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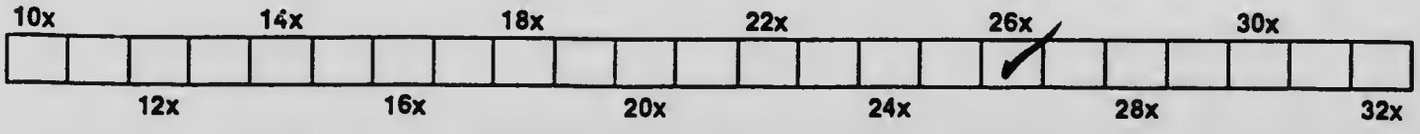

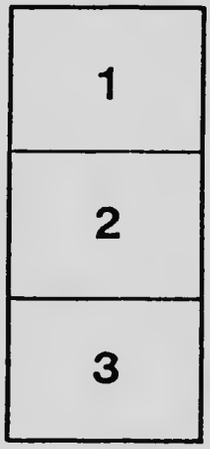

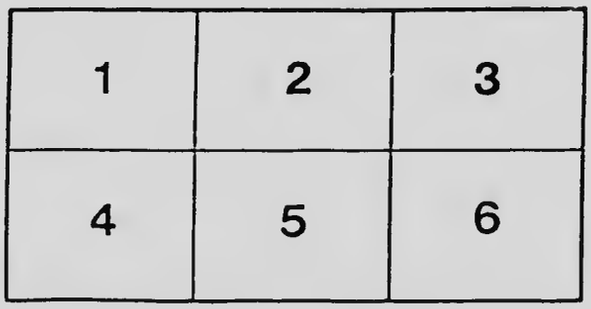

BRITISH COLUMBIA FISHERIES DEPARTMENT, 1915.

STATISTICS OF THE HALIBUT FISHERY IN THE PACIFIC: THEIR BEARING ON THE BIOLOGY OF THE SPECIES AND THE CONDITION OF THE BANKS.

A NOTE ON A SPOROZOAN PARASITE OF THE HALIBUT.

THE PROBLEM OF THE HALIBUT.

BY

WILLIAM F. THOMPSON,
Stanford University.

[Reprinted without change of paging from Report of the B.C. Commissioner of Fisheries, 1915.]

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BY WILLIAM F. THOMPSON, STANFORD UNIVERSITY.

INDEX.

TABLES EMPLOYED IN REPORT.

I. INTRODUCTION.

At the inception of the work on the life-history of the halibut by the Fisheries Department of the British Columbia Government in the spring of 1914, many voyages were made by the author on every class of vessel engaged in its capture. One of the things which first attracted attention was the care with which the masters and mates of the vessels kept their logs, or ships records, and the excellent nature from a scientific standpoint of the data kept in them. It was, therefore, soon one of the prime objects of the field-work to examine as complete a series of the log-books as was possible. In the course of this the logs for over 900 voyages were obtained, and from them the data herein presented were carefully extracted. The labour of doing this has been very great, yet the results have well repaid it.

There are but few data extant, as far as the writer knows, which give in satisfactory fashion the effects on the banks of overfishing with lines.* From that viewpoint those given here should be valuable, for such knowledge is, without doubt, of the greatest importance in the consideration of the future of the fishery, the protection of the species, or the merits, from the standpoint of conservation, of various methods of fishing. These considerations alone would justify any trouble put forth to secure such data, but there are others which are as important. Thus the present condition of a bank is intimately related to its past history, and this must underlie the conclusions drawn from studies made on the biology of such a bank. Indeed, the contribution which is made to the knowledge of the natural history of the species by such detailed statistics is surprising in itself. Although this work is considered by the writer to be simply an indication of what could be done, hardly an illustration, one of its aims is to prove what even imperfect data are capable of showing, and to urge the collection of whatever is available. It might be possible that those engaged in any extensive fishery could, without prejudice to their interests, keep such records as would throw light on their operations, when it has been done voluntarily in the present case.

The most immediately important conclusion reached in this paper is the fact of depletion. It would seem improbable that any one who was at all conversant with the facts would deny it, yet this has been frequently done, and more often the statement has been challenged for proof.† It has therefore been thought to be of the utmost importance to advance irrefutable proof of the state of the banks.

In considering the evidence here presented, it should be borne in mind that the banks off the coast of British Columbia are but a portion of the total, on which but a part of the catch is obtained. As a matter of fact, vessels from Vancouver and Seattle now travel beyond Kodiak Island, as far as the entrances to Bering Sea, the principal yield for 1915 having come from the Gulf of Alaska (*see* page 75 for remarks on the shifting of the fisheries), and this fact is eloquent proof of the prevalence on the banks of South-eastern Alaska of the same conditions shown to exist on those treated here. It must be expected that the fishery would be carried on to the new banks as soon as the increased difference in yield would offset the greater distance to be traversed. The principle of this is obvious, for all of the vessels must in a way compete for the fish to be obtained, being subject to the same economic pressure. Therefore, in considering the evidence, it should be remembered that the area covered by it is typical of the whole, save

* *See*, however, the abstracts of Scottish Fishery Statistics by T. Wemyss Fulton and D'Arcy Wentworth Thompson, particularly in North Sea Fisheries Investigation Committee, Fifth Report (Northern Area) on Fishery and Hydrographical Investigations in the North Sea and Adjacent Waters, 1908-1911 (Fishery Board for Scotland), pages 67 and 205.

† By Professor Arthur Willey, Investigation into the Pacific Halibut Fisheries, British Columbia, in "Contributions to Canadian Biology," 1914-15. Sessional Paper No. 38A; pages 1 to 17. Issued in 1916.

In this connection we may quote from the above paper issued by the Biological Board of Canada, which came to hand after the completion of this work: "Under these conditions we have to consider whether the stock of halibut will continue to stand the strain that is imposed upon it. Practical fishermen are sometimes apt to be pessimistic in this regard, although the aggregate catches do not as yet show any sign of diminution. Up to a certain point the thinning-out of the banks by the capture of surplus fishes must be beneficial to the numbers and quality of those that remain. But this optimum standard of fishing intensity is vague and cannot be defined otherwise than arbitrarily. Recommendations to curtail the fishery are easily made, but they would be entirely ineffective unless there happened to be a clear case for the immediate enforcement of rigid restrictions. The fact is that there is no such pressing call for drastic action, and therefore this aspect of the question need not be discussed here. What we are asked to do is to devise measures for the expansion, not for the limitation of the industry." (Page 15.)

Proof for no part of this statement is given. The meaning of "expansion" is problematic, for if it implies the necessity of finding new banks the depletion of the old is acknowledged. Conclusions such as are reached in this quotation are assuredly based on a lesser knowledge than is possessed by the fishermen, but materially strengthen the influence of those opposed to any control of the fishery.

in so far as it is nearer to the markets than other areas, and that the depletion of the banks accessible to fisherman from a given port means the loss of the industry to that port and the region it serves.

As may be seen by reference to the statistics of fish landed given by the reports of the United States Bureau of Fisheries, and in the "Year-book" of the *Pacific Fisherman*, a trade journal published in Seattle, there is no decrease evident in the total yield per year. No consideration is made, however, for accurately judging the increase of the fleet, save in the recent numbers of the *Pacific Fisherman*. It has been thought best, therefore, to frankly disregard all published statistics, save where they may be shown to explain incidental problems.

It is unfortunate that the logs from which the data were taken had to be returned to the captains from whom they were borrowed, but the data have been copied on special blanks. It will be impossible to print anything save the tables compiled from these, although in the event of a future study of the beds other questions may arise for which the copied data will be necessary. These have been, therefore, bound and preserved for reference.

For the opportunity of examining their logs and records, thanks are due Captains Knighthall, Selig, Dave Candow, Robert Candow, Harry, Hansen, and Freeman, also to Mr. Greenwood, of the Skeena River Fisheries, and Mr. Hagar, of the Canadian Fishing Company. To Captain Freeman and his interest is due a large part of the record, as well as a great deal of the perhaps limited knowledge the writer has of the fishing-banks. Captain Freeman has been on the Pacific Coast engaged in halibut-fishing throughout its phenomenal increase, and his well-balanced, acute observations have been of great assistance in the work which the writer has carried on aboard his vessel, the "Flamingo." His kindly courtesy, and that of his crew, has rendered working conditions pleasant where they might not have been. Great assistance in the laborious task of compiling and computing the statistics has been given by Mrs. Thompson, and several sections are based on her work. Thanks are due Dr. C. H. Gilbert for the privilege of working in the laboratories of Stanford University, California, as well as for his many kindnesses and his encouragement.

II. DISCUSSION.

Among the facts presented in the following pages, the one which stands forth most conspicuously is the great effect which the operations of the fishermen have had on the character of the halibut populations of the various banks. Not only have they been very extensively depleted, but the proportions of mature and immature, of large and small fish have been radically changed. The presence of the greatest numbers of immature fish on those banks which have been exploited for the longest time and most intensely would be extremely misleading unless the effect of overfishing were discounted. It is impossible in this connection to refrain from observing the striking parallelism between this condition and that prevailing in the North Sea in the case of the plaice. There, although it is known that the Bight of Heligoland and the Dutch Coast are regions most intensely fished, the presence of great numbers of immature fish and the absence of mature has been urged in support of theories of migration from these "nurseries" to the deeper water "spawning-banks."* However this may be in regard to the plaice, it is evident that migration in the halibut must be shown by other means. It is not intended by this to deny the occurrence of migration, but simply to call attention to the obvious importance of the history of a bank in the consideration of its biological problems. It is a corollary of this that the distribution of large and small fish is not a criterion of fast and slow growth unless the depletion of the banks is taken into account. Throughout the attempt to correlate the average size of the fish on a bank and its geographical position, the use of the terms fast and slow growing as synonyms of large and small has been avoided.

The discovery of "spawning-banks" is often stated as an object of research, but, in the case of the halibut at least, this term is subject to suspicion as to its correctness. Those areas characterized by mature and spawning fish deserve rather the name of undepleted banks, in view of their history. It is customary among the fishermen to resort to these especially in winter, and by a coincidence they are always situated in deep water. The seasonal change in the depths at which fishing for halibut is carried on is shown on page 76 to be very considerable. This must, one would think, have some basis in the catch to be obtained, and the deep-water fishing

* Garstang, in Vol. III., "Des Rapports et Proces Verbaux du Conseil International pour l'exploration des la Mer, Août 1905." Also in "International Investigation, Marine Biological Association, Report 1, 1902-3."

must be more profitable, during the winter months, than that in shoal water. This is far from implying, however, that there are more fish caught per unit of gear during the colder months in deep water than during the warmer months. It might be assumed that the fishermen were "following the fish," as they say, if such an increase were evident; in other words, the large spawning fish caught would be supposedly migrants from the shoaler banks. Aside from the fact that there is no decrease in the average size of the fish caught on the latter banks at that season, there are reasons why the fishing in deeper waters should not decline as extensively as that in shallower. It is well known that the fluctuations in temperature with the seasons are less in the deeper strata of the oceans, and in the portions nearest the main body of water. A fall in temperature has been shown to cause a lessening of the activity and metabolism of fish, and the conclusion follows that where the fall is least the fish remain most active—namely, in the deeper waters. If this is true, areas which are but lightly, or not at all, fished during the summer may because of their depth compare favourably with inshore banks during the winter in so far as the way in which the fish take the bait. In the case of the halibut, these outer banks are those on which the intensity of fishing has been least, and which have been exploited last, with the result that their fish have been able to remain nearer maturity than the others. The objections to such a theory are certainly less than to one implying migration, although data as to seasonal fluctuations of temperature on the different banks are lacking, as are records concerning the yield (*see* Tables 52 and 53 for those which are available).

In fact, the results given in the present paper confirm those of the previous one by the writer* in indicating the improbability of any considerable migration between banks. If, in the long time provided by the life of a halibut, which reaches an age of over twenty years and does not mature until twelve, the populations of adjacent banks do not become mixed to such a degree as to nullify differences in rate of growth, the extent of migration is of slight practical importance, or the differences exceedingly large. The close proximity of some of these banks has been remarked on in the text. It is perfectly possible, it must be recognized, that these evidences of isolation are due to the presence of barriers not visible above water, which may confine or limit movements, but this does not in any degree contradict the conclusion that the halibut is not an extensively migratory fish.

The distribution of the banks characterized by large and small fish is not favourable to any conception of migration to explain the differences. The banks outside the entrance to Hecate Strait have smaller fish than those inside, whereas the reverse would be expected if the large fish migrated outward to deeper water to spawn. On the other hand, the migration cannot be to these inner banks, because they have been shown to be lacking in mature fish, the catch being to an increasing extent of small fish.

The fact that there is a seasonal difference in the size of fish caught on all the banks, outer as well as inner, is not conformable to any conception of migration, but it may be difficult to explain in a completely acceptable way. A careful examination of the evidence has led to a possible theory which will serve to emphasize the importance of work along certain lines—namely, those of the effect of the seasons on the character of the fish population. It is a well-known fact that the principal growth of fish takes place during the warmer months, for it is on that basis that the age is deciphered from the markings of the otoliths and scales. There should be, because of this summer growth, an increase during the whole of the period of rapid growth in the number of fish which have reached the size suitable for catching with the hook, with a resultant depression of the average size.

As is remarked on page 97, it seems probable that the halibut are found in "schools," or populations of various average sizes, and, as indicated in Table 43, the tendency is to constantly depend more and more on the fish of small size. Indeed, the larger fish form numerically an increasingly smaller part of the whole, and it has become a predominant characteristic of halibut-fishing that the large "schools" of small or medium-sized fish are sought out especially, and a set is rarely repeated where but few fish (generally large) are caught. It is hence very probable that the young fish are caught off to a great extent the first year they come of sufficient size. There cannot be many of them left in the fall, considering that the intensity of fishing is such as is shown to be the case. On the other hand, the large fish, scattered or in small schools, are scarcely worthy of attention while there are young fish to be caught, and their numbers do not form an appreciable part of the catches until it is necessary to take what-

* Report of the British Columbia Commissioner of Fisheries for 1914, page 76.

ever may be found. They therefore form a lnrger part of the winter catches than of the summer, with a consequent increase in the average size caught.

Where the mature fish have been nearly all caught, or where depletion has been going on so vigorously that none have been allowed to grow to maturity, the larger fish on the banks would be represented by the remnnnts of schools of the preceding one or two years; but where there is still a considerable number of larger fish left from a number of years, the average age would be greater, with a consequent greater contrnst in size between them and the new schools. It should be anticipated, therefore, that on certain hanks a slighter seasonal difference will be found than on others, as seems to be actnally the case. It is not to be expected, however, that each catch of larger fish would be of uniform size on the same bank, hut considerable variation must exist between "schools," and where hut few records are obtained from an aren it mny be possihle that the npparent differences are due simply to imperfect datn.

An nlternative to this explanation would he the simple assumption that during the winter the younger or smaller fish cease to take the bait as eagerly ns the larger, or perhaps the smaller male censes to take the hook. There seems to he no evidence in favour of this theory as far ns the halibut is concerned. Neither is there any in favour of that of migration as an explanation, while there is much against. The winter increase in size is evident on all the banks examined, whereas through migration there should be an actnal decrease in winter size on certnin of the hanks. It seems more satisfactory to nssign the phenomenon to the periodical growth of young fish, due to the changes in temperature or food consequent on the seasons.

It is possible that the differences in average size of the fish fonnd on different banks nlso may he dne to temperature or to some factor dependent on temperature, such as food. The distribntion of the large and snall fish, discounting the effects of depletion, is such as would conform to this, for the inshore waters are generally supposed to he warmer than the offshore, nithough they may fluctuate through greater extremes. This, of course, assumes that the average sizes nre resultant from the rates of growth. In support of such n theory no evidence as to the seasonal changes in temperature in the North Pacific is avaliable to the writer, while the question of food in the case of n carnivorous fish is replete with difficulty. It may he pointed out, however, that the seasonal variation in the catch per skate wonld argue for a difference in the nctivity of the halibut, rather than a lack of food alone.

Unfortuunately there are no data at hand to show the fluctuations in temperature in any portion of the fishing-grounds, nor are there sufficient to indicate a lesser change in the catch per skate on the deeper banks than on the shoal. The correlation of the average size with the rate of growth is still to he accomplished, nithough partinlly indicated. When these things have been investigated it may he possihle to discuss the bearings and meaning of the facts presented in this paper with more assurance.

The intense fishery has, it is evident, made its influence felt throughout the whole hiological appearance of the species, and in doing so it has rendered precarious the future of the banks, particularly the older or longer known. The numbers still found on them is so small, nnd the percentage of mature fish in this population has fallen so low, that it appears luminent that the halibut in the Pacific will drop to a minor position among the food-fishes. It may recede northward as it did from the shores of Massachusetts, and from the coast of England, until it exists only in the more remote and difficult to reach of the banks. It is very difficult to see wherein more proof than is at hand may be adduced to emphasize this tendency, save the final one of the catastrophe of commercial extinction itself.

The rate of decrease shown, over 70 per cent. for each decade, is surprisingly large. Yet it must be remembered that the constant shifting to new banks has staved off n portion of the effects of impov[illegible]ment. This extension is, in its way, a measure of depletion. Just as a mine may he exhausted and its owners reduced to working over the discarded low-grade ore, so may the halibut banks. The progress from Cape Flattery to Hecate Strait, and from there to Yakutat and beyond, has been at a constantly accelerated rate as the total catch has grown from year to year. When the end will be reached, perhaps in the southern Bering Sea, perhaps on the Siberian Coast, is, of course, difficult to forecast. In the meantime the expenses of long voyages are gradually growing, and the necessity for vessels of large steaming radius is becoming greater, until it is a question whether the finni reserves of halibut shall he exploited hy vessels from our coasts. When expansion is at an end, as will inevitnbly he, the vessels must return to fishing on the older banks, which will then he depleted beyond their present condition unless

measures are taken to allow them to recuperate. They cannot support the fishery now existent, it is very plain, or anything comparable with it.

There are many reasons why this depletion does not evince itself in the prosperity of the fishing business in direct proportion. The rising prices demanded of the consumer and the extension to new banks require no comment as to their effects. More important than these, however, is the fact that the time and effort required to obtain the fish is only a portion of that necessary to carry the fish from the ocean to the consumer, and a seemingly overwhelming increase in the fishing-time of the boats is but a moderate increase in the total. The length of the voyage, we shall see, does not increase in the same proportion as the actual fishing-time, and the length of the voyage is but a part of the whole journey over ocean and land. In fact, it is but just to assume that there has been a heightening of the efficiency in transportation during the development of the fishing industry. In other words, the increased expense of obtaining the fish is distributed between that of transporting and selling, and is felt correspondingly less. It is evident, therefore, that an automatic abatement of the fishery in direct proportion to the rate of depletion is far from what is to be expected, and those who rest content in the belief that it will not pay commercially to deplete the banks beyond the limit of recuperation are on unsafe grounds.

Although a prophecy of the immediate commencement of a decline in the total yield would be out of place, the situation appears sufficiently serious to warrant the taking of immediate steps for conservation. The contemplation of experiments in hatching the halibut, however, must lead simply to ill-founded optimism on the part of the fishermen. The hatching of cod and plaice has been carried on by several Governments with results which are local and limited, and have been disputed. These species are much smaller, more easily handled, come to maturity at a smaller size, and the near-ripe fish are obtainable in greater numbers than is the case with the halibut. The ova of the latter are not found on the surface, and even with the spawning fish in breeding-ponds it would be difficult to obtain the fertilized eggs, although there is no doubt that they could be obtained. In the face of the wholesale reduction of the numbers of halibut on the banks, the establishment of hatcheries cannot be regarded as anything but exceedingly expensive experimental work. Nothing could be known as to its results for many years, unlikely as they are to be of value, and those years might mean the ruin of the industry if action were delayed pending the arrival at a conclusion. It is, therefore, necessary to regard the suggestion of such a remedy as of purely theoretical value, which might do great harm by misleading those with the interest of the fishery at heart.

It is not the purpose here to discuss the steps which could be taken, but several facts vital to their formulation have been brought out in the present paper. The exhausted condition of the southern banks, with the exception of those off the coast of Oregon, has been shown. It must be borne in mind that the vital need of these is protection during that portion of the year when they are yielding their largest proportion of small and immature fish. That the main fishery has shifted to a position farther north is also evident, and there should be no great obstacle to the application of adequate measures to the older banks. That protection to a small area would have no effect on the whole is equally obvious, so that whatever is done must be applied to the whole of the depleted portion. The effect of close seasons in various months may be judged from the comparative statistics of yield which are hereafter given, the value of such closures being in direct proportion to the activity of the fishery at the time they are put in force.

III. NATURE OF THE LOG DATA EMPLOYED.

From the mass of data obtained from ships' logs it was thought best to select that obtained from five vessels of similar type. These were of steel construction, steaming approximately ten knots per hour, and operating from the same port in British Columbia. They were vessels which had long records in the halibut fishery, had been ably commanded and similarly provisioned, so that there is every probability that the data obtained are homogeneous. They are designated as vessels A, B, C, D, and E throughout the present work.

The methods employed in fishing on these steamers have been ably, and more authoritatively, described by Captain H. B. Joyce,* and it will suffice here to give very briefly the necessary facts for the proper understanding of the data. Recent years have seen the introduction of the

* In United States Bureau of Fisheries Document No. 763, page 6. Washington, 1912.

"long-line" boats, or those which fish over the side—not from dories; but these vessels employ different units of gear than do the dory vessels, and their results are not comparable, hence they are omitted from consideration in the present description.

The steamers usually carry twelve dories, sometimes ten, each manned by two men. These small boats are set in a long line a quarter to half a mile apart along the edge of the bank, and then run their long "ground-lines" parallel to each other across the bank, or area over which the captain has given them instructions to fish. The ground-lines are composed of bundles of gear called skates, usually from two to four of them being set by a dory at one time, attached in a single long piece and buoyed at either end, where there are also anchors to hold the lines in place. These skates are at present composed of eight lines of 50 fathoms each, with hooks set about thirty-two to the line. At the inception of the present records, in 1902, the skate on the vessels which are here considered consisted of ten lines, as stated by Captain Freeman,* but in recent years, since 1909, when deep-water fishing began, eight lines have been used. Since the short skate is often as effective as the long, especially on narrow banks, it has been judged undesirable to modify the data directly in proportion, hence no allowance has been made. Usually two sets or trials are made in a day, occasionally one or three. On the map on page 124 there is plotted in about 51° 30′ latitude and 130° 45′ longitude, the space covered by such a trial or "set," in order to graphically illustrate the great extent of territory. The line run daily by a single vessel is about forty-eight miles in length, with more than 25,000 hooks.

If such a set is not successful in obtaining a paying amount of fish, the ground is abandoned and a set made in a different place. The great desire is to find what is called a "pocket" or "school" of fish, usually composed of medium or small fish in considerable numbers. Some of the captains shift ground constantly in their search for good pockets, others are content with obtaining a paying quantity of fish. A pocket does not last very long after discovery, although large cargoes are caught.

At first the fishermen were paid by the fish, the two in each dory according to the number their boat brought in, and as a consequence the fish were carefully counted. This had certain advantages, as the captains were able to tell in which part of the area covered by the set the fish were most abundant, and thus judge where it was best to work the next time. Therefore, when payment by the fish was discontinued and the men received "share and share alike," it continued to be the custom to record the number of fish, and is yet among the dory-vessel officers. At the same time, it has constantly been the habit of the captains to estimate the weight of fish caught at each set or on each day. All this information was set down in the logs, as a rule one or more features of it being neglected, according to the ideas of the mate or the captain as to what was necessary. The recorded data is treated in this paper.

On page 121 is given a reproduction of a page from one of the pilot-house logs, and on page 103 an illustration of the data taken from the records of a voyage. As to the accuracy of these data the writer has satisfied himself, knowing that they are as close as the fishermen are able to give them—fully as carefully noted as are the statistics of fish landed usually given in governmental records. The errors found have apparently been constant in their extent throughout, not decreasing or increasing in any special way, and no hesitation should be experienced in accepting their value for the purposes for which they are used in the text. The accuracy of the estimated weights has been discussed on page 83, where the methods are given by which such estimates are made.

In compiling and computing, the adding-machine has been used wherever possible, and the slide-rule has been employed throughout. As a result of the use of the latter, the figures were never carried to decimal points beyond those which were necessary.

IV. STATEMENT OF PURPOSE AND OUTLINE OF PAPER.

It will be sought to throw light on the following things:—

(1.) The fact of depletion, which will be evident throughout:

(2.) The rate of impoverishment of the banks:

(3.) The biology of the species, and the effects on it of overfishing.

* In a letter dated June 18th, 1910: "The length of the skate now used on the halibut-boats has been reduced from ten lines to eight lines of 50 fathoms each, or from a former length of 500 fathoms to 400. This change took place on the steamers about seven years ago."

Since it would be difficult to follow the above order, for almost all the data have some bearing on each phase, the following sequence has been adopted in treatment:—

(1.) The shift of the fishing-grounds:
(2.) The length of the voyages:
(3.) The time spent in fishing, as compared with the other parts of the voyage:
(4.) Yield:
  (*a.*) Weight caught per skate and per cargo:
  (*b.*) Number caught per skate and per cargo:
(5.) Sizes of fish obtained, fluctuations in:
(6.) Variations in average size of fish from different banks:
(7.) Relative productivity of different areas.

The summary will be found under the heading "VI." on page 107, and the discussion of the general bearing of the facts ascertained under "II." on page 68. Wherever possible the tables with detailed data have been placed at the close of the report, and those derived from them included in the text.

V. PRESENTATION OF RECORDS.

(1.) THE SHIFT OF THE FISHING-GROUNDS.

The utilization of new banks and the partial abandonment of the old is one of the first evidences of impoverishment. It does not mean in itself the rapid exhaustion of the supply, but assuredly does indicate the fact that the process is under way. If it takes place soon after the beginning of the fishery, and while the fishing fleet is yet small, it is fair to presume that the depletion is rapid. Whatever evidence is available in the log data has therefore been considered, with additional notes from other sources.

The five vessels under consideration sailed from British Columbian ports, and in consequence the banks to the south were exploited by them first, being largely abandoned only when the fishing became unprofitable. It is possible to trace the change which took place either through the depths fished in, or by plotting the fishing records on charts for the various years. It may also be seen in the data showing the yield, as will be pointed out, a temporary increase being evident, for example, in 1910 and 1911 in the weight caught per skate, due to the use of the North Island and Alaskan banks. It should be recognized, however, that the records of these five vessels are not identical by any means with those of the whole fleet, for the most active use of the banks off the coast of Alaska and of those in the inland straits was carried on by other vessels. In fact, the records here presented show the tendencies in a portion only of the total area.

In Table 1 are given the records available as to the depths in which fishing was done. It will be noticed that an abrupt increase is to be found in 1910; also the winter months seem to be characterized by fishing in somewhat deeper water. The change in the depths between the early and later records is well shown in Table 2, which is a summation of Table 1. The averages for 1907 and 1908 are in every case lower than those for 1911 and 1912. The seasonal change in 1911 and 1912 is evident, but in the earlier years its extent is not as clear as is desirable. In Table 3 the yearly averages for 1909, 1910, and 1911 are shown, although 1910 is incomplete, and the abrupt change seems evident. The records for March and April are comparable throughout a series of years, and are presented in Table 4. It shows in similar fashion the increase in 1910. This is due to the inclusion of records from off North Island, marking a change to deeper banks in general, although not the complete abandonment of the old banks.

The reason for the existence of fishing on the older banks when they are apparently partly depleted is seen in the great seasonal variation in the yield obtained. It is evident from almost all the data presented that during the winter months the yield falls very greatly, but rises to its maximum in summer, during June and July. It is during these best months that it is possible to do profitable fishing on these banks, and that fact keeps a certain number of vessels on the impoverished areas. Notwithstanding this, it is common knowledge that even during the best season it now pays to go to the Far North.

The number of records from various depths may be shown in Table 5, constructed only from those records having, in addition, the average weight of the fish caught, and hence somewhat

limited in number. This illustrates the change in the banks particularly, because all the records under 75 fathoms are from the old banks—that is, those fished previously to the year 1910. In 1913, for instance, two modes may be seen, representing the old and the new banks. It is not meant to imply by this statement that no fishing beyond this depth was carried on previously to 1910, or that no fishing was done on the banks here called new. It is simply meant that a clear division has been made in the present case, representing the change that took place more gradually in point of fact.

On the maps shown on pages 122-125 may be seen the plotted fishing records for two periods, one before the change in banks and the other after. In constructing these maps, the fishing which was done in Alaska was omitted from consideration. The extent of this, as far as the vessels here considered are concerned, may be judged from the figures given in Table 6, showing the distribution of the voyages according to the locality of the catch. The maps show that the banks off the outer coast of the Queen Charlotte Islands were not exploited in the early years of the fishery, but about 1910 and 1911 they were very extensively resorted to. By comparing Table 6 it may be seen that this change was accompanied by the use of the Alaskan banks. However, the near-by Alaskan banks were soon depleted, being already partially exhausted by other vessels, and it became necessary to go great distances for banks better than those off the coast of British Columbia. It is common knowledge that in the last few years the southern banks have been so completely impoverished that a good proportion of the voyages are to the far-distant northern banks.

Proof of this condition may be adduced from what statistics are available for the Alaskan fisheries. From the reports of the United States Commissioner of Fisheries for the various years, the following statistical abstract may be taken, showing in pounds the total quantity landed in Alaska each year:—

	Lb.
1907	4,492,118
1908	5,692,000
1909	5,234,924
1910	21,630,289
1911	17,315,571
1912	16,896,743
1913	13,687,784
1914	14,807,797

These figures illustrate the extension of the main fishery from the southern banks into the Alaskan in 1910, although, of course, if figures were available for the place of capture of catches landed in Seattle, they would doubtless show the same change.

The change in Alaskan fisheries may also be judged by comparing the yearly reports of the United States Agents in Alaska, who have accompanied their statistical summaries with remarks on the condition of the fisheries. The use of the banks off South-eastern Alaska, the exhaustion of these, and the necessity for larger and better-found boats for the more distant northerly (or rather north-westerly) banks are all chronicled in turn. As the reports cannot here be quoted at length, the following references may be given for those interested. They are all contained in the reports of the United States Commissioner of Fisheries, or in the appendices thereto under the heading of "Bureau of Fishery Documents" for the given years.

Rathbun, Richard. Report for 1888, pages XLI.-CVII. 1892.
Alexander, A. B. Report for 1904, pages 121-162. 1904.
Cobb, J. N. Bureau of Fisheries Document No. 603. 1906.
Marsh and Cobb. Bureau of Fisheries Document No. 632. 1908.
Chamberlain and Cobb. Bureau of Fisheries Document No. 766. 1912.
Chamberlain and Bower. Bureau of Fisheries Document No. 780. 1913.
Bower and Fassett. Bureau of Fisheries Document No. 797. 1914.

As bearing out these reports, and substantiating the fact that vessels now go as far as Yakutat and beyond for the greater part of the supply of halibut, the statistical bulletins issued monthly by the United States Bureau of Fisheries during a part of 1915 and 1916 may be quoted.

Halibut landed at Seattle.

	Lb.
October, 1915—	
From Flattery Bank (3 trips)	1,930
„ West Coast of Vancouver Island (3 trips)	64,000
„ Goose Island Banks (2 trips)	50,000
„ Hecate Strait (16 trips)	479,000
„ Yakutat Bay (7 trips)	1,049,862
November, 1915—	
From West Coast of Vancouver Island (10 trips)	321,000
„ Hecate Strait (3 trips)	21,000
„ Forrester Island (1 trip)	12,000
„ Yakutat Bay (16 trips)	1,958,527
January, 1916—	
From Coronation Island	80,000
„ Yakutat	843,055
February, 1916—	
From West Coast of Vancouver Island (1 trip)	38,000
„ Coronation Island (1 trip)	15,000
„ Yakutat Bay (5 trips)	653,931
March, 1916—	
From Flattery Banks (8 trips)	63,709
„ West Coast of Vancouver Island (1 trip)	7,000
„ Hecate Strait (2 trips)	113,003
„ Coronation Island (8 trips)	141,003
„ Yakutat Bay (10 trips)	222,404
„ Portlock Bank (2 trips)	268,000

The positions of banks not shown in the map on page 122 are:—

Flattery Bank: At the entrance of the Strait of Juan de Fuca.

Yakutat Bay: Latitude, 59° 35′ N.; longitude, 140° W. Distant 1,025 miles from Seattle.

Forrester Island: Near the Canadian Boundary in South-eastern Alaska.

Coronation Island: Latitude, 55° 50′ N.; longitude, 134° 10′ W. In South-eastern Alaska.

Portlock Bank: Latitude, 58° 20′ N.; longitude, 150° W. Near Kodiak Island, distant 1,300 miles from Seattle via Cross Sound.

It should be borne in mind, however, that the sharp classification of voyages under the heads of single banks is not as a rule possible save in an approximate way, and that these monthly lists undoubtedly present simply the localities from which the greater part of the catches came. It is probable that under the head of Yakutat are included fish from banks as far or farther than Cape Cleare.

The changes in the location of the fishery may be summarized briefly. In 1888 the fishery commenced, and grew rapidly, most of the fish coming from the Cape Flattery Banks, but about 1895 the banks in Hecate Strait were being exploited. In the early years of the first decade of this century the South-eastern Alaskan and British Columbian banks in more or less sheltered localities were being utilized, resulting about 1910 in their impoverishment. The fishermen then moved to deeper waters in more exposed situations on the outer coasts, fishing in more than 100 fathoms coming into vogue. Those banks lying off the coast of Alaska as far as Icy Strait were in great part depleted by 1913 or before, and at the present date, 1916, the greater part of the catch comes from Yakutat and beyond. Mention should be made of the banks off the coast of Oregon which have been recently developed by the United States Fish Commission. This constant movement was not made because richer banks were being discovered, but because the yield from the older banks for the gear employed steadily fell the longer they were fished. It is unfortunate that fishing is still carried on best within these old areas during that season of the year when the young fish are to be caught in greatest abundance. In brief, the history of the fishery is that of a nomadic fleet, stripping the grounds as it goes, but leaving behind a sufficient number of vessels to prevent recuperation.

*Table 1.—Average Depths in which Fishing has been carried on.**

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.
1902	56-7	...	...	...	...	...	...	...	...	47-9	...	40-3
1903	32-8	...	...	...	...	...	...	...	...	...	...	...
1904	...	...	...	...	...	...	...	...	...	52-3	34-5	...
1905	...	...	18-2	46-4	42-4	...	...	...	...	...	...	...
1906	...	31-2	39-5	45-1	28-8	49 8	44-5	51-4	48-5	30-5	49-9	24-10
1907	37-5	38-7	51-6	28-11	...	47-3	...	29-2	...	60-1	62-4	50-2
1908	29-4	40-1	38-5	33-3	43-3	36-3	37-7	34-4	56-5	...	17-5	27-3
1909	50-11	40-10	40-23	21-15	20-12	43-9	41-4	58-2	29-3	30-1	21-7	54-6
1910	78-10	106-19	140-15	94-15	22-9	54-2	75-2	51-1	...	...	...	110-5
1911	100-4	100-6	108-12	50-11	36-17	78-9	74-12	46-21	48-16	74-18	76-9	94-9
1912	120-6	188-10	79-8	93-16	98-16	98-10	70-5	42-3	54-14	50-7	46-4	...
1913	...	...	98-8	65-15	73-16	48-6	72-13	105-5	79-10	83-8	...	...
1914	...	104-4	82-2	58-2	85-12	99-5	77-8	67-5	...	...	...	135-1
1915	...	169-3	97-1	125-1	66-1	24-1	...	...	...	...	...	...

* Number of records on which each average is based is given after the hyphen in each case.

Table 2.—Seasonal Variation in Depths at which Fishing is done.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.
1911 and 1912	110.0	144.0	93.5	71.5	67.2	88.0	72.0	44.1	51.0	65.0	61.1	93.6
Ave. in group		115.8			75.6			55.7			73.2	
1907 and 1908		40.3			37.4			39.0			43.2	

Table 3.—Annual Averages of Depths fished in.

	Fathoms.
1909	
1910	37.2
1911	81.1
	73.7

Table 4.—Averages for March and April of Depths in which Fishing was done.

	Fathoms.
1905	
1906	32.0
1907	42.0
1908	39.5
1909	35.5
1910	30.5
1911	116.8
1912	78.9
1913	86.2
1914	81.7
1915	69.5
	111.0

Table 5.—Number of Records given by Depth for each Year for which Average Weights were available.

Depths.	15 and 20	25 and 30	35 and 40	45 and 50	55 and 60	65 and 70	75 and 80	85 and 90	95 and 100	105 and 110	115 and 120	125 and 130
1902..	...	2	3	3	6	1	...	...	...	...	...	...
1904..	1	2	...	2	2	...	...	...	...	...	...	...
1906..	7	4	7	6	3	2	...	...	...	...	...	...
1907..	...	...	1	...	...	...	...	...	...	...	...	...
1908..	2	1	1	...	...	...	...	...	...	...	...	...
1909..	14	7	6	5	4	1	1	...	...	...	...	...
1910..	6	...	...	...	...	1	...	1	1	2	3	...
1911..	2	6	14	[illegible]	4	4	3	1	13	8	1	2
1912..	...	2	2	10	6	...	2	5	5	2	3	...
1913..	4	1	1	8	4	...	...	4	9	11	5	1
1914..	...	...	...	1	1	2	2	...	1	3	1	...

Table 6.—Number of Voyages according to Locality in which the Catch was obtained for the Five Vessels used in the Present Paper.

Year.	Off B.C. Banks.	At and South of Cape Ommaney.	At and South of Icy Strait.	At and South of Yakutat.
1901	8	...	...	...
1902	20	...	...	...
1903	40	...	...	...
1904	43	...	...	...
1905	28	...	...	...
1906	57	1	...	...
1907	85	8	...	...
1908	101½	2½	...	...
1909	81	3	...	...
1910	69	10	1	...
1911	57½	35	3½	...
1912	39	4	2	...
1913	34½	1½	2	6
1914	33	...	...	...
1915	16	...	...	...
Totals	712½	74	8½	6

Grand total of voyages examined, 800.

The figures in Table 2 illustrate a phase of this change in fishing-banks which is very illuminating. It will be noticed that 1911 and 1912 represent a period when both old and new banks were in use; in other words, shoal, inshore, and deep, offshore banks were available, whereas in 1907 and 1908 for all practical purposes the latter were unknown. The depths for 1911 and 1912 show a sharp seasonal fluctuation, which is not as evident in 1907 and 1908. The cause for this will in all probability be found in the relative fluctuations in temperature and the effect of this on the activity and metabolism of the fish. Deeper, outside banks fluctuate less than shoal, inshore banks in seasonal temperatures, and hence the latter are much warmer in summer, thereby presumably rendering the halibut more inclined to take the bait. The offshore, deeper waters, on the other hand, are supposed to be more constant in temperature, and are available for fishing when the colder weather has rendered the shallower banks unprofitable. It would be highly desirable to prove this by observation on the banks of the Pacific Ocean, rather than by relying on comparison with the results found in the North Sea.*

* A few of the references available which deal with the relation of temperature to the rate of growth, activity, and metabolism of fish are here given:—
Fulton, T. W. Rate of Growth of Sea-fishes. In Twentieth Annual Report of the Fishery Board for Scotland, being for the Year 1901. Part III., pages 326-439 (see page 335). Shows the correspondence of rate of growth with the fluctuations in temperature. *(Concluded on p. 78.)*

(2.) LENGTHS OF VOYAGES.

The most complete portion of the data available is that dealing with the length of the voyages. In a way it is also the most satisfactory index of the depletion of the banks, because it represents very directly what is of most immediate concern to the dealers, the increasing difficulty of obtaining a yield. It should be considered, of course, in connection with the cargoes obtained.

The conditions on the Pacific Coast lend themselves to the obtaining of uniform data in an admirable fashion. The voyage to and from the banks is not subject to any delay other than that of going successively farther afield. The banks lie comparatively close along shore, and the powered vessels universally used traverse the splendid inland passages characteristic of British Columbia and South-eastern Alaska. Thus it is that the voyages are made almost on a schedule to and fro, the only considerable delays being met with on the fishing-banks. In the days when a catch could be obtained in protected waters, the voyages were made with clock-like regularity as compared with those made in other seas. To illustrate this, the dates of sailing and arrival of vessel B for the early part of 1906 may be given (Table 7).

Table 7.—Voyages of Vessel B in 1906 during the Period January to May.

Voyage.	Sailed.	Arrived.	Length.
1	Dec. 30	Jan. 9	10 days 5 hours.
2	Jan. 11	„ 23	12 „ 16 „
3	„ 25	Feb. 6	12 „ 15 „
4	Feb. 0	„ 17	8 „ 14 „
5	„ 20	March 1	9 „ 8 „
6	March 3	„ 12	9 „ 8 „
7	„ 15	„ 23	8 „ 15 „
8	„ 25	April 2	8 „ 15 „
9	April 4	„ 15	11 „ 14 „
10	„ 18	„ 26	8 „ 11 „
11	„ 28	May 3	5 „ 6 „
12	May 4	„ 8	4 „ 15 „
13	„ 10	„ 15	5 „ 14 „
14	„ 16	„ 20	4 „ 5 „

The first source of delay to come to mind, in considering the length of a voyage, is the weather, which varies from year to year and month to month, but which may simply be ignored in forming conclusions based on averages. It does not, as is shown above, affect to any appreciable extent the trips to the banks, or from them, but bad weather does result in a cessation of fishing and forces the vessels to lie idle in the many harbours adjacent to the banks. Other factors tending to lengthen the voyages are resultant directly from the depletion of the banks—namely, the constantly decreasing yield for the labour, and the consequent necessity for search or prospecting, and the use of banks farther afield. Any constant tendency to increase the length of the voyages must therefore be assigned to the effects of depletion, especially as the same vessels are used throughout.

Fulton, T. W. The Rate of Growth of Fishes. In Twenty-second Annual Report of the Fishery Board for Scotland, being for the Year 1903. Part III., pages 141-241, Plates VI.-XII. (*see* page 142 and page 159).

Sund, Oscar. Undersökelser over Brislingen i Norske farvand. In Aarsberetning vedkommend Norges Fiserier, 1910. Bergen, 1911. Shows the correspondence between the fat contents of herring and the temperature.

The second paper by Fulton referred to above may be cited (page 170). From sufficiently extensive experiments with various fishes in aquaria he reaches the following conclusion: "It appears that the influence of temperature is active in modifying the rate of growth by acting directly upon the metabolism of the fish and also by affecting the rapidity of digestion. In very cold water the fishes give up feeding altogether, because the ferments upon which digestion depends do not act, or act very slowly, at low temperatures, and in fishes, as in other animals, appetite waits on digestion, and this is, on the other hand, correlated with the metabolism in the tissues. It has been shown by Krukenberg that the pepsine or analogous body in the stomach of fish acts as well at 20 C. as at 40 C., at which, among mammals, digestion is most active, and that the rapidity of its action is closely related to temperature; and Knauthe and Zuntz have shown that the same thing applies to the metabolism in fish, the vital activities being more active in the higher temperatnre, as shown by the excretion of carbonic-acid gas and other products of metabolism." Fulton kept fishes in tanks with very slightly different temperatures, and found marked differences in rate of growth. A sudden change of 7° C. served to kill some species immediately.

As a table compounded from data for a number of vessels would naturally be more satisfactory than that for a single one, it was decided to make use of those for all five vessels. The variation in the records for any single vessel would thus be counteracted. But since statistics for the individual vessels do not cover exactly the same time, such a table would be affected by any inherent difference in the speed of the ship or other minor factors. These were measured by a comparison of the data which covered the same dates. Thus the vessel A was taken as the standard; B had a half of its records on dates for which records for A were also available, and the sum of these records stood to each other as 43 to 40, the latter being those of A. The same was done for the other vessels, the other proportions being 61 to 60 for C to A, 16 to 15 for D to A, and 21 to 20 for E to A. None of these changes was considerable in extent, but they were made nevertheless. The unchanged records are in every case given in separate tables so that the work may be corroborated. The resultant figures represent simply the rate of depletion when those on different dates are compared, this rate being present in the data for each vessel and remaining unchanged because of the uniform alteration. The record used for each vessel in each month is the average of the length of the voyages made during that month. During the later years of the period covered, the length of a voyage grew to be such that but a single one was made in the month. The following table is the result of the compilation (Table 8), but the unaltered data are given at the end of the report (Table 57).

The average length of the voyages per year may be calculated from Table 8 for 1903 to 1914, inclusive, and are given in Table 9. It is evident that an increase began almost at the inception of the records. The voyages increased 2.1 times in length between 1904 and 1914; 1.96 times between 1903 and 1913; and about 1.5 times between 1909 and 1914, or 1908 and 1913. This is much within the true rate of depletion, because it does not consider the decreased sizes of the cargoes or the use of new banks, and that the time spent in passing outward and inward bound has not increased in due proportion to the remainder.

By comparing the monthly averages one with the other, it may be seen that the voyages are much longer during the winter months. The averages for each month for the period from 1903 to 1914, inclusive, are given in Table 10, showing that the voyages in January were 1.8 times as long as those in June. (*See* also Table 7.)

Table 8.—Average Number of Hours per Voyage.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1902	...	...	...	...	...	...	...	...	90	157	214	221
1903	288	254	204	120	164	155	145	108	135	222	279	218
1904	237	216	172	104	139	89	117	115	143	275	307	223
1905	223	245	283	162	168	156	153	151	177	217	343	206
1906	255	227	198	188	130	112	163	187	181	250	214	279
1907	339	305	297	219	192	154	169	191	212	250	258	351
1908	334	420	314	281	217	210	161	160	216	219	246	292
1909	318	306	272	197	142	174	161	250	217	333	344	362
1910	420	392	297	369	257	212	228	154	272	344	376	413
1911	514	356	288	297	268	259	250	288	301	332	390	384
1912	528	490	327	299	257	246	255	289	328	368	410	480
1913	350	372*	393	324	324	288	372	372	359	410	526	410
1914	444	409	359	309	246	262	291	327	355	569	504	426
1915	...	...	...	...	284	292	269	335	302	452	...	...

* Supplied by averaging the months to either side.

Table 9.—Annual Average of Hours per Voyage.

	Hours.
1903	191
1904	178
1905	207
1906	190
1907	245
1908	256

1909	256
1910	311
1911	328
1912	356
1913	375
1914	376

Table 10.—Average Number of Hours per Voyage for each Month, showing Seasonal Variation.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1904 to 1914 (inc.)	354	333	284	239	200	193	206	216	241	317	350	337

(3.) THE TIME SPENT IN FISHING, AS COMPARED WITH THE OTHER PARTS OF THE VOYAGE.

In studying the time spent in fishing, the days on which gear was run were regarded as fishing-time, and, expressed in hours, are given in Table 58 as averages for each month for the respective vessels. The latter are designated as in Table 57. As in the treatment of the length of the voyages, and following the same procedure, these data are corrected and combined to form Table 11.

The time spent in obtaining a certain amount of catch in various years should represent fairly the relative variation in abundance during those years, but it may not be as evident on first consideration why the length of the voyages should not do so, and in fact should vary widely. The voyage is, however, utilized in doing several things—namely, passing to and from the grounds, fishing, and in suspended operations during those times when bad weather prevents fishing. As has been indicated, the passage to and from the banks is not subject to the effect of the weather, being accomplished through the inland straits that traverse the coast. Hence the time thus consumed does not increase save in response to a necessity for travelling to more distant banks. That lost on account of bad weather is, however, lost during the time spent on the banks or in the adjacent harbours, and naturally forms a definite proportion of the total time thus spent when averages for a suitable period are concerned. As the time spent on the banks is dependent solely on the necessity of obtaining a cargo, all the good weather is utilized in fishing. Hence the time lost on account of bad weather is as definitely related to the spent in fishing as the climate is stable, and must increase in the same proportions.

In Table 12 in the last two columns are presented for the several years the average time spent per voyage on the fishing-banks, and the percentage that it forms of the average length of the voyages. It will be seen that between 1904 and 1914 the time increased two and three-quarter times, somewhat faster than did the average length of the voyages as indicated by the column of percentages. An examination of the four winter months and of the four summer months in the same table shows, however, that the time spent fishing in summer has increased with great rapidity, approximately four times between 1904 and 1914, while it has not increased thus in the winter. Although the actual hours per voyage have increased to twice, the percentage does not seem to have altered radically. It is evident in that case that a portion of the impoverishment of the banks would evince itself through a more rapid decrease in the yield per voyage. In Table 13 and on page 87 it is proved that the average weight of the winter cargo is decreasing much more rapidly than that of the summer. In this case it is obvious that the winter months have become increasingly unprofitable in comparison with the remainder of the year.

In accordance with what has been said concerning the time lost on account of bad weather, it may be seen that there is also an increase in the time spent otherwise than in fishing. In Table 13 the hours spent in fishing have been subtracted from the length of the voyages, considering the averages for the four summer and four winter months. This gives the time spent in passage to and from the banks, combined with that lost on account of bad weather. As little time is lost on account of bad weather in the summer months, it is possible to arrive at some measure of what is lost on account of increased bad weather during the winter, although the

time taken in finding the banks is perhaps increased during the winter, and cannot, unfortunately, be distinguished from the other. The resultant data is shown in column 4 of Table 13, and was obtained by subtracting the figures in the second column from those in the third. It will be noticed that the increase shown by this is almost the same as that of the fishing-time for the same months, the time for 1904 being to that for 1914 as 10 is to 18 in both cases. This is in accordance with the expectation as noted in the second paragraph of this section.

It is evident, in fact, that during the winter there is not a very great difference between the rate of increase of the length of the voyage, of the time spent in fishing, and of the time lost on account of bad weather. For the period from 1903 to 1908, inclusive, this lost time averaged 20.2 per cent. of the length of the voyages, and for the period from 1909 to 1914, 30.6 per cent. For the same periods the fishing-time was 43.5 and 48.4 per cent. respectively of the lengths of the voyages. These figures are, of course, approximate, but contrast sufficiently with those given for the summer. If a reason is sought for this, it is necessary to consider the steaming radius of the vessels, the preservation of the fish on the ice, and the market conditions. It is entirely probable that the fishing-time would be increased as much as possible to offset the decreased yield if such a course were possible or profitable.

There is every reason to believe that the length of time consumed in passage to and from the banks has increased greatly in recent years, as will be indicated in the section dealing with the shift in the fishing-grounds. This is perhaps more particularly true of the winter, as indicated on the charts, even as early as 1911 and 1912. The effect of this will be commented on later.

The distribution of time, considering the average for all the complete years in Table 11, shows that in the four summer months approximately 59.3 per cent. of the time was spent in fishing and 40.7 per cent. in reaching the banks. In the four winter months 30 per cent. of the total time for the voyage was spent on account of increased bad weather, 46 per cent. in fishing, and 24 per cent. in passage to and from the grounds. However, it is evident in Table 12 that the percentage of time spent fishing in summer is increasing rapidly, and if data for 1913 and 1915 are added, the average time spent fishing in summer rises to 62.6 per cent. of the total for the voyage. In Table 14 the average percentage of time spent in fishing each month has been calculated from data covering the years 1903 to 1912, inclusive. This serves to supplement the above tables.

To summarize, it is evident that the time per voyage is not an adequate measure of the depletion of the banks; nor is the fishing-time per voyage, calculated for the whole year. That for the summer is shown to be more nearly adequate. There is no reason, however, which would prevent the fishing-time, either in winter or summer, in conjunction with the yield expressed in the average cargoes, being considered as giving a correct measure. (*See* page 86.)

Table 11.—Average Number of Hours per Voyage spent in Fishing, by Months. Corrected for Vessel Variation.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1902	...	...	...	...	...	...	...	...	...	...	124	112
1903	122	109	118	27	82	68*	55	44	75	150	82	68
1904	109	101	90	46	62	46	54	66	66	106	112	109
1905	123	137	118	109	82	82	91*	101	102	164	123	82
1906	137	137	145	101	85	57	84	110	123	123	124	118
1907	117	129	129	147	85	95	85	86	120	125	97	126
1908	179	136	120	126	129	129	92	74	128	111	108	147
1909	161	173	179	113	95	91	93	124	144	191	182	219
1910	199	167	218	185	117	114	119	88	162	177	177	164
1911	142	156	185	190	156	155	164	189	175	185	181	172
1912	270	220	198	175	212	168	147	209	207	184	184	204
1913	...	...	298	234	206	204	264	204	200	219	166	232
1914	233	207	220	142	183	214	216	276	264	228	216	300
1915	336	312	288	312	276	216	216	223	240	264	...	...

* Supplied by averaging the adjacent months of the same year.

Table 12.—Comparison of Length of Voyage and Fishing-time per Voyage.

Year.	Nov., Dec., Jan., Feb.			May, June, July, Aug.			Whole Year.	
	Fishing-hours per Voyage.	Total Hours per Voyage.	Per Cent. spent Fishing.	Fishing-hours.	Total for Voyage.	Per Cent. spent Fishing.	Fishing-hours.	Per Cent. spent Fishing.
1903	95	260	36.5	62	143	43.4	83	43.5
1904	108	246	43.9	57	115	49.6	81	45.5
1905	116	254	45.7	80	157	50.7	110	53.2
1906	129	244	52.9	84	148	56.7	112	50.3
1907	117	313	37.4	88	177	49.7	112	45.7
1908	143	323	44.3	104	187	55.6	123	48.0
1909	184	333	55.3	101	182	55.5	147	57.5
1910	177	400	44.3	110	213	51.6	157	50.5
1911	163	411	39.7	166	269	61.7	171	52.1
1912	235	477	49.2	184	262	70.1	203	57.1
1913	...	...	...	235	339	69.3	...	...
1914	239	446	53.6	222	282	78.8	225	59.9
1915	...	...	...	233	295	79.0	...	...

Table 13.—Time spent in reaching Banks and lost through Bad Weather.

Year.	May, June, July, Aug.	Nov., Dec., Jan., Feb.	Increase in Winter.
1903	81	175	94
1904	58	138	80
1905	68	138	70
1906	64	115	51
1907	89	196	107
1908	83	180	77
1909	1	149	68
1910	3	223	120
1911	3	248	145
1912	78	242	164
1913	104	...	...
1914	60	...	...
1915	62	...	...

Table 14.—Comparison of Length of Voyages and Time spent Fishing for the Period from 1903 to 1912 (inclusive).

	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Length of voyages	346	321	265	224	193	177	181	189	218	282	317	321
Fishing-time	156	146	150	122	110	100	98	109	130	152	137	147
Per cent. spent fishing	45.0	45.5	56.6	54.5	57.0	56.5	54.0	57.7	59.6	54.0	43.2	45.8

(4.) YIELD.

In analysing the cause of the increase in the length of the voyage and of the greater time taken in fishing, the first factor to be met with is naturally the yield which is obtained for the work. As has been previously explained, it was possible to obtain data on this subject by

calculating the average yield per skate of gear fished, and by making comparisons between successive years. In the logs the yield is given in either or both of two ways, in actual counts of the number or in estimated weight of fish caught. The weight, naturally, is less accurate in separate instances, but there is no reason why it should not be sufficiently accurate when a great many records are utilized. In order to test this, the logs were carefully examined for voyages for which the total estimate was given or where it was possible to find the estimated weight for all the catches, and thus to arrive at an estimated weight for the cargo. These were compiled and compared with the actual weights for which the fishermen were paid. Considering that there is usually a certain amount culled from each cargo and not reckoned in the final tally, the estimates are fairly close. Different periods do not show any change in manner of variation of the estimates, so it is plain that the data are acceptable. It should be mentioned that the "small" fish, for which the men were paid but a portion of the price of large fish, are included in the tally totals. The following table (15) consists of records of cargo weights taken from the logs as they came in order of their dates, hence is without prejudice:—

Table 15.—Showing Correspondence of Estimated and Actual Weights of Cargoes.

1906, 1907, and 1908.		1913 and 1914.	
Estimated Weight.	Actual Weight.	Estimated Weight.	Actual Weight.
115,000	101,000	80,000	87,884
135,000	137,000	220,000	194,100
80,000	63,890	248,000	248,500
188,000	161,925	183,000	178,510
190,000	177,610	90,500	86,980
91,000	78,470	62,000	61,000
115,000	113,050	59,500	58,000
75,000	70,845	60,000	55,000
143,000	142,180	78,000	74,770
214,000	178,215	142,000	144,310
110,000	109,000	116,000	122,120
75,000	83,740	119,000	122,800
91,000	102,550	75,500	68,000
130,000	124,000	135,000	140,640
54,000	51,945	...	...
70,000	61,520	...	...
1,886,000	1,763,540	1,608,500	1,642,074

As is shown in the table, the variation of the estimates from the actual weights is not large, and in no case so distinct as to invalidate the comparisons made with their aid, in which the decrease in yield per skate is shown to be as high as 75 per cent. in ten years. The degree of accuracy attained is due to the methods used by the fishermen in judging the weights of the catches. The fish are, on dory vessels, thrown into "checkers" on the deck as they are taken from the dories. These "checkers" are pens formed by partitions, placed to check the sliding of the fish around the deck as the vessel rolls—hence the name "checkers." The fishermen soon become cognizant of the number of pounds it requires to fill these, and thus are able to arrive at the close estimates noted in their logs. The fish-hold is similarly divided into sections called pens, and the fishermen who place the fish on the ice are able to tell very closely what weight of fish is in each of these. It is, from these two sources, possible to form a fairly accurate judgment, for it is not in reality estimating, but rather measuring somewhat crudely.

(4A.) WEIGHT CAUGHT PER UNIT OF GEAR AND PER CARGO.

The rate of decrease in weight obtained per skate may be reckoned from Table 17, which is derived from Table 16. (*See* Table 59 for details.) As shown by the column giving the annual averages, the yield in 1907 was 2.13 times what it was in 1912, a period of five years. This, multiplied by 2, gives 4.26 times for a period of ten years. The other two columns of the same table show the weight per skate in 1907 to be 3.25 and 2.87 times, respectively, what it was in

1914, seven years later. This, averaged, would indicate for a period of ten years an initial weight of fish 4.37 times the final. As would be expected, these two results for a period of ten years slightly exceed the figures obtained by considering the time spent fishing in summer, which was between 3.5 times and 4. One might easily explain this discrepancy by considering the smaller cargoes required in the later years; and the decrease in the length of the skate, which if applied in proportion would reduce 4.26 times to 3.40 (*see* page 72). It is evident, then, that there is in the yield per skate a true index of the productivity of the banks in general, when the use of new banks and all the modifying factors are included without being discounted.

The amount per unit of gear was much less in winter than in summer, as shown in Tables 18 and 19, being in January about half of what it was in July. The significance of this will be discussed later, although it is, of course, evident that it is of great importance in considering a close season.

*Table 16.—Weight of Halibut caught per Skate.**

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.
1902	...	...	...	...	...	...	...	...	1,307	1,000	...	...
1903	...	...	...	...	...	...	...	...	...	...	...	...
1904	...	...	...	...	...	...	...	...	...	293	321	...
1905	...	...	...	...	...	...	...	...	...	...	...	...
1906	...	...	...	...	395	973	139	438	649	201	650	453
1907	310	460	483	582	507	516	473	430	316	609	454	324
1908	270	299	318	308	234	486	710	454	588	210	412	257
1909	189	227	229	538	485	334	...	456	211	161	192	...
1910	500	344	246	619	492	...	...	556	500	166	...	...
1911	562	354	200	276	537	627	316	325	322	241	226	210
1912	145	138	200	223	244	314	289	367	220	165	130	122
1913	...	...	117	131	201	205	78	69	171	99	84	115
1914	95	169	126	166	257	131	136	125	120	69	97	...
1915	...	...	...	...	...	142	138	128	111	...	...	...

* These averages are based on the individual catches, not on the averages for each vessel.

Table 17.—Weight caught per Skate, showing Averages for such Periods as are best compared. In Table 16.

Year.	Whole Year.	Jan. to May (Inc.).	May, Aug., Sept., Oct.
1906	...	...	421
1907	455*	468	466
1908	379	286	372
1909	...	334	328
1910	...	440	429
1911	350	386	356
1912	213	190	249
1913	...	...	135
1914	...	163	143

* Data for July supplied by averaging June and August.

Table 18.—Seasonal Fluctuation in Weight caught per Skate, by Months. From Table 16.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.
1907, 1908 1912	242	299	334	371	328	439	491	417	375	328	332	234

* December lacking.

Table 19.—Seasonal Fluctuation of Weight caught per Skate. Contrasting Averages for Six-month Periods.

Year.	Winter.	Summer.
1907	440	471
1908	204	463
1912	150	276
1914*	106	156

To compare with the yield per skate as shown by the total catch on the fishing-grounds, the yield for a limited area was compiled, thus obviating the result of the use of new banks. (*See* Table 60 for detailed records.) The banks found in Hecate Strait (Areas II. and III.) and those off Goose Island (Area I.) were combined, utilizing the same methods as were employed in equalizing data from different vessels (*see* page 79). In general, the same results were obtained as for the more complete records, showing the sharp seasonal variation and the constant decrease.

In combining the data, the comparative yield per skate was obtained for the three banks. This was done by utilizing those records which were simultaneous, the sums of such records giving what is presumed to be the nearest indication of the comparative yield. Thus the sums of records on common dates were:—

$$\frac{\text{Goose Island Banks (Area I.)}}{\text{Rose Spit-Bonilla Banks (Area II.)}} = \frac{4,415}{5,572}$$

$$\frac{\text{East Coast of Queen Charlottes (Area III.)}}{\text{Rose Spit-Bonilla Banks (Area II.)}} = \frac{8,040}{8,389}$$

According to these proportions, the yield of the Goose Island Banks should be to those of the East Coast of the Queen Charlottes as 2,480 is to 3,332. There are but ten records in common between these two areas, and these give the proportions of 2,480 to 3,332, not a variation of any importance. If we consider the yield of the Rose Spit-Bonilla Banks as a unit, the yield from Goose Island would be 0.79, and that from the East Coast of the Queen Charlottes 1.07. This relative productivity may be the result of the difference in size of the fish or the capacity of the bank to support fish, which is the same thing in the end, theoretically, the latter condition leading supposedly to a slower growth. In view of the depleted condition of the banks it is difficult to see how competition for food could effect the relative size very greatly.

Eliminating this difference in productivity by multiplying the yield from each by a factor derived from the proportions given above, the data given in Table 20 were obtained. The decrease is fully as evident as in Table 16, and the seasonal fluctuation is also. By comparing the months given under 1914 with the same months in 1907 and 1908 (*see* Table 20) and observing the rate of decrease, it is seen that the catch in the earlier years of a ten-year period would be respectively 4.4 and 4.77 times what it would be in the later, and by comparing 1907 and 1912 it would appear to be 4.71 times. (When modified in accordance with the decrease in length of skate, this would be 3.77 times.) It is evident that this rate of depletion is somewhat more rapid than the rate found when all the available records were used without correction for the different banks (4.26 to 4.37), but this would be expected. As was remarked on page 72, these banks were exploited until it paid to go farther to new banks, the old banks being fished on only when it paid to do so. We may consider, then, the difference between the rate of decrease for the whole fishery and that for the separate banks as a measure of the greater drain the latter are subject to on account of their position and characteristics.

It would appear that the rates of depletion as found in the several ways are consistent and substantially corroborate each other to such an extent that there cannot be any doubt as to their approximate correctness.

Table 20.—Weight of Halibut caught per Skate. Corrected for Variations in Bank Productivity.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.
1902	...	...	...	...	...	...	...	...	1,026	1,085	...	...
1903	...	...	...	...	...	...	...	...	...	...	...	...
1904	...	...	...	...	...	...	...	...	...	233	324	...
1905	...	...	...	...	333	...	...	...	...	...	...	...
1906	...	...	...	...	306	...	...	551	1,080	201	701	342
1907	258	413	486	531	[illegible]	483	*410	355	246	*343	439	322
1908	286	335	330	328	225	514	680	449	382	219	363	206
1909	212	302	230	504	493	419	...	...	245	53	198	...
1910	111	...	179	...	363	...	...	...	500	208	195	...
1911	...	375	168	247	428	...	405	283	326	230	96	154
1912	92	...	131	121	205	191	263	212	181	198	136	...
1913	...	...	110	181	138	...	76	...	188	76	85	92
1914	95	39	114	170	200	157	163	136	139	97	...	...

* Supplied by averaging the adjacent months.

Table 21.—A. Averages of the Years 1907 and 1908 of Table 20. B. Averages of the Years 1907, 1908, 1909, and 1914.

	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.
A	272	374	408	429	368	498	549	402	314	281	401	264
B	213	272	290	383	357	393	...	...	253	...	...	...

The weights of the cargoes landed are of primary importance to fishermen and dealers, and, taken in conjunction with the length of the voyages, indicate to them the condition of the fishery. Hence, although it must be understood that they do not give an adequate idea of the actual state of affairs, the data obtained concerning them are of considerable interest. (*See* Table 61 for the records unmodified for vessel differences.)

The constant decrease in the average weight of the cargoes is shown in Table 23, derived from Table 22, the data from the different vessels having been combined (page 87). The average for 1914 is seen to be slightly more than a half of that for 1905, but that for 1914 is not complete, lacking December, a month when the yield is lowest. Comparing the summer and winter months of Table 23, the decrease is seen to be less in the summer, due perhaps to the effect of the increased bad weather, or perhaps to the limitation of the voyage-length by the low steaming radius of the vessels.

It is interesting to see how far this rate of decrease of the cargoes will explain the discrepancy mentioned on page 83 between the decrease shown by the yield per skate and that shown by the time spent in fishing per voyage. Taking the years 1907 and 1914, and considering the averages of 1914 for the several classes of data as units, in terms of which the others may be expressed, we may construct the following table:—

Year.	Catch per Skate (Weight).	Fishing-time per Voyage.	Cargo.
1914	1.00	1.00	1.00
1907	3.48	0.50	1.80

It may be seen that the catch per skate, as indicating the abundance of fish, multiplied by the time spent in fishing per voyage, should indicate approximately the size of the cargo. This expectation for the cargo of 1907 would be about 1.75 times* that of 1914, whereas it is found to be, by the actual data, as above, 1.8 times. When it is considered that there are many other

* If the increased length of the skate were taken into consideration, this would be 1.89 times.

small factors entering into any such calculation, the agreement is satisfactory, and indicates the essential correctness of the date. The difference is not as great as would be expected to ensue from the longer time needed to handle a skate of gear in the deeper water utilized in later years.

Comparisons of other years for the same purpose as that above give slightly varying results, as would be expected. It was found that the cargo of 1911 should have been 1.3 times as large as that of 1908, instead of 1.1 times, as was actually the case. That for 1912 should have been 0.9 instead of 0.8, as was found in comparison with 1908. That for 1914 was 0.63 instead of 0.6. The results vary on each side of the expectation.

It should be noticed that the comparison of summer and winter yields in Table 24 shows that the yield for January and December is between approximately a third and a fourth of that for the best summer months. This is of considerable importance in the discussion of a close season.

Table 22.—Weight of Cargoes landed. From Corrected Data, based on Table 61.

Year.	Jan.	Feb.	March.	April.	May.	June.
1902	...	...	...	...	...	...
1903	83,875	140,520	100,112	146,862	...	...
1906	108,566	152,755	208,633	139,843	124,840	185,800
1907	132,800	182,167	133,150	127,325	122,400	175,500
1908	87,233	108,600	83,233	145,392	151,324	203,464
1909	43,382	63,276	105,232	158,258	127,206	122,463
1910	47,403	70,065	118,026	73,335	189,198	158,000
1911	79,492	114,305	138,575	148,230	162,647	221,407
1912	37,000	91,900	145,897	128,151	167,692	144,817
1913	...	...	...	87,884	132,428	219,473
1914	41,797	62,462	59,973	91,000	126,103	99,865
1915	...	...	...	...	...	86,945

Year.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1902	...	...	138,000	165,000	...	111,900
1903	...	151,100	120,739	90,705	78,947	128,935
1906	152,400	177,695	142,618	101,675	113,288*	124,900
1907	127,640	167,633	104,150	190,000	142,225	82,100
1908	154,670	134,000	170,762	111,702	118,419	84,485
1909	153,550	122,056	105,495	113,510	101,708	72,636
1910	167,178	104,223	160,340	150,237	78,325	32,957
1911	172,521	146,953	149,779	128,675	105,433	33,150
1912	76,085	182,857	127,078	62,365	42,005	...
1913	113,400	124,008	83,422	58,000	29,447	38,690
1914	114,392	77,508	77,815	23,985	...	...
1915	99,828	96,000	...	...	...	...

* Derived by averaging adjacent months of same year.

Table 23.—Average Weight of Cargoes for Years and for Seasons.

Year.	Weight of Cargo, Annual Average.	Weight for Six Winter Months.	Weight for Six Summer Months.
1905	148,174*	105,484	139,567*
1906	144,417	134,969	153,866
1907	140,501	143,740	137,441
1908	129,440	98,945	159,535
1909	114,898	83,291	146,505
1910	112,441	82,836	142,046
1911	133,431	99,938	169,923
1912	109,622*	75,833*	137,780
1913	98,538*	42,046*	126,784
1914	77,490*	54,744*	97,781

* From incomplete data, *see* Table 22.

Table 24.—Seasonal Change in Weights of Cargoes. From Corrected Weights (as given in Table 22).

Year.	Jan.	Feb.	March.	April.	May.	June.
1906 to 1911 (inc.)	83,145	115,195	131,142	132,004	146,269	177,772
Year.	**July.**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**
1906 to 1911 (inc.)	154,699	142,093	153,857	132,633	109,900	71,705

(48.) NUMBER OF FISH CAUGHT PER UNIT OF GEAR AND PER CARGO.

The number of fish caught per skate is given in Tables 25 to 28, as taken from Table 62. There is to be seen the constant evidence of depletion which pervades all the data utilized, but the comparable periods are somewhat irregular, and the complete years all follow 1907. The period covering March, April, and May is easily compared, as is that containing September, October, November, and December, but neither of these is extensive enough to give a thoroughly reliable average.

Comparing these tables with Table 20, giving the weight per skate, the same variations are shown in 1910 and 1911, resultant from the heavy catches recorded from the newer banks, notably those offshore from North Island.

The yield caught per skate in 1908 is shown, according to the annual averages, to be 2.43 times that for 1914, six years later, which would be equivalent to 4.05 times in ten years. When 1909 and 1914 are compared, this equivalent would be 4.07 times. Other years would give for periods of ten years: 1908 and 1913, 3.49 times; 1908 and 1912, 3.38 times; 1909 and 1913, 3.66 times. Whichever of these figures is nearest the average rate of decrease, it is evident that it is less than was found for the weight caught per skate (page 84), and in this fact is to be found the first evidence yet given that the average weight of the fish caught has steadily and extensively declined. Whether this is due to a shift to new fishing-banks, or is due to an actual change in the population of each bank, will be taken up later.

In Table 28 the seasonal variation in number caught per skate is shown, that for January being about a quarter of that for July, whereas the fluctuation of weight has been shown to be a half (page 86). This indicates that the average weight of the fish caught is heavier in winter, of which further proof will be given.

Table 25.—Average Number of Fish caught per Skate. A Summation of Table 62.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.
1902	...	...	...	...	...	...	...	...	51.5	34.8	31.0	33.7
1903	19.5	...	...	...	...	...	...	...	...	...	...	...
1905	....	21.9	24.3	32.9	27.2	...	...	...	...	...	...	...
1906	...	21.1	18.0	22.3	17.5	50.6	64.3	34.4	48.6	9.1	21.0	31.4
1907	8.6	13.5	11.5	...	...	...	...	33.9	19.3	47.2	17.7	9.3
1908	7.8	10.1	8.3	25.9	23.3	29.3	20.7	19.9	43.2	20.3	11.8	9.3
1909	7.8	5.5	7.7	17.3	22.4	20.8	36.1	30.2	19.6	12.4	7.0	5.9
1910	7.5	10.2	13.3	31.4	14.9	30.2	32.6	35.0	23.3	32.6	12.3	6.0
1911	7.7	20.9	10.6	13.1	26.3	20.5	24.3	21.6	21.3	10.2	11.8	4.0
1912	2.3	13.2	10.4	9.5	17.0	20.5	28.6	24.7	19.1	16.1	4.5	3.5
1913	...	...	9.4	13.2	12.8	26.3	7.7	15.0	9.6	5.7	5.8	4.3
1914	5.9	14.7	6.3	7.7	17.9	13.9	8.3	8.7	7.3	2.5	3.7	...

Table 26.—Average Numbers of Fish caught per Skate for Comparable Groups of Months. From Table 25.

Year.	Annual Average.	March, April, May.	Sept., Oct., Nov., Dec.
1902	...	...	37.7
1905	...	28.1	...
1906	...	19.3	27.5
1907	...	...	23.4
1908	19.2	19.2	21.2
1909	16.1	15.8	11.4
1910	21.1	19.9	18.6
1911	16.0	16.7	11.8
1912	14.2	12.3	10.7
1913*	11.0*	11.8	6.4
1914*	7.9*	10.6	4.5*

* Not complete; *see* Table 25.

Table 27.—Average Number caught per Skate for Seasons of Six Months, showing same Decrease both Seasons. From Table 25.

Periods compared.	Summer.	Winter.
1906, 1907, and 1908	31.1	16.5
1912, 1913, and 1914	14.9	7.6

Table 28.—Seasonal Variation in Number of Fish caught per Skate. From Table 25.

Period.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.
1908 to 1912 (Inc.)	6.6	11.9	10.1	19.4	20.8	24.3	28.5	26.3	25.3	18.3	9.6	5.7

As in the case of the weight of fish caught per skate, the number caught per skate was reckoned for the same three areas (*see* page 85). The resultant table shows depletion in the same manner, and the seasonal fluctuation in the same degree (*see* Table 64). In fact, each individual bank showed the same tendencies, but the greater number of records from the combined areas allowed of more uniform results (*see* Tables 29 and 30 for the separate areas, and Table 31 for a single bank, Rose Spit).

In the formation of Table 29 the same methods of correcting the data were used as in treating of the weight per skate (*see* page 85). The simultaneous records from the areas yielded the following sums:—

Twenty-seven records gave—

Rose Spit-Bonilla (Area II.) 3,905
East Coast of Queen Charlottes (III.) 2,794

Thirty-one records gave—

Rose Spit-Bonilla (II.) 5,535
Goose Island Banks (I.) 5,811

These two proportions would lead to an expected proportion of: the yield of Area I. is to that of Area III. as 2,807 is to 2,035; but the actual proportion found from fifteen records is 2,807 to 1,920. This is not an excessive variation. By reference to page 85 it may be seen that this relation of banks is the reverse to that shown by the weight per skate, which must indicate, of course, what is really the case, that the fish from these three banks vary widely in size. This is not to be attributed to the effects of depletion, which would leave only the young, but to an actual difference in the rate of growth; for, as has been seen, there are actually more

fish by number to be caught on those banks where the yield in weight per skate is the smallest. Although, in view of the small number of records available, no great significance should be attached to the exact figures, the reversed order of the two methods of counting the yield may be graphically illustrated by expressing them in terms of the Rose Spit-Bonilla Banks as a unit.

Area.	Weight per Skate.	Number per Skate.
I.	0.79	1.05
II.	1.00	1.00
III.	1.07	0.71

The comparable periods in Table 29 are averaged in Table 30. It is apparent that the annual averages are too few to compare with advantage, but the groups of months supply a certain basis. It has been thought best, however, not to base the calculation of the total rate of decrease on anything but the annual average, and therefore it has not been given. A comparison between the rates of decrease shown by similar groups of months in Tables 26 and 29 has been thought permissible, the purpose being to show that the rate of decrease for the three areas is greater than that for the whole fishery. This is the same relation which was found above in the comparison of the rates of decrease in the average weight caught per skate, and illustrates the result of the constant exploitation of new and undepleted banks. The average for 1905 was compared with those for 1912, 1913, and 1914; that for 1906 was compared with those for 1913 and 1914; that for 1908 with 1914, considering the months March, April, and May, and the resultant rates of depletion expressed in terms of that for ten years and the whole averaged. The yield for the initial year of a ten-year period proved to be 3.22 times that for the final when the three areas were considered, and 2.63 times when the whole fishery was included. Utilizing the months of September, October, November, and December, comparing 1902 with 1910, 1911, and 1913, and 1906 with 1911 and 1913, the initial yield was found to be 5.03 times the final in the limited areas and 4.45 times in the whole. It is apparent that the rate of depletion shown by the number caught per skate on the Areas I., II., and III. is in harmony with that derived from the whole fishing-ground. In considering the seeming magnitude of the last rate found, it should not be regarded as contradicting the lower rates obtained from comparing longer periods, when the tendency toward variation found in such fishing statistics and the seasonal fluctuations are borne in mind.

The averages for each month given below (Table 29) bear out the range of variation found from the statistics for the whole ground, and they show in their contrast to the weight caught per skate as given in Table 21 that the winter weights of the fish are heavier than the summer.

Table 29.—Number of Fish caught per Skate, Areas I., II., III. Corrected for Bank Variation. From Table 64.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.
1902	...	...	...	...	...	...	...	...	37.4	44.4	31.0	33.7
1903	15.8	...	7.7	...	...	...	...	...	...	...	...	...
1904	...	...	...	...	...	...	...	...	62.8	12.0	26.8	...
1905	...	23.7	20.4	34.6	24.9	...	...	...	...	...	...	...
1906	...	37.4	14.8	33.4	25.3	20.1	94.0	32.7	63.8	9.1	20.5	24.8
1907	6.2	13.0	13.5	...	...	...	...	32.2	21.7	19.4	17.5	12.8
1908	4.5	7.2	9.6	23.6	31.5	28.3	18.9	18.4	22.1	25.0	12.3	21.0
1909	9.1	7.1	8.2	21.7	31.4	20.3	34.4	10.1	19.9	4.6	10.1	5.9
1910	5.3	4.5	8.1	21.2	17.5	16.5	21.2	34.3	46.5	14.9	14.9	8.7
1911	8.1	20.8	9.4	16.0	27.3	20.7	23.0	17.8	21.8	15.7	6.7	2.9
1912	2.6	...	9.3	6.3	13.2	22.1	9.9	13.8	24.2	18.8	16.4	...
1913	...	...	2.7	19.8	8.7	8.6	5.5	...	10.4	3.7	4.6	2.2
1914	4.1	...	5.4	7.8	19.6	16.8	7.4	16.1	11.2	3.5	...	...
Ave. 1908 to 1911 (inc.)	6.7	9.9	8.8	20.6	26.9	21.5	24.4	20.2	27.6	15.1	11.0	9.6

Table 30.—Number of Fish caught per Skate on Areas I., II., and III. Averages of Comparable Periods in Table 29.

Year.	Annual.	March, April, May.	Sept., Oct., Nov., Dec.
1902	...	...	36.6
1905	...	26.6	...
1906	...	24.5	29.6
1907	...	...	17.8
1908	18.5	21.6	20.1
1909	15.2	20.4	10.1
1910	17.6	15.6	21.2
1911	15.9	26.4	11.8
1912	...	9.6	...
1913	...	10.4	5.2
1914	...	10.0	...

Table 31.—Average Number and Weight per Skate taken on Rose Spit Bank.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.
1902, No.	...	...	...	...	...	...	...	...	...	62.2	51.3	...
„ Wt.	...	...	...	...	...	...	...	...	...	1560	...	...
1903, No.	16.7	...	...	...	...	...	...	...	...	...	...	...
„ Wt.	...	...	...	...	...	...	...	...	...	...	...	...
1904, No.	...	..	...	...	...	...	...	...	...	10.3	13.7	...
„ Wt.	...	...	...	...	...	...	...	...	...	250	361	...
1905, No.	...	...	16.5	...	47.0	...	...	...	...	...	...	...
„ Wt.	...	...	...	...	...	...	...	...	...	...	...	...
1906, No.	...	...	...	...	89.3	...	...	...	...	10.8	18.9	37.4
„ Wt.	...	...	...	...	1180	...	...	...	...	277	821	...
1907, No.	...	12.9	9.5	...	...	...	...	67.6	26.6	...	...	16.7
„ Wt.	...	472	...	...	...	...	...	729	459	...	440	...
1908, No.	...	17.0	11.0	42.9	33.1	22.4	...	...	12.6	...	...	17.7
„ Wt.	347	417	308	389	...	430	...	...	...	...	...	...
1909, No.	13.2	3.3	1.7	...	...	19.9	...	...	7.9	5.3	...	7.1
„ Wt.	282	...	...	...	...	417	...	...	119	93	...	...
1910, No.	...	...	...	...	...	...	...	...	...	...	...	...
„ Wt.	...	...	...	...	...	...	...	...	...	...	...	...
1911, No.	9.0	...	20.7	...	26.9	...	...	...	31.3	10.1	...	6.0
„ Wt.	...	...	...	...	277	...	...	...	400	247	151	184
1912, No.	. .	...	...	17.7	...	...	...	23.3	17.8	...	...	...
„ Wt.	...	...	...	208	...	...	...	336	287	125	...	...
1913, No.	...	...	..	...	...	...	5.2	...	14.7	...	...	...
„ Wt.	...	...	.	...	...	...	67	...	228	181	...	...
1914, No.	...	...	.	...	...	...	7.4	...	...	...	...	...
„ Wt.	..	...	.11	...	...	...	...	...	...	...	62	...

The average number... ish per cargo are tabulated in Table 63. In Table 32 are given the annual averages derived from these data after correction for vessel variation. It is noticeable that a marked decrease is not evident save in 1907 and in 1912, which may be simply a variation. In fact, there is no ground shown for believing that there has been either a decrease or an increase. However, if Table 23 is referred to, the years 1913 and 1914 show a marked decrease in the average weight, perhaps correlated, if complete statistics were available, with a similar marked decrease in number. What is presented in the unmodified table for these years surely seems to bear this out. The point to be emphasized is, however, the fact that, despite the increase in length of the voyages and the shifting to new banks, there has been no corresponding increase, save perhaps temporarily, in the number of fish caught per voyage.

Table 32 is a comparison of the annual averages for the weight of the cargoes (from Table 23) and the number of fish in them, to show the decreased weight of fish. It will be shown later that this is consequent to a decrease in the case of each bank, rather than because fishing is

carried on over areas characterized by smaller fish, although, to be sure, the shifting of the fishery to undepleted banks has counterbalanced the decrease to a certain extent.

In Table 33 the monthly average weight per cargo is divided by the averages for number per cargo to give the average individual weights according to the season. In these there is somewhat of an error because of the comparison of periods which are not strictly contemporaneous. It will be seen from this table that there is a very decided fluctuation in average weight, that of the winter months being very much greater, the average for May, June, and July being but two-fifths of that for December.

Table 32.—Average Number of Fish per Cargo.

Year.	No. of Fish.	Average Weight.*
		Lb.
1904	6,027	...
1905	6,520	22.7
1906	...	...
1907	4,996	29.2
1908	...	...
1909	6,814	16.8
1910	8,004	14.1
1911	7,268	18.4
1912	5,967	18.3

* As compared with Table 23.

Table 33.—Comparison of Average Pounds per Cargo by Months with Average Number per Cargo, to show Heavier Proportionate Average Weight in Winter.

Month.	Monthly Average Weight per Cargo, 1906-11.	Average Number per Cargo, 1906-12.	Average Weight.
January	83,145	2,386	34.8
February	115,195	3,940	29.3
March	131,142	5,094	25.8
April	132,064	6,501	20.3
May	140,269	10,202	14.3
June	177,772	10,131	17.5
July	154,660	11,073	14.0
August	142,093	11,292	12.6
September	153,857	10,333	14.9
October	132,633	7,535	17.6
November	109,900	3,921	28.0
December	71,705	1,959	36.7

(5.) FLUCTUATIONS IN AVERAGE SIZES OF FISH CAUGHT.

In considering the changes in size of the fish caught by the vessels there are four factors taken into consideration. These are: First, the effect of the fishing on the average size; second, the seasonal fluctuations; third, the differences in the sizes of fish caught on the different banks and at the different depths; and, fourth, the possible schooling of fish in sizes and sexes.

The most disturbing feature in the effects of the line-fishing for halibut is the marked lowering of the size of the fish obtained, as was indicated in discussing the number of fish caught per skate, on page 89. This has been, up to the present time, hidden to the dealers and in part to the fishermen by the constant extension of the fishery to new banks and the consequent influx of fish from localities in which the average size had not decreased to such a marked degree (*see* Tables 1 and 6). Therefore, for the clearest manifestations of the fact the records of the individual banks must be examined, preferably the older banks. It must be borne in mind, however, that these results giving the average size of fish caught are not strictly adequate to represent the real degree of change, as the records in which large fish are caught are given the same importance in the computations as are catches characterized by their small

size, although the former are predominately light yields because of few fish, while the latter are heavy, with many fish. In Table 43 this is discounted and a truer picture given of the decrease in size.

In Table 35 are given the average sizes of fish caught in three areas (I., II., and III.), which are outlined on the chart, page —. The decrease in size is seen to be very marked. The data in this table are combined to form Table 36 by averaging the individual records within the six-month seasons. The decrease in weight is shown even more distinctly, although it must be recognized that the six-month periods into which the data are separated are not completely filled in every case. Table 37 also shows the decrease, though somewhat less clearly because of the paucity of records. It is not attempted to give figures for the rate at which the size was decreasing, because of the lack of sufficient data in suitable years.

The seasonal fluctuation in the size of the fish caught is very noticeable, and represents what is one of the most interesting problems raised by the present data, and one which must be considered in treating the calculations as to average size. It bears on the probabilities of migration, as well as on the extent of depletion, and is of importance from a commercial standpoint.

In Table 35 are shown the seasonal changes in the size of fish as brought in by the vessels without regard to the banks from which they came. These data are taken from records of actual counts and weights made on the docks, which, however, do not state the amount of fish culled out. It would be barely possible that the change was connected with more extensive culling in winter, if it were not true that the records for the individual catches show it likewise (Table 36). The average weights in the case of the cargoes were obtained by dividing the weight of the cargo by the number of the fish, but the records of individual catches were made while the vessels were on the banks, hence are not influenced by any question of culling. It may be seen that the seasonal fluctuation shown in the table is very plain and unmistakable.

The records for the individual banks are not as complete as is the case with the records for the cargoes landed, so they have been grouped in winter and summer seasons of six months each (Tables 36 and 37). There is, of course, a change from month to month within these periods, but it will not affect the validity of the comparisons save where two adjacent months are contrasted as summer and winter. In such cases, for example, under Virago Sound in 1909, where the months of September and October are thus used, the fact is shown in the table, and not much weight should be given to their seeming reversal of the ordinary seasonal relationships (Table 37). Even including these, in twenty-three cases the average for the winter is shown to be the heavier, while in but four the opposite is indicated, in each of them by a narrow margin. The evidence, then, is that there is an actual change in the average weight from season to season.

This change, as shown by the direct evidence of the records, may be checked by a comparison (Table 38) of the average weight and the average number caught per skate in the different seasons. These data are taken from the tables for the three areas compared in Table 36. The weight per skate, (B) and (C), for each month from Table 21 was divided by the number of fish per skate for the corresponding month (A) from Table 29, and the proportions shown in the rows headed B/A and C/A. This is not, of course, indicative of the actual weight of the fish caught in any particular year and month, but represents merely the proportion of the average weight in each case to that of the other months. It is evident that the seasonal change is the same that has been shown for the cargoes and for the individual banks.

In Table 36 are given the averages for all those years which have records for both seasons, considering only the three large areas there indicated. With regard to these it will be well to call attention to the age relationship. The lengths of which these weights are characteristic may be calculated from the chart given in a preceding paper by the present writer in the Report of the British Columbia Commissioner of Fisheries for 1914 (1915), page 78, using the "cleaned and headed" curve. These lengths may in turn be applied to the charts giving the average length at any age on page 80 of the same report. From these sources Table 39 is compiled. It is noticeable that in this case there is a year's growth, more or less, difference in size between the average seasonal weights. On examining data from other banks (see Table 37), the seasonal difference is very much greater than this, giving pause to any explanation based on age. This will be discussed later.

Table 34.—Average Weight of Fish in Cargoes, as weighed at Dock.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.
1902	...	...	...	...	...	...	...	...	...	...	...	14.6
1903	...	...	...	...	...	...	...	...	...	...	...	...
1904	...	...	...	...	...	...	...	...	...	...	...	21.4
1905	23.3	19.8	22.7	18.7	...	...	...	18.4	17.3	32.8	27.3	33.4
1906	22.3	20.0	32.9	23.3	18.6	15.9	15.2	13.8	18.2	23.3	...	24.3
1907	18.3	24.2	27.5	17.3	16.4	13.4	14.7	17.0	17.3	19.9	23.0	23.0
1908	17.8	25.8	32.4	14.1	14.1	14.3	15.3	22.8	13.4	15.6	28.0	16.9
1909	17.5	33.5	30.1	16.0	20.4	12.9	12.1	11.0	13.6	18.0	25.8	20.2
1910	22.9	36.0	23.2	17.0	13.0	12.4	18.5	14.9	15.5	11.9	16.9	16.0
1911	19.5	21.9	24.6	21.2	12.9	22.3	12.5	16.8	17.4	18.4	21.0	30.6
1912	33 3	24.0	27.8	22.3	13.0	18.3	12.4	14.7	14.2	12.1	21.9	...
1913	...	...	...	...	11.7	13.6	17.6	24.2	17.5	20.0	18.4	16.5
1914	15.6	19.2	19.2	...	16.0	13.6	20.8	13.5	16.0	11.5	...	...
Ave. 1907 to 1912	21.6	27.6	27.6	18.0	15.0	15.6	14.3	16.2	15.2	16.0	22.8	21.7

Table 35.—Average Weights for Periods which are Comparable. Taken from Table 34.

Year.	Jan. to April.	May to Oct.	Summer.	Winter.	Annual.
1905	21.1	...	...	26.6	...
1906	24.6	17.5	17.5	...	...
1907	21.8	16.5	16.0	22.7	19.3
1908	22.5	15.9	15.7	22.8	19.3
1909	24.3	14.7	14.3	24.2	19.3
1910	24.8	14.4	15.2	21.2	18.2
1911	21.8	16.7	17.2	22.7	19.9
1912	27.1	14.4	15.8	...	...
1913	...	17.5	...	...	...
1914	...	15.2	...	...	...

*Table 36.—Comparison of Average Weights of Fish.**

Year.	II. Rose Spit-Bonilla Bank.		III. East Coast of Queen Charlottes.		I. Goose Island Banks.	
	Winter.	Summer.	Winter.	Summer.	Winter.	Summer.
1902	27.2-4	20.5-2	...	...	...	19.8-2
1903	...	...	...	...	...	...
1904	...	...	...	...	...	...
1905	...	...	...	...	...	...
1906	27.0-17	21.9-4	28.5-1	23.4-2	...	14.7-6
1907	...	...	...	...	...	...
1908	26.4-24	20.6-31	32.5-9	34.3-2	...	...
1909	25.0-20	21.4-6	34.4-10	26.9-22	16.8-11	11.0-1
1910	13.8-5	12.0-1	...	...	...	13.3-1
1911	20.5-11	14.3-19	17.0-4	17.9-21	...	14.6-9
1912	19.4-8	16.3-17	...	...	10.2-1	11.2-18
1913	16.5-1	12.0-10	27.9-3	14.5-4	...	9.1-10
1914	...	...	...	...	10.7-2	9.0-17
Average	22.0	18.6	28.1	23.4	12.6	10.4

* The number of records on which each average is based is indicated by the number following the hyphen in each case.

Table 37.—Average Sizes of Fish on Various Banks during Winter and Summer.[a]

Year.	Winter.	Summer.	Year.	Winter.	Summer.
Area IV.			*Area XI.*		
1906	...	21.6-2	1911	...	22.1-3
1909	33.0-1	16.1-4	1912	30.1-1	28.3-5
1910	...	20.0-1	*Area XII.*		
1911	...	15.7-11	1910	25.8-8	12.6-3
1912	...	12.5-4	1912	...	13.2-5
1914	...	12.6-2	1914	17.1-5	...
Area V.			*Area XIII.*		
1912	26.2-10	19.1-16	1911	...	34.0-5
1913	...	18.5-2	1914	21.1-4	...
1914	26.2-2	17.8-3	*Area XIV.*		
Area VI.			1906	23.5-3	...
1914	...	22.7-7	1908	...	11.1-6
Area VII.			1909	11.2-6	13.4-2
				Oct.	Sept.
1911	...	29.3-1	1911	13.2-2	...
1912	33.0-1	29.5-1	1912	8.9-1	...
1913	...	18.1-3	1913	...	9.0-1
Area VIII.			1914	...	9.6-1
1914	...	22.2-8	*Area XV.*		
Area IX.			1909	12.6-1	...
			1912	...	9.4-7
1906	...	17.0-7	1913	...	10.8-4
1908	13.6-4	...	*Rose Spit Part of Area II.*		
1909	22.3-1	...	1902	25.1-1	...
1911	...	10.8-4	1904	25.1-3	...
1912	...	21.3-6	1906	37.7-5	13.2-1
1913	...	14.0-4	1907	13.3-1	...
1914	16.0-1	14.8-2	1908	26.2-5	15.3-6
Area X.			1909	16.2-5	15.9-2
			1911	26.2-5	11.3-5
1902	28.7-4	28.2-6	1912	...	12.6-8
	Oct.	Sept.	1913	...	12.8-1
1911	...	12.7-2	Average of years with records for both seasons	26.6	18.1
1912	...	10.2-1			

[a] The number of records on which each average is based is indicated by the number following the hyphen in each case.

Table 38.—Comparison of Seasonal Variations in Weight and in Number caught per Skate.

Period.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
A. 1908 to 1911 (inclusive)	6.7	9.0	8.8	20.6	26.0	21.5	24.4	20.2	27.6	15.1	11.0	9.6
B. 1907 and 1908	272	364	408	429	368	498	549	402	314	281	401	264
C. 1907-09 & 1914	213	272	290	383	357	393	..	..	253	..	..	..
B/A	40.5	37.7	46.4	20.8	13.7	23.1	22.5	19.9	11.4	18.6	36.4	27.5
C/A	31.7	27.5	32.9	18.6	[illegible]	18.3	..	..	9.1	..	..	..

Table 39.—Showing the Computed Ages of the Fish caught during Summer and Winter.

	Area II.		Area III.		Area I.	
	Winter.	Summer.	Winter.	Summer.	Winter.	Summer.
Average weight	22.0	18.6	28.1	23.4	12.6	10.4
Lengths (inches)	31	29½	30⅞	37¾	30½	29
Age†	9.4	8.3	10.2	9.0	9.4*	8.6*

* Using the curve for Frederick Island, as more characteristic of the rate of growth found on Area I.
† In the paper from which the rates of growth are taken, the Roman numerals denote the year in which the fish was at the time of being caught. The figures here given represent the number of years completed.

It has been shown that there is a seasonal change in the size of fish, and also a constant decrease in size. It remains to be proved that these will not account for all the variations found, but the statistics at hand are unfortunately not extensive enough to give much light on the subject. Whether the distribution of fish within a bank is affected by depth is unsettled. Table 40 is presented in this connection, showing that there is apparently a connection between depth and size, but here it has been impossible to show that this is not due to the inclusion of different banks with different rates of growth and different depths. The number of records for each limited area are too few for an examination in this regard. The division into two periods, before 1910 and after, serves to separate the records from the older banks, and the data after 1910 is a mixture of those from old and new banks. It will be seen that in the case of the old banks the size seems to decrease with greater depth, but where the new and deeper but undepleted banks with their large fish are included the opposite seems to be'd. The difficulty in reaching a safe conclusion is plain.

Table 40.—Decrease in Average Size with Greater Depth.

Fathoms.	Before 1910.	After 1910.	Fathoms.	After 1910 (Con.).
	lb.	lb.		lb.
15	27.7	14.2	80	19.2
20	27.4	13.8	85	23.3
25	35.5	17.0	90	20.8
30	29.3	10.0	95	23.1
35	20.6	13.1	100	22.0
40	22.3	12.3	105	22.1
45	23.9	14.4	110	19.9
50	20.5	12.4	115	25.0
55	17.4	11.7	120	21.6
60	20.0	16.1	125	...
65	17.7	18.1	130	13.9
70	19.6	20.1	135	28.6
75	16.7	14.4	...	...

The above table does not take into consideration those causes of variation which are of importance. The variation from exactness in the records, inevitable in dealing with estimated weights, renders it imperative that large numbers of such be used, but the depth is the class of data most frequently omitted, and there are in all only 150 records available for the older banks. The limits within which the fishing was done were almost always stated as between a maximum and a minimum, which are usually far apart. The variations in the average weight of fish caused by depletion and by the seasonal fluctuation cannot be eliminated without a sufficient number of records for particular times. The differences between banks in rate of growth are great, and are not known exactly enough to allow of correction. Hence it has been thought best to present the available records in an appended table (66) without attempting further conclusions. This, of course, leaves the question of the distribution of the fish (within strictly local limits) without presenting evidence and entirely undecided. It is a question, of course, distinct from that of migration between banks.

By arranging the records of catches in weight classes (Tables 41 to 44), the numbers caught per skate may be shown to be in direct correlation. This would indicate that every catch does not contain an equal number of heavy and light fish, but that there are catches which are composed predominantly of heavy or light fish; in other words, a catch is not strictly representative of the population of a bank, but of certain portions of it which may perhaps deserve the name of schools. However, we meet here the same objection that is met in considering other statistics—namely, that the records are from different banks. In order to remedy this, those from the Rose Spit-Bonilla Area (II.) were studied in the same way (Table 44), and the same conditions shown. Even in such a case there is the possibility of including local areas of different characteristics. There are not enough records to allow of the study of finer divisions in the same way, but the fact that there are great fluctuations in the average sizes of fish in catches from strictly limited areas is shown in Table 45. It is worthy of notice that the correlation between size of catch and average weight proves that these fluctuations are not the product of chance, although they are obviously so great as to obscure that correlation when but a few records are considered.

Table 41 illustrates the fact that in the catches in general there is a reliance on younger and smaller fish, but under the 1911 to 1914 totals there are included numerous data from the new banks opened in 1910. The division of these into old and new banks is the same as dividing them at 75 fathoms, as they are indicated in Table 42. The comparison of the first sections in Tables 41 and 42 shows the increased dependence on small fish on the old banks and the more rapid proportional decrease of the large fish.

By dividing the years 1902 to 1910 into two periods the same tendency of increased dependence on small fish may be seen (*see* Table 43). This takes for granted the equal distribution of fishing on the old banks. Since Table 42 shows the newer and undepleted banks to be characterized by a dependence on larger fish, it is also proved that it is not the change to deeper banks which has produced the decrease in size of fish.

In the examination of the statistics from the Rose Spit-Bonilla Area (II.) (Table 44), it is evident that there is the same increased number per skate when the catch is made up of small fish, the same dependence on small fish in later years, and the same rapid failure of the supply of large fish. In it, as was not the case in the tables for the banks in general, the seasonal fluctuations in size, the changes in average size from year to year, and the differences in size between areas were guarded against. It is improbable that there has been any change in the location of the fishery within the same bank or area, as these are too small to allow of extensive changes when the great space covered by each trial or set of the lines is considered (*see* chart on page 122).

Theoretically, the supply of young fish would be kept up for some time after the mature fish had been so far depleted as to affect the number spawned. The hooks catch no fish before they reach a length of 15 inches, and it is probable that on the average a fish is not caught until it is over 24 inches long. This would allow the last full brood about three or four years at least before it was caught, and hence the depletion of young fish would lag that far behind that of the larger. In examining Table 44 it is evident that there is some question of depletion in the 5- to 15-lb. class at least before 1912, whereas there is none in regard to the 15- to 25-lb. class after 1900. There is no clear evidence for the 25- to 35-lb. class, unfortunately, but the fact that there are no records of average catches in that class after 1912 is eloquent of the state of affairs.

It is not to be doubted, in view of the evidence given above, that the conditions on the older banks as a whole are based on the presence of similar conditions on the individual banks, and that the increased dependence on young fish is due to the effects of depletion on each local population. The corollary of this is that the number of mature fish on the banks has been disproportionately depleted on the overfished banks, and that their absence is not a natural condition, but a result of the commercial fishery. The fact is of the utmost importance in considering the state of the banks, for it must be urged with all emphasis that the future of a species in any region is not dependent simply on the number of fish present, but rather *on the proportion of those fish which are allowed to come to maturity*. Granted that the total population has fallen each decade to a quarter of its initial number, as has been shown, the mature population must have fallen still more rapidly. As was shown in a preceding paper by the author,* fish from Hecate Strait do not begin to mature until they reach a length of 35 inches

* Report of the British Columbia Commissioner of Fisheries for 1914, page 92, 1915.

(weighing 18 lb. cleaned and headed), and a comparison with Table 44 will show that there are no more catches made in Area II. averaging that high, although this was by no means the case in earlier years. To emphasize this it may be well to point out that 50 per cent. are not mature until they have reached a length of 43 inches (44 lb.). It is very evident from these figures that the longer these banks are subject to such a drain, the longer they will require for recuperation, if such be possible when adequate measures are taken to allow it.

Table 41.—Correlation of Size of Fish and Number caught per Skate, in Two Periods.

Weight Classes.	5 to 15 Lb.	15 to 25 Lb.	25 to 35 Lb.	35 to 45 Lb.
Average for 1902 to 1910 (all under 75 fathoms)	37.5 (16 records)	24.4 (41 records)	18.0 (31 records)	17.6 (12 records)
Average for 1911 to 1914 (all depths)	23.2 (71 records)	14.4 (69 records)	16.8 (27 records)	12.8 (4 records)

Table 42.—Correlation of Size and Number on "Old" and "New" Banks (under and over 75 Fathoms) between 1911 and 1914 (inclusive).

Weight Classes.	5 to 15 Lb.	15 to 25 Lb.	25 to 35 Lb.	35 to 45 Lb.
1911 to 1914, under 75 fathoms	25.0 per skate (61 records)	12.1 per skate (30 records)	8.0 per skate (2 records)	...
1911 to 1914, over 75 fathoms	11.8 (10 records)	16.1 (40 records)	17.7 (25 records)	12.8 (4 records)

Table 43.—Correlation of Size and Number on the "Older" Beds.

Weight Classes.	5 to 15 Lb.	15 to 25 Lb.	25 to 35 Lb.	35 to 45 Lb.
Average for 1902 to 1906	48.8 (9 records)	28.5 (15 records)	24.6 (16 records)	27.4 (5 records)
Average for 1907 to 1910	23.1 (7 records)	21.7 (27 records)	11.6 (15 records)	10.6 (7 records)
Average for 1911 to 1914	25.0 (61 records)	12.1 (30 records)	8.0 (2 records)	... ...

Table 44.—Correlation of Weight of Individuals and Number caught per Skate on Area II.

Weight Classes.	Season.	5 to 15 Lb.		15 to 25 Lb.		25 to 35 Lb.	
		No. per Skate.	No. of Records.	No. per Skate.	No. of Records.	No. per Skate.	No. of Records.
1908	S.	27.3	7	20.3	9	20.7	5
"	W.	17.1	2	15.2	8	10.5	13
1909	S.	12.9	4	27.5	4	...	...
"	W.	7.8	2	12.7	10	6.2	8
1910	S.	41.6	1	...	...	...	...
"	W.	18.6	4	7.9	2	...	...
1911	S.	30.4	13	15.5	5	4.8	1
"	W.	18.9	2	9.5	4	8.5	4
1912	S.	26.8	12	13.2	5	15.1	1
"	W.	29.2	3	8.5	2	11.5	4
1913	S.	15.6	8	8.5	2	...	...
"	W.	...	...	8.4	1	...	...
1914	S.	9.1	4	...	...	...	...
"	W.	7.5	3	...	...	...	...
Average*	S.	23.7	49	18.1	25	17.3	7
"	W.	17.0	16	12.1	27	9.2	29

* Based on the sum of the individual records, not on averages for the seasons of each year. Catches averaging over 35 lb. are omitted, as being too few in number.

*Table 45.—Weight per Individual and Number per Skate caught on Limited Areas, to show the Fluctuation.**

Date.	Average Weight.	Number.	Date.	Average Weight.	Number.
July, 1908 (Two Peaks)	18.3	25.9	March, 1912 (Otter Passage and Shrub Island)	17.0	5.9
	23.1	33.1		24.1	3.9
	24.5	18.2		26.8	16.6
	32.3	18.0		26.9	7.1
	34.1	16.3		27.0	10.6
	36.8	22.6		27.6	7.1
	39.1	15.9		28.2	10.5
	41.9	14.9		28.3	6.3
	42.4	33.4	April, 1912 (Cape Scott)	18.7	11.1
May, 1911 (Two Peaks)	33.1	8.4		19.0	4.8
	35.3	9.5		20.3	10.2
	38.2	9.7		22.2	4.2
	38.2	10.9		23.5	17.2
	45.6	10.9		24.1	11.1
Sept., 1908 (Virago Sound)..	10.5	71.4	Sept., 1902 (Cape Scott)	20.3	68.3
	10.8	93.0		25.0	66.5
	10.8	58.7		26.6	84.6
	11.5	101.4		27.4	55.6
	11.5	90.5		32.6	21.3
	11.6	47.7		37.0	51.1
Aug., 1911 (Horseshoe)	11.4	27.5	Sept., 1912 (Atli Head)	9.7	14.3
	13.4	24.8		11.7	27.3
	14.0	33.4		12.2	15.9
	15.5	40.3		14.2	87.8
	16.0	41.7		14.9	16.7
	17.3	12.0		15.6	8.9
	17.6	47.4		21.9	8.9
	25.4	23.4	Aug., 1911 (Atli Head)	14.1	19.9
June, 1912 (Otter Passage and Shrub Island)	13.7	49.4		15.4	33.5
	14.7	8.5		16.6	16.8
	15.9	12.5		16.7	10.8
	17.6	14.0		16.8	43.3
	17.6	20.7		18.7	22.3
	18.1	6.7		18.9	30.2
May, 1909 (Reef Island) ...	16.3	12.7	April, 1913 (N.W. Corner of Goose Island Bank)	6.7	15.4
	18.1	28.7		7.8	22.6
	22.5	39.2		7.8	17.8
	30.7	13.6		8.3	42.8
	32.1	13.0		9.3	19.0
	37.0	16.1		9.8	17.0
	38.5	15.5			
	38.7	13.5			

* All examples at hand which had more than five records for the same date, for the same limited locality, are presented.

(6.) VARIATIONS IN AVERAGE SIZES OF FISH FROM DIFFERENT BANKS.

In the consideration of the preceding data it has been constantly evident that there are differences in the average size of fish obtained on different banks. In a previous paper by the writer† there has been shown a difference in rate of growth on different banks, but the ages of specimens from all the banks here treated have not been determined. The presumption would be, however, that difference in average size means a difference in rate of growth, hence the present data is of absorbing interest. If a correlation between the situation of a bank and the rate of growth characteristic of it can be established it will be of the utmost importance, both from the standpoint of the study of the halibut itself and of other marine animals, and it is here attempted to demonstrate a correlation at least between average size and situation.

In the paper cited above it has been shown that the rates of growth are very divergent on different banks (page 80 *et seq.*), and that the largest sizes attained were in correlation with

† Report of British Columbia Commissioner of Fisheries for 1914, page 76.

these rates of growth. In considering the average size of the fish caught, however, we must discount the fact of the decrease in average size resultant from overfishing and of the seasonal fluctuations. There is presumably also a difference in the natural rate of mortality, but this is impossible to measure except after the elimination of all other factors, and it would not be expected that it would be a predominating influence. If it be possible to show that the rate of growth and the normal average size of fish caught on each bank stand in close agreement, it will be possible to more accurately measure the effect of depletion by a comparison of rates of growth and of existing average sizes. At the same time, our knowledge would be extended to banks where the approximate extent of depletion is known, but from which at present no specimens are obtainable in sufficient numbers to determine the rate of growth. The importance of such facts in formulating general statements is obvious.

On the chart or areas of halibut fishing-banks (page 122) are shown the various banks between the Alaskan border-line and Vancouver Island. In so far as the surveys available show them, the 70-fathom lines have been stippled to give the outlines of the banks. In the case of the banks off North and Frederick Islands (designated as Areas XII. and XIII. on the chart) the line shown is rather that of 110 fathoms, as that depth is nearer that utilized for fishing on those banks. In each case the most prominent landmarks from which the fishermen name the banks are shown. The areas treated as units in this work were chosen because the records of the fishermen lend themselves to such a division—not primarily because of the apparent topography of the bottom. In fact, it would have been misleading to base divisions on such features of this as were available, because of their inaccuracy and incompleteness. Hence the conclusion must be guarded against that it is meant to imply in any way the essential unity of the areas.

As a matter of fact, the records are not capable of being located with absolute accuracy. The vessels in one set of gear may cover ten miles of bank, and hence may catch fish from widely different banks. Again, the position of the vessel is never certainly known unless the day is very clear so that landmarks may be sighted. And, finally, the exact position, if known, is not always recorded, the reference being merely to the bank and its depth, using the locality known to the fishermen, as "Horseshoe" or "Horseshoe of Two Peaks" (meaning two different banks). Hence it has seemed best to establish certain facts which apply to the average condition of the various areas, holding in mind meanwhile the possibility of a diversity within them. Even where the local conditions accurately discernible, the formation of averages for large areas would be a necessity to the discovery of the causes of variation.

Examining the accompanying map, the various areas may be seen to be distinguished by Roman numerals, indicating the order of treatment. Of these, Areas I. to IX. (inclusive) have been fished from before the beginning of the records given here (Banks Island was fished about 1895), and the great development of the halibut fishery before 1910 took place, particularly on these banks. We may look, then, at them as capable of comparison year by year. But in regard to Areas XI., XII., and XIII., the case is different, although fishing, to be sure, had been done there. Not until 1910 were many fish taken on them; hence their depletion should be reckoned from that date.

As shown in Table 36, Area I. (Goose Island Grounds) is characterized throughout by a uniformly smaller-sized fish than the other two dealt with. Area III. has a larger size than II., but it is plain that I. is distinctly in a separate class. The averages indicate what are the approximate proportionate weights. The differences in these banks are evident when the seasons are compared separately and when the decrease due to overfishing is indicated; hence should be indisputable.

It is possible, however, to make a somewhat more thorough comparison. In Table 65 the monthly averages of the catches made in each area are given in each year, and the method used in correcting the variations between banks and vessels, on page 81, was used. Comparing Area II. with Area I., all the months in which averages for both were obtainable were included, and the sums of the simultaneous records found. From this the average weight was again reckoned, giving, for eleven months, 14.9 lb. for Area I. and 20.2 lb. for Area II.; and for seventeen months, for Area II. 19.9 lb. and for Area III. 23.6 lb. By comparing these results with the averages in Table 36 there is evident some variation, but the general conclusions as to the relative sizes are the same.

Area IV., the bank famous among the fishermen as the "Horseshoe," is treated separately because it was thought that on it might be found fish intermediate in size between those on Areas I. and II. That this is perhaps true may be seen by comparing the data based on sufficient numbers of records in Tables 36 and 37 but no exact comparison has been attempted because of the paucity of records. The difference between I. and IV. is clear, and it is evident that the former is rather to be classified with II. and III.

Areas V., VI., VII., and VIII. are known as "along shore" banks. Table 37 and the final column of Table 46 show that what records are available classify them as banks with large fish. Similarly situated and of similar character, the size of their fish might be expected to be nearly the same, and all the records so indicate them. They contrast sharply with Area I., where there is found a smaller fish. There is a distance of but fifteen or twenty miles of deep water between these banks.

Area IX. (Table 37) was heavily fished in early days, and it is well within the limits of probability that the halibut have been allowed to recuperate on them. As has been shown on the maps illustrating the shift in the fisheries from year to year (page 122), a somewhat similar case of the recrudescence of fishing on the bank off the northern end of Banks Island may be found. Area IX. has been confused with X. in the records, and it is probable that a difference is present between them.

The West Coast of the Queen Charlotte Islands (Table 37, Area XI.) was rarely fished until 1911 and 1912; hence but little decrease in average size in the records is to be expected when the available data cover but these two years. The records on which Table 37 are based show very few fish caught per skate in this area in 1912, as follows: 16.1 per skate (average weight 15.5 lb.); 6.1; 7.8; 2.1; 5.4; and 5.3. The banks are extremely narrow, and the catches are made in reality in the mouths of the inlets or almost among the rocks of the shore. (*See* remarks on "inside waters.")

In Area XII. (Table 37) the data are more acceptable, and it is distinctly shown that, considering that the data concern what is the early history of the bank, the average sizes are small. The years 1910 and 1912 in Table 37 should be compared with 1895 and 1897 for Hecate Strait. In the determination of the age of the fish taken in Area XII. (*see* Report of British Columbia Commissioner of Fisheries for 1914, page 80) it was found that this small size was based on the slow rate of growth, as compared, for instance, with fish from Hecate Strait. These areas on the western coast of the Queen Charlotte Islands are interesting in their revelation of the independence of the various areas by their existence in an undepleted condition so close to impoverished banks.

The offshore banks of North Island (Area XIII.) are on the shoal grounds which extend southward from Forrester Island, and the records available are not sufficient to base accurate judgment on.

Between North Island and Rose Spit are found three or four banks—namely, those off Pillar Bay, Virago Sound, Masset, and Tow Hills. They are combined in the text to form Areas XIV. and XV. (Table 37). The average size of the fish from these banks is decidedly smaller than that of those from Hecate Strait, corresponding in this regard to those from the Goose Island grounds (Area I.). The returns from Rose Spit, which is intermediate between these areas and Area II., show a wide variation, small fish and large fish being caught—probably age-groups—although there is the possibility that Rose Spit is in reality two separate banks. Without considering Rose Spit, however, it is but thirty five-miles between banks with sharply different characteristic sizes.

If the records of individual catches, which are given in Table 45 to show the fluctuation in limited areas, are examined, it may be seen that the bank differences are very well defined. The records of a single voyage in Table 47 illustrate the same thing, the Virgin Rocks (Area VIII.) having 20-lb. fish, while the Gravel Grounds (Area I.) have 11-lb. The data for the other records were not given in the log, as was too often the case.

Other evidence that the average size in individual catches may be adduced to show the differences between the banks. In Table 49 the average weight of the fish in those cargoes which come in their entirety from individual banks is given. By comparing it with the immediately foregoing text it may be seen that the data bear out the conclusions when seasonal fluctuation and annual decreases are allowed for. For example, Areas XIV. and XV., Masset and Virago Sound, may be compared with Areas I. and II.

It is evident, then, that the areas which are sheltered, if such a term is admissible, from the open ocean are characterized by larger fish, while those which are open to it have as a rule smaller fish. In the chart on page 122 these two types of banks are marked by differing lines. However, it should be remembered that the sizes characteristic of the sheltered banks also vary, as, for instance, those for Areas II. and III., and the conclusion should not be made so sweeping as to regard an area as uniform within itself. The significance of the results found are heightened when it is shown that there are closely situated banks which have widely different rates of growth.

It is perhaps questionable whether the large average sizes of fish which are known to be taken in enclosed waters is due to the same cause as the increased growth and large size of fish from certain of the banks. In Table 50 are given records from such inside waters, for the most part portions of the inland passages frequented by the vessels on the way to and from the banks. It is noticeable that the number of fish caught per skate is very low; and the personal experience of the writer with halibut-fishermen in the small gasolene-boats which fish in such waters has led him to regard these fish as isolated individuals of considerable age and size. They are caught, as will be seen from the records, along what would correspond to the inner edges of the banks which lie along the shore. It is safe, in all probability, to regard them as fish which have drifted away from the banks—the chances of a fish doing this increasing directly in proportion to his age—or as the isolated survivors of unfavourable conditions.

Table 46.—Records of Catches on Inshore Banks, Areas VI., VII., and VIII.*

Date.	Number per Skate.	Weight per Skate.	Average Weight.
Area VI.			
1914, July	6.8-8	143-16	22.7-7
„ August	...	133-1	...
„ September	3.5-1	...	...
1915, August	...	133-8	...
Area VII.			
1909, February	2.9-1	...	...
1910, January	0.6-1	...	...
„ June	23.0-2	...	...
1911, May	4.3-1	125-1	29.3-1
1912, January	1.0-1	...	...
„ February	2.5-1	83-1	33.0-1
„ April	3.8-2	156-3	29.5-1
„ September	...	133-1	...
„ December	1.6-1	...	...
1913, June	...	729-1	18.1-1
„ September	...	56-1	...
1914, June	...	104-1	...
„ July	...	188-1	...
Area VIII.			
1905, May	61.3-1	...	...
1910, January	1.4-1	...	...
„ April	6.2-1	...	...
1913, May	...	167-1	...
„ October	...	23-1	...
1914, June	10.0-4	219-6	22.0-5
„ July	6.4-2	105-5	23.0-2
„ September	3.4-1	73-1	21.6-1

* The number of records on which each average is based is indicated by the number following the hyphen in each case.

Table 47.—Data to be taken from the Daily Log.

(Name of Vessel: *Flamingo*. Captain: *A. Freeman*. Home Port: *Vancouver*. Number of Dories: *Twelve*. There are *eight* lines to a skate.)

Date, 1914.	Locality.	No. of Skates.	Catch.		Remarks.
			No.	Lb.	
June 16...	S.E. of Virgin Rocks	48	623	12,000	Sailed June 15.
„ 17...	„ „	96	977	22,000	
„ 18...	„ „	96	901	20,000	
„ 19...	„ „	84	613	16,000	
„ 20...	Gravel Grounds	36	...	...	"No fish."
„ 21...	„ „	48	838	...	
„ 22...	„ „	96	1,693	12,000	
„ 23...	„ „	84	1,028	12,000	
	Tally-sheet totals ...	..	6,073	103,685	Arrived June 24 (counted and weighed at dock).

*Table 48.—Records taken from Table 47.**

Date.	Catch per Skate.		Average Weight of Fish.
	No.	Lb.	
June 16	13.0	250	19.3
„ 17	10.2	229	22.5
„ 18	9.4	208	22.2
„ 19	7.3	190	26.1
„ 20	...	...	...
„ 21	17.4	...	...
„ 22	11.4	125	11.0
„ 23	12.2	143	11.7
Tally-sheet			17.1

* From the data in Table 47 the average number and weight per skate were calculated by dividing the catch for the day by the number of skates utilized, and the average weight of the fish in each catch by dividing the pounds by the number.

Table 49.—Average Weight of Fish in Cargoes as weighed at the Dock, considering those from Single Banks.

Date.	Average Weight.	Date.	Average Weight.
Area I., Goose Island.		*Area II., Exact Localities (?).*	
1906, September	12.7	1905, February	18.8
1909, May	13.6	„ March	16.9
„ „	13.0	1906, February	18.9
„ June	11.9	„ March	30.0
„ „	13.6	1908, October	13.9
„ „	13.1	„ December	17.5
1910, May	12.8	„ „	16.2
„ July	11.0	1909, January	18.7
„ „	13.2	„ November	28.9
„ August	13.2	*Area II., White Rocks.*	
„ „	12.6	1908, November	31.3
„ „	15.3	1912, October	12.8
1911, July	11.5	*Area II., Browning Entrance.*	
1914, May	8.8	1908, November	26.9
„ June	10.0		

Table 49.—Average Weight of Fish in Cargoes, etc.—Concluded.

Date.	Average Weight.
Area II., Rose Spit.	
1908, April	12.8
1912, August	15.8
Area II., Two Peaks.	
1909, January	15.2
„ February	35.0
1910, September	14.8
„ December	16.0
1914, January	15.6
Area II., Cape George.	
1910, June	14.2
Area III., Exact Localities (?).	
1909, May	26.8
Area III., Cumshewa.	
1909, May	33.8
Area III., Atli Head.	
1906, April	22.8
„ July	16.7
Area III., Ramsay Island.	
1913, June	15.9
Area IV., Horseshoe.	
1906, July	14.1
1910, September	16.2
1911, July	13.4
„ August	15.0
Area V., off Otter Point.	
1914, July	23.4
Area VII., off Gosling Rocks.	
1909, April	17.3
„ „	14.7
Area VIII., off Virgins and Ganders.	
1914, July	21.5
Area IX., Cape Scott.	
1905, April	18.7
1906, June	15.3
„ „	15.3
1912, March	30.8
„ April	23.6
Area XI., West Coast of Queen Charlottes.	
1911, April	21.2
„ May	12.8
„ September	23.0
1912, January	33.3
„ February.	24.0
1914, March	19.2
Area XII., North Island.	
1911, February	21.7
„ June	18.1
1912, May	12.3
„ June	26.6
1914, February	17.6
Areas XIV. and XV., Masset and Virago.	
1910, October	12.1
„ „	11.7
1912, July	11.2

Table 50.—Number, Weight per Skate, and Individual Weight of Fish in Catches made in Inside Waters.

Locality.	Date.	No. per Skate.	Weight per Skate.	Average Weight.
Off Fort Rupert	1909, March	2.2	...	...
Near Cape Calvert*	1910, September	3.3	...	...
Inside Dundas Island	„ December	0.8	...	...
„ Chatham Sound*	„ „	4.6	...	...
„ Dundas Island	1911, January	5.6	...	...
„ Virgins	1912, „	0.3	...	...
Between Zayas and Dundas Island*	„ March	7.6	182	24
Inside Banks Island	„ „	...	83	...
„ Round Island	„ May	0.8	55	72
„ Banks Island	„ October	...	56	...
„ Aristazable	„ November	5.5	...	...
In Laredo Channel	„ „	7.0	...	...
„ Petrel Channel	„ „	1.8	83	45
North of Stephens Island	„ December	2.2	...	...
„ „	„ „	2.2	...	...
Beaver Passage	„ „	6.0	125	21
Laredo Sound	1913, July	...	56	...
Inside Price Island	„ „	2.2	...	...
Principe Channel	„ October	...	62	...
Inside West Rock	„ November	...	26	...
„ Stephens Island	„ „	1.5	...	...
Off Cape Caution	1914, January	3.4	...	...
Blackfish Sound	„ October	1.0	...	...
Strait of Georgia	„ November	0.03	...	...

* In situations but little removed from the banks, hardly deserving the name of "inside waters."

(7.) RELATIVE PRODUCTIVITY OF DIFFERENT AREAS.

The comparison of the productivity of the different banks is very difficult. The wealth of fish on a bank before it is impoverished may be altered widely by the intensity of commercial fishing to which it is subjected, both absolutely and in its standing in comparison with other banks. This is, of course, the essence of what is meant by depletion. Statistics which cover a period of years include several stages of impoverishment, and unless the process has been simultaneous on the areas the accuracy of the comparison is impaired. At the same time, banks which had an initially large stock of fish may decline much more rapidly than others with a small stock, and the comparison might result in a truer picture than would be given by a large number of records within a short time. The data obtained undoubtedly fluctuate widely with the varying intensities of fishing; they are sparse for certain banks, and have naturally a wide range of variation, as has been previously indicated. Hence the lending of much importance to the results tabulated is deprecated.

The methods used have been given on page 89, where comparisons between Areas I., II., and III. have already been made. The tables from which the averages used have been taken are indicated in Table 51, and the derived proportions are given in terms of Area II. as a unit. The columns headed "No. of Dates" give the number of dates the averages for which were utilized. In some cases the number of records used in obtaining each of these averages has been considerable, as may be seen from the cited tables. For the location of the various areas the chart on page 122 may be used.

Table 51.—Relative Productivity of Different Areas.

Area.	Table with Data.	Weight per Skate.	No. of Dates.	No. per Skate.	No. of Dates.
I.	60 and 64	0.79	21	1.05	31
II.	60 and 64	1.00	...	1.00	...
III.	60 and 64	1.07	30	0.71	27
IV.	54	1.35	10	0.97	9
V.	55	1.20	11	0.78	13
VI.	46	...	...	0.32	2
VII.	46	0.56	4	0.46	6
VIII.	46	0.73	3	1.28	4
IX.	55	0.25	3	0.42	8
X.	55	1.18	12	0.85	19
XI.	53	1.00	7	0.56	8
XII.	52	3.54	6	2.89	6
XIV. and XV.	56	1.23	16	1.49	26
Inside Waters	50	0.51	8	0.26	20

In comparing this table with the results in the preceding pages, certain facts may be seen to be corroborated. Thus the large yield of Area XII. is obviously the consequence of its late exploitation, mentioned on page 101. It would be expected that Area XI. would show the same relative yield, but, as was stated on page 101, it is peculiar in its narrowness and steepness. In fact, it seems to bear a certain definite resemblance to Areas VI., VII., VIII., and IX., which are along-shore banks and are also characterized by a light yield. It will be observed that, in comparison with these areas, Area XI. has a heavy yield, in harmony with its late exploitation and its undepleted state at the time the records were obtained from it. To this class of banks those called "Inside Waters" should be added, judging from the yield and from their actual continuity. It is very probable that an examination of Areas II. and III. would show a differentiation of inshore and offshore banks, but in these cases it is well known that the heaviest yields have come from the banks which are not farther from the shore nor more discontinuous with it than is the case with Area VII., for instance (*see* charts on pages 123-125).

Attention should be called to the striking fact that Area XII. remained undepleted for a considerable period of time after the impoverishment of the other banks was in evidence. It is proof that there is no systematic migration between it and other banks, and that there is a considerable degree of independence, at least, in so far as casual migration or diffusion is concerned.

*Table 52.—Number and Weight per Skate caught on Area XII., off North Island.**

Date.	No. per Skate.	Weight per Skate.	Date.	No. per Skate.	Weight per Skate.
1910, January	14.2-7	630-3	1911, October	16.8-1	278-2
,, February	15.6-12	404-11	1912, January	...	41-2
,, March	20.7-7	951-4	,, May	37.7-4	385-4
,, April	48.3-3	1,326-4	,, June	16.6-6	537-10
,, October	30.1-1	...	1914, February	15.3-4	288-4
1911, January	19.1-1	...	,, March	...	417-1

* Number of records used in reaching averages indicated in each case by figure following hyphen.

*Table 53.—Number and Weight per Skate caught on Area XI., West Coast of Queen Charlottes.**

Date.	No. per Skate.	Weight per Skate.	Date.	No. per Skate.	Weight per Skate.
1911, April	33.24	1,058-3	1912, March	13.6-5	...
,, May	9.6-7	...	,, June	16.1-1	236-2
,, June	11.0-1	...	,, July	6.9-2	202-2
,, July	12.3-1	194-1	,, August	3.7-2	152-2
,, September	14.7-6	321-10	,, December	5.3-1	208-1
,, October	9.1-1	250-1	1913, October	...	150-1
1912, January	2.6-8	248-4	1914, March	6.0-1	72-2
,, February	18.0-9	168-1			

* Number of records used in reaching averages indicated in each case by number following hyphen.

*Table 54.—Weight and Number per Skate caught on the "Horseshoe."**

Date.	No. per Skate.	Weight per Skate.	Date.	No. per Skate.	Weight per Skate.
1906, May	8.7-1	250-1	1910, September	14.2-2	...
,, June	94.4-1	...	1911, April	13.8-1	238-1
,, July	62.7-4	729-2	,, July	50.2-5	532-2
1907, March	...	312-2	,, August	28.8-11	507-8
1908, May	25.0-1	...	1912, June	54.1-3	764-3
,, July	...	897-1	,, July	...	33-1
1909, March	5.2-2	143-1	,, September	13.2-1	173-2
,, August	32.1-5	456-4	1914, August	10.6-1	167-1
1910, July	36.8-4	...	,, September	8.8-1	83-1
,, August	27.7-1	556-1			

* Number of records from which each average is formed is given after the hyphen in each case.

*Table 55.—Average Number and Weight per Skate caught on Areas V., IX., and X.**

Date.	No. per Skate.	Weight per Skate.	Date.	No. per Skate.	Weight per Skate.
Area X., Cape Scott.			*Area X.*—Continued.		
1902, September	57.9-6	1,571-6	1908, October	15.9-4	187-5
,, October	32.5-4	916-4	1909, February	4.0-1	...
1903, January	7.3-1	...	,, March	8.5-6	437-1
1905, April	31.3-1	...	,, December	4.0-1	...
,, May	16.8-2	...	1910, January	6.1-6	...
1906, June	47.2-6	973-1	,, March	9.1-1	238-1
,, September	11.2-1	238-1	,, April	5.1-1	...
1907, March	...	333-1	,, May	...	808-2
1908, ,,	4.1-1	...	,, October	1.8-1	...
,, August	33.7-1	...	1911, March	10.0-3	...

* Number of records from which averages are formed indicated in each case by figure following hyphen.

Table 55.—Average Number and Weight per Skate.—Concluded.

Date.	No. per Skate.	Weight per Skate.	Date.	No. per Skate.	Weight per Skate.
Area X.—Concluded.			*Area V., Otter Passage.*†		
1911, April	7.2-6	112-3	1900, December	2.2-1	...
„ May	13.0-1	156-1	1910, March	3.2-2	...
1912, April	11.9-7	117-11	1912, February	9.7-1	272-2
„ May	3.9-1	...	„ March	8.5-8	202-0
„ September	...	119-1	„ April	15.5-5	312-8
1913, April	19.5-5	207-4	„ May	12.2-2	280-4
„ August	7.0-1	...	„ June	18.6-6	250-8
1914, March	17.4-1	278-1	„ July	...	150-1
„ May	7.8-3	288-4	„ September	12.9-4	193-5
„ June	...	73-1	„ November	2.8-4	91-1
„ September	...	90-1	1913, April	...	136-2
„ October	0.7	...	„ May	3.0-1	...
1915, July	...	56-1	„ October	5.8-1	...
Area IX., Hope Island.			„ November	2.1-1	...
1906, February	2.8-1	...	„ December	0.5-1	...
1908, January	5.3-1	...	1914, January	7.2-2	163-1
1909, March	2.0-1	...	„ February	4.5-1	111-2
„ November	3.5-1	...	„ May	12.3-1	213-3
1910, April	...	446-2	„ June	7.0-1	119-1
1911, March	14.7-1	...	„ August	6.5-1	132-2
„ April	9.4-14	132-3	„ October	0.7-1	...
„ May	5.4-1	33-1			
1912, May	4.9-1	81-2			
1913, October	5.2-1	...			
1914, August	1.5-1	10-1			

† Includes Otter Passage, Shrub Island, Haycocks, and Estevan.

*Table 56.—Average Number and Weight per Skate caught on Areas XIV. and XV., Virago Sound and Masset.**

Date.	No. per Skate.	Weight per Skate.	Date.	No. per Skate.	Weight per Skate.
1905, February	12.6-1	...	1911, August	10.9-1	...
1906, November	24.9-2	472-2	„ October	24.6-1	440-4
1907, October	58.3-7	745-4	„ December	4.2-2	135-2
„ November	17.9-4	456-8	1912, February	2.9-1	...
1908, April	1.9-2	...	„ March	0.3-1	...
„ September	66.5-7	787-9	„ July	21.6-3	212-5
„ December	1.5-1	...	„ August	53.7-2	1,000-1
1909, January	3.3-3	...	„ September	31.1-4	276-6
„ September	17.7-5	276-3	„ October	34.9-1	225-2
„ October	20.0-11	271-5	„ November	...	139-4
„ November	20.7-1	...	„ December	1.6-1	...
„ December	5.7-3	...	1913, April	4.7-1	59-1
1910, March	8.0-1	...	„ July	21.9-8	125-4
„ October	37.4-5	...	„ September	...	120-4
„ November	18.8-2	...	„ October	...	78-6
„ December	5.8-1	...	1914, July	7.6-2	100-1
1911, January	...	513-1	1915, June	...	138-7

* Number of records from which each average is formed indicated by figure following hyphen.

VI. SUMMARY.

The conclusions may be summarized first in the order in which they were reached in the text, and then, briefly, in that utilized in stating the objects of the paper.

(1.) THE SHIFT OF THE FISHING-GROUNDS.

The location of the most intense fishery is shown to have shifted year by year to a greater distance.

The comparison of the average depths at which fishing was done indicates a change to deeper waters in 1910.

The plotted fishing records for one period before and one after 1910 illustrate this change, which was to the coast outside the Queen Charlottes and Alaska.

That a similar change took place in Alaska is shown by quotations and statistics from the reports of United States Government agents.

Statistics as to the localities from which the fish landed in Seattle were obtained prove the extension of the most active fishery to banks still farther north.

The voyages made by the five vessels whose records are utilized prove this constant extension by their distribution in successive years.

The tendency to fish in deeper waters during the winter months than during the summer became apparent after the outer banks were utilized.

(2.) THE LENGTH OF THE VOYAGES.

The increase in the length of the voyages, due to depletion, was between 1.96 times and 3 times for a period of ten years.

The voyages were much longer during the winter than during the summer, January having an average 1.8 times that for June.

(3.) THE TIME SPENT IN FISHING AS COMPARED WITH THE OTHER PARTS OF THE VOYAGES.

The length of the voyages is not a direct measure of depletion, as it is composed of the time spent in passage, in fishing, and that lost during bad weather while on the grounds.

The time of passage did not increase save in response to the necessity of going to new and more distant banks.

The fishing-time increased 2¾ ti.. .n ten years, but faster in summer (four times in ten years) than in winter.

The time lost on account of bad weather during winter increased in the same proportion that the fishing-time did (1.8 times in ten years).

Although the actual fishing-time was longer in winter, the percentage of the total for the voyage was less.

The winter fishing, it is concluded from the above figures, tends to become increasingly more expensive than that in the summer.

(4.) THE YIELD.

(a.) The Catches by Weight.

The rate of decrease in the weight caught per skate on all grounds was 4.26 to 4.37 times in ten years; that is, the initial yield was that many times greater than the final in each decade.

The weight caught per skate was about half in January what it was in July, considering all banks.

The rate of decrease in weight caught per skate was higher in limited areas, being 4.4 to 4.77 times in ten years, or, as expressed in per cent., 77.3 to 79 per cent. This would be 71.6 to 73.8 per cent. if full allowance were made for the decrease in length of the skate.) This is a truer rate than that for the whole fishing-ground.

The seasonal fluctuation was the same for the limited areas as for all banks.

The rate of decrease shown by the weight of the cargoes landed, when combined with that for the fishing-time per voyage (on the ground that they supplement each other), gives the same rate of decrease which is found for the yield per skate. Since the cargoes were weighed at the docks this fact completely corroborates the latter rate of decrease.

The decreased size of cargoes in winter is shown very clearly, those for December and January being one-third to one-quarter of those for the best of the summer months.

(b.) The Catches by Number of Fish.

The number of fish caught per skate were at the beginning of each decade 3.38 to 4.05 times what it was at the end. This rate varies slightly from that found from the weight caught per skate, showing the decreasing average weight of the individual fish.

The seasonal variation in number caught per skate is proved to be very great, that for January being a quarter of that for July. In comparison with the lesser decrease or fluctuation in weight, this shows the increased weight of the fish in winter.

In obtaining the preceding results the variance between the figures for the relative productivity of the banks, when calculated for the weight and for the numbers, foreshadowed the difference in the average sizes characteristic of the various areas.

The decrease in numbers per skate is greater in the tables for separate areas than in those for the whole fishery, as was also found in the case of the weight.

The seasonal variation in number caught on the limited areas shows, when compared with the yield in weight, the same indications of a fluctuation in average seasonal weight of the fish as did the yield for the whole fishing area, and also corroborates the extent of seasonal changes.

There has been no distinct increase in the number of fish caught per voyage in response to the increase in the length of the voyages.

The average weight of, and numbers of, fish in the cargoes indicates that the average individual weight of the fish has fallen.

A comparison of averages for cargo weights and numbers also indicates that the average weight of individuals obtained in winter exceeds that of the summer fish.

(5.) SIZES OF FISH OBTAINED, FLUCTUATIONS IN.

The average weight is shown to have been lowered very markedly when statistics either from limited areas or from the whole are considered, using direct data from the catches.

The seasonal fluctuation is proved by the average weights of the individuals in the cargoes as a whole, by the averages for the separate records of catches, and by the comparison of average weight and average number taken per skate.

It is shown that in the case of Areas I., II., and III. the seasonal fluctuation corresponds closely to a year's growth, while it does not seem to do so on other banks with fewer records. An explanation is suggested.

The influence of depth on the size of fish caught remains unsettled. Although there is an apparent decrease with depth on the older banks, the introduction of newer and deeper banks results in a reversal of this relation.

Records of catches in weight classes show a correlation of average weight with number per skate, small fish being caught in larger numbers.

There is presented evidence of the presence of schools, or local populations of different composition as to sizes.

Increased reliance on young fish is evident from the examination of weight classes, both in the records from the whole and in those from limited parts of the fishing-ground.

The mature fish upon which propagation depends are shown to be depleted to a more serious extent than the immature or small. Their absence is shown to be due to commercial fishing, not being natural.

(6.) VARIATIONS IN AVERAGE SIZE OF FISH FROM DIFFERENT BANKS.

The average sizes in different areas are shown to differ markedly by comparisons of records of individual catches, in averages for months and seasons, and also in certain cases of cargoes which came from single banks. The banks nearest the open ocean seem to be characterized by small fish, while the more "sheltered" banks and the enclosed waters have large ones.

(7.) RELATIVE PRODUCTIVITY OF DIFFERENT BANKS.

The banks exploited last show the largest comparative yield.

The inner or along-shore banks were characterized by small yields but large fish, being apparently less productive naturally.

The fact of the impoverishment of the banks is evident in every phase of the above summary, the shifting location of the most intense fishery, the increased time and effort required to obtain a yield, the lowering of the average size of the fish on the banks, and the direct comparison of the productivity of depleted and undepleted banks. The rate at which this has taken place is definitely ascertained, and a careful examination of the possible ways of calculating it shows the correctness of that obtained through the yield per skate, while at the same time the evidence from every source is shown to concur in the result. It is therefore believed that the banks have depreciated in yield by weight between 70 and 80 per cent. each decade since their active use was begun.

In so far as the biology of the banks is concerned, a correlation between their position and the average sizes of their fish seems evident, and there are recorded seasonal changes in the average weights and the catch per unit of gear. Certain indications as to the "schooling" of the fish are given. The relative abundance of mature and immature fish and the relative productivity of different types of banks are ascertained as far as possible.

Table 57.—Average Length of Voyages per Vessel for each Month, in Hours.

Year.	Vessel.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1902	B	...	...	...	...	...	...	...	...	...	204	252	260
"	B	...	...	...	...	...	...	...	...	90	134	200	216
1903	B	319	246	219	120	176	167	156	116	145	240	300	234
"	D	208	208	...	...	...	...	...	...	...	...	...	...
1904	B	255	232	184	112	150	90	126	132	160	168	300	240
"	B	...	...	...	...	...	...	...	114	146	419	298	...
1905	B	240	263	304	174	180	168	165	162	190	233	300	221
1906	B	274	244	213	202	107	...	164	187	200	258	226	...
"	B	...	...	...	...	172	120	186	...	...	...	...	293
"	E	...	...	...	...	...	...	...	211	177	278	229	298
1907	A	...	...	...	...	...	...	219	192	256	147	...	403
"	C	370	303	283	198	195	168	103	231	177	...	227	247
"	D	361	277	320	261	208	178	198	160	...	308	304	376
"	E	329	375	329	228	199	136	...	205	216	300	280	364
1908	A	360	310	360	247	205	231	186	158	232	260	244	303
"	B	...	...	...	...	...	219	162	172	228	...	...	...
"	C	337	369	348	340	...	...	...	...	267	242	305	320
"	D	425	394	319	280	245	198	171	183	222	199	275	276
"	E	262	672	271	286	229	232	154	160	198	204	193	...
1909	A	342	327	254	199	160	146	154	258	252	301	258	337
"	C	258	308	275	...	...	...	...	...	...	310	426	372
"	D	366	320	320	242	146	201	182	243	196	420	382	410
"	E	351	312	280	176	135	199	168	279	...	...	...	...
1910	A	397	328	353	340	346	186	200	158	292	311	367	388
"	B	432	531	429	187	168	...	...	...	...	...	...	...
"	C	421	516	335	400	...	...	...	...	...	...	...	...
"	D	450	304	...	457	252	268	236	191	286	378	412	410
"	E	473	470	220	334	200	210	276	131	270	389	...	493
1911	A	479	376	345	290	245	272	263	267	286	340	468	504
"	B	241	608	469	274	277	249	319	294	286	316	429	...
"	C	...	...	...	285	227	267	221	...	...	...	...	275
"	D	540	464	213	330	358	252	263	324	332	348	374	264
"	E	589	271	335	324	282	281	327	311	324	349	458	537
1912	A	499	480	276	290	257	246	255	286	346	395	432	480
"	B	...	...	403	344	374	...	...	347	268	...	...	...
"	C	588	508	332	...	...	...	...	298	315	348	396	...
"	D	...	...	405	...	..	...	...	...	...	...	...	...
1913	A	350	372	360	336		288	372	372	312	420	576	384
"	B	...	...	...	395	.	...	...	...	437	460	...	...
"	C	...	...	434	318	...	...	...	...	413	408	483	443
1914	A	...	456	...	...	272	252	285	327	355	560	504	426
"	C	451	367	365	314	223	278	302	...	...	...	...	...
1915	A	...	...	...	...	284	292	269	335	302	452	...	...

Table 38.—Average Number of Hours spent Fishing per Vessel (Data unmodified).

Year.	Vessel.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1902	B	...	...	...	...	...	...	...	...	...	96	120	103
"	D	...	...	...	...	...	...	...	...	48	72	102	96
1903	B	104	96	103	24	72	...	48	38	06	132	72	60
"	D	103	...	...	...	...	...	...	...	...	...	...	...
1904	B	96	80	79	41	54	41	48	60	72	96	96	96
"	D	...	...	...	...	...	...	...	60	48	96	84	...
1905	B	108	120	103	96	72	72	...	80	90	144	108	72
1906	A	...	...	...	...	...	...	...	...	108	...	96	144
"	B	120	120	127	80	60	...	96	113	96	113	120	...
"	D	...	...	...	...	96	54	55	...	...	...	...	96
"	E	...	...	...	...	...	...	...	96	96	120	144	113
1907	A	132	108	120	...	...	...	...	96	77	144	96	84	120
"	B	...	...	...	...	..	120	72	72	108	.:.	...	...
"	D	96	96	120	168	80	65	72	72	...	132	108	144
"	E	120	120	144	120	70	84	...	113	96	144	96	108
1908	A	102	108	120	144	144	151	120	72	108	137	80	180
"	C	...	...	...	...	...	...	...	...	96	96	120	156
"	D	102	120	96	120	120	120	66	80	108	120	120	144
"	E	144	180	144	113	120	113	65	60	96	84	96	96
1909	A	156	192	192	96	82	70	84	120	144	168	144	228
"	C	168	144	180	...	...	...	...	...	144	168	192	216
"	D	156	144	168	156	...	96	96	108	132	216	192	192
"	E	156	204	156	70	115	96	...	144		..	...	...
1910	A	192	168	240	192	161	96	120	101		58	192	168
"	B	144	192	204	113	108	...	...	...		..	...	...
"	C	192	144	144	216	...	...	...	...	...	...	...	...
"	D	240	132	...	240	96	144	108	89	180	156	168	151
"	E	192	168	216	132	84	96	127	72	120	204	168	168
1911	A	168	288	192	228	168	180	151	175	192	192	216	144
"	B	96	144	192	168	144	120	168	180	168	151	192	168
"	C	...	...	...	168	137	192	132	...	...	...	...	168
"	D	144	96	156	180	144	113	168	168	144	192	120	264
"	E	144	72	168	168	161	144	168	204	168	180	168	72
1912	A	240	216	192	185	192	168	144	192	216	216	168	264
"	B	...	...	216	144	204	...	...	216	156	120	...	...
"	C	288	216	216	...	...	...	144	180	216	192	192	...
"	D	...	...	120	...	...	...	...	...	...	...	...	...
1913	A	...	...	...	240	240	204	264	204	216	228	168	216
"	B	...	...	...	240	336	...	...	...	144	156	...	...
"	C	...	...	288	180	168	...	...	...	240	240	156	240
1914	A	192	216	216	...	192	204	200	276	264	228	216	300
"	C	264	192	216	135	168	216	216	...	...	...	...	...
1915	A	336	312	288	312	276	216	216	223	240	264	...	...

*Table 59.- Weight of Fish caught per Skate by each Vessel.**

Date.	Vessel.	Jan.	Feb.	March.	April.	May.	June.
1902	D	...	...	...	...	...	...
1903	..	...	...	...	...	...	...
1904	D	...	...	...	...	...	...
1905	B	...	...	...	...	...	...
1906	D	...	...	...	...	395–11	973–1
„	E	...	...	...	...	...	...
1907	E	310–10	400–6	483–15	582–11	507–8	516–2
1908	A	...	...	...	...	...	...
„	B	...	...	...	...	...	...
„	C	...	...	...	...	...	...
„	D	375–4	375–4	302–5	375–4	...	476–5
„	E	270–12	271–11	326–11	281–10	234–5	536–1
1909	A	...	...	454–2	...	473–5	...
„	C	200–5	174–5	181–4	...	...	...
„	D	146–10	208–5	176–8	476–1	...	...
„	E	263–5	317–4	262–5	646–5	491–0	334–5
1910	A	...	...	...	...	...	...
„	B	...	382–3	287–4	483–3	808–2	...
„	C	...	...	238–1	...	...	...
„	E	500–4	330–8	333–2	665–9	386–6	...
1911	A	...	...	...	739–3	889–7	743–7
„	B	787–3	302–3	226–6	152–14	368–15	473–10
„	C	...	...	...	...	...	...
„	D	...	...	...	...	...	1,351–1
„	E	226–2	407–3	148–3	323–3	559–3	...
1912	A	100–1	133–7	217–22	219–27	291–26	287–25
„	B	...	...	164–7	282–2	164–15	...
„	C	145–11	168–1	83–1	...	...	...
1913	A	...	...	...	125–12	206–16	205–9
„	B	...	...	...	138–13	207–14	...
„	C	...	...	117–8	129–14	170–6	...
1914	A	106–3	265–10	136–8	111–3	204–13	171–14
„	C	89–6	95–13	122–26	173–24	290–16	100–18
1915	A	...	...	...	...	202–2	142–12

Date.	Vessel.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1902	D	...	...	1,307–10	1,000–8	...	...
1903	..	...	...	...	...	...	...
1904	D	...	...	...	233–3	324–3	...
1905	B	...	...	...	...	...	...
1906	D	139–1	...	...	...	...	...
„	E	...	438–2	649–3	201–6	650–9	453–5
1907	E	...	430–5	315–8	609–9	454–12	324–7
1908	A	...	...	594–2	...	...	...
„	B	762–3	...	...	...	...	...
„	C	...	...	365–4	240–4	350–7	253–8
„	D	692–9	454–12	...	187–5	384–6	259–11
„	E	...	...	...	...	1,011–1	...
1909	A	...	...	...	...	...	...
„	C	...	...	211–12	161–12	193–8	...
„	D	...	...	...	...	...	...
„	E	...	456–4	...	...	...	...
1910	A	...	...	500–1	208–1	...	...
„	B	...	...	...	...	...	...
„	C	...	...	...	...	...	...
„	E	...	556–1	...	146–2	...	...
1911	A	387–7	320–19	317–21	265–21	151–19	152–6
„	B	270–12	290–15	329–15	151–11	321–7	358–2
„	C	146–2	...	...	...	...	38–2
„	D	...	...	...	...	...	...
„	E	450–3	414–7	...	486–2	377–5	340–3
1912	A	264–17	414–18	206–14	208–12	166–8	122–3
„	B	...	...	277–13	131–7	...	...
„	C	371–5	290–11	171–11	162–7	110–14	...
1913	A	78–6	69–1	143–4	117–12	97–6	167–2
„	B	...	...	...	...	...	...
„	C	...	...	178–16	89–21	74–8	100–7
1914	A	143–12	125–14	120–13	69–4	97–3	...
„	C	133–29	63–1	...	...	...	...
1915	A	138–18	128–18	111–5	...	...	...

* Number of records from which each average was obtained follow it, separated by a hyphen.

*Table 60.—Average Weight caught per Skate on Areas I., II., and III. (uncorrected for Bank Variation).**

Date.	Area.	Jan.	Feb.	March.	April.	May.	June.
1902	I.	...	...	...	...	...	...
„	II.	...	...	...	...	...	...
1904	II.	...	...	...	...	...	...
1905	II.	...	...	...	...	...	...
1906	I.	...	...	...	...	333–1	...
„	II.	...	...	...	...	104–1	...
„	III.	...	...	...	...	490–4	...
1907	II.	341–8	413–5	292–2	...	317–2	...
„	III.	187–2	...	726–7	567–10	...	...
1908	I.	...	...	...	...	546–6	515–2
„	II.	347–4	417–2	335–4	380–3	...	...
„	III.	240–7	260–13	347–8	286–11	...	526–5
1909	I.	...	...	229–11	...	241–5	536–1
„	II.	212–16	313–7	101–2	...	...	417–1
„	III.	...	311–3	319–3	538–6	521–1	312–2
1910	II.	111–1	...	179–1	...	496–12	...
„	III.	...	...	...	...	...	...
1911	I.	...	...	...	...	386–6	...
„	II.	...	375–1	168–1	...	337–3	...
„	III.	...	...	...	264–3	335–7	...
1912	I.	...	...	83–1	...	559–3	...
„	II.	92–4	...	255–7	125–2	254–11	237–7
„	III.	...	...	...	125–2	88–3	83–1
1913	I.	...	...	...	140–16	...	...
„	II.	...	...	110–3	255–9	143–9	...
„	III.	...	...	...	120–6	195–4	...
1914	I.	...	...	75–7	...	42–1	...
„	II.	95–5	39–2	134–21	170–27	276–21	124–14
„	III.	...	...	...	...	...	...
1915	I.	...	...	...	...	56–1	...
„	II.	...	...	...	...	159–12	...

Date.	Area.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1902	I.	...	...	889–2	...	...	...
„	II.	...	...	931–2	1,085–4	...	...
1904	II.	...	...	...	233–3	324–3	...
1905	II.	...	...	...	...	...	...
1906	I.	...	437–2	854–2	...	...	...
„	II.	...	...	...	201–6	701–7	342–5
„	III.	...	...	...	...	...	...
1907	II.	...	475–4	381–6	...	439–6	322–3
„	III.	...	250–1	118–2	...	...	...
1908	I.	694–1	...	...	...	...	...
„	II.	514–17	449–2	382–3	219–4	363–9	148–9
„	III.	694–1	...	...	...	...	281–8
1909	I.	...	...	...	11–1	...	...
„	II.	...	...	245–4	92–1	223–3	...
„	III.	...	...	...	...	196–5	...
1910	II.	...	...	500–1	208–1	195–4	...
„	III.	...	...	...	...	...	...
1911	I.	321–5	134–7	194–1	...	...	...
„	II.	...	270–4	336–10	245–6	115–7	154–4
„	III.	...	438–10	424–8	229–3	83–5	...
1912	I.	105–2	42–1	33–1	...	...	...
„	II.	393–4	371–23	160–5	209–12	136–12	...
„	III.	...	..	363–8	201–12	...	...
1913	I.	...	...	...	...	...	...
„	II.	75–2	...	188–15	58–4	95–2	92–3
„	III.	83–1	...	...	101–4	...	424–4
1914	I.	129–17	165–7	...	...	...	...
„	II.	...	63–1	106–3	97–1	...	...
„	III.	...	...	185–4	...	...	...
1915	I.	129–8	135–8	129–3	...	...	...
„	II.	...	...	83–1	...	...	...

* Number of records from which each average is formed indicated by figure following hyphen in each case.

*Table 61.—Average Weight of Cargoes as landed by each Vessel (Data uncorrected for Vessel Variation).**

Date.	Vessel.	Jan.	Feb.	March.	April.	May.	June.
1902	D	...	...	...	...	...	...
1905	B	83,875–1	140,520–1	109,112–3	146,962–3	...	...
1906	B	108,560–2	152,755–3	208,633–3	139,843–3	121,313–5	...
„	C	...	...	...	...	...	...
„	D	...	...	...	...	101,615–2	141,235–3
1907	A	...	...	...	...	...	...
„	C	80,975–2	120,245–1	126,737–2	95,644–3	104,826–3	114,186–4
„	D	153,515–1	131,342–2	85,517–2	153,655–1	89,033–3	169,600–3
1908	A	...	...	...	160,070–1	181,548–3	221,594–3
„	C	68,882–2	104,007–2	81,438–2	111,840–1	104,826–3	...
„	D	63,725–1	55,830–1	39,375–1	108,665–2	89,033–3	141,063–3
1909	A	36,955–2	83,105–1	128,397–3	161,887–2	123,289–5	122,463–3
„	C	42,000–1	46,000–1	96,000–1	...	...	...
„	D	40,660–2	45,452–2	49,260–2	...	104,250–2	...
1910	A	47,403–2	70,065–1	118,026–2	73,335–2	189,198–3	158,000–3
1911	A	53,985–1	114,305–2	138,575–2	223,460–1	156,970–2	200,814–2
„	B	105,000–1	...	...	73,000–1	174,000–1	198,000–1
„	C	...	...	...	...	...	...
„	D	...	...	...	...	...	217,400–1
1912	A	37,900–1	91,900–1	145,897–2	128,151–3	167,692–2	144,817–3
„	B	...	...	...	...	...	...
„	C	20,700–1	...	...	...	...	...
1913	A	...	...	...	87,884–1	132,428–2	219,473–2
„	B	...	...	...	...	...	...
„	C	...	...	...	...	75,800–1	...
1914	A	41,797–1	67,192–2	42,620–1	...	115,838–3	86,229–2
„	C	...	43,653–1	56,500–2	74,885–2	116,560–2	93,540–2
1915	A	...	...	...	...	...	86,945–1

Date.	Vessel.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1902	D	...	...	105,200–5	125,670–3	...	85,000–1
1905	B	...	151,100–3	120,739–4	90,705–2	78,947–2	128,935–2
1906	B	138,313–3	177,695–3	142,618–3	101,675–3	...	...
„	C	...	...	...	...	...	120,095–1
„	D	127,208–3	...	...	...	...	78,150–1
1907	A	...	...	250,000–1	...	...	320,000–1
„	C	92,782–2	138,093–3	85,250–2	...	119,295–2	78,917–2
„	D	103,630–3	...	...	144,330–2	106,076–2	41,005–1
1908	A	154,425–2	126,127–2	172,405–2	124,637–3	132,032–3	68,137–2
„	C	...	...	108,000–1	60,000–1	130,000–1	54,000–1
„	D	117,950–3	104,706–4	143,722–2	...	74,017–2	83,612–2
1909	A	140,277–4	114,240–2	153,990–1	100,410–2	76,562–2	72,636–2
„	C	...	...	75,250–2	115,000–1	125,000–1	...
„	D	130,033–3	97,120–3	180,350–1	...	...	...
1910	A	167,178–3	104,223–4	160,340–1	150,237–2	78,325–1	32,957–1
1911	A	184,337–3	146,953–3	134,168–2	109,025–1	101,650–2	33,150–1
„	B	98,500–1	199,000–1	181,000–1	46,000–1	113,000–1	...
„	C	...	...	...	...	...	17,500–1
„	D	187,700–1	...	...	175,795–1	...	...
1912	A	76,085–2	182,857–2	127,078–2	76,298–2	42,005–1	...
„	B	...	...	...	34,500–1	...	...
„	C	...	...	97,200–2	...	...	...
1913	A	113,400–2	124,098–2	68,590–1	61,814–2	35,340–1	48,180–1
„	B	...	...	86,980–1	44,670–2	21,265–2	24,065–1
„	C	...	...	76,175–1	...	...	...
1914	A	126,320–3	77,508–2	77,815–1	23,985–2	...	...
„	C	70,500–2	...	...	...	...	...
1915	A	99,828–2	96,000–1	...	...	...	...

* Number of records from which each average is formed indicated by number following hyphen in each case.

*Table 62.—Average Number of Fish caught per Skate, by Month and Vessel.**

Date.	Vessel.	Jan.	Feb.	March.	April.	May.	June.
1902	D	...	...	...	...	...	...
1903	D	19.5–9	...	...	...	...	...
1904	D	...	...	...	...	...	...
1905	B	...	21.9–6	24.3–12	32.9–11	27.2–9	...
1906	A	...	...	...	...	...	...
"	B	...	21.1–4	18.0–15	22.3–8	...	...
"	D	...	...	...	...	17.5–12	50.6–8
"	E	...	...	...	...	...	...
1907	A	5.3–8	13.5–7	11.5–10	...	...	...
"	E	17.3–3	...	...	...	...	...
1908	A	3.7–9	5.4–9	5.4–10	14.5–10	28.3–6	32.3–4
1909	C	...	...	...	...	...	...
"	D	...	20.7–4	13.2–6	42.2–7	24.6–6	29.1–9
"	E	...	...	...	...	8.4–2	19.4–1
1909	A	3.4–3	6.0–10	7.8–16	25.9–9	22.8–15	29.5–7
"	C	2.1–5	3.4–2	7.9–5	...	...	...
"	D	6.4–13	4.5–11	7.7–14	9.3–9	...	...
"	E	12.7–12	6.1–15	7.6–14	16.6–9	21.8–11	15.7–12
1910	A	5.9–18	3.6–4	9.8–11	19.0–11	12.1–3	30.3–11
"	B	...	...	2.6–1	...	...	...
"	C	5.1–2	14.3–6	6.6–2	...	...	...
"	E	13.3–6	10.5–8	22.0–8	48.5–8	16.4–6	...
1911	A	7.7–7	20.9–8	9.6–10	27.9–10	44.1–12	21.4–13
"	B	...	...	10.3–6	10.1–14	26.8–15	24.5–10
"	C	...	...	...	5.9–15	19.4–10	16.3–5
"	E	...	20.8–3	11.8–9	14.2–12	15.3–14	5.5–2
1912	A	2.5–9	13.7–10	10.1–19	9.8–16	23.3–17	20.5–18
"	B	...	...	13.5–5	8.3–5	10.3–16	...
"	C	1.4–2	12.3–5	9.2–9	...	...	...
1913	A	...	...	...	7.7–2	14.1–18	26.3–7
"	B	...	...	...	13.9–13	11.0–14	...
"	C	...	...	2.7–6	...	...	...
1914	A	5.9–8	14.7–9	6.3–7	10.6–2	17.9–12	13.9–15
"	C	0.7–1	1.4–1	2.5–1	2.1–1	...	1.5–1

Date.	Vessel.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1902	D	...	...	51.5–8	34.8–9	31.0–2	33.7–4
1903	D	...	...	...	...	...	...
1904	D	...	...	73.6–2	9.7–4	26.8–3	...
1905	B	...	...	...	...	...	...
1906	A	...	...	...	...	...	32.4–7
"	B	...	...	...	...	...	...
"	D	64.3–6	...	...	...	...	...
"	E	...	34.4–2	48.6–3	9.1–6	21.0–8	27.9–2
1907	A	...	33.9–7	19.3–8	47.2–9	17.7–7	9.3–7
"	E	...	...	...	18.6–1	...	...
1908	A	55.1–1	23.7–2	27.0–5	23.2–6	10.8–8	11.4–8
1909	C	...	...	31.5–2	...	13.4–6	6.5–4
"	D	20.7–10	19.2–11	59.4–7	15.9–4	10.5–10	8.9–13
"	E	...	...	...	...	23.8–1	...
1909	A	36.1–8	25.3–2	28.1–4	11.9–13	8.2–12	5.8–15
"	C	...	...	17.3–15	12.7–14	6.9–11	5.9–14
"	D	...	...	...	...	...	...
"	E	...	32.1–5	...	...	...	...
1910	A	22.3–2	24.0–5	21.3–15	35.5–9	12.3–7	4.9–6
"	B	...	...	...	...	...	...
"	C	...	...	...	...	...	...
"	E	35.6–7	51.9–3	24.3–2	27.5–5	...	7.7–3
1911	A	32.8–15	25.7–11	20.6–17	13.9–10	12.4–8	4.0–6
"	B	16.7–13	20.3–15	22.1–15	9.7–12	11.4–13	...
"	C	...	...	...	...	...	1.6–2
"	E	20.9–8	18.3–8	...	16.7–1	...	...
1912	A	28.6–10	24.7–17	19.1–11	20.3–10	4.6–10	3.5–8
"	B	...	...	19.2–15	9.9–7	...	...
"	C	5.0–1	36.0–1	...	17.9–1	36.0–1	...
1913	A	7.7–8	15.0–2	8.7–7	5.7–11	5.8–7	6.8–3
"	B	...	...	11.8–3	...	...	...
"	C	...	...	...	...	1.5–3	1.9–3
1914	A	8.3–13	8.7–15	7.3–12	2.5–8	3.7–6	...
"	C	1.1–1	...	...	...	...	...

* Number of records on which averages are based indicated by figure following hyphen in each case.

*Table 63.—Number of Fish per Cargo, by Vessel and Month.**

Date.	Vessel.	Jan.	Feb.	March.	April.	May.	June.
1902	B	...	...	...	...	...	...
„	D	...	...	...	...	...	...
1903	B	3,492–2	6,795–2	8,137–3	4,724–4	6,059–4	...
„	D	3,483–2	...	...	...	...	...
1904	B	6,219–2	3,929–3	6,128–3	5,590–3	5,625–4	3,395–3
„	D	...	...	...	...	...	...
1905	B	6,457–2	5,819–2	5,015–3	7,924–3	5,777–4	5,390–1
1906	B	4,817–2	7,099–3	6,399–3	6,038–3	6,759–5	...
„	D	...	...	...	...	4,938–3	8,959–4
„	E	...	...	...	...	...	...
1907	A	1,207–1	5,459–1	4,317–2	...	...	...
„	C	3,681–2	5,991–2	2,810–2	6,288–2	6,424–3	7,481–3
1908	A	1,471–1	1,621–2	2,141–2	2,206–1	...	...
„	C	3,729–2	4,117–2	2,511–2	5,956–1	...	...
„	D	...	...	3,450–1	8,514–1	9,151–1	9,341–2
1909	A	1,345–1	...	4,104–2	9,347–2	5,378–4	10,809–2
„	C	...	...	3,141–1	...	...	...
„	D	1,745–2	1,547–2	2,579–2	4,184–1	...	...
„	E	3,279–2	2,885–1	3,348–2	4,692–3	4,362–4	7,021–1
1910	A	2,139–2	1,945–1	5,245–2	7,243–2	14,865–3	11,397–2
„	C	...	3,609–1	...	...	...	...
„	E	...	...	3,907–1	6,128–1	5,095–1	...
1911	A	2,764–1	5,206–2	5,630–2	10,553–2	12,091–2	9,253–3
„	B	...	...	...	4,526–2	14,431–3	9,094–2
„	C	...	...	...	3,397–2	11,353–1	4,812–1
„	E	...	...	...	...	5,628–1	...
1912	A	1,139–1	3,827–1	5,447–2	5,865–3	12,020–2	8,877–3
„	B	...	...	4,158–1	2,768–1	6,150–1	...
1913	A	...	...	...	...	11,948–2	17,757–2
1914	A	2,686–1	3,503–1	2,185–1	...	11,422–3	6,464–2

Date.	Vessel.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1902	B	...	...	...	5,665–1	...	4,535–3
„	D	...	...	4,108–5	4,636–3	4,235–2	5,674–2
1903	B	4,573–5	5,060–5	6,185–4	...	3,393–2	3,068–4
„	D	...	...	...	...	...	...
1904	B	6,292–2	6,794–4	4,917–3	5,434–2	1,804–2	4,149–2
„	D	...	...	5,300–1	1,770–1	734–1	...
1905	B	...	5,741–3	7,265–4	2,731–2	2,710–2	3,880–2
1906	B	9,220–3	11,354–4	7,817–4	4,580–4	...	...
„	D	7,319–3	...	...	...	...	...
„	E	...	...	...	...	7,081–1	...
1907	A	...	4,385–3	4,228–1	1,816–2	3,627–1	1,591–1
„	C	8,286–3	7,928–3	4,916–2	3,387–1	7,910–1	3,427–2
1908	A	...	...	1,339–1	...	5,148–2	4,073–2
„	C	...	...	...	...	4,887–1	...
„	D	4,031–3	4,871–4	...	...	2,753–2	2,745–2
1909	A	12,084–2	11,465–1	11,352–1	5,644–2	3,510–3	2,902–1
„	C	...	...	5,443–1	7,335–2	4,354–1	...
„	D	...	...	...	...	...	...
„	E	...	11,006–1	...	...	...	...
1910	A	13,839–4	7,520–4	11,999–2	12,663–2	4,642–1	2,075–1
„	C	..	...	...	...	...	...
„	E	...	9,500–1	...	...	...	...
1911	A	15,530–2	9,071–3	8,235–2	5,432–2	4,694–1	1,243–1
„	B	7,082–2	12,651–1	11,608–2	4,863–2	5,119–1	2,085–1
„	C	...	...	...	...	...	...
„	E	...	...	...	...	...	...
1912	A	6,290–2	12,408–2	10,007–2	6,296–2	1,915–1	974–1
„	B	...	...	8,051–2	3,225–1	...	...
1913	A	6,647–2	6,004–2	3,912–1	3,131–2	1,924–1	2,922–1
1914	A	6,396–3	5,764–2	...	1,960–2	2,208–1	...

* Number of records on which each average is based given by figure following hyphen in each case.

*Table 64.—Average Number caught per Skate, given by Areas.** (See charts on pages 123-125.)

Date.	Area.	Jan.	Feb.	March.	April.	May.	June.
1902	I.	...	...	...	...	...	...
„	II.	...	...	...	...	...	...
1903	II.	15.8–6	...	7.7–1	...	...	...
1904	II.	...	...	...	...	...	...
1905	I.	...	...	4.1–1	46.7–3	13.5–1	...
„	II.	...	23.7–5	30.9–8	35.3–5	37.0–3	...
„	III.	...	...	18.9–2	17.1–5	...	...
1906	I.	...	...	8.9–2	18.4–1	25.5–3	27.4–1
„	II.	...	37.4–2	12.8–5	...	26.3–5	...
„	III.	...	...	...	35.3–3	8.3–1	...
1907	I.	...	...	12.9–1	...	...	...
„	II.	9.2–10	13.0–7	12.6–8	...	...	...
„	III.	2.3–1	...	...	...	...	...
1908	I.	6.8–1	7.0–4	7.4–6	10.7–2	31.4–9	37.7–5
„	II.	2.3–1	7.0–6	14.6–5	36.9–11	33.1–3	20.6–6
„	III.	3.3–2	...	5.1–1	...	...	...
1909	I.	...	...	12.8–12	25.9–9	31.2–1	29.8–8
„	II.	9.1–25	5.3–23	3.9–6	...	41.2–1	12.2–9
„	III.	...	6.3–7	6.0–18	13.4–18	16.7–16	...
1910	I.	...	...	13.3–2	19.1–6	...	9.6–2
„	II.	5.3–5	...	7.9–1	...	12.1–3	23.8–4
„	III.	...	3.2–3	2.0–1	17.3–1	16.4–6	...
1911	I.	...	...	...	17.0–5	31.7–12	21.7–6
„	II.	8.1–6	20.8–3	14.1–4	...	31.7–7	...
„	III.	...	...	3.3–2	11.3–9	14.3–12	...
1912	I.	...	...	8.2–1	2.5–1	22.3–8	23.2–9
„	II.	2.6–2	...	10.7–9	10.1–2	5.2–2	...
„	III.	...	...	...	...	...	...
1913	I.	...	...	...	22.4–6	12.3–7	...
„	II.	...	...	2.7–1	18.2–5	9.9–4	8.6–2
„	III.	...	...	...	...	3.2–1	...
1914	I.	...	...	3.5–2	...	20.6–6	17.6–5
„	II.	4.1–5	...	7.4–1	7.8–3	...	...
„	III.	...	...	...	...	...	...

Date.	Area.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1902	I.	...	...	44.7–2	...	...	...
„	II.	...	...	32.2–2	44.4–4	31.0–2	33.7–4
1903	II.	...	...	...	...	...	...
1904	II.	...	...	62.8–1	12.0–3	26.8–3	...
1905	I.	...	...	...	...	...	...
„	II.	...	...	...	...	...	...
„	III.	...	...	...	...	...	...
1906	I.	...	34.3–2	67.0–2	...	...	...
„	II.	...	...	...	9.1–6	20.5–7	32.4–7
„	III.	67.3–2	...	...	...	...	12.2–1
1907	I.	...	...	...	...	...	...
„	II.	...	32.2–8	21.7–4	19.4–1	17.5–3	12.8–3
„	III.	...	...	...	...	...	...
1908	I.	...	...	...	...	...	34.1–1
„	II.	18.9–16	18.4–2	22.1–4	25.0–5	12.3–16	9.4–12
„	III.	...	...	...	...	...	...
1909	I.	36.1–8	...	...	0.7–1	...	...
„	II.	...	10.1–1	19.9–9	8.5–10	7.4–6	7.0–17
„	III.	...	...	...	...	9.1–12	3.5–1
1910	I.	22.3–2	54.8–4	...	...	...	...
„	II.	...	16.3–2	46.5–8	14.9–1	14.9–8	6.7–2
„	III.	...	...	...	...	...	7.6–1
1911	I.	24.1–6	6.1–2	6.5–1	...	...	...
„	II.	...	12.3–5	22.5–9	11.8–5	6.7–1	4.9–5
„	III.	...	25.3–7	26.3–9	14.0–4	...	0.7–2
1912	I.	15.4–1	1.8–1	...	...	...	...
„	II.	5.0–1	26.0–14	12.1–4	15.7–5	16.4–3	...
„	III.	...	...	26.0–8	15.7–2	...	...
1913	I.	...	...	...	...	...	...
„	II.	5.5–2	...	10.4–4	3.7–1	4.6–4	2.3–1
„	III.	...	...	...	2.6–1	...	1.5–2
1914	I.	...	16.9–5	...	...	...	...
„	II.	7.4–1	...	7.0–4	3.5–4	...	...
„	III.	...	...	11.1–3	...	...	...

* Number of records on which each average is based given in each case by figure following hyphen.

*Table 65.—Average Size of Fish caught in Areas I., II., and III., by Months.**

Date.	Area.	Jan.	Feb.	March.	April.	May.	June.
1902	I.	...	...	...	...	...	...
„	II.	...	...	...	...	...	...
1904	II.	...	...	...	...	...	...
1905	II.	...	...	...	...	18.8–1	...
1906	I.	...	...	...	...	18.9–1	...
„	II.	...	...	...	...	21.9–4	...
„	III.	...	...	...	...	33.9–1	...
1907	II.	20.4–3	...	...	...	...	...
1908	II.	...	24.8–2	23.2–4	11.4–5	...	25.0–5
„	III.	...	...	...	...	34.3–2	...
1909	I.	...	...	16.8–11	...	...	11.0–1
„	II.	24.5–13	24.6–2	44.5–1	...	25.6–1	18.5–2
„	III.	...	39.5–3	39.9–3	31.7–7	24.7–15	...
1910	I.	...	...	...	...	...	...
„	II.	21.5–1	...	...	...	...	...
„	III.	...	...	...	...	24.4–6	...
1911	I.	...	...	...	9.9–1	13.0–3	...
„	II.	...	14.2–1	15.7–1	...	10.2–7	...
„	III.	...	...	31.2–1	26.1–3	21.4–3	...
1912	I.	...	...	10.2–1	...	10.9–8	11.5–8
„	II.	...	...	27.8–3	14.3–2	...	...
„	III.	...	...	...	...	...	...
1913	I.	...	...	...	8.3–6	10.4–4	...
„	II.	...	...	...	11.0–5	10.7–2	...
„	III.	...	...	...	...	13.2–1	34.0–2
1914	I.	...	...	10.7–2	...	8.5–9	12.0–4
„	II.	12.1–1	...	11.2–1	11.8–1	...	...
„	III.	...	...	...	...	...	...

Date.	Area.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Average.†
1902..	I.	...	...	19.8–2	...	...	...	19.8
„ ..	II.	...	...	29.5–2	27.2–4	...	...	27.9
1904..	II.	...	...	...	20.4–3	29.3–4	...	25.5
1905..	II.	...	...	...	...	...	...	18.8
1906..	I.	...	14.7–3	12.6–2	...	...	...	14.7
„ ..	II.	...	...	...	22.9–7	29.9–10	...	26.1
„ ..	III.	...	12.9–1	...	...	...	28.5–1	25.1
1907..	II.	...	...	...	...	...	...	20.4
1908..	II.	31.2–16	21.7–2	13.2–3	...	26.6–12	28.6–6	25.4
„ ..	III.	...	...	...	...	42.5–1	31.3–8	32.8
1909..	I.	...	...	...	...	...	...	16.3
„ ..	II.	...	...	15.9–3	16.4–1	24.1–3	...	23.5
„ ..	III.	...	...	...	...	26.4–4	...	29.2
1910..	I.	...	13.3–1	...	...	...	...	13.3
„ ..	II.	...	...	12.0–1	13.9–1	11.1–3	...	13.5
„ ..	III.	...	...	...	...	...	...	24.4
1911..	I.	11.1–2	15.4–2	29.8–1	...	...	...	14.6
„ ..	II.	...	21.3–3	15.1–9	20.4–5	19.1–2	28.1–2	16.6
„ ..	III.	...	16.7–7	14.6–8	12.3–3	...	...	17.8
1912..	I.	11.5–2	...	...	...	...	...	11.2
„ ..	II.	...	18.2–11	12.2–4	11.9–3	18.1–2	...	17.3
„ ..	III.	...	...	14.4–8	13.0–2	...	...	14.1
1913..	I.	...	...	...	...	...	...	9.1
„ ..	II.	12.8–1	...	15.4–2	...	16.5–1	...	12.4
„ ..	III.	10.8–1	...	...	27.9–3	...	...	20.3
1914..	I.	...	7.2–4	...	...	...	...	9.2
„ ..	II.	...	...	11.9–3	10.4–1	...	...	11.6
„ ..	III.	...	...	15.5–3	...	...	...	15.5

* Number of records on which each average is based indicated by figure following hyphen in each case.
† Based on the sum of individual records, not on monthly averages.

Table 66.—Average Weights of Fish and Depths at which caught on Various Banks.

Date.	Depth, Fathoms.	Weight, Lb.
North-west Corner, Goose Island.		
1906, May	51	18.0
1912, March	56	10.2
1913, April	53	6.7
" "	52–56	7.8
" "	51	7.8
" "	52–56	8.3
" "	51	9.3
" May	51	7.0
" "	51	9.3
" "	51	10.9
Gravel Grounds, Goose Island.		
1906, Sept.	58	12.0
" "	57–67	13.2
1909, June	28–41	11.0
1914, May	52	8.9
South-east Corner, Goose Island.		
1906, Aug.	30–38	16.5
1909, March	32–60	20.5
1912, May	42	8.6
Cape Scott.		
1902, Sept.	65	20.3
" "	60	26.0
" "	60	37.0
" Oct.	45–55	22.6
" "	48–68	25.2
" "	60	31.4
" "	58–65	35.5
1906, June	45–65	15.2
" "	45–50	15.3
" "	48	15.3
" "	46–54	15.3
" Sept.	33–38	21.3
" "	33–45	23.0
1909, March	33–48	22.3
1911, May	30	12.0
1913, April	39–49	20.9
Horseshoe.		
1909, Aug.	48–60	16.0
1911, "	30–40	14.0
Vicinity of Otter Passage.		
1912, June	50–65	13.7
" "	60–75	14.7
" "	55–90	17.6
" March	55–90	24.1
" "	120–45	26.9
" "	50–120	28.2
Inside Gulley, North Island.		
1910, Jan.	105	23.4
" "	70	29.1
***Inside Gulley, North Island*—Concluded.**		
1910, Jan.	85–95	33.4
" Feb.	200	16.5
" "	50–60	18.4
" "	80–106	30.2
" "	100–200	31.2
" April	120	12.2
" "	140–180	12.6
Two Peaks.		
1904, Nov.	40–45	26.1
1911, May	35	8.4
" "	25–40	9.5
" "	16–30	9.7
" "	16–30	10.9
" "	38	10.9
" "	15–57	11.4
" Sept.	48–70	20.0
1912, March	90	26.3
" "	90	29.5
" Sept.	18–40	8.0
White Rocks.		
1902, Sept.	45–55	28.5
" Oct.	40	31.0
1904, Nov.	26–30	33.7
1906, May	11–14	32.8
1909, Nov.	35	13.2
" "	14–20	29.7
Reef Island.		
1909, March	15–50	39.0
" "	40–80	45.0
" April	20–25	26.1
" "	17–25	29.8
" "	15	32.6
" May	17–19	16.3
" "	16–17	18.1
" "	16–17	22.5
" "	15	38.5
1910, "	19–21	27.5
" "	17	28.0
1911, "	15–17	16.6
" "	17–24	17.1
1912, Sept.	52–60	14.8
1913, May	18	13.2
Skidegate.		
1910, May	17–20	20.0
" "	16	22.2
" "	17	24.2
" "	14	24.4
1911, March	15	31.2
Atli Head.		
1909, Feb.	20–25	31.3
" "	30	42.5
" "	20–30	44.8
" May	17	17.2
" "	18–40	19.6

Table 66.—Average Weights of Fish, etc.—Concluded.

Date.	Depth, Fathoms.	Weight, Lb.
Atli Head—Concluded.		
1911, Sept.	35	17.5
,, Oct.	45–50	13.6
1912, Aug.	35	16.7
,, ,,	35–50	16.8
,, ,,	35	18.7
,, ,,	35	18.9
,, Sept.	30–48	12.2
,, ,,	50–53	9.7
,, ,,	52–56	11.7
,, ,,	52	12.2
,, ,,	52	14.2
,, ,,	43–56	14.9
,, ,,	54	15.6
,, ,,	44–62	21.9
,, Oct.	51	12.3
,, ,,	51	13.7
Flat Grounds North of Skidegate.		
1906, Dec.	8–16	28.5
1909, May	20–24	14.5
Cape George.		
1902, Sept.	25–30	30.5
1904, Oct.	35–75	13.0
,, Nov.	25–33	31.1
1905, May	25	18.8
Cape George—Con.		
1906, Oct.	28–35	17.3
,, Nov.	28–45	23.1
1907, Jan.	30–45	25.8
1909, June	40	19.3
,, Nov.	11	29.3
1911, Aug.	30	15.0
,, ,,	30	14.6
Rose Spit.		
1902, Oct.	16–65	25.1
1904, ,,	35–60	23.6
,, ,,	50–55	25.6
,, Nov.	13–20	26.1
1906, ,,	30–65	41.0
,, ,,	30–70	43.4
,, ,,	24–30	48.0
1908, March	18	22.7
1909, Jan.	50	13.8
,, ,,	48–70	15.6
,, ,,	75	16.7
,, ,,	15–60	17.6
,, ,,	40–60	18.7
1911, Sept.	25–55	10.3
,, ,,	20–50	14.2

PILOT HOUSE — LOG BOOK

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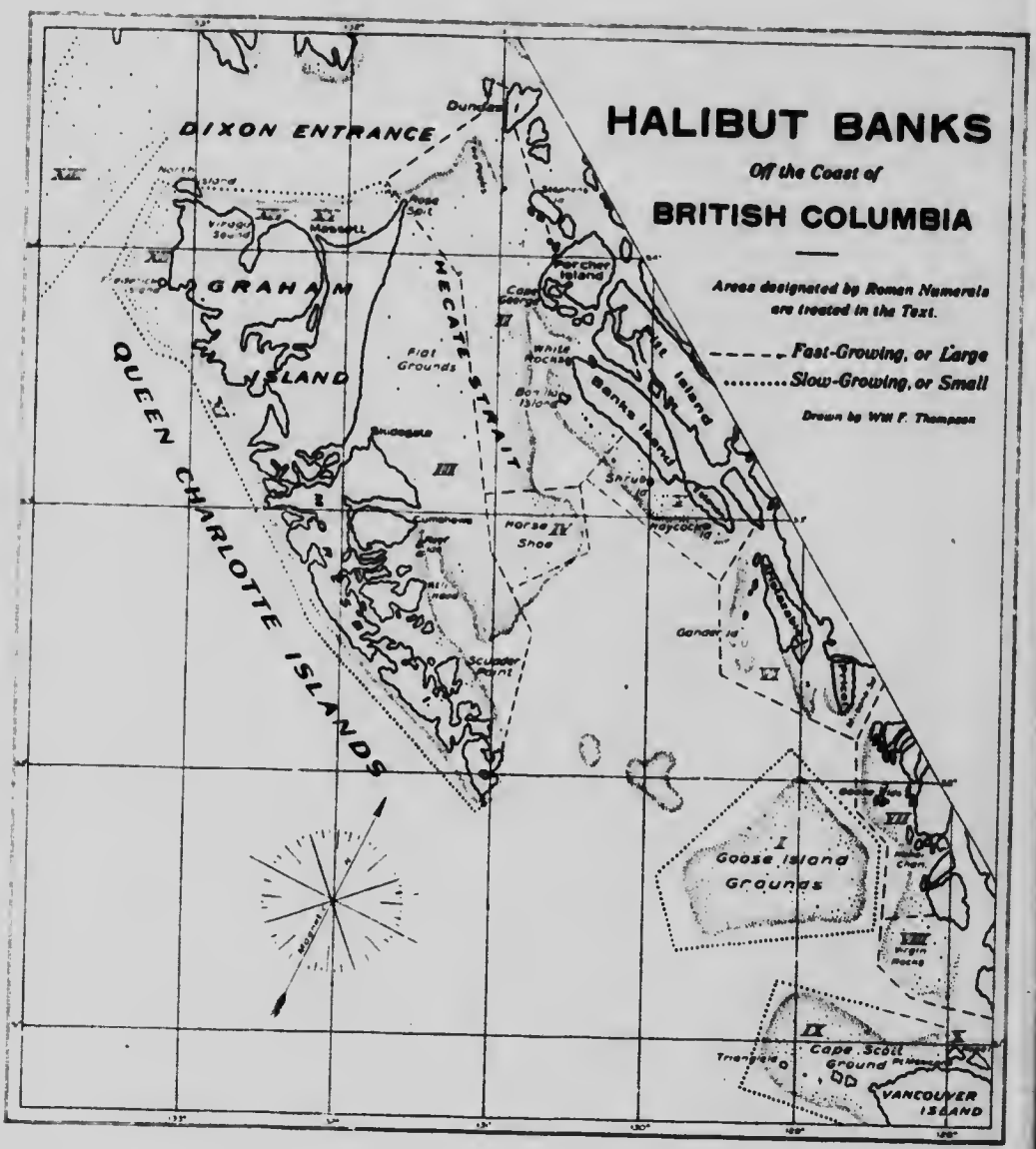
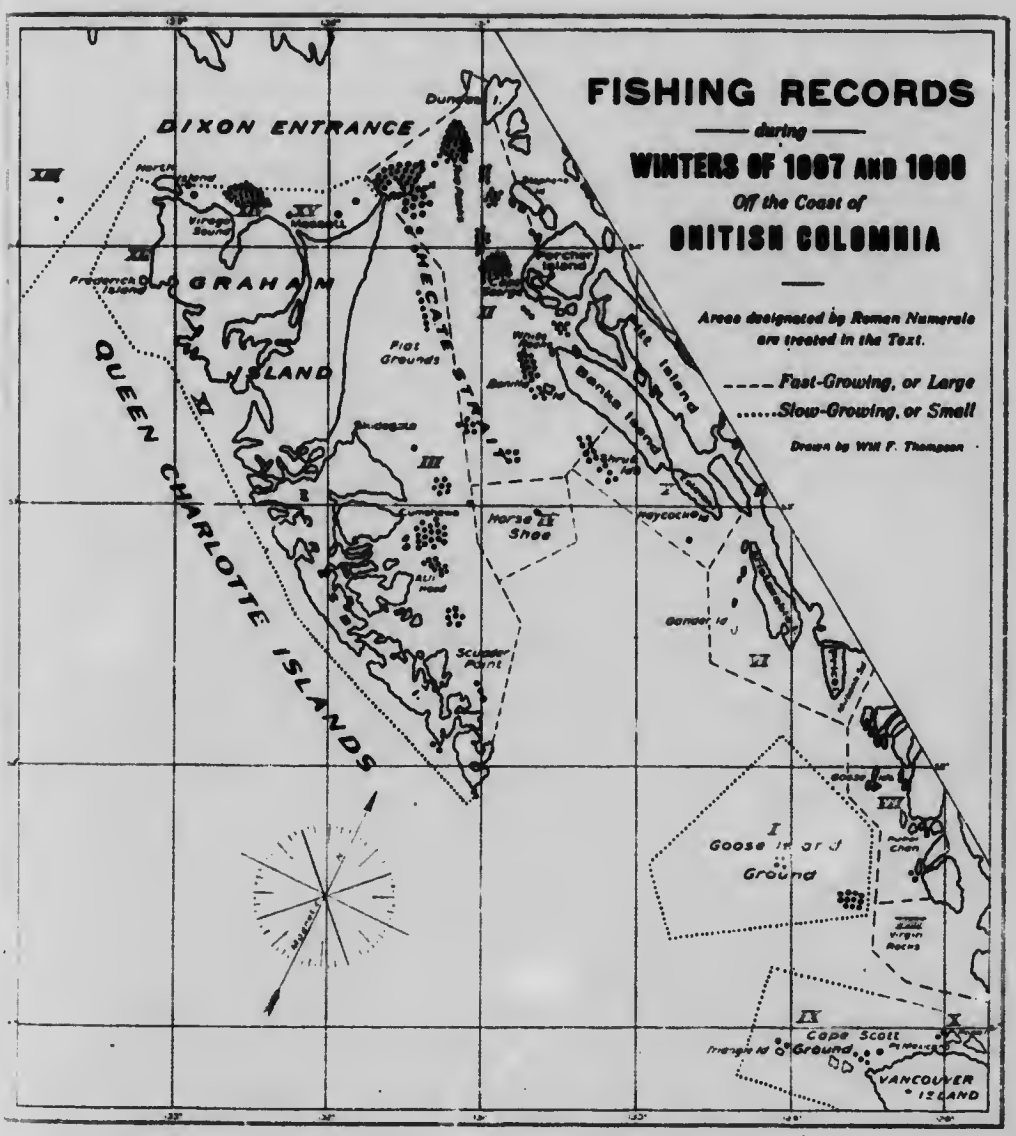
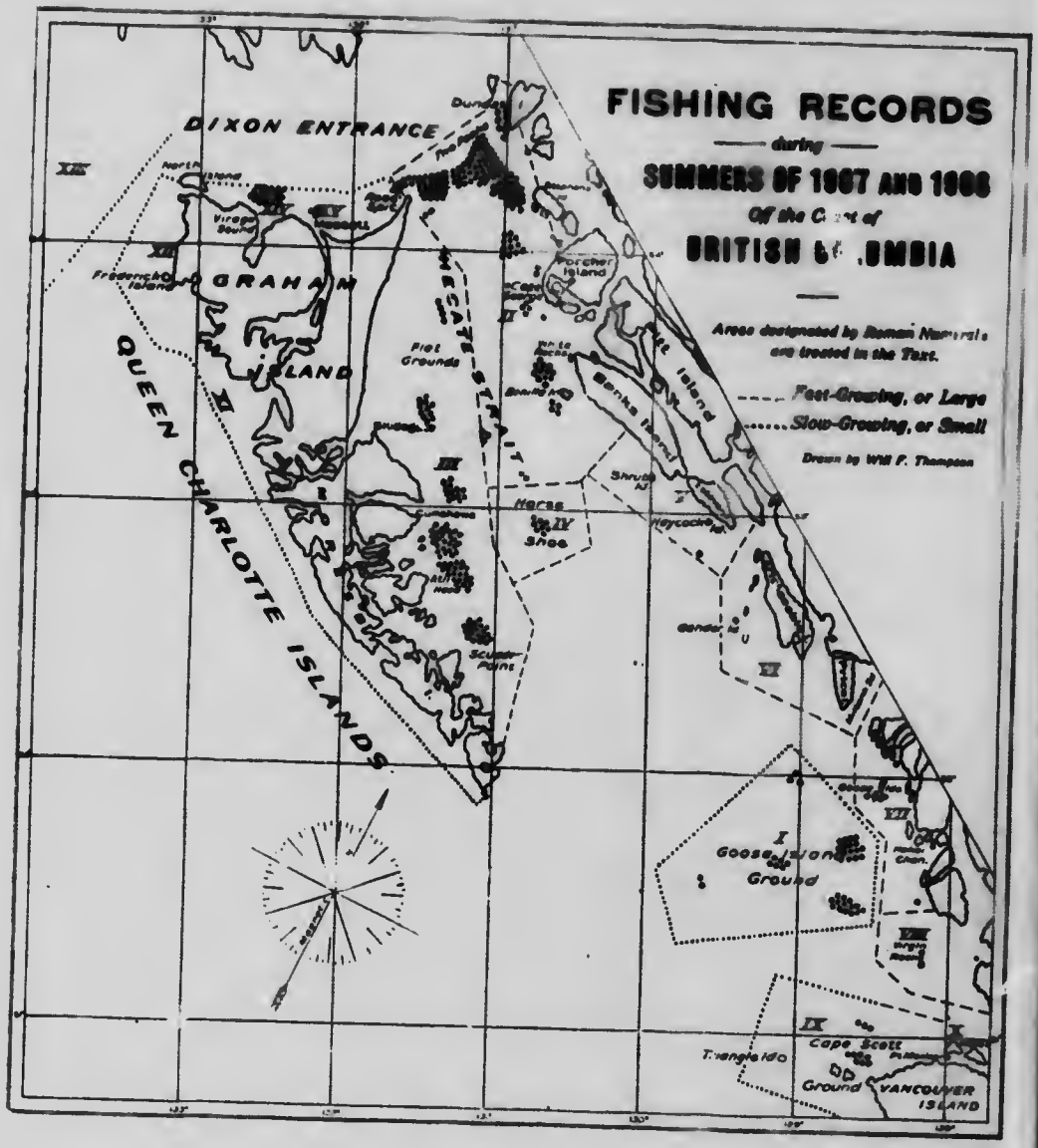
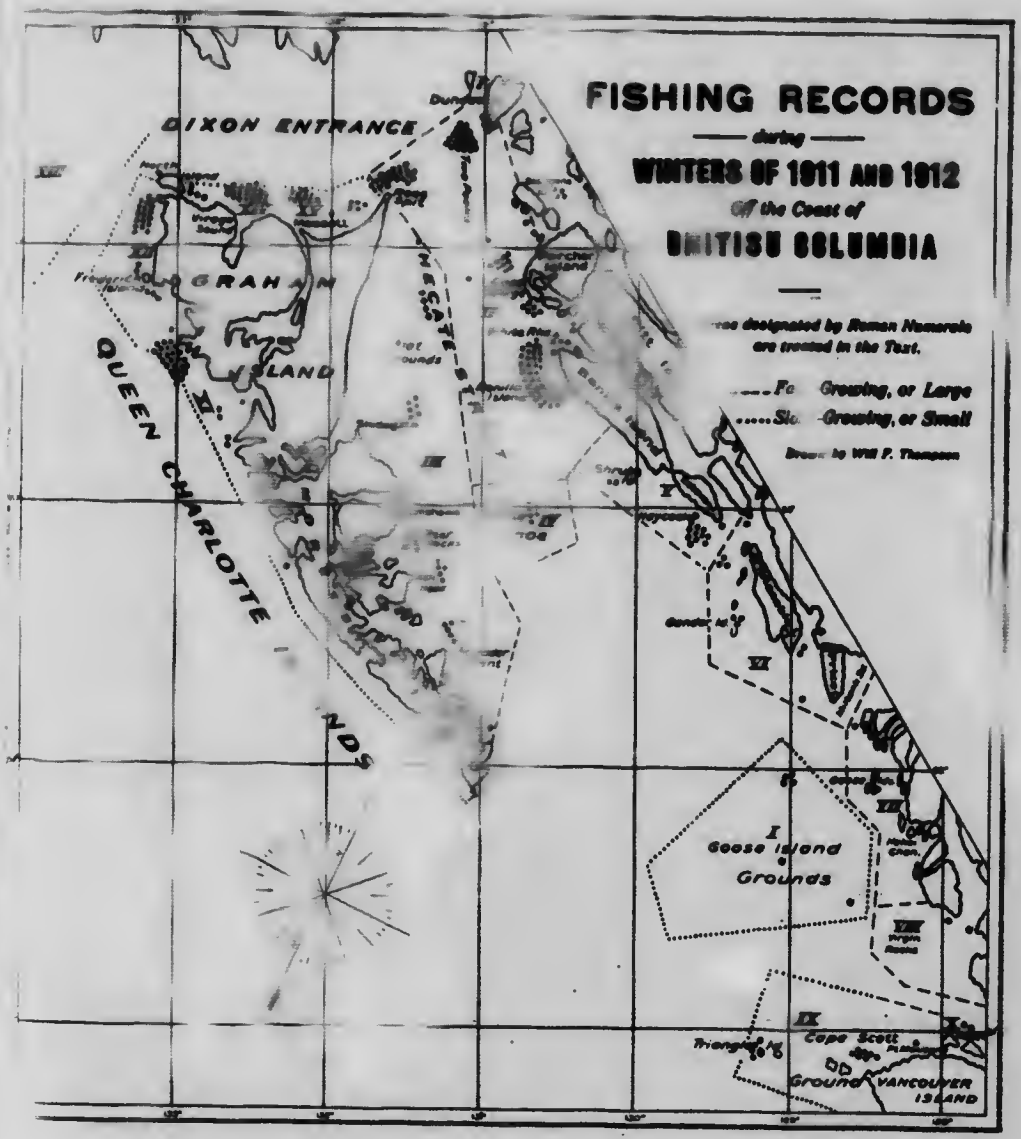
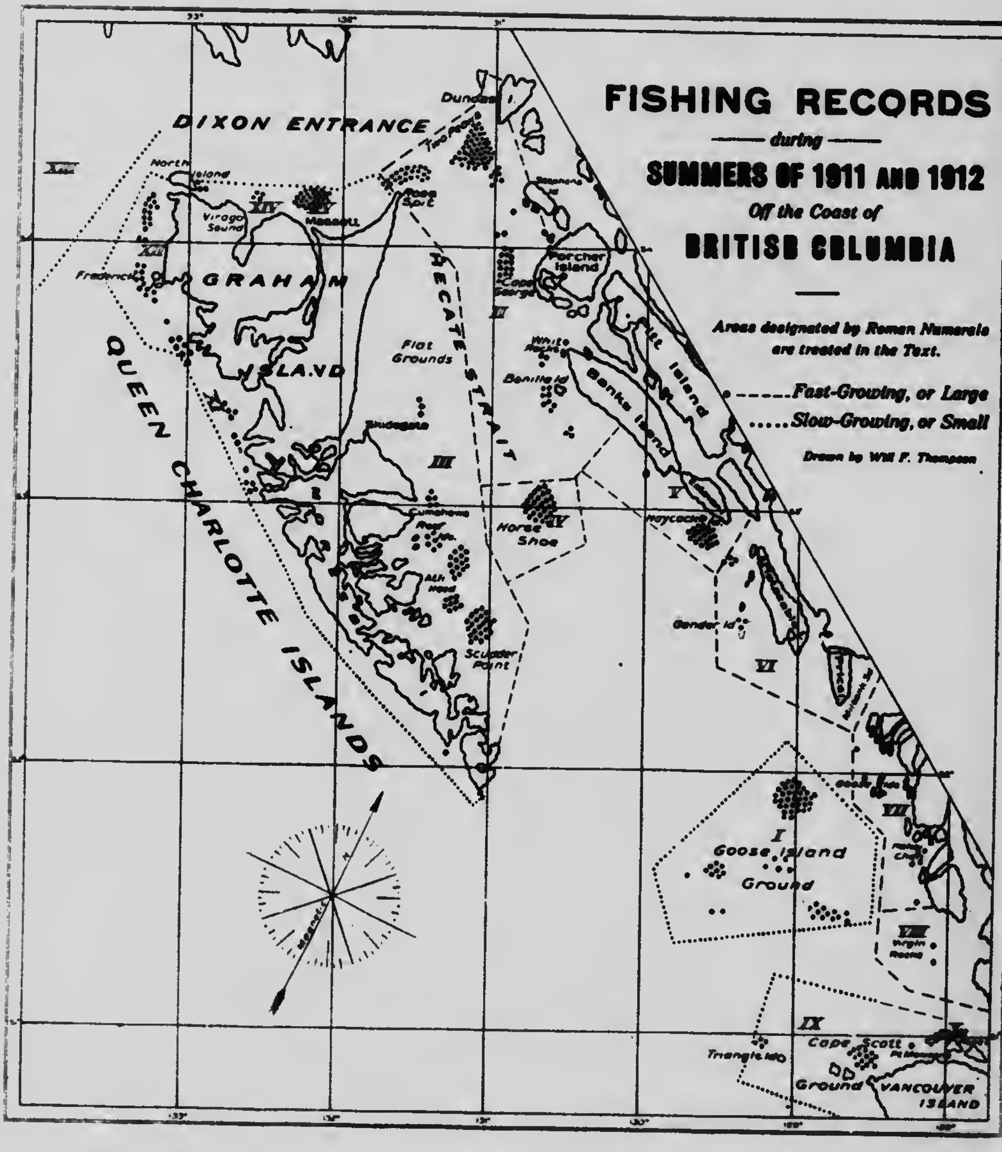

HALIBUT BANKS
Off the Coast of
BRITISH COLUMBIA
Areas designated by Roman Numerals are treated in the Text.
Fast-Growing, or Large
Slow-Growing, or Small
Drawn by Will F. Thompson
DIXON ENTRANCE
GRAHAM ISLAND
QUEEN CHARLOTTE ISLANDS
HECATE STRAIT
Dundas I.
Rose Spit
Virago Sound
Masset
Port Chanter Island
Cape George
Flat Grounds
White Rocks
Bonilla Island
Banks Island
Flat Island
Skidegate
Shrubb I.
Naycock Pt.
Horse Shoe
Cumshewa
Lyell I.
Scudder Point
Goose Island Grounds
Virgin Rocks
Cape Scott
Triangle I.
VANCOUVER ISLAND
I
II
III
IV
V
VI
VII
VIII
IX
X
XI
XII


FISHING RECORDS
during
WINTERS OF 1907 AND 1908
Off the Coast of
BRITISH COLUMBIA
Areas designated by Roman Numerals are treated in the Text.
Fast-Growing, or Large
Slow-Growing, or Small
Drawn by Will F. Thompson
DIXON ENTRANCE
GRAHAM ISLAND
QUEEN CHARLOTTE ISLANDS
HECATE STRAIT
Flat Grounds
Banks Island
Mitt Island
Horse Shoe
Goose Island Ground
Cape Scott Ground
VANCOUVER ISLAND
I
II
III
IV
V
VI
VII
VIII
IX
X
XI
XII
XIII
XIV
XV


FISHING RECORDS
during
SUMMERS OF 1907 AND 1908
Of the Coast of
BRITISH COLUMBIA
Areas designated by Roman Numerals are treated in the Text.
Fast-Growing, or Large
Slow-Growing, or Small
Drawn by Wm F. Thompson
DIXON ENTRANCE
GRAHAM ISLAND
QUEEN CHARLOTTE ISLANDS
HECATE STRAIT
Pilot Grounds
Banks Island
Forrester Island
Goose Island Ground
Cape Scott
Triangle Ground
VANCOUVER ISLAND


FISHING RECORDS
during
WINTERS OF 1911 AND 1912
Off the Coast of
BRITISH COLUMBIA
Fo Growing, or Large
Sc Growing, or Small
DIXON ENTRANCE
GRAHAM ISLAND
QUEEN CHARLOTTE
I
Goose Island
Grounds
Cape Scott
Ground
VANCOUVER ISLAND


FISHING RECORDS
during
SUMMERS OF 1911 AND 1912
Off the Coast of
BRITISH COLUMBIA
Areas designated by Roman Numerals are treated in the Text.
Fast-Growing, or Large
Slow-Growing, or Small
Drawn by Will F. Thompson
DIXON ENTRANCE
GRAHAM ISLAND
QUEEN CHARLOTTE ISLANDS
HECATE STRAIT
Virago Sound
Frederick
North Island
Masset
Rose Spit
Dundas
Porcher Island
Cape George
White Rocks
Bonilla Id
Banks Island
Pitt Island
Flat Grounds
Horse Shoe
Scudder Point
Goose Island Ground
Cape Scott Ground
Triangle Ids
VANCOUVER ISLAND
Virgin Rocks
Gander Id
Haycocks

A NOTE ON A SPOROZOAN PARASITE OF THE HALIBUT.

BY WILLIAM F. THOMPSON, OF STANFORD UNIVERSITY.

In considering the cause of what is known as "mushy" halibut among the fishermen, certain facts have come to light which may be recorded, although the investigation is not complete. They possess importance as steps towards an adequate knowledge of a subject difficult of approach. The work has been done in the laboratories of Stanford University, and the writer is under obligations to Dr. C. H. Gilbert for permission to do this, and also for calling attention to the problem.

"Mushy" halibut are usually understood to mean those fish which are discarded by the dealers because of their softness. The number thus culled varies widely during the seasons, and also, according to the fishermen, between cargoes of vessels which have fished on the same grounds. It is said that the banks off the coast of Oregon yield an especially large percentage of this "mushy" halibut. In the course of the work the culling of a number of cargoes was witnessed. It was evident that under the head of "culls" there were included several different types—namely, those which were "white-meated"; those which were "yellow," or slightly spoiled; those which were "mushy"; and those which were "wormy." A fish which was in an advanced state of "mushiness" was termed "milky." In observing the culling at various establishments in the United States and Canada, it became evident that methods were used which varied widely, the proportion of fish which were culled on account of being "wormy" forming, however, but a small part of the total. It is not the purpose here to discuss other than the "mushy" and "wormy" halibut.

The so-called "wormy" halibut are rare, relatively speaking, in proportion to the total culls, but are readily discovered by cutting into the flesh, as is done by the culliers. Thus far no cases have been observed in which a "wormy" or parasitized halibut was "milky" or "mushy," and the two types may be distinguished sharply by their appearance. There is no external evidence of the infection by the parasite which causes "worminess." A cut through the trunk muscles parallel to the grain exposes the parasites as silvery threads lying among the muscle-fibres. These threads lie with the fibres in a regular way, and extend from septum to septum of the myomeres, but not through them. The muscles of the head are apparently less liable to infection than those of the trunk, and usually none are to be seen in the head of even a heavily infected specimen. The density of infection varies somewhat in different individuals.

Plate 1,* Fig. 1, a photo-micrograph of a cross-section of a portion of muscle, enlarged eighteen times, gives some idea of the size of the threads as compared to the muscle-fibres, and of the density of infection. These threads vary between 0.20 and 0.30 mm. in diameter, four or five times that of the fibres. In Plate 1, Fig. 2, is a cross-section of a single thread, enlarged about 185 times. It will be seen that the thread is actually a tube-like structure, containing a mass of fine granule-like bodies with an envelope formed by the fibrillæ of the muscle, within which the parasite exists. The muscle-fibres are not degenerate in any way, the striations being as perfectly evident as in adjacent fibres. In Plate 3, Figs. A and B, are given reconstructions of the ends of two of these threads. It will be noticed that the threads are formed of several cysts or trophozoites disposed in no definite order—end to end or side by side. Small projections are frequent.

The material when found on the wharves was not in the best possible condition, and, pending the discovery of specimens when freshly caught, the minute structure of the parasite is given in a provisional way. The sections which were made were stained in Hansen's iron hæmatoxylin and counterstained with eosin.

There is no definite wall to the tubule, or trophozoite, the substance of the limiting layer being continuous with a reticulum which extends into the interior. Occasionally (Plate 3, Fig. 9) there may be seen a densely staining layer on the external surface, but this appears to be either an atrophied portion of muscle or a decomposition product, and not found over the whole tubule. In the meshes of the reticulum may be found various types of bodies. The more frequent ones along the immediate periphery are small bodies (0.001 mm. or less in diameter) which stain black with iron hæmatoxylin (Plate 3, Fig. 6). These appear to be

* Plates referred to follow the text.

surrounded with clear zones of protoplasm at times, and may be individual cells. The larger bodies, which may be termed spores until more is known about them, are about 0.003 mm. in diameter, are destitute of a spore-capsule, and apparently compound. There is always present a large eosinophyle body (Plate 3, Figs. 1 to 8), but whether there are more than the one in any case remains to be seen. This large body (polar capsule?) lies to one side, and in the crescent thus left are found nuclear-like bodies somewhat similar to those found in the periphery of the tubule. Occasionally (Plate 3, Fig. 3) it would seem undeniable that each of these is surrounded by its own zone of cytoplasm, and that there is in this case really a set of small cells partially wrapping the large eosinophyle body. Vacuoles which are sometimes present may indicate the commencement of degeneration, due to preservation so long after the death of the halibut (Plate 3, Figs. 2 and 4, ca.). In the centre of the tubule these spores seem to be surrounded by less reticulum than on the periphery.

The great similarity between the tubules would indicate that the parasites had reached a definite stage in which they had halted, and that the infection was not progressing. This is supported by the fact that all the fish affected were healthy specimens, as far as could be ascertained, and that the examination of "sick" fish when first caught does not show the presence of the parasite.

In considering this, there may be mentioned a very curious modification of the muscle-fibre in which the parasite lies. In Plate 3, Fig. A, is given a drawing of a portion of a thread. Around this, toward one end of the section shown, may be seen a band of fibrillæ, like a sphincter muscle, outside of the longitudinal fibrillæ. In Plate 1, Fig. 3, is given a photo-micrograph of a cross-section of the same thread, in which the circular course of the fibrillæ may be easily traced. Careful examination of these fibres show that they are definitely striated, as distinctly as the muscles in any other part of the section. The tubules seem to show the evidences of past constrictions. The origin of these circular fibrillæ is obscure, of course, and no theory is advanced to account for them. They are not present in any case in normal muscle-fibres, as has been carefully ascertained. The conclusion which must be drawn from their presence is that they are modifications produced by the presence of the parasites, and this indicates the probability that the parasitized tissues have not been vitally injured. It would seem that some time would be necessary for the production of such a reaction.

In examining the "mushy" halibut, a spore was found which may or may not be the cause of that condition. It is evidently from a sporozoön. Its shape is somewhat like that of a four-pointed star, with four polar capsules. The investigation of this has not gone far enough to enable a connection to be made between it and the sporozoan responsible for the "wormy" condition. It is also not at all easily decided whether the "mushy" and "milky" fish are the results of sporozoan or of bacterial infection. The inability of fishermen, as well as the writer, to distinguish mushy fish when freshly caught would seem to require explanation. Plate 2, Figs. 1 and 2, are photographs of slices made of a "milky" halibut after hardening in formaldehyde.

It has been thought best to refrain from discussion of the systematic relationships of the species or the stages represented until more is known of the life-history. It is hoped that what is here described will be of use to workers in this field, and that it will be amplified by further work. The material is hard to obtain in good condition, and the study of the life-history may be slow to progress.

EXPLANATION OF PLATES.

Plate 1. Cross-sections of Parasitized Tissue.

Fig. 1. Showing density of infection, enlarged 24 times.

Fig. 2. A single tubule, enlarged 185 times.

Fig. 3. A tubule showing the circular muscle fibrillæ, enlarged about 225 times.

Plate 2. Slices of "Milky" Halibut, after Hardening in Formaldehyde, showing White Areas of "Milk."

Fig. 1. Transverse section of trunk. The cavity between the three crosses is a typical result of advanced infection.

Fig. 2. Sagittal section of trunk muscles.

Figure 1

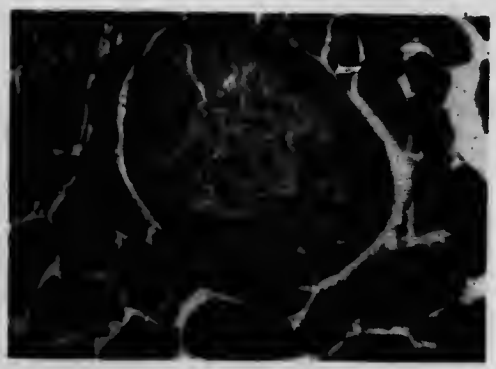


Figure 2

Figure 3

Plate 1

Figure 1

Figure 2

Plate 2.

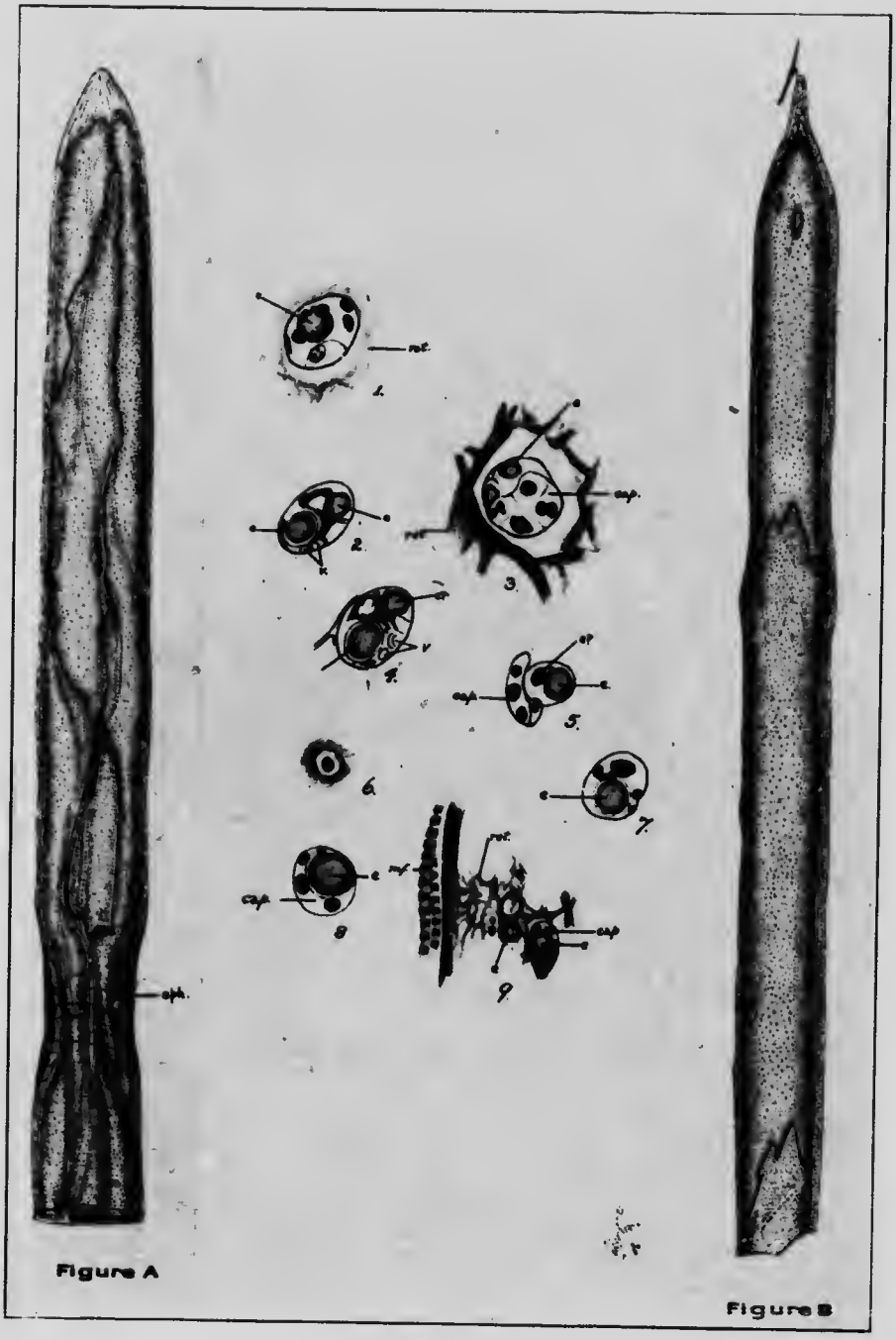


Plate 3.

Plate 3. Reconstruction from Series of Sections of the Threads of Infected Tissue.

Fig. A. Thread with several tubules side by side, enlarged about 70 times.
sph, sphincter fibrillæ.

Fig. B. Thread with tubules lying end to end.

Figs. 1, 2, 3, 4, 5, 7, and 8. Spores of varying appearance. Figs. 2 and 4 may be degenerating, as shown by the vacuoles; 5 has its capsule of small bodies apparently loosened or not yet in final position; 8 represents the usual type of spore, and by far the most abundant.

Fig. 6. A small body from the periphery of the trophozoite.

Fig. 9. A portion of the periphery of the trophozoite, showing the false (?) external envelope and the striated muscles.
cap, capsule of small cells (?).
e, large eosinophyle body.
mf, striated muscle.
ret, reticulum.
v, vacuoles.

THE PROBLEM OF THE HALIBUT.*

BY WILLIAM F. THOMPSON, BRITISH COLUMBIA FISHERIES DEPARTMENT.

One of the chief problems confronting fishery authorities on the Pacific Coast is that of the halibut. Second only to the salmon in value, the landings during 1914 at Pacific Coast ports are estimated† at over 64,000,000 lb., an apparent increase over 1913 of 9,000,000 lb. It is believed that the figures for 1915 will show little or no falling-off,‡ though there is a general conviction amongst those interested in the industry that the halibut is being depleted. This conviction is based upon the fact that the length of time required to complete a catch is longer than formerly, that the fishing-vessels must proceed to more distant banks, that on various well-known banks the fish are no longer abundant and are growing scarcer.

SEA FISHERIES ARE EXHAUSTIBLE.

It is not generally recognized that sea fisheries are exhaustible, and it is urgently necessary, in the case of the halibut, to know what vitality there is behind the tremendous yield, and what measures may be taken to care for it. The real value of a species must be measured only in terms of what it is capable of yielding without damage to itself, and it behooves us to ascertain whether the present catch is a normal yield, or made at the expense of the future existence of the halibut; in other words, whether we are using the interest only or are also drawing on the principal. It is also necessary to determine the possibility of preventing the ruin of the industry, a problem which can only be solved by earnest research. The yield of halibut in the Atlantic is too small to provide the wealth of material necessary for research-work without unduly prolonged and excessive effort. Hence, there is in the Pacific the last opportunity to deal adequately with the problem and it is passing rapidly.

INVESTIGATION OF HALIBUT.

The British Columbia Department of Fisheries recognized that an inquiry, to be complete, must deal with the whole life of the halibut, including the growth, history, food, seasonal distribution, and period of fertility. The writer has been actively engaged upon the study of this problem since the spring of 1914. The work of collecting data was done on the fishing-vessels, it being necessary to accompany them to the banks on each trip, and the conditions met with on the boats modified the procedure greatly. Much time was thus lost, as the vessels usually fished only when the weather was suitable, and were compelled to prospect a great deal until banks were found which yielded well. The conditions were anything but those to be found in the laboratory, and, as accurate work consumes time, it was rarely possible to examine as many as 100 fish a day. Nevertheless, nearly 3,000 specimens have been examined in the course of the work.

It is perhaps natural to ask why it was not possible to examine the fish when they were brought ashore, and thus avoid the disagreeable living and working conditions at sea. It cannot be too strongly emphasized that work of that sort would have been nearly worthless. The fish in any vessel may come from any bank; as all the viscera are removed, the sexes cannot be distinguished, and the cuts made in cleaning the fish, which is done on the banks, allow the head to assume an unnatural position and make the measurement of length inaccurate. The inability to distinguish the two sexes would alone be sufficient to invalidate any work after the vessels are docked.

LITTLE INFORMATION AVAILABLE.

There is very little existing literature on the halibut, and the field is practically a virgin one. Isolated notes have appeared, most of them conjectural or of little value, the most valuable being notes on the ova of the halibut, and its spawning season in the North Atlantic, observations

* Read at meeting of Conservation Commission, January, 1916.
† From *Pacific Fisherman*.
‡ Since the above was written, the *Pacific Fishermen's Year-book* has estimated the catch for 1915 as 1,410,280 lb. more than that for 1914.

made in a scattering way, but valuable in corroboration of what has been discovered in the Pacific. It is believed that this is the first systematic attempt which has ever been made to work out the life-history of the halibut. The fallacy of reasoning from the habits of other species of flatfish is evident, and nothing has been accepted as true unless shown so by actual data obtained. The writer, however, freely acknowledges that the direction of his efforts has been very largely influenced by the splendid work of the English, Scotch, and German writers on the plaice (*Pleuronectes platessa*) of the North Sea.

PHYSICAL CHARACTERISTICS.

There are few commercial fish which exceed the halibut in average size, and among those of the north temperate regions there are no important ones which individually exceed it in weight, save the sturgeon. It is simply a giant flounder, active and predacious, one of the group with its eyes both on one side of its head, a bottom dweller with the habit of lying on one of its sides, hence very dark on the upper or right, and white on the lower, or left, surface. The female sometimes reaches a length of over 6 feet and a weight of over 200 lb., though, as a rule, the fish in any catch average from 15 to 30 lb

VESSELS AND HANDLING.

The vessels used in the Pacific Coast halibut fishery are of two classes, steam and gasolene, sailing-vessels being out of place in the long narrow inlets and passages of our western coast. The steamers are the familiar trawlers, of about 125 tons burthen, about 100 feet long, making as high as 11 knots, and capable of carrying 200,000 or 250,000 lb. of halibut on ice. Some of them carry dories, as many as twelve in some instances, but it is becoming more and more necessary to use the method known as "long-lining," or fishing from the deck. With two fishermen to a dory, the engine and deck hands bring the total crew up to thirty or thirty-five. The gasolene-boats vary greatly in size, the largest being 100 tons burthen, but they do not usually carry more than six dories. A great many small ones are manned by two men, who do not use a dory, but fish over the side.

RAPID DELIVERY OF HALIBUT.

Each trip usually lasts about two weeks, longer in winter, however, than in summer, and the fish are cleaned and kept with crushed ice in the hold. On landing, these fish are reiced and shipped by fast trains, or placed in cold storage. The consumer often receives fish which have been on ice a month, and the quality of the flesh is such that it does not markedly deteriorate. Every condition has lent itself to the building-up of a great market and to the rapid depletion of the supply.

It is difficult to realize the enormous part played by perfection of transportation facilities and the institution of cold-storage methods. Halibut caught in the North Pacific, off Alaska, are placed fresh on the markets of California and Massachusetts at rates which, as the magnitude of the business testifies, are anything but prohibitive. There would, obviously, be no demand for the enormous yield unless such an extensive market were open.

METHODS USED IN FISHING.

Dory fishing only has been considered, as in "long-line" fishing proper data are rarely kept. The gear used consists of pieces of "ground-line" or stout trawl-line in lengths of about 400 fathoms, and, when not in use, coiled on a square piece of canvas, called a "skate," perhaps because of its resemblance to that fish. The whole coil has come to be called a "skate." On this line are attached short lengths of smaller line, the "gangings," with the hooks at the ends, about 265 to a "skate." Each dory, of which there are usually twelve on a steamer, uses two to four "skates" to a "set," tied into a single piece, baited with herring or other fish. The dories lay their lines parallel to each other over a bank, both ends of each line anchored and buoyed. The catch of the different dories used to be reckoned separately, as the men were paid according to the catch. This no longer obtains, but the fish in each dory are counted, as it is thus possible to see what part of the bank yields best, and so guide further work. The total number of fish for the day, divided by the number of "skates" used, gives a comparable index of the amount of fish obtained and a clue to the abundance on the bank.

TRAWLING DESTROYS MANY OTHER FISH.

Trawl-line fishing destroys as many fish of other species as are caught of halibut. Records made on the banks show a total of 193 halibut to 246 other fish, of which 171 were edible. At times, on certain banks, the catch is exclusively of some undesired species, and all of these are usually discarded, often so badly injured that it is safe to say that few escape mortal hurt. A number of counts were made of fish as they came aboard one of the long-line vessels and the following table gives these. The red or rock cod come to the surface with their air-bladders distended, their eyes nearly popping out, from the release of the pressure under which they live at great depth. They, therefore, are unable to sink, and sometimes thousands of them cover the water for miles over the fishing-banks. To eliminate this waste, the use of such fish should be given every encouragement.

	March, 1914.				Dec., 1915.			
Halibut	37	44	31	26	35	20	..	193
Black cod	22	4	22	11	11	13	83	
Arrow-toothed halibut*	8	16	7	12	1	..	44	
Dogfish*	3	..	24	3	..	..	30	
Skate	2	2	2	3	..	..	9	246
Red cod	3	1	4	3	21	36	68	
Grey cod	2	..	5	4	..	..	11	
Chimæra*	1	..	..	..	..	..	1	
Total fish	78	67	95	62	68	69	..	439
Species	12	12	13	15	15	15	..	...

* Numbers of fish of each species brought up on the halibut trawl—the non-edible fish being marked with an asterisk.

THE FOOD OF THE HALIBUT.

It is difficult to say whether a fish eats more of another valuable species than is legitimate, for it may also eat great quantities of some enemy of that valuable species. The fabric of marine life is so interwoven and complex that, with our present slight knowledge, we cannot separate the strands. Hence, one must not take too seriously food data which apparently testify against the halibut, but the incomplete results of these researches are presented below.

The following are consumed, many of which are not available directly as food to man: Sea-anemones, starfish, brittle-stars, sea-urchins, sea-cucumbers, worms, small shell-fish, devil-fish, squids, crabs (other than the edible crab), dogfish, skates, red and black cod, herring, ratfish, sand-lances, and grey cod. Among the species of value are the red cod, black cod, herring, and grey cod, with perhaps certain small flounders. Only one species is markedly an article of food—namely, the grey cod—and at present there is no commercial fishery for it on the halibut banks. Among the mass of other food consumed the grey cod loses its relative importance. It is probable that any damage done this way is offset by the fact that the grey cod is digested to form halibut, and also by the destruction of probable grey-cod enemies, such as the red cod and black cod. In fact, the extinction of the halibut might decrease the supply of grey cod rather than increase it.

RESTRICTED AREA OF HALIBUT BANKS.

An important factor in the life-history of the fish is the area of the fishing-banks. The width of the continental shelf is much less on the Pacific Coast of America than on the Atlantic, and, as a corollary of this, the fishing-banks are restricted in area. There are no available published figures, but a close approximation made by us places the total area between the 140-fathom line and the outer coast, without the inlets, between the Shumagin Islands in Northern Alaska and the entrance to the Strait of Juan de Fuca, at 80,000 square miles. Of this, 19,500 square miles are off the British Columbian coasts. This area is distributed along the coast-line of 1,600 miles, and hence has an average width of fifty miles. The total is much less than that of the North Sea, and, in addition, the valuable fishing-banks constitute but a small portion of

the 80,000 square miles. Whether any extensive new banks will be discovered is problematical. One must, therefore, guard against the false conclusion that the Pacific Coast banks are very extensive, and must recognize the relatively small area as one of the contributing factors to rapid exhaustion.

BANKS EASILY DEPLETED.

The peculiar length and narrowness of the Pacific continental shelf renders it more easily depleted locally, for there are no near-by banks from which immigrants may come in any number. This is isolation, to a certain degree, which should render itself evident in the origin of regional races, with their own peculiar characteristics as to rate of growth and dimensions. A bank is not surrounded on all sides by other banks, but is connected by narrow shore-line banks only; hence the idiosyncrasies of the local stock are not entirely counteracted by interchange. In fact, such local peculiarities are of great significance in judging the degree of isolation which might exist, the probability of local extermination, and the rate of repletion possible by migration from near-by banks.

In the work under consideration an attempt has been made to gather such statistics, and a good degree of success has been met with.

The rate of growth has been shown to be sharply different in localities not far distant one from the other, as Frederick Island and Rose Spit, but this will be treated later. That obtained by a series of measurements of the head-length is particularly striking, and is indicative of what may be expected of other data dealing with measurements of body-depth, height or length of fins, counts of fin-rays, etc., when such are compiled.

It is evident that there is no extensive interchange of fish between localities, otherwise such differences as are given could not remain permanent. The progressive depletion of the banks from the south northward is therefore comprehensible. It has been like the annihilation of an army in detail, each separate detachment encountering the full force of the fishing fleet, which might be resisted if the resources of the remainder could be called on to aid. Fortunately it does not pay to fish a region over closely when by going a distance an abundance may be obtained, so there are still fish to be caught on the southern banks and presumably propagation continues there. But only when too late does one know when a species has been depleted on a bank past the limit of safety.

SLOW GROWTH OF HALIBUT.

Not only does the nature of the coastal bank lend itself to rapid depletion, but the nature of the species itself is such as to render it little resistant. It will be recalled that it was said to be one of the largest of market fish, and, reasoning from this, it is evident that a larger area of bank is necessary to support each individual than is the case with smaller fish. The total population must hence be less, and, as the increased size renders it less difficult to catch great quantities, the rate of depletion is correspondingly rapid.

If it took merely a few years to grow a fish of such a size, this would not be so serious, but, as a matter of fact, one of the earliest and most important of the results of the investigation was to show the slow rate of growth and the comparatively great age attained. The table following gives this in figures, as extracted from the Report of the British Columbia Commissioner of Fisheries for 1914:—

Average Length in Inches of Halibut at Any Age.

Age.	Hecate Strait.		Frederick Island.		Kodiak Island.	
	Male.	Female.	Male.	Female.	Male.	Female.
III.	(17.0)	...	...	...	...	...
IV.	19.3	20.6	(21.0)	(22.5)	...	...
V.	(23.8)	24.2	(18.5)	(20.5)	...	...
VI.	24.3	28.1	(24.6)	(28.5)	...	...
VII.	27.6	30.7	(23.0)	(26.6)	(20.3)	(22.7)
VIII.	31.6	35.4	(27.8)	(23.5)	22.4	25.5
IX.	31.7	37.0	25.4	(25.1)	24.0	27.8

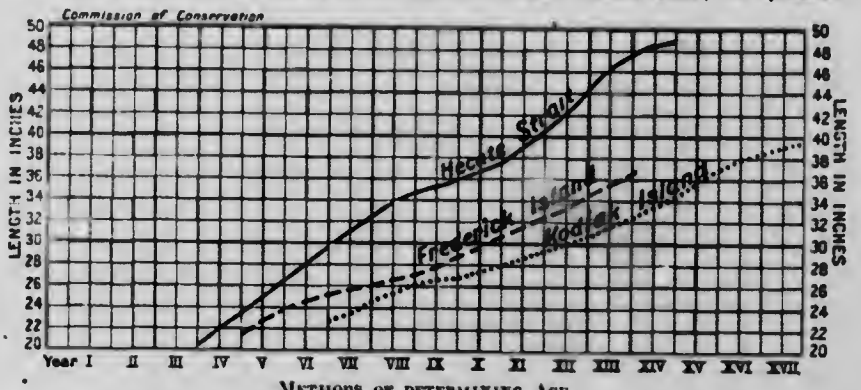
Average Length in Inches of Halibut at any Age—Concluded.

Age.	Hecate Strait.		Frederick Island.		Kodiak Island.	
	Male.	Female.	Male.	Female.	Male.	Female.
X.	33.6	(35.6)	27.4	30.7	25.2	26.8
XI.	34.3	39.3	29.4	32.8	26.3	28.6
XII.	36.6	41.8	(27.5)	(30.0)	27.7	29.0
XIII.	39.4	51.6	(30.2)	(36.8)	28.8	31.8
XIV.	(39.0)	48.2	(31.5)	...	29.0	34.5
XV.	(37.7)	49.9	...	...	29.7	(33.8)
XVI.	42.8	...	(37.5)	...	32.4	38.0
XVII.	(41.5)	61.2	(37.5)	...	(32.1)	(42.4)
XVIII.	(43.0)	60.0	(38.2)	...	(36.4)	38.4
XIX.	...	(65.0)	(36.7)	...	(30.7)	...
XX.	...	...	(37.5)	...	...	...
XXI.	...	(55.2)	...	...	...	...
XXII.	...	(57.7)	...	...	...	...

NOTE.—The figures in parentheses are based on too few specimens, less than five, to be considered at all conclusive.

*Average Length of Female Halibut at Any Age, within Limits caught by Hook.**

Kodiak Island, 125 specimens; Frederick Island, 32 specimens; Hecate Strait, 170 specimens.



METHODS OF DETERMINING AGE.

The methods employed in obtaining these age determinations have been the same as those used with such good effect in the case of the plaice (*Pleuronectes platessa*) of the North Sea and in the case of many other fish. It has been found that, during a year, there are great fluctuations in the rate of growth of any fish, it being very rapid during the summer and almost *nil* during the winter. This fluctuation leaves its traces on all the hard parts of a fish, and a difference in structure between the parts laid down during the different seasons can be distinguished. The bones of the body, especially the vertebræ and gill-covers, show this differentiation, but these are not nearly as readily utilized as are the scales and the limy concretions in each ear-chamber, called "ear-bones," or otoliths, which show annular rings in many ways strongly resembling those of trees. In the case of the halibut the otoliths were found to be the best, and were consequently used. In other species, by actually raising fish, it has been demonstrated that the age is correctly given by these structures.

HALIBUT REACHES GREAT AGE.

The oldest halibut obtained had reached twenty-five years, but the great majority seemed to attain an age of between fourteen and nineteen years. The youngest caught were three, four, and five years old, the size of the hook used apparently preventing the capture of smaller and

* Plates furnished by Dominion Commission of Conservation.

younger specimens. The females from Hecate Strait had an average length of 2½ feet when seven years old, and 4 feet when fourteen years old. A fish 4 feet long would weigh between 60 and 70 lb. It will be seen that the rate of growth on different banks is very different and that of males is much slower than that of females. By utilizing those figures based on enough specimens to be correct, or by using smooth curves, it was found that the males are but 88 per cent. (about ⅞) of the length of the females, practically the same proportion when any one of the three banks is considered. A male of 26 lb. (35 inches long) would be the same age as a female of 35 lb. (40 inches long), the male being but three-fourths of the weight of the female, and in comparing rates of growth on various banks the same sex should be used.

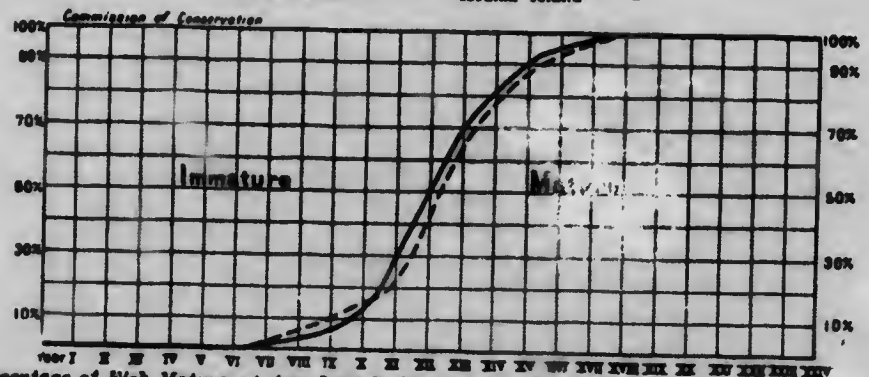
VARIATIONS IN SIZE AND WEIGHT.

There is also a striking difference in size attained by the fish from the different banks. A fish 26 lb. (35 inches long) from Frederick Island is approximately the same age as one 45 lb. (43½ inches long) from Hecate Strait. In other words, the fish from Frederick Island average but 55 to 60 per cent. of the weight of those from Hecate Strait. The fish from Kodiak Island are, in turn, smaller than those from Frederick Island. They are approximately 73 per cent. of the length and 40 to 52 per cent. of the weight of those from Hecate Strait.

This work on the rate of growth and the difference in this regard on different banks has met with complete corroboration from another source—namely, that of the age at sexual maturity. On the Hecate Strait banks one-half of the females mature at the length of 43 inches, on the Frederick Island banks at 35 inches, and off Kodiak Island at 30 inches. These lengths are in each case those reached during the twelfth year, according to the otoliths. Thus it is at least evident that the relative sizes reached at maturity indicate the same comparative rates of growth as do the otoliths.

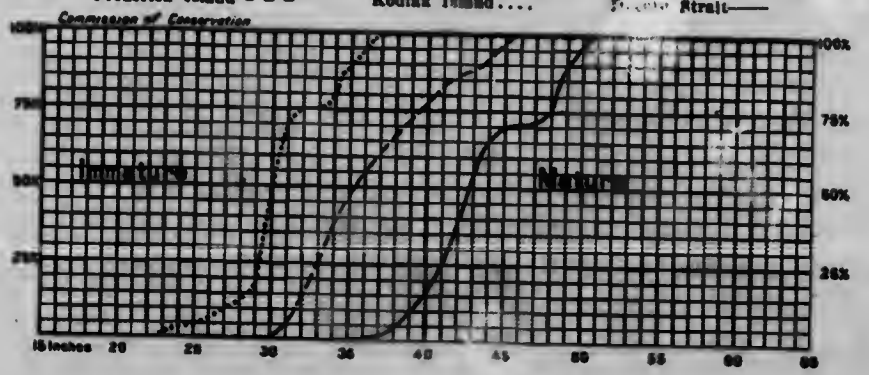
Percentage of Fish Mature at Any Age.

Hecate Strait—— Kodiak Island - - -



Percentage of Fish Mature, at Any Length, from Hecate Strait, Kodiak and Frederick Islands

Frederick Island - - - Kodiak Island.... Hecate Strait——



RATE OF GROWTH OF HALIBUT.

These data as to the maturity age of the halibut are significant from another standpoint than that of mere corroboration of the rate of growth. Indeed, there is no more important phase of the life-history of an animal than its sexual period, as this is directly concerned with the propagation of the species. The accompanying charts indicate the age and size at maturity, although, of course, it is difficult to obtain any idea of the length of life after maturity is attained. It is probable that the numbers of the species diminish nearly as rapidly in the classes which are mature as in those which are immature, and that the fish rarely attain a greater age than eighteen or nineteen years. This has yet to be worked out, but enough has been done to show that different conditions exist on different banks, and that, in some cases at least, overfishing has diminished in a marked degree the percentage of mature fish. The greatly decreased average size of fish caught on Rose Spit and Two Peaks are suggestive in this regard, and indicates that almost all the catches are composed of small, immature fish.

DANGER OF FUTURE DEPLETION OF BANKS.

The present average size of fish caught on these banks is about 12 lb., and no females are found mature under 26 lb.; hence mature females probably exist in small proportion. At all events, it is certain that maturity comes at a late period in the life of the halibut, and that under certain conditions the majority never reach that state. This abbreviation of the sexual period is something which needs the closest attention, as it is vitally connected with the existence of the species. The percentage of mature fish on the banks should be constantly watched, as it, better than the abundance of individuals, indicates most unmistakably the danger of depletion of the banks. This would be analogous to the inspection of the spawning-beds of the salmon, where a lack of spawning fish presages a small run when that year's brood returns as mature fish.

An attempt has been made to work out a method of distinguishing mature and immature fish at any time of the year, other than the spawning season. This is not yet complete, and is subject to certain qualifying conditions, which do not, it is believed, impair its validity. It is based on the fact that in the female gonad, or organ bearing the sexual products, provision is made for future years, a certain group of ova becoming ready for spawning every winter. This readiness is indicated largely by the attainment of large size, and each future year's group may be recognized by its distinctive diameter. The growth is extended over several years at least, and it is possible to see in preparation the groups destined for each year in the near future. By carefully measuring a number of ova they may be clearly distinguished one from the other and the years of maturity readily assigned. Practice enables any one, as a rule, readily to decide, by the appearance of the ovary, its opacity and the size of the largest ova, whether a given fish is destined to spawn the following year.*

FACTORS LEADING TO DEPLETION.

The factors affecting the depletion of the banks may be tentatively enumerated as follows:—

(1.) The comparatively small extent of the banks in proportion to the great catch, with the peculiar length and narrowness of the continental shelf on which they lie:

(2.) The large size of the fish:

(3.) The slow rate of growth, indicating the comparatively long time required to reach market size:

(4.) The late maturity of the females.

Enough work has been done along these lines to indicate that they are valid causes of depletion, but it is, as yet, impossible to definitely apportion their relative importance. A great deal of work remains to be done to complete our studies of these depletion factors. It is, however, axiomatic that any attempt to conserve the supply of halibut must take into consideration these causes of depletion.

ITAPIN DEPLETION OF EASTERN BANKS.

We must procure demonstrable data respecting the rate of depletion, and a special effort has been made to obtain such data. The history of the banks on both the Atlantic and Pacific

* For details the Report of the Commissioner of Fisheries for British Columbia for 1914 should be consulted.

has been one of rapid depletion. In 1830 the New England cod-fishermen regarded the halibut as nuisances, but, once a market for halibut was established, the demand increased with the supply, and in 1884 vessels were going to Iceland and Davis Strait for cargoes. The banks to the south soon became entirely depleted and now no halibut are found there. The catch landed at Gloucester has fallen from 11,300,000 lb. in 1879 to 4,024,000 lb. in 1910. The fishery on the Pacific Coast is not as old, the first cargoes being landed about 1888, but it is being pursued most energetically, and, owing to the great increase in the number of vessels employed and the use of banks further afield, the total yield apparently does not indicate a marked decrease. The statistics of annual yield do not indicate the depletion of the banks until long after it is well advanced. Unfortunately, also, returns are very fragmentary, compiled in anything but a systematic manner, and hence are unreliable.

Information as to the yield, however, can be gathered from the ships' daily records or logs. These logs are the notes kept by the officers concerning the movements of the vessels, the amount of gear used, and the catch. These were not at first accepted as accurate, but extended acquaintance with the fishermen and their records has shown that they are as accurate as is necessary. The depletion of the banks has been shown to be so pronounced as to override any variations in records due to inaccuracy, which, at most, are not greater than in the average commercial record. The captains and mates are, as a rule, intelligent men.

RESULTS OF INVESTIGATION.

Provided one is well acquainted with the banks and with the methods used, there is no reason whatever to doubt the accuracy of the results obtained by a study of the logs. The methods of fishing have been already described, and the meaning of the term "skate" as a unit of gear has been defined. The average yield per skate has been compiled from records of over 500 voyages. Three-month periods were treated as units because the number of records per month was not always sufficient to give satisfactory average results. It showed that, during the summer months, the yield was heaviest and that there was a more uniform decrease. Comparing the years 1906 and 1912, the number of fish caught per "skate" was reduced about 50 per cent. in six years—from an average of 42.8 fish per skate in 1906 during the summer to an average of 21.9 in 1912. The logs of some vessels, for the six summer months, also show that the time spent per fishing voyage had increased proportionately—namely, from 3.4 days in 1906 to 8.9 days in 1912. In addition, the size of the catch actually decreased, despite the fact that in early years the dealers placed a limit on the cargo which might be brought in, the average load in the summers of 1905 and 1906 being 135,300 lb., and that in the same period of 1913 and 1914, 107,800 lb. To demonstrate that these figures are representative and accurate the following tables are appended:—

Showing Average Number of Fish caught per Unit of Gear used, for Six-month Periods.

Years.	1902.	1903.	1904.	1905.	1906.	1907.	1908.	1909.	1910.	1911.	1912.	1913	1914.
April-September ..	50.1	...	73.6	30.1	42.8	36.9	20.1	24.1	28.6	25.1	21.9	17.1	12.9
October-March	33.2	19.5	12.2	23.9	18.5	12.9	11.1	7.4	14.1	10.7	8.5	6.1	6.8

Showing the Average Number of Days fished per Voyage in order to obtain a Cargo.

Year.	Jan.-Mar.	Apr.-June.	July-Sept.	Oct.-Dec.
1902	...	...	2.0	4.2
1903	4.6	3.2	2.1	3.4
1904	3.6	2.0	2.5	3.8
1905	4.6	3.7	3.7	4.5
1906	5.1	2.9	4.0	4.9
1907	5.4	...	3.8	4.5
1908	5.3	5.8	3.7	5.7
1909	6.7	3.6	3.7	7.5
1910	8.3	5.2	4.7	7.4
1911	9.8	6.9	6.9	7.4
1912	9.0	10.5	7.4	9.0
1913	No records	9.2	9.6	8.7
1914	8.8	10.2	10.0	10.6

Showing Average Cargoes landed by Three Steamers of Similar Capacity.

Those marked with an asterisk (*) are averages affected by a limit placed on cargoes by the dealers.

Months.	Jan.	Feb.	March.	April.	May.	June.
Years 1905 and 1906	108,215	146,833	171,313	143,353	110,162*	141,235*
Years 1913 and 1914	37,900	67,192	42,620	76,295	122,474	152,851

Months.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Years 1905 and 1906	132,761*	157,313	126,967	97,287	78,340	125,988
Years 1913 and 1914	121,152	100,802	73,202	42,898	35,340	59,770

Showing Number of Fish caught per "Skate" on Rose Spit and Two Peaks Banks during Summer and Winter Months.

Based on 226 records. The starred figures being obtained from but three or four records, hence not conclusive.

Years.	1902.	1903.	1904.	1905.	1906.	1907.
October to March	56.7*	16.7*	11.4*	24.8	24.6	12.9
April to September	No records	No records	No records	47.1	No records	27.5

Years.	1908.	1909.	1910.	1911.	1912.	1913.	1914.
October to March	19.1	6.0	9.3	9.3	6.5	No records	7.9
April to September	22.5	18.0	27.9	25.2.	19.3	11.1	9.2

Showing Decreased Average Weight of Fish caught on Two Peaks and Rose Spit Banks.

Year.	Average Weight.	Year.	Average Weight.
1902	25.1	1909	20.8
1903	No records	1910	16.1
1904	25.1	1911	16.7
1905	No records	1912	17.1
1906	33.9	1913	13.4
1907	No records	1914	12.3
1908	25.2		

Not only is the depletion very evident in the banks as a whole, but the same tendencies are evident in the returns from individual banks, as instanced in tables of catch on Two Peaks and Rose Spit banks. An alarming feature disclosed by the table is the decrease in average size of the fish caught on this bank, resulting from the capture of the larger and older fish.

GROWING MARKET FOR OTHER FISH.

It is evident, then, that there has been a great and marked decrease in the abundance of fish on the banks off British Columbia. This is shown by the above tables as directly and truthfully as possible, more so than by the statistics of fish landed, upon which advocates of fish-conservation have usually based their arguments. When the catch is cut in half in six years, the rate of

decrease on the banks is a very rapid one. It may well be asked what the nltimate result will be. At present it ceases to be profitable to fish when a certain minimnm retnrn is not obtained, and that limit has been reached in onr southern waters for the winter season. However, the rapidly growing market for other species, such as black cod, will enable vessels to fish there profitably, whereas before they conld not. The demand that there be a close season dnring the winter by international agreeme.t incidentally seeks to render vessels profitable by the elimination of the most nnprofitable season when it is necessary to make longer voyages. Whether such a close season wonld benefit the halibnt to snch a degree that it wonld stand the consequently more severe attack in snmmer is as yet a qnestion unanswerable, depending mainly on whether this closnre would be made of snfficient length.

REMEDIAL MEASURES ADVOCATED.

The discovery of the rate of depletion is the only direct method at present available for determining the abnndance and vitality of the species. Bnt it is snfficiently accurate to demonstrate to every one that we are using both the principal and interest; therefore we must either conserve the former by lessening the drain or increase the yield by niding natnre in the propagation of the young. A species may never be replaced. Its destruction is not the diversion of capital into new hands and new uses; it is the destruction of a tool, fashioned by hands man cannot imitate, which shonld make available the resources of the sea for an indefinite nnmber of years.

Knowing, then, the fact of depletion, and certain of the canses, it follows that remedial measnres should be songht. Through "artificial" propagation natnre may be assisted by aiding the yonng fish to survive what is perhaps the most critical period of its life, or by giving it some measure of protection from its hnman enemies. But to assist nature effectively requires accurate scientific knowledge. Every detail of the life of a fish seems to have some bearing on the problem, and the more complete the knowledge the better the prospect of success. In the case of salmon, the breeding habits were comparatively easily and readily observed in a direct way, and the early history of the fish was known in its broad features because of the conditions nnder which it spawns and lives. When the life-history of a pnrely marine fish is considered a more obscure field is entered. The salmon migrates up the streams and breeds at easily ascertained times, bnt no one knows whether the halibnt migrates, for all its movements are ont of sight, nor, nntil recently, when it bred. The ova of the salmon are laid and they may be watched in their development, bnt the halibut ova have never been fonnd, once they are laid, nor is anything known of how or where they develop. Where aid may be given or restraint nsed cannot be told nntil the life-history is fairly well known. Only a little progress has been made along that line, which is necessarily a difficult one.

UNIFORM SPAWNING SEASON.

The spawning season for the halibut in European waters, as derived from scattered records, seems to correspond in general to that on our Pacific Coast. We first ascertained the latter by examination of specimens sent in by fishermen and by actnal observation. It has now been observed throughout in the Gulf of Alaska. It extends from the end of December to the end of April. It is at its height probably in Jannary or February, bnt it is still unknown whether the time varies with the latitude. The time of spawning was, of conrse, one of the first things it was necessary to ascertain.

VARIATIONS IN RATE OF GROWTH.

There are few differences between the two sexes, and none of these may be relied npon to distinguish them at sight. The finding of such a one would have saved a great deal of work in dissection and rendered available the catches landed at the wharves. However, there are real and striking differences in the average rate of growth and proportions of the sexes. The difference in rate of growth has already been shown, and the difference in length of head is given in the tables of variations between localities in the Report of the British Columbia Fisheries Department for 1914, page 83. There is also a difference in the depth of the pocket in which the sexnal organs lie, bnt all these differences so overlap that they cannot be relied npon to distinguish individuals of the two sexes. Hence it is apparent that no measnres can be taken to give far-reaching protection to one sex rather than the other.

ARTIFICIAL PROPAGATION.

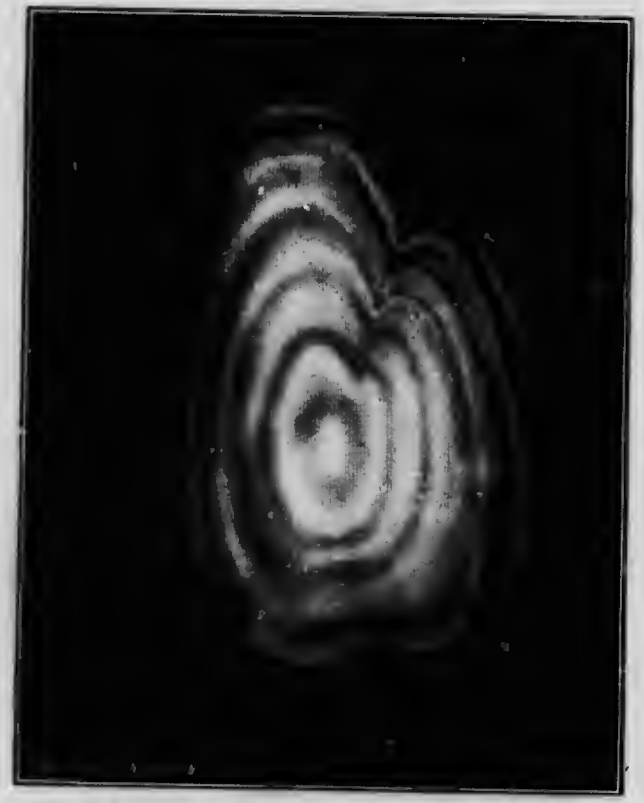
The number of ova laid and their method of ripening are very important, not merely from a general standpoint, but as factors in artificial propagation. The gonads in the mature female at certain times of the year—just before spawning—contain large, loose ova. In the British Isles counts of the ova contained in the ovary range from 1,000,000 to 3,000,000. The count made by us of the ova in a 40-inch female from Pacific waters showed it to contain about 370,000 ova. This is very much less than the European fish, but it is probable that, as the lengths given would indicate, the latter were much larger and older. Probably the rule holds as in the case of the plaice—namely, that the number of large ova increases both with age and size. While the halibut carries great numbers of ova, this does not mean that it is prolific, because, as a rule, species which lay a great number of ova do so in order to overcome great natural obstacles to their survival.

Using the minimum, that counted by us, it is easy to reckon the volume which would be occupied by the mature ova. The ova, shortly before maturity, undergo a rapid enlargement, becoming transparent and loose in the ovary. The final diameter, as found in samples collected on the Pacific Coast and preserved in formalin, is 3.67 mm. (1/7 inch, nearly). For 370,000 turgid ova this would yield a volume equal to between half and three-fourths of the bulk of the parent fish. We therefore conclude that the ova ripen gradually and are discharged over some period of time. If this conclusion is corroborated it will have a vital bearing on the collection of ova for propagation. In the case of the European flounder, it has been found necessary to keep it in captivity to obtain the entire yield. With the halibut this would be an impossibility without great expense, while the fact that the ova do not float would hinder the employment of brooding enclosures such as are used with the cod.

DEARTH OF INFORMATION.

The work being done at present includes an elaboration of these facts, the importance of which is apparent. Data should be gathered as to the development of the larvæ, about which absolutely nothing is known. This implies research with plankton and otter-trawl nets. Nor is anything known as to where the young fish live. Probably they are to be found on the halibut banks, but it is necessary to have a sea-going vessel fitted for otter-trawling to collect any data on this score, and unfortunately there are no vessels of this character employed in commercial fisheries on this portion of the coast. A small otter-trawler was used in protected waters, but no results were obtained. The need of such work is very urgent, as the halibut is rapidly decreasing in numbers, particularly in southern waters.

From the foregoing it is evident that it is still impossible to come to a definite conclusion regarding methods of protecting or aiding the halibut. The facts of the life-history show the species to be peculiarly exposed to depletion, and statistics demonstrate that such depletion is taking place. It is not possible to look forward to artificial propagation with any degree of optimism, and probably we shall be left with the alternative of restricting the operations of the fishermen. The work we are doing is handicapped by lack of apparatus, but, as a preliminary study of the problem, is worth while. Until we know the spawning habits, the migrations, and the population of the different banks, and until we solve many related problems, it will be impossible to take action with definite assurance that it will be adequate.



Photograph of a polished otolith, or ear-bone, of the halibut, showing ring or zones which represent years of growth.

Photograph of the scale of the halibut.

Docking the catch.

Cleaning the catch.