

**REPORT OF THE INTERNATIONAL FISHERIES
COMMISSION**

**APPOINTED UNDER THE TREATY BETWEEN THE UNITED STATES
AND GREAT BRITAIN FOR THE PRESERVATION OF THE
NORTHERN PACIFIC HALIBUT FISHERY**

NUMBER 1

BY

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SEATTLE, WASHINGTON
INTERNATIONAL FISHERIES COMMISSION

1931

FOREWORD

This is the first report issued by the International Fisheries Commission upon its work under the terms of the Convention of 1924 between the United States and Great Britain for the preservation of the halibut fishery of the Northern Pacific Ocean, including Bering Sea. Printed originally by the Canadian Government, the unrevised text has been included in the reports of the Commissioners of Fisheries of the United States and of British Columbia. It is now issued by the International Fisheries Commission in a form similar to that of the subsequent reports, but with unaltered text.

REPORTS BY THE INTERNATIONAL FISHERIES COMMISSION

1. Report of the International Fisheries Commission appointed under the Northern Pacific Halibut Treaty, by John Pease Babcock, Chairman, and William A. Found, Miller Freeman, and Henry O'Malley, Commissioners. Dominion of Canada, Ottawa, 1928.
Same. Report of British Columbia Commissioner of Fisheries for 1928, pp. 58-76. Victoria, 1929.
Same. Report of United States Commissioner of Fisheries for 1930, Appendix 1. U. S. Bureau of Fisheries Document No. 1073. Washington, 1930.
Same. Unrevised edition by the International Fisheries Commission, Vancouver, B. C., 1931.
2. Life History of the Pacific Halibut (1) Marking Experiments, by William F. Thompson and William C. Herrington. Victoria, B. C., 1930.
3. Determination of the Chlorinity of Ocean Waters, by Thomas G. Thompson and Richard Van Cleve. Vancouver, B. C., 1930.
4. Hydrographic Sections and Calculated Currents in the Gulf of Alaska, 1927 and 1928, by George F. McEwen, Thomas G. Thompson, and Richard Van Cleve. Vancouver, B. C., 1930.
5. The History of the Pacific Halibut Fishery, by William F. Thompson and Norman L. Freeman. Vancouver, B. C., 1930.
6. Statistics of the Halibut Fishery (1) Changes in Yield of a Standardized Unit of Gear, by William F. Thompson, Harry A. Dunlop, and F. Heward Bell. Vancouver, B. C., 1931.
7. Investigations of the International Fisheries Commission to December, 1930, and their Bearing on Regulation of the Pacific Halibut Fishery, by John Pease Babcock, Chairman, William A. Found, Miller Freeman, and Henry O'Malley, Commissioners.

Further reports will bear serial numbers and will be issued separately by the commission.

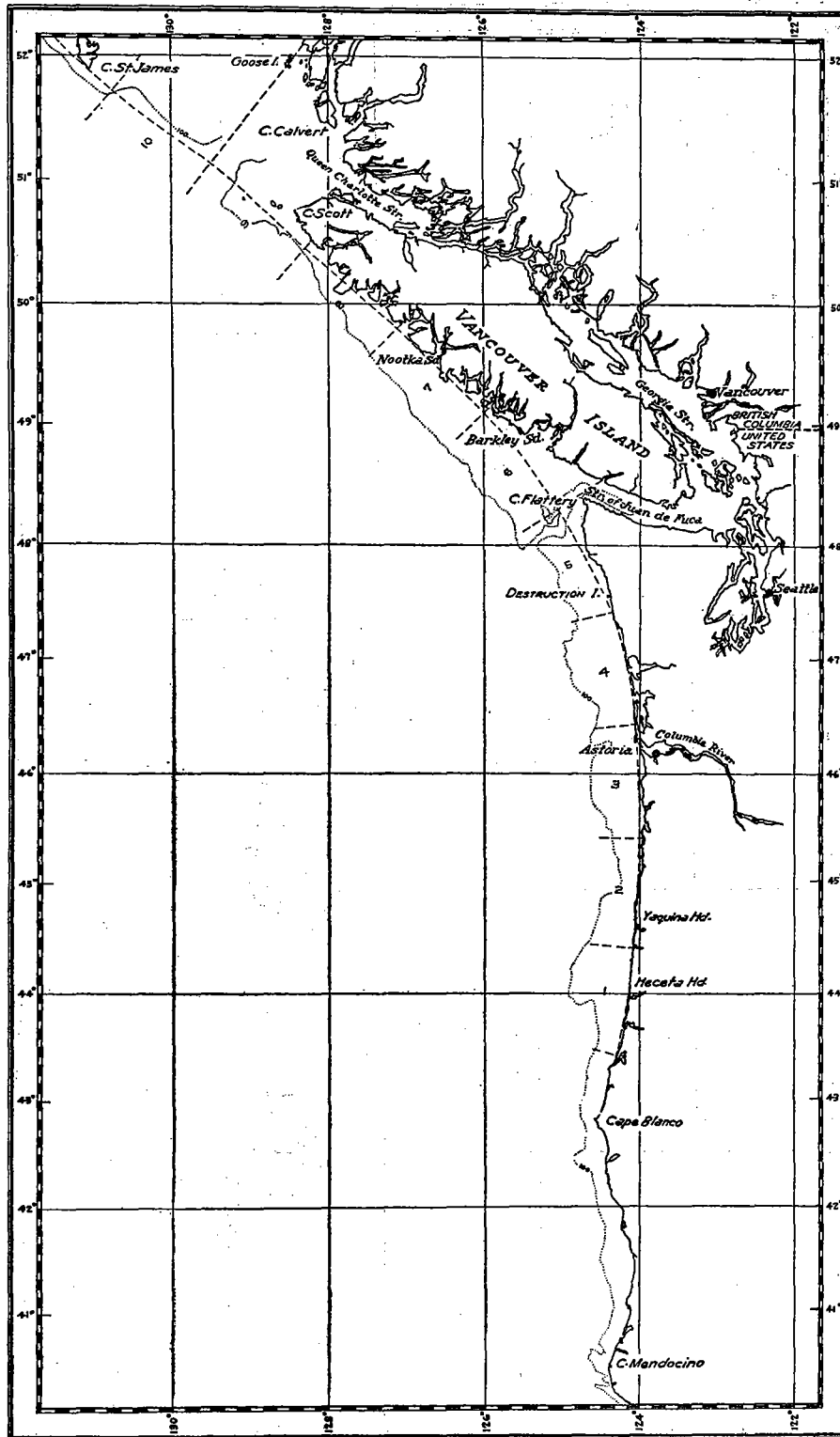


FIGURE 1.—Cape Mendocino to Cape St. James.

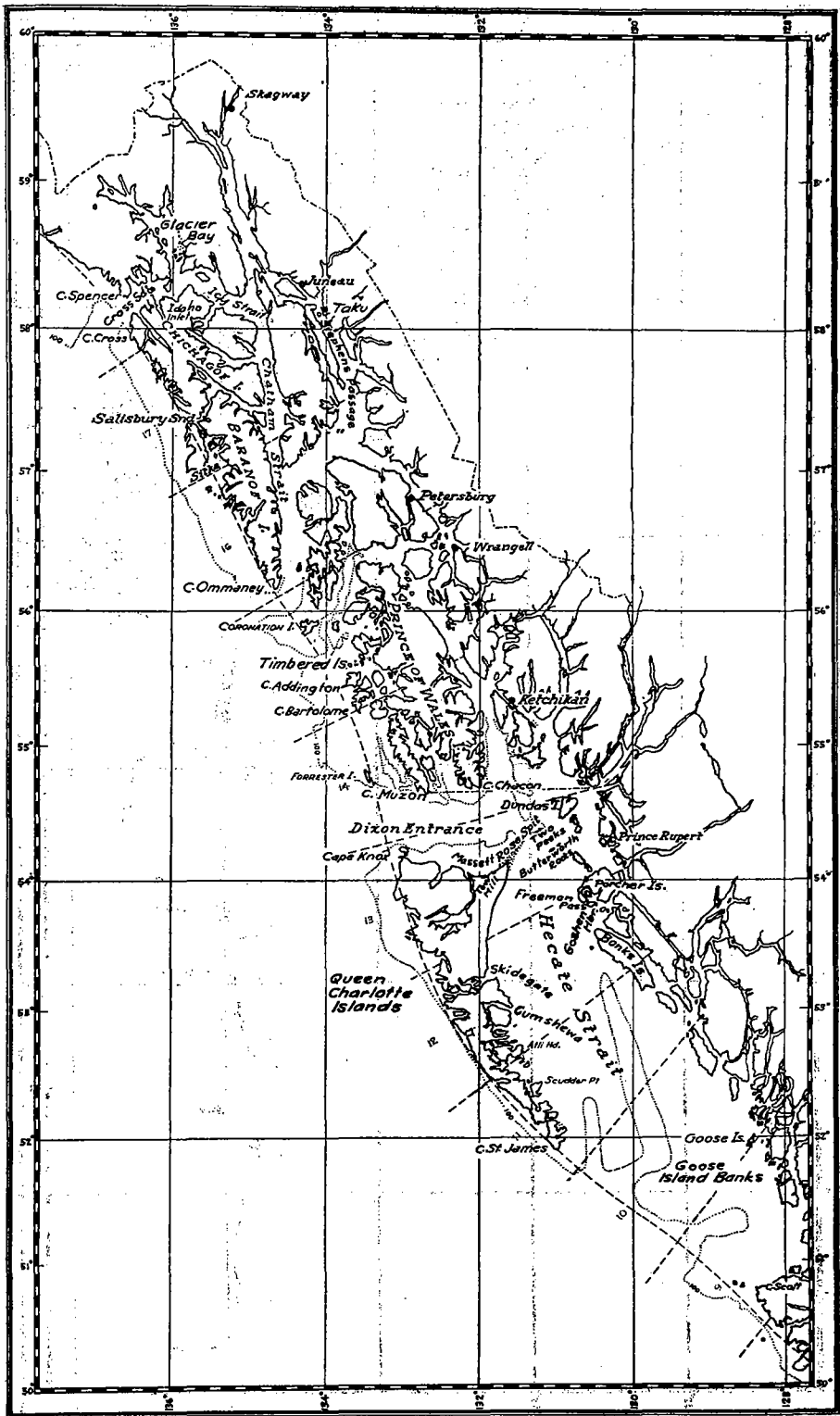


FIGURE 2.—Cape Scott to Cape Spencer.

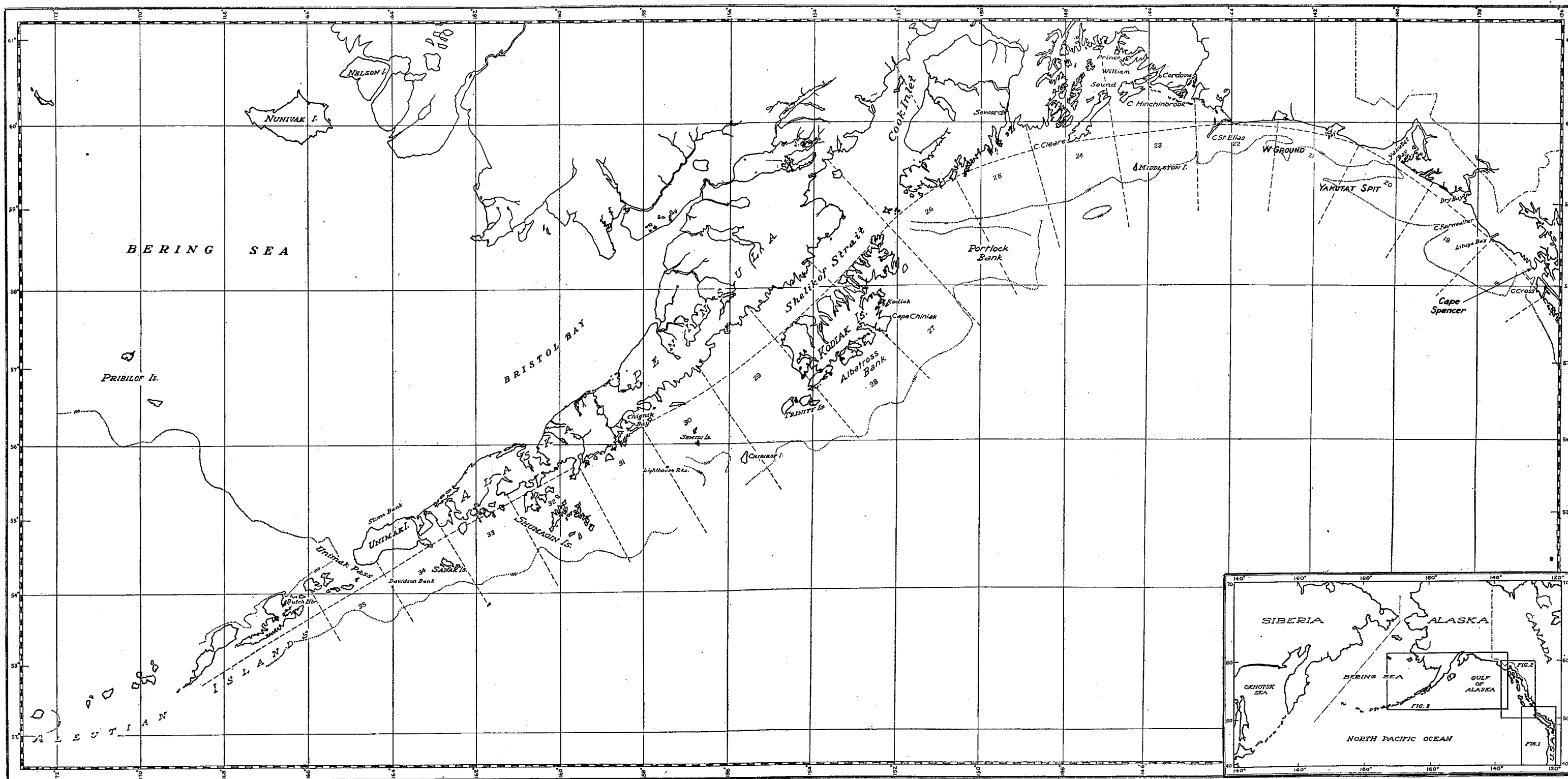


FIGURE 3.—Cape Spencer to the Aleutian Islands.

REPORT OF THE INTERNATIONAL FISHERIES COMMISSION APPOINTED UNDER THE NORTHERN PACIFIC HALIBUT TREATY

The treaty between Canada and the United States for the preservation of the halibut fishery of the northern Pacific Ocean, including Bering Sea, was ratified on October 21, 1924. It is remarkable from the double standpoint that it is the first treaty entered into by Canada as a nation and that it is the first effective one anywhere having for its object the conservation of a threatened high seas fishery. It therefore serves as a precedent for international co-operative control of sea fisheries, where such is necessary. This forms an important additional reason why success should be achieved under it.

The treaty provides an entire cessation of halibut fishing for three months each year. This was regarded, at the time it was entered into, as an essential minimum of protection. It also provided for the appointment of an International Fisheries Commission, the duties of which are to make recommendations regarding the need for modification of the closed season, to make a thorough investigation into the life history of the Pacific halibut, and to make recommendations as to the regulation of the fishery that may be deemed desirable for its preservation and development. The specific provisions of the convention dealing with these phases follow:

"The nationals and inhabitants and the fishing vessels and boats of the Dominion of Canada and of the United States, respectively, are hereby prohibited from fishing for halibut (*Hippoglossus*) both in the territorial waters and in the high seas off the western coast of the Dominion of Canada and of the United States, including Bering Sea, from the 16th day of November next after the date of the exchange of ratifications of this convention, to the 15th day of the following February, both days inclusive, and within the same period yearly thereafter, provided that upon the recommendation of the International Fisheries Commission hereinafter described this closed season may be modified or suspended at any time after the expiration of three such seasons, by a special agreement concluded and duly ratified by the High Contracting Parties.

"The High Contracting Parties agree to appoint within two months after the exchange of ratifications of this convention, a commission to be known as the International Fisheries Commission, consisting of four members, two to be appointed by each party. This commission shall continue to exist so long as this convention shall remain in force. Each party shall pay the salaries and expenses of its own members and joint expenses incurred by the commission shall be paid by the two High Contracting Parties in equal moieties.

"The commission shall make a thorough investigation into the life history of the Pacific halibut, and such investigation shall be undertaken as soon as practicable. The commission shall report the results of its investigation to the two Governments and shall make recommendations as to the regulation of the halibut fishery of the North Pacific Ocean, including the Bering Sea, which may seem desirable for its preservation and development."

The undersigned, having been appointed commissioners under the treaty by their respective Governments, undertook their duties without delay. At the outset they decided to employ a competent man as director of investigations, in which

capacity the services of W. F. Thompson were secured. He not only brought to the work the needed training and ability, but the experience and knowledge that resulted from three seasons' investigations in the Pacific halibut fishery, which he had undertaken some years previously on behalf of the provincial government of British Columbia. A competent staff of young energetic scientists to assist him was also employed. The commission further arranged for the appointment of an honorary scientific council, with which not only the commission but the director of investigations could consult, and to which has been submitted the plans of investigations to be undertaken from time to time. This council consists of two representatives from each country:

Professor John N. Cobb, Dean of the College of Fisheries of the University of Washington, Seattle.

Mr. N. B. Scofield, Head of the Department of Commercial Fisheries of the Fish and Game Commission of California.

Dr. C. McLean Fraser, Professor of Zoology in the University of British Columbia, and formerly Director of the Marine Biological Station at Nanaimo, B. C.

Dr. W. A. Clemens, present Director of the aforesaid Station.

The director and staff have from time to time presented reports on the progress of the investigation and on their findings to the commission, and to the scientific council. These findings are used in the formulation of the present recommendations. The scientific results are, however, not inserted in this report, but will be published later in more detailed form than is practicable here.

The task with which the commission found itself to be charged is one of great magnitude and difficulty. The fishery covers a coast line of about 1,800 miles in length. The halibut can only be studied at sea and under difficult conditions. Hence it has not been possible in the three years during which the commission has been at work to cover the whole field exhaustively. What has been accomplished has, however, been done with care and the information obtained is sufficient to satisfy the commission as to the necessity of certain main lines of action, if the fishery is to be preserved.

Though the investigation has been highly scientific in character, the commission determined at the outset that it would be carried out along practical lines, with close adherence to facts and avoidance of unsupported theory. Its aim has been to establish beyond doubt the actual condition of the fishery at present and the history of its trend to that condition. It has sought to define the remedial measures which should be adopted to save the fishery and to build it up, as well as the conditions that would have to be met in applying such measures.

Statistics have formed an indispensable part of the facts gathered. They have included not only complete records of landings, but of operations at sea. Through the splendid co-operation of the fishing vessel captains, the commission has secured extensive records of the individual catches, from which the yield per unit of fishing effort, the "skate," has been ascertained for each section of the coast. These cover every season and are for years as far back as 1906.

Even more important have been the biological studies. These have included the rates of growth according to locality, the migrations, the "races" existent, and the spawning habits. Material has been collected by the staff, not merely from voyages on fishing vessels, but through the operations of vessels chartered for the purpose. Thousands of halibut have been caught and released with numbered tags attached, and have been recovered from fishermen through rewards offered. From the records thus furnished it has been possible to determine the migrations of the halibut. Extensive studies of the physical characteristics and the growth of the different races have confirmed such findings. The drift of the eggs and larvae in the open ocean have been studied by means of fine meshed silk nets and by observation of the currents. The results of these biological studies, in conjunction with those from the statistics, form the basis for the conclusions reached in this report.



FIGURE 4.—Live halibut ready for liberation with numbered tag on cheek bone.

IMPORTANCE OF FISHERY

Fisheries for halibut are prosecuted in the North Pacific and the North Atlantic Oceans, and yield about ninety millions of pounds annually. The Pacific halibut fishery, which is covered by the terms of this convention, is the greatest in the world. The annual catch exceeds fifty millions of pounds, which represents about 60 per cent of the world's catch. Of the remainder about thirty millions are credited to European countries and six millions to the Atlantic coast of this continent. The value of the Pacific halibut catch to the fishermen is about seven million dollars annually, and it is consequently one of the most important fisheries in North American waters. The Pacific halibut is, therefore, one of the most important species of food fishes indigenous to the waters of the North American continent. The halibut fishery banks of the eastern Pacific are shown in Figures 1 to 3. The division into areas shown thereon is for statistical purposes and should not be confused with those referred to in the commission's recommendations, which will be submitted later on.

CONDITION OF FISHERY

The Pacific halibut fishery originated soon after the first railway communication was established between the two coasts of the United States. It is, therefore, comparatively young. It had its inception in 1888 near Cape Flattery, at the entrance to Juan de Fuca Strait. The fishery expanded rapidly and by 1910 it had extended to grounds off Cape Ommaney, Baranof Island, 600 miles to the north. Subsequent expansion has extended the fishery until it now covers about 1,800 miles of coast. Formerly as many fish were taken from the 600 mile stretch as are now procured from the entire area of 1,800 miles. The banks on the eastern side of the Gulf of Alaska, which yield spawning fish, were first exploited in 1913. In 1926 the larger boats made by far the greater part of their catches in the vicinity of Kodiak Island, on the western side of the Gulf of Alaska, about 1,200 miles beyond the original fishery. The catch on the older grounds south of Cape Ommaney has decreased from a total in excess of fifty million pounds in 1910 to about twenty-one millions in 1926, and much greater effort was exerted in making the catch in the latter year. It is evident that the present level of production has been maintained by extending fishing operations to new areas, as the catch on the older grounds decreased, and by increasing the intensity of the fishing effort.

The amount of gear now used on the older banks is about two and one-half times the quantity formerly used, yet the present catch is only about 40 per cent of the former yield from these grounds. Under the stress of this great intensification of fishing effort the abundance¹ of fish on the older banks has fallen enormously, to 16 per cent of the abundance in 1906. Where in 1906 the catch per set of a unit of fishing gear was nearly 300 pounds, in 1926 it was below 50 pounds. Expressed in another way it required six units of gear to catch as much fish as one unit caught in 1906. The decline has gone on at an even rate and shows no tendency to slacken. Accompanying this fall in abundance there

¹Throughout this report the term "abundance" is taken to mean the amount of fish in pounds as landed, not the number of fish.—Note by editor.

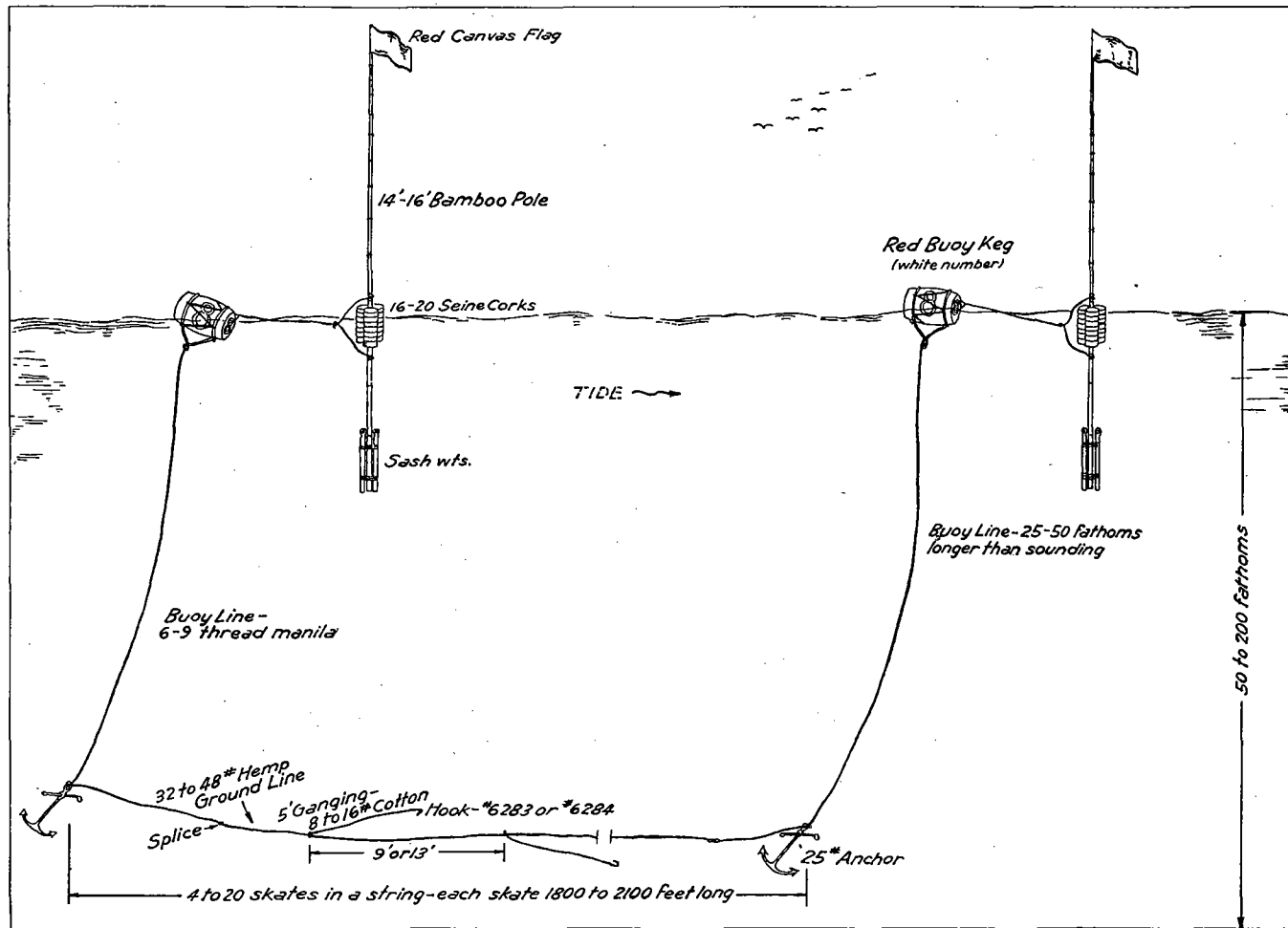


FIGURE 5.—Halibut gear. Ground line made up of units called skates, set on the bottom and usually baited with herring.

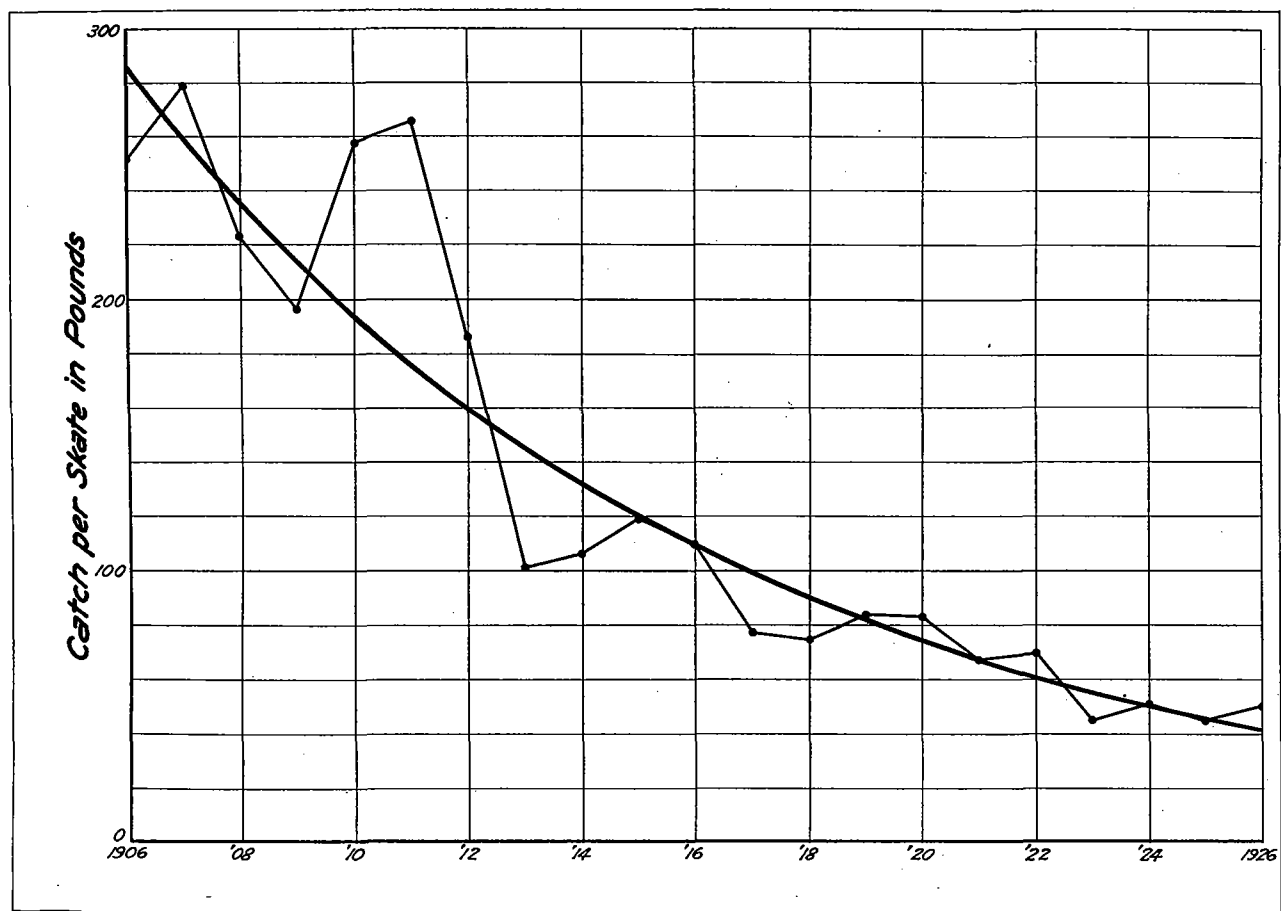


FIGURE 6.—Decline of abundance of fish, as shown by the catch in pounds per set of a standard unit of gear, the skate. From 1906 to 1926, on the grounds south of Cape Ommaney.

has been a decrease in the average size of the fish landed, and a great increase in the percentage of undersized fish. For example, between 1919 and 1926 the percentage amount of undersized fish from the older banks increased from 20 to 30 per cent.

The more recently exploited banks to the westward show the same trend, the catch having fallen from 160 pounds per unit of gear in 1923 to 100 pounds in 1926, and was still lower in 1927, while at the same time there was an increase in the number of fish under $11\frac{3}{4}$ pounds.

The rapidity of decline is regarded as especially serious because of the very slow rate of growth of the halibut, an adult being from 12 to 25 years, or over, in age. Hence the present decline has taken place within the life span of one halibut of ordinarily large size. As nearly all the fish which are being caught now were spawned 8 to 10 years ago, the abundance of the younger fish, which will annually be available for capture in the next 10 years, has already been established. If these are greatly reduced in numbers, and the intensity of the fishery is maintained, the outlook for a future stock of spawning fish sufficient to maintain the supply, presents a hopeless picture. In fact the commission's investigations indicate that relatively few mature halibut are now found on the older banks.

These illustrations demonstrate beyond a doubt that the fishery is in a very serious condition, and that the banks cannot stand the intensity of fishing to which they are subjected. The commission is fully convinced that the conditions are so serious that no delay should be permitted in the adoption of additional conservation measures. In the light of the investigations made, such action is essential to the maintenance of the fishery.

RECOMMENDATIONS

The commission recommends certain additional measures of conservation, which are here summarized and are dealt with in detail in pages following.

It is recommended that power be given proper governmental authorities:

1. (a) To establish areas, within each of which, if deemed necessary for the preservation of the fishery there, the total catch of halibut may be reduced by a predetermined percentage annually, commencing not less than one year after the putting into force of this recommendation, until the fishery therein shall reach a state of stability of yield.

- (b) To determine upon the amount of this percentage reduction, and to revise the same from time to time as may be found necessary, the intent being to restrain any increase in the amount of fishing within such area.

2. To close permanently to all fishing the two areas herewith defined, and known to be populated by small, immature halibut, and to close such other grounds as may be found by the commission to be populated by a similar class of fish.

3. To prevent the use of any fishing gear deemed unduly destructive.

4. To extend the present closed season by two weeks at its beginning, making the closure for all fishing in all areas from November 1 to February 15, both dates inclusive, and to facilitate future alterations in the length of the closed season.

5. To license all vessels fishing for halibut in treaty waters, under such terms as are necessary for the purpose of the treaty, including statistical returns, and for clearance to regulated waters.

FIRST RECOMMENDATION

ESTABLISHMENT OF AREAS AND LIMITATION OF CATCH THEREIN

The commission is unable, after careful scrutiny, to recognize in the closed season as now constituted, any contribution to the preservation of the halibut fishery. From its study of the effects of the closure and of the fishery in general, it has reached the conclusion that to render any regulations beneficial from this aspect, they must be framed so as to distribute their effects according to the needs of the different banks or areas, and that on each of the badly depleted areas the amount of fish taken must be reduced. The present measure is not thus framed.

Its investigations have shown that the banks along the Pacific coast are inhabited by stocks of halibut which are largely independent. Extensive tagging experiments have been carried on, with careful examination of physical characteristics and rates of growth. The fish below spawning size have thus been shown to be well differentiated according to bank, and to move but little in comparison with the great extent of the grounds. The fish of mature size are perhaps less limited in range, but are still sufficiently localized to render generally ineffective regulations of local application. In accord with these findings, and in checking them, the various banks have been found to be very unevenly depleted. A relative abundance exists on the more distant banks, with a marked degree of depletion on the nearer, the degree of depletion being dependent upon the distance of the banks from the markets. The proportion of spawners is high on the more distant, but almost non-existent on the nearby banks. There appears to be no such active interchange as would render regulations applied to one bank effective on all.

It has, therefore, become of paramount importance to discover how far the effects of regulation are localized, for each area must bear the burden of its own regeneration. The commission has, therefore, carefully and laboriously collected statistics regarding the effect of the closed season on the several main areas of the fishery. The closure being from November 16 to the following February 15, it has affected directly the fisheries at that time taking place. These were along the eastern side of the Gulf of Alaska, between Cape St. Elias and Cape Spencer. Here there has been prevented a very considerable fall, winter, and spring catch of mature fish. In contrast to this, the fishery on the older, more depleted banks south of Dixon Entrance has for years been a summer fishery, and accordingly, the amount of the catch eliminated has been very small. At the time of adoption

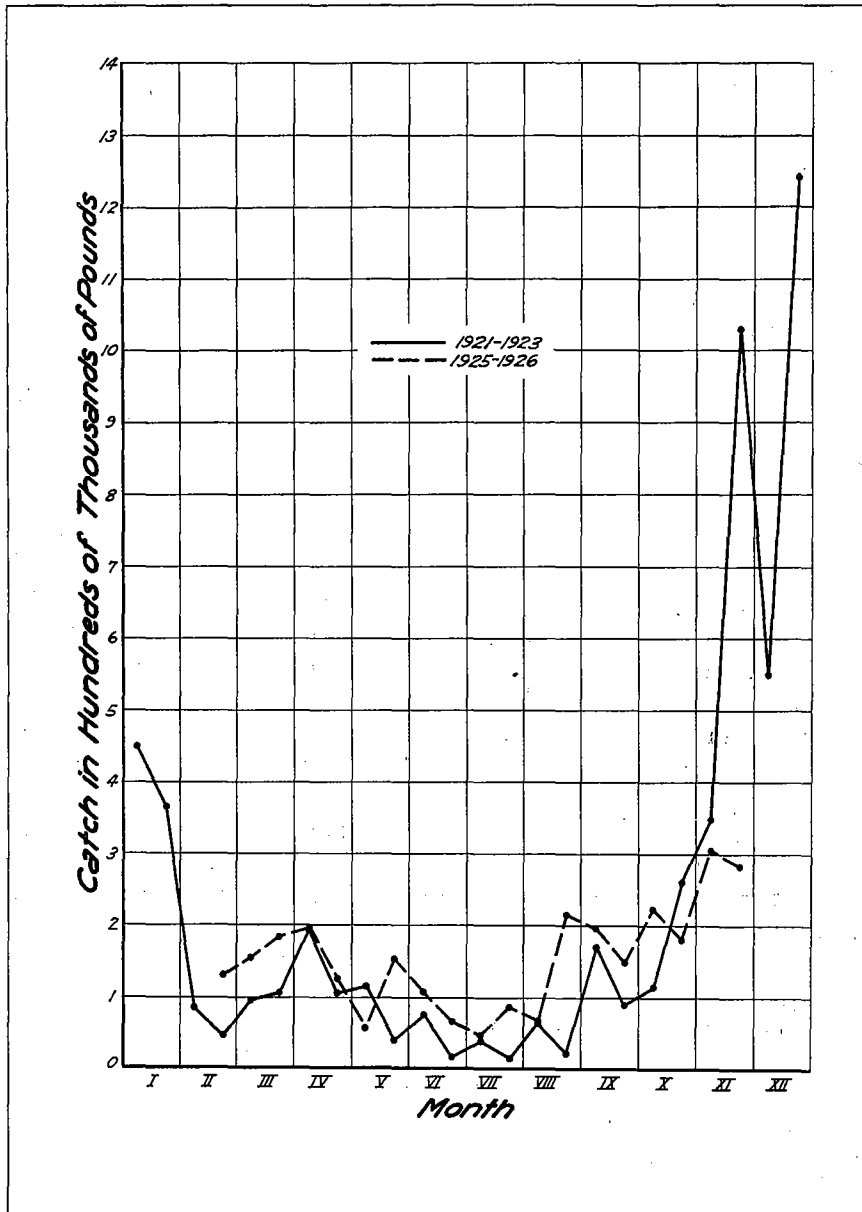


FIGURE 7.—Catch of halibut from the eastern side of the Gulf of Alaska, between Cape Spencer and Cape St. Elias, by two week periods, as hauled in Prince Rupert. Unbroken line before, and broken line after the closure of the winter season, November 16 to February 15.

of the present treaty, the newer, less depleted banks to the farther west of the Gulf of Alaska, did not have a fishery of any magnitude, but since then a very considerable summer, or open season, fishery has been developed. The closed season has mainly affected, therefore, one area—that on the eastern side of the Gulf of Alaska.

Examination of catches on these affected grounds has shown that the fish protected were largely fish collected there for spawning, which is well known. It is therefore evident from these facts that the closed season has been operative almost entirely upon the fish of a given region, and upon a single category of these fish, facts which should be considered in connection with the independence of the various stocks of halibut.

The commission finds that the fish thus protected by the closure were exposed to fishing that was increased in intensity during the open season, and consequently the abundance on the banks has undergone a further decline due to a progressive depletion.

Tagging experiments with the spawning fish on the banks thus most affected—those on the eastern side of the Gulf of Alaska—showed that a considerable migration occurred to the westward as far as Portlock Bank, where many of the tags were recovered. There, fishing during the open season has increased enormously during the three years that have elapsed since the closed season has been in effect, sufficient to more than offset the decline in the winter fishery on the other banks. But this increase has not been due to any increase in numbers of fish, for the intensification of the Portlock fishery has led to a rapid fall in yield per unit of gear fished, from 160 to 100 pounds per skate, and these western banks are not “holding up.” If further proof were required that this enormous increase of the fishery on Portlock is not due to the presence of more fish there, it will be remembered that halibut are on the average considerably more than five years of age when they first come into the commercial size, and that the great increase in catch was, therefore, from the pre-existing stock.

The same increase in the open season total catch is obvious on the banks referred to as most effected. This increase, too, was due to the more intensive fishing and not to an increase in the abundance of fish. Had there been an increase in abundance, there would inevitably have been an instant increase in fishing, sufficient to destroy the increase in abundance before it progressed far—it could not escape the notice of the fleet.

On the older banks, as has been said, the effect of the closure was very small, and during each month of the open season there was a decrease in the total taken, due to the progressing depletion of the banks. Yet this decline did not suffice to balance the increase on the other banks.

In accord with this, the absence of marked effects beneficial to the perpetuation of the fishery is shown by the fact that there has been no reduction in the total annual catch. On the contrary, there has been an increase, as is shown by

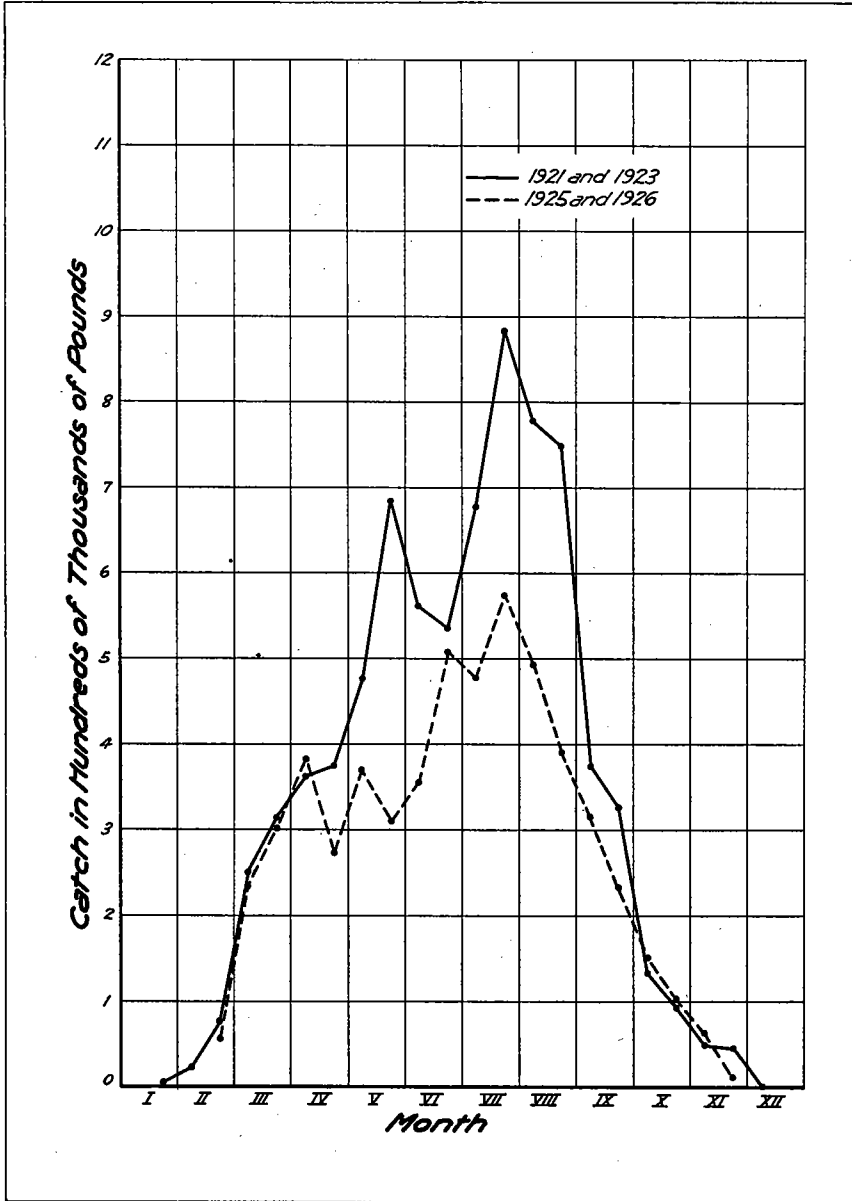


FIGURE 8.—Catch of halibut from Hecate Strait and Dixon Entrance, by two week periods, as hailed in Prince Rupert. Unbroken line before, and broken line after, the closure of the winter season, November 16 to February 15.

the following statistics of landings for the five year average preceding the closed season and for the four years the closed season has been operative:

Five years average, 1919 to 1923.....	51,595,000 pounds
1924	57,691,000 "
1925	53,170,000 "
1926	56,278,000 "
1927	56,899,000 "

The closed season, therefore, has merely shortened the period within which the catch has been taken.

The reasons for this increased intensity of fishing, which has more than balanced the effects of the closed season, are not far to seek. The economic advantages of the closure are sufficiently great to explain the lack of decline in total catch. The season of the year during which fishing is prevented, was the most expensive because of the bad weather, the consequent loss of gear and of time, and the severe effect on the morale of the men. With the elimination of the three winter months the work during the remainder of the year has become more efficient, and the losses and delays inherent in fishing operations have been greatly reduced. Moreover, the vessel owners at present spend part of the closed season in overhauling their gear and boats. A certain part of it is used en route to and from the fishing areas. The market for frozen fish is steadier, giving better prices for frozen fish according to general opinion. Furthermore the grade of fish taken during the summer months is said to be superior to that formerly taken during the winter. The closure thus being of benefit from an economic standpoint, it follows that as long as the fishery continues to pay well, as it has in the past, there is no limit to the expansion it will undergo, beyond the satisfaction of the demand. The closed season could not be expected to restrict, without adverse economic effects.

It is true, moreover, that in the past there has been a general and rapid increase in intensity of fishing sufficient to counterbalance the effect of the closure. Thus on the older banks the amount of gear fished is about two and one-half times that employed in 1910. This great and rapid increase in intensity has gone on unchecked during the nine most important months of the year. So great has it been that it has sufficed to maintain the total catch despite a fall in returns per unit of gear fished, and despite the fact that the new grounds exploited have yielded at their maximum but a third the abundance of fish found originally on the older southern grounds. Some measure of the effect of the closure in relation to this increased intensity can be gained by comparing the amount of catch formerly taken on the grounds along the eastern side of the Gulf of Alaska, with the effect of the fall in abundance from year to year. It is estimated that not more than six or seven million pounds came from these grounds before the closure, or about 10 or 12 per cent of the total for the coast. The loss of this could not exceed that annually lost through a failing supply, since, on the older grounds, the fall in abundance was approximately 10 per cent yearly, and, on the newer grounds, even greater.

It is evident that the closed season has met a complexity of conditions which destroys its uniformity of operation, and that in its application to one subordinate portion of the fishery it has left abundant opportunity for all supposed benefits to

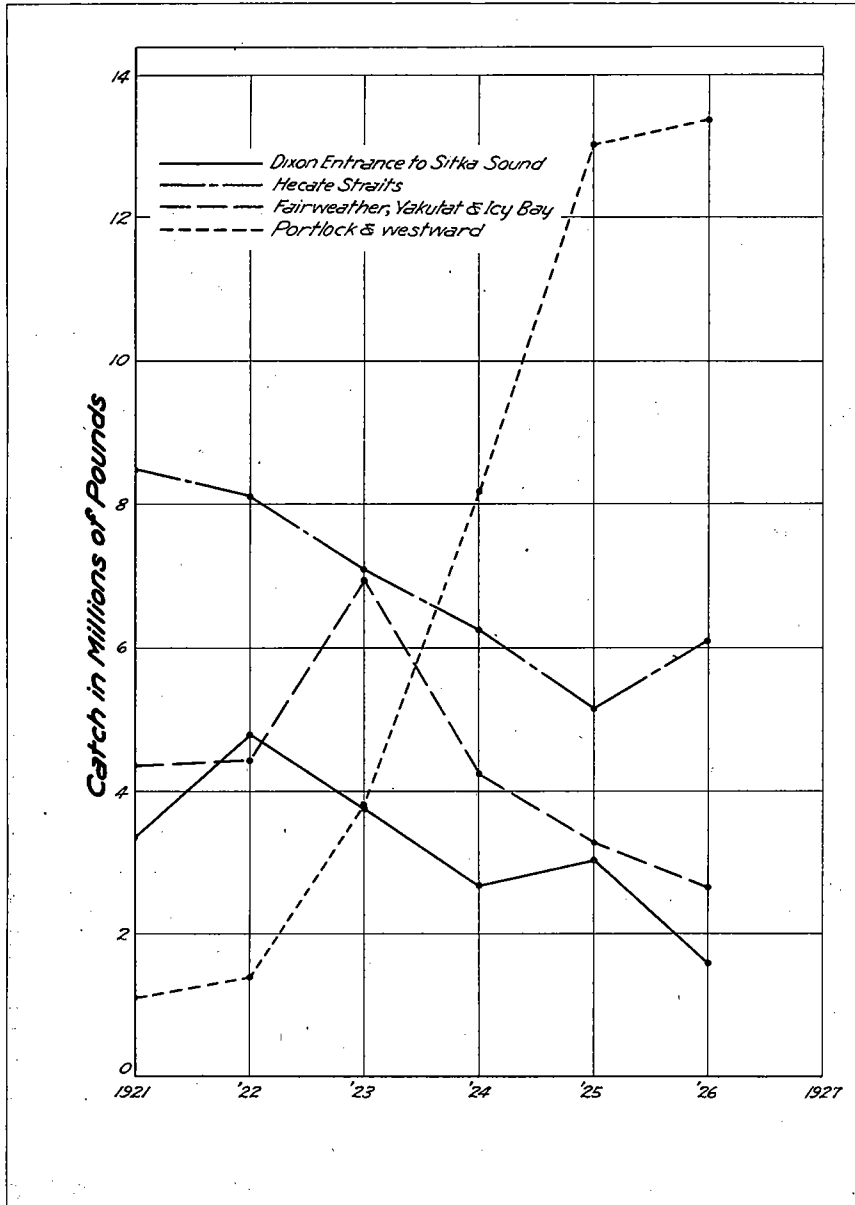


FIGURE 9.—The rise in landings from the westward banks including Portlock, contrasted with the decline in those from other regions. Prince Rupert, 1921 to 1926.

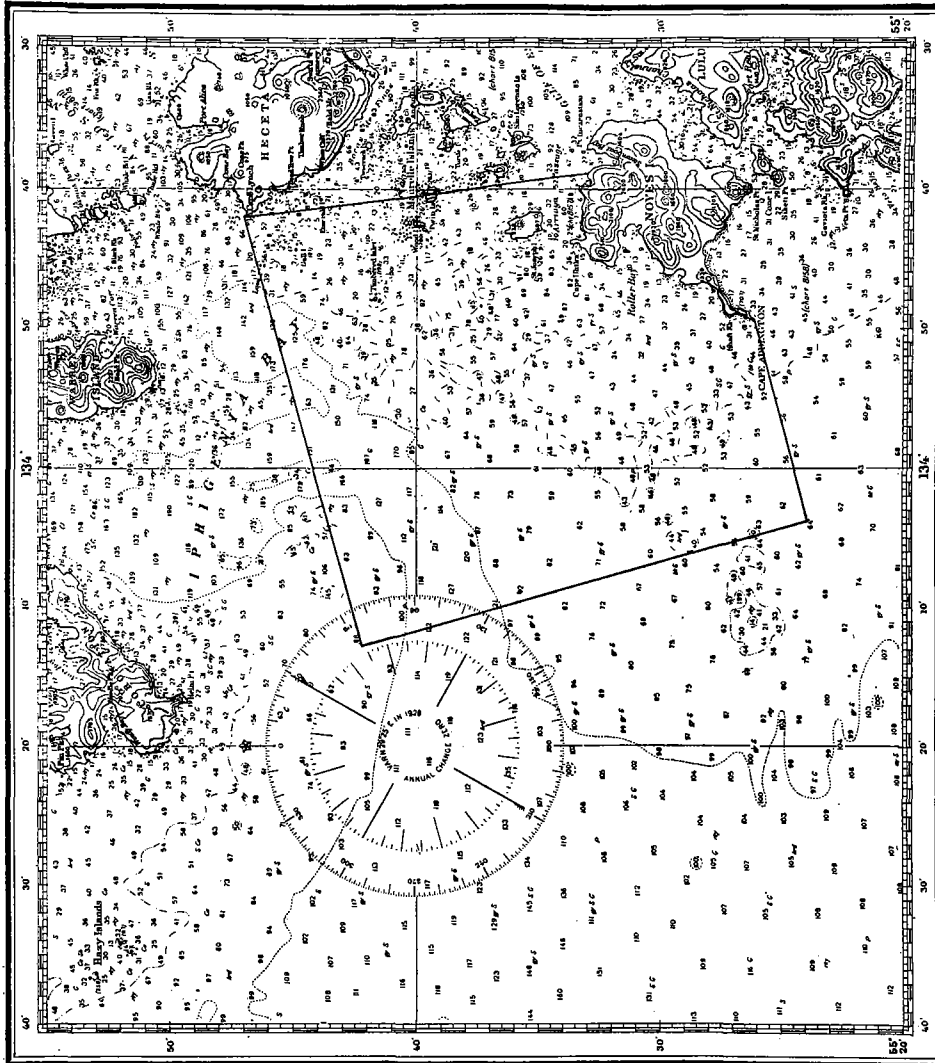


FIGURE 10.—Proposed Timbered Islet closed nursery.

be eliminated. A stream cannot be controlled by throwing a dam half across its course. The result is nothing more than an increased rate of flow in the other half.

The commission has been unable to devise any general measure for the whole fishery which would properly meet the needs of the various areas.

Artificial propagation of the halibut is, for technical and scientific reasons, impracticable. The numbers of young that could be thus produced would be a minute part of those hatched under natural conditions. Their culture would be expensive and the young fish could not be kept long after hatching. Hence it is evident that the natural supply is overwhelmingly the most important, and that it must be cared for. The only adequate manner of meeting the present situation

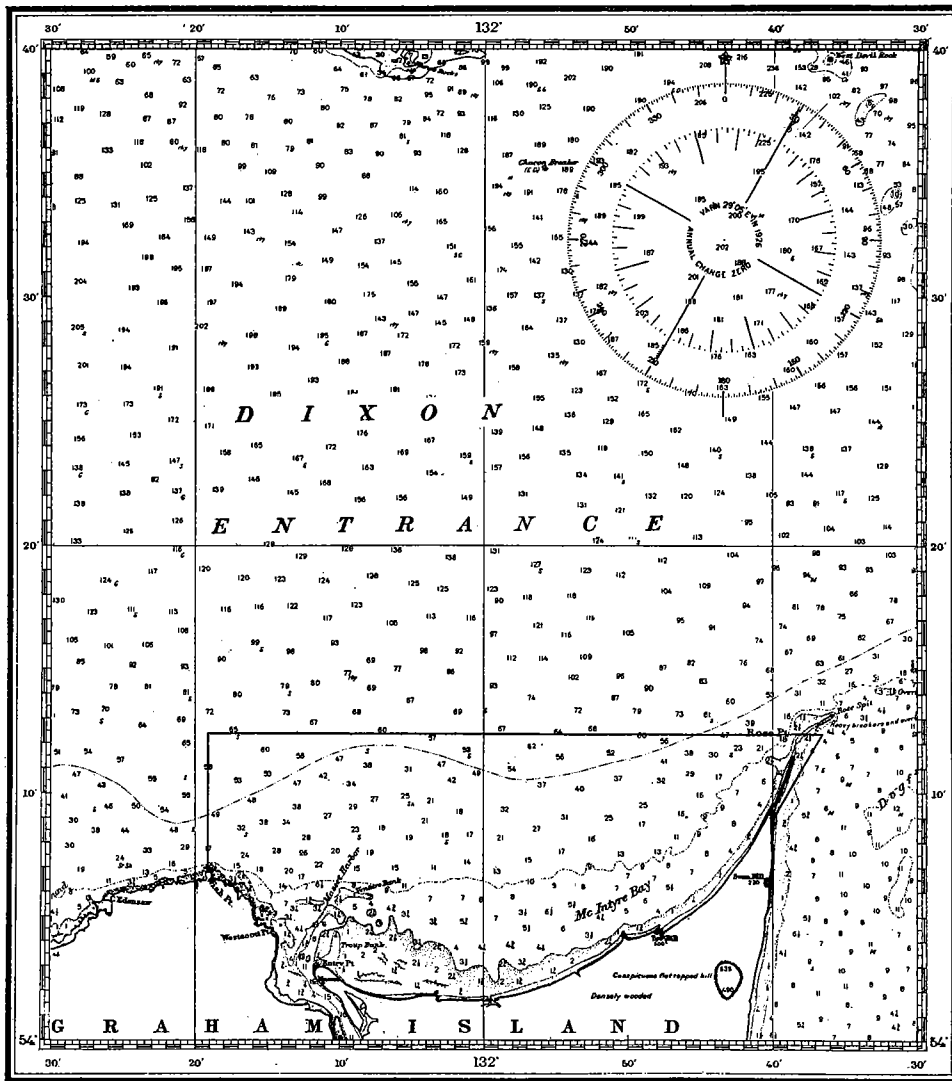


FIGURE 11.—Proposed Massett closed nursery.

is to preserve in each area a sufficient number of young to produce spawning adults, and to leave enough of the latter to produce an adequate amount of spawn under natural conditions.

It becomes evident, upon the first study of the halibut fishery, that regulations designed to produce and protect such a spawning reserve must be adapted to very different conditions in the various areas. The state of depletion varies from area to area, and the need for regulation varies accordingly. Certain of the banks have been resorted to for many years, while others are undergoing their first exploitation. In accord therewith the yield and abundance of fish varies. Moreover, the initial returns from any bank reflect the abundance thereon under natural conditions, and the newer, more westerly banks are much less productive naturally than the older southern banks—about a third in fact. In agreement with the state of depletion, the percentage of mature fish varies from a very small one on the southern banks to a high one on the western, and there is therefore a fishery for spawning-age fish on some banks and a fishery for immature fish on others. The fish on the banks vary not merely in their natural abundance, but in their rates of growth, and physical characteristics. Thus the trade terms applied to fish according to size have a very different meaning and do not indicate their age or their need of protection. The seasons of the fishery vary also, in accord with the biology of the fish and the geographic location of each bank. In agreement with all this, the same complexity is found reflected in the fleet, the fishery on various banks being carried on by different types of fishing vessels, with different seagoing ability, different methods of fishing to some extent, and different landing ports. No uniform protection of a single class of fish, such as the spawners, no closed season, no size limit or limit on gear, will be found to apply equally and efficiently.

The commission therefore finds itself forced by the aforesaid conditions to a consideration of the treatment of each individual area according to its needs. In thus acting it sees two alternatives.

One of these is to follow the method used in adopting the present closed season, and on the basis of an exact and intimate knowledge of the fishery in each area, to close such seasons, protect such classes of fish, or prohibit such gear as will reduce the amount of fish caught to the amount which the species is able to replace. This alternative has the same faults as has the present closed season. It is necessary to look forward to a compensating intensity of the fishery on those classes not protected or upon all classes during the open season. The degree of this reaction of the fishery is an economic matter, for as long as the fishery pays there is no doubt but that it will increase gear and vessels to supply the demand. The restriction cannot be effective unless it so raises the expense of the fishery, the costs of operation, as to prevent this increase. In that sense the restrictions become, if successful, economic handicaps adjusted to limit to the required extent the fleet and the amount of fish removed. The results of the present closure, the complicated conditions to be met, the extensive and arbitrary powers which would be necessary to meet unforeseen changes in the economic world, and the wide knowledge necessary, discourage the adoption of this alternative.

The commission feels that the effect of regulations so varied would be difficult to forecast, and that in many cases the results would be harmful rather than good. The manner in which the fishery compensates itself for the protection of a single category of fish, such as spawners or young, has already been referred to in the discussion of the closed season, and will be further discussed when dealing with the closure of small fish grounds. The biological conditions underlying the principle of protecting spawning, mature or young halibut are still unknown, and it is impossible to be certain that the shifting of the strain to any one of these classes rather than another is actually beneficial. Great fisheries exist which make exclusive use of one or the other. Many regulations, particularly those regarding gear, may be handicaps in the development of efficiency, or become causes of high cost of operation, which limit the output per man and prevent the sale of the catch at reasonable prices. Failure to dispose of the catch causes a surplus. The existence of the surplus creates a demand for further restriction of the catch per man or per vessel, with still higher costs of operation, so that the evil may be intensified instead of relieved.

The commission therefore regards this first alternative as undesirable and ineffective, both from scientific and administrative standpoints. It would be, at best, an attempt, by indirect methods, to reduce the amount of fish taken from the bank. The commission regards it as the part of wisdom to proceed directly to a regulation of the amount of fish taken from each area, by closure when such amount reaches a predetermined limit.

The commission is fully aware of the care which must be used in undertaking a task of this character. It has given careful consideration to the determination of the minimum reduction consistent with the perpetuation of the fishery, having in mind the least possible harm to the industry.

There has been, without restrictions, a decrease in the total catch from the older areas. The banks south of Cape Ommaney yielded, in 1910 more than fifty million pounds; whereas at present there are not more than twenty-one millions taken. Since the amount of fishing which produced these totals is, and has been, too great for the banks in their present state, this decrease must be taken into account, and the restriction imposed must be sufficient to more than cover this decline, or it would be meaningless.

This declining total yield is secured by means of an increasing amount of gear. In other words, the intensity of the fishery has become greater, and a constantly higher proportion of the stock is taken. Six units of gear are set now for the same result that one formerly yielded. This increase in the amount of gear and vessels is not in the best interests of either the fishermen or the halibut, and it is the greatest danger to which the fishery is subjected. The increased proportion of the stock taken lowers the abundance of fish on the banks progressively until a very minimum is produced, not merely for the effort involved, but in total. Therefore, if stability of return from the fishery is sought, the intensity of the fishery should not be continually increased.

Without positive restriction, the investment in gear and vessels already existent will face a decline in returns of fish, in accord with the decline in yield per set of a standard unit of gear, the skate. This yield reflects the abundance of halibut on the banks, and its changes; and a certain number of sets of such skates should on the average take a definite proportion of the total stock on the banks. So that to maintain the present rate of removal, or proportion of the existing supply taken annually, the total catch allowed from a given area must be diminished at a rate at least equal to the rate of this decline in returns of the gear in present use.

But knowing that the present proportion of the supply captured is too great a strain upon the species, what hope can be held forth that the retention of that rate of removal would bring stability or permanence to the yield? The proportion taken is already in excess of the rate of replacement. We know that with the total yield as it is, this abundance—as measured by the yield per unit of gear—is still declining. Is there any ground for believing that this decline would stop?

Hopefulness lies in the fact that the rate of replacement varies with the condition of the fishery. It is a well recognized biological law that under a state of nature a maximum population brings about a decline in the rate of reproduction until replacement just balances mortality. This is self-evident, since species cannot go on increasing indefinitely without overpopulating the world, which none of them do. But where, from one cause or another, the maximum population is not present, the rate of reproduction is much higher than the mortality, and up to a certain point becomes increasingly so. This has been observed in many organisms, ranging from man, and the various species of birds introduced into America, to transplanted species of fish such as the shad, and various insect pests. Among indigenous species this phenomenon must hold true, in order that they may recover from disastrous years. Whether this is caused by a greater abundance of food for the fewer individuals, or by some other factor, it would seem to be a general rule that the rate of replacement is higher when the species is below its maximum in numbers. Hence, if the decline has not gone too far, it is to be expected that in response to steadiness of the mortality rate the numbers of the species will decline only until the thereby increased rate of replacement is sufficient to balance the mortality.

With the data at hand, evidence of this increased productivity in the halibut is available. The abundance has fallen on the grounds south of Cape Ommaney in 16 years to about 25 per cent of its original amount, but the total catch seems to have fallen to about 40 per cent, therefore not as fast. Such a calculation cannot in the nature of things be exact, yet it errs on the conservative side, as for reasons that cannot be detailed here, the fall in abundance may have been greater than this, possibly to such a degree that the present abundance is but 15 per cent of its original amount. In this case, the contrast with the decrease in total catch is still more marked. The lower level of abundance seems to have produced in recent years a higher catch in proportion, although not in total figures.

There is, therefore, ground for believing that if the proportion taken does not increase, the halibut fishery on the older banks will ultimately come to a

position of stability. This would imply the reduction of the total catch at a rate equal to the fall in abundance of the stock of fish. The latter can best be measured by the returns per set of a standard unit of gear. This indicates that from 1906 to 1926 the fall has been at the rate of 10 per cent a year. Such a reduction in total catch is the minimum which could be considered for the purpose, and is equivalent to the use of a fleet and gear the equal of that now employed.

It will be noted that the essential principle of the reduction in total catch is that it shall proceed at a rate at least equal to that of the declining return from a definite amount of fishing. Were this to be accomplished with precision, the reduction in catch would cease immediately with the cessation of the decline in abundance; and with a definite amount of fishing the returns would then be constant. It is the same principle upon which regulation of the salmon fisheries in Alaska and British Columbia is conducted, that a definite proportion of the fish shall be allowed to pass the commercial fishermen.

The adoption of such a procedure must be made with full knowledge that it may not suffice. The thinning out of the population may have already gone so far as to have increased the rate of replacement to its maximum. No further increase may be possible, so that the present degree of intensity of fishing may suffice to continue the decline, or the present drain on the species may exceed anything that even an increased rate of replacement may be able to care for. In such case, the only alternative would be to reduce the catch annually at a faster rate. That is for the future to indicate.

On the other hand, it is well recognized by the fishermen that the banks are now but very sparsely populated, and it is more than possible that the maximum rate of replacement was reached long before the thinning out had proceeded as far as it has. In that case a larger population of halibut than now exists on the banks would give a proportionately larger total replacement and a greater amount would be available for the fishery without harm to the species. Therefore, once the halibut fishery is brought to a stable condition, the question will undoubtedly arise as to whether a further step to increase the "breeding stock" may not be advisable. This distinct possibility of increase in total yield would necessitate a temporarily greater restriction than that which is here proposed.

The determination of the amount of the reduction in the total catch from any area must, then, be guided by a study of the amount of fishing in relation to the returns. In making this determination, the discretion of the regulatory powers must be relied upon in drawing conclusions from the statistics obtainable. The latter should, however, be as accurate and comprehensive as is possible. The information now in the hands of the commission is very extensive for recent, but less so for the earlier years. It must serve as a basis for the initial reduction. For the period 1906 to 1926 the rate of fall in abundance has been 10 per cent a year, with minor fluctuations of one to five years in duration, when there may or may not have been a continuous fall. Further reductions should be based on accurate, comprehensive data as to men, boats, and gear used, and the returns therefrom, so that the condition of the fishery may be measured in as many ways

and as correctly as possible. Upon this information the rate of reduction in total catch should be revised at as frequent intervals as possible.

The frequent revision of this rate of reduction is necessary for several reasons. In case the reduction reflects the changes in the abundance of fish, as shown by the catch of a given amount of gear, unnecessary increases and decreases in fishing operations would be avoided. Furthermore, in case the rate of decline in abundance slackens, the reduction in the catch should be less, so that when the fishery becomes stable in yield, reduction will cease at once.

From present statistics, the initial total catch, from which the reduction should be made, can only be estimated for the several regions. The information at hand is designed to be representative only, and not comprehensive. It was obtained through voluntary returns, and may not give results comparable with those from a more complete, legally enforceable system. The commission regards it as necessary that the installation of a complete system of records be made at once, so that the initial amount from which reduction is made shall have been obtained by the same system and under the same conditions as those subsequently determined as limits. For that reason no reduction should be made until complete returns are at hand for a full year.

As has already been said, the reduction made in the total catch should vary with the needs of the various areas. This implies the formation of such areas for administrative purposes. In view of the fact that such control, if adopted, would be applied for the first time in the history of deep-sea fisheries, it is the commission's opinion that they should be large enough to render enforcement easily effective, and that they should correspond to a natural division of the fleet. For this purpose the first division should be into two main areas—the banks south of Cape Spencer and those north and west thereof. Later, when there has been more experience with the matter, smaller areas may be chosen, if deemed necessary.

SECOND AND THIRD RECOMMENDATIONS

PERMANENT CLOSURE OF SMALL FISH GROUNDS. PREVENTION OF GEAR DEEMED UNDULY DESTRUCTIVE.

In the halibut fishery the sizes vary from two or three pounds to over two hundred. The value of the very small fish, if they are accepted at all, is very low. It is not until a size of $1\frac{3}{4}$ pounds is reached that full price is obtained.

The small fish are everywhere the young, still rapidly growing, and are not a different race of fish from the medium-sized, first-grade fish. The smallest fish, the so-called "baby chickens," are from five to eight years of age, and during that period treble their weights. The next class of fish, the "chickens," are from eight to eleven years of age, on the average, and within the three years they double their weight. These statements are, of course, approximate only, and pertain to halibut from Hecate Strait. On the western banks the ages are greater because of the

slower growth. The mortality of these young fish is probably light, since even at their ages they are larger than most of those fishes which are presumably their enemies.

It therefore appears economically desirable to protect these small fish until they are of larger size. The gain in weight of the individual would be supplemented by the increased value, pound for pound, so that the economic gain would very probably be considerable. The hearings held by the commission indicate almost universal acceptance of this view, one which the commission endorses.

The commission believes it very evident, however, that if the small fish become more valuable at a later stage of life, and that if the fishery thereby gains from an economic standpoint, the intensity of the fishery will correspondingly increase. It is natural that the profit in a fishery should govern its intensity, and the greater the profit in fishing the larger classes of fish, the more they will be sought after. What would be saved in one part of the fishery would simply be added to another part, and there is no economic reason why that part should not be fished just as closely and to as low a level as before. This being so, it is unlikely that any considerable part of the fish protected by regulation would survive the four or five years necessary to reach spawning size after leaving the baby chicken stage. To retain for the fishery the benefits that accrue from the protection of these small fish would involve restraint of the fishery within the area concerned for other grades of fish as well.

Nor can the gain by such protection be in any way a substitute for general restriction of the fishery. Even were there thus permanently withheld from the fishery some small fraction of the total population, there would be serious doubt as to whether it could compare in magnitude with the loss in abundance that is year by year incurred by the general increase in gear used. It would, as was remarked in connection with the closure of the winter season, simply cause a temporary setback that would be offset by an increase in intensity of the fishery.

Furthermore, it is to be considered that protection has to some extent been afforded these smaller sizes in the past, by trade usage and agreements with the dealers. The price obtainable for them has always been low. The sentiment against baby chickens being landed was, and still is, strong. They have constituted a third grade of fish, which were supposed to be destroyed and not sold. Yet the decline in the halibut fishery has gone on.

The percentage of the smallest size of fish landed is not known, but that of chickens is recorded. This should show the trend. There has been, for instance, a more or less steady increase from 20 to 30 per cent of the total landed at Prince Rupert from Hecate Strait in the last seven years. There is little doubt that undersized fish are forming a continually larger share of the catches from the southern banks in general. Legal protection to these small fish may prevent their use in the future to an increasing extent, but it can be preventive only and not constructive. It cannot apply to the factors which have caused the damage in the past unless there are sizes included which have in the past formed acceptable parts of the market landings.

In considering the protection of these small fish, whatever sizes are included as such, their distribution is important. They are found to a greater or less extent in all areas, and form a factor in all catches. But the smallest sizes are found in much greater proportion on certain banks commonly called "nurseries." Whether the extent of these banks, or the number of small fish thereon, has increased is difficult to say, as accurate observations have not yet been completed. Those nurseries which have been recognized for many years are on the old, more southern banks; but when the western grounds are better known, nurseries will doubtlessly be distinguished by fishermen there. At present, little can be discovered statistically as to distribution or relative abundance in various areas. Vessels fishing on nurseries are reluctant to admit the fact. Catches everywhere are mixed, and are rarely made from one area. The fishermen shake off the smaller sizes, frequently in great numbers, so that their catches do not give a fair picture of the proportion of small fish. They reflect, more than anything else, the market demand. But they also reflect the distance of the bank fished, since a catch of low priced fish is not likely to be brought from a great distance as long as there is any chance for first grade fish. Hence, although it is possible to say that certain nurseries actually exist, it is not possible as yet to give an accurate picture of the distribution of young, nor of what the effect of various restrictive measures on the various areas might be.

There have been three methods of protection for small fish suggested, namely: the imposition of a size limit, the prohibition of the use of small hooks, and the closure of nurseries to all fishing.

The use of a minimum size limit would involve a great destruction of under-size fish, much more extensive than is now the case. The investigations of the commission during tagging operations showed that more than 50 per cent of the small fish are seriously injured by hooking even when carefully handled. It is deemed highly probable that when such fish are handled as roughly as is done in commercial fishing, when they are jerked off the hook, only a very small part of the 50 per cent are in good condition for survival. Yet, as previously explained, in all commercial fishing, wherever the lines may be set, it is impossible to avoid the capture of a certain percentage of these small fish, and occasionally a high percentage. If such catches were to be discarded, great waste would be entailed.

To a certain extent, fishing on nurseries or small fish grounds would be penalized. Yet when prices for fish are good, it is probable that vessels would nevertheless use these grounds, culling extensively, as is now frequently the case. It is, therefore, preferable to act directly in the protection of these nurseries, as is proposed below.

Another proposed method of protecting small fish is to prohibit the use of smaller sized hooks (other than the standard No. 6283), which are used with lighter lines. This matter was carefully investigated by the commission in a series of experiments. It was found that the small hook gear, supposed to catch an undue proportion of small fish, actually did not do so, but took no larger nor smaller proportion of small fish than did the standard gear. On the other hand,

the small hook gear was more efficient, catching as much as 60 per cent more fish per unit of gear set, whether large or small fish were considered. But the lighter lines are adapted to fishing in shoaler water, where fishing conditions are easier and where there are now greater quantities of small fish than formerly in proportion to large. In deep water, and for large fish, the amount of breakage was found to be high. The prohibition of this gear therefore becomes a means of penalizing the present fishery on the older grounds, where the fish are mostly small.

At present the commission has not ascertained the efficient element in the combination, which would have to be covered by a "blanket" prohibition. Heavier, less flexible lines, would have to be required on all grounds. Yet it is entirely possible that the efficient element could be adapted for use in deep water fishing for large fish, and the commission is loath to block the development of efficiency for its own sake. If the shoaler grounds are to be fished at all, and indeed if the halibut fishery in general is to be carried on, it would seem the part of reason that it should be done with efficiency, and that the amount taken should be limited in a direct fashion, as has already been proposed.

The use of the small hook gear is, moreover, a relatively recent matter. As with the nurseries, prohibition of its use is a preventive of future additional ills, and not for those which have already injured the fishery. Its prohibition cannot suffice in itself, to meet all of the existing conditions, the extent of its effect cannot easily be foretold, and the great increase of the fishery could proceed unchecked along previous lines. It partakes of the disadvantages of indirect economic restrictions, which must in the end be justified by the amount of restriction in total catch they impose, a method regarded undesirable by the commission (see page 24).

In all the circumstances the commission desires to defer its recommendation as to the use of this gear, but provision should be made to prevent the use of any such gear deemed unduly destructive in the light of future investigation.

The third alternative, the closure of the young fish grounds, or nurseries, remains to be considered. On these areas the commission, by means of its own fishing operations, has found that the fish are actually the younger classes only. They are populated by very few fish over eleven pounds in weight, the majority being well under eight, and some being as small as three pounds. Their age, on the average, is from 5 to 8 years. No mature fish are found among them except as strays.

Closure of these areas would, therefore, be a clear-cut protection of young fish. Unlike a size limit, it would not involve great waste of culled fish, but it would prevent the worst of what now occurs. No hindrance would thereby be placed upon the use of what small fish are taken on the banks in general in the course of ordinary fishing. There would be no penalty upon efficiency of method. The economic benefits to be derived from the increase in weight and value per pound would not be conditioned in any way by economic losses. If the protection of young fish is desirable, then the closure of the nurseries must be.

But the area thus protected is very small, in comparison with the extent of the banks as a whole. The some five or six hundred square miles include but a very small fraction of the general halibut population, or indeed of the small fish in general. To that extent their closure could, even if it completely removed these fish from the catch, be of but small effect compared to the general increase in intensity of the fishery. Moreover, what effect is observable must be confined to the general region in which these nurseries are located because of the slow migratory movements. For these reasons, the closure of nurseries being advisable, the principle should be extended to all similar banks, in all parts of the grounds, as soon as definite information is at hand.

In view of the present condition of our knowledge of marine fisheries, a word of caution in regard to such closures may be added. The maximum productivity of a bank may not be served by permitting overpopulation. Although it would seem unlikely that such would occur, nevertheless the condition of the nurseries should be under observation, and too implicit faith in their efficiency should be withheld.

The commission, therefore, while it agrees with the universal sentiment for closure of these grounds, regards the principal justification for closure as economic. The value of such action for the perpetuation of the species must be conditioned upon the control of the remaining fishery, and must at best be insufficient to stem the course of overfishing in general.

The areas that the commission recommends should now be closed are the so-called nurseries about Timbered Islet, Alaska, and Massett, British Columbia. Their description is as follows:

TIMBERED ISLET NURSERY

The waters off the coast of Alaska within the following boundaries: From the northwest extremity of Cape Lynch, Hecata Island, southwest (magnetic) 18 miles to a point approximately latitude $55^{\circ} 42' 21''$ N, longitude $134^{\circ} 12' 30''$ W; thence southeast (magnetic) 19 miles to a point approximately latitude $55^{\circ} 24' 0''$ N, longitude $134^{\circ} 3' 42''$ W; thence approximately northeast (magnetic) 8.5 miles, to the southern extremity of Cape Addington, Noyes Island.

From the northwest extremity of Cape Lynch, Hecata Island, southeast three-fourths south (magnetic) approximately 14.5 miles, to a point on Noyes Island in range with the peak shown on chart numbered 8150 published by the U. S. Coast and Geodetic Survey, said point being approximately in west longitude $132^{\circ} 39' 30''$.

MASSETT NURSERY

The waters off the north coast of Graham Island within the following boundaries: From the northwest (magnetic) extremity of Wiah Point, Graham Island, true north 5.5 miles to a point approximately latitude $54^{\circ} 12' 20''$ N, and longitude $132^{\circ} 19' 18''$ W; thence true east 25 miles to a point approximately latitude $54^{\circ} 12' 20''$ N and longitude $131^{\circ} 37' 0''$ W; thence south (magnetic) to a point on Graham Island.

FOURTH RECOMMENDATION**THE EXTENSION OF THE PRESENT CLOSED SEASON BY TWO WEEKS,
AND THE FACILITATION OF FUTURE ALTERATIONS**

Article I of the present treaty provides a yearly closed season for all halibut fishing in the waters covered by the treaty from the 16th day of November to the 15th day of February following, both days inclusive. The economic advantages of this closure and the absence of effects beneficial to the perpetuation of the fishery have already been commented upon. It is evident that the closed season has merely shortened the period within which the catch has been taken.

The commission is, however, satisfied that the adoption of the closed season was a wise measure, as it has obvious beneficial economic effects as far as the whole fishery is concerned. It eliminates the most expensive fishing part of the year, and one which is also full of hardship. It stabilizes the price of frozen halibut, and this in turn has a favorable effect on the demand for such frozen fish. The catches at that time of year are claimed to be of poor quality, and frequently so great as to lower the selling price below what is profitable. On account of these conditions all branches of the industry and the commission are unanimous in their support of maintaining the closed season.

Indeed, with the exception of the owners of some of the large fishing vessels, who feel that their investment is too great to admit of a longer closed season, the industry favors the lengthening of the closure by two weeks at both ends.

The commission is satisfied that lengthening the closed season by two weeks at the beginning would not be seriously detrimental to any interest, and would be economically beneficial to the industry as a whole. Hence it recommends that by special agreement of the character provided for in Article I of the treaty, the annual closed season be lengthened so as to begin on the 1st instead of the 16th of November in each year.

It is entirely conceivable, however, that under other circumstances, the present length of the closed season would be too great, and would lead to serious economic difficulties. Conditions in a fishery are not so stable as to justify reliance upon their indefinite continuation. At the present time, prosperity would seem to render the maximum closure possible, but it does not follow that this will be permanently true. There should, therefore, be provided means whereby the length of the closed season may be altered more readily than is now the case.

In concluding, the commissioners desire respectfully to urge upon their Governments the very serious condition of this great fishery and the necessity for prompt action to rehabilitate it.

(Signed)

JOHN PEASE BABCOCK,
Chairman
WM. A. FOUND,
MILLER FREEMAN,
HENRY O'MALLEY.