	7	53	3	1,365	3
3	2,841	29	409	4	729	5
4	736	10			1,053	8
5	23	1	571	3	1,351	6
6	695	14	626	3	712	6
7	767	12			98	2
8	653	8	82	1	569	7
9	156	3			288	3
10	326	6			934	11
11	617	12			1,192	7
12	2,988	30			436	8
13	1,374	18	311	2	79	5
14	819	13	392	3		
15	832	11			803	14
16	1,148	7	607	3	670	9
17	1,736	13	231	3	151	1
18	2,832	16	623	3	1,773	16
19	1,454	11	602	3	567	5
20	2,379	13	467	3		
21	2,573	18	374	4		
22	1,523	12	1,490	3		
23	444	4				
24	1,173	15	451	2		
25	606	15				
26	213	5	650	4		
27	1,021	17	164	3		
28	719	11	74	2		
29	421	3	240	2		
30	2,078	14	510	5		
31	3,655	15				
Total	39,817	379	9,296	63	15,583	124

Table 23d

Daily Landings of Dog-fish Livers
Caught off Barkley Sound by Sunken Gill-net Boats
(from available data).

	August 1944		August 1945	
	Weight of Dog-fish Livers lb.	Number of Trips	Weight of Dog-fish Livers lb.	Number of Trips
1	1,711	13	122	2
2	1,090	14	317	3
3	398	5	396	4
4	1,311	17	603	4
5	527	8	583	3
6	1,025	19	252	3
7	223	7	470	5
8	349	2		
9	1,004	13	571	4
10	893	16	64	1
11	452	6	658	6
12	20	1	5	1
13	767	9		
14	595	10	378	3
15	2,709	32	123	3
16	600	13	255	3
17	350	4		
18	1,437	19	63	3
19	585	5	353	5
20	2,204	18	59	3
21	581	6	442	5
22	755	15		
23	3,190	33	136	4
24	629	16	143	3
25	1,111	15	447	3
26	840	8		
27	1,232	15	414	2
28	1,018	12	296	3
29	535	12	63	1
30	524	4	67	3
31	41	1	52	2
Total	28,706	368	7,332	82

Table 23e

Daily Landings of Dog-fish Livers
Caught off Barkley Sound by Sunken Gill-net Boats
(from available data).

	September 1944	
	Weight of Dog-fish Livers lb.	Number of Trips
1	837	8
2	820	8
3	2,825	23
4	1,159	16
5	372	7
6	65	3
7	151	2
8	207	4
9	424	4
10	477	6
11	151	1
12	132	2
13	96	2
14	268	5
15	180	3
16	457	4
17	59	2
18		
19	76	2
20	58	3
21		
22		
23		
24		
25		
26		
27	30	1
28	102	2
29	84	1
30		
Total	9,030	109

Table 24.

Total Catch (lb.) of Dog-fish Livers landed by Sunken Gill-net Boats Fishing off Barkley Sound on the West Coast of Vancouver Island from 1944 to 1946.
(from available data)

The number of boats fishing in each month is indicated in brackets.

	1944	1945	1946
May	19,404 (20)	22,123 (14)	
June	41,609 (31)	30,246 (14)	45,749 (17)
July	39,817 (31)	9,296 (6)	15,583 (13)
August	28,706 (24)	7,332 (6)	
September	9,030 (13)		
Total	138,566 (119)	68,997 (40)	61,332 (30)

Table 25

Index of the Return per-Unit-of-Fishing Effort for Dog-fish Livers landed by Sunken Gill-net Boats Fishing off Barkley Sound on the West Coast of Vancouver Island, from 1944 to 1946.

	1944	1945	1946
May	15.5	25.1	
June	16.9	22.5	33.5
July	15.0	21.1	18.0
August	11.1	12.8	
September	11.8		