and in White Bay, but that the greater portion of the east coast, where great numbers occurred in 1932, was not frequented. On southern Grand Bank a mere five squid were captured in the course of a trawling survey, as compared with hundreds in previous years.

For the cause of failure we are inclined to look farther than to unsuitable water conditions alone. In comparing the latter (in the spring of 1932 and 1933, and at a depth of 25 metres) we observe that slope water was abundant off Grand Bank in the former year, and absent in 1933, when, as has been stated, salinities generally were low. The temperature in 1933 at this depth over Grand Bank was lower than in the previous year, although the observations were made three weeks later in the season (3°–2°–1° from south to north, as compared with 4°–3°–2° in 1932). Perhaps it will always turn out to be the case that in years, such as 1933, when a strong influx of Arctic water has just occurred, and the warmer and more saline " slope " water is not found off Grand Bank at moderate depths, a poor squid run will follow. Only time will tell. On the other hand, it is to be noted that at one point on southern Grand Bank where, at the bottom, the water had in the fall a salinity of 34·20°/₀₀ and a temperature of 4·8° C., only one squid was taken where hundreds might have been expected, since these physical conditions are highly suitable for squid. Again, turning to an examination of temperatures inshore, we find that not all were unsuitable for the occurrence of large numbers of squid. In the previous report it was concluded (on the results of 1932 alone, it is true) that, at a depth of 25 metres, squid were most plentiful between temperatures of 2° and 9° C., the optimum temperatures being probably 5° or 6°. An examination of Fig. 6 shows that the water off the east coast was probably too cold (1° to 5° C.). At Bay Bulls temperature data were collected from spring onwards. The water at 15-metres' depth was consistently colder than in 1932 up till July 20th, reached the same temperature as in that year from then onwards till the end of August, again to become comparatively much colder in September, when no squid were taken. The threat of cold water conditions supervening was ever present. On the other hand the water off the south-west coast may have proved slightly too warm (6° to 9° C.), although the estimated optimum temperatures of 5° and 6° occurred in conjunction on the west side of Placentia Bay. Squid did occur in the latter region—more so, in fact, than in any of the previous three years. It is even possible they were exceedingly numerous, since some reports stated that they were so but that they could not be jigged. In that case the reported catches would underestimate the relative degree of plenty. On the whole, however, we feel inclined to postulate that squid were, in the whole Newfoundland area, much less plentiful than might have been expected from the physical conditions, that some unknown factor—perhaps the scarcity of the relative year's brood after a poor spawning season—was at work, and that its effect happened to coincide with, and be aggravated by, water conditions of low salinity and temperature.

The dropping off of the numbers of crustacea in the fall has already been mentioned in dealing with plankton. It was observed that, on the banks, squid contained much less of this food than in 1932. A similar condition existed inshore, and squid sizes, as far as ascertained, were rather smaller than in that year, and equivalent to those found in 1931, when plankton food was also scarce.

The fact that squid, when located, were often disinclined to take the jigger may have been due to the comparatively low temperatures existing in the upper water layers. In a previous report we have called attention to the unusual activity of the squid when it involuntarily finds itself, in shallow bays, in water of a much higher temperature than that to which it is accustomed. On the east coast the surface temperature varied between 4° and 12° C. in 1933. In 1932 the variation was between 12° and 13° C., and large catches of squid were jigged.

2. *Gonatus fabricii.*

This species breeds on the continental slope off the Newfoundland area, and in certain years some evidence of its occurrence is found. This is particularly so when, as in the fall of 1933, the influx of Arctic water becomes very restricted, and a compensating influx of cold oceanic water occurs directly from the east—usually into the deep eastern bays of the island. The presence of such water does not appear to favour immigration of either *Illex* or cod.

Evidence of *Gonatus* was fairly plentiful in 1931, when the Arctic influx was slight, but in 1932 no reports of its inshore occurrence were received. As might be expected from the evidence already submitted with regard to the decrease in 1933 of the intensity of the Arctic current, this squid species again made its appearance. Between October 14th and December 10th it was observed at various points between Bonavista Bay and Bay Bulls. Great quantities of a size of from 2 to 4 inches, were in particular noted when cast ashore in Bonavista Bay (November 28th) and at several points in Trinity Bay—e.g. at Salvage (October 30th), Bay Bulls Arm (November 7th) and Hearts Delight (December 10th). As usual, no adults of this species occurred, only the small young stages, almost uniform in size, being observed. As has been stated previously, the adolescent stages have been found in the Atlantic, and the adult stages on north European shores.

A further feature of the cold conditions off the east coast was a reported striking in of caplin to the Bonavista coast during the fall. There is no previous record of such an occurrence.

The situation in 1933 as far as squid were concerned may be summed up as follows: Except in Placentia Bay and certain other very restricted localities inshore and on the banks, water conditions were on the whole too cold for the arrival of squid in very large quantities; the cold conditions are accounted for by the previous very large influx of Arctic water, lack of strong summer heat, and restriction of the Atlantic influx from the south; much evidence accordingly occurred of the presence of the cold water species, *Gonatus*; the ordinary bait squid, *Illex*, was abnormally scarce, the causes probably being less than usually favourable water conditions, and actual general scarcity of the brood which should have constituted the "run" of the year. A more prolonged period of study of the whole problem will be necessary if definite conclusions are to be reached.

D. LOBSTERS

The continuous shrinkage in the returns from the lobster fishery, referred to in the report for 1932, proceeded one stage further in the spring of 1933, when the average catch per trap was 17 lobsters, against approximately 20 in the previous year. For the third successive year, however, in order to alleviate the acute economic depression, permission was given to prosecute the lobster fishery in the fall, with the rather unexpected result that in two districts particularly (Placentia–St. Mary's and St. Barbe) lobsters were captured in large numbers, reminiscent, indeed, of those which rewarded the fisherman's efforts many years ago.

Thus, in the St. Barbe district, which occupies the western coast of the northern peninsula of the island, 1044 cases of lobsters were packed in the fall, and only 721 in the spring. It is understood that the quality of the fall lobsters was good, and a proposal has been mooted that in this district the lobster fishery should be opened only in the fall, when fishermen are mostly free to undertake it, and that the spring season, during which salmon and codfish are available, should be discontinued.

In the Placentia–St. Mary's Bay region the fall pack likewise exceeded that of the spring, but to a lesser degree than at St. Barbe. Here again the quality of the lobsters was said to be satisfactory. Evidence from other years shows that this may not always be the case, and some investigation of the exact facts is called for, since it is possibly desirable to revise the time of incidence and the extent of the lobster fishery in certain districts.

The question may be asked—does this local demonstration of a copious supply of lobsters in the fall of 1933 indicate that the period of scarcity has come to an end, and that lobsters are on the increase? It is impossible at this stage to give a dogmatic opinion of the matter. The more hopeful might seek to derive favourable evidence from the fact that comparatively small numbers of lobsters have been removed from the sea in recent years, and that a degree of conservation of the stock has therefore occurred. (In 1898 there were packed 62,000 cases, and in 1933 not more than 7500 cases, or approximately one-eighth of the former large amount.) Against such a theory may be set the fact that, although only 17 per cent fewer hands were at work in 1933 than in 1932, the amount of the pack declined by 22 per cent. A second encouraging fact is that the average size of the lobsters packed in the various districts does not appear to be declining, as might be expected to happen did a state of chronic overfishing exist. Actually in recent years the average size packed is, according to the best available statistics, larger than in pre-war days, when size-restriction was apparently not enforced. Thus we find, on the three chief coasts :

		Lobsters per case (48 lbs.).	
		Average Number Year 1900 to 1908.	Average Number Year 1930.
EAST	Notre Dame Bay . . .	187	139
	Bonavista Bay . . .	178	147
	Trinity Bay	186	157
SOUTH-WEST	Burgeo–La Poile . . .	196	215
	Burin	200	172
	Placentia–St. Mary's Bays .	227	197
	Fortune Bay . . .	322	240
	St. George Bay, etc. . .	231	244
NORTH-WEST	St. Barbe	274	285

The statistics make it appear that on the whole a larger lobster is being packed than in the past. In other words, the very large packs of the early days of the industry were to a more considerable extent based on small lobsters, now excluded by law, and might even to-day be more closely approached by including the smaller lobster sizes.

The rate of growth of the lobster on these coasts is unknown, but, owing to the generally low average temperature of the water, may be comparatively slow. If no size limit were enforced, it might be possible to pack considerably greater amounts with, however, disastrous effects on the numbers surviving to the larger sizes. Too much emphasis cannot be given to the desirability of returning undersized lobsters to the sea in the live state.

The evidence from gradually diminishing returns during the last few years, while apparently pointing to a depletion of the stock, is not yet quite conclusive, especially when the remarkable results of the fall fishery of 1933 are taken into reckoning. The latter may, however, be the result of a temporary spurt, due either to the upgrowth of a particularly numerous year's brood, or to the prevalence of exceptionally favourable inshore water conditions in the fall of 1933. In the case of the St. Barbe district, where the phenomenon was most pronounced, correlation with favourable conditions is feasible. As has been stated in the section dealing with hydrography, there was a most unusual influx of moderately warm water from the south-west right along this coast, the influence being felt as far as St. Anthony, whereas in previous years any such influence has stopped short at a point well to the south of Belle Isle Straits. Drift bottles followed the same unusual course, as has also been shown. The fall temperature along the whole west coast was uniformly 11° C. at the surface, and 10° C. at 15 fathoms, whereas in 1932 it was irregular, dropping, at the surface, from 13° C. in the south to 8° in the north, and at 15 fathoms from 13° to 5°. There was, therefore, in 1933 practically no temperature gradient either from south to north, or from the surface to the moderate depths in which lobsters occur inshore. In 1932 a gradient existed in either case, a fact which might have tended to limit the movements of the lobster.

In the Placentia–St. Mary's Bay district, however, no such correlation was patent. Here the lobster lives, on the whole, under relatively colder water conditions. In 1933 the temperature at the surface was 14° C., and at 15 fathoms ranged between 6° and 3° C. In 1932 the figures were similar at 15 fathoms, but rather higher (16° C.) at the surface. While, therefore, the temperature gradient from the surface to 15 fathoms' depth was rather greater in 1932 than in 1933, the difference is trifling, and fails to corroborate the apparently promising evidence from the St. Barbe district. Probably the increased catch was due to the much more active use of the traps which occurs in the fall of this region.

It would appear that at least one further year's evidence is necessary to determine the trend of this fishery, and that in the meantime every effort should be concentrated on securing the return to the sea of egg-bearing lobsters, and also of undersized lobsters, in the live state. Concurrently the noticeable improvement which occurred in 1933 in the quality of the canned product will, it is to be hoped, be maintained or indeed carried a stage further.

E. SALMON

Small summer fish more plentiful than in 1932.

During 1933 the biological study of the life histories of the salmon composing the coastal and river fisheries was continued. A full examination of the scales from 3300 salmon (as compared with 4300 in the previous year) was made; the falling off in available material being due to the effect of the economic depression, which tended to limit collecting activities generally.

It was found that the fishery was dependent, as usual, on there being a large run of small summer fish—i.e. salmon which have spent two years at sea after leaving the rivers which saw their birth. There was a distinct shortage of this class of salmon in 1932, which, it will be remembered, was therefore a year of sub-normal catches, especially so since excessively cold water conditions occurred on the east coast. Grilse (salmon which have spent only one year at sea) were, however, more plentiful than in 1931, and, as was pointed out in the Report for 1932, this constituted, if anything, a promising augury for fish one year older (small summer fish) in the 1933 fishery—i.e. should excessively cold water conditions not recur in the spring of 1933. It was stated in the Report that the prospects for 1933 were for improved catches on the north and east coasts, with the possible exception of the south-eastern section, including Trinity Bay. This exception was made on account of the comparative scarcity of grilse in this latter section in 1932. The results of the fishery in 1933 proved these anticipations to be correct. An exhaustive study of the biological results has been made, and these, as in the case of results obtained in 1932, confirm and amplify those which have already been fully described for 1931. They are reserved for full treatment at a future date, when a biological census of the stock of salmon over a period of years will be available. Meanwhile chief interest centres in the attempt to find means, if possible, of anticipating the course of the coming fishery. First of all we will examine the broad facts, as far as they were revealed, of the situation existing in 1933.

In general small summer fish were found to be plentiful (except when ice conditions interfered with fishing activities) everywhere except in the south-east and on the west coast in the region of Bonne Bay. The fishery, which commences in the south-east in Trinity Bay and Bonavista Bay, was at first almost a complete failure, but normal catches were obtained later on in the north-east and on the Labrador coast. The south-west coast was also normally productive. Reference to the Report for 1932 will show that these results accord well with the relative numbers of grilse found in these areas in the previous year, 1932. It is of further interest, however, to examine the influence of the prevailing water conditions, which, if adverse, might be expected to aggravate poor results in localities where in any case salmon of the year's run were scarce, or, if favourable, to improve results where such fish were plentiful.

Relation of catches to water-temperature.

A general survey of the hydrographic conditions existing in 1933 has already been given. It was shown that the intensity of the Arctic current suffered very great diminution early in the year, and that the warmer influence of Atlantic water was then felt. In the south-east the unusually large amount of drift ice delayed normal vernal heating, so that the water remained too cold for a good salmon run beyond the usual time for the opening of the fishery. The result was that by the time the ice had disappeared the influence of warmer currents was at work and the transition occurred too abruptly. Thus at Dildo, Trinity Bay, where one of the refrigerated vessels conducting the fishery was stationed, three phases occurred, as follows:

May 10–13. Temperature at surface 1·0° C. Temperature at 25 metres —0·7° C.

May 14–21. Temperature at surface 2·3° C. Temperature at 25 metres 1·8° C.

May 22–27. Temperature at surface 3·5° C. Temperature at 25 metres 3·1° C.

From being too cold in the first phase the water rapidly increased in temperature to a point (over 3° at 25 metres' depth) rather warm for eastern spring salmon in abundance. In Bonavista Bay a somewhat similar effect was observed. The catches were very poor, but were best just before the ice came inshore (towards the end of May) for the last time. Thereafter the temperature of the surface water rose rapidly. From 8th–16th June it ranged from 5° to 8°, while remaining at too cold a level (nearly one degree below zero) at a depth of 25 metres. Such a sharp thermocline between the temperature at the surface and that at a moderate depth appears to be avoided by salmon. Shortly afterwards the water even at 25 metres' depth quickly reached a temperature of between 2° and 3°, and the fishery was definitely over. Farther north, in Notre Dame Bay, temperatures were also found to be higher than at the same time in 1932. In the Englee sector (White Bay), however, lower temperatures occurred, the average at the surface being 3·7°, while at 25 metres' depth a figure around zero was maintained. Off the Labrador coast similar conditions occurred, the surface temperature lying between 2° and 3°, and that at 25 metres between zero and one degree below. Salmon were, for a short period, plentiful in both these latter regions, and it becomes increasingly apparent that, in northerly parts at least, cold water—even sometimes sub-surface water of slightly negative temperature—is suitable for salmon. In the south-west, however, copious numbers of salmon occurred in the spring of 1933 in water of temperature some 3° to 8° above zero, and it is apparent that in this area the optimum conditions for salmon, as well as for cod, are different from those occurring in the north and east.

On the whole, therefore, it may be said that temperature conditions favoured the salmon run, although the period of suitability, in the east and north, was late in occurring on account of the presence of much ice, and restricted in extent, especially in the south-east, owing to the rapid change over to warmer conditions. At one point it appeared as though the required quota of salmon was not to be obtained.

In this series of studies of the annual salmon run there remains to be encountered a year of abundance, such as 1930. From similar observations in such a year much could be learnt as to the nature of the optimum conditions. For comparison therewith we have already a knowledge of the conditions occurring during a season of comparative failure, such as 1932.

The Spring Fishery at Bay Bulls.

In order to ascertain the exact nature of the salmon run at Bay Bulls, two nets were fished at Shoal Bay, some three miles to the north of the harbour. Complete records were kept of temperatures and catches. From 20th May to 24th June both nets were almost continually in commission, with the exception of rare days when one or the other had to be taken in for clearing from drift seaweed or for slight repair. The catch per fishing day varied between 9 and 274 lbs. of salmon, with an average of 68 lbs. The total number of salmon caught was 150, of average weight 10 lbs.—i.e. typical small summer fish, with here and there an occasional grilse. At the close of this period the local fishermen took in their nets, as the time for setting cod traps had arrived, but one net was run experimentally from 26th June to 14th July, during which period it was in action for 15 days. Daily catches varied between nil and 134 lbs., with an average of 50 lbs. The catch was almost exclusively of grilse, the average fish weighing 5½ lbs. This run of grilse, succeeding that of small summer fish, appears to continue beyond mid-July, as during the last week of the month and in the first few days of August, at least a dozen grilse were taken in the local cod traps. This class of salmon is not sought after for sharp-freezing for export, hence is neglected ; but from the above figures it appears to be capable of producing results equivalent in weight to those obtained in the actual fishery for larger salmon. These smaller fish are highly suitable for canning in half-pound cans. From the experiment generally it was deduced that the salmon fishery on this coast could be prosecuted on a remunerative basis by a half-decked boat, carrying ice, fishing a fleet of at least a dozen nets, and maintaining them in a clean and well-repaired condition. At present numerous small motor-boats carry out the fishery independently, each fishing two or three nets, which are not always well maintained. The returns are meagre in proportion to the effort expended.

It is of interest to make a comparison of the water-temperatures prevailing in each of the seasons 1932 and 1933. Salinities were also determined but, as hitherto, could not be shown to have much bearing on results. In 1933 colder water conditions prevailed than in 1932, and the first salmon returns were accordingly at least one week later in being obtained. The period of maximum catch was also considerably later in occurrence. The best catches, in order of occurrence, were obtained at the following temperatures :

Surface	3°	4°	5° ;	5°	6½°
15 metres' depth	1½°	2°	2½° ;	2°	4°
	Small summer fish ;			Grilse.	

During intervening periods much smaller catches occurred when the temperature rose or fell sharply for a spell. Except in the case of grilse, for which no previous figures have been obtained, these temperatures are in general accord with those hitherto obtained.

The Outlook for 1934.

Whether or not the substantial correctness of the anticipations, given in the 1932 Report for the course of the fishery in 1933, was the outcome of mere coincidence, or was founded on valid reasoning, is an open question. Strictly speaking it is quite inadvisable to enter the field of fishery prediction on the basis of limited data collected, not only for a very short period of years, but also in no comprehensive or directed fashion. Two factors, however, encourage the making of the attempt. The first is the rather speculative nature of the fresh-frozen salmon industry on its existing basis, whereby there is risk involved in fitting out expensive refrigerating vessels to proceed to locations where salmon may not be obtainable in large quantities. The industry has repeatedly stated its great desire to have any prior information—amounting even to mere probabilities—which can be made available. It should therefore be the first concern of an investigating body to try out the existing means of providing such information. The second factor arises from the first, in that the attempt focuses attention on the collection and study of a large body of relevant data which might otherwise never be obtained.

The tentative prediction of the 1933 fishery was formed from the consideration of the relative numbers of grilse in the various regions in 1932, and from the anticipated nature of the water conditions. With a fishery service organised in such manner that officers, as part of their duties, send in periodical reports on the sea-water conditions in their areas, it would become unnecessary to have to forecast the latter, and more accuracy would ensue. With regard to proportions of grilse caught, both at sea and in the rivers, there is no reason why, if the need is made clear very complete information should not be made available.

Pending such improvements the best must be made of the existing data, which, unfortunately, were less complete in 1933 than in 1932. With regard to numbers of grilse, we find an increase in relative numbers, over those of 1932, in the south-west and especially in the south-eastern areas, and a slight falling off in numbers in the north-east, the west, and on Labrador (in the case of Labrador this may be due to the fact that owing to the abundance of larger fish grilse were not accepted). Given average hydrographic conditions, therefore, the available data suggest much improved results from the south-eastern section, including Trinity Bay and possibly Bonavista Bay, and, if anything, slightly lesser available numbers of small summer fish in the north-east and off Labrador. (Greater returns from large summer fish may, however, offset any such diminution.)

The season, in the south-east especially, may begin a week or two earlier in the absence of the redevelopment of a strong influx of the Arctic current. In the north-east and off Labrador it may also be rather early in commencement, and of longer duration than in the last two years, especially off Labrador in the Cartwright area.

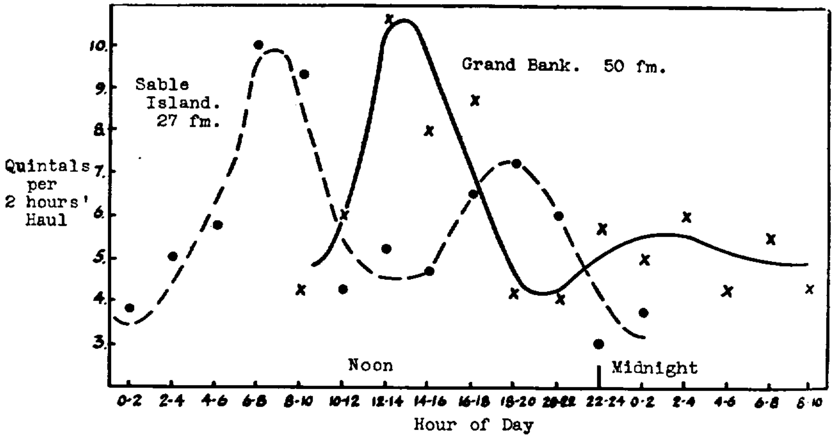
F. COD INVESTIGATIONS

The Bank Fishery.

Generally speaking, a successful bank fishery was experienced in 1933. This remark applies both to foreign trawlers, which did well in the usual locations on the banks, and to Newfoundland schooners, to which even a larger fishing area is available, on account of the employment of the bultow (line) method of fishing. This method can be used even on rough ground, on which a trawled net would be destroyed by boulders, etc. However, on account of lack of bait in the late summer and in the fall, the season's results for the schooners fell short of being satisfactory.

In addition to the usual spring and fall survey cruises over the area, the research vessel was utilised in spring on two commercial fishing voyages to the banks. These took place in April and May. Approximately 1150 quintals of cod and haddock, with a large preponderance of cod, were obtained on each occasion in from 14 to 16 days of actual fishing. Haddock were comparatively scarce on Sable Island Bank, but extraordinarily plentiful on southern Grand Bank, where during the best day's fishing 85 quintals of this fish were obtained. Temperature and salinity, as well as other determinations, were made during these trips. As usual, salinity changes could not be correlated with fluctuations in catches, but temperature changes were obviously of great importance.

The first ground tried out was the southern edge of Grand Bank, between the 50- and 100-fathom depth contours. The zone covered is cross-hatched in Figure 4. In the previous spring (1932), when the bottom temperature in this area was low (chiefly between zero and 2° C.), very large catches were obtained. In 1933, however, the catches were negligible, the temperature being 3° and over. In the Report for 1932 such temperatures were reckoned to be high, in this locality and in spring, for abundance of cod, and confirmation of the truth of this deduction was obtained in April, May and June, 1933. The vessel was therefore headed for Sable Island Bank, although, as subsequent events proved, suitably low temperatures and large catches could have been obtained on Grand Bank



YIELD PER TWO-HOUR TRAWL HAUL. MAY 1933.
FIG. 13.

50 miles to the north-east. The latter area, also shown in Figure 4, was visited towards the end of the second trip, with excellent results. The bulk of the fishing was however done in the region of Sable Island shown in Figure 4.

Relationship of Time of Day to Catch of Cod.

From three to ten hauls of two hours' duration were made daily, the number depending on weather conditions and the time occupied in moving from one ground to another. Dividing the day of twenty-four hours into twelve periods of two hours, and averaging the catches (in quintals of approx. 3 cwts. of round fish) made in each period, we obtain the results shown in Figure 13. In the Sable Island region the number of hauls in each of the twelve two-hourly periods averaged 6½, and, on Grand Bank, 5. It will be seen that in the former region, where the water is comparatively shallow (about 27 fathoms on the average), by far the best catches were made between 6 a.m. and 10 a.m.—i.e. just after dawn. Thereafter the quantities caught declined in the middle of the day, to increase again to a secondary maximum at dusk. On Grand Bank the time of maximum catch was quite different, being delayed till around noon each day. Here, however, the depth of water is almost twice as great. No definite secondary maximum occurred. Further observations of this kind are desirable to determine the degree of constancy of such occurrences, as the most intense fishing effort should certainly be made during the periods of greatest probable yield. Fishermen who work in comparatively shallow water, especially inshore, are great believers in operating at dawn or in the evening. Less is, however, known about the best time for fishing in deeper water. This may vary with area, but the above results for Grand Bank indicate that there is, at least in spring, considerable fish activity at the brightest period of the day. Here lance is the chief food. This bait-fish is often found at some distance from the sea-floor, but may seek the latter during the hours of greater illumination of the upper water layers, and, of course, be followed thither by cod.

Relationship of Temperature and Catch.

At Sable Island lucrative results were obtained as long as the temperature at the bottom remained between 1·5° and 3° C. This it did for several weeks in the most consistent fashion. Fifty-four hauls yielded an average of 7½ quintals. On 21st May, however, the temperature rose definitely above 3° C., and this fact, accompanied by the meagre catches of cod (20 hauls yielded an average of only 2½ quintals) and the increase in the relative amounts of haddock caught, influenced the skipper to leave the area for Grand Bank.

The southern edge, previously tested without success, still showed water of a temperature of over 3° C., and the higher levels of the bank, a few miles to the north-east, were next tried. Comparative success was at once attained. The temperature at the bottom varied between 1° and 2½° C. Eight hauls at temperatures between 1 and 1·4° yielded an average of 10½ quintals, and thirty-five hauls between 1·5° and 2·5° yielded an average of 5½ quintals. Confirmatory evidence was thus obtained that, on Grand Bank in spring, best catches of cod are most frequently secured in water of temperature just over zero.

In the spring of 1933 temperatures on Grand Bank were slightly higher than in the spring of 1932, and best catches were accordingly obtained further to the north-east—i.e. in the direction of cooler water. In 1932 very large catches were obtained on the southern ledge of the bank at temperatures around 1°C. In 1933, as has been stated, the temperature in this zone already registered over 3° C. and cod were scarce. Information was therefore issued, in the form of bulletin, that schooners fishing Grand

Bank should try farther to the north-east. The soundness of this advice was proved later on by the trawler itself, as shown by the above results. The outlook for the Sable Island region was also broadcast.

Further evidence was accumulated during the ordinary survey cruises of the research vessel. Coinciding with the higher temperature of the water overlying the southern portion of Grand Bank (1·2° to 5·5°, as compared with 0·5° to 3·7° in spring, 1932) the average catch was only 1903 cod per 10 hours' trawling as compared with 5203 in the previous year. Best results were obtained at temperatures between 1 and 1½°, precisely as was the case some weeks previously, as shown above. In 1932 the best catches were secured between zero and 1·8°. Above 3° catches were poor in both years.

The opposite side of the picture—temperatures which are too low—is apt to be shown on northern Grand Bank, where in consequence cod are never so abundant as in the south. In 1933, however, the temperature, although very low as usual, was nearly half a degree higher than in 1932. The range was between minus 0·2° and minus 0·9° in spring, and between minus 0·5° and minus 0·7° in the fall, and better catches were accordingly obtained than in the previous year, in the ratio of 1017 : 740 and 1700 : 270 (per 10 hours) in the spring and fall respectively. Similarly, inshore at St. Mary's and Placentia Bays—areas previously shown to be linked with northern Grand Bank conditions—much improved catches were obtained. This was in accord with anticipations formed early in the season. It is interesting to note that the bottom temperature in the St. Mary's region rose just above zero, whereas in the previous year it remained for the whole season at minus 0·9°.

Other regions which gave increased yields of cod were those of the southern Labrador coast and the Straits of Belle Isle. In both cases the temperature of the water was that given as most suitable in the Report for 1932. Poor results from the east coast of Newfoundland appear to have been caused chiefly by lack of bait. The water temperature in Notre Dame Bay was quite suitably low, although in the Fogo, Bonavista and Trinity Bay regions it appeared to be rather on the high side. In the case of the Straits and Trinity Bay, as in that of St. Mary's, these results were anticipated in private communications issued in response to inquiries by interested parties. Farther south, on the Avalon coast, catches were on the whole meagre, with the notable exception, for about two weeks at the end of July, of the Bay Bulls district. It should be pointed out that here a deeper type of trap (20 fathoms) is employed than is the general custom in other portions of the island, and that the vicissitudes of shallow-water fishing are to some extent avoided, especially so in a season such as 1933, in which summer heating supervened rather suddenly after a prolonged cold spring. The more general use of the deeper type of trap is to be recommended.

Predominant Age-groups in 1933.

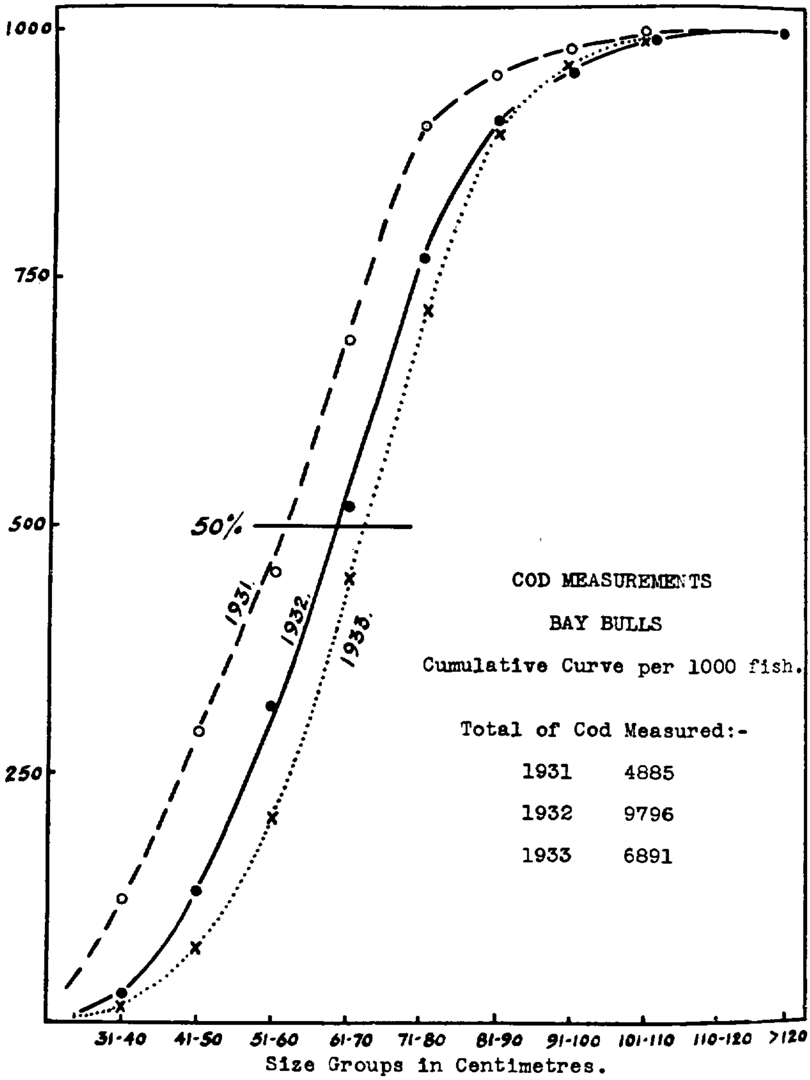
In continuance of the work begun in 1931 on the age analysis of the cod comprising the inshore fishery at Bay Bulls, it was again found that the 1927 and 1924 broods predominated. The proportionate numbers of cod, per 1000 caught, has been as follows :

	In 1931.	*In* 1932.	*In* 1933.
1930 Brood . . .			4
1929 ,, . . .		18	51
1928 ,, . . .	124	117	110
1927 ,, . . .	**185**	**195**	**173**
1926 ,, . . .	102	90	137
1925 ,, . . .	120	125	174
1924 ,, . . .	**277**	**235**	**223**
1923 ,, . . .	122	135	67
1922 ,, . . .	41	50	
Earlier broods . .	(29)	(35)	(61)

In 1933 these two predominant broods were six and nine years old respectively. Broods intermediate in age between these two are also well represented, and the immediate outlook is therefore very reassuring as far as availability of good-sized cod is concerned. In fact, during the last three seasons, there has been a gradual increase in the average size of cod coming to the shore. This is clearly shown by forming a cumulative summation of the numbers occurring in each size-group of 10 centimetres (Fig. 14). In 1933 the size below and above which 50 per cent of the fish could be grouped was about 10 centimetres greater than in 1931. We may now expect the 1924 group to pass gradually out of the inshore catches, and a gradual recession in the average size of cod taken, until a prominent young brood again reduces the average size to around that occurring in 1931. As yet there is no clear indication of the existence of such a brood. The present period of years appears to be one of comparative abundance of cod. Whether there are similar periods of comparative scarcity, due to natural causes such as failure of breeding seasons, remains to be demonstrated.

It is of interest to note one outcome of this gradual increase in the average size of cod caught. The studies on Vitamin A values of cod liver oil, reported upon elsewhere in this Report, prove clearly that increase of age of fish is accompanied by increase in vitamin potency of the oil. An increase in potency might therefore be expected to have occurred progressively during the last three years, and has, in fact, been observed, average values having advanced from around 12 units to around 14 units. It is important, in establishing standards of potency for trade purposes, that the likelihood of such periodic fluctuation be taken into account, and that the standard value be not pitched too high (e.g. 15 units are frequently asked for).

The winter fishery on the south-west coast was shown, in the winter of 1931, to be based principally on seventh, eighth and ninth year cod, and in 1932 age-analysis of the catches showed that the same age-groups, then one year older, formed the mainstay of the fishery.



1931	120	290	450	687	902	955	982	997	999	1000
1932	25	131	317	517	766	905	959	990	999	1000
1933	14	74	203	445	715	898	964	992	1000	1000

FIG. 14.

Similar age-analyses were made of the cod on the banks and in various portions of the coast, including Labrador. On Grand Bank the predominating broods were as at Bay Bulls. In addition, however, large numbers of older cod, from ten to fourteen years of age, were found on southern Grand Bank in April. This is the first occasion during these surveys that very large cod have been found so far up on the bank, within the 50-fathom depth contour. Their normal location is deeper down on the slopes, which may have been largely deserted on this occasion on account of the rather high temperatures prevailing.

Further data were collected on the relationships of the cod populations in different portions of the Newfoundland area. Consideration of these is deferred till a later date.

Tagging of Cod.

A commencement on an experimental scale was made in cod-tagging. At Bay Bulls 74 fish were tagged. Eighteen of these were tagged between 29th and 31st July, and six were recaptured before the close of the season. The extreme migrations shown were to Petty Harbour (12 miles to the north-east) and Pig Bank, off Cape Race (about 60 miles to the south-west). The remaining 56 were tagged between 12th and 18th October, with only one return before the season closed.

Two hundred cod were tagged off the Labrador coast late in the season. No returns were received before the season closed, but some may be looked for in the coming season.

It is proposed to conduct more extensive tagging operations in 1934. From the results of these operations it is hoped to obtain direct evidence on the inter-relationships of the cod populations, in contradistinction to the results so far derived from theoretical considerations. In this connection attention may be drawn to the important results now being obtained by the Danish investigators from tagging operations carried out several years ago. A considerable movement is being shown to be possible in either direction between Greenland and Iceland, and that the migration can in extreme cases be still more extensive is shown by a recapture recently reported to this Laboratory. This concerned a cod tagged two years previously at Westmann Islands, on the south coast of Iceland, and retaken by a fisherman off the north-east coast of Newfoundland.

G. HADDOCK INVESTIGATIONS

Reference has already been made to the large quantities of haddock found on Grand Bank in the spring of 1933. This followed up an increase in numbers in 1932 as compared with 1931, and the evidence is all in favour of assuming that the haddock stocks are at the present period definitely on the increase. A great deal of data bearing on this subject has been examined during the last three years, chiefly with the object of defining the relationships and fluctuations of the haddock populations of the Nova Scotian and Newfoundland Banks. The present increase seems to be due to the upgrowth of a couple or more of good broods. This is normally the deciding factor. On Grand Bank the 1927 brood has already been referred to as being plentiful, and in the year just closed the younger brood of 1928 also came into distinct prominence. On the Nova Scotian Banks the 1929 brood appeared in the catches in large numbers, while the 1928 brood maintained its prominent position of the previous year. The further growth of these broods, in their respective areas, will be noted with interest. All indications point to excellent haddock catches on the banks in 1934, if not also in 1935.

The trend towards increased catches of haddock is illustrated by the following average catches (per 10 hours' trawling) in either area:

		Spring.	*Fall.*
Grand Bank . . .	1931		255 (5)
	1932	3726 (5)	782 (5)
	1933	2772 (4)	5292 (4)
Nova Scotian Banks . .	1931		2540 (7)
	1932	1160 (1)	820 (1)
	1933		5547 (2)

(The figures in brackets denote the number of hauls made in each area.) The increase in the Nova Scotian area refers to Banquereau, where young broods tend to make their first appearance in the comparatively warm waters of that section of the banks. The Sable Island region has already been referred to as not being very productive of haddock in the spring of 1933, but immigration of the young 1929 brood from Banquereau seems certain to occur.

In 1933, as in the two previous years, very few haddock fry of the season were captured by the plankton nets of the research vessel. There is thus no evidence that either of these last three years has produced a very numerous brood. On the other hand the degree of sampling may be inadequate.

APPENDIX A

CRUISES OF STEAM TRAWLER *CAPE AGULHAS*

1. *Spring Cruise* 9/6/33–7/7/33 Stations 201–254 (Fig. 4).
2. *Fall Cruise* 23/8/33–27/9/33 Stations 255–319 (Fig. 5).

PLANKTON NETS. No. 1. Hjort, fine silk, 27½ inches diameter.
No. 2. 1-metre cheese cloth.
H=horizontal.
V=vertical.
No. 3. 2-metre Stramin.
No. 4. Squid Trawl.

DREDGES AND TRAWLS. O.T.=Otter Trawl.
V.D.=Otter Trawl, French pattern.
A.T.=Agassiz Trawl, 5 foot.

m=metres.

Station.	Dpth at bottom (m.).	Plankton Nets Time towed, and depth.	Dredges and Trawls.	Station.	Dpth at bottom (m.).	Plankton Nets Time towed, and depth.	Dredges and Trawls.
Off Bay Bulls June 9th	80	No. 1 (50 m.). No. 2 (H. 25 m. ½ hr.; 50 m. ½ hr.). No. 3 (50 m. ½ hr.; 75 m. ½ hr.).		204. 47°47′N 49°15′W June 10th	180	No. 1 (100 m.). No. 2 (H. 50 m. ½ hr.; 75 m. ½ hr.). No. 3 (75 m. ½ hr.; 100 m. ½ hr.).	V.D. (½ hr.).
46°34′N 51°21′W June 9th	80	No. 1 (50 m.). No. 2 (H. 25 m. ½ hr.; 50 m. ½ hr.). No. 3 (50 m. ½ hr.; 75 m. ½ hr.).		205. 46°54′N 48°00′W June 11th	130	No. 1 (100 m.). No. 2 (H. 25 m. ½ hr.; 50 m. ½ hr.). No. 3 (75 m. ½ hr.; 100 m. ½ hr.).	V.D. (½ hr.).
47°07′N 50°25′W June 10th	105	No. 1 (50 m.). No. 2 (H. 25 m. ½ hr.; 50 m. ½ hr.). No. 3 (50 m. ½ hr.; 74 m. ½ hr.).	V.D. (½ hr.).	206. 46°12′N 48°14′W June 11th	105	No. 1 (50 m.). No. 2 (H. 25 m. ½ hr.; 50 m. ½ hr.). No. 3 (50 m. ½ hr.; 75 m. ½ hr.).	V.D. (½ hr.).

Station.	Dpth at bottom (m.).	Plankton Nets Time towed, and depth.	Dredges and Trawls.
207. 45°42′N 48°33′W June 11th	125	No. 1 (50 m.). No. 2 (H. 25 m. ¼ hr.; 50 m. ¼ hr.). No. 3 (50 m. ¼ hr.; 75 m. ¼ hr.).	V.D. (¾ hr.).
208. 45°16′N 50°14′W June 12th	65	No. 1 (40 m.). No. 2 (H. 15 m. ½ hr.). No. 3 (40 m. ½ hr.).	
209. 44°22′N 49°16′W June 12th	45	No. 1 (40 m.). No. 2 (H. 15 m. ½ hr.). No. 3 (35 m. ½ hr.).	V.D. (½ hr.).
210. 44°02′N 50°06′W June 12th	55	No. 1 (50 m.). No. 2 (V. 50 m.). No. 3 (20 m. ¼ hr.; 40 m. ¼ hr.).	V.D. (¾ hr.).
211. 43°50′N 51°12′W June 13th	75	No. 1 (50 m.). No. 2 (H. 10 m. ¼ hr.; 35 m. ¼ hr.). No. 3 (25 m. ¼ hr.; 60 m. ¼ hr.).	V.D. (¾ hr.).
212. 44°05′N 52°13′W June 13th	90	No. 1 (50 m.) No. 2 (H. 25 m. ¼ hr.; 50 m. ¼ hr.). No. 3 (50 m. ¼ hr.; 75 m. ¼ hr.).	V.D. (1¾ hrs.).
213. 44°20′N 53°10′W June 13th		No. 1 (100 m.). No. 3 (75 m. ¼ hr.; 100 m. ¼ hr.). No. 4 (25 m. ¼ hr.).	
214. 44°30′N 53°14′W June 13th	180	No. 1 (100 m.). No. 2 (H. 25 m. ¼ hr.; 50 m. ¼ hr.). No. 3 (75 m. ¼ hr.; 100 m. ¼ hr.).	V.D. (1 hr.).
215. 44°45′N 53°41′W June 14th	105	No. 1 (50 m.). No. 2 (H. 25 m. ¼ hr.; 50 m. ¼ hr.). No. 3 (50 m. ¼ hr.; 75 m. ¼ hr.).	V.D. (½ hr.).

Station.	Dpth at bottom (m.).	Plankton Nets Time towed, and depth.	Dredges and Trawls.
216. 45°13′N 53°22′W June 14th	95	No. 1 (50 m.). No. 2 (H. 25 m. ¼ hr.; 50 m. ¼ hr.). No. 3 (50 m. ¼ hr.; 75 m. ¼ hr.).	
217. 45°14′N 55°27′W June 14th	105	No. 1 (50 m.). No. 2 (H. 25 m. ¼ hr.; 50 m. ¼ hr.). No. 3 (75 m. ¼ hr.; 100 m. ¼ hr.).	
218. 45°23′N 55°50′W June 14th	70	No. 1 (50 m.). No. 2 (H. 25 m. ½ hr.). No. 3 (50 m. ½ hr.).	
219. 46°22′N 52°46′W June 15th	150	No. 1 (50 m.). No. 2 (H. 25 m. ¼ hr.; 50 m. ¼ hr.). No. 3 (75 m. ¼ hr.; 100 m. ¼ hr.).	
201. Repeated 47°13′N 52°39′W June 15th		No. 1 (50 m.).	
220. 46°22′N 53°50′W June 17th	135	No. 1 (50 m.). No. 2 (H. 25 m. ¼ hr.). No. 3 (50 m. ¼ hr.).	
221. 46°37′N 54°58′W June 17th	170	No. 1 (50 m.). No. 2 (H. 25 m. ¼ hr.). No. 3 (50 m. ¼ hr.).	
222. 47°13′N 55°37′W June 20th	198	No. 1 (100 m.). No. 2 (V. 100 m.).	
223. 46°52′N 56°02′W June 20th	84	No. 1 (50 m.). No. 3 (25 m. ¼ hr.).	
224. 47°19′N 56°45′W June 21st	234	No. 1 (100 m.). No. 2 (H. 25 m. ¼ hr.; 50 m ¼ hr.). No. 3 (75 m. ¼ hr.; 100 m. ¼ hr.).	

Station.	Dpth at bottom (m.).	Plankton Nets Time towed, and depth.	Dredges and Trawls.
47°27'N 58°43'W June 22nd	147	No. 1 (100 m.). No. 2 (H. 25 m. ¼ hr.; 50 m. ¼ hr.). No. 3 (75 m. ¼ hr.; 100 m. ¼ hr.).	
46°26'N 59°14'W June 25th	113	No. 1 (50 m.). No. 2 (H. 50 m. ½ hr.). No. 3 (75 m. ½ hr.).	V.D. (½ hr.). No colln.
46°51'N 58°47'W June 25th	360	No. 1 (100 m.). No. 2 (H. 25 m. ¼ hr.; 50 m. ¼ hr.). No. 3 (75 m. ¼ hr.; 100 m. ¼ hr.).	
47°30'N 59°50'W June 26th	450	No. 1 (100 m.). No. 2 (H. 25 m. ¼ hr.; 50 m. ¼ hr.). No. 3 (75 m. ¼ hr.; 100 m. ¼ hr.).	
47°28'N 60°39'W June 26th	60	No. 1 (50 m.). No. 2 (H. 25 m. ½ hr.). No. 3 (50 m. ½ hr.).	V.D. (½ hr.). No colln.
48°06'N 59°26'W June 26th	80	No. 1 (50 m.). No. 2 (H. 25 m. ½ hr.). No. 3 (50 m. ½ hr.).	
48°25'N 58°51'W June 26th	104	No. 1 (50 m.). No. 2 (H. 25 m. ½ hr.). No. 3 (50 m. ½ hr.).	
48°45'N 59°12'W June 27th	77	No. 1 (50 m.). No. 2 (H. 25 m. ½ hr.). No. 3 (50 m. ½ hr.).	O.T. (½ hr.). Badly torn.
49°17'N 58°31'W June 27th	63	No. 1 (50 m.). No. 2 (H. 25 m. ½ hr.). No. 3 (50 m. ½ hr.).	O.T. (20 min.). Badly torn.
50°32'N 57°46'W June 28th		No. 1 (50 m.). No. 3 (75 m. ¼ hr.; 100 m. ¼ hr.).	
235. 51°23'N 56°58'W June 29th	52	No. 1 (50 m.). No. 2 (V. 50 m.). No. 3 (25 m. ½ hr.).	V.D. (½ hr.).
236. 51°31'N 56°43'W June 29th	108	No. 1 (50 m.). No. 2 (H. 25 m. ½ hr.). No. 3 (50 m. ½ hr.).	
237. 51°54'N 55°43'W June 30th	133	No. 1 (50 m.). No. 2 (H. 25 m. ½ hr.). No. 3 (50 m. ½ hr.).	
238. 52°19'N 55°31'W June 30th	113	No. 1 (100 m.). No. 2 (H. 25 m. ½ hr.). No. 3 (50 m. ½ hr.).	
239. 52°52'N 55°26'W July 1st	144	No. 1 (100 m.). No. 2 (H. 25 m. ¼ hr.; 50 m. ¼ hr.). No. 3 (75 m. ¼ hr.; 100 m. ¼ hr.).	
240. 53°02'N 55°37'W July 1st	122	No. 1 (50 m.). No. 2 (H. 25 m. ¼ hr.; 50 m. ¼ hr.). No. 3 (75 m. ¼ hr.; 100 m. ¼ hr.).	
241. 53°30'N 55°28'W July 3rd	90	No. 1 (50 m.). No. 2 (H. 25 m. ¼ hr.). No. 3 (50 m. ¼ hr.).	
242. 53°39'N 56°09'W July 3rd	41	No. 1 (25 m.). No. 2 (V. 25 m.). No. 3 (25 m. ½ hr.).	O.T. (10 mins.). Torn.
243. 51°40'N 55°40'W July 4th	45	No. 1 (35 m.). No. 2 (V. 25 m.). No. 3 (25 m. ¼ hr.).	
244. 51°33'N 55°22'W July 4th	80	No. 1 (50 m.). No. 2 (H. 25 m. ¼ hr.). No. 3 (50 m. ¼ hr.).	O.T. (20 mins.).
245. 51°21'N 55°31'W July 4th	56	No. 1 (50 m.). No. 2 (V. 50 m.). No. 3 (25 m. ¼ hr.).	

Station.	Dpth at bot-tom (m.).	Plankton Nets Time towed, and depth.	Dredges and Trawls.
246. 50°55′N 55°41′W July 5th	54	No. 1 (50 m.). No. 2 (V. 50 m.). No. 3 (25 m. ¼ hr.).	O.T. (½ hr.).
247. 50°25′N 55°46′W July 5th		No. 1 (100 m.). No. 2 (H. 25 m. ¼ hr.; 50 m. ¼ hr.). No. 3 (75 m. ¼ hr.; 100 m. ¼ hr.).	
248. 50°18′N 54°28′W July 5th	223	No. 1 (100 m.). No. 2 (H. 25 m. ¼ hr.; 50 m. ¼ hr.). No. 3 (75 m. ¼ hr.; 100 m. ¼ hr.).	
249. 50°00′N 53°10′W July 6th		No. 1 (100 m.). No. 3 (75 m. ¼ hr.; 100 m. ¼ hr.).	
250. 49°06′N 52°57′W July 6th		No. 1 (100 m.). No. 2 (H. 25 m. ¼ hr.; 50 m. ¼ hr.). No. 3 (75 m. ¼ hr.; 100 m. ¼ hr.).	
251. 48°40′N 52°54′W July 6th	83	No. 1 (50 m.). No. 2 (H. 25 m. ¼ hr.). No. 3 (50 m. ¼ hr.).	
252. 48°22′N 52°46′W July 6th	180	No. 1 (100 m.). No. 2 (H. 25 m. ¼ hr.; 50 m. ¼ hr.). No. 3 (75 m. ¼ hr.; 100 m. ¼ hr.).	
253. 48°08′N 52°32′W July 7th	203	No. 1 (100 m.). No. 2 (H. 25 m. ¼ hr.; 50 m. ¼ hr.). No. 3 (75 m. ¼ hr.; 100 m. ¼ hr.).	
254. 57°42′N 53°00′W July 7th	208	No. 1 (100 m.). No. 2 (H. 25 m. ¼ hr.; 50 m. ¼ hr.). No. 3 (75 m. ¼ hr.: 100 m. ¼ hr.).	V.D. (½ hr. 198 m.).
Off Bay Bulls July 7th		No. 1 (50 m.). No. 2 (H. 25 m. ¼ hr.). No. 3 (50 m. ¼ hr.).	
255. 1½ miles off Bay Bulls Aug. 23rd		No. 1 (100 m.). No. 2 (H. 25 m. ½ hr.). No. 3 (50 m. ½ hr.).	
256. 46°30′N 53°17′W Aug. 24th	59	No. 1 (55 m.). No. 2 (H. 15 m. ½ hr.). No. 3 (40 m. ½ hr.).	
257. 46°52′N 53°47′W Aug. 24th	110	No. 1 (100 m.). No. 2 (H. 25 m. ½ hr.). No. 3 (50 m. ½ hr.).	V.D. [illegible] m.).
258. 46°16′N 54°00′W Aug. 24th	128	No. 1 (125 m.). No. 2 (H. 25 m. ½ hr.). No. 3 (50 m. ½ hr.).	
259. 46°31′N 54°50′W Aug. 24th	192	No. 1 (100 m.). No. 2 (H. 25 m. ½ hr.). No. 3 (75 m. ½ hr.).	
260. 46°24′N 55°36′W Aug. 25th	148	No. 1 (100 m.). No. 2 (H. 25 m. ½ hr.). No. 3 (75 m. ½ hr.).	
261. 47°13′N 55°41′W Aug. 25th	225	No. 1 (100 m.). No. 2 (H. 25 m. ½ hr.). No. 3 (75 m. ½ hr.).	
262. 47°28′N 56°28′W Aug. 28th	256	No. 1 (100 m.). No. 2 (H. 25 m. ½ hr.). No. 3 (75 m. ½ hr.).	
263. 47°07′N 57°51′W Aug. 28th	73	No. 1 (50 m.). No. 2 (H. 10 m. ½ hr.). No. 3 (35 m. ½ hr.).	
264. 47°19′N 58°37′W Aug. 29th	216	No. 1 (100 m.). No. 2 (H. 25 m. ½ hr.). No. 3 (100 m. ½ hr.).	

Station.	Dpth at bot-tom (m.).	Plankton Nets Time towed, and depth.	Dredges and Trawls.	Station.	Dpth at bot-tom (m.).	Plankton Nets Time towed, and depth.	Dredges and Trawls.
5. 46°53′N 59°15′W Aug. 29th	420	No. 1 (100 m.). No. 2 (H. 25 m. ½ hr.). No. 3 (200 m. ½ hr.).		276. 44°28′N 53°00′W Sept. 2nd	128	No. 1 (120 m.). No. 2 (H. 25 m. ½ hr.). No. 3 (50 m. ½ hr.).	V.D. (1 hr.).
6. 46°22′N 59°28′W Aug. 30th	110	No. 1 (90 m.). No. 2 (H. 25 m. ½ hr.). No. 3 (50 m. ½ hr.).		277. 44°31′N 52°38′W Sept. 2nd	95	No. 1 (90 m.). No. 2 (H. 25 m. ½ hr.). No. 3 (50 m. ½ hr.).	V.D. (1 hr.).
7. 46°09′N 59°00′W Aug. 30th.	113	No. 1 (95 m.). No. 2 (H. 75 m. ½ hr.). No. 3 (50 m. ½ hr.).		278. 44°00′N 52°10′W Sept. 2nd	97	No. 1 (90 m.). No. 2 (H. 50 m. ½ hr.). No. 3 (50 m. ½ hr.).	
8. 44°52′N 57°47′W Aug. 31st	44	No. 1 (40 m.). No. 2 (H. 40 m. ½ hr.). No. 3 (25 m. ½ hr.).	V.D. (¾ hr.).	279. 43°46′N 50°55′W Sept. 3rd	79	No. 1 (75 m.). No. 2 (V. 75 m.). No. 3 (40 m. ½ hr.).	
9. 44°36′N 57°52′W Aug. 31st.	36	No. 1 (35 m.). No. 2 (H. 35 m. ½ hr.). No. 3 (20 m. ½ hr.).	V.D. (¾ hr.).	280. 44°00′N 49°40′W Sept. 4th	53	No. 1 (50 m.). No. 2 (V. 50 m.). No. 3 (25 m. ½ hr.).	V.D. (¾ hr.).
. 44°57′N 56°55′W Aug. 31st	439	No. 1 (100 m.). No. 2 (H. 25 m. ½ hr.). No. 3 (100 m. ½ hr.).		281. 44°52′N 49°17′W Sept. 4th	88	No. 1 (80 m.). No. 2 (H. 25 m. ½ hr.). No. 3 (50 m. ½ hr.).	V.D. (¾ hr.).
1. 45°05′N 55°59′W Sept. 1st	106	No. 1 (100 m.). No. 2 (H. 25 m. ½ hr.). No. 3 (50 m. ½ hr.).		282. 44°50′N 49°00′W Sept. 4th		No. 1 (100 m.). No. 2 (H. 25 m. ½ hr.). No. 3 (100 m. ½ hr.).	
2. 45°16′N 55°14′W Sept. 1st	179	No. 1 (100 m.). No. 2 (H. 0 m. ½ hr.). No. 3 (50 m. ½ hr.).		283. 45°49′N 48°26′W Sept. 5th	94	No. 1 (90 m.). No. 2 (H. 25 m. ½ hr.). No. 3 (50 m. ½ hr.).	V.D. (½ hr.).
3. 45°12′N 54°21′W Sept. 1st	128	No. 1 (115 m.). No. 2 (H. 25 m. ½ hr.). No. 3 (50 m. ½ hr.).		284. 46°53′N 48°00′W Sept. 5th	130	No. 1 (100 m.). No. 2 (H. 25 m. ½ hr.). No. 3 (75 m. ½ hr.).	V.D. (¾ hr.).
4. 44°44′N 53°35′W Sept. 2nd	101	No. 1 (95 m.). No. 2 (H. 25 m. ½ hr.). No. 3 (50 m. ½ hr.).	V.D. (1 hr.).	285. 47°57′N 49°21′W Sept. 6th	192	No. 1 (100 m.). No. 2 (H. 25 m. ½ hr.). No. 3 (75 m. ½ hr.).	
5. 44°22′N 53°16′W Sept. 2nd	329	No. 1 (100 m.). No. 2 (H. 25 m. ½ hr.). No. 3 (100 m. ½ hr.).		286. 48°19′N 50°49′W Sept. 6th	172	No. 1 (100 m.). No. 2 (H. 25 m. ½ hr.). No. 3 (75 m. ½ hr.).	

Station.	Dpth at bottom (m.).	Plankton Nets Time towed, and depth.	Dredges and Trawls.
287. 47°14′N 50°17′W Sept. 6th	95	No. 1 (90 m.). No. 2 (H. 25 m. ½ hr.). No. 3 (50 m. ½ hr.).	V.D. (¾ hr.).
288. 46°31′N 51°26′W Sept. 7th	90	No. 1 (85 m.). No. 2 (H. 25 m. ½ hr.). No. 3 (50 m. ½ hr.).	A.T. (½ hr.).
289. 45°53′N 51°12′W Sept. 7th	92	No. 1 (90 m.). No. 2 (H. 25 m. ½ hr.). No. 3 (50 m. ½ hr.).	
290. 2 miles off Bay Bulls Sept. 8th		No. 1 (100 m.). No. 2 (H. 25 m. ½ hr.). No. 3 (75 m. ½ hr.).	
291. 47°54′N 52°56′W Sept. 9th		No. 1 (100 m.). No. 2 (H. 25 m. ½ hr.). No. 3 (50 m. ½ hr.).	
292. 48°06′N 52°44′W Sept. 9th	153	No. 1 (100 m.). No. 2 (H. 25 m. ½ hr.). No. 3 (75 m. ½ hr.).	
293. 48°22′N 52°51′W Sept. 9th	260	No. 1 (100 m.). No. 2 (H. 25 m. ½ hr.). No. 3 (100 m. ½ hr.).	
294. 48°41′N 52°55′W Sept. 9th	80	No. 1 (80 m.). No. 2 (H. 25 m. ¼ hr.). No. 3 (50 m. ¼ hr.).	
295. 49°05′N 52°56′W Sept. 9th		No. 1 (100 m.). No. 2 (H. 25 m. ¼ hr.). No. 3 (100 m. ¼ hr.).	
296. 50°03′N 53°02′W Sept. 10th		No. 1 (100 m.). No. 2 (H. 25 m. ¼ hr.). No. 3 (100 m. ¼ hr.).	
297. 50°05′N 53°50′W Sept. 10th	139	No. 1 (100 m.). No. 3 (100 m. ¼ hr.).	
298. 50°05′N 54°41′W Sept. 10th	216	No. 1 (100 m.). No. 2 (H. 25 m. ¼ hr.). No. 3 (100 m. ¼ hr.).	
299. 50°41′N 56°00′W Sept. 12th	134	No. 1 (100 m.). No. 2 (V. 100 m.). No. 3 (75 m. ¼ hr.).	
300. 50°55′N 55°42′W Sept. 12th	45	No. 1 (40 m.). No. 2 (V. 40 m.).	
301. 51°33′N 55°22′W Sept. 13th	80	No. 1 (50 m.). No. 2 (V. 50 m.). No. 3 (25 m. ¼ hr.).	
302. 52°28′N 55°36′W Sept. 14th	65	No. 1 (65 m.). No. 2 (H. 0 m. ½ hr.). No. 3 (30 m. ½ hr.).	
303. 53°28′N 55°30′W Sept. 15th	87	No. 1 (75 m.). No. 2 (H. 0 m. ½ hr.). No. 3 (35 m. ½ hr.).	
A. 53°37′N 55°59′W Sept. 16th	48	No. 1 (45 m.). No. 2 (V. 45 m.). No. 3 (25 m. ½ hr.).	
304. 54°10′N 55°26′W Sept. 18th	140	No. 1 (100 m.). No. 2 (H. 25 m. ½ hr.). No. 3 (75 m. ½ hr.).	
305. 54°19′N 54°45′W Sept. 19th	189		
306. 52°57′N 55°29′W Sept. 19th	131	No. 1 (100 m.). No. 2 (H. 25 m. ½ hr.). No. 3 (75 m. ½ hr.).	
307. 51°53′N 55°40′W Sept. 20th	135	No. 1 (100 m.). No. 2 (H. 25 m. ¼ hr.). No. 3 (75 m. ¼ hr.).	
308. 51°36′N 56°13′W Sept. 20th	60	No. 1 (60 m.). No. 2 (H. 0 m. ¼ hr.). No. 3 (30 m. ¼ hr.).	

Station.	Dpth at bottom (m.).	Plankton Nets Time towed, and depth.	Dredges and Trawls.	Station.	Dpth at bottom (m.).	Plankton Nets Time towed, and depth.	Dredges and Trawls.
09. 51°23′30″N 56°59′W Sept. 20th	30	No. 1 (25 m.). No. 2 (V. 25 m.). No. 3 (15 m. ½ hr.).	V.D. (½ hr.).	315. 48°24′N 58°46′W Sept. 23rd	34	No. 1 (30 m.). No. 2 (V. 30 m.). No. 3 (15 m. ¼ hr.).	
10. 50°49′N 58°12′W Sept. 21st	64	No. 1 (50 m.). No. 2 (H. 0 m. ½ hr.). No. 3 (30 m. ½ hr.).		316. 48°01′N 59°23′W Sept. 23rd	82	No. 1 (75 m.). No. 2 (H. 0 m. ¼ hr.). No. 3 (35 m. ¼ hr.).	
11. 50°18′N 58°06′W Sept. 21st	230	No. 1 (100 m.). No. 2 (H. 25 m. ½ hr.). No. 3 (100 m. ½ hr.).		317. 47°45′N 60°00′W Sept. 23rd		No. 1 (100 m.). No. 2 (H. 25 m. ½ hr.). No. 3 (100 m. ½ hr.).	
12. 49°56′N 58°08′W Sept. 21st	93	No. 1 (90 m.). No. 2 (H. 25 m. ½ hr.). No. 3 (50 m. ½ hr.).		318. 47°33′N 60°43′W Sept. 24th	62	No. 1 (50 m.). No. 2 (H. 0 m. ½ hr.). No. 3 (30 m. ½ hr.).	V.D. (½ hr.).
13. 49°10′N 58°35′W Sept. 22nd	76	No. 1 (60 m.). No. 2 (H. 0 m. ¼ hr.). No. 3 (30 m. ¼ hr.).		319. 46°46′N 53°50′W Sept. 27th	104	No. 1 (100 m.). No. 2 (H. 25 m. ¼ hr.). No. 3 (50 m. ¼ hr.).	V.D. (¾ hr.).
14. 48°37′N 59°11′W Sept. 22nd	38	No. 1 (35 m.). No. 2 (V. 35 m.). No. 3 (25 m. ¼ hr.).		1. Off Bay Bulls Sept. 27th	115	No. 1 (100 m.). No. 2 (H. 25 m. ¼ hr.). No. 3 (50 m. ¼ hr.).	

APPENDIX B

TEMPERATURES AND SALINITIES AT DEPTH m (METRES)

(*a*) *FIRST COMMERCIAL CRUISE*

m=depth in metres; t°=temperature, centigrade; $S^{\circ}/_{\circ\circ}$=Salinity (parts per 1000); I–XVI=trawling stations.

South Grand Bank. I.

Date and Position	m.	t°	$S^{\circ}/_{\circ\circ}$
1933 IV 13 2.30 p.m. 44°07′N. 52°20′W	0	3·5	32·94
	15	3·2	32·92
	95	2·6	33·93

South Grand Bank. II.

Date and Position	m.	t°	$S^{\circ}/_{\circ\circ}$
1933 IV 13 4.00 p.m.	0	3·5	
	100	3·1	32·97
	125	3·5	34·36

South Grand Bank. III.

Date and Position	m.	t°	$S^{\circ}/_{\circ\circ}$
1933 IV 13 6.00 p.m.	0	3·5	32·90
	50	3·2	32·92
	95	2·9	33·48

South Grand Bank. IV.

Date and Position	m.	t°	$S^{\circ}/_{\circ\circ}$
1933 IV 15 8.00 a.m.	0	3·4	32·95
	90	2·3	33·58

Sable Island Bank. I.

Date and Position	m.	t°	$S^{\circ}/_{\circ\circ}$
1933 IV 16 72 m. 3.30 p.m. 43°45′N. 59°13′W	0	2·0	32·83
	10	1·8	32·86
	30	1·6	32·92

Sable Island Bank. II.

Date and Position	m.	t°	$S^{\circ}/_{\circ\circ}$
1933 IV 16 6 p.m.	0	2·0	
	10	1·5	32·77
	70	1·6	33·04

Sable Island Bank. III.

Date and Position	m.	t°	$S^{\circ}/_{\circ\circ}$
1933 IV 16 8.00 p.m.	0	2·0	
	60	1·6	33·13

Sable Island Bank. IV.

Date and Position	m.	t°	$S^{\circ}/_{\circ\circ}$
1933 IV 17 1.00 p.m.	0	2·3	32·81
	30	1·6	32·95
	50	1·6	32·99
	80	1·8	33·21

Sable Island Bank. V.

Date and Position	m.	t°	$S^{\circ}/_{\circ\circ}$
1933 IV 17 8.00 p.m.	0	2·3	32·90
	30	1·7	33·13
	50	1·8	33·24
	75	1·8	33·30

Sable Island Bank. VI.

Date and Position	m.	t°	$S^{\circ}/_{\circ\circ}$
1933 IV 18 88 m. 11.00 p.m.	0	2·2	32·81
	30	1·6	32·97
	80	2·0	33·39

Sable Island Bank. VII.

Date and Position	m.	t°	$S^{\circ}/_{\circ\circ}$
1933 IV 20 45 m. 2.00 p.m.	0	1·9	32·63
	35	1·6	32·66

Sable Island Bank. VIII.

Date and Position	m.	t°	$S^{\circ}/_{\circ\circ}$
1933 IV 21 65 m. 12.30 p.m.	0	1·9	32·79
	30	1·6	32·81
	70	1·9	33·37

Sable Island Bank. IX.

1933 IV 22
1.00 p.m.

m.	t°	S°/₀₀
0	2·1	32·68
30	1·6	32·79
70	1·8	33·26

Sable Island Bank. X.

1933 IV 23
78 m.
11.30 a.m.

m.	t°	S°/₀₀
0		
30	1·6	32·77
60	1·7	33·04

Sable Island Bank. XI.

1933 IV 23
8.00 p.m.

m.	t°	S°/₀₀
0	1·95	32·20
50	1·65	32·95

Sable Island Bank. XII.

1933 IV 24
70 m.
11.00 a.m.

m.	t°	S°/₀₀
0	1·9	32·65
50	1·5	32·66

Sable Island Bank. XIII.

1933 IV 25
65 m.
1.00 p.m.

m.	t°	S°/₀₀
0	2·3	32·70
30	1·9	32·70
75	1·8	33·15

Sable Island Bank. XIV.

1933 IV 27
100 m.
3.00 p.m.

m.	t°	S°/₀₀
0	2·9	
30	2·4	
50	2·3	
80	1·8	

Sable Island Bank. XV.

1933 IV 29
S.E. edge of bank
12.00 a.m.

m.	t°	S°/₀₀
0	2·5	
10	2·4	
35	2·4	

Sable Island Bank. XVI.

1933 IV 30
Near edge of 25 fathom line
9.30 p.m.

m.	t°	S°/₀₀
0	2·7	
10	2·7	
20	2·6	
35	2·3	

(b) *SECOND COMMERICAL CRUISE*

Station A.

1933 V 12
Sable Island Bank

m.	t°	S°/₀₀
0	3·1	32·07
15	2·9	32·09
30	2·3	32·32
40	2·3	32·32

1933 V 13
Sable Island Bank

m.	t°	S°/₀₀
0	2·9	32·10
15	2·7	32·09
30	2·7	32·25
40	2·5	32·27
50	2·2	32·41

1933 V 14
Sable Island Bank
65 m.

m.	t°	S°/₀₀
0	3·0	32·12
30	2·7	32·25
45	2·3	32·45
60	2·2	32·48

1933 V 15
Sable Island Bank
60 m.

m.	t°	S°/₀₀
0	3·1	32·21
30	2·7	32·21
45	2·4	32·36
55	2·3	32·36

1933 V 16
Sable Island Bank
35 m.

m.	t°	S°/₀₀
0	3·3	32·03
30	2·9	32·10
40	2·7	32·14
50	2·5	32·27

1933 V 17
6 ml. S.S.E. Sable Island
50 m.

m.	t°	S°/₀₀
0	4·1	32·01
15	3·9	32·03
30	3·7	32·03
40	3·3	32·03
45	3·0	32·03

Station B.

Date and Position	m.	t°	S°/oo
1933 V 18	0	3·7	31·85
	15	3·6	31·85
	30	3·6	32·05
	45	2·8	32·25
	55	2·2	32·47

Date and Position	m.	t°	S°/oo
1933 V 18	0	3·7	32·03
	15	3·5	32·05
	35	2·2	32·32
	45	2·0	32·27

Station A.

Date and Position	m.	t°	S°/oo
1933 V 19 60 m.	0	4·0	32·00
	30	2·8	32·10
	40	2·7	32·12
	55	2·5	32·14

Station C.

Date and Position	m.	t°	S°/oo
1933 V 21 68 m. 43°36′N. 60°22′W	0	4·8	32·14
	30	4·7	32·16
	50	4·0	32·23
	65	3·3	32·25

Station D.

Date and Position	m.	t°	S°/oo
1933 V 21 60 m. 43°40′N. 60°50′W	0	5·4	32·14
	25	5·0	32·20
	40	4·2	32·21
	55	3·1	32·27

Station E. Grand Bank.

Date and Position	m.	t°	S°/oo
1933 V 24 95 m. 44°30′N. 52°37′W	0	5·2	32·41
	30	4·0	32·45
	60	3·2	32·45
	80	1·8	33·01
	90	1·7	33·01

Station E.

Date and Position	m.	t°	S°/oo
1933 V 25 95 m.	0	4·9	32·36
	30	4·0	32·36
	55	3·6	32·32
	70	2·9	32·57
	80	1·4	33·01
	90	1·4	33·01

Date and Position	m.	t°	S°/oo
1933 V 27 95 m.	0	5·1	32·36
	30	4·8	32·36
	60	4·3	32·36
	80	2·5	32·65
	90	1·8	32·99

Date and Position	m.	t°	S°/oo
1933 V 29 100 m.	0	5·2	32·28
	30	4·9	32·36
	60	3·4	32·36
	80	2·1	32·84
	95	1·8	32·97

Station F.

Date and Position	m.	t°	S°/oo
1933 V 30 95 m. 44°18′N. 52°10′W	0	5·1	32·32
	30	4·5	32·34
	65	2·8	32·50
	80	2·5	32·65
	90	2·2	32·94

Station F.

Date and Position	m.	t°	S°/oo
1933 V 31 100 m.	0	5·9	32·41
	20	5·5	32·38
	45	4·8	32·43
	65	3·5	32·38
	85	1·5	33·06
	95	1·5	33·01

Off Bay Bulls.

Date and Position	m.	t°	S°/oo
1933 VI 1 2 ml. N.N.E. from B. B. Lighthouse	0	1·7	31·87
	30	0·9	31·89
	50	−1·2	32·36
	70	−1·6	32·57
	85	−1·6	32·65

(c) *SPRING RESEARCH CRUISE.*

June 9th–July 7th, 1933.

Date and Position	m.	t°	S°/oo
Station 201.			
1933 VI 9			
80 m.			
Off Bay Bulls	0	3·3	31·62
	15	2·9	31·67
	25	2·4	31·73
	50	−0·2	31·85
	75	−1·4	32·48
Station 202.			
1933 VI 9			
80 m.			
46°34′N. 51°21′W	0	3·2	32·16
	15	3·2	32·16
	25	3·1	32·20
	50	1·5	32·47
	75	0·5	32·68
Station 203.			
1933 VI 10			
105 m.			
47°07′N. 50°25′W	0	2·9	32·43
	15	2·7	32·41
	25	2·4	32·43
	50	1·3	32·65
	75	0·2	32·77
	100	−0·7	32·99
Station 204.			
1933 VI 10			
180 m.			
47°47′N. 49°15′W	0	2·6	32·56
	15	2·6	32·61
	25	1·4	32·68
	50	0·6	32·70
	75	−0·4	32·94
	100	−1·1	33·12
	175	−0·2	33·66
Station 205.			
1933 VI 11			
130 m.			
46°54′N. 48°00′W	0	3·0	32·56
	15	2·3	32·66
	25	1·7	32·66
	50	−1·0	32·88
	75	−1·3	33·03
	100	−0·7	33·26
	125	−0·3	33·37
Station 206.			
1933 VI 11			
105 m.			
46°12′N. 48°14′W	0	3·3	32·65
	15	2·5	32·61
	25	2·5	32·66
	50	−1·1	32·92
	75	−1·3	33·01
	100	−0·9	33·21

Date and Position	m.	t°	S°/oo
Station 207.			
1933 VI 11			
125 m.			
45°42′N. 48°33′W	0	3·4	32·66
	15	2·7	32·66
	25	1·9	32·68
	50	−0·6	32·83
	75	−0·7	32·99
	100	−0·6	33·17
	120	−0·6	33·17
Station 208.			
1933 VI 12			
65 m.			
45°16′N. 50°14′W	0	4·5	32·70
	15	3·3	32·70
	25	2·0	32·77
	50	0·3	32·94
	60	0·3	32·88
Station 209.			
1933 VI 12			
45 m.			
44°22′N. 49°16′W	0	3·8	32·68
	15	1·9	32·81
	25	1·5	32·81
	40	1·4	32·81
Station 210.			
1933 VI 12			
55 m.			
44°02′N. 50°06′W	0	6·9	32·65
	15	5·4	32·68
	25	2·9	32·70
	50	2·9	32·70
Station 211.			
1933 VI 13			
75 m.			
43°50′N. 51°12′W	0	7·2	32·56
	15	6·6	32·63
	25	4·2	32·70
	50	2·3	32·79
	70	1·2	32·94
Station 212.			
1933 VI 13			
90 m.			
44°05′N. 52°13′W	0	8·1	32·38
	15	6·7	32·39
	25	4·9	32·45
	50	3·1	32·48
	75	1·2	32·97
	85	2·0	33·37

Station 213.

Date and Position	m.	t°	S°/oo
1933 VI 13			
No sounding			
44°20′N. 53°10′W	0	7·8	32·43
	15	6·5	32·94
	25	2·5	32·81
	50	0·9	32·99
	75	0·8	33·26
	100	4·2	33·89
	200	5·9	34·49
	300	5·0	34·72
	400	4·6	34·81

Station 214.

Date and Position	m.	t°	S°/oo
1933 VI 13			
180 m.			
44°30′N. 53°14′W	0	7·8	32·29
	15	6·0	32·39
	25	4·8	32·39
	50	3·0	32·66
	75	0·5	32·99
	100	1·7	33·49
	175	5·5	34·38

Station 215.

Date and Position	m.	t°	S°/oo
1933 VI 14			
105 m.			
44°45′N. 53°41′W	0	8·1	32·29
	15	8·1	32·30
	25	6·9	32·43
	50	3·6	32·72
	75	1·4	33·15
	100	3·2	33·68

Station 216.

Date and Position	m.	t°	S°/oo
1933 VI 14			
95 m.			
45°13′N. 53°22′W	0	7·7	32·39
	15	7·5	32·45
	25	6·2	32·45
	50	3·6	32·45
	75	0·9	32·72
	90	1·5	32·97

Station 217.

Date and Position	m.	t°	S°/oo
1933 VI 14			
105 m.			
45°14′N. 55°27′W	0	7·8	32·41
	15	7·3	32·43
	25	6·7	32·45
	50	3·6	32·54
	75	0·0	32·79
	100	−0·9	32·94

Station 218.

Date and Position	m.	t°	S°/oo
1933 VI 14			
70 m.			
45°23′N. 55°50′W	0	6·8	32·21
	15	5·1	32·27
	25	3·8	32·32
	50	0·7	32·45
	65	0·7	32·45

Station 219.

Date and Position	m.	t°	S°/oo
1933 VI 15			
150 m.			
46°22′N. 52°46′W	0	4·6	31·74
	15	4·1	32·07
	25	1·9	32·20
	50	−0·2	32·63
	75	−1·1	32·84
	100	−1·2	32·94
	145	−0·8	32·94

Station 201 (Repeat).

Date and Position	m.	t°	S°/oo
1933 VI 15			
47°13′N. 52°39′W	0	5·0	31·76
	15	4·9	31·78
	25	1·0	32·14
	50	−1·0	32·54
	75	−1·6	32·74
	100	−1·6	32·84
	150	−1·3	33·04

Station 220.

Date and Position	m.	t°	S°/oo
1933 VI 17			
135 m.			
46°22′N. 53°50′W	0	5·1	31·92
	15	5·0	32·01
	25	4·6	32·05
	50	−0·6	32·34
	75	−1·1	32·59
	100	−1·4	32·68
	125	−1·4	32·79

Station 221.

Date and Position	m.	t°	S°/oo
1933 VI 17			
170 m.			
46°37′N. 54°58′W	0	6·8	32·10
	15	6·2	32·10
	25	2·1	32·25
	50	−0·2	32·41
	75	−0·6	32·48
	100	−1·0	32·61
	165	−1·0	32·68

Station 222.

Date and Position	m.	t°	S°/oo
1933 VI 20			
198 m.			
47°13′N. 55°37′W	0	7·0	31·73
	15	6·8	31·78
	25	3·4	31·92
	50	0·6	32·07
	75	0·0	32·20
	100	0·3	32·32
	175	0·1	32·36

Station 223.

Date and Position	m.	t°	S°/oo
1933 VI 20			
84 m.			
46°52′N. 56°02′W	0	6·1	32·07
	15	5·6	32·07
	25	5·2	32·09
	50	1·3	32·29
	75	0·2	32·48

Date and Position	m.	t°	S°/oo
Station 224.			
1933 VI 21			
234 m.			
47°19′N. 56°45′W	0	6·1	31·64
	15	5·9	31·64
	25	4·0	31·92
	50	1·3	32·18
	75	0·5	32·47
	100	0·7	32·90
	200	4·0	34·18
Station 225.			
1933 VI 22			
147 m.			
47°27′N. 58°43′W	0	7·2	31·13
	15	5·9	31·64
	25	5·1	31·78
	50	1·6	31·96
	75	0·5	32·14
	100	0·3	32·47
	140	0·9	32·90
Station 226.			
1933 VI 25			
113 m.			
46°26′N. 59°14′W	0	8·3	30·39
	15	6·5	30·93
	25	3·1	31·46
	50	1·4	31·91
	75	0·3	32·20
	100	0·1	32·48
Station 227.			
1933 VI 25			
360 m.			
46°51′N. 58°47′W	0	7·7	31·36
	15	6·1	31·64
	25	2·8	31·82
	50	0·5	32·14
	75	0·2	32·56
	100	0·8	32·94
	200	3·9	34·20
	300	4·3	34·65
Station 228.			
1933 VI 26			
450 m.			
47°30′N. 59°50′W	0	7·5	31·58
	15	6·5	31·58
	25	3·1	31·78
	50	1·0	31·98
	75	0·4	32·36
	100	0·7	32·77
	200	3·3	34·04
	300	3·9	34·47
	400	3·5	34·74
Station 229.			
1933 VI 26			
57 m.			
47°28′N. 60°39′W	0	7·8	30·90
	15	5·9	31·38
	25	1·6	31·78
	50	0·6	32·05

Date and Position	m.	t°	S°/oo
Station 230.			
1933 VI 26			
80 m.			
48°06′N. 59°26′W	0	6·3	31·58
	15	5·2	31·62
	25	2·4	31·94
	50	0·7	32·25
	75	0·7	32·54
Station 231.			
1933 VI 26			
104 m.			
48°25′N. 58°51′W	0	9·5	30·08
	15	4·8	31·60
	25	3·1	31·80
	50	0·7	31·98
	75	0·0	32·21
	100	0·2	32·59
Station 232.			
1933 VI 27			
77 m.			
48°45′N. 59°12′W	0	8·4	30·81
	15	8·3	30·91
	25	5·8	31·40
	50	0·7	31·94
	75	0·2	32·05
Station 233.			
1933 VI 27			
63 m.			
49°17′N. 58°31′W	0	6·3	31·44
	15	5·2	31·62
	25	1·3	31·96
	50	−0·3	32·09
Station 234.			
1933 VI 28			
No sounding			
50°32′N. 57°46′W	0	5·2	31·46
	15	4·1	31·58
	25	2·0	31·80
	50	−0·4	31·91
	75	−0·4	32·09
	100	−0·7	32·52
	200	0·9	33·31
Station 235.			
1933 VI 29			
52 m.			
51°23′N. 56°58′W	0	1·4	29·16
	15	0·1	30·62
	25	−0·1	30·84
	50	−1·0	31·76
Station 236.			
1933 VI 29			
108 m.			
51°31′N. 56°43′W	0	0·4	29·76
	15	−0·6	31·26
	25	−0·7	31·33
	50	−0·8	31·71
	75	−0·8	31·71
	100	−0·7	31·73

Station 237.

Date and Position	m.	t°	S°/₀₀
1933 VI 30 133 m. 51°54′N. 55°43′W	0	−0·2	31·22
	15	−0·9	31·47
	25	−1·0	31·65
	50	−1·3	32·27
	75	−1·5	32·48
	100	−1·5	32·74

Station 238.

Date and Position	m.	t°	S°/₀₀
1933 VI 30 113 m. 52°19′N. 55°31′W	0	3·3	26·78
	15	0·4	32·32
	25	−0·2	32·36
	50	−1·5	32·63
	75	−1·5	32·68
	100	−1·5	32·81

Station 239.

Date and Position	m.	t°	S°/₀₀
1933 VII 1 144 m. 52°52′N. 55°26′W	0	3·0	29·47
	15	1·3	31·60
	25	−0·2	31·58
	50	−0·2	32·61
	75	−0·8	32·77
	100	−0·8	32·95
	125	−1·0	33·45

Station 240.

Date and Position	m.	t°	S°/₀₀
1933 VII 1 122 m. 53°02′N. 55°37′W	0	3·4	28·46
	15	0·6	30·34
	25	−0·6	32·30
	50	−1·5	32·61
	75	−1·4	32·72
	100	−1·3	32·90

Station 241.

Date and Position	m.	t°	S°/₀₀
1933 VII 3 90 m. 53°30′N. 55°28′W	0	2·4	27·48
	15	0·6	31·20
	25	−0·1	31·76
	50	−1·2	32·45
	75	−1·3	32·59

Station 242.

Date and Position	m.	t°	S°/₀₀
1933 VII 3 41 m. 53°39′N. 56°09′W	0	1·6	28·22
	15	−0·1	30·19
	25	−1·4	31·89
	35	−1·5	32·18

Station 243.

Date and Position	m.	t°	S°/₀₀
1933 VII 4 45 m. 51°40′N. 55°40′W	0	0·9	30·61
	15	0·7	30·68
	25	0·6	30·77
	35	0·1	31·15

Station 244.

Date and Position	m.	t°	S°/₀₀
1933 VII 4 80 m. 51°33′N. 55°22′W	0	1·8	30·75
	15	1·6	30·77
	25	1·6	30·77
	50	0·7	31·04
	75	−0·8	32·18

Station 245.

Date and Position	m.	t°	S°/₀₀
1933 VII 4 56 m. 51°21′N. 55°31′W	0	2·1	30·82
	15	1·6	30·82
	25	0·5	31·15
	50	−0·5	31·89

Station 246.

Date and Position	m.	t°	S°/₀₀
1933 VII 5 54 m. 50°55′N. 55°41′W	0	2·2	30·62
	15	0·1	31·47
	25	−0·6	31·91
	50	−1·2	32·20

Station 247.

Date and Position	m.	t°	S°/₀₀
1933 VII 5 No sounding 50°25′N. 55°46′W	0	3·3	30·08
	15	1·0	31·17
	25	−0·1	31·78
	50	−1·4	32·32
	75	−1·1 (rep.)	32·47
	100	−1·5	32·61
	200	−1·0	33·40
	300	−1·0	33·31

Station 248.

Date and Position	m.	t°	S°/₀₀
1933 VII 5 223 m. 50°18′N. 54°28′W	0	4·2	32·16
	15	2·3	32·47
	25	1·2	32·61
	50	−0·8	32·94
	75	−1·3	33·19
	100	−1·0	33·44
	200	0·9	34·04

Date and Position	m.	t°	S°/oo
Station 249.			
1933 VII 6			
No sounding			
50°00′N. 53°10′W	0	3·4	32·57
	15	3·3	32·59
	25	2·9	32·59
	50	−0·9	33·12
	75	−0·9	33·42
	100	−0·8	33·57
	200	0·9	34·16
	300	1·9	34·52
Station 250.			
1933 VII 6			
No sounding			
49°06′N. 52°57′W	0	6·1	30·95
	15	3·1	31·13
	25	−0·9	32·30
	50	−0·4	32·54
	75	−0·5	32·56
	100	−0·8	32·72
	200	−0·7	33·46
	300	0·7	34·04
Station 251.			
1933 VII 6			
83 m.			
48°40′N. 52°54′W	0	6·0	30·81
	15	4·8	30·82
	25	0·5	31·91
	50	−1·2	32·52
	75	−1·5	32·59

Date and Position	m.	t°	S°/oo
Station 252.			
1933 VII 6			
180 m.			
48°22′N. 52°46′W	0	5·1	31·83
	15	4·0	31·85
	25	3·1	31·87
	50	−0·8	32·30
	75	−1·2	32·54
	100	−1·6	32·61
	175	−1·1	33·08
Station 253.			
1933 VII 7			
203 m.			
48°08′N. 52°32′W	0	5·2	31·53
	15	4·6	31·58
	25	0·6	32·30
	50	−0·8	32·59
	75	−1·5	32·68
	100	−1·8	32·81
	200	−0·8	33·33
Station 254.			
1933 VII 7			
208 m.			
57°42′N. 53°00′W	0	7·1	31·51
	15	5·5	31·56
	25	0·7	31·91
	50	−1·0	32·30
	75	−1·4	32·59
	100	−1·5	32·70
	200	−1·2	32·97
Station off Bay Bulls.			
1933 VII 7			
84 m.			
	0	4·9	31·71
	15	2·5	31·94
	25	2·4	31·98
	50	−0·3	32·32
	75	−1·0	32·47

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Station 255.			
1933 VIII 23			
1½ miles off Bay Bulls			
	0	12·6	31·13
	10	10·9	31·24
	25	4·7	31·87
	50	−0·5	32·44
	75	−1·0	32·67
	100	−1·5	32·82
Station 256.			
1933 VIII 24			
59 m.			
46°30′N. 53°17′W	0	10·7	31·54
	10	8·3	31·75
	25	1·3	32·47
	55	−0·5	32·60
Station 257.			
St. Mary's Bay.			
1933 VIII 24			
110 m.			
46°52′N. 53°47′W	0	13·3	31·73
	10	6·9	32·10
	25	2·2	32·36
	50	0·3	32·49
	75	0·1	32·51
	110	0·0	32·51

Station 258.

Date and Position	m.	t°	S°/oo
1933 VIII 24			
128 m.			
46°16′N. 54°00′W	0	14·6	31·81
	10	14·6	31·81
	25	4·5	32·19
	50	−0·5	32·60
	75	−1·2	32·74
	100	−1·4	32·84
	125	−1·4	32·86

Station 259.

Date and Position	m.	t°	S°/oo
1933 VIII 24			
192 m.			
46°31′N. 54°50′W	0	14·0	31·90
	10	14·0	31·90
	25	11·4	31·99
	50	0·4	32·53
	75	−0·9	32·69
	100	−1·3	32·72
	180	−1·4	32·86

Station 260.

Date and Position	m.	t°	S°/oo
1933 VIII 25			
148 m.			
46°24′N. 55°36′W	0	13·5	31·77
	10	13·5	31·82
	25	6·7	32·17
	50	0·7	32·44
	75	−0·4	32·54
	100	−1·0	32·71
	140	−1·1	32·72

Station 261.

Date and Position	m.	t°	S°/oo
1933 VIII 25			
225 m.			
47°13′N. 55°41′W	0	14·2	31·50
	10	14·2	31·50
	25	6·1	32·07
	50	2·6	32·31
	75	1·2	32·47
	100	0·3	32·51
	200	0·2	32·56

Station 262. Off Hermitage Bay.

Date and Position	m.	t°	S°/oo
1933 VIII 28			
256 m.			
47°28′N. 56°28′W	0	15·5	31·55
	10	15·1	31·57
	25	10·5	31·92
	50	3·3	32·30
	75	1·3	32·54
	100	0·1	32·60
	200	3·9	34·18
	250	4·4	34·52

Station 263.

Date and Position	m.	t°	S°/oo
1933 VIII 28			
73 m.			
47°07′N. 57°51′W	0	15·8	31·24
	10	15·3	31·24
	25	6·5	31·92
	50	1·1	32·44
	70	1·1	32·53

Station 264.

Date and Position	m.	t°	S°/oo
1933 VIII 29			
216 m.			
47°19′N. 58°37′W	0	16·5	30·38
	10	15·6	31·20
	25	7·3	32·03
	50	2·4	32·33
	75	1·0	32·54
	100	0·9	32·74
	200	4·5	34·30

Station 265.

Date and Position	m.	t°	S°/oo
1933 VIII 29			
420 m.			
46°53′N. 59°15′W	0	17·7	28·90
	10	16·9	29·33
	25	3·1	31·50
	50	1·9	32·19
	75	1·2	32·33
	100	0·7	32·42
	200	3·0	33·91
	300	4·4	34·62
	400	4·1	34·81

Station 266.

Date and Position	m.	t°	S°/oo
1933 VIII 30			
110 m.			
46°22′N. 59°28′W	0	16·2	29·96
	10	16·2	29·87
	25	8·5	31·39
	50	1·2	32·10
	75	0·8	32·45
	100	0·7	32·62

Station 267.

Date and Position	m.	t°	S°/oo
1933 VIII 30			
113 m.			
46°09′N. 59°00′W	0	16·9	30·08
	10	16·8	30·08
	25	9·0	31·79
	50	2·3	32·16
	75	1·1	32·51
	100	1·0	32·69

Station 268.

Date and Position	m.	t°	S°/oo
1933 VIII 31			
44 m.			
44°52′N. 57°47′W	0	16·0	31·54
	10	16·0	31·54
	25	10·3	32·05
	40	8·0	32·12

Station 269.

Date and Position	m.	t°	S°/oo
1933 VIII 31			
36 m.			
44°36′N. 57°52′W	0	16·2	31·52
	10	16·0	31·46
	25	10·9	31·99
	35	10·0	32·07

Station 270.

Date and Position	m.	t°	S°/oo
1933 VIII 31			
439 m.			
44°57′N. 56°55′W	0	16·5	31·92
	10	16·0	31·92
	25	6·1	32·38
	50	1·9	32·63
	75	−0·7	32·85
	100	−0·7	32·94
	200	6·6	34·71
	300	5·2	34·83
	400	4·6	34·85

Station 271.

Date and Position	m.	t°	S°/oo
1933 IX 1			
106 m.			
45°05′N. 55°59′W	0	14·7	31·79
	10	14·3	31·81
	25	4·7	32·36
	50	−0·6	32·78
	75	−1·1	32·88
	100	−1·1	32·88

Station 272.

Date and Position	m.	t°	S°/oo
1933 IX 1			
179 m.			
45°16′N. 55°14′W	0	15·7	31·87
	10	15·1	31·90
	25	9·2	32·23
	50	2·9	32·54
	75	−0·7	32·92
	100	−0·8	32·92
	170	4·2	34·13

Station 273.

Date and Position	m.	t°	S°/oo
1933 IX 1			
128 m.			
45°12′N. 54°21′W	0	15·8	32·03
	10	15·8	32·07
	25	10·2	32·19
	50	3·6	32·63
	75	2·0	32·72
	115	0·1	33·21

Station 274.

Date and Position	m.	t°	S°/oo
1933 IX 2			
101 m.			
44°44′N. 53°35′W	0	16·0	32·07
	10	15·8	32·07
	25	7·6	32·54
	50	2·7	32·74
	75	2·2	32·87
	95	1·5	33·08

Station 275.

Date and Position	m.	t°	S°/oo
1933 IX 2			
329 m.			
44°22′N. 53°16′W	0	17·6	32·50
	10	17·4	32·52
	25	7·3	32·88
	50	3·9	33·49
	75	4·1	33·89
	100	6·0	34·28
	200	6·2	34·76
	300	5·0	34·76

Station 276.

Date and Position	m.	t°	S°/oo
1933 IX 2			
128 m.			
44°28′N. 53°00′W	0	17·5	32·44
	10	17·3	32·46
	25	11·1	32·64
	50	0·9	33·10
	75	0·6	33·36
	100	2·2	33·56
	120	4·8	34·20

Station 277.

Date and Position	m.	t°	S°/oo
1933 IX 2			
95 m.			
44°31′N. 52°38′W	0	17·1	32·10
	10	16·5	32·21
	25	6·3	32·55
	50	2·5	32·79
	75	2·7	33·38
	90	1·7	33·51

Station 278.

Date and Position	m.	t°	S°/oo
1933 IX 2			
97 m.			
44°00′N. 52°10′W	0	17·0	32·30
	10	17·0	32·30
	25	11·9	32·34
	50	2·5	32·87
	75	1·3	33·47
	90	1·3	33·47

Station 279.

Date and Position	m.	t°	S°/oo
1933 IX 3			
79 m.			
43°46′N. 50°55′W	0	16·1	32·32
	10	16·1	32·32
	25	6·2	32·68
	50	2·0	32·94
	75	1·1	33·21

Station 280.

Date and Position	m.	t°	S°/oo
1933 IX 4			
53 m.			
44°00′N. 49°40′W	0	14·6	32·21
	10	14·6	32·23
	25	4·3	32·68
	50	3·0	32·73

Date and Position	m.	t°	S°/₀₀
Station 281.			
1933 IX 4			
88 m.			
44°52′N. 49°17′W	0	11·5	31·72
	10	10·7	31·57
	25	4·7	32·28
	50	−0·6	32·77
	80	−0·7	32·79
Station 282.			
1933 IX 4			
No sounding			
44°50′N. 49°00′W	0	11·0	32·25
	10	9·7	32·25
	25	−0·5	32·83
	50	−0·5	33·03
	75	−0·6	33·08
	100	−0·9	33·14
	200	1·5	34·13
	300	2·5	34·46
Station 283.			
1933 IX 5			
95 m.			
45°49′N. 48°26′W	0	11·1	31·75
	10	10·3	32·19
	25	0·4	32·81
	50	−0·6	33·16
	75	−0·7	33·21
	90	−0·7	33·23
Station 284.			
1933 IX 5			
130 m.			
46°53′N. 48°00′W	0	11·4	31·55
	10	11·4	31·57
	25	1·0	32·44
	50	−1·5	32·75
	75	−1·5	32·81
	100	−1·2	33·17
	125	−0·5	33·47
Station 285.			
1933 IX 6			
192 m.			
47°57′N. 49°21′W	0	12·0	31·35
	10	12·0	31·35
	25	6·2	32·19
	50	−0·5	32·48
	75	−1·1	32·79
	100	−1·1	32·92
	155	−0·5	33·56
Station 286.			
1933 IX 6			
172 m.			
48°19′N. 50°49′W	0	12·2	30·53
	10	12·0	30·53
	25	2·1	32·08
	50	−1·0	32·61
	75	−1·3	32·81
	100	−1·1	33·10
	140	−0·7	33·40

Date and Position	m.	t°	S°/₀₀
Station 287.			
1933 IX 6			
95 m.			
47°14′N. 50°17′W	0	13·4	31·68
	10	13·3	31·68
	25	12·2	31·72
	50	1·8	32·62
	75	0·0	32·79
	90	−0·5	32·94
Station 288.			
1933 IX 7			
90 m.			
46°31′N. 51°26′W	0	13·5	31·33
	10	13·5	31·33
	25	12·4	31·72
	50	2·2	32·50
	75	0·8	32·77
	85	0·7	32·77
Station 289.			
1933 IX 7			
92 m.			
45°53′N. 51°12′W	0	14·0	32·30
	10	14·0	32·30
	25	10·6	32·80
	50	3·9	33·19
	75	1·3	33·29
	90	1·1	32·81
Station 290.			
1933 IX 8			
2 miles off			
Bay Bulls			
	0	12·5	31·04
	10	12·5	31·24
	25	6·8	31·77
	50	−0·3	32·92
	75	−1·2	33·23
	100	−1·2	33·29
	135	−1·2	33·52
Station 291.			
1933 IX 9			
47°54′N. 52°56′W	0	13·1	30·49
	10	13·0	30·58
	25	6·7	31·24
	50	−0·2	32·30
	75	−1·0	32·45
	100	−1·4	32·78
Station 292.			
1933 IX 9			
153 m.			
48°06′N. 52°44′W	0	13·2	30·42
	10	12·2	30·54
	25	3·3	31·75
	50	−0·5	32·44
	75	−1·0	32·60
	100	−1·2	32·74
	150	−1·3	32·99

Date and Position	m.	t°	S°/₀₀
Station 293.			
1933 IX 9			
260 m.			
48°22′N. 52°51′W	0	12·7	30·60
	10	11·5	30·45
	25	2·2	31·41
	50	−0·1	32·12
	75	−0·8	32·42
	100	−1·1	32·60
	200	−0·7	33·42
Station 294.			
1933 IX 9			
80 m.			
48°41′N. 52°55′W	0	12·6	30·30
	10	12·5	30·30
	25	3·5	31·37
	50	−0·3	32·30
	75	−1·0	32·54
Station 295.			
1933 IX 9			
No sounding			
49°05′N. 52°56′W	0	11·8	30·45
	10	11·5	30·45
	25	1·0	31·94
	50	−0·7	32·38
	75	−1·1	32·54
	100	−0·8	32·72
	200	−0·9	33·34
Station 296.			
1933 IX 10			
No sounding			
50°03′N. 53°02′W	0	10·5	30·63
	10	10·4	30·69
	25	0·9	32·42
	50	−0·9	33·03
	75	−0·8	33·37
	100	−0·6	33·52
	200	+1·0	34·09
Station 297.			
1933 IX 10			
139 m.			
50°05′N. 53°50′W	0	12·1	30·49
	10	12·0	30·49
	25	4·3	31·04
	50	−0·9	32·44
	75	−1·1	32·71
	100	−0·9	32·92
Station 298.			
1933 IX 10			
216 m.			
50°05′N. 54°41′W	0	8·1	31·02
	10	8·0	31·09
	25	1·0	32·31
	50	−0·9	32·72
	75	−0·9	32·88
	100	−0·7	33·17
	200	+0·4	33·95

Date and Position	m.	t°	S°/₀₀
Station 299.			
1933 IX 12			
134 m.			
50°41′N. 56°00′W	0	3·3	31·89
	10	3·1	31·92
	25	0·4	32·45
	50	−0·9	32·72
	75	−1·0	32·87
	100	−0·1	32·88
Station 300.			
1933 IX 12			
45 m.			
50°55′N. 55°42′W	0	5·5	31·43
	10	5·3	31·48
	25	2·7	31·96
	40	0·5	32·31
Station 301.			
1933 IX 13			
80 m.			
51°33′N. 55°22′W	0	9·5	30·76
	10	9·5	30·76
	25	9·0	30·83
	50	7·2	30·84
	75	0·9	32·35
Station 302.			
1933 IX 14			
65 m.			
52°28′N. 55°36′W	0	3·7	31·22
	10	3·6	31·33
	25	0·0	32·16
	50	−0·7	32·63
Station 303.			
1933 IX 15			
87 m.			
53°28′N. 55°30′W	0	4·8	31·06
	10	4·6	31·08
	25	3·5	31·59
	50	2·0	32·29
	75	−0·3	32·40
Station A.			
1933 IX 16			
48 m.			
53°37′N. 55°59′W	0	6·5	30·01
	10	6·4	30·03
	25	6·2	30·19
	45	4·3	30·78
Station 304.			
1933 IX 18			
140 m.			
54°10′N. 55°26′W	0	4·9	31·99
	10	4·8	32·01
	25	5·0	32·44
	50	−0·2	33·03
	75	−0·8	33·28
	100	−0·7	33·36
	135	0·0	33·71

Date and Position	m.	t°	S°/oo
Station B.			
1933 IX 18			
189 m.			
54°37′N. 55°30′W	0	4·7	31·35
	10	3·6	31·54
	25	4·1	32·36
	50	1·0	33·08
	75	−0·6	33·29
	100	−0·6	33·34
	175	0·4	33·97
Station 305.			
1933 IX 19			
189 m.			
54°19′N. 54°45′W	0	4·0	32·14
	10	4·0	32·14
	25	3·9	32·17
	50	−0·1	33·05
	75	−0·5	33·23
	100	−0·4	33·47
	175	0·2	33·80
Station 306.			
1933 IX 19			
131 m.			
52°57′N. 55°29′W	0	6·1	30·56
	10	6·0	30·54
	25	4·4	31·15
	50	1·6	31·98
	75	−0·6	32·44
	100	−0·9	32·80
	125	−0·9	33·01
Station 307.			
1933 IX 20			
135 m.			
51°53′N. 55°40′W	0	4·2	31·34
	10	4·2	31·31
	25	1·7	31·99
	50	0·0	32·25
	75	−0·3	32·44
	100	−0·5	32·56
	125	−0·8	32·83
Station 308.			
1933 IX 20			
60 m.			
51°36′N. 56°13′W	0	11·5	31·13
	10	11·4	31·13
	25	10·2	31·24
	50	0·8	32·44
Station 309.			
1933 IX 20			
30 m.			
51°23′30″N.	0	8·1	31·20
56°59′W	10	7·6	31·22
	25	5·6	31·66

Date and Position	m.	t°	S°/oo
Station 310.			
1933 IX 21			
64 m.			
50°49′N. 58°12′W	0	7·6	31·35
	10	7·6	31·35
	25	3·9	31·72
	50	−0·7	32·31
Station 311.			
1933 IX 21			
230 m.			
50°18′N. 58°06′W	0	7·2	31·39
	10	7·1	31·39
	25	6·6	31·48
	50	−0·6	32·42
	75	−0·7	32·60
	100	−0·2	32·90
	200	3·0	34·11
Station 312.			
1933 IX 21			
93 m.			
49°56′N. 58°08′W	0	11·1	30·95
	10	8·8	31·34
	25	7·3	31·41
	50	0·0	32·33
	75	−1·2	32·60
	90	−1·3	32·74
Station 313.			
1933 IX 22			
76 m.			
49°10′N. 58°35′W	0	11·2	31·09
	10	11·1	31·09
	25	9·7	31·24
	50	1·4	32·16
	65	1·0	32·16
Station 314.			
1933 IX 22			
38 m.			
48°37′N. 59°11′W	0	10·3	31·26
	10	10·2	31·26
	25	10·2	31·29
	35	6·1	31·72
Station 315.			
1933 IX 23			
34 m.			
48°24′N. 58°46′W	0	11·2	31·22
	10	11·0	31·26
	25	10·8	31·27
	30	3·1	32·28
Station 316.			
1933 IX 23			
82 m.			
48°01′N. 59°23′W	0	10·3	30·63
	10	10·2	31·04
	25	9·0	31·24
	50	3·0	32·16
	75	1·3	32·45

Date and Position	m.	t°	S°/₀₀
Station 317.			
1933 IX 23			
No sounding			
47°45′N. 60°00′W	0	9·7	31·15
	10	9·7	31·13
	25	7·4	31·64
	50	1·6	32·27
	75	1·3	32·31
	100	1·0	32·56
	200	2·5	33·80
	300	4·5	34·59
	400	4·2	34·88
Station 318.			
1933 IX 24			
62 m.			
47°33′N. 60°43′W	0	12·4	29·87
	10	12·4	29·89
	25	10·6	30·21
	50	1·2	32·36
Station G.			
1933 IX 26			
No sounding			
46°15′N. 58°00′W	0	13·1	30·86
	10	13·1	30·88
	25	12·0	31·09
	50	2·5	32·36
	75	1·3	32·51
	100	0·5	32·63
	200	4·0	33·91
	300	4·1	34·62
	400	4·2	34·76

Date and Position	m.	t°	S°/₀₀
Station H.			
1933 IX 26			
54 m.			
46°17′N. 56°47′W	0	13·3	31·63
	10	13·3	31·63
	25	13·3	31·63
	50	3·6	32·21
Station 319.			
1933 IX 27			
104 m.			
46°46′N. 53°50′W	0	10·0	31·22
	10	7·7	31·52
	25	2·3	32·23
	50	0·6	32·40
	75	0·2	32·42
	100	0·1	32·40
Station 1.			
1933 IX 27			
115 m.			
Off Bay Bulls			
	0	10·7	30·82
	10	10·5	30·82
	25	9·0	31·06
	50	−0·1	32·38
	75	−1·0	32·60
	100	−1·4	32·72

APPENDIX C

NOTES ON A GIANT SQUID (*ARCHITEUTHIS SP*). CAPTURED AT DILDO, NEWFOUNDLAND, IN DECEMBER, 1933.

By Nancy Frost.

Toward the latter part of December, 1933, a giant squid was captured at Dildo, Trinity Bay, Newfoundland. As will be discussed later, this specimen has been identified as belonging to the family *Architeuthidæ* and probably to the species *A. Harveyi.*

SYNOPSIS OF PREVIOUS RECORDS OF CAPTURE.

Until comparatively recent times no accurate observations had been made on any species of giant Cephalopods, although there were many exaggerated and more or less fabulous accounts of them. Steenstrup and Harting (**1**) were the first to describe in scientific terms a number of fragments of these gigantic species, so that some idea of their real character could be obtained. A. C. Verrill (**2**) gives the first comprehensive account of the gigantic squids of this region. Indeed Verrill draws special attention to the comparatively frequent occurrence during the decade 1871–1881 of huge squids in Newfoundland waters and adjacent areas. Many of the specimens captured had been cursorily described by the Rev. M. Harvey and Mr. Alex Murray of St. John's, while Verrill himself was enabled to study several of the preserved parts. As the available data from these parts is usually quite inadequate for the purpose of relating the specimens to definite species, Verrill numbers and lists them to the extent of about twenty-five in all. The following is a brief résumé of Verrill's description of the various large squids whose capture was reported.

No. 1. Grand Bank, October, 1871 (*Architeuthis princeps*).

This specimen, found dead and floating at the surface, was taken on board a fishing schooner and part of it used for bait. The jaws were preserved and through them the specimen indentified as *A. princeps.* Rough measurements were taken as follows : Body, length 15 feet, circumference 4 feet 8 inches; arms mutilated, but the residual portions 9 or 10 feet in length and 22 inches in circumference. Estimated weight 2000 lbs.

No. 2. Near Portugal Cove, Conception Bay, 27th October, 1873 (*Architeuthis Harveyi* ?).

This individual was seen resting at the surface and was attacked by two men in a small boat. Large portions of a tentacular arm and of one sessile arm were chopped off as the squid threw them across the boat. The sessile arm was subsequently destroyed.

No. 3. Coomb's Cove, Fortune Bay, 1872 (*Architeuthis Harveyi* ?).

This large squid, which was almost washed ashore, was secured by the inhabitants and the following measurements were taken: Body, length 10 feet; tentacular arms, 42 feet and 41·5 feet respectively; sessile arms, length 6 feet, breadth 9 inches; mantle thickness 2·25 inches.

No. 4. Bonavista Bay (*Architeuthis Harveyi*). No date given.

This specimen was washed ashore. It measured 32 feet (probably including the tentacular arms) and was about 6 feet in circumference. The jaws and two of the suckers from the tentacular arms were examined by Verrill.

No. 5. Logie Bay, 1873 (*Architeuthis Harveyi*, type).

This, the first almost complete specimen examined, was caught by fishermen after it had become entangled in a herring net. Unfortunately the head, eyes, siphon, and front part of the mantle were badly mutilated. Measurements: Mantle, length 7 feet, circumference 5–6 feet; caudal fin, arrow-shaped, 22 inches broad; tentacular arms, length 24 feet, circumference 2·5 inches; largest suckers 1·25 inches in diameter, with serrated edge; sessile arms, length 6 feet, circumference 10 inches, with 100 large oblique suckers having serrated margins, and approximately 200 smaller suckers toward the tip. The general character of the pen could be reconstructed, although only portions from the posterior part and fragments from the middle were preserved.

No. 7. West St. Modest, Straits of Belle Isle, Labrador. No date given.

This squid was presumably following herring when seen by herring fishermen. It was captured after some difficulty, although it had probably been disabled previously. It was cut up for dog food and only the following measurements were taken: Body, length 15 feet; tentacular arm, length 37 feet; diameter of large suckers approximately 2 inches.

Nos. 8 and 9. Lamaline, South Coast, 1870–71.

Two specimens are recorded as having been cast ashore, measuring respectively 40 and 47 feet in total length.

No. 10. "Sperm Whale Specimen" (*Architeuthis princeps*).

Only the two jaws of this individual were obtained. They were taken from the stomach of a sperm whale, but the exact date and locality are unknown. The jaws were the largest so far obtained and seemed to belong to a new species. This Verrill named *A. princeps*.

No. 11. Bonavista Bay, December, 1872.

The following are rough measurements of a specimen cast ashore in December, 1872. Tentacular arm, length 32 feet; sessile arm, length 10 feet and thicker than a man's thigh; body, length approximately 14 feet; diameter of largest sucker 2·5 inches. (This is probably an exaggeration.)

No. 12. Harbour Grace, Conception Bay, 1874–75.

A specimen was cast ashore during the winter but destroyed before any measurements could be taken.

No. 13. Grand Bank, Fortune Bay, December, 1874.

Only the jaws and one of the large suckers of a tentacular arm were preserved from this specimen, which was cast ashore. In addition the following rough measurements were taken: Tentacular arms, length 26 feet, circumference 16 inches; sessile arm, length 9 feet; circumference of the head, behind the bases of the arms, 36 inches; body length (base of arms to origin of caudal fin), 10 feet, cut base of sessile arms, 5×6×5 inches.

The jaws resembled in structure those of *A. princeps*.

No. 14. Catalina, Trinity Bay, September, 1877 (*Architeuthis princeps*).

When cast ashore this specimen was nearly complete. Measurements: Body, length (tip of tail to base of arms) 9·5 feet, circumference 7 feet; head, circumference 4 feet; tentacular arms, length 30 feet, circumference 5 inches; longest sessile arm, length 11 feet, circumference at base 17 inches.

No. 15. Hammer Cove, Notre Dame Bay, November, 1876.

After being cast ashore, this squid was badly mutilated by birds, a mere 5 feet of the body and 2 feet of the basal part of the arms remaining when it was found. Only about a 16-inch portion of the pen was secured, and the following scanty measurements were made. Head, breadth 18 inches; tail, breadth 18 inches; eye-sockets 7×9 inches; diameter of arm-stump 3·5 inches.

No. 16. Lance Cove, Trinity Bay, November, 1877 (*Architeuthis princeps*?).

This specimen was stranded on the shore, but only the following rough measurements were obtained: Body, length (including head?) 11 feet; tentacular arm, length 33 feet; sessile arm, length estimated at 13 feet and at the base thicker than a man's thigh. The length and thickness of the sessile arms of this specimen would indicate that it belonged to *A. princeps*.

No. 17. Trinity Bay, October, 1877.

This record refers to a specimen cast ashore, but no measurements were made.

No. 18. Thimble Tickle, Notre Dame Bay, 1878.

This specimen, found partially disabled near the shore, was secured by fishermen. Unfortunately it was cut up for dog food before it could be examined, and only the following measurements taken: Body, length (beak to extremity of tail) 20 feet; tentacular arm, length 35 feet.

No. 19. Three Arms, Notre Dame Bay, 1878 (*Architeuthis princeps*).

On being cast ashore, this squid was soon destroyed. The following data would seem to indicate that it was a specimen of *A. princeps*. Body, length from beak to tail 15 feet, circumference 12 feet; sessile arm (only one perfect), length 16 feet and thicker than a man's thigh.

No. 20. Banquereau, January, 1879.

The terminal portion of a tentacular arm, including the club and part of the naked arm below it, was found in the stomach of a large and voracious fish, *Alepidosaurus ferox*. After preservation in strong alcohol it measured 18 inches. Club, breadth 0·75 inch ; naked arm, breadth 1·25 inches ; length from first large sucker to tip 9·25 inches ; large suckers, diameter 0·5 inches ; marginal suckers, diameter 0·12 inches.

This squid was possibly a young specimen of *Architeuthis Harveyi*.

No. 22. Brigus, Conception Bay, October, 1879.

The squid was cast ashore after a storm, but only two of the short arms, each measuring 8 feet in length, were found, along with other mutilated parts.

No. 23. James Cove, Bonavista Bay, November, 1879.

Unfortunately this specimen, complete when captured by fishermen, was quickly destroyed, and very few measurements were taken. These were : Total length 38 feet ; body, length 9 feet, circumference 6 feet ; tentacular arm, length 29 feet.

No. 24. Grand Banks, April, 1880.

Most of the head and arms of this squid were secured, although the animal was dead and much mutilated when found floating at the surface. At some time previous to its death, the dorsal and lateral arms had apparently been truncated at 12–13 inches from their bases. The arms had not only healed up, but each one had begun to regenerate its lost part.

Nos. 25, 26, etc. Grand Banks, 1875.

An unusual number of giant squids were found floating at the surface in this year. They were mostly dead and more or less mutilated. Many were caught and used as bait. Those recorded measured 10–15 feet in length and averaged 18 inches in diameter. The arms were almost always mutilated. One specimen, when cut up, filled a large hogshead tub known to be capable of holding 700 lbs. of codfish. The specimen when intact would probably have weighed 1000 lbs.

The above is a synopsis of all records of *Architeuthis* given by Verrill. In the *Evening Telegram*, St. John's, 21st December, 1933, it is stated that in 1881 a specimen with a body eleven feet in length was obtained at Portugal Cove, and in the same issue Hon. Capt. A. Kean states that over fifty years ago he found at Flowers Cove a giant squid, measuring 72 feet from tip to tip, and almost dead.

As far as can be determined there have been no more recent records of the capture of giant squid in these waters. Pfeffer (**3**) quotes Verrill, but gives no additional information. The years 1871–81 seem to have been most unusual as regards the number of giant squid seen. Speaking particularly of the year 1875, Verrill says:

"The cause of so great a mortality among these great Cephalopods can only be conjectured. It may have been due to some disease becoming epidemic among them or to an unusual prevalence of deadly parasites or other enemies. It is worth while, however, to recall the fact that these (squid) were observed at about the same time, in Autumn, when most specimens have been found cast ashore at Newfoundland in different years. This time may, perhaps, be just subsequent to their season for reproduction, when they would be so much weakened as to be more easily overpowered by parasites, disease, or other unfavourable conditions."

This is a possible explanation. Perhaps a more probable one is that a chance straying from warmer oceanic waters carried these squid into the colder waters off the Newfoundland coast, and the squid, as winter approached, encountered conditions too severe for continued survival. Those specimens which had been cast ashore may have been caught up in tidal currents while in a condition too weak to escape.

DESCRIPTION OF THE GIANT SQUID CAUGHT AT DILDO, TRINITY BAY, NEWFOUNDLAND, DECEMBER 1933.

Although this specimen was captured toward the latter part of December, 1933, owing to transportation difficulties it was not till February that it was examined. During the intervening period it was kept in cold storage, so that the internal organs were found to be extremely well preserved. Through much handling, however, the external part had suffered considerable injury. The head and tail were detached from the body, and all the arms, with the exception of one almost intact tentacular club and about two feet at the basal end of the sessile arms, were hopelessly mutilated. So much of the arms was missing, and the remainder was in such small fragments, that it was impossible to attempt a reconstruction or even to surmise the original length. As far as can be learned no measurements were taken of the squid at the place of capture. When the specimen arrived in St. John's, the longest intact arm was found to be 12 feet, but in all likelihood this arm was not complete.

Figures 1 and 2 (Plate I) are reproductions of actual photographs, and show the general appearance and form of the squid.

The measurements taken were as follows:

Sessile Arms.	*cms.*	*ins.*
Dorsal arm, length from base to 10th sucker . . .	55	21·6
2nd pair, length from base to 10th sucker	52	20·4
3rd pair, length from base to 10th sucker	48	18·8
4th pair, length from base to 10th sucker	52	20·4

Dorsal Pair.	Near base. cms.	ins.	At 5 ins. cms.	ins.	At 10 ins. cms.	ins.
Breadth of front, excluding membranes	4	1·6	8	3·2	7	2·8
,, ,, including membranes	9	3·5	10·5	4·15	10	3·95
Diameter transversely (section) .	9·5	3·7				
,, from front to back . .	8	3·2	7	2·8	6	2·4
Circumference			25·5	10		

Second Pair.						
Breadth of front, excluding membranes	4	1·6	7	2·8	7	2·8
,, ,, including membranes			10·5	4·15	8	3·2
Diameter transversely	10	3·95				
,, from front to back . .	9	3·5	8·5	3·35	8	3·2
Circumference			30	11·8		

Third Pair.						
Breadth of front, excluding membranes	3	1·2	7	2·8	6·5	2·55
,, ,, including membranes			10	3·95	9·5	3·75
Diameter transversely	9·5	3·7				
,, from front to back . .	13	5·1	9·5	3·7	11	4·35
Circumference			29·5	11·6		

Fourth Pair.						
Breadth of front, excluding membranes	3	1·2	8·5	3·35	7	2·8
,, ,, including membranes			8	3·2	10	3·95
Diameter transversely	9·5	3·7				
,, from front to back . .	8·5	3·35	7·5	2·95	7	2·8
Circumference			29·0	11·4		

Suckers of Sessile Arms.	cms.	ins.
Dorsal arms, external diameter of 10th sucker . .	2·0	0·8
aperture diameter of 10th sucker . .	1·6	0·6
2nd pair arms, external diameter of 10th sucker . .	2·2	0·85
aperture diameter of 10th sucker . .	1·4	0·55
3rd pair arms, external diameter of 10th sucker . .	2·2	0·85
aperture diameter of 10th sucker . .	1·6	0·6
4th pair arms, external diameter of 10th sucker . .	1·5	0·6
aperture diameter of 10th sucker . .	1·0	0·4

Tentacular Arms.		
Diameter at base, transversely	3·0	1·2
,, ,, dorsal-ventral	9·5	3·7
Length of club	35·0	13·8
Length occupied by 24 largest suckers.	29·5	11·6
,, ,, small distal suckers	19·0	7·5
Greatest breadth of club	7·0	2·8
Diameter of club, front to back	5·0	2·0
Circumference of widest part of club	14·0	5·5

Suckers of Tentacular Arms.		cms.	ins.
Diameter of largest sucker		2·4	0·95
Height of largest sucker		1·5	0·6
Diameter of lateral sucker		0·9	0·35
Height of lateral sucker		0·8	0·3
Diameter of smooth-rimmed sucker		0·5	0·2
,, tubercle		0·5	0·2
Mouth.	Transverse diameter	9	3·5
	,, ,, of buccal mass, dorsal-ventral	26	10·25
	,, ,, ,, membrane (approx.)	39	15·35
Eyelid.	Approximate height	11	4·35
	,, breadth	20	7·9
Funnel.	Length from mantle edge (ventral)	30	11·8
Tail.	Breadth (broken)	62	24·4
	Length (tip to anterior point of insertion)	45	17·7
Body.	Length, caudal end to mantle edge, ventral (tail removed)	156	61·4
Mantle.	Breadth of widest portion of wall (after dissection)	4·75	1·9
	Height of mantle cartilage	20	7·9

Measurements given in St. John's Press :

Tip of tail to tip of longest tentacle	20 feet.
Longest tentacle	12 ,,
Body	8 ,,
Girth	56 inches.
Weight	570 lbs.

These measurements were taken in St. John's, apparently before the tail and possibly the head had been severed from the body.

BRIEF DESCRIPTION OF PARTICULAR ORGANS.

Verrill (2) gives a very detailed description of the species *Architeuthis Harveyi*. The recent Dildo specimen appears to agree with it in nearly all details, and a brief description of the various parts is given below.

Caudal Fin.

This was rather damaged and detached from the body, but the sketch (Fig. 1) is probably a fairly accurate presentation of its original form.

This shows it to have been sagittate, with the posterior end tapering to a long acute tip. The narrow lateral lobes extended for some distance forward beyond their points of insertion. The whole was relatively small in comparison with the huge bulk of the body.

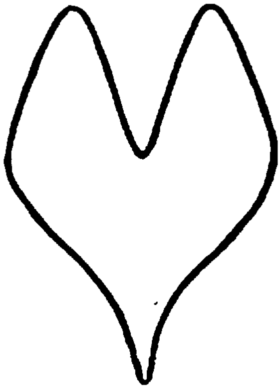

FIG. 1. Caudal Fin.

Eyes.

Unfortunately the eyes had been destroyed and the sockets were considerably damaged, so that no measurements could be made. Each eye had been protected by a large flap of skin, the eyelid, one of which was almost intact and capable of being measured.

Tentacular Arms.

Both tentacles had been cut off close to their bases, but separate fragments had been preserved. Amongst these was an almost intact "club" portion with a few feet of naked arm attached. The general form of the club is shown in Plate II, Figure 1. For purposes of description the various portions have been lettered. The seven inches at the tip of the arm, *a–b*, were armed with numerous small suckers with very long pedicels. These, unfortunately, had been too much injured to allow of a more detailed description.

On *b–c*, the broadest and most flattened portion of the club, were 26 large suckers arranged in two rows, the largest suckers being situated towards the middle of the club. The denticles, as shown in Figure 2 (*a*), were sharply serrate and nearly equal all round the circumference. Between each pair of large suckers was a smaller marginal sucker, the denticles resembling those of the larger ones but being relatively longer and sharper (Fig. 2, *b*). The pedicels, too, were more elongated. Area *c–d* represents an intermediary portion, armed with perhaps a dozen small suckers with acutely serrated denticles. This is followed by the area *d–e* armed with small smooth-rimmed suckers, irregularly placed, and among which are scattered numerous smooth tubercles (Fig. 2, *c*). These, as Verrill states, are probably to secure points of adhesion for corresponding suckers of the opposite arm, so that the tentacles may be used in conjunction. For some distance along the otherwise naked portion of the arm were scattered small smooth-rimmed suckers and tubercles, one sucker and one tubercle usually occurring in fairly close proximity. They occurred roughly in two rows, as shown in Plate II, Figure 1.

The club portion of the tentacular arm was triangular in cross-section, becoming compressed laterally in the area *a–b*, and tapering off regularly to the tip.

Sessile Arms.

Only the basal portions of these remained attached to the head. The suckers were in two rows, but so arranged that no sucker was opposite one of the other row. Sketches of the suckers have been made in Figure 2,

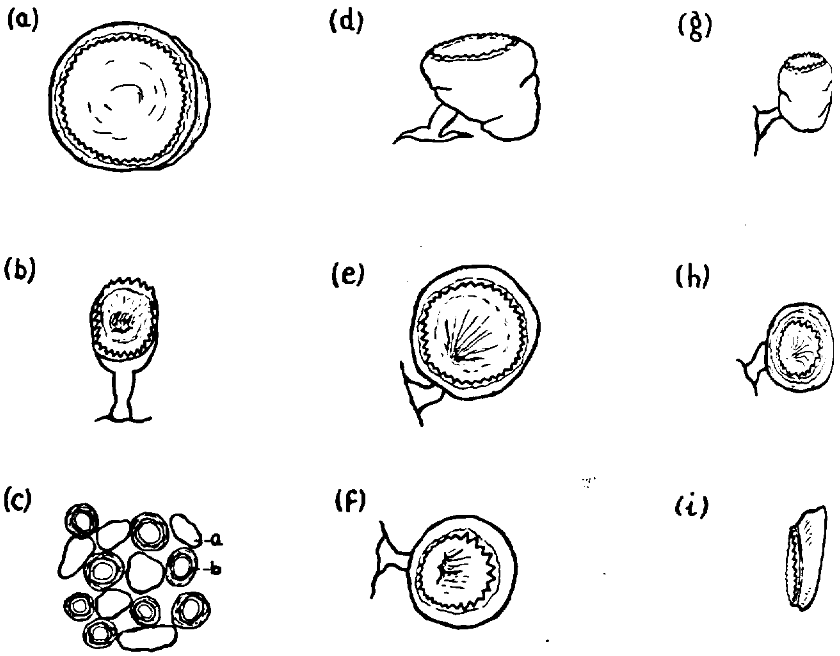

FIG. 2.

FIG. 2.—(*a*)–(*c*) Suckers from tentacular club; (*a*) large sucker; (*b*) small marginal sucker situated between 4th and 5th large suckers; (*c*) **a** tubercle, **b** smooth-rimmed sucker from area *d–e*.

(*d*)–(*f*) Suckers from second arm; (*d*) and (*e*) 8th suckers; (*f*) 18th sucker; (*g*)–(*h*) 8th sucker from fourth arm; (*i*) horny ring from a sucker.

All drawn natural size.

(*d–i*). Each sucker was possessed of an oblique horny ring, about three times as deep on one side as on the other (Fig. 2, *i*). Where the denticles were unequal, the largest was on the deepest side of the ring. All the horny rings of the basal suckers on the dorsal arms were absent, but as far as could be determined, they would resemble those of the second arm in having the denticles small and equal in the first few suckers. In all the arms, beyond about the first ten suckers, the denticles of one side had begun to atrophy and those of the other to enlarge, the 18th sucker (Fig. 2, *f*) being now typical of the form. The largest suckers on the arms were always the basal ones, there being an apparent diminution in size towards the tip of the arm.

The suckers of the third and fourth arms were somewhat smaller than those of the other pairs, and even the most proximal ones were unevenly denticulated (Fig. 2, *h*).

The denticulation of the suckers does not altogether agree with Verrill's data, but more detailed reference will be made to this point in the discussion of the species which follows below.

The wide buccal membrane was attached to each arm at its base. This was partially damaged, but the approximate diameter is given.

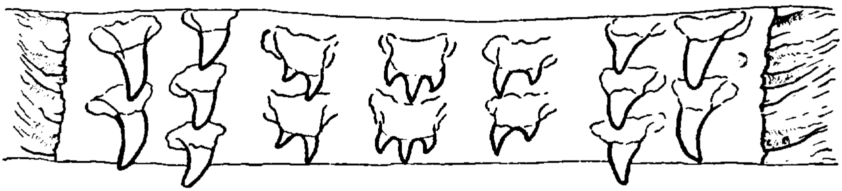

FIG. 3. Section from radula.

Radula.

The destruction of the jaws and the partial eversion of the buccal mass, allowed the parts of the odontophore and radula to be seen clearly without further dissection. The radula was a tough, cartilaginous ribbon about 2½ centimetres in width. For the entire length of the ribbon the middle portion of 1½ centimetres was considerably strengthened by dark-brown muscle fibres armed with seven rows of sharp teeth (Fig. 3). The teeth are shown to have been bounded laterally by a ridge, leaving the marginal portions of the radula colourless and unarmed.

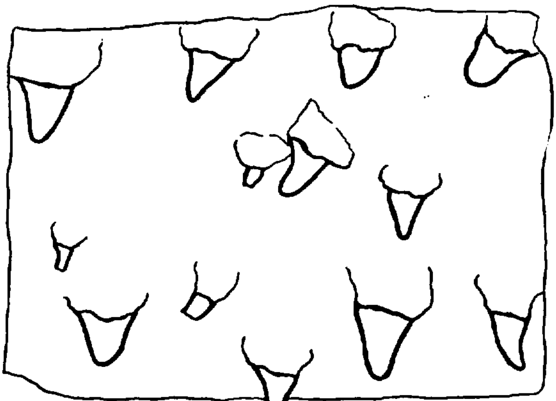

FIG. 4. Teeth on the membrane lining the palate.

The teeth which lined the palate were very unevenly placed, and although generally similar in shape differed considerably in size (Fig. 4).

Internal Organs.

A median ventral incision was made along the whole length of the mantle, and the internal organs of the animal were found to be extremely well preserved. The photograph (Pl. III) was taken before any membranes were cut. The diagram (Fig. 5) is sufficient to give some idea of the position of the viscera seen after the ventral membrane which covered them had been slit.

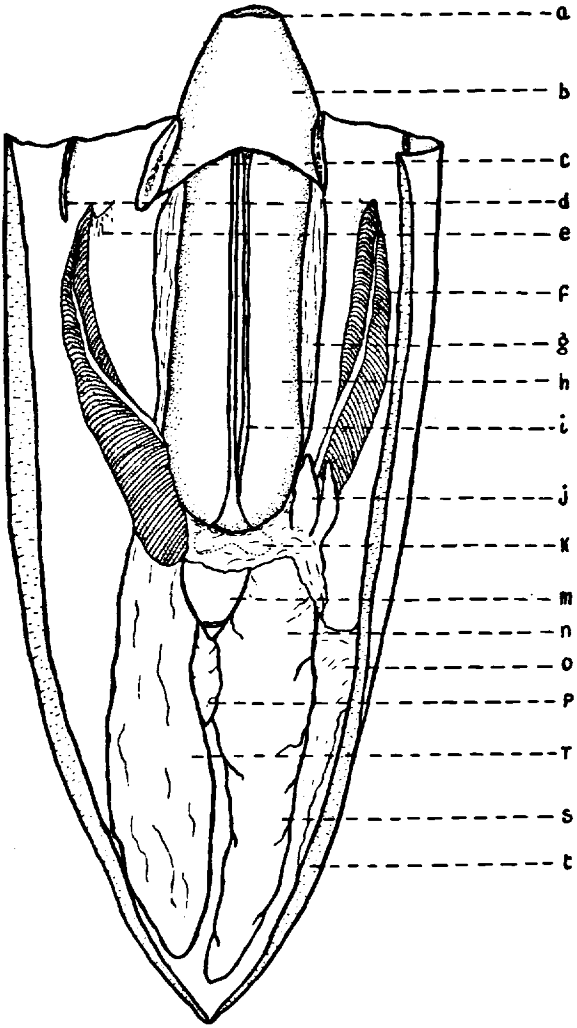

Fig. 5.—Ventral view of internal organs after partial dissection.

(*a*) aperture of funnel; (*b*) funnel; (*c*) funnel cartilage; (*d*) mantle cartilage; (*e*) ligament supporting gill; (*f*) gill; (*g*) lateral muscle of neck; (*h*) liver; (*i*) rectum; (*j*) sperm sac; (*k*) ink sac still covered by membrane; (*m*) heart; (*n*) glandular plicated stomach, an anterior continuation of (*s*); (*o*) ventral ligament; (*p*) first stomach or gizzard; (*r*) gonad; (*s*) second stomach or cæcum; (*t*) mantle wall in section.

The stomach was opened and found to consist of a thick-walled anterior region which was well supplied with rugae, and an extremely thin-walled posterior region. The transition between these two regions was very abrupt, with no appreciable change in the circumference of the organ. The membranous lining was very loosely attached to the stomach wall, and that portion of it which overlaid the rugae was of a dark red colour. The stomach contained no trace of food.

The gonad was in a soft condition, but

the specimen appeared to be a male. If so, the white glandular organs which protruded through the ventral membrane were, in all probability, parts of the sperm sac.

The ink sac was bilobed.

Portions of the pen, relatively broad and very fragile, could be seen protruding at the caudal end of the specimen.

Pigmentation.

Previous specimens have been described as "reddish inside as well as out" or "of a pale, pink colour," indicating that the pigmentation was similar to that of the common squid. Externally the Dildo specimen was almost pure white, but this was possibly due to the rubbing off of the cuticle. Internally the membranes were deeply pigmented and dark red in colour. Before the photograph (Pl. III) was taken, the membranes had been destroyed at the caudal end, this fact accounting for the light area to be seen there.

On account of the lack of any existing precise description of the internal organs of this species, the specimen was given merely a superficial examination, and, after light treatment with formalin preservative, repacked for expert examination in South Kensington Museum, London. Sufficient detail was, however, discerned to enable a provisional determination of species to be made.

DISCUSSION OF SPECIES.

Verrill (**2**) says that it is probable that only three forms are indicated by the large Newfoundland specimens of *Architeuthis*, and two of these may be respectively the male and female of one species. One of the principal differences usually indicated by the measurements is in respect to the size and length of the shorter arms, one form having them comparatively stout, often thicker than a man's thigh, while the other form has them long and slender (usually 3 to 5 inches in diameter, with a length of 6–11 feet). In case these differences prove to be sexual, those with stout arms will probably be the females, judging from analogy with the small squids nearest related. In the three specimens, of which he had seen the arms, the latter were long and slender, but in one the arms were much longer in proportion to the body than in the others; there were also differences in the denticulation of the suckers of the short arms. These differences appeared to Verrill to indicate two species, which he named *Architeuthis Harveyi* and *Architeuthis princeps*. From his discussion of the type forms, the differences between these species can be tabulated as follows:

	Architeuthis Harveyi.	*Architeuthis princeps.*
Sessile Arms.	Nearly equal in length, but scarcely as long as the body alone. Unequal in size.	Unequal in length, the ventral and longest arms exceeding the combined length of the head and the body by 1/6th.

	Architeuthis Harveyi.	*Architeuthis princeps.*
Suckers.	Larger towards the base of the lateral and dorsal arms, with numerous acute teeth all around the circumference; all similar in shape, but those on the inner margin smaller than those on the outer. Remaining suckers on these arms, and all on the ventral arms, toothed on the outer margin only.	Those on the short arms denticulated. Two forms: (*a*) oblique horny rings with outer edge very strongly toothed and inner edge slightly or imperfectly denticulated. (*b*) Less oblique rings with denticles similar in form all round, though smaller on the inner margin.
Caudal Fin.	Small, less than 1/3rd of the length of the mantle. Sagittate in form, with narrow lateral lobes extending forward beyond their insertions. Posterior end tapering to a long acute tip.	Short sagittate. Posterior end less acuminate than in *Architeuthis Harveyi.*
Jaws.	With smaller notch and lobe than in *A. princeps.* Angle of 90° between the alar edge and the cutting edge of the rostrum.	Jaws stronger than in *A. Harveyi*, with deeper notch and more elevated tooth on the anterior edge. Angle of 110° between the alar edge and the cutting edge of the rostrum. Texture of jaws firmer and colour darker.

Pfeffer (**3**) reviews Verrill's work on these species of *Architeuthis.* He points out that there are numerous discrepancies and inaccuracies owing to the incompleteness of Verrill's sources of data. He reaches the conclusion that, in the material submitted, there is not sufficient proof for a final determination of species, and that all the distinguishing points which have been listed above might easily be accounted for, either by inaccuracy in description and measurement or, as Verrill himself admitted as a possibility, by the differences between male and female. Pfeffer does not, however, add to the knowledge of the giant Cephalopods of the western Atlantic.

According to Pfeffer's Key to the Families of the *Oegopsidæ* based on external characteristics, the recent Dildo specimen belongs to the Family *Architeuthidæ.* In this there is but the one genus *Architeuthis*, and the only species discussed as belonging to the western Atlantic are those of Verrill, viz. *Architeuthis Harveyi* and *Architeuthis princeps.* The caudal fin of this recent specimen is similar to that described by Verrill for *A. Harveyi*, but other diagnostic features such as the angles of the jaws and the length of the sessile arms could not be determined. The denticulation of the suckers does not entirely agree with that given for either species, for whereas in *A. Harveyi* all the suckers on the ventral arms are toothed on the outer margin only, in this specimen the basal suckers are toothed all around, the denticles being merely smaller on one side. That this may prove to be but an individual variation can easily be conceived if, as Pfeffer imagined, the two species *A. Harveyi* and *A. princeps* prove to be identical.

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1. Steenstrup, J., and Harting, P., in Verrill, A.E., U.S. Fish. Comm. Report for 1879 (1881–1882), p. 211 and p. 261.
2. Verrill, A. E. Report on the Cephalopods of the North-eastern Coast of America. U.S. Fish Comm. Report for 1879 (1881–1882), pp. 211-260. Pls. I–XI.
3. Pfeffer, George. Die Cephalopoden der Plankton Expedition, 1912. Kiel and Leipzig. Text pp. XX–XXI and pp. 16–27.

EXPLANATION OF PLATES.

Plate I. Fig. 1. Squid, external view. Photo: A. Proctor.
Head and tail were detached from body but placed in approximate positions.

Fig. 2. External view, taken when the squid was landed at St. John's. Photo: E. Maunder.

Plate II. Fig. 1. Tentacular arm.

Fig. 2. Basal portion of sessile arm.
Photos: A. Proctor.

Plate III. Oblique view of internal organs before dissection.
(*a*) funnel; (*b*) funnel cartilage; (*c*) anus; (*d*) mantle cartilage; (*e*) liver; (*f*) lateral muscle of neck; (*g*) gill; (*h*) sperm sac; (*i*) membrane covering pericardial cavity; (*j*) ventral ligament; (*k*) membrane covering viscera; (*m*) cut edge of mantle; (*n*) torn membrane.
Photo: A. Proctor.

FIG. 1.

FIG. 2.

PLATE II

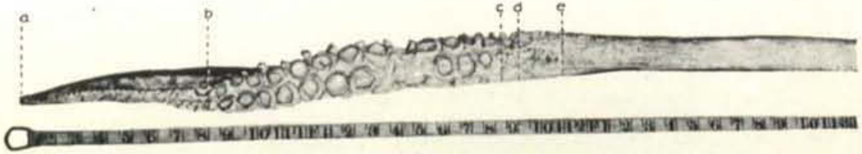
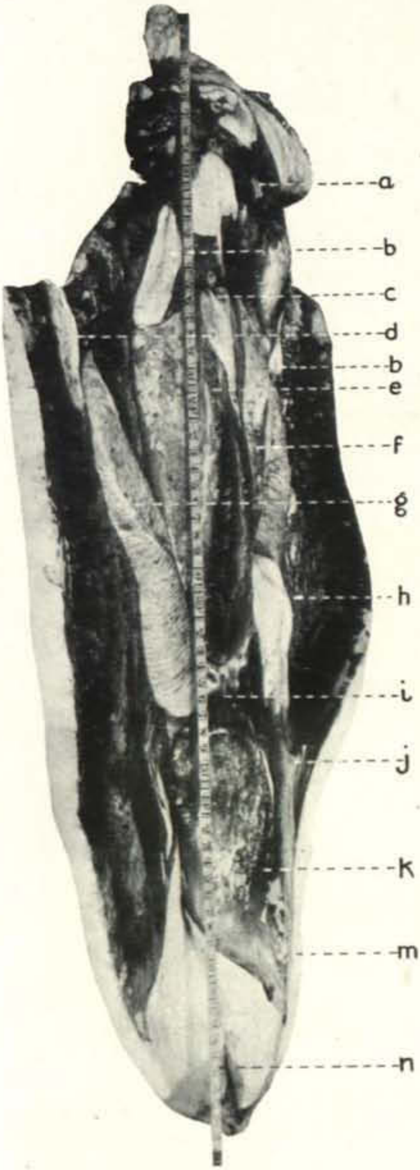


FIG. 1.

FIG. 2.


a
b
c
d
b
e
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APPENDIX D.

THIRD LIST OF FISHES IN THE NEWFOUNDLAND FISHING AREA 1933

(Index Nos. 3 to 76 refer to corresponding species in First and Second Lists.) The remaining figures represent *Cape Agulhas* Stations at which species were found.

3. **Spiny Dogfish** (*Squalus acanthias* Linnæus). 212, 214, 269, 309.

5. **Prickly Skate** (*Raja scabrata* Garman). 204–207, 209, 211, 215, 226, 229, 257, 269, 274, 276, 277, 280, 281, 283, 284, 287, 318

6. **Barn-door Skate** (*Raja stabuliformis* Garman). 268, 269, 318.

8. **Herring** (*Clupea harengus* Linnæus). Trawled at 257, 274.

12. **Capelin** (*Mallotus villosus* Müller). 204, 212, 242, 246. Taken pelagically at 229, 232, 238, 255–257, 259, 260, 274, 287, 290–296, 298, 301, 310, 311, 313, 318, 319, 1, A.

14. **Pearlsides** (*Myctophum glaciale* Reinhardt). 214. Taken pelagically at 264, 317.

20. **Sand Launce ; Sand Eel** (*Ammodytes americanus* De Kay). 269. Taken pelagically at 202–204, 208, 209, 211–221, 224, 228, 201 rep., 241, 244, 255, 258–260, 273–275, 277, 306, 311

25. **Cunner** (*Tautogolabrus adspersus* Walbaum). Taken pelagically at 261, 265, 266, 275, 290–292, 294, 315.

26. **Rosefish ; Red Bream ; Norway Haddock** (*Sebastes marinus* Linnæus). 214, 229, 276, 319. Taken pelagically at 201, 203–205, 211, 224–231, 238, 248, 249, 251, 260, 261, 263, 278, 311.

28. **Sculpin, Mailed** (*Triglops ommatistius* Gilbert). 204–207, 244, 257, 283, 287, 289.

29. **Sculpin, Short-horned** (*Myoxocephalus scorpius* Linnæus). 242, 244, 246, 268. Taken pelagically at 201?, 238?, 241.

30. **Sculpin, Long-horn** (*Myoxocephalus octodecimspinosus* Mitchill). 269, 318.

31. **Sea Raven** (*Hemitripterus americanus* Gmelin). 269.

32. **Alligator Fish** (*Aspidophoroides monopterygius* Bloch). Taken pelagically at 282, 286, 287.

33. **Lumpfish** (*Cyclopterus lumpus* Linnæus). 229, 232, 235, 309. Taken pelagically at 261.

34. **Lumpfish, Spiny** (*Eumicrotremus spinosus* Müller). 242.

35. **Sea Snail** (*Neoliparis atlanticus* Jordan and Evermann). Young forms, probably of this species taken pelagically at 203, 204, 208, 211, 254-256, 260.

36. **Sea Snail, Striped** (*Liparis liparis* Cuvier). 235, 254.

37. **Rock Eel** (*Pholis gunnellus* Linnæus). 235.

38. **Snake Blenny** (*Lumpenus lampetræformis* Walbaum). Young forms, probably of this species taken pelagically at 215, 216.

41. **Wrymouth** (*Cryptacanthodes maculatus* Storer). Taken pelagically at 220, 221, 253.

42. **Wolffish ; Catfish** (*Anarhicus lupus* Linnæus). 254, 283, 287. Taken pelagically at 236, 242, 243.

44. **Eelpout, Arctic** (*Lycodes reticulatus* Reinhardt). 254. Taken pelagically at 241.

45. **Silver Hake** (*Merluccius bilinearis* Mitchill). 214, 269, 277.

47. **Cod ; Rock cod** (*Gadus callarias* Linnæus). 203–207, 209, 211, 212, 214, 215, 226, 229, 232, 233, 235, 242, 244, 254, 257, 268, 269, 274, 276, 277, 280, 281, 283, 284, 287, A, 307, 309, 318, 319. Taken pelagically at 204, 206, 210, 229, 236–239, 242–251, 201 rep., 255, 256, 258, 259, 261, 271, 272, 274, 275, 289, 293–295, 297, 298, 302, 303, 306, 307, A.

48. **Haddock** (*Gadus æglefinus* Linnæus). 210–212, 215, 226, 268, 269, 274, 276, 277, 280. Taken pelagically at 273.

49. **Hake, white ; Ling** *Urophycis tenuis* Mitchill). 214, 274, 276, 277.

52. **Rockling, Four-bearded** (*Enchelyopus cimbrius* Linnæus). Taken pelagically at 255, 260, 262, 263, 277, 290–292, 296, 308, 316, 317, 1.

54. **Halibut** (*Hippoglossus hippoglossus* Linnæus). 215, 269.

55. **Halibut, Greenland ; Newfoundland Turbot** (*Reinhardtius hippoglossoides* Walbaum). 204, 254.

56. **Plaice, American ; Sand or Rough Dab** (*Hippoglossoides platessoides* Fabricius). 203–207, 209, 211, 212, 226, 229, 232, 233, 235, 242, 254, 257, 274, 276, 277, 280, 281, 283, 284, 287, 318, 319. Taken pelagically at 201, 203, 209, 217, 218, 224, 252, 255–262, 270–272, 274–277, 293-298, 307, A.

57. **Rusty, Sand or Mud Dab** (*Limanda ferruginea* Storer). 211, 268, 269, 280.

59. **Flounder, Witch** (*Glyptocephalus cynoglossus* Linnæus). 205, 211, 212, 214, 215, 226, 229, 232, 274, 276, 277, 280, 287. Taken pelagically at 220, 221, 229, 255, 256, 258, 260–263, 265, 270–272, 274–278, 286, 290–294, 296, 297, 309, 317.

62. **Goosefish ; Monkfish ; Angler** (*Lophius piscatorius* Linnæus). 269, 277. Taken pelagically at 204, 205.

65. **Agonus decagonus** Schneider. Taken pelagically at 210, 246, 247, 254, 284.

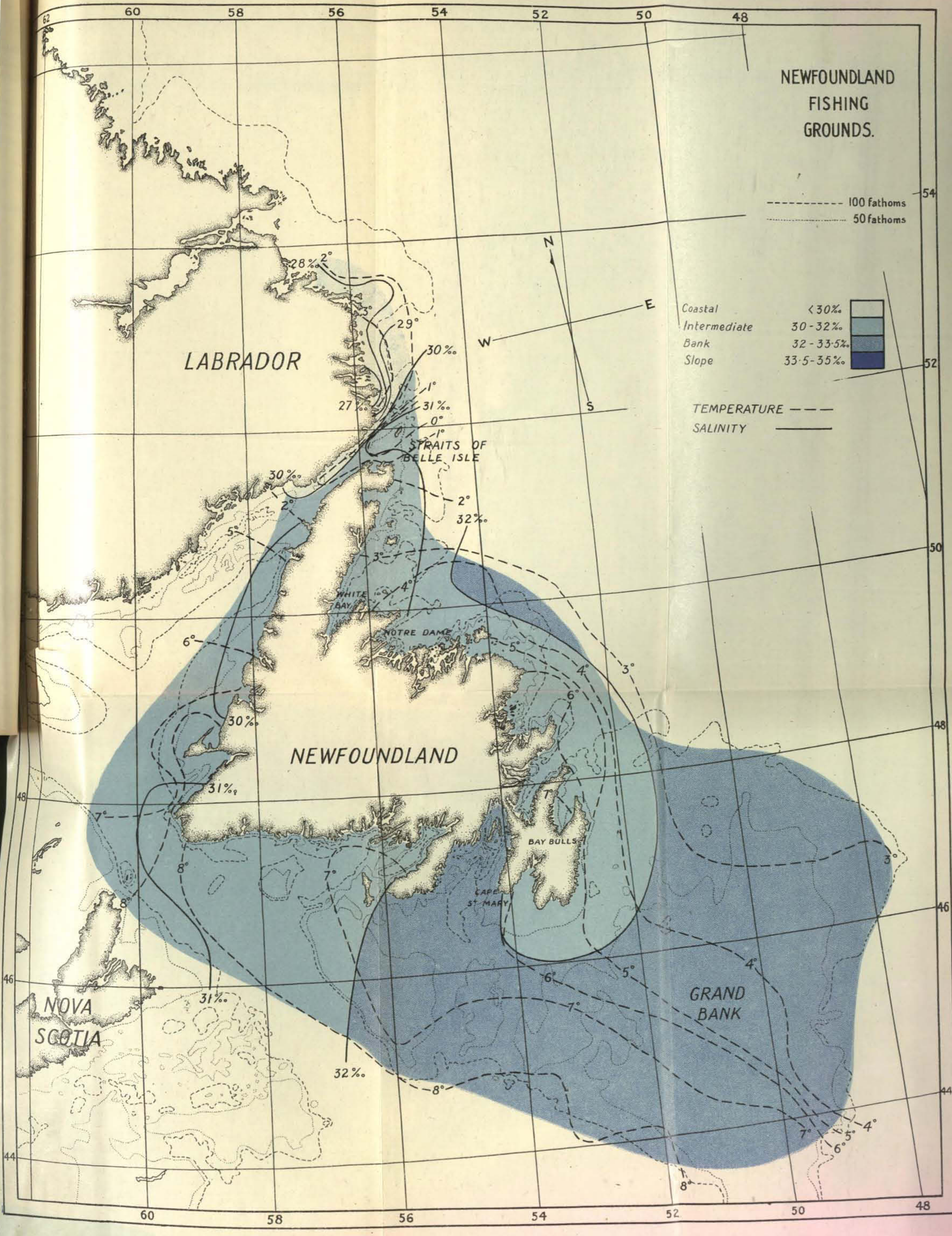
74. **Common Grenadier** (*Macrourus bairdii* Goode and Bean). 214.

75. **Spotted Wolffish** (*Anarhichas minor* Olafsen). 203.

76. **Smooth Skate** (*Raja senta* Garman). 215.
Chirolophus Sp. (?). Taken pelagically at 236, 238, 245, 246, 247, 253.

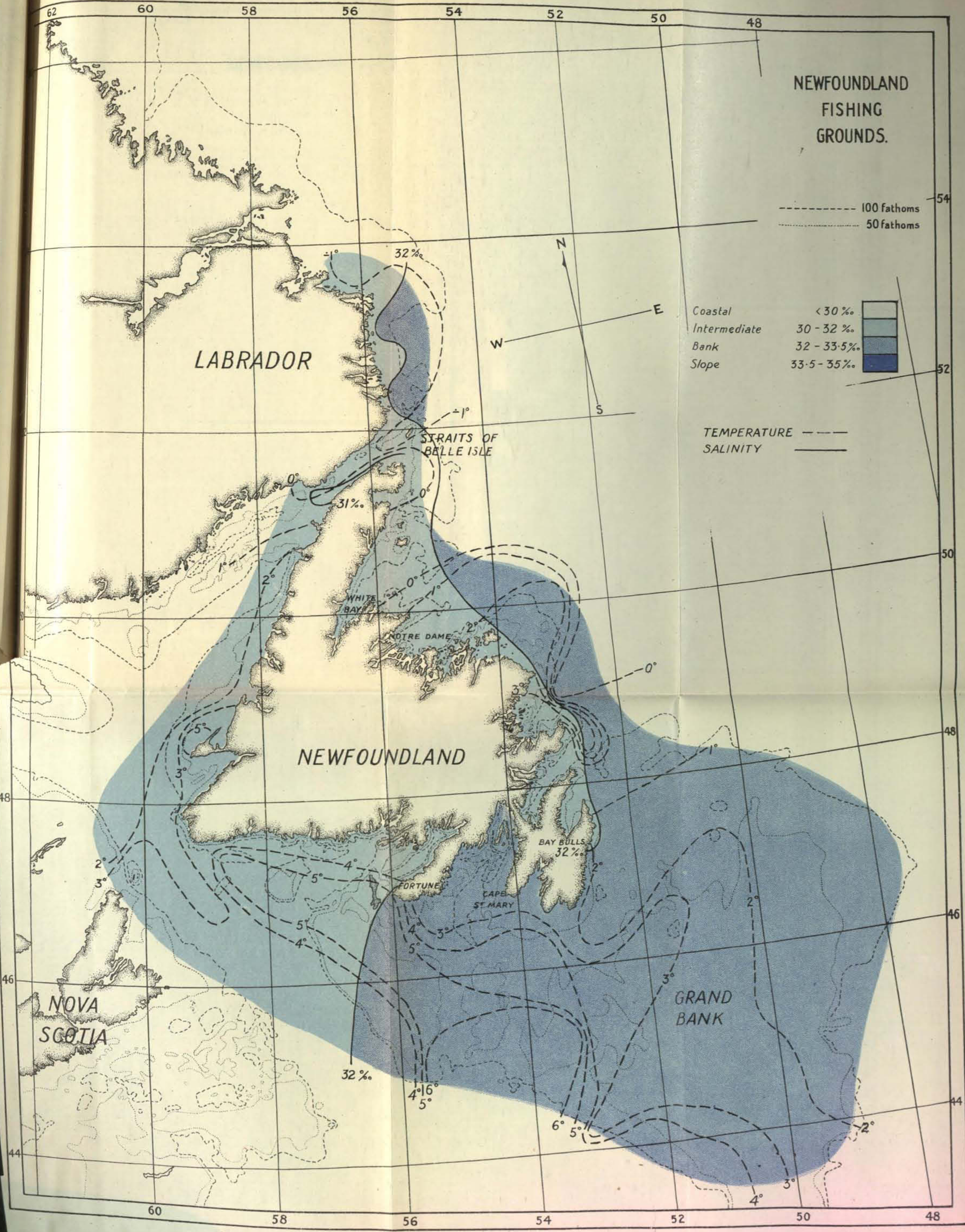
In accordance with the colder average water conditions prevailing in 1933 there was less evidence of the occurrence of oceanic or southerly species. No pilot whales stranded, nor were sunfish recorded. Billfish, butterfish and mackerel were much scarcer than in the two previous years.

Fig. 1.



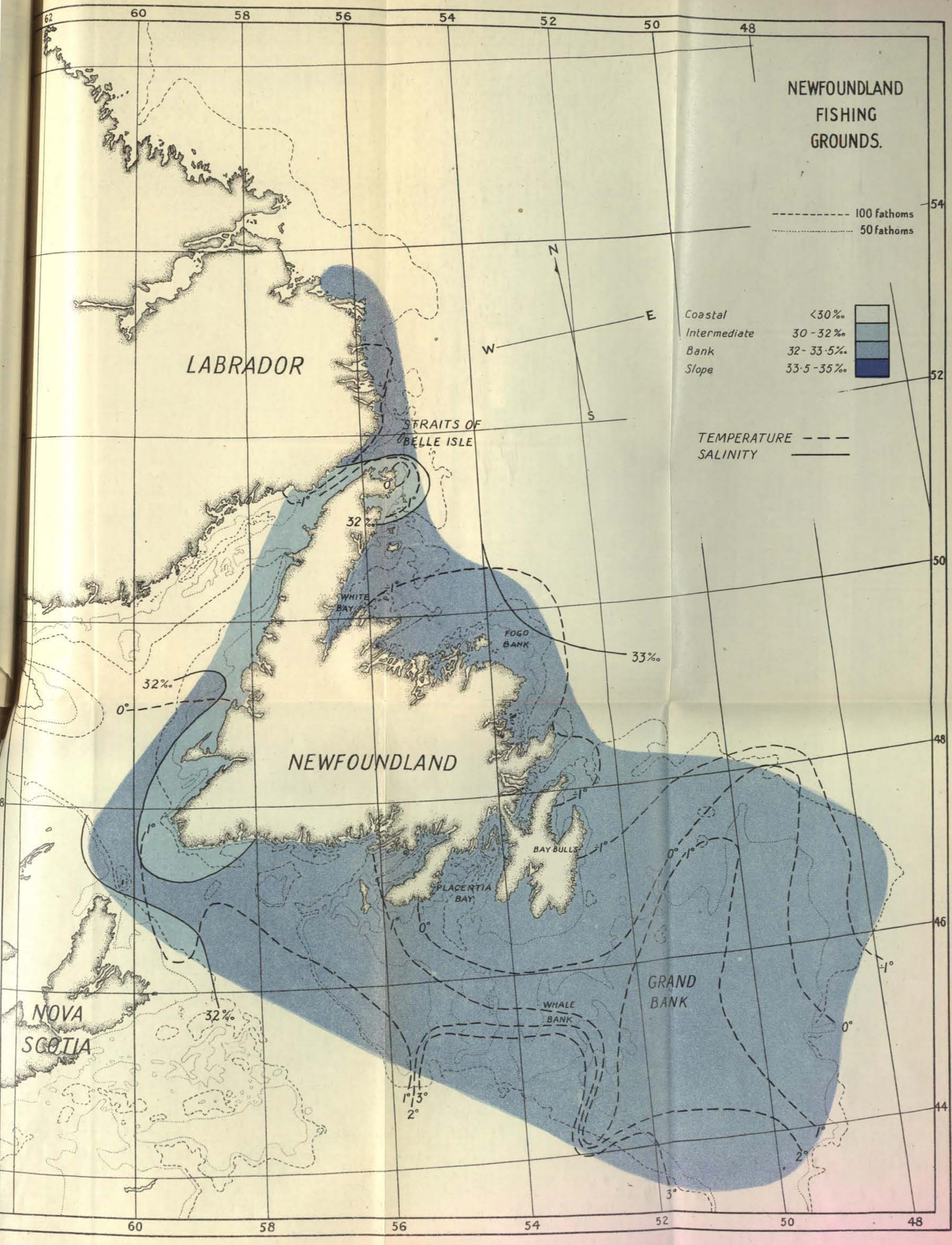
Temperatures and Salinities at Surface
Spring Cruise 1933.

Fig. 2.



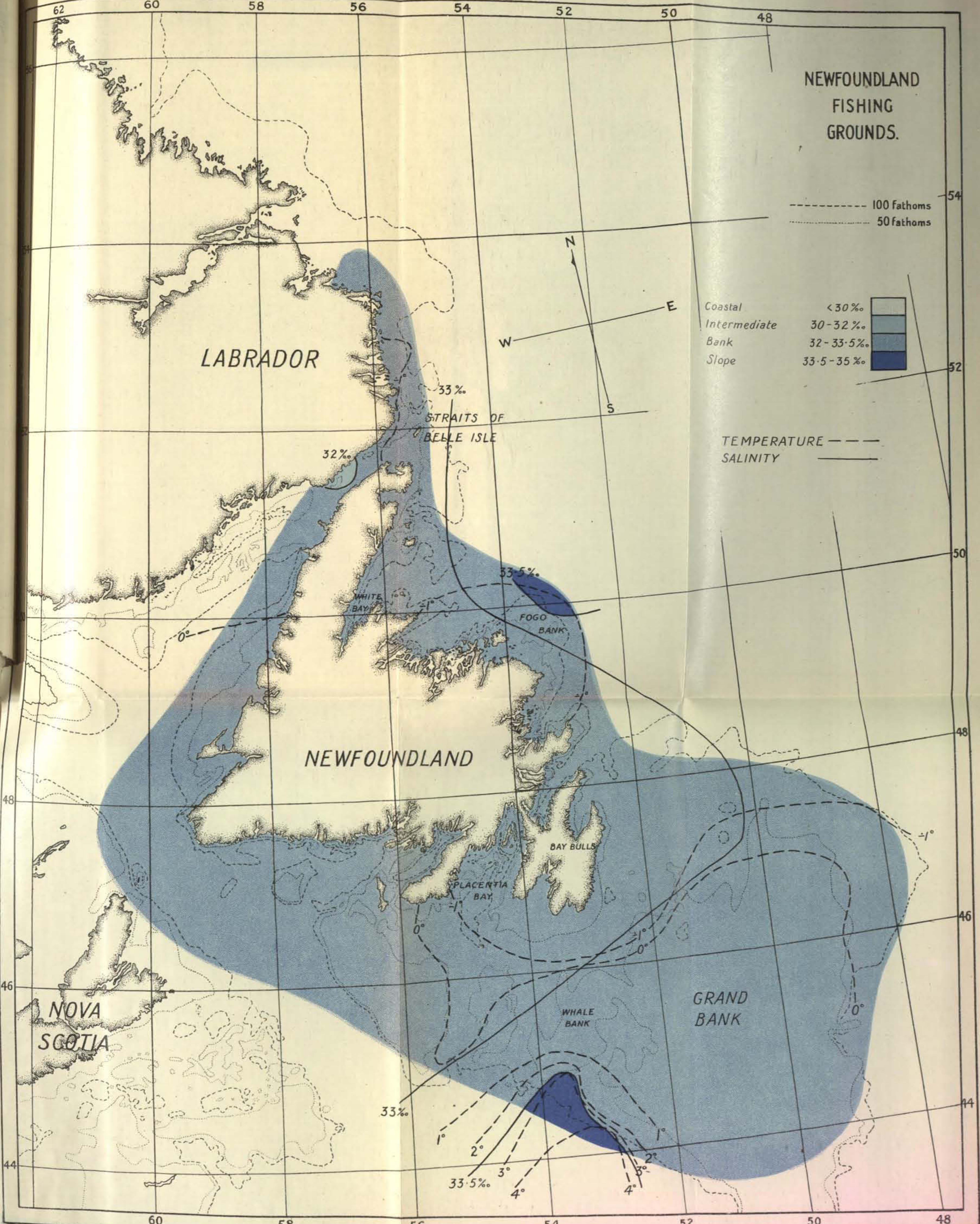
Temperatures and Salinities at 25 metres.

Fig. 3.



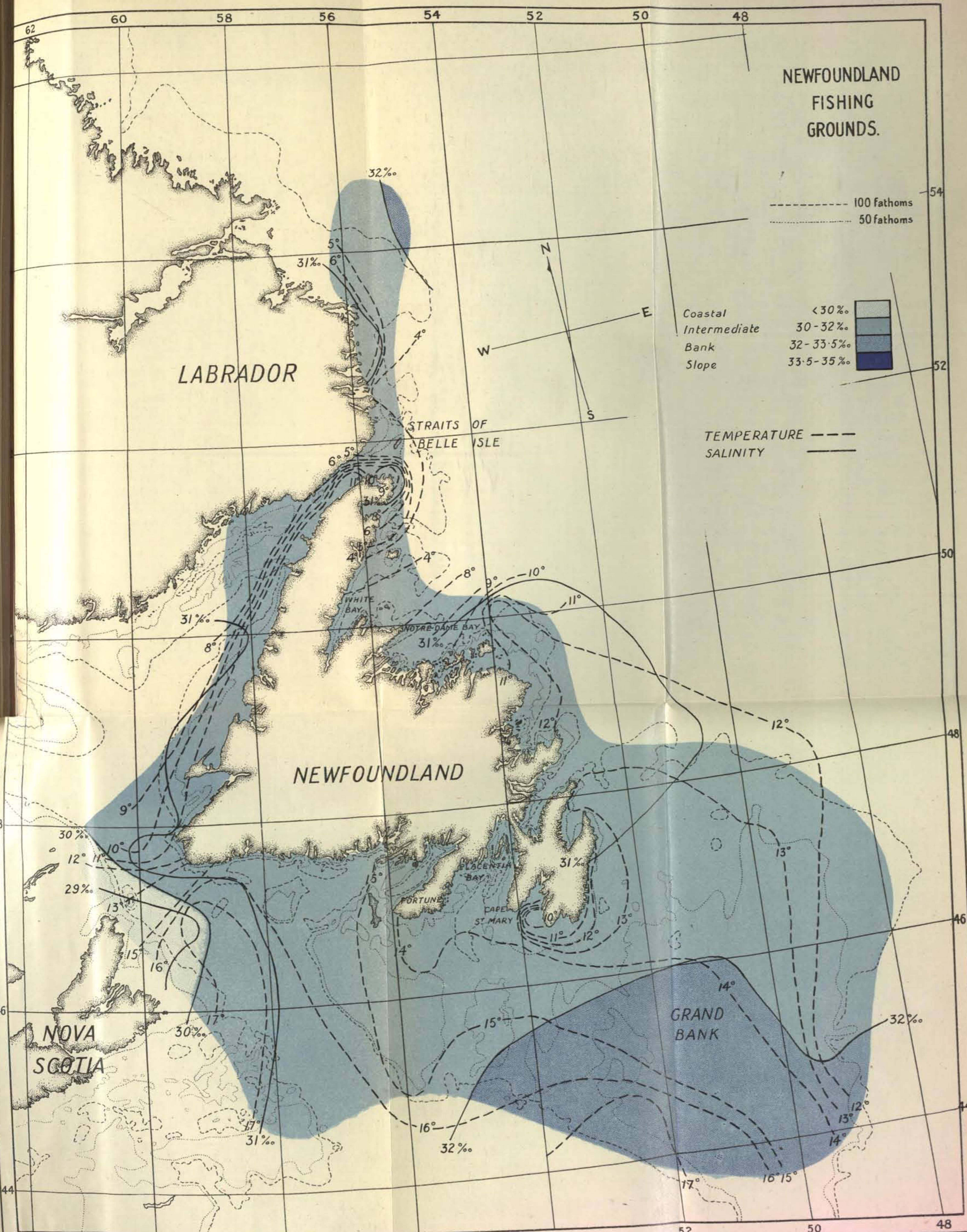
Temperatures and Salinities at 50 metres.
Spring Cruise 1933.

Fig. 4.



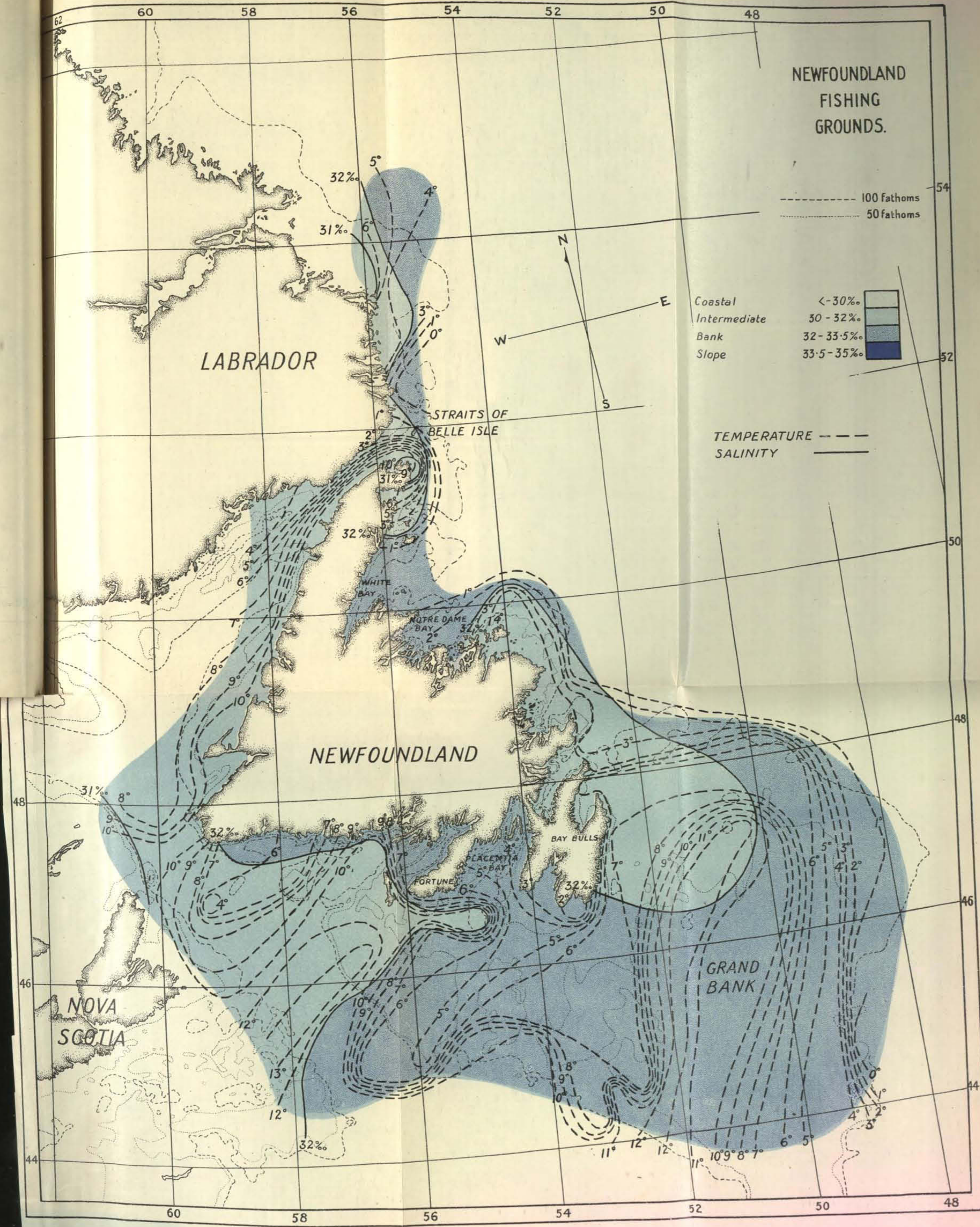
Temperatures and Salinities at 100 metres.
Spring Cruise 1933.

Fig. 5.



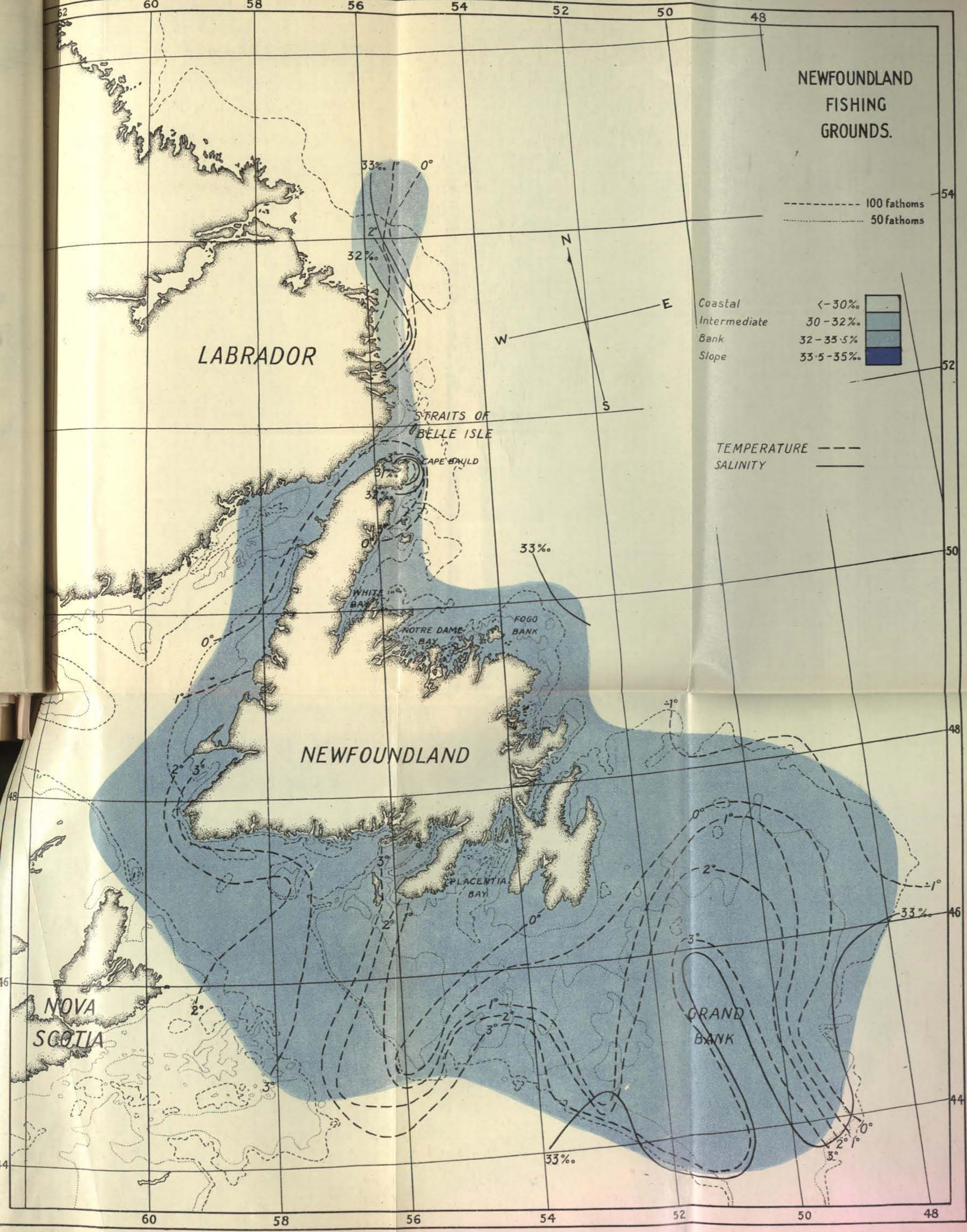
Temperatures and Salinities at Surface.
Fall Cruise 1933.

Fig. 6.



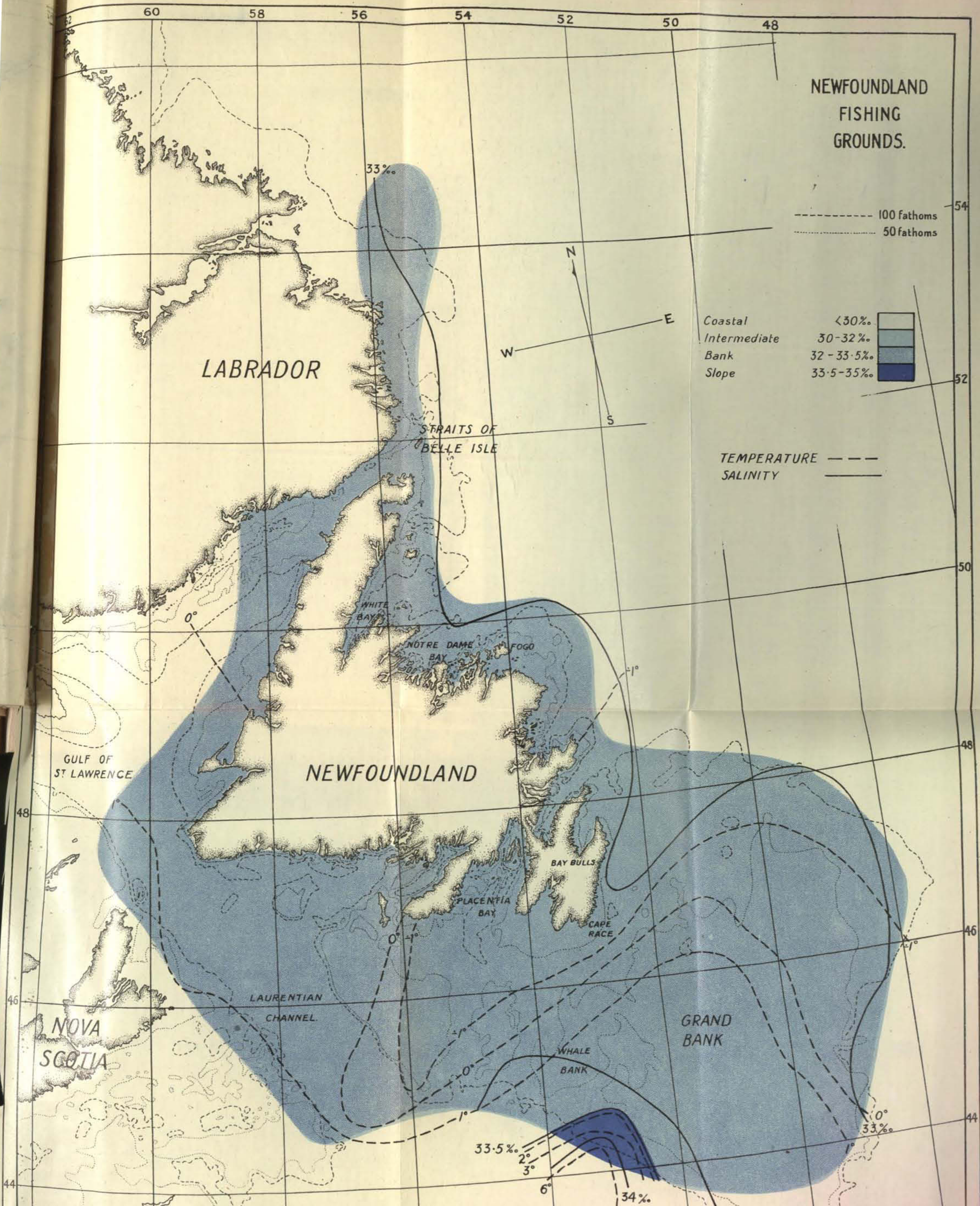
Temperatures and Salinities at 25 metres.
Fall Cruise 1933.

Fig. 7.



Temperatures and Salinities at 50 metres.
Fall Cruise 1933.

Fig. 8.



Temperatures and Salinities at 100 metres.
Fall Cruise 1933.

Fig. 9.

MOVEMENTS OF DRIFT BOTTLES

REPORTS OF THE NEWFOUNDLAND FISHERY RESEARCH LABORATORY

1934

DEPARTMENT OF NATURAL RESOURCES

NEWFOUNDLAND

DIVISION OF FISHERY RESEARCH

ANNUAL REPORT

YEAR 1934

(APRIL, 1934—MARCH, 1935)

With 10 *Figures and* 9 *Charts*

This Report is in continuation of the Reports previously issued by the Fishery Research Commission, Newfoundland, and may be referred to as

VOL. II, No. 3

the title of the series now being changed to "Reports of the Newfoundland Fishery Research Laboratory, Division of Fishery Research, Department of Natural Resources, Newfoundland."

Price $1.00

CONTENTS

APPENDICES

I. INTRODUCTION

By H. Thompson

THIS report deals with the year ending March, 1935, and constitutes the fourth annual report of the Newfoundland Fishery Research Laboratory. Previously set up to operate under the Fishery Research Commission, a body appointed by the British Empire Marketing Board (abolished in 1933) and the Newfoundland Government (superseded by Government by Commission in 1934), the laboratory was during the latter year transferred for administrative purposes to the Department of Natural Resources, under the Commission of Government. The Fishery Research Commission was accordingly abolished. The closer association of the laboratory with the authority charged with the formulation and administration of fishery policies should certainly prove mutually advantageous.

Shortly after assuming office the new Government purchased the entire laboratory premises, part of which only had previously been rented for laboratory purposes. The resulting freedom for expansion of activities has already proved beneficial. The experimental cannery has been extended so as to have, as needed, a definite production capacity on a commercial basis. There has been installed a semi-automatic, double-seaming vacuum canning machine, capable of handling various shapes and sizes of cans. Extra retorts have been acquired, along with an electrically-driven Hobart slicer and mixer, and a 5 gallon steam-jacketed monel metal pan. For the preparation of emulsions a De Laval homogeniser, with a capacity of 33 gallons per hour, has been fitted. There has also been obtained, through the generosity of Mr. Stephen Kunzer (of Messrs. Frederick Boehm, London), an electrically-heated 1½ gallon Soxhlet extractor for solvent extraction of halibut livers and of other oily materials, such as cod liver residues ("foots" or "chum") not amenable to the practice of ordinary steam extraction. For the preparation of anti-anaemia extracts of cod livers there was designed and installed a stainless steel vacuum extractor and still. The established potency of these extracts, as compared with the similar but expensive extracts of mammalian livers, renders it desirable to test out costs of production in Newfoundland, where cod livers can be obtained in the absolutely fresh state essential for the preparation of a satisfactory product.

In order that the essential service of testing cod liver oils for Vitamin D content can be provided, the laboratory will, as from June, 1935, be fully equipped for carrying out biological tests for the assay of this vitamin. All three methods—colorimetric, spectrophotometric, and biological—are also available for making Vitamin A tests.

Most of the cold-storage department continued to be rented to Messrs. Tors Cove Trading Company, which operates an extensive blending, chilling, and cold filtering business in cod liver oil. The proportion of production of the more remunerative non-freezing quality to other sorts was again increased, and it was found possible to reduce the loss of oil as stearin. The utilisation of this stearin by-product as a source of fats and vitamins in the feeds of local farm stock is highly recommended. A small portion of the refrigerated space was operated as a Government bait-store, being separately equipped with an automatic refrigerating unit, and useful for preservation of fish for canning and other purposes. During the year Messrs. Mead Johnson & Co., Indiana, U.S.A., leased a portion of the laboratory premises for the experimental production of cod liver oil by a new technique, and were accorded such co-operation as was required.

In the body of this report further data are furnished to complete the survey of the principles and practice of the curing of codfish for the salt-cod markets. Special consideration is given to the correct use of salt on the fish, and a strong recommendation is made that salt should be sold by weight instead of by volume. A comprehensive treatise on the salt codfish industry is about to be published.

Using all three methods of testing Vitamin A, Dr. Macpherson and Miss A. M. Wilson obtained positive confirmation of the fact that the potency of cod liver oil increases with increased age of the fish. By the separate rendering of livers from large, medium, and small cod, three grades of oil of distinctly different potency can be prepared, and the finding has commercial value in that much preliminary chemical testing can be avoided, for, if the average size of the fish is known, the potency of any oil is capable of approximate determination from the size-potency relationship table which has been prepared. A similar relationship holds for other fish-liver oils tested—e.g. those of halibut and salmon.

Cod liver oil is bought and used chiefly for its vitamin content, and the increasing recognition of this fact has lately led to discrimination being exercised, particularly by the better class British and American drug stores. It is in fact difficult to effect a sale without declaring the vitamin specification, and a price-gradient is accordingly gradually coming into use on this score. As a result of the protection afforded to oils of Empire origin by the Ottawa agreement, a vast development of cod liver oil production has occurred on British trawlers, fishing chiefly on the Iceland grounds. Produced mainly at sea, this oil falls chiefly into the so-called poultry-oil class, and has affected the market for the latter. No official specification of its vitamin potency has been issued, but it is learnt unofficially that its Vitamin A potency averages 15 Blue Units. This is approximately the same as the average potency of all Newfoundland oil, and is considerably higher than the average for Norwegian oils. Assuming that this finding is confirmed, Newfoundland oil retains the distinct advantage of coming naturally within the medicinal oil class, since the livers are processed on shore immediately after the fish are caught. With regard to its Vitamin D content the British oil is (also unofficially) stated to average about 145 international units per gramme. However, it is unlikely that sufficiently comprehensive assays have been made to establish this value. *Bills et al*[1] state that a cod liver oil of average potency contains 100 international units per gramme, and considerable reliance can be placed on this finding of one of the leading trade laboratories in the U.S.A. The average potency of all Newfoundland oils tested at the Rowett Institute is also 100 units. As for oil sold in Great Britain, **Morgan and Pritchard**[2] tested the potencies of an average sample of cod liver oil, prepared by mixing together equal quantities of 64 samples of medicinal oil purchased retail from pharmacies in different parts of the British Isles. Forty pairs of rats were used in assaying Vitamin A, and a similar number in assaying Vitamin D. Only 670 international units (per gramme of oil) were found in the case of Vitamin A, and only 81 international units in the case of Vitamin D. The blue value of the mixed oils was 9·3 units—well below the Newfoundland standard.

It is obviously of great importance to make a thorough investigation of the Vitamin D potencies of Newfoundland oils, and, in realisation of this fact, the Government has made provision for analyses to be made in the only satisfactory manner—that is, at the source of production, where accurate criteria of the locality of capture of the fish, the relative sizes and quality of the latter, and the amounts caught are obtainable. Miss S. T. Lindsay was seconded for a period during the year in order to proceed to England to study and practise the accepted methods of assay. Newfoundland exporters of large quantities of cod liver oil will, therefore, be enabled to secure certificates of analysis of their product, and it is likely that, after the present period of transition passes, a broadening world market will result for cod liver oil in general as a result of the specific demonstration of its value as a source of vitamins. The limited supply of

[1] *Jour. Biol. Chem.*, Vol. 108, No. 2, February, 1935.
[2] *J. Soc. Chem. Ind.*, Vol. 54, No. 8, February 22, 1935.

oils of abnormally high potency will, however, probably be culled out and retained in a highly-priced category ; while the general bulk of oil will be standardised so as not to fall below the minimum specification allowed in the U.S. Pharmacopoeia, viz., 600 international Vitamin A units (= between 5 and 6 Blue Units), and 85 international Vitamin D units per gramme of oil.

Reference has been made to the proposed use of cod liver oil stearin in stock-feeds. Stearin is a by-product from the preparation of non-freezing cod liver oil, is half the price of the latter, and appears to be a potentially valuable adjunct in the winter diet in a country where foodstuffs for farm stock are expensive. In a few rough tests made at Bay Bulls satisfactory results were obtained by including 2% stearin in the diet of chickens, young pigs, cattle, and horses. Further tests are being conducted by Mr. W. W. Baird, Superintendent of the Experimental Farm for Eastern Nova Scotia. It is obvious that most of the stearin (which is exported at virtually throw-away prices) produced in Newfoundland could be advantageously absorbed by incorporation in the winter diet of live-stock, and replace expensive imported materials containing similar food values. Its Vitamin A potency equals that of the parent oil. Tests for Vitamin D remain to be made.

During the year an experimental quantity of emulsion of malt extract with selected cod liver oil of high Vitamin A potency was placed on the local market and rapidly came into favour. It is now, therefore, possible to arrange to supply the entire Newfoundland market for this product, and to negotiate for markets abroad. Acknowledgement is made of the support received in this project from the Department of Public Health and from the medical profession. A complementary type of cod liver oil emulsion is being experimented with, and the marketing possibilities of this will be determined in similar fashion. Apart from demonstrating the suitability of Newfoundland cod liver oil for incorporation in emulsions, these products can, even if duty is paid on imported ingredients, be produced locally at a figure below that paid for the imported article, and can, therefore, become valuable commodities in the nutritional economy of the country.

The canning industry has not been developed in Newfoundland as in other countries. There is no reason to doubt that it is about to go ahead, especially if the deep-sea fishery is exploited by trawlers. Much remains to be done by co-operative effort to preserve vegetables and fruits for winter use in the various settlements of the country ; whilst, in the second place, there appears to be a large commercial proposition in the canning of fresh codfish, more abundant in the inshore waters of Newfoundland than elsewhere. Given a satisfactory product it is certain that there is a wide market, not reached by fresh or frozen fish, to which the canned article would appeal. This applies particularly to inland continental areas and to tropical and sub-tropical countries. The canning of her commonest fish, the cod, should become one of Newfoundland's objectives. The Atlantic salmon taken on the coasts must always prove of subsidiary importance in a canning industry, on account of the restricted numbers in which it occurs. In the case of the cod, certain flatfish, herring, and even halibut, the raw material can be secured for canning at a sufficiently low price to allow the finished product to be produced at a cost competitive with that of other foodstuffs. Thus, in the case of the Atlantic salmon, the objective must be to place the product in the luxury class ; whereas in the case of the cod the objective is clearly to aim at small profits on a large overturn. There are many settlements in which a regular supply of cod could be arranged for during from five to seven months of the year, and in some cases (e.g. at St. Mary's, where there are cold storage facilities) inshore cod catches could be supplemented by the last day's (fresh) catches of small schooners returning to port. Some organisation would be requisite to ensure that the vessels sailed from and returned to port in more or less regular succession.

Experimental canning work undertaken at the laboratory during the past year has definitely established the fact that an acceptable canned codfish product is feasible. Only the smaller class of cod are used, as larger cod have the better value as salt codfish. Only fillets are canned, and a process has been developed which avoids loss of water from the flesh and the resulting denaturation (indicated by toughness) of the proteins of the muscle fibres. Little if any liquid is accumulated in the can. Flat oval cans are most suitable and are used in pound and half-pound sizes. Both fresh and smoked fillets are packed, and it is considered that the employment of the cold vacuum process gives a superior product. Quite possibly, however, further work will demonstrate that it is possible to use the exhaust box method also. Samples of the products have proved acceptable in the markets, and there will apparently be no difficulty in disposing of such increased quantities as means can be found to produce. There is still room, however, for some fundamental work aimed at effecting minor improvements and adjustments of technique. Particularly is it essential to discover the most appropriate methods of keeping fish, over a period of some days, either at sea or in cold storage, in sufficiently good condition for the production of a canned product equivalent in quality to that obtained from the freshly caught fish. In the case of halibut, however, it has been found possible to produce a satisfactory canned article from fish kept in schooners in ice for a week or more. Thus an additional outlet for these halibut, which have hitherto been difficult to dispose of profitably, has been found. The livers of the halibut are also of high value as a source of oil, and a method has been found of preserving these livers until they can be brought in for solvent extraction at the laboratory.

The biological work of the year was based mostly on the usual survey cruises of the s.s. Cape Agulhas, valuable data being also obtained from three commercial fishing voyages carried out in spring. Repetition of observations yearly over a period of at least five years is essential to obtain anything approaching a basic conception of the highly complex hydrographical changes occurring in the Newfoundland area. Through the analysis of samples of water taken from different localities, as also through a study of water temperatures and the nature of the animals occurring in the plankton, it is now clearly proved to be possible to trace the short-term changes occurring from time to time in the intensity of the cold arctic current, which so greatly affects the nature of the fishery. In the course of time the periodicity of the occurrence of the long-term changes can similarly be determined. A four-year period of study has witnessed the marked increase of the current in 1932 and early in 1933, and the subsequent decline. In 1934, therefore, water conditions warmer than usual were experienced in the area of Grand Bank, and, as was anticipated, the best fishery occurred towards the north, in the Bonavista and Fogo region, where naturally colder conditions could be expected to occur. Farther south the fishery was a failure owing to the prevailing warm conditions. Failure also occurred on the south and south-west coasts, but, strangely enough, the chief adverse factor in this instance was the prevalence of water several degrees colder than usual. This originated from the Gulf of St. Lawrence basin, where an extremely cold winter (1933–34) led to the production of a large mass of cold continental water. On Labrador, as elsewhere on the east coast, best fishing results were obtained down towards the north, again chiefly owing to the occurrence of warmer than usual conditions towards the south. Some indication was obtained of the tendency of the arctic current to increase in the late fall. All over, the year provided valuable additional confirmation of the relationship between the catch of fish and the associated water temperatures.

A second factor of importance affects the catches. Independently of the existence or otherwise of suitable water conditions, much depends upon whether or not cod are naturally plentiful, i.e. have been bred in adequate numbers in the years just past. Fortunately, as was stated in a previous report, there are usually present a number of sufficiently plentiful year broods to spell success. Two or three of these prevail over the remainder in relative numbers, and as they increase in age, the average size of cod caught increases. Such an increase was observed steadily from 1931 to 1933. In 1934, however, there was a very distinct falling off of average size of cod, owing to the departure from coastal waters of the oldest fish (a normal occurrence when an age of 9 or 10 years is attained). A fresh batch of younger cod made its first appearance in the catches. It is therefore anticipated that fish of medium rather than of large size will predominate in inshore catches in 1935 ; also that, with the return of cold-water conditions, south-eastern districts will experience much better fisheries than in 1934.

Foreknowledge of both these factors—hydrographic conditions and availability of cod stocks—affords an indication of the probable course of the fishery. It is hoped gradually to introduce a system of regular water temperature reports from a series of points round the coast, so that constant touch with the course of events can be maintained and the more local fishing prospects estimated.

Several thousand codfish were tagged at various points on the banks and around the coast, and up to March 31, 1935, approximately 8% had been reported as being recaptured. As is usual in work of this sort, the great bulk of returns came from points within 25 miles of the place of liberation. Thus cod shoals do not migrate *en masse* from region to region within a space of a year, but remain within a limited radius. However, a few tagged cod carried out definite and rather extensive movements, e.g. from Bay Bulls northerly to Conception and Trinity Bays, and southerly to Pig Bank ; from Port-au-Port (in the fall) to Rose Blanche (in the winter), and from Grady (Labrador) to White Bay. No codfish tagged inshore was recaptured on the banks, or *vice versa*. This work will be extended during 1935 and carried on further until the chief codfish migrations are clearly demonstrated.

With the kind co-operation of the firms exporting frozen salmon, it was, for the fourth successive year, possible to collect biological material from the salmon runs on the east coast ; with the co-operation of the Department of Natural Resources, material was also obtained from the rivers. It is considered that, with the addition of material from the south-west coast, sufficient data will have been accumulated to make a complete classification, in a regional sense, of the salmon stocks. Fairly successful attempts have been made during the last two years to publish general forecasts of the prospects for the salmon fishery. As was anticipated in the report for 1933, the 1934 season commenced a week or two earlier than usual, much improved results were obtained in the south-east (including Trinity Bay and Bonavista Bay), and rather poorer results than usual farther north and on Labrador. When the present cod-tagging experiments are concluded it is desirable to carry out similar extensive work on salmon-tagging.

The usual courses of instruction to fishery officers and to scholarship students were repeated. With the recent establishment of a system of district fishery officerships it should prove possible, for the first time, to obtain really reliable statistics of the fishery, including biological statistics bearing upon the scattered lobster fishery.

The laboratory continued to co-operate in the programme of the North American Council for Fishery Investigation. During the year two new committees were formed, one for the co-ordination of cod and haddock research, the other for initiating a common programme of salmon investigations. The report of the Proceedings of the Council for the triennium 1931–33 will shortly be available.

II. HYDROGRAPHIC AND BIOLOGICAL INVESTIGATIONS

A. HYDROGRAPHIC CONDITIONS IN 1934

By H. Thompson and A. M. Wilson

1. *TEMPERATURE*

No recovery in the degree of influx of arctic water occurred till the latter part of 1934. On the other hand warm Atlantic water spread in a north-easterly direction over Grand Bank, and in the eastern area generally there occurred the warmest water conditions noted during the four year period of study. According to the definition given by French investigators, 1934 would be classed as a "warm" year, since minimum temperatures occurred chiefly at a depth of from 50 to 75 metres, and cold water flooded only the shallower plateaux of the bank. At greater depths the temperature increased again. The following are the observations for the depth of occurrence of minimum temperatures in the years 1932–1934 (depth in metres) :—

	North Grand Bank	South Grand Bank	Laurentian Channel
Spring, 1932 ..	50–150 m.	50–100 m.	100 m.
Spring, 1933 ..	50–125 m.	75 m.	75 m.
Spring, 1934 ..	50–90 m.	50–75 m.	50–75 m.

The level of the occurrence of the coldest temperatures has, therefore, been rising since 1932. It should be noted, however, that in the south-west region conditions were several degrees colder than usual, the area being flooded to a considerable depth with cold continental water, probably the product of the extremely cold winter conditions in the Gulf of St. Lawrence region in the previous winter. This body of water resisted to a large extent the advance of warm Atlantic water, and even flooded the outer Nova Scotian bank area (Sable Island bank, e.g.) in spring.

For comparative purposes there are listed in the following table the approximate mean temperatures derived from an inspection of the isothermic charts published at the end of this report and of the reports for the years 1931–33. Observations in 1931 were, however, incomplete.

Table I

Approximate Mean Temperatures (Degrees centigrade).
Newfoundland Region. 1931–34

1. *SPRING.*

Year	Depth	Labrador	Straits	White Bay	N. Dame Bay	N. Grand Bank	South East	C. St. Mary's	Placentia Bay	S. Grand Bank	South West	West
1932	Surface ..	1½	3½	1½	1½	2½	3½	5	6	6	5½	4
1933	,, ..	2½	½	3	4	3	6	5½	6½	7½	7½	6
1934	,, ..	4	3½	4	6	5	5	2	5½	9	5	7
1932	25 metres ..	0	½	0	½	2½	2½	3	3	4	1	1
1933	25 ,, ..	–1	½	0	1½	1½	1	2½	2½	5	4	3½
1934	25 ,, ..	1½	1½	1	1	3½	3½	0	0	7½	1	5
1932	50 metres ..	–1	–½	–1	–1	0	0	1	½	1	½	–1
1933	50 ,, ..	–1	–½	–1	–1	–½	–1	–½	–½	2½	½	–½
1934	50 ,, ..	½	0	–1	–1	–½	0	–1	0	5½	–½	–½
1932	100 metres ..	–1	–1	–1	–1	–1	–1	–1	–1	0	–1	–1
1933	100 ,, ..	–1	–1	–1	–1	–1	–1	–1	–1	2½	0	–½
1934	100 ,, ..	–1	–1	–1½	–1½	–1	–1½	–1½	–1	6	–½	–1

2. *FALL.*

Year	Depth	Labrador	Straits	White Bay	N. Dame Bay	N. Grand Bank	South East	C. St. Mary's	Placentia Bay	S. Grand Bank	South West	West
1931	Surface ..	6½	9	9½	12	14½	13	14	14½	18	15	13
1932	,, ..	6½	8	11	12½	15	13½	15	17	18½	16½	10
1933	,, ..	5	8	6	10	12½	11½	12	14	16½	16	11
1934	,, ..	7	8½	11	11	13½	12½	14½	14	17½	14½	12½
1931	25 metres ..	..	..	..	..	..	..	..	..	..	..	..
1932	25 ,, ..	5	4½	5	4	5½	3	4	5½	13½	10	9
1933	25 ,, ..	3	5½	3½	3	4	4½	3	8	9½	7½	10
1934	25 ,, ..	5	7½	6	1½	7	6	7½	4½	8½	4	6
1931	50 metres ..	–½	2	–½	..	–½	–½	½	½	..	2	1½
1932	50 ,, ..	–½	0	–½	–1	–½	0	1	2	5	2	7
1933	50 ,, ..	1	½	1½	–½	–½	0	0	½	2	3	1½
1934	50 ,, ..	1	0	–1	–½	–½	1	0	0	4	½	–½
1931	100 metres ..	–1	–½	–1	..	–1	–1	0	–½	..	–½	–½
1932	100 ,, ..	–1	–½	–1	–1	–1	–1	–1	–½	1½	0	–½
1933	100 ,, ..	–1	–½	–1	–1	–½	–1	–1	–1	2	0	–½
1934	100 ,, ..	–1	–1	–1	–1	–1	–1	–1	–1	3	½	–½

There is a considerable variation in relative conditions according to the depth and to the portion of the area considered. On the whole, however, warmest conditions occurred in 1934 (except, as stated, in the south and south-west), and coldest conditions in 1932 and 1933. Conditions in 1933 were colder than in 1932 down to a depth of 50 metres or more—at least in the fall—but warmer at a depth of 100 metres, thus showing at this depth the beginning of the warm Atlantic influx which increased to such a large extent in 1934.

2. *SALINITY.*

The ranges of salinity, determined by inspection of the hydrographic charts, were as listed in Table II.

Table II
Range of Salinity.
Expressed as parts salt per 1,000 parts water.

	Year	Depth	S. Grand Bank	N. Grand Bank	White Bay	Labra-dor	S. West	West
1. *SPRING.*	1934	Surface ..	32–33	32–33	31–32	27–31	31	31–32
	1933	,, ..	32	32	30	28	31–32	30–31
	1932	,, ..	32–33	32–33	32	28–30	31–32	31–32
	1934	25 metres ..	32–33	32–33	32–33	32	32	32
	1933	25 ,, ..	32	32	31–32	32	31–32	31–32
	1932	25 ,, ..	33	33	32–33	31–32	32	31–32
	1934	50 metres ..	33½–34	33	32–33	32	32	32
	1933	50 ,, ..	32	32	31–32	32	31–32	31–32
	1932	50 ,, ..	33–33½	33	32–33	32	32–33	32
	1934	100 metres ..	33½–35	33–33½	33	33	33	33
	1933	100 ,, ..	33–33½	33	32–33	..	32–33	32–33
	1932	100 ,, ..	33–33½	33–33½	33	33	33	33
2. *FALL.*	1934	Surface ..	32	31–32	31	30	31	30
	1933	,, ,, ..	32	31–32	31	31	31	31
	1932	,, ..	32–33	31–32	30	28–29	31–32	30–31
	1931	,, ..	32–33	32	31	30–31	31–32	31
	1934	25 metres ..	32	32	32	31–32	31–32	31–32
	1933	25 ,, ..	32	32	31–32	31–32	32	31
	1932	25 ,, ..	32–33	32	31	30–31	32	31
	1931	25 ,, ..	..	..	..	..	..	..
	1934	50 metres ..	33	33	32–33	32–33	32–33	32–33
	1933	50 ,, ..	33	32–33	32–33	32–33	32	32
	1932	50 ,, ..	33	32–33	32–33	32	32–33	32
	1931	50 ,, ..	..	32–33	32–33	32	32	32
	1934	100 metres ..	33–34	33	33	33	33	33
	1933	100 ,, ..	33–34	33	33	33	33	33
	1932	100 ,, ..	33-34	33	33	33	33	33
	1931	100 ,, ..	..	33	33	33	33	33

An examination of the figures for spring shows that lowest salinities in all areas, with the rarest of exceptions, occurred in 1933. This confirms the evidence from other sources that the fresher water of the arctic current was present in greatest proportion in that year. Highest salinities are mostly shown for the year 1934, in the deeper water layers, and here we have evidence of the increase of Atlantic water in that year. Among the figures for the fall season can be seen lowest salinities for Labrador and White Bay in 1932, indicating increased activity of the arctic current, first to be observed, naturally enough, in the north. This is noticeable both at the surface and at 25 metres' depth. There is also a fainter suggestion of a similar occurrence at Labrador in 1934, and it will be seen later that slight biological evidence also existed to support the suggestion that some increase of the arctic current was once more occurring. Otherwise, throughout the remainder of the area generally, considerable mixing of water laters had occurred by the fall, and salinities showed little variation.

3. *DRIFT BOTTLES.*

Of 395 surface drift bottles liberated during 1934, only 30 were recovered within the year. The percentage of recovered bottles during the last four years has been 5·8, 15·8, 7·8, and 7·6 respectively. Only from the 1932 experiments, therefore, was a good return made, and the poor proportion of returns in 1934, when the arctic current was restricted, lends further support to the suggestion previously advanced, to the effect that only in years of intensified strength of the arctic current are large returns of surface drifters obtained.

The features of the chief courses taken by the drift bottles in previous years may be recapitulated.

In *1931* the arctic current was weak, and no returns came from the east coast. A fair number went ashore on the south-west coast.

In *1932* the arctic current was strong. Large numbers of bottles were carried eastwards into the Atlantic Drift, ultimately reaching various points on the European coast. A strong current also passed westwards through the Straits of Belle Isle, and bottles were carried far to the west along the Quebec coast. A definite continuation of the drift to the Cape Breton coast was also clearly indicated.

In *1933* the arctic current diminished in intensity in the fall, the portion passing to the west through the Straits retaining greatest volume, and carrying drift bottles well along the Quebec coast. Magdalen Islands, and in one instance in the following spring, Sable Island Bank, were reached—the latter record being of interest in connection with the cold water found to prevail on that bank in the spring of 1934. The branch of the arctic current traversing the eastern Newfoundland area was, however, weak. No bottles were recovered in the bays of the south-east, but five (as compared with eight in the previous year) crossed the Atlantic. There was a comparatively strong counter-flow of warm Atlantic water up the west Newfoundland coast.

In *1934* there was little evidence of a strong arctic influx through the Straits, only local returns being obtained. (Warmer conditions may, therefore, be anticipated in the south-western Newfoundland area and on the Nova Scotian Banks in 1935). The bulk of the returns, as in 1931, came from the south-west coast, where (Chart 9) the advance of warm Atlantic water appears to have been held up by the mass of cold water formed during the cold winter (1933–34) in the Gulf of St. Lawrence. A system of eddies appears to have resulted off the south-west coast, leading to the ultimate stranding of these drift bottles as the cold water was forced onshore. Only one bottle was carried down the east coast and recovered in the south-east. There is thus little or no evidence of a strong southerly drift of arctic water on the east coast. Of the strength of the branch of the current splitting off at the latitude of North Grand Bank, and carrying bottles in an easterly direction into the Atlantic Drift, no evidence will be obtained until returns (if any) are received from European sources in 1935.

The results of this series of drift-bottle experiments are thus proving of great value, varying as they do from year to year. They afford definite additional evidence that the arctic current attained its greatest volume, within the period of study, in 1932, and began to diminish in force in 1933; whilst as a natural result the accumulation of arctic water was greatest in 1933.

From hydrographic and plankton investigations made in the previous fall it may prove to be possible to form a fairly accurate anticipation of the amount of arctic ice to be expected in any year to invade the area. Within the period covered by these studies, the greatest amount of ice occurred on the east coast early in 1933, at the culmination of the period of the strong influx of arctic water. There was much less ice in 1934 and 1935.

Charts 1–8 (at the end of this report) continue the yearly series depicting isothermic and isohaline conditions at various depths; while chart 9 shows the chief movements of surface drift bottles.

B. THE PLANKTON IN 1934

By H. Thompson and N. Frost

It was shown that, after a period of scarcity prior to the marked increase in the influx of arctic water in 1932–33, the volume of microscopic plants and animals (micro-plankton) increased to a maximum in the spring of 1933, and appeared to be severely on the decrease by the fall of that year. Since no momentum was gained by the arctic current during the greater part of 1934, and since, indeed, this current appears to have fallen away to a minimum, it is not surprising to find that the volume of plankton still further diminished. The following table shows the average volumes, in cubic centimetres, which could be centrifuged from the hauls of plankton made by the standard Hjort net hauled from a depth of 100 metres to the surface in the various portions of the Newfoundland area :—

Year	1931	1932	1933	1934
Spring ..	–	7·3	*24·1*	6·6
Fall ..	3·0	*7·8*	*7·8*	3·8

These volumes exhibit a remarkably regular increase, followed by a regular decrease, in absolute agreement with the contemporaneous increase and decrease of the intensity of the arctic current. This correlation goes far to justify the method of estimation employed, and to encourage the belief that large flunctuations in the available amount of plankton are capable of being detected by its use.

From the discussion on the hydrographic conditions of 1934 it is certain that Atlantic water influence predominated in the eastern area more than at any other time during the four-year period of study. In fact, it is probable that these influences were at their peak during the latter part of the year, and that a return to colder conditions will first be in clear evidence during 1935. Thus in the fall of 1934 there was some indication if the increased occurrence of arctic water organisms in the Labrador and White Bay areas, and this increase can be expected to continue and extend farther south in 1935. For example, in the case of *Oikopleura vanhöffeni*, an organism never found except in water of arctic source, greatest numbers occurred in spring, 1933, but in the fall of that year a decrease set in, and this continued in spring, 1934. In the fall, however, there was a distinct tendency for an increase to occur. This increase was, however, confined to the Labrador and White Bay areas in the north. The other three species of *Copelata* (used in previous reports as indicators of arctic water mixed in varying degrees with warmer water) all showed a marked decrease in numbers. It is evident that such mixed water conditions were not prevalent on the banks as they were in 1933 and 1932. For the *Copelata* the following are the average numbers taken during the last four years in standardised hauls with the Hjort net from a depth of 100 metres to the surface :—

	O. vanhöffeni.	*Fritillaria.*	*O. labradoriensis.*	*O. dioica.*	Total.
Spring, 1932	635	2,908	721	0	4,264
1933	*1,342*	*3,207*	*888*	0	*5,437*
1934	290	2,873	327	0	3,490
Fall 1931	27	850	101	*526*	1,504
1932	*124*	*1,550*	152	214	*2,040*
1933	26	879	*194*	*416*	1,515
1934	*101*	233	70	96	500

From the total figures it can be concluded with a fair degree of certainty that this group reached maximum development in the fall of 1932 and the spring of 1933, and had dwindled to what appears likely to be a minimum in the fall of 1934. This is in strict accordance with the period of increase and decrease of the influx of arctic water.

It was stated in the report for 1933 that an analysis of the distribution of any other group in the plankton would probably yield information

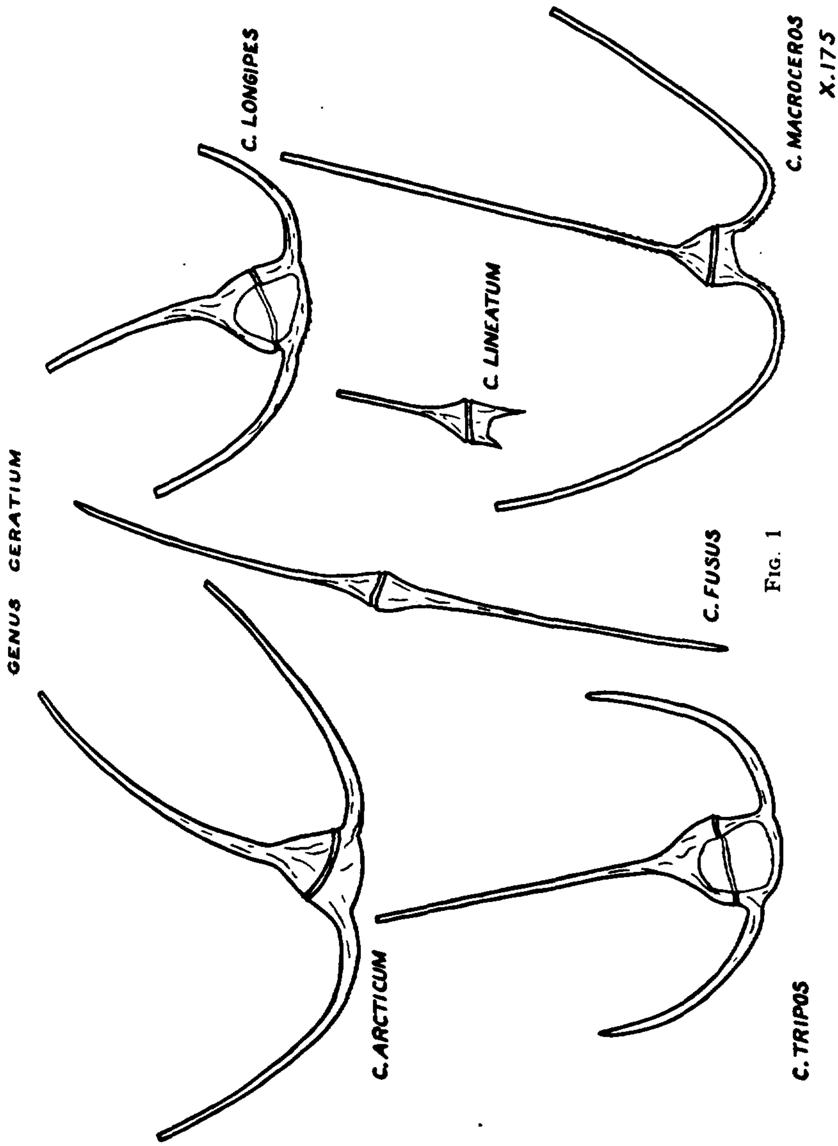


Fig. 1

leading to the same conclusions as those derived from a study of the Copelata group. Such an analysis has been made of the very important *Ceratium* group. This group consists of microscopic but very prolific organisms, forming a large part of what may be called the "pasture" or elementary foodstuff in the sea. In all, six species of *Ceratium* have been found in the Newfoundland area. These form a perfect series if one takes as criterion their tolerance or intolerance of cold (usually arctic) and warm (usually Atlantic) water conditions respectively. In order of decreasing tolerance of cold conditions the species can be arranged thus :—

1. *Ceratium arcticum.*—Found in cold water and, therefore, most widely distributed and most plentiful in 1932. Then numbers diminished and distribution became more and more restricted to the north during 1933 and 1934.
2. *Ceratium longipes.*—Found in mixed water. Most poorly represented in 1932, when it occurred in quantity only in the abundant mixed water of that year on Grand Bank. Gradual improvement to a maximum in 1934, influenced by the interplay of relatively cold and warm conditions in the Gulf of St. Lawrence.
3. *Ceratium fusus.*—Also a mixed-water species, with a bias towards warmer conditions. Distribution most restricted in 1932, but extending northwards gradually as conditions became warmer in 1933 and 1934. In the fall of 1934, however, there were signs of restriction in numbers and range in the north. (This agrees with the increasing occurrence of the arctic species *O. vanhöffeni.*)

4, 5, and 6. *Ceratium tripos, Ceratium macroceros, Ceratium lineatum.*—These species, in the order named, were more and more sparingly found in spring, although *C. tripos* increased its range of distribution in a northerly direction to north Grand Bank in 1934. In the cold fall season of 1932 *C. lineatum* did not occur at all ; in the fall of 1933 all these species spread northward to south Grand Bank ; and in the fall of 1934 to North Grand Bank and even, in one instance, to Notre Dame Bay.

Since the Newfoundland area is one in which cold water predominates, it is interesting to note that, if frequency of occurrence (density of population) be selected as criterion, the species also arrange themselves in the above order, *C. arcticum* being found in greatest numbers, and *C. lineatum* being rare (completely absent in the colder years 1931–32 ; attaining maximum numbers in a warm year such as 1934). In the period of 1931–34 *C. arcticum* attained maximum development in the cold season of 1932, to be increasingly displaced owing to the increase of warmer conditions in 1933 and 1934 by *C. longipes* and *C. fusus*, which favour mixed water conditions, and ultimately by *C. tripos, C. macroceros*, and *C. lineatum*, which develop best in warm Atlantic water conditions. The first two species occur commonly both in the spring and fall seasons, *C. fusus* chiefly in the fall, and the remaining species almost entirely in the fall. It is obvious that warmest conditions in the area generally are typified in 1934, with the possible exception of Labrador, where signs of the resumption of colder conditions can be detected in the fall of that year.

As further evidence of the unusual northerly occurrence of warm water conditions in 1934 there may be cited from the plankton analysis:—

1. The occurrence of *Sagitta serratodentata* in spring. This species of arrow-worm has, in previous reports, only been noted as occurring in the fall.
2. The copious distribution of caplin and cod fry, and of cod and flat-fish (long rough dab) eggs along the Labrador coast. By comparison we find that in 1932, a cold season, these constituents of the plankton were absent from the Labrador coast, and occurred in the rather more temperate waters south of the Straits of Belle Isle. (Caplin, in addition to spawning rather farther to the north than usual in 1934, also spawned in deeper water than is usually occupied on the south-east coast. The explanation of these facts lies in the necessity of carrying out the spawning process in comparatively cold water, not to be found except in deeper water than usual.)

C. RELATIONSHIP BETWEEN CATCH OF COD AND WATER TEMPERATURE

By H. Thompson

1 *ON THE FISHING BANKS*

Three commercial fishing cruises—in March, April, and May respectively —were undertaken by the research trawler, s.s. Cape Agulhas. The average catch on each trip was around 1,650 quintals (1 quintal = approx. 500 lbs. of cod, round, as taken from the water). This is a satisfactory and remunerative catch.

Following his usual custom on the first voyage, the skipper set a course for Sable Island Bank, which can usually be relied upon to provide at least a saving catch. Thus in 1933 he obtained a satisfactory yield there during the first trip and part of the second—until, indeed, the water temperature rose above 3°C., when he found it necessary to change over to Grand Bank. In 1934, however, Sable Island Bank was unproductive of codfish. Although the Labrador current was very much reduced in volume, and most of the southern Grand Bank area was covered by water of a temperature greater than at any time during the last four years, the Sable Island area was flooded by cold continental water (zero temperature), probably from the Gulf of St. Lawrence, where a very cold winter had been experienced. As a result the temperature of the water from surface to bottom (40 fathoms) was zero. Approximately 12 hauls averaged but 3 quintals of large cod per haul. (In the spring of 1933, when the temperature ranged almost entirely between 2° and 3°, the average of 54 hauls was 7½ quintals.) The skipper, therefore, proceeded to Grand Bank, where he had no difficulty in securing all the fish required.

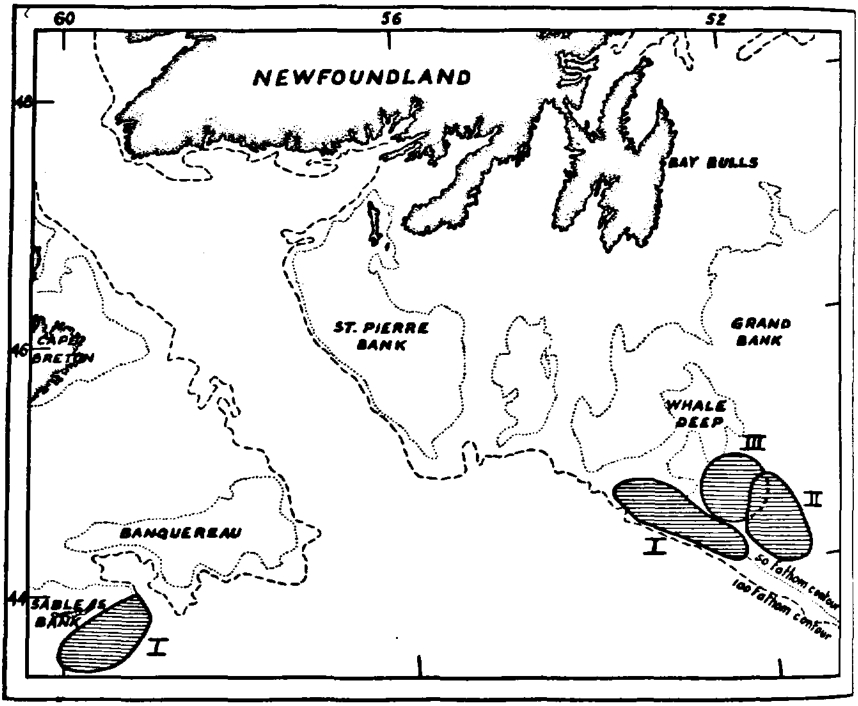


FIG. 2

Trawling Grounds, s.s. "Cape Agulhas," Voyages I, II, and III, 1934.

The positions occupied are shown in Fig. 2. The average temperatures at the bottom during these trips were 5·7°, 4·8°, and 2·5°C. respectively, so that, although the season was advancing trip by trip, fishing was designedly conducted in colder and colder water, since it was found that, although small cod were abundant at the higher temperatures, large cod were only to be found in colder water. The latter did not occur on the southern ledge of the bank, where the depth is over 50 fathoms. The following table shows, in quintals, the average results of the hauls made, as well as the water temperatures at the bottom :—

Temperature (°C.).	*Voyage* I.	*Voyage* II.	*Voyage* III.
$-\frac{1}{2}$° to $\frac{1}{2}$°			**6** (3)
$\frac{1}{2}$° to 1°			**13** (15)
1° to 2°		**12** (16)	**16** (27)
2° to 3°	**2** (4)	**12** (4)	**18** (9)
3° to 4°		**16** (15)	**15** (13)
4° to 5°	**12** (20)	**6** (28)	**16** (10)
5° to 6°	**22** (13)	**5** (37)	**19** (13)
6° to 7°	**21** (16)	**16** (10)	
7° to 8°	**4** (8)		
8° to 9$\frac{1}{2}$°		**7** (1)	
Temperature Avr.	5·7°	4·8°	2·5°

The figures within brackets represent the number of hauls, each of approximately 2 hours' duration (inclusive of shooting and hauling the gear). It may be mentioned that during similar work in 1933 best results were obtained in water whose temperature varied between 1° and 2$\frac{1}{2}$°C. Where the temperature exceeded 3$\frac{1}{2}$°C. results were poor. The 1934 results clearly indicate the conscious quest for low temperarures, since the skipper found that at these only did he secure large cod. He states that, through the guidance of the readings of the thermometer, he was able repeatedly to alter the course of his vessel so as to keep in touch with the shoals of larger cod. (More modern trawlers, equipped with the sonic sounding gear, can, once the depth at which the fish lie is discovered, obtain a similar result by maintaining their position over water of that depth ; for, since the depth of water largely determines the temperature, they will automatically be fishing in water of approximately uniform temperature.)

One feature, new to these experiments in Newfoundland waters, emerged during the voyages. It is obvious from the results, particularly those of the first voyage, that large catches of small and medium-sized cod can, in years when the latter are plentiful, be secured in spring at temperatures between 3° and 7°C. The fisherman can to a large extent avoid catching too great a proportion of these small cod by seeking water of lower temperature (i.e. on Grand Bank, by shifting his location farther to the north-east). This was actually done by the skipper of the research trawler during his second voyage, with the result that he raised the size of the bulk of his catch from a range of 53 to 70 centimetres (voyage 1) to a range of 66 to 80 centimetres (voyage 2). This appears to apply only to the months of March and April, which are, according to our observations, spent by the cod in feeding rather than spawning activities. In May there is apparently a considerable departure of the larger cod for other grounds for spawning purposes. Although it is still advisable to fish in water of a low range of temperature if large cod are to be taken, fewer of the latter are then available. This feature is probably more in evidence in a year such as 1934, when water of temperature much higher than normal tended to flood the area early in the season, and the sizes of the bulk of the cod caught during the third voyage dropped back to between 50 and 70 centimetres. In the 1933 season, however, large cod remained on these grounds until early in June, and this is very probably the normal occurrence.

A clear idea of the variation in the sizes of the cod obtained during the three 1934 voyages can be obtained from the inspection of Fig. 3.

2. *INSHORE*

It will be apparent from the following figures that there is great variation in the catches taken year by year in the inshore cod-traps so commonly used in Newfoundland. Operating four large traps, the leading Bay Bulls fishery concern took, in the course of 2¾ months in the summer of each year :—

	(a) Quintals	(b) % Extra Small	(c) % Large &Medium	(d) % Large in (c)	Mean Temperature (centigrade) at 25 metres depth) June	July	August
1931	1,097	10	11	30	..	..	..
1932	2,020	5	49	60	3·5	1·5	2·0
1933	2,974	2	35	70	1·3	2·3	4·7
1934	473	60	8	15	4·6	6·5	6·2

(b), (c), and (d) are near estimates only.

These figures are of extraordinary interest. In the first place they show that in the best of the four years, 1933, six and one-third times as many cod were captured as in the poorest year, 1934. Secondly, fishing was best during 1932 and 1933, when arctic water was most plentiful, and poorest in 1934, when it was scarce. Indeed, in the latter year, practically nothing but small codfish were taken, as is evident from the figures given in columns (b) and (c) above. Hook and line fishermen reported better results, and more medium-sized cod, from depths of 55 metres and more, where, of course, colder water occurred. In 1932 and 1933, when arctic water was more abundant, there was a much improved proportion of medium and large cod, with, of course, a marked falling off in the proportion of small fish. It is obvious that, although the traps can take enormous catches of cod in favourable years, the prosecution of the fishery by the line method at the most favourable depth each year will yield more consistent results—as in 1934, when, although the trap fishery was a failure on the south-east coast, line fishermen achieved quite satisfactory results.

Fig. 3 illustrates the great variation in the sizes of cod caught at Bay Bulls during the period 1931–34. The points where the cumulative

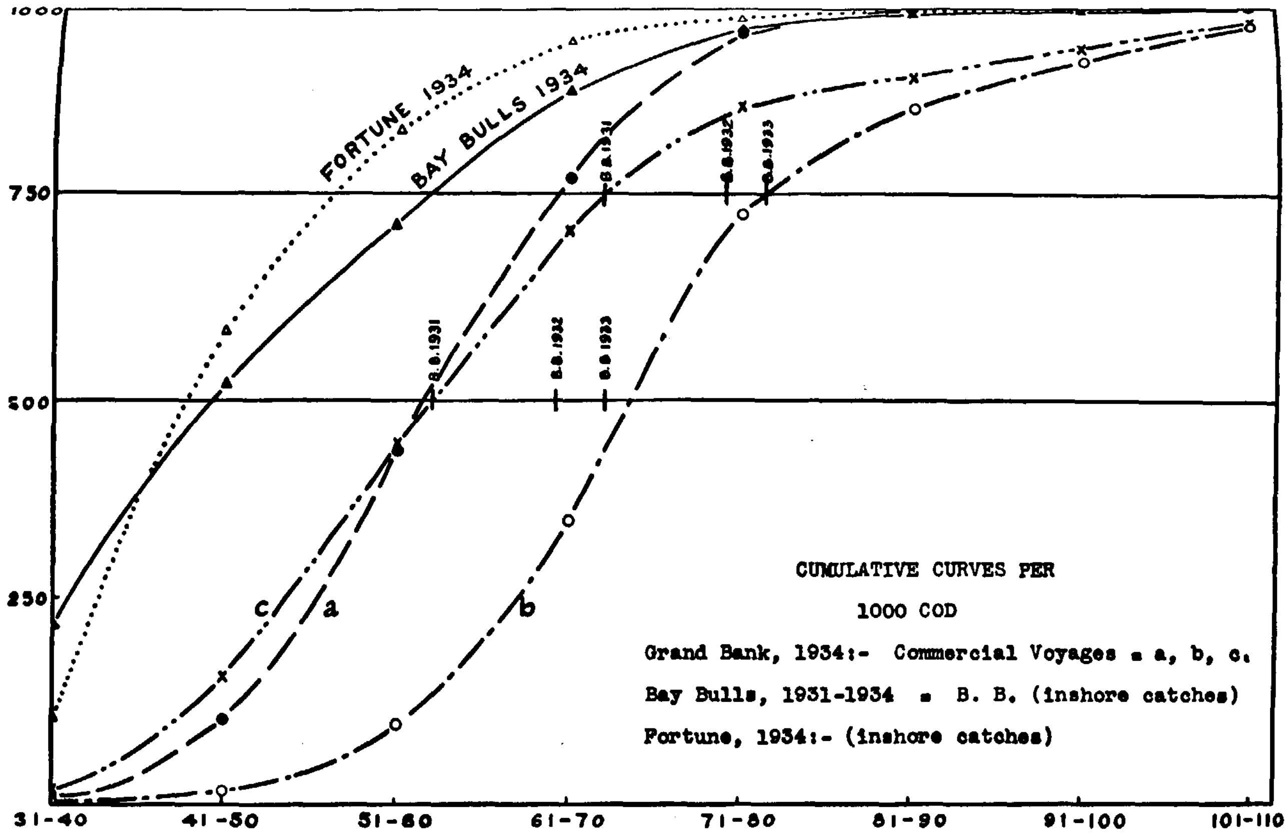


FIG. 3.—Size Groups in Centimetres.

curves per 1,000 fish cut the 50% and 75% lines are shown for 1931, 1932, and 1933, and a progressive increase in size is demonstrated during these years. The entire curve for 1934 is shown, and the striking drop in fish size is obvious. This fall can, as argued above, be explained partly by the high average temperature of the water ; but it was also probably part due to the departure of the large and old cod of the prominent 1924 brood from the inshore area. This latter event was anticipated in the report for the year 1933, and, as will be shown below, the year 1934 witnessed the appearance in quantity in both bank and inshore catches, of the numerically strong young year classes resulting from the 1928 and 1929 spawning seasons. That the appearance of cod of small size was not confined to the south-east coast is shown by the cumulative curve for a representative sample of fish measured at Fortune, on the south-west coast. Unfortunately, no measurements were taken on the mid-east coast, but there is evidence that there somewhat larger sizes occurred. In the Fogo region, for example, where, owing to the more northerly situation, quite normally cold water temperatures prevailed, the fishery was reported as being three times as productive as in the previous year. It is clearly proved elsewhere in this report that large cod yield liver oils of a higher Vitamin A potency than that of oils rendered from the livers of small cod. The following are the average potencies of oils from different regions in 1934 :—

1. *South-east Shore.*	Trap Fishery.	175 samples, Vit. A avr. 11·2 Blue Units.
	Line Fishery. (Caplin bait.)	82 samples, Vit. A avr. 18·2 Blue Units.
	Line Fishery. (Squid Bait.)	124 samples, Vit. A avr. 16·4 Blue Units.
2. *Bay de Verde.*	Trap Fishery.	186 samples, Vit. A avr. 12·0 Blue Units.
	Line Fishery. (Caplin bait.)	127 samples, Vit. A avr. 16·6 Blue Units.
	Line Fishery. (Squid bait.)	49 samples, Vit. A avr. 14·0 Blue Units.
3. *Fogo* (*mid-east*).	Trap Fishery.	49 samples, Vit. A avr. 16·0 Blue Units.
	Line Fishery (Caplin bait.)	3 samples, Vit. A avr. 16·6 Blue Units.
	Line Fishery. (Squid bait.)	Insignificant yield. No data.

In all, 795 barrels (= approx. 20,000 gallons) of oil were tested to obtain these figures, which are, therefore, representative. It will be observed that in all three districts the line (so-called "trawl") fishery yielded oils of higher value than did the trap fishery. This is to be expected, since it is conducted in water of considerably greater depth and lower temperature, hence larger cod on the whole are caught. There is also an increase in the direction of 1 to 3, or from south to north, in the value from the trap fishery—so much so that at Fogo, where suitably cold water prevailed both at the upper and lower depth levels, there is little difference between the results from trap to trawl fishery. The latter part of the trawl or line fishery, conducted with squid instead of caplin bait, gives somewhat lower values, a not unexpected result, since large fish are most likely to run earlier in the year before the temperature of the water rises sharply.

The significance to the trade of correlations such as these is obvious, since the oils from the different classes of fishery can be either segregated, or blended to an average vitamin potency, according to marketing considerations.

Reference is made in the following section to the results of the inshore fishery on other sections of the coast. The main picture of events is obtained by taking into consideration the fact that off the whole eastern area warmer water than usual prevailed, and that the south-west coast and the Gulf of St. Lawrence experienced colder water conditions than usual, this being due chiefly to the excessively cold atmospheric conditions prevailing in the St. Lawrence area during the previous winter. The resulting cold water masses of continental origin have already been shown to have affected the Sable Island bank area early in the season; they also affected the whole south-western Newfoundland area, where ice was very prevalent (although there was practically no ice on the south-east coast). On the south-west coast the temperature at a depth of 25 metres was in the fall season three of four degrees centigrade colder than in the previous year (range 1·7° to 6°, as compared with 6° to 10·5° in 1933), and too low for the occurrence of cod in quantity in this particular region. The fishery was a failure with both trap and trawl. In the region of the Straits of Belle Isle warm and cold conditions were fairly well balanced, and a good fishery occurred early in the season. On the Labrador coast the warmer easterly conditions had a slight superficial influence—sufficient to cause the best fishery to be obtained well to the north, where it is reported that excessively large number of cod occurred. The run was also earlier than usual, interfering to some extent with the salmon fishery, which normally precedes that for cod.

3. *IN THE NEWFOUNDLAND AREA GENERALLY*

In Vol. II, No. 1 of the Reports (p. 79), it was shown that it is possible to distinguish several groups of cod in the Newfoundland area. Each of these is largely restricted to its own natural area, at least in the early years of life, and is "acclimatised" to the prevailing physical conditions. Thus it was shown how the Gulf of St. Lawrence cod are to be taken by trap in maximum numbers from water 6° to 12°C. in temperature, whilst Grand Bank cod are normally most plentiful in water of 0° to 5½°.

Bank Fishery. Various estimates place this at from 142,000 to 150,000 quintals, or fully 30% more in than 1933. The amount of fishing effort was greater than in the previous year, but not sufficiently so to account for most of this increase. From the results of the "Cape Agulhas" voyage it is obvious that the unusually warm water conditions on the southern portion of Grand Bank drove the cod to seek cooler conditions in a north-easterly direction, so that they would become chiefly distributed on the shallower and rougher portions of the bank, frequented by the banking schooners.

Labrador Shore Fishery. As might be anticipated from a study of the prevailing (warmer than normal) conditions, this fishery was excellent farther down to the north (Hopedale to Grady), fair south of this in the section to Battle Harbour, and poor still farther south in the region of the Straits (Battle Harbour to Bonne Esperance). A glance at Chart 6 shows that, e.g. at 25 metres' depth, water of 8–9°C. would form a barrier to the southerly movement of any large number of Labrador cod, which occur only in colder water.

Straits. On the east side of the Straits, however (C. Bauld to Flower's Cove), the trap fishery was the best for many years. This is in accordance with the prevailing warm conditions (e.g. 8–9° at 25 metres' depth). It has been previously stated that comparatively high temperatures are necessary for large catches on the Gulf type of codfish in traps. By August, however, the water had become too warm (12°C.) for further large catches to be made.

East Coast (*a*). In the C. Bauld to C. St. John sector the fishery failed, the water temperature in the upper layers being 6–11°, compared with 3½–6° in 1933. The former range is too high for the abundant occurrence of the mixed class of codfish usually taken in this region.

(*b*) *In Notre Dame Bay,* however, there was a fair fishery. Here and south of here suitably cold conditions existed. The temperature was around 2° at 25 metres' depth in the fall.

(*c*) *Fogo and Wadham Island District.* Here the best inshore fishery occurred. It was reported to be 200% better than in the previous year. An excellent fishery was also obtained in the region of

(*d*) *Bonavista Bay* and south thereof to about Ireland's Eye on the north side of Trinity Bay. A glance at Chart 6 (the chart of isotherms at a depth of 25 metres) shows that in regions (c) and (d) the temperature was 2° or 3°, hence suitably low for large catches of cod.

(*e*) *Trinity Bay to C. Race.* The same chart shows that the warm isotherms (8°–9°) ran west from Grand Bank to near Ireland's Eye in Trinity Bay, and that the whole section of the east coast to the south of this point was inundated with this warm type of water. The trap fishery was a failure, as has been shown in detail for the Bay Bulls district. Down in deeper and colder water fish were, however, to be caught freely by hook and line.

(*f*) *South and South-west Coasts.* This section was exceptional, in a year of warm water prevalence, in being flooded by cold water from the Gulf of St. Lawrence, where extremely cold conditions prevailed in the preceding winter. The inshore fishery was a failure. Hook and line men obtained some results by fishing in deep water several miles off the coast. For the most part temperatures were about 3°C. below normal. The extreme east (Cape St. Mary's) had the peculiar experience of having water conditions several degrees colder than usual in spring, and several degrees warmer than usual in the fall, when the bank conditions already referred to prevailed over the cold western conditions.

(*g*) *West Coast.* The 8° isotherm already referred to in connection with Straits' fishery is shown in Chart 6 to embrace most of the west coast. A fair fishery resulted, this temperature being within the rather high range at which Gulf codfish are found in quantity.

These correlations amply prove that the whole course of the inshore fishery is profoundly affected by water-temperature conditions. Seldom, if ever, are the latter the same for two consecutive seasons. A rise or fall of two, three, or four degrees from the normal is sufficient to cause scarcity of fish. By this it is not implied that no fish will be caught, but that the volume of catch required to make a short seasonal fishery pay will not be obtained. The range of temperature at which very large catches occur is a very narrow one for each region—usually no more than from two to three degrees centigrade. A rise or fall of from two to three degrees from normal, whether in east or west, is now proved to be disastrous to the fishing results—although, fortunately, there are always sections of the coast experiencing normal conditions and good catches.

D. DISTRIBUTION OF THE AGE-CLASSES OF COD IN 1934

During the season age-assessment from scale samples was made on 2,609 cod from Bay Bulls, 2,160 cod from southern Grand Bank, 878 cod from Fortune, and on lesser numbers in various other regions. The following table shows how the age-classes were represented. Comparative figures are calculated per 1,000 cod examined :—

Season :	1931	Bay Bulls 1932	1933	1934	Grand Bank 1934	Fortune 1934
Born 1932	–	–	–	–	6	1
,, 1931	–	–	–	22	17	31
,, 1930	–	–	4	173	24	117
,, 1929	–	18	51	279	149	416
,, 1928	124	117	110	241	217	202
,, 1927	185	195	173	170	315	129
,, 1926	102	90	137	50	121	64
,, 1925	120	125	174	27	46	31
,, 1924	277	235	223	24	40	6
,, 1923	122	135	67	5	28	4
,, 1922 or earlier	70	115	61	0	19	1

As was anticipated in the report for 1933, the predominant 1924 year class ceased to be taken in large numbers. The 1927 class, also predominant in recent years, was most prominent in Grand Bank catches, but not so inshore, where the high water temperature conditions would tend to favour the occurrence of still younger cod. Among these there appeared, for the first time as a predominant brood, the year class originating in 1929. This occurred both at Bay Bulls and Fortune. The 1928 brood was also well represented. On Labrador the 1926 year class was captured in the greatest numbers.

The Outlook for 1935.

It is obvious from the above discussion on the bank and inshore codfish caught in 1934 that new age-classes are, for the first time since 1931, having a marked effect on the average size of fish caught. To some—or even a large—extent warm water conditions may have accentuated their numerical significance. As colder water conditions appear to be supervening, the 1927 year class will probably appear again in the trap catches during 1935, and a higher average size of cod should be caught. Since, also, young fish are at the present time abundant, both on the banks and inshore, and since the plentiful 1927 year class should, on the banks and in deep water, provide large numbers in the higher size-range of medium cod, the prospects are for :—

On Southern Grand Bank. Good catches of medium-sized and of small cod (the greater number from 24 to 34 inches in length).

Inshore. Small and medium-sized cod (mostly 18 to 34 inches in length) predominating. Best trap fishing on the south-east coast and southerly on Labrador. Improved catches should occur on the south-west coast, where the very cold conditions of 1934 are not expected to recur.

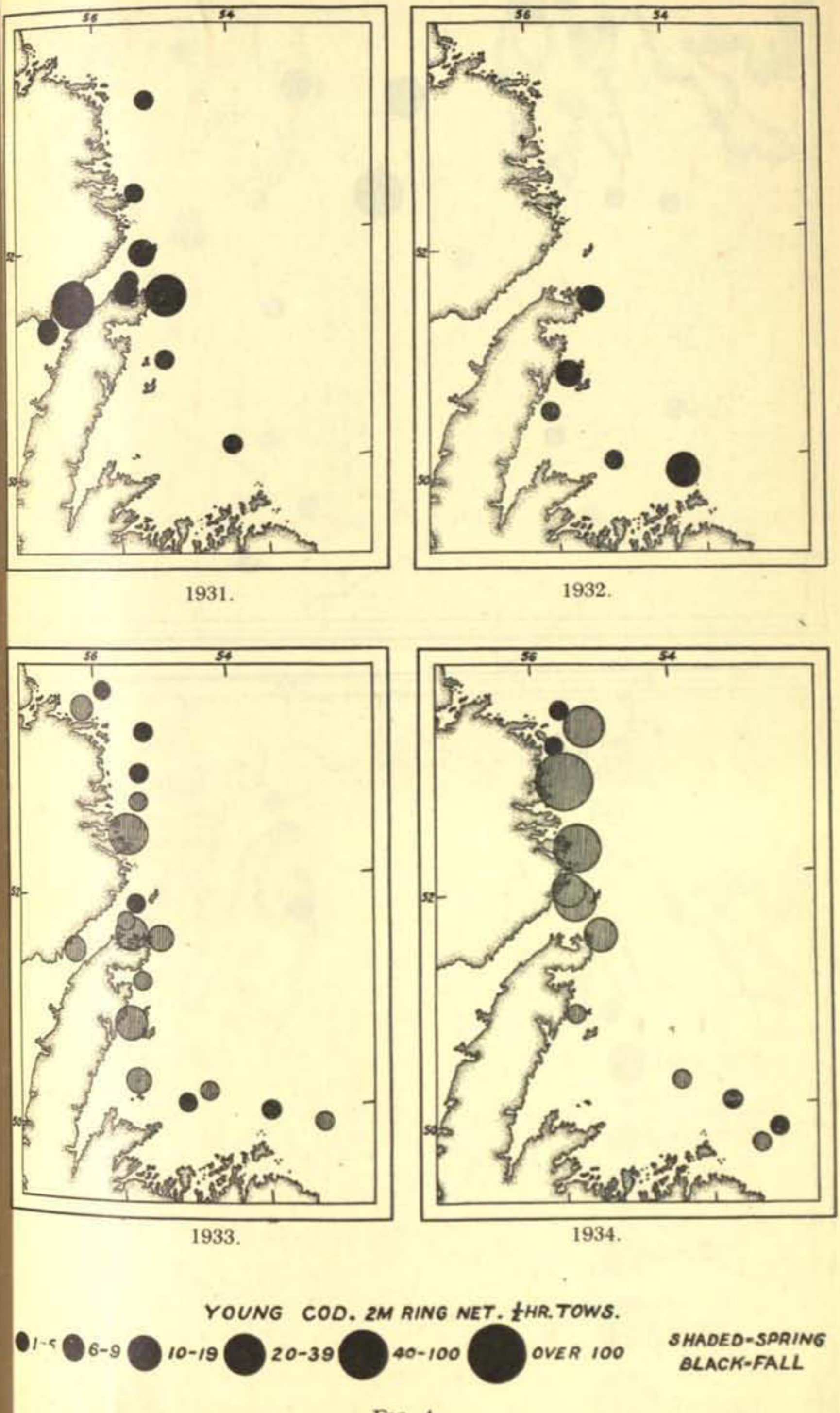

56
54
52
50
1931.
1932.
1933.
1934.
YOUNG COD. 2M RING NET. ½ HR. TOWS.
1-5
6-9
10-19
20-39
40-100
OVER 100
SHADED-SPRING
BLACK-FALL

FIG. 4

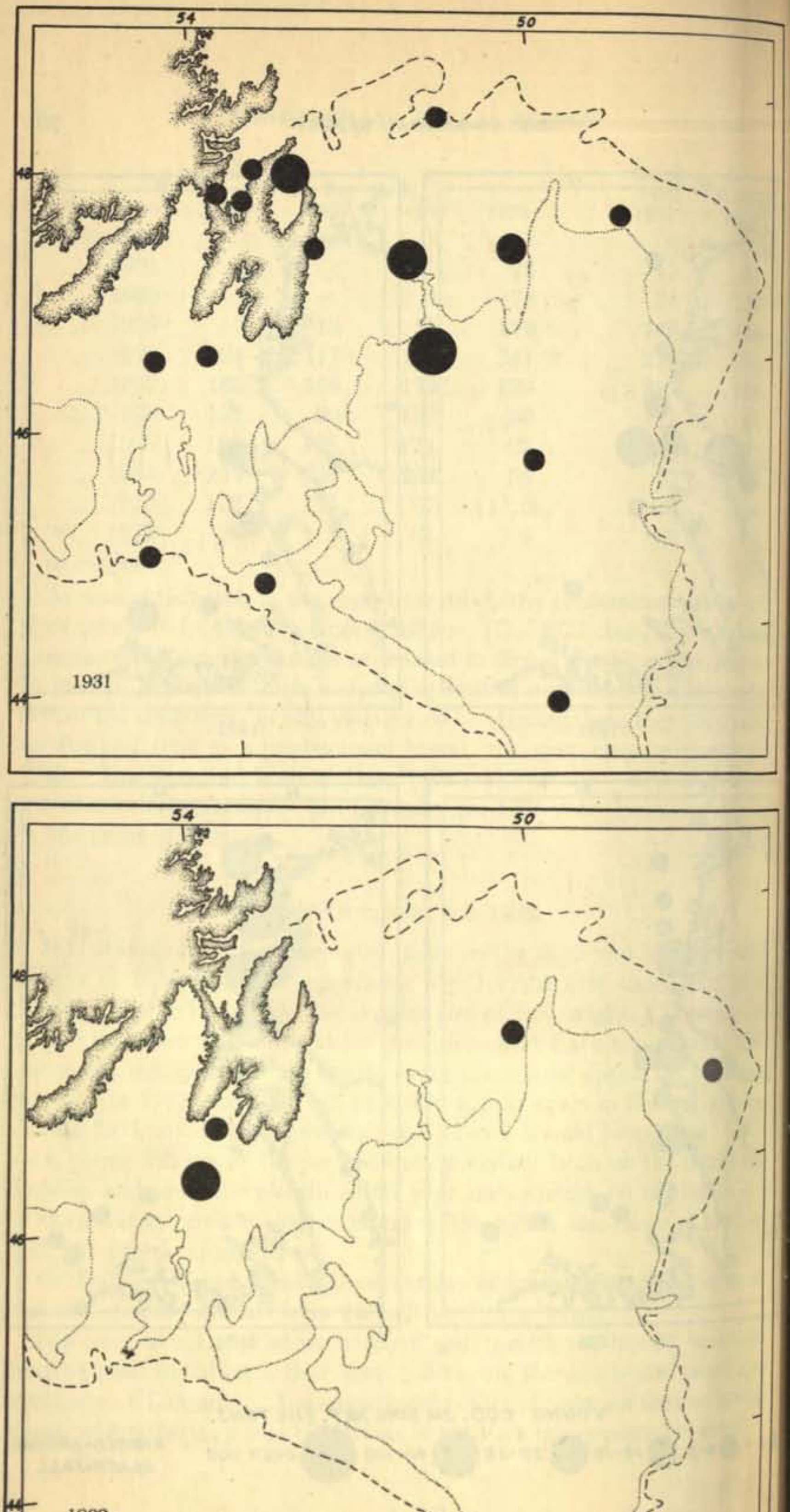


Fig. 5—(I)

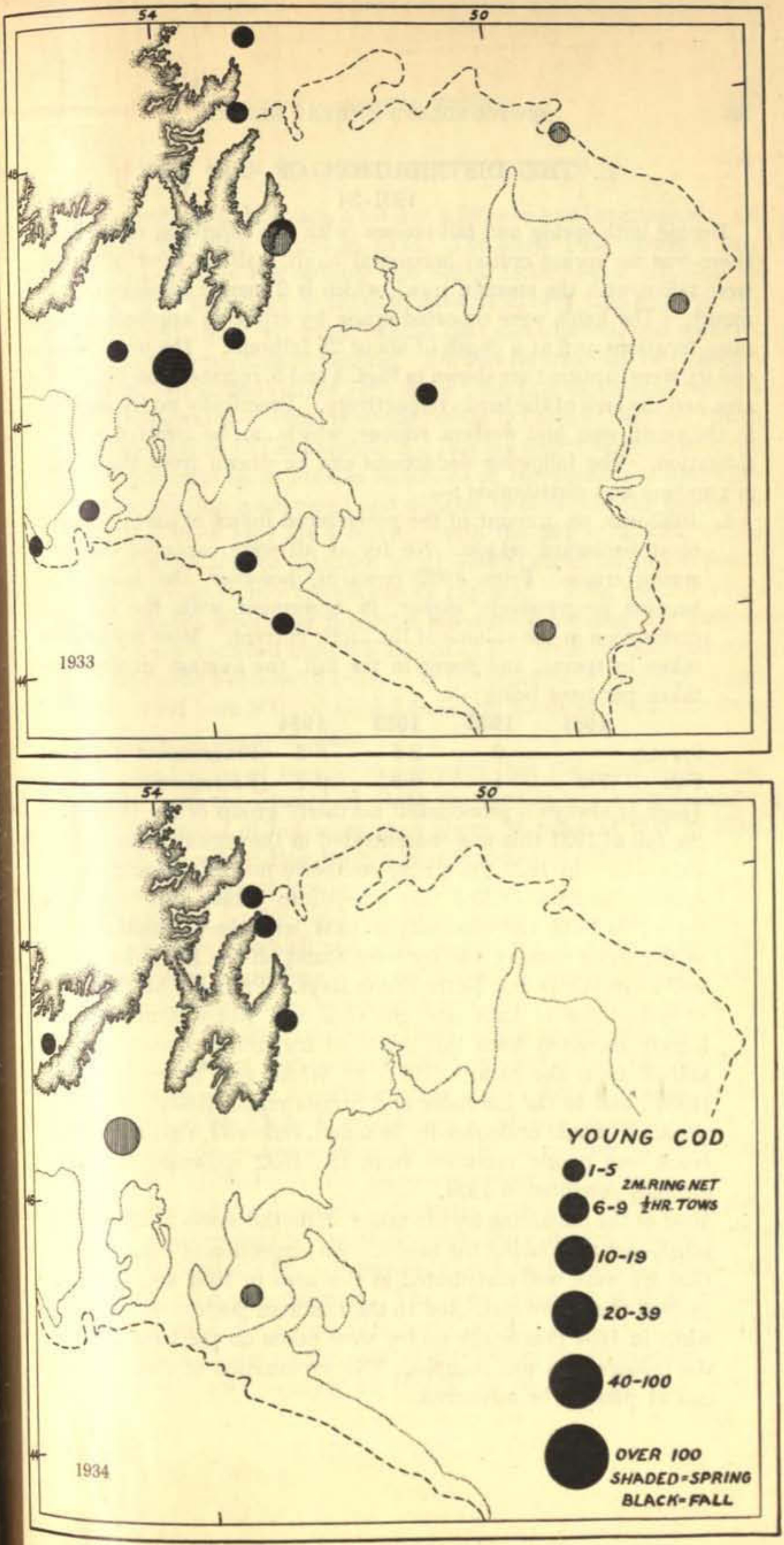

54
50
1933
54
50
1934
YOUNG COD
1-5
2M. RING NET
6-9
½ HR. TOWS
10-19
20-39
40-100
OVER 100
SHADED=SPRING
BLACK=FALL

FIG. 5—(II)

E. THE DISTRIBUTION OF COD FRY 1931–34

During both spring and fall cruises (with the exception of 1931, when there was no spring cruise) horizontal hauls, half an hour in duration, were taken with the stramin trawl, which is 2 metres in diameter at the mouth. The hauls were repeated cruise by cruise in approximately the same locations and at a depth of about 25 fathoms. The areas in which cod fry were captured are shown in Figs. 4 and 5, representing the northern area and the area of the banks respectively. Practically no fry were taken in the south-west and western regions, which can be omitted from consideration. The following deductions can be drawn from the variation in numbers and distribution :—

1. 1932 was, on account of the pronounced influx of arctic water, the most backward season. No fry at all were captured during the spring cruise. From 1932 onwards, however, the seasons have become progressively earlier, in agreement with the concurrent diminution in the volume of the arctic current. More fry have been taken in spring, and fewer in the fall, the average number of fry taken per haul being :—

	1931	**1932**	**1933**	**1934**	
Spring	—	0	2·5	5·2	(Progressive increase).
Fall	7·8	1	0·8	0·2	(Retrogressive decrease).

2. There is always a pronounced northerly group of fry (Fig. 4). In the fall of 1931 this was concentrated in the region of the Straits of Belle Isle ; in 1932 the strong southerly flow of the arctic current appears to have drifted this group into White and Notre Dame Bays ; in 1933, and especially in 1934, with the diminution of force of the arctic current, the fry were found off the Labrador coast, as well as in White and Notre Dame Bays. Probably all three stocks of cod—those of Labrador, the Gulf and Notre Dame Bay—are largely recruited from this group of fry, the centre of which has shifted from the Straits (1931) to White and Notre Dame Bays (1932), and to the Labrador and Straits region (1934). From these results it should undoubtedly be found, *inter alia*, that the Labrador stock was poorly recruited from the 1932 spawning season, and strongly recruited in 1934.
3. Most of the remaining fry are taken off on the banks or inshore in the south-east area facing the banks. An inspection of Fig. 5 will show that fry were well distributed in this area in 1931 and 1933 ; that in 1932 they were restricted to the northern portion of Grand Bank, while in 1934 practically no fry were taken on the banks, although the inshore area was occupied. No explanation of these variations can at present be advanced.

F. COD TAGGING EXPERIMENTS.

By the end of the 1934 season a total of 3,397 cod had been tagged. Of this number, 278 were tagged in 1933. The great bulk of these fish, having been tagged in the summer and fall of 1934, had at the close of that season only been two or three months at liberty, and most of the recaptures were, therefore, made within that short period, and within a short radius of the position of tagging. Further returns may be expected in the future. In all 255 cod, or 7½% of the total tagged, have so far been reported as recaptured. There is strong reason to believe that many more have been recaptured but not reported. This is a defect inseparable from tagging experiments in an area in which, as in Newfoundland and Labrador, the population is scattered and difficult to inform of the procedure to be followed when tags are secured. With the recent division of the coast into areas, each to be patrolled by a Fishery Officer, an improvement in the broadcasting of information can be expected. Most of the returns were from districts where the fishery is intensively pursued, e.g. 20% of returns have been received from fish tagged at Bay Bulls in 1933 and 16% from fish tagged at Fortune in 1934. On the other hand only one return has been received from 300 cod tagged on Grand Bank, and only two from 184 fish tagged off the west coast.

It is a usual feature of tagging experiments that the great bulk of the returns come from the locality in which the tagging was undertaken, or from within a radius of not more than about 25 miles of that locality. Thus one cod tagged off Bay Bulls was recaptured in precisely the same location after 418 days of freedom. Of the 255 tagged cod subsequently recaptured, only 18 (or 7%) had moved an appreciable distance. Fig. 6 shows the locations in which cod were tagged, the number tagged, and the more extensive migrations. No codfish which was tagged in inshore waters was recaptured on the banks, and, *vice-versa*, no fish tagged on the banks was retaken in inshore waters. There is thus no evidence so far of a marked interchange between inshore and bank cod stocks, and it will be of considerable interest to observe whether after a more prolonged period of freedom such interchange is established as having occurred. It is of first-class importance to know definitely whether or not intensive trawling operations on the banks would adversely affect the numbers of cod available to the inshore fishery, or merely affect an almost entirely separate stock indigenous to the banks and rarely, if ever, coming to the shore in any quantity. The movements of cod tagged at Bay Bulls and Fortune are commonplace enough. The more extensive of these exhibit northerly migration to Conception and Trinity Bays, and southerly migrations to Pig Bank, in the case of the Bay Bulls experiment ; and easterly to Burin and westerly to Hermitage Bay, in the case of the

Fortune experiment. A feature of the latter was the large number of returns from Lamaline, showing a mass movement of cod in an easterly direction from Fortune in the fall of 1934. Codfish tagged on either side of the Straits of Belle Isle were in certain cases recaptured on the opposite

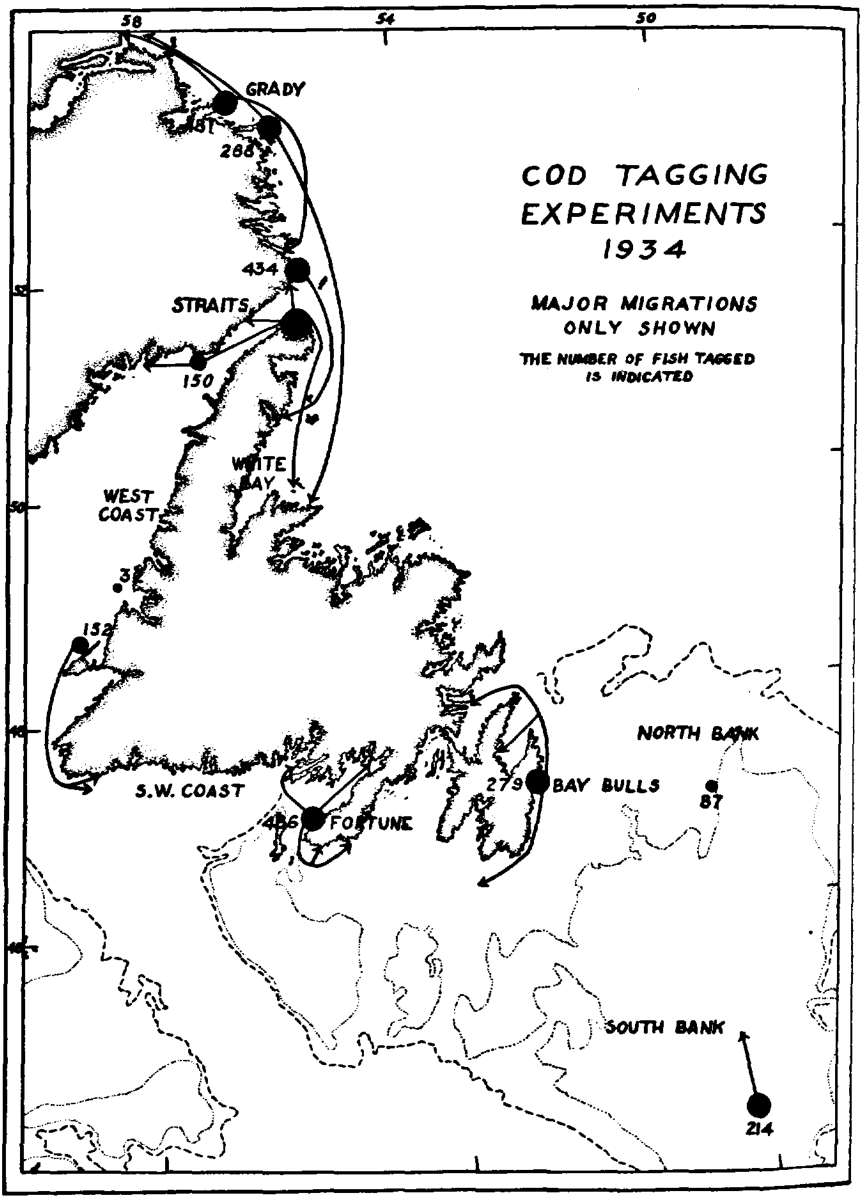


FIG. 6.

coast, this fact showing that there is no barrier to interchange across the Straits. Straits cod did not, however, penetrate far into White Bay (i.e. along the so-called "French Shore"), although several cod tagged off Labrador came as far south as Horse Islands and Cape St. John. Some were reported even from Fogo, but the validity of these latter returns is not yet established. In the case of the longer migrations, and assuming that the codfish travelled by the shortest possible route, no greater average speed was achieved than 7½ miles per day.

It is proposed to continue these tagging experiments on a more extensive scale. Apart from the desirability of reaching a conclusion with regard to the inter-relationship of bank and inshore cod, it is of importance to determine to what extent Labrador codfish migrate—if they do so at all—to Greenland or Icelandic waters. Evidence as to the degree of intensity of the inshore fishery is also obtainable from the percentage number of recaptures effected within a limited time, e.g. it is rather striking that within three months of their being tagged and liberated at Fortune at least 78 out of 488 fish (16%) were again caught.

G. SALMON INVESTIGATIONS

By H. Thompson

For the fourth successive year biological data were collected from the coastal and river runs of salmon. Measurements and scale samples were obtained from 4,000 salmon at various points on the east and Labrador coasts, and from 450 salmon taken from the rivers. It is hoped that similar data for south and west coast salmon will be obtained in 1935, whereupon it will be possible to effect a complete classification of Newfoundland salmon and to proceed to other phases of investigation, such as tagging, determination of smolt characteristics for different rivers (for comparison with those already deduced from scale studies on coastal salmon, and hence useful for the study of migrations) and the problem of making certain rivers easier of ascent by salmon on their spawning migration. For further statistics bearing upon coastal salmon runs reliance must in future be placed chiefly upon the records compiled by the firms prosecuting the fresh frozen salmon industry. These records ought to be sufficiently detailed to show whether the stock of salmon is being maintained at an economic level, and what the proportion of the numbers of small fish (grilse) is to the numbers of larger salmon. As will be shown below, the Newfoundland investigations tend to show that the presence of a large proportion of grilse in the catches in any one year is, on the whole, a favourable indication that salmon of commercial size will be plentiful in the following year. This is not yet a definite finding, since insufficient time has elapsed to test it repeatedly, nor are the data of as extensive a nature as could be desired.

INDICATIONS FROM PROPORTIONAL OCCURRENCE OF GRILSE

From the records of their operations, kindly supplied by Messrs. Job Bros., the following percentage occurrences of grilse have been worked out for the period 1929–1934 :—

Year		No. of Grilse	Total No. of Salmon	% Grilse in Total
1929	..	52,078	148,626	35·1%
1930	..	12,463	159,168	7·8%
1931	..	2,667	99,965	2·7%
1932	..	16,815	90,323	18·6%
1933	..	8,117	89,702	9·0%
1934	..	6,520	88,780	7·4%

It should be pointed out that, while these figures are probably sufficiently accurate to indicate broad variations, circumstances can arise in any one year whereby some bias may be introduced. Thus the industry calls for the larger type of salmon, and if the latter are abundant a smaller proportion of grilse than usual will be bought from the fishermen. Alternatively, when the larger sorts of salmon are unusually scarce, there will be a tendency to accept a greater proportion of grilse in order to make weight. Even so it is unlikely that the general picture is obscured. Thus, within the period under review, salmon were most plentiful in 1930—and grilse would appear to have been present in greatest proportion a year earlier, in 1929. Conversely 1931 was not a year in which salmon were very plentiful, and it might be reasoned that, if grilse were plentiful fair, numbers would have been accepted ; yet the records for that year demonstrate that the proportion of grilse sank to the lowest level during the six year period. There naturally followed in 1932 the poorest run of salmon experienced during the period. The proportion of grilse, however, rose markedly (doubtless, in part, owing to the scarcity of larger salmon), and in 1933 a much improved salmon fishery followed. However, the proportion of grilse fell in that year to a more moderate level, and a less successful fishery occurred in 1934. No increase in the proportion of grilse was indicated by the 1934 records, a fact which may indicate that the fishery of the 1935 season will also be of moderate dimensions.

Before each of the seasons of 1933 and 1934 an attempt was made in the laboratory reports to anticipate, in general terms for each district, the probable course of the forthcoming fishery, with comparatively encouraging results. For the 1934 season the prospects were stated to be for the season to commence a week or two earlier than usual ; much improved results were anticipated from the south-eastern section (including Trinity and, possibly, Bonavista Bays); and, if anything, slightly decreased catches in the north-east and off Labrador. As a matter of fact, the season commenced, in the south-east, some 10 days earlier than in 1933, while water temperatures were so appreciably higher than usual off the Labrador coast that the run of codfish developed prematurely, and in places interfered with the salmon fishery. Anticipations as to the varying success of the fishery on the different portions of the east coast were also realised, improved catches being secured in the south-east, while in the north a falling off was registered. This study has not yet been extended to the south-west coast which, exceptionally, experienced much colder water conditions than usual, with the result that the salmon fishery was poor.

Since an increase in the intensity of the arctic current occurred late in 1934, and will probably continue, the time of commencement of the 1935 fishery can be expected to be normal. No definite improvement in results is indicated for the south-eastern section, where grilse were not unusually plentiful (according to the available statistics) in 1934. A normal fishery should, however, occur in the section between Conche and Cape Freels, where grilse were relatively plentiful in 1934. Data appertaining to the proportion of grilse taken on the Labrador coast in 1934 are lacking.

Northern Salmon with Long Parr Life

Reference has previously been made to the unusually long duration of the early river (parr) life of all Newfoundland salmon except those of the south coast. The average duration of this period is from three to six years. However, during the 1934 season, scales were obtained from salmon in the Hamilton Inlet region, i.e. further north than has hitherto been the case ; several of these showed a seven year period of parr life (Plate 1a), and one extraordinary record of an eight-year period of parr life was secured (Plate 1b). The extensive duration of river life in the northern region generally (five years on the average) very probably implies that regeneration of the salmon stock is anything but prolific, and that artificial propagation would be relatively ineffective owing to the seven-year lag in securing results (to the five years of river life must be added two in the sea before salmon return to the coast). It follows that this stock of salmon cannot be expected to sustain a very intensive fishery. Indeed, there is an incipient uneasiness in trade circles that depletion is already noticeable. These remarks do not apply to the south and south-west, however, where the duration of parr life is only three years.

H. HADDOCK INVESTIGATIONS

By H. Thompson

The survey work of the s.s. "Cape Agulhas" has revealed the fact that, on the southern portion of the Grand Banks, there is a very considerable amount of haddock—more probably than has generally been realised. Up to 25,000 per 10 hours fishing have repeatedly been obtained. Thus, while of course the Newfoundland fleet fishes essentially for cod, haddock inevitably form a proportion of the catch, and the larger of them have a definite value, even when marketed as salt-fish. With the increase in number of long-distance trawling vessels, equipped with refrigeration and, therefore, for the marketing of haddock in the fresh state, added importance is to be attached to the degree of natural abundance of haddock, and to the study of prospects for their capture. It has been proved elsewhere (North Sea, Georges' Bank, etc.), that the haddock fishery is subject to great fluctuations, caused chiefly by the varying degree of success of reproduction of stock from year to year. For example, there is at present a definite and anticipated shortage on Georges' Bank, and the U.S.A. trawling fleet has perforce had to move its centre of operation to the east, to Sable Island Bank and Banquereau, in order to locate adequate shoals. Grand Bank is but a step farther, and, in the absence of some measure of conservation of haddock stocks, such as by the use of increased sizes of mesh of net in order to allow the escape of undersized and immature haddock, is certain to be exploited in its turn as scarcity develops elsewhere. These considerations make it important that, especially at the present juncture, when intensive trawling has not developed in the Newfoundland area, some form of census should be made of the existing stocks. More attention is, as a matter of fact, now to be given to haddock research in western Atlantic waters. Owing to the increasing scarcity of haddock in the more westerly of these waters, the North American Council for Fishery Investigations decided at its 1934 meeting to appoint a special sub-committee to draft a five year scheme of co-operative investigations into the haddock of the whole area. Newfoundland, as well as being charged with the convening of this committee, will effect and communicate the results of researches on the Grand Banks and the northern portion of the Western Banks.

Although the study of the haddock has received only minor attention during the four years in which the Newfoundland surveys have been going on, much valuable information has been accumulated. An exhaustive study of this remains to be made at a future date, but certain of the facts are capable of simple expression at the end of each year's study.

It is usual and desirable to endeavour to estimate the amount of successful regeneration each season by tracing the numbers of young fry occurring in the upper and middle water layers. Experience has generally shown, however, that it is more feasible to locate the brood of the year after it has reached the bottom stage. Till recently in the Newfoundland work little evidence has been obtained of either of these stages. However, definite signs of the success of the 1933 brood were observed during 1934 ; and, of the 1934 brood, during 1935. These very young haddock—just over a year in age—were found in large numbers in the catches of the ordinary commercial trawl net, in the region of southern Grand Bank. The 1933 and 1934 broods appear, therefore, to have been the first really successful year broods since those of 1927, 1928, and 1929—of which that of 1928 was particularly successful. As will be seen from the following table, these three broods again dominated the catches in 1934. In addition, the 1925 class was prominent in samples taken inshore at Fortune Bay. (This class, along with that of 1924, has during the four-year period predominated among the older year-classes both in the Grand Bank and Western Bank areas.)

Scale Age Analysis of Samples of Haddock from 1934 Catches.
Year—Classes :

	1933	1932	1931	1930	1929	1928	1927
Grand Bank ..							
(March–May)	135	5	3	28	198	411	227
(June) ..				1	16	21	12
Fortune Bay ..				4	22	17	10
Western Banks				4	30	4	

Year—Classes :

	1926	1925	1924	1923	1922	1921
Grand Bank						
(March–May) ..	42	31	2	3		1
(June) ..	1	1				
Fortune Bay ..	4	19	8		3	1
Western Banks						

(The scales of western Atlantic haddock can be read with precision up to the age of six or seven years ; after this age growth becomes very slow, and the closeness of the annual rings on the scale renders accurate age-determination a matter of difficulty. The statement that the 1925 group was prominent at Fortune is, therefore, based on mere probability—at best, on a "majority" reading of the apparent ages from the scales.)

In addition to the haddock which were measured and scaled, large numbers were measured only. A full treatment of the measurement data obtained in 1934 and the previous years remains to be made.

Canadian investigators have shown that 1920 was a successful spawning year in the western area; from the Newfoundland work it would appear that the periods 1924–25, 1927–29, and 1933–34 were also productive, more or less in the whole area.

It is essential, however, to go further than to make merely qualitative estimates such as the above. As a quantitative measure of haddock stocks, it is usual to estimate the average numbers of each year-class which are captured in a series of hauls (on one or two hours' duration), made in the different portions of the areas under investigation, and to raise the numbers to a uniform basis of 10 or 100 hours' trawling. If the number of test hauls is very large, there is ample proof from work done in the North Sea that accurate and usable estimates are obtained. Owing to pressure of other work, it has not been possible to achieve this accuracy in the Newfoundland surveys, which have been limited to from six to ten test hauls each year (apart from the numerous hauls made during commercial fishing and referred to below). For what they are worth, the average numbers of haddock taken in the survey hauls may be given. Almost all of these haddock were over 35 centimetres in length.

		Spring	*Fall*
Grand Bank	1931	No data	255 (5)
	1932	3,726 (5)	782 (5)
	1933	2,772 (4)	5,292 (4)
	1934	3,242 (4)	No data
Western Banks	1931	No data	2,540 (7)
	1932	1,160 (1)	820 (1)
	1933	No data	5,547 (2)
	1934	16,150 (2)	No data

The figures in brackets indicate the number of hauls.

The anticipation, expressed in the report for 1933, that, on account of the presence of the plentiful 1928 and 1927 broods, catches of haddock on Grand Bank should be good in 1934, was fully realised. Since, also, the successful brood of the year 1929 has now appeared in the catches, the prospects continue to be favourable for large catches of haddock in 1935. This forecast applies also to the western banks, where the 1929 brood was located in very large numbers (about 30,000 per 10 hours' fishing on Banquereau) in the spring of 1934. The average size of the haddock was 46 centimetres, and, allowing for a further year's growth of the fish, large catches of haddock ranging in size round 52–53 centimetres can be expected in 1935.

Relationship of Catch of Haddock and Water Temperature.

As has been clearly shown in the hydrographical section of this report, the water temperatures on southern Grand Bank—the portion frequented by haddock—have been rising since 1932. There has, accordingly, been a tendency for larger catches of haddock to be taken. This effect has already been partially explained by the upgrowth of plentiful year-classes, but increasing temperature of water may have assisted. The evidence from the survey cruises, given above, appears to demonstrate maintenance or increase of haddock numbers in 1933–34 ; the comparative results of the commercial fishing cruises of the s.s. "Cape Agulhas" on Grand Bank appear also to demonstrate an increase.

In spring, 1932, the catch per two-hour haul ranged up to 2 quintals in water of 2½ to 3°C.; and up to 5 quintals in water of 3 to 3½°C. No temperature higher than 3½° was encountered. Catches may be designated as fairly poor.

In spring, 1933, 36 hauls at 1½ to 3°C. averaged 7½ quntals each, and two hauls at 3 to 4°C. averaged only 2½ quintals each. These results may be termed moderately good.

In spring, 1934, the results were also at least moderately good :—

	1½°–3°	3°–4°	4°–5°	5°–6°	6°–7°	7°–9½°
Avr. No. of quintals (500 lbs.) ..	*3·7*	*4·4*	*7·0*	*8·3*	*9·5*	*6·0*
No. of hauls	25	15	39	36	23	2

Best results were obtained between 4° and 7°C. in 1934, but between 1½ and 3°C. in 1933, when water of higher temperature did not occur on Grand Bank in spring. In 1932 and 1931 low temperatures were also associated with definite haddock catches, and it is possible that the warmer conditions of 1934 are to be regarded as exceptional. Further data bearing on this subject are being secured in 1935.[1] As regards the Nova Scotian (western) Banks, it has previously been shown that haddock are scarce at temperatures below 3°C., but that up to 25 quintals per haul (in 1933) were obtained at 3° to 3½°C. In the spring of 1934 the area visited (Sable Island Bank) was covered by water of zero temperature, and few haddock could be secured. Later in the same spring the very large catch of young haddock of the 1929 brood was effected at Banquereau, in water of 6°C., hence the general indication is that on the western banks haddock occur in water of rather higher temperature than on Grand Bank.

[1] Those to hand from the March Voyage indicated continued plentifulness of haddock. The water temperature was lower than in 1934, but at temperatures between 3° and 7° up to 50 quintals per haul were secured. On present day standards this is probably equivalent to, if not better than, the results obtainable anywhere in the North Atlantic.

III. TECHNICAL INVESTIGATIONS

A. VITAMIN A IN LIVER OILS

By N. L. Macpherson and A. M. Wilson

(*a*) *Cod Liver Oil*

THE EFFECT OF AGE ON POTENCY AND ON VALUES IN INTERNATIONAL UNITS.

IN the annual report for 1933 evidence was set forth correlating the Vitamin A potency of liver oil with the age of the cod. It was demonstrated beyond question that the Blue Unit value to be obtained with the antimony trichloride in chloroform colour test of the liver oil of cod depends on the age of the cod. Livers from young cod 12–15 cms. in length and in their second year of life gave oil samples *with no blue value*. The older the fish from whose liver the oil sample was obtained, the higher was the blue value. Charts were given showing this relationship. It was also pointed out that a few tests of the intensity of absorption of U.V. of 328 mu gave similar results, the liver oil from a 48 cm. (four year old) cod giving the value of 0·26 for $E^{1\%}_{1\,cm.}$ and that from a 113 cm. (ten year old) cod giving 4·63 for $E^{1\%}_{1\,cm.}$

During the past year, measurements of absorption values were made with a Hilger Vitameter A. Below is given a record of some of the absorption values with the corresponding blue unit value of the sample, and in addition the number of international units calculated from the absorption value. The figures are arranged in increasing order of absorption and, therefore, of international units. The intention was to obtain corroboration of the finding that increasing age leads to accumulation of Vitamin A in the liver oil of the cod. A glance at the figures reveals that this corroboration has been obtained. In the region of low absorption the cod are in the thirty, forty, and fifty centimetre size-classes, and are three, four, five, or six years old. As the absorption value increases, although some of the smaller sizes are still to be found, it is seen that larger and older fish are associated with the higher values. When the highest absorption values are reached, there is no question that the corresponding fish are very large and old. The general trend cannot be disputed.

The calculated values for international units are extremely interesting and give much information.

Absorption Values, Blue Values, and International Unit Values of Some Oil Samples

Size of Cod in cms.	Age in Years	$E\frac{\cdot 25\%}{1\ cm.}$	Concentration of Standard Solution giving same Absorption	International Units on basis of Standard oil =3000	$E\frac{1\%}{1\ cm.}$	International Units on basis of $E\frac{1\%}{1cm.}\times 1600$	Blue Units 10% Dilution
Under 54	–	·15	·095	1,140	·6	960	4·5
40	5+	·15	·095	1,140	·6	960	1·0
42–51	3+	·15	·095	1,140	·6	960	3·0
39	4+	·20	·12	1,440	·80	1,280	3·0
72–75	–	·20	·12	1,440	·80	1,280	7·0
79–84	–	·225	·15	1,800	0·9	1,440	5·2
48	6+	·25	·16	1,920	1·0	1,600	4·3
59	6+	·25	·16	1,920	1·0	1,600	4·9
57	5+	·25	·16	1,920	1·0	1,600	–
100	10+	·25	·16	1,920	1·0	1,600	–
34	3+	·30	·195	2,340	1·2	1,920	5·0
40	4+	·30	·195	2,340	1·2	1,920	5·0
53	5+	·30	·195	2,340	1·2	1,920	5·5
64	6+	·30	·195	2,340	1·2	1,920	5·4
56	6+	·30	·195	2,340	1·2	1,920	2·3
63	7+	·30	·195	2,340	1·2	1,920	3·2
99	10+	·35	·22	2,640	1·4	2,240	8·0
80	8+	·40	·255	3,060	1·6	2,540	7·0
69	7+	·40	·255	3,060	1·6	2,540	6·2
78	10+	·40	·255	3,060	1·6	2,540	5·5
80	11+	·45	·29	3,480	1·8	2,880	8·0
111	11+	·50	·32	3,840	2·0	3,200	9·6
99	9+	·55	·35	4,200	2·2	3,520	7·0
119	12+	·60	·38	4,560	2·4	3,840	8·5
140	Over 15	·70	·45	5,400	2·8	4,480	9·0
149	Over 15	·80	·51	6,120	3·2	5,120	11·6
133	Over 15	·85	·58	7,020	3·4	5,440	12·7

While the two methods of calculating (comparison with the absorption of an oil of known international unit potency, or multiplication of the extinction coefficient by the recommended factor 1,600) give slightly different results, these results are, nevertheless, of the same order for each sample. They range from around one thousand units for the small fish liver oils up to over five thousand units for large fish liver oils. This means that, according to this method of establishment, the Vitamin A potency of Newfoundland cod liver oils lies within the range 1,000 to 6,000 international units. The potency of average commercial samples will depend upon the age composition of the cod catches and will vary within certain limits from year to year.

A recent paper submitted to the Society of Public Analysts by **R. S. Morgan** and **H. Pritchard** (1935) gave the Vitamin A potency of an average sample of cod liver oil prepared by mixing together equal quantities of medicinal oil purchased retail from 64 pharmacies in different parts of the British Isles. They found this representative sample contained 670 international units by biological rat assay. They also gave 0·505 as the extinction coefficient at 328 mu of a 1% solution in a 1 cm. cell via the unsaponifiable matter. By calculation ($E\frac{1\%}{1\text{ cm.}} \times 1{,}600$) their value for international units would, therefore, be approximately 800 for the average oil retailed in the British Isles. There would thus seem to be no doubt whatsoever that the Vitamin A potency of Newfoundland oil is very much higher than the average oil meantime being retailed in the British Isles. Again, the fact that the minimum permissible standard of the United States Pharmacopoeia (1934) is as low as 600 units indicates that many oils are encountered of considerably lower potency than Newfoundland oils, otherwise there would be no necessity for such a low permissible standard.

In order to check definitely the age-potency correlation and to find out the range in values from biological assays, five oils were assayed in comparison with a standard oil of 3,000 international units per gramme. The particulars of the oil samples assayed are as follows :—

S. Standard Oil. A reference cod liver oil distributed by the Board of Trustees of the United States Pharmacopoeial Convention under the supervision of the U.S.P. Vitamin Advisory Board. It contained 3,000 international units of Vitamin A per gramme.

A. Large Livers. A sample prepared from the livers of five large codfish, 95 cm., 97 cm., 103 cm., and 105 cm. long.

B. Small Livers. A sample prepared from the livers of 50 small codfish, ranging from 34 to 54 cms. long.

C. Witless Bay Livers. A sample of oil prepared from the livers of fish from Witless Bay, all about 30 inches long.

D. Emulsion Oil. A very good commercial sample of oil used in the preparation of an emulsion product.

E. Commercial Oil. A comparatively low blue value commercial oil.

The assay procedure was carried out according to the specifications of the 1934 Interim Revision Announcement, No. 2, of the Pharmacopoeia of the United States. The test diet used was as given below, and during the depletion period and assay period each rat was given, in addition to the test diet and test diet plus oil under assay, two drops of Radiostol solution (British Drug Houses) per week as a source of Vitamin D.

Test Diet.

Casein	100 parts
Dried Yeast	92 parts
White Starch	250 parts
Hardened Cottonseed Oil .. .	75 parts
Salt Mixture (McCollum No. 185) ..	25 parts

The results obtained are set out in the fourth column of the following table :—

Oil Sample	Absorption Test $E\frac{\cdot 25\%}{1\text{ cm.}}$	Carr Price Blue Units	International Units/gm from rat assay	International Units/gm on basis standard oil=3,000	International Units/gm on basis $E\frac{1\%}{1\text{ cm.}} \times 1{,}600$
S	·40	16·4	3,000	3,000	2,560
A	·70	26·6	5,146, 3,673 5,560	5,400	4,480
B	·15	9·0	1,032, 1,235	1,140	960
C	·35	14·0	3,807, 2,723	2,640	2,240
D	·35	18·0	2,333, 2,087	2,640	2,240
E	·30	12·2	1,828, 1,504	2,340	1,920

The results are entirely confirmatory of previous claims. The sample from large fish livers unquestionably produces the best growth, as the sample from small fish livers unquestionably produces the least.

The commercial oil sample had a vitamin value of 12·2 Carr Price Blue Units. This is below average for commercial oil, and yet the potency is from 1,500 to 2,000 international units, a value much in excess of the 600 minimum standard of the U.S.P. or of the 670 found by Morgan and Pritchard.

This synopsis of results would seem to establish definitely the high Vitamin A potency of average Newfoundland oil, as compared with the expected and determined potency of commercial oils for retail to the public of Great Britain and the United States.

(*b*) *Other Fish Liver Oils*

During the past year some measurements of absorption coefficients of the liver oils of salmon and halibut were made. In general, the age-potency correlation was corroborated, although several apparent exceptions were encountered. The number of samples examined, however, was small, and more data would conceivably substantiate the correlation. The calculated figures for international units are of great interest, and some of the figures are given to illustrate this point.

Number of Salmon	Age		E 1 cm.		International Units on basis of Standard Oil
	River	Sea	·25%	·05%	
915	4	1+	·65		4,920
634	3	2+	·85		6,480
742	4	3SM1+		·45	17,400
903	2	3SM1+		·70	27,000

Number of Halibut	Size in Cms.	E 1 cm.		International Units on basis of Standard Oil
		·1%	·05%	
1	62–72	·40		7,500
8	65	·40		7,500
4	75–80	·55		10,800
7	100	·65		12,600
10	124	·80		15,000
4A	174		·70	27,000

SM=Spawning mark, indicating a visit to the river for spawning.

It is readily seen how much higher the international unit values are both for salmon and for halibut than for cod. The values for the salmon liver oils listed would indicate as high a potency as in the case of halibut liver oils, but it must be remembered that only a small percentage of salmon caught have spent four years in the sea with an intervening period spent spawning in the river. Nevertheless salmon liver oils are more potent than oils from the oldest cod.

B. THE DRIED CODFISH INDUSTRY

By N. L. Macpherson

Investigations of the dried codfish industry have now reached the stage when a marshalling of the data collected, together with a description of the industry accompanied by technical suggestions for improvement of methods, would prove of value. A comprehensive survey has been compiled and will be published separately. It will be sufficient to indicate in this report the ground covered in the publication.

A description is given of the development of the different methods of preserving the large supplies of cod according to the exigencies of local conditions. The types of cure are described, and the amounts of salt used in the production of the light-salted and heavy-salted cures are recorded. The method of selecting or culling the fish for market categories is mentioned, and the recent regulations as to legal standards of cull are included. Some comments are made on the difficulties of the industry with reference to the technical aspects of the quality of the finished products. The economic aspects of market quotas and so forth are not included.

Before discussing technical aspects in detail, the general principles of food preservation are set forth, and the general methods of combating autolytic decomposition of tissue material and bacterial decomposition are emphasised. A detailed description is given of the mechanism of the extraction of water by salt from tissue materials. It is considered essential that this principle be understood, as otherwise no satisfactory understanding of the fish salting process is possible. The description brings out such points as why sea water is superior to fresh water for washing green fish. All methods of preservation are mentioned briefly.

A section is devoted to the preparation of the cod for salting, and the necessity for cleanliness and for avoiding rough handling is stressed. All details as to why care is necessary in washing off blood and guts are given, whereupon the salting process is dealt with. Considerable attention is paid to the question of salt quality, and the effects of salt impurities are explained. The solar salt origin of the organism producing "Red" or "Pink" is mentioned, and it is pointed out how the spores of the Dun fungus can contaminate salt which has been kept in premises where dun fish have been stored. An important aspect of the salt question is the relative weight of different brands of salt. The measure of salt used throughout Newfoundland is the hogshead. Now, there may be three or four hogsheads to one ton of salt, a point the importance of which is not generally appreciated. This matter is gone into thoroughly, relative weights of different salts are given, as well as the relative quantities of fish which can be salted with one hogshead of different brands. There is a discussion of the frequently occurring query as to what is the best kind of salt to use. Some points in the actual salting process are discussed also. Water contents and salt contents of the finished products are given, and upon these figures, and also the recorded figures for waste in passing from green fish from the sea to split fish, calculation of the yields in the different types of cure have been based. These calculations afford a very interesting study of the relative values of different products.

The whole drying process as now in general use is described, and "slime," "sun-burn," and "salt-burn" are explained. The causes and control of these factors are discussed. A complete explanation of the principles of evaporation shows how important a part atmosphere humidity conditions play in determining the efficiency of drying conditions. The variations in relative humidity from day to day and from year to year are demonstrated, and the necessity shown for adequate control of the drying operations during wet spells in any one season, or during an entirely unsatisfactory season.

The disadvantages and faults of artificial drying methods receive attention, and particulars are given of how the whole problem has been tackled. The experience gained from the design and operation of a small drier, of which details are given, has been used to justify theoretical conclusions as to the control of air conditions inside a drying chamber. The effect of heat on cold moist air is to lower the relative humidity to a remarkable degree, and it is pointed out how unduly dry and, therefore, harmful air may easily be admitted to the fish. The advantage of heat control inside the drier is argued, and an explanation is given of what will constitute satisfactory control.

In the publication, therefore, an attempt has been made to discuss principle and practice in the fullest possible manner.

APPENDIX A

CRUISES OF STEAM TRAWLER "CAPE AGULHAS"

1. *Spring Cruise* 5/6/34–18/7/34 Stations 320–381 (Fig. 8)
2. *Fall Cruise* 23/8/34–20/9/34 Stations 382–447 (Fig. 9)

PLANKTON NETS. No. 1. Hjort, fine silk, 27½ inches diameter.
No. 2. 1-metre cheese cloth.
H=horizontal.
V=vertical.
No. 3. 2-metre Stramin.

DREDGES AND DRAWLS. O.T.=Otter Trawl.
V.D.=Otter Trawl, French pattern.
m=metres,

Station	Dpth at bottom (m.)	Plankton Nets Time towed and depth	Dredges and Trawls
1. Off Bay Bulls June 5th	104	No. 1 (100 m.) No. 2 (V. 100 m.)	
320. 46°28′N. 53°05′W. June 5th	70	No. 1 (100 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	
321. 46°21′N. 53°50′W. June 5th	115	No. 1 (100 m.) No. 2 (V. 100 m.)	
322. 46°31′N. 54°54′W. June 6th	190	No. 1 (100 m.) No. 2 (H. 50 m. ¼ hr.) No. 3 (100 m. ¼ hr.)	
323. 46°35′N. 55°32′W. June 6th	135	No. 1 (100 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	
324. 46°54′N. 56°03′W. June 7th	104	No. 1 (100 m.) No. 2 (V. 50 m.)	

Station	Dpth at bottom (m.)	Plankton Nets Time towed and depth	Dredges and Trawls
325. 47°20′N. 55°32′W. June 9th	153	No. 1 (100 m.) No. 2 (V. 100 m.)	
326. 47°27′N. 56°39′W. June 11th	242	No. 1 (100 m.) No. 2 (H. 50 m. ¼ hr.) No. 3 (100 m. ¼ hr.)	
327. 47°31′N. 58°41′W. June 12th	144	No. 1 (100 m.) No. 2 (V. 100 m.)	
328. 47°07′N. 59°29′W. June 12th	423	No. 1 (100 m.) No. 2 (H. 50 m. ¼ hr.) No. 3 (150 m. ¼ hr.)	
329. 46°27′N. 59°25′W. June 19th	123	No. 1 (100 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	

ation	Dpth at bot-tom (m.)	Plankton Nets Time towed and depth	Dredges and Trawls
6°13'N. 8°58'W. une 19th	108	No. 1 (100 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	V.D. (½ hr.)
4°43'N. 7°44'W. ine 20th	39	No. 1 (35 m.) No. 2 (V. 25 m.) No. 3 (25 m. ¼ hr.)	V.D. (¼ hr.)
4°55'N. 6°45'W. une 20th	410	No. 1 (100 m.) No. 2 (H. 50 m. ¼ hr.) No. 3 (100 m. ¼ hr.)	
5°18'N. 5°50'W. une 20th	79	No. 1 (75 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	
5°12'N. 5°21'W. une 20th	141	No. 1 (100 m.) No. 2 (H. 50 m. ¼ hr.) No. 3 (100 m. ¼ hr.)	
5°21'N. 4°16'W. une 20th	108	No. 1 (100 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	
5°14'N. 3°27'W. une 21st	79	No. 1 (50 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	
4°46'N. 3°37'W. une 21st	103	No. 1 (100 m.) No. 2 (H. 25 m. ¼ hr.)	V.D. (¼ hr.)
4°41'N. 3°07'W. une 21st	93	No. 1 (75 m.) No. 2 (V. 50 m.)	V.D. (¼ hr.)
4°23'N. 3°05'W. une 21st	193	No. 1 (100 m.) No. 2 (H. 50 m. ¼ hr.) No. 3 (100 m. ¼ hr.)	
4°15'N. 2°15'W. une 21st	90	No. 1 (75 m.)	
3°52'N. 1°20'W. une 22nd	79	No. 1 (50 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	V.D. (¼ hr.)

Station	Dpth at bot-tom (m.)	Plankton Nets Time towed and depth	Dredges and Trawls
342. 44°05'N. 50°04'W. June 22nd	46	No. 1 (40 m.) No. 2 (V. 40 m.)	V.D. (½ hr.) Repeated twice
343. 44°17'N. 49°25'W. June 22nd	48	No. 1 (40 m.) No. 2 (V. 40 m.)	
344. 45°14'N. 50°12'W. June 23rd	63	No. 1 (50 m.) No. 2 (V. 50 m.)	
345. 45°45'N. 48°24'W. June 23rd	108	No. 1 (100 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	V.D. (½ hr.)
346. 46°18'N. 48°25'W. June 23rd	90	No. 1 (75 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	
347. 46°57'N. 48°03'W. June 24th	115	No. 1 (100 m.) No. 2 (H. 25 m. ¼ hr.) No, 3 (50 m. ¼ hr.)	
348. 47°25'N. 49°17'W. June 24th	95	No. 1 (75 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	
349. 47°08'N. 50°20'W. June 24th	100	No. 1 (75 m.) No. 2 (V. 50 m.)	V.D. (½ hr.)
350. 46°55'N. 51°22'W. June 25th	95	No. 1 (75 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	
1. Off Bay Bulls June 25th	108	No. 1 (100 m.)	
351. 47°35'N. 52°38'30" W. June 27th	113	No. 1 (100 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	
352. 47°45'30" N. 53°07'30" W. June 27th	62	No. 1 (50 m.) No. 2 (V. 50 m.)	

Station	Dpth at bottom (m.)	Plankton Nets Time towed and depth	Dredges and Trawls
353. 48°07′30″ N. 52°46′W. June 28th	138	No. 1 (100 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	
354. 48°25′N. 52°57′W. June 28th	233	No. 1 (100 m.) No. 2 (H. 50 m. ¼ hr.) No. 3 (100 m. ¼ hr.)	
355. 48°39′N. 52°54′W. June 28th	103	No. 1 (75 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	
356. 49°03′N. 52°53′W. June 28th		No. 1 (100 m.) No. 2 (H. 50 m. ¼ hr.) No. 3 (100 m. ¼ hr.)	
357. 49°48′N. 53°08′W. June 29th	118	No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	
358. 50°14′N. 54°18′W. June 29th		No. 1 (100 m.) No. 2 (H. 50 m. ¼ hr.) No. 3 (100 m. ¼ hr.)	
359. 50°55′N. 55°41′W. July 2nd	45	No. 1 (40 m.) No. 2 (V. 40 m.) No. 3 (25 m. ¼ hr.)	
360. 51°22′N. 55°29′W. July 2nd	55	No. 1 (50 m.) No. 2 (V. 50 m.) No. 3 (25 m. ¼ hr.)	
361. 51°34′N. 55°22′W. July 2nd	44	No. 1 (40 m.) No. 2 (V. 40 m.) No. 3 (25 m. ¼ hr.)	
362. 51°59′N. 55°33′W. July 3rd	131	No. 1 (100 m. ¼ hr.) No. 2 (H. 25 m. No. 3 (50 m. ¼ hr.)	
363. 52°48′N. 55°30′W. July 5th	229	No. 1 (100 m.) No. 2 (H. 50 m. ¼ hr.) No. 3 (100 m. ¼ hr.)	
364. 53°02′30″ N. 55°41′W. July 5th	63	No. 1 (50 m.) No. 2 (V. 50 m.) No. 3 (25 m. ¼ hr.)	
365. 53°29′N. 55°33′W. July 6th	79	No. 1 (75 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	
366. 53°47′N. 56°27′W. July 6th	36	No. 1 (25 m.) No. 2 (V. 25 m.)	
367. 52°22′N. 55°34′W. July 8th	94	No. 1 (90 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	
368. 52°02′N. 55°37′W. July 10th	82	No. 1 (75 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	
369. 51°39′N. 55°47′W. July 11th	22	No. 1 (20 m.) No. 2 (V. 20)	
370. 51°23′30″ N. 57°00′W. July 11th	45	No. 1 (40 m.) No. 2 (V. 40 m.)	[illegible]
371. 51°13′N. 57°12′W. July 11th	83	No. 1 (75 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	
372. 50°31′N. 57°54′W. July 12th	251	No. 1 (100 m.) No. 2 (H. 50 m. ¼ hr.) No. 3 (100 m. ¼ hr.)	
373. 49°10′N. 58°35′W. July 13th	73	No. 1 (70 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	
374. 48°47′N. 59°00′W. July 13th	39	No. 1 (35 m.) No. 2 (V. 35 m.)	
375. 48°23′N. 59°04′W. July 13th	84	No. 1 (75 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	
376. 48°01′N. 59°24′W. July 13th	85	No. 1 (75 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	

ation	Dpth at bot-tom (m.)	Plankton Nets Time towed and depth	Dredges and Trawls
7°22′N. 9°47′W. uly 14th	440 (ap-prox-im'te)	No. 1 (200 m.) No. 2 (H. 50 m. ¼ hr.) No. 3 (100 m. ¼ hr.)	
7°20′N. 7°52′W. uly 14th	214	No. 1 (100 m.) No. 2 (H. 50 m. ¼ hr.) No. 3 (100 m. ¼ hr.)	
6°20′N. 5°52′W. uly 16th	117	No. 1 (100 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	
6°29′N. 4°50′W. uly 17th	207	No. 1 (100 m.) No. 2 (H. 50 m. ¼ hr.) No. 3 (100 m. ¼ hr.)	
6°18′N. 3°30′W. uly 17th	141	No. 1 (100 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	
ff Bay Bulls uly 18th	111	No. 1 (100 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	
ff Bay Bulls ug. 23rd	100		
6°27′N. 2°55′W. ug. 24th	117	No. 1 (100 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	
6°32′N. 3°54′W. ug. 24th	52	No. 1 (100 m.) No. 3 (25 m. ¼ hr.)	
6°43′N. 4°36′W. ug. 24th	135	No. 1 (135 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (75 m. ¼ hr.)	
7°00′N. 5°00′W. ug. 24th	65	No. 1 (50 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	

Station	Dpth at bot-tom (m.)	Plankton Nets Time towed and depth	Dredges and Trawls
387. 47°14′N. 55°40′W. Aug. 25th	205	No. 1 (100 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	
388. 47°26′N. 56°30′W. Aug. 27th	300	No. 1 (200 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	
389. 47°12′N. 57°50′W. Aug. 27th	165	No. 1 (150 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (75 m. ¼ hr.)	
390. 47°18′N. 58°40′W. Aug. 28th	250	No. 1 (200 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (75 m. ¼ hr.)	
391. 46°55′N. 59°22′W. Aug. 28th		No. 1 (200 m.)	
392. 46°25′N. 59°26′W. Aug. 29th	103	No. 1 (100 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	V.D. (¼ hr.)
393. 44°49′N. 57°46′W. Aug. 30th	40	No. 1 (35 m.) No. 2 (V. 35 m.) No. 3 (25 m. ¼ hr.)	V.D. (5 mins.) Torn.
394. 45°06′N. 56°58′W. Aug. 30th	350	No. 1 (200 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (75 m. ¼ hr.)	
395. 45°28′N. 56°16′W. Aug. 30th	68	No. 1 (60 m.) No. 3 (25 m. ¼ hr.)	V.D. (1 hr.)
396. 45°21′N. 55°09′W. Aug. 31st	140	No. 1 (100 m.)	
397. 45°12′N. 54°17′W. Aug. 31st	108	No. 1 (100 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	
398. 44°46′N. 53°22′W. Aug. 31st	94	No. 1 (90 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	V.D. (1 hr.)

Station	Dpth at bottom (m.)	Plankton Nets Time towed and depth	Dredges and Trawls
399. 44°18′N. 53°06′W. Aug. 31st		No. 3 (100 m. ½ hr.)	
400. 44°21′N. 52°05′W. Sept. 1st	82	No. 1 (50 m.) No. 3 (75 m. ½ hr.)	
401. 43°55′N. 51°20′W. Sept. 1st	78	No. 1 (75 m.) No. 3 (50 m. ½ hr.)	V.D. (1 hr.)
402. 43°56′N. 49°50′W. Sept. 1st	48	No. 1 (45 m.) No. 3 (35 m. ½ hr.)	V.D. (1 hr.)
403. 44°50′N. 48°56′W. Sept. 2nd		No. 1 (200 m.) No. 2 (H. 25 m. ½ hr.) No. 3 (75 m. ½ hr.)	
404. 44°59′N. 49°20′W. Sept. 2nd	72	No. 1 (70 m.) No. 2 (H. 25 m. ½ hr.) No. 3 (50 m. ½ hr.)	
405. 45°38′N. 48°41′W. Sept. 2nd	90	No. 1 (90 m.) No. 2 (H. 50 m. ½ hr.) No. 3 (75 m. ½ hr.)	V.D. (1 hr.)
406. 46°51′N. 48°06′W. Sept. 3rd	108	No. 1 (100 m.) No. 2 (H. 50 m. ½ hr.) No. 3 (75 m. ½ hr.)	
407. 47°13′N. 50°19′W. Sept. 3rd	100	No. 1 (100 m.) No. 2 (H. 35 m. ½ hr.) No. 3 (75 m. ½ hr.)	V.D. (½ hr.) Torn.
408. 48°17′N. 51°15′W. Sept. 4th	162	No. 1 (160 m.) No. 2 (H. 50 m. ½ hr.) No. 3 (75 m. ½ hr.)	
409. 47°22′N. 52°00′W. Sept. 4th	139	No. 1 (135 m.) No. 2 (H. 50 m. ½ hr.) No. 3 (75 m. ½ hr.)	
410. 1 mile off Bay Bulls Lighthouse Sept. 4th	102	No. 1 (100 m.) No. 2 (H. 25 m. ½ hr.) No. 3 (50 m. ½ hr.)	
411. 48°01′N. 52°47′W. Sept. 6th	144	No. 1 (140 m.) No. 2 (H. 50 m. ½ hr.) No. 3 (75 m. ½ hr.)	
412. 48°22′N. 52°51′W. Sept. 6th		No. 1 (200 m.) No. 2 (H. 50 m. ½ hr.) No. 3 (75 m. ½ hr.)	
413. 48°46′N. 52°52′W. Sept. 6th	131	No. 1 (130 m.) No. 2 (H. 50 m. ½ hr.) No. 3 (75 m. ½ hr.)	
414. 49°23′N. 52°55′W. Sept. 7th		No. 1 (200 m.) No. 2 (H. 50 m. ½ hr.) No. 3 (75 m. ½ hr.)	
415. 49°53′N. 52°56′W. Sept. 7th		No. 1 (200 m.) No. 2 (H. 50 m. ½ hr.) No. 3 (75 m. ½ hr.)	
416. 50°04′N. 53°43′W. Sept. 7th	171	No. 1 (171 m.) No. 2 (H. 50 m. ½ hr.) No. 3 (75 m. ½ hr.)	
417. 50°04′N. 54°45′W. Sept. 7th	216	No. 1 (200 m.) No. 2 (H. 50 m. ½ hr.) No. 3 (75 m. ½ hr.)	
418. 50°26′N. 55°30′W. Sept. 8th	234	No. 1 (200 m.) No. 2 (H. 25 m. ½ hr.) No. 3 (50 m. ½ hr.)	
419. 50°54′N. 55°41′W. Sept. 8th	42	No. 1 (40 m.) No. 3 (25 m. ½ hr.)	
420. 51°33′N. 55°22′W. Sept. 8th	41	No. 1 (40 m.) No. 3 (25 m. ½ hr.)	
421. 52°08′N. 55°04′W. Sept. 8th	138	No. 1 (135 m.) No. 2 (H. 50 m. ½ hr.) No. 3 (75 m. ½ hr.)	
422. 52°21′N. 55°23′W. Sept. 9th	172	No. 1 (170 m.) No. 2 (50 m. ½ hr.) No. 3 (75 m. ½ hr.)	

Station	Dpth at bot-tom (m.)	Plankton Nets Time towed and depth	Dredges and Trawls
52°36'N. 55°41'30" W. Sept. 9th	52	No. 1 (50 m.) No. 3 (30 m. ¼ hr.)	
53°17'30" N. 55°40'W. Sept. 10th	50	No. 3 (35 m. ¼ hr.)	
53°32'N. 55°41'W. Sept. 11th	56	No. 1 (50 m.) No. 3 (35 m. ¼ hr.)	
53°38'N. 55°15'W. Sept. 11th	130		
53°42'N. 54°34'W. Sept. 11th	140	No. 1 (140 m.)	
53°00'N. 55°12'W. Sept. 12th	145	No. 1 (140 m.) No. 3 (50 m. ¼ hr.)	
52°04'N. 55°32'W. Sept. 12th Sept. 14th	105	No. 1 (100 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	
51°41'N. 56°22'W. Sept. 12th	72	No. 2 (H. 20 m. ¼ hr.) No. 3 (40 m. ¼ hr.)	
51°25'N. 56°55'W. Sept. 12th	73	No. 1 (70 m.) No. 3 (50 m. ¼ hr.)	V.D. (1 hr.)
50°57'N. 57°57'W. Sept. 13th	153	No. 1 (150 m.) No. 2 (H. 50 m. ¼ hr.) No. 3 (75 m. ¼ hr.)	
50°11'N. 58°12'W. Sept. 14th	250	No. 1 (200 m.) No. 2 (H. 50 m. ¼ hr.) No. 3 (75 m. ¼ hr.)	
49°39'N. 58°26'W. Sept. 14th	82	No. 1 (80 m.) No. 3 (40 m. ¼ hr.)	
49°13'N. 58°29'W. Sept. 14th	41	No. 1 (40 m.) No. 3 (25 m. ¼ hr.)	

Station	Dpth at bot-tom (m.)	Plankton Nets Time towed and depth	Dredges and Trawls
436. 48°53'N. 58°54'W. Sept. 14th	48	No. 1 (40 m.)	
437. 48°34'N. 59°17'W. Sept. 14th	72	No. 1 (70 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	
438. 48°00'N. 59°30'W. Sept. 15th	148	No. 1 (145 m.) No. 2 (H. 50 m. ¼ hr.) No. 3 (75 m. ¼ hr.)	
439. 47°37'N. 60°00'W. Sept. 15th			
440. 47°16'N. 60°24'W. Sept. 15th	162	No. 1 (160 m.) No. 2 (H. 50 m. ¼ hr.) No. 3 (75 m. ¼ hr.)	
441. 46°41'N. 59°00'W. Sept. 18th		No. 1 (300 m.) No. 2 (H. 50 m. ¼ hr.) No. 3 (75 m. ¼ hr.)	
442. 48°50'N. 59°09'W. Sept. 18th	216	No. 1 (200 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	
443. 46°42'N. 56°57'W. Sept. 18th	72	No. 1 (70 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	
444. 46°47'N. 55°05'W. Sept. 19th	145	No. 1 (140 m.) No. 2 (H. 50 m. ¼ hr.) No. 3 (75 m. ¼ hr.)	
445. 46°35'N. 53°52'W. Sept. 19th	55	No. 1 (50 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	
446. 46°48'N. 53°48'W. Sept. 20th	102	No. 1 (100 m.) No. 3 (50 m. ¼ hr.)	
447. Off Bay Bulls Sept. 20th	85	No. 1 (80 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	

APPENDIX B

TEMPERATURES AND SALINITIES AT DEPTH m (METRES)

(*a*) *FIRST COMMERCIAL CRUISE*

m = depth in metres ; t° = temperature, centigrade ; S°·°° = Salinity (parts per 1000)
I–XVII = trawling stations.

Off Bay Bulls. I.

Date and Position	m.	t°	S°/°°
1934 III 7			
70 m.			
Off Bay Bulls	0	−1·5	32·58
	10	−1·5	32·53
	25	−1·7	32·62
	50	−1·6	32·76
	65	−1·6	32·65

Southern Edge of Grand Banks. II.

Date and Position	m.	t°	S°/°°
1934 III 8			
108 m.			
44°16′N. 52°30′W	0	2·5	32·16
	10	2·5	32′19
	25	2·4	32′17
	50	2·5	32′17
	75	3·7	?33·71
	100	2′6	32′21

Sable Island Bank. I.

Date and Position	m.	t°	S°/°°
1934 III 12			
80 m.			
43°38′N. 59°25′W	0	0·1	31·83
	50	0·2	32·21
	75	0·0	31·83

Sable Island Bank. II.

Date and Position	m.	t°	S°/°°
1934 III 12			
60 m.			
43°47′N. 59°22′W	0	0·1	31·50
	10	0·1	31·66
	25	0·1	31·75
	50	0·0	32·03

Sable Island Bank. III.

Date and Position	m.	t°	S°/°°
1934 III 13			
45 m.	0	0·1	
	10	0·1	
	25	0·0	
	40	−0·1	

Grand Bank. II.

Date and Position	m.	t°	S°/°°
1934 III 15			
110 m.			
44°34′N. 53°29′W	0	3·0	32·44
	10	3·0	32·53
	25	3·0	32·45
	50	3·0	32·58
	75	4·3	33·51
	100	6·6	34·39

Grand Bank. II.

Date and Position	m.	t°	S°/°°
1934 III 16			
105 m.	0	2·4	
	10	2·4	
	25	2·5	
	50	2·9	
	75	5·1	
	100	6·2	

Grand Bank. II.

Date and Position	m.	t°	S°/°°
1934 III 17			
108 m.	0	2·5	
	10	2·5	
	25	2·5	
	50	3·3	
	75	4·4	
	100	7·0	

Grand Bank. II.

Date and Position	m.	t°	S°/°°
1934 III 18			
110 m.	0	2·5	
	10	2·4	
	25	2·4	
	50	3·0	
	75	4·1	
	100	6·5	

Grand Bank. II.

Date and Position	m.	t°	S°/°°
1934 III 19			
104 m.	0	2·5	
	10	2·5	
	25	2·5	
	50	2·5	
	75	3·3	
	100	5·5	

Grand Bank. III.

Date and Position	m.	t°	S°/°°
1934 III 20			
103 m.			
44°40′N. 53°10′W	0	2·5	
	10	2·4	
	25	2·2	
	50	2·1	
	75	2·5	
	100	4·4	

Grand Bank. III.

Date and Position	m.	t°	S°/°°
1934 III 21			
105 m.	0	2·6	32·28
	10	2·6	32·27
	25	2·6	32·25
	50	3·0	32·44
	75	4·4	33·38
	100	8·0	34·43

Grand Bank. III.

Date and Position	m.	t°	S°/°°
1934 III 23			
96 m.	0	2·3	
	10	2·4	
	25	2·6	
	50	2·9	
	75	5·7	
	90	5·7	

Grand Bank. III.

Date and Position	m.	t°	S°/°°
1934 III 24			
103 m.	0	2·0	
	10	2·2	
	25	2·4	
	50	3·0	
	75	6·4	
	100	6·5	

Grand Bank. IV.

Date and Position	m.	t°	S°/°°
1934 III 26			
95 m.			
44°24·N. 52°48′W	0	2·1	
	10	2·0	
	25	1·9	
	50	1·9	
	75	4·2	
	90	4·3	

Grand Bank. IV.

Date and Position	m.	t°	S°/°°
1934 III 27			
94 m.	0	2·2	
	10	2·3	
	25	2·3	
	50	2·4	
	75	4·0	
	90	4·7	

Grand Bank. IV.

Date and Position	m.	t°	S°/°°
1934 III 28			
104 m.	0	2·7	
	10	2·7	
	25	2·6	
	50	2·6	
	75	3·5	
	100	5·7	

Grand Bank. IV.

Date and Position	m.	t°	S°/°°
1934 III 29			
104 m.	0	2·5	32·19
	10	2·5	32·19
	25	2·6	32·23
	50	2·6	32·34
	75	3·4	32·98
	100	6·2	34·04

Off Bay Bulls.

Date and Position	m.	t°	S°/°°
1934 III 30			
40 m.	0	−1·3	32·45
	10	−1·5	32·56
	25	−1·6	32·65
	35	−1·6	32·69

(*b*) *SECOND COMMERCIAL CRUISE*

Grand Bank. I.

Date and Position	m.	t°	S°/°°
1934 IV 8			
85 m.			
44°44′N. 53°22′W	0	2·5	32·33
	50	4·2	33·40
	75	4·9	33·51

Grand Bank. I.

Date and Position	m.	t°	S°/°°
1934 IV 9			
98 m.			
44°44′N. 53°22′W.	0	2·4	
	10	2·4	
	25	2·8	
	50	4·9	
	75	6·0	
	90	6·0	

Grand Bank. II.

Date and Position	m.	t°	S°/°°
1934 IV 11			
95 m.			
44°36′N. 53°29′W	0	2·5	
	10	2·5	
	25	2·5	
	50	2·8	
	75	5·7	
	90	6·0	

Grand Bank. II.

Date and Position	m.	t°	S°/°°
1934 IV 12			
92 m.	0	2·9	
	10	2·9	
	25	3·0	
	50	3·0	
	75	4·5	
	85	4·9	

Grand Bank. III.

Date and Position	m.	t°	S°/°°
1934 IV 13			
91 m.			
44°16′N. 52°16′W	0	2·7	32·31
	25	3·0	32·31
	50	5·1	33·12
	85	9·7	34·79
		(repeated)	

Grand Bank. IV.

Date and Position	m.	t°	S°/°°
1934 IV 14			
4 m. S.E. of			
position III	0	2·6	
	10	2·6	
	25	2·7	
	50	3·1	
	75	5·8	
	90	6·1	

Grand Bank. V.

Date and Position	m.	t°	S°/°°
1934 IV 15			
84 m.			
44°24′N. 52°21′W	0	2·4	
	25	2·6	
	50	2·8	
	75	3·1	

Grand Bank. VI.

Date and Position	m.	t°	S°/°°
1934 IV 16			
81 m.			
44°27′N. 52°14′W	0	2·6	32·08
	25	2·6	32·10
	50	2·7	32·16
	75	2·3	32·78

Grand Bank. VII.

Date and Position	m.	t°	S°/°°
1934 IV 17			
81 m.			
44°24′N. 52°21′W	0	3·0	
	10	3·0	
	25	2·9	
	50	2·6	
	75	3·8	

Grand Bank. VII.

Date and Position	m.	t°	S°/°°
1934 IV 18			
83 m.	0	3·3	
	10	3·0	
	25	2·8	
	50	3·1	
	75	5·7	

Grand Bank. VIII.

Date and Position	m.	t°	S°/°°
1934 IV 19			
82 m.			
44°16′N. 52°00′W	0	4·0	
	10	4·0	
	25	3·1	
	50	1·5	
	75	4·6	

Grand Bank. IX.

Date and Position	m.	t°	S°/°°
1934 IV 20			
44°30′N. 51°56′W	0	3·4	
	10	3·4	
	25	2·6	
	50	2·5	
	75	3·3	

Grand Bank. X.

Date and Position	m.	t°	S°/°°
1934 IV 21			
75 m.			
44°21′N. 51°44′W	0	3·1	32·07
	10	3·1	32·07
	25	2·9	32·14
	50	2·2	32·19
	70	1·9	32·78

Grand Bank. XI.

Date and Position	m.	t°	S°/°°
1934 IV 23			
81 m.			
44°10′N. 51°52′W	0	4·1	
	10	4·1	
	25	4·0	
	50	2·9	
	75	4·6	

Grand Bank. XI.

Date and Position	m.	t°	S°/°°
1934 IV 23			
81 m.	0	4·0	
	10	4·0	
	25	3·0	
	50	3·1	
	75	6·0	

Grand Bank. XII.

Date and Position	m.	t°	S°/°°
1934 IV 24			
75 m.			
44°34′N. 52°05′W	0	4·0	
	10	3·9	
	25	3·5	
	50	2·3	
	70	1·5	

Grand Bank. XIII.

Date and Position	m.	t°	S°/°°
1934 IV 25			
78 m.			
44°06′N. 51°40′W	0	4·0	
	10	3·7	
	25	3·5	
	50	1·5	
	75	1·8	

(c) THIRD COMMERCIAL CRUISE

Date and Position	m.	t°	S°/°°
Off Bay Bulls.			
1934 IV 30	0	–1·2	32·83
57 m.	10	–1·2	32·79
	25	–1·4	32·83
	50	–1·5	32·92
Grand Bank. I.			
1934 V 5			
77 m.			
44°30′N. 52°10′W	0	3·8	32·27
	25	2·1	32·32
	75	5·1	33·95
Grand Bank. I.			
1934 V 5			
85 m.	0	4·6	
	25	3·8	
	50	3·0	
Grand Bank. II.			
1934 V 6			
85 m.			
44°38′N. 52°16′W	0	4·1	
	75	0·6	
Grand Bank. II.			
1934 V 7			
85 m.	0	4·8	
	25	4·1	
	50	4·6	
	75	4·1	
Grand Bank. III.			
1934 V 8			
81 m.			
44°32′N. 52°20′W	0	4·1	
	25	4·0	
	50	1·5	
	75	2·8	
Grand Bank. IV.			
1934 V 9			
77 m.			
44°31′N. 52°25′W	0	4·5	
	15	4·3	
	25	4·1	
	50	1·5	
	60	1·4	
Grand Bank. V.			
1934 V 10			
81 m.			
44°32′N. 52°23′W	0	4·3	32·29
	25	3·8	32·34
	50	1·7	32·34
	75	–0·5	33·03

Date and Position	m.	t°	S°/°°
Grand Bank. VI.			
1934 V 10			
86 m.			
44°37′N. 52°32′W	0	6·0	
	50	2·1	
	75	1·7	
Grand Bank. VII.			
1934 V 11			
75 m.			
44°34′N. 52°23′W	0	4·4	
	15	3·9	
	25	3·8	
	50	1·5	
	70	0·9	
Grand Bank. VII.			
1934 V 11			
85 m.	75	2·7	
Grand Bank. VII.			
1934 V 12			
68 m.	0	4·7	
	50	1·4	
	65	1·5	
Grand Bank. IX.			
1934 V 14			
81 m.			
44°40′N. 52°26′W	0	5·7	
	25	4·4	
	50	3·4	
	75	4·1	
Grand Bank. X.			
1934 V 14			
83 m.			
44°40′N. 52°31′W	0	6·4	
	25	4·6	
	75	3·7 (repeated)	
Grand Bank. XI.			
1934 V 15			
81 m.			
44°33′N. 52°31′W	0	6·3	32·23
	25	5·9	32·65
	50	3·8	32·97
	75	5·5	34·07
Grand Bank. XII.			
1934 V 16			
83 m.			
44°36′N. 52°25′W	0	6·6	
	25	5·1	
	50	2·8	
	75	3·9	

Grand Bank. XIII.

Date and Position	m.	t°	S°/°°
1934 V 17 80 m. 44°37′N. 52°12′W	0	6·2	
	25	5·8	
	50	3·2	
	75	2·2	

Grand Bank. XIV.

Date and Position	m.	t°	S°/°°
1934 V 18 79 m. 44°40′N. 52°18′W	0	6·2	32·25
	25	6·2	32·28
	50	3·1	32·58
	75	–0·4	33·00

Grand Bank. XV.

Date and Position	m.	t°	S°/°°
1934 V 19 85 m. 44°26′N. 52°21′W	0	6·8	
	25	5·5	
	50	2·3	
	75	4·2	

Grand Bank. XV.

Date and Position	m.	t°	S°/°°
1934 V 19 88 m.	85	4·1	

Grand Bank. XVI.

Date and Position	m.	t°	S°/°°
1934 V 20 81 m. 44°40′N. 52°20′W	0	6·2	
	25	6·2	(rep.)
	50	1·5	
	75	1·2	

Grand Bank. XVII.

Date and Position	m.	t°	S°/°°
1934 V 21 81 m. 44°34′N. 52°18′W	0	6·2	32·19
	25	4·8	32·27
	50	1·8	32·40
	75	2·0	32·76

Off Bay Bulls.

Date and Position	m.	t°	S°/°°
1934 V 22 81 m.	0	2·9	32·74
	10	2·9	32·74
	25	1·5	32·85
	50	–0·8	33·03
	75	–1·5	33·21

(*d*) *SPRING RESEARCH CRUISE*

June 5–*July* 19, 1934.

Station 1.

Date and Position	m.	t°	S°/°°
1934 VI 5 104 m. Off Bay Bulls	0	3·9	32·73
	10	3·8	32·77
	25	3·8	32·79
	50	–0·6	32·98
	75	–1·2	33·12
	100	–1·5	33·23

Station 320.

Date and Position	m.	t°	S°/°°
1934 VI 5 70 m. 46°28′N. 53°05′W	0	–0·1	32·92
	10	–0·2	32·92
	25	–0·3	32·98
	50	–0·8	33·08
	65	–1·2	33·12

Station 321.

Date and Position	m.	t°	S°/°°
1934 VI 5 115 m. 46°21′N. 53°50′W	0	5·2	32·43
	10	5·2	32·43
	25	4·8	32·43
	50	–0·6	32·79
	75	–1·5	32·99
	100	–1·5	33·16

Station 322.

Date and Position	m.	t°	S°/°°
1934 VI 6 190 m. 46°31′N. 54°54′W	0	4·7	32·16
	10	4·7	32·16
	25	4·0	32·17
	50	–0·2	32·62
	75	–1·1	32·80
	100	–1·1	33·10
	175	0·8	33·45

Station 323.

Date and Position	m.	t°	S°/°°
1934 VI 6 135 m. 46°35′N. 55°32′W	0	4·5	32·08
	10	4·5	32·08
	25	4·4	32·10
	50	0·2	32·48
	75	–0·7	32·57
	100	–1·2	32·70
	125	–0·9	32·99

Station 324.

Date and Position	m.	t°	S°/°°
1934 VI 7 104 m. 46°54′N. 56°03′W	0	6·0	31·15
	10	4·9	31·48
	25	1·3	32·16
	50	–0·1	32·48
	75	–0·6	32·64
	100	–0·8	32·68

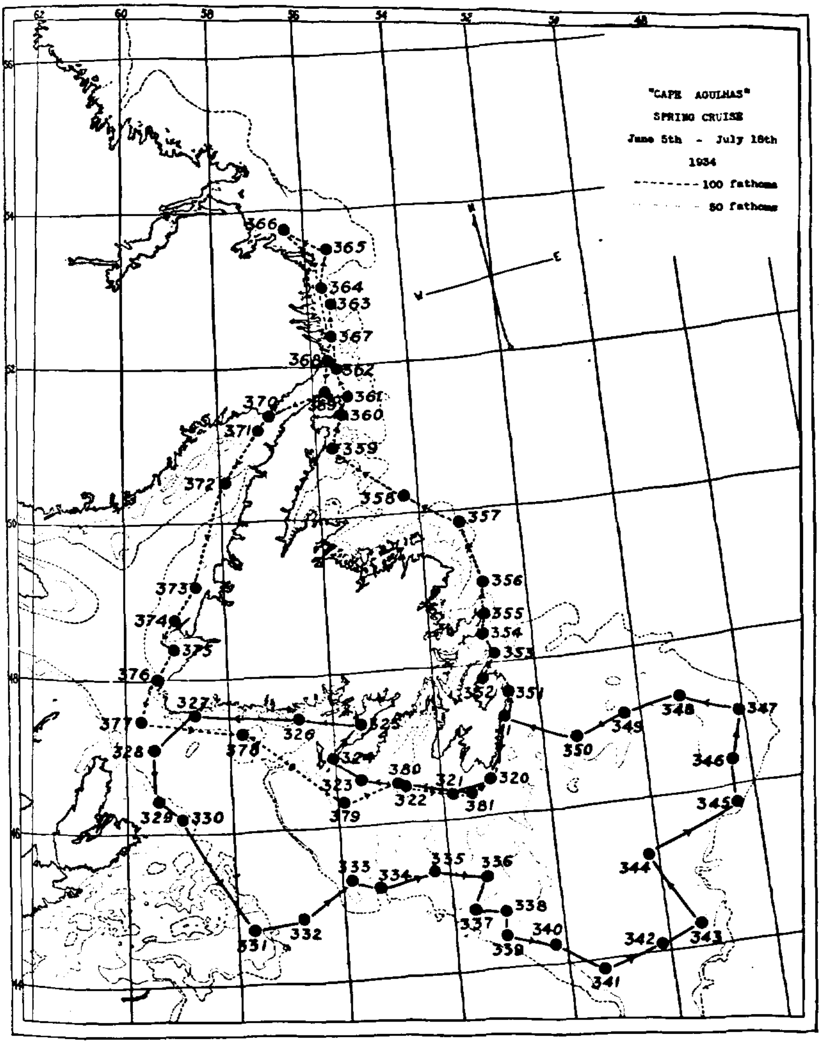

"CAPE AGULHAS"
SPRING CRUISE
June 5th - July 18th
1934
100 fathoms
50 fathoms
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FIG. 8

Station 325.

Date and Position	m.	t°	S°/°°
1934 VI 9			
153 m.			
47°20′N. 55°32′W	0	6·0	30·80
	10	3·0	31·50
	25	0·0	32·16
	50	–0·5	32·43
	75	–0·3	32·48
	100	–0·3	32·52
	150	–0·3	32·61

Station 326.

Date and Position	m.	t°	S°/°°
1934 VI 11			
242 m.			
47°27′N. 56°39′W	0	5·7	31·39
	10	5·3	31·55
	25	1·2	32·03
	50	–0·4	32·25
	75	–0·4	32·37
	100	–0·2	32·64
	200	3·4	34·26

Station 327.

Date and Position	m.	t°	S°/°°
1934 VI 12			
144 m.			
47°31′N. 58°41′W	0	4·0	31·57
	10	3·9	31·59
	25	2·4	31·77
	50	–0·5	32·16
	75	–0·5	32·25
	100	–0·2	32·43
	140	0·8	32·96

Station 328.

Date and Position	m.	t°	S°/°°
1934 VI 12			
423 m.			
47°07′N. 59°29′W	0	7·0	31·33
	10	6·0	31·34
	25	3·7	31·64
	50	–1·2	32·03
	75	–0·5	32·27
	100	0·5	32·83
	200	3·4	34·24
	300	4·1	34·66
	400	4·1	34·81

Station 329.

Date and Position	m.	t°	S°/°°
1934 VI 19			
123 m.			
46°27′N. 59°25′W	0	6·7	30·95
	10	6·5	31·04
	25	4·7	31·22
	50	–1·0	31·92
	75	–0·7	32·34
	100	0·5	32·81

Station 330.

Date and Position	m.	t°	S°/°°
1934 VI 19			
108 m.			
46°13′N. 58°58′W	0	6·9	31·02
	10	5·9	31·02
	25	2·0	31·44
	50	–0·7	31·87
	75	–0·4	32·30
	100	1·5	33·34

Station 331.

Date and Position	m.	t°	S°/°°
1934 VI 20			
39 m.			
44°43′N. 57°44′W	0	7·0	31·75
	10	6·4	31·75
	25	6·1	31·75
	35	6·0	31·77

Station 332.

Date and Position	m.	t°	S°/°°
1934 VI 20			
410 m.			
44°55′N. 56°45′W	0	9·0	32·37
	10	8·5	32·35
	25	7·9	32·35
	50	1·5	32·71
	75	1·3	32·94
	100	5·0	33·79
	200	6·0	34·62
	300	5·2	34·71
	400	4·0	34·81

Station 333.

Date and Position	m.	t°	S°/°°
1934 VI 20			
79 m.			
45°18′N. 55°50′W	0	8·6	32·10
	10	8·0	32·12
	25	6·3	32·12
	50	–0·5	32·57
	75	–0·8	32·70

Station 334.

Date and Position	m.	t°	S°/°°
1934 VI 20			
141 m.			
45°12′N. 55°21′W	0	8·5	32·12
	10	8·0	32·12
	25	6·0	32·14
	50	0·0	32·48
	75	–1·2	32·83
	100	0·1	33·12
	125	0·2	33·16

Station 335.

Date and Position	m.	t°	S°/°°
1934 VI 20			
108 m.			
45°21′N. 54°16′W	0	8·7	32·10
	10	8·5	32·12
	25	7·5	32·12
	50	2·0	32·10
	75	1·1	32·55
	100	5·1	

Station 336.

Date and Position	m.	t°	S°/°°
1934 VI 21			
79 m.			
45°14′N. 53°27′W	0	8·2	32·12
	10	7·8	32·21
	25	7·2	32·23
	50	0·9	32·50
	75	–0·6	32·64

Date and Position	m.	t°	S°/°°
Station 337.			
1934 VI 21			
103 m.			
44°46′N. 53°37′W	0	9·4	31·79
	10	9·3	31·81
	25	8·8	32·17
	50	2·5	32·73
	75	–0·2	32·85
	100	4·0	33·60
Station 338.			
1934 VI 21			
93 m.			
44°41′N. 53°07′W	0	9·3	32·16
	10	9·3	31·85
	25	8·9	31·85
	50	0·6	32·16
	75	3·5	33·17
Station 339.			
1934 VI 21			
193 m.			
44°23′N. 53°05′W	0	10·3	32·68
	10	11·2	32·70
	25	10·0	32·79
	50	9·8	34·53
	75	11·4	35·16
	100	11·0	35·14
	175	8·5	35·03
Station 340.			
1934 VI 21			
90 m.			
44°15′N. 52°15′W	0	9·6	32·38
	10	9·6	32·30
	25	4·3	32·37
	50	2·1	32·94
	75	4·8	33·84
Station 341.			
1934 VI 22			
79 m.			
43°52′N. 51°20′W	0	9·4	32·08
	10	9·4	32·08
	25	8·0	32·28
	50	2·0	32·79
	75	2·5	33·34
Station 342.			
1934 VI 22			
46 m.			
44°05′N. 50°04′W	0	8·4	32·52
	10	8·0	32·52
	25	3·0	32·70
	40	3·0	32·79
Station 343.			
1934 VI 22			
48 m.			
44°17′N. 49°25′W	0	8·3	32·50
	10	8·0	32·50
	25	3·2	32·75
	40	3·0	32·77

Date and Position	m.	t°	S°/°°
Station 344.			
1934 VI 23			
63 m.			
45°14′N. 50°12′W	0	7·1	32·61
	10	7·0	32·61
	25	7·0	32·66
	50	–0·3	33·05
Station 345.			
1934 VI 23			
108 m.			
45°45′N. 48°24′W	0	6·0	32·73
	10	6·0	32·77
	25	2·6	33·01
	50	–1·2	33·29
	75	–1·7	33·43
	100	–1·5	33·45
Station 346.			
1934 VI 23			
90 m.			
46°18′N. 48°25′W	0	6·0	32·78
	10	6·0	32·79
	25	4·3	32·83
	50	–1·5	33·23
	75	–1·6	33·34
Station 347.			
1934 VI 24			
115 m.			
46°57′N. 48°03′W	0	6·0	32·79
	10	6·0	32·79
	25	2·1	32·90
	50	–1·6	33·23
	75	–1·5	33·40
	100	–1·1	33·47
Station 348.			
1934 VI 24			
95 m.			
47°25′N. 49°17′W	0	5·3	32·73
	10	5·2	32·73
	25	2·1	32·79
	50	–1·1	32·99
	75	–1·4	33·25
	90	–1·3	33·45
Station 349.			
1934 VI 24			
100 m.			
47°08′N. 50°20′W	0	6·0	32·68
	10	5·5	32·68
	25	3·4	32·77
	50	–0·3	32·90
	75	–1·0	33·08
	90	–1·1	33·10
Station 350.			
1934 VI 25			
95 m.			
46°55′N. 51°22′W	0	5·9	32·62
	10	5·9	32·64
	25	5·4	32·66
	50	0·1	32·88
	75	–1·2	32·98
	90	–1·3	33·08

Station 1.

Date and Position	m.	t°	S°/°°
1934 VI 25 108 m. Off Bay Bulls	0	5·9	31·96
	10	5·9	31·96
	25	5·4	32·01
	50	5·0	32·28
	75	−1·2	33·08
	100	−1·5	33·17

Station 351.

Date and Position	m.	t°	S°/°°
1934 VI 27 113 m. 47°35′N. 52°38′ 30″ W	0	5·3	31·73
	10	5·2	31·79
	25	4·8	32·48
	50	1·5	32·52
	75	−0·9	32·94
	100	−1·5	32·99

Station 352.

Date and Position	m.	t°	S°/°°
1934 VI 27 62 m. 47°45′30″N. 53°07′30″W	0	7·4	32·03
	10	6·9	32·16
	25	5·3	32·30
	50	1·0	32·68

Station 353.

Date and Position	m.	t°	S°/°°
1934 VI 28 138 m. 48°07′30″N. 52°46′W	0	6·7	31·67
	10	6·7	31·74
	25	4·4	31·85
	50	−0·6	32·84
	75	−1·4	33·12
	100	−1·6	33·21
	135	−1·6	33·17

Station 354.

Date and Position	m.	t°	S°/°°
1934 VI 28 233 m. 48°25′N. 52°57′W	0	6·0	31·33
	10	5·5	31·37
	25	2·6	32·17
	50	0·8	32·57
	75	−1·2	33·14
	100	−2·0	33·28
	200	−2·1	33·36

Station 355.

Date and Position	m.	t°	S°/°°
1934 VI 28 103 m. 48°39′N. 52°54′W	0	7·2	30·10
	10	5·3	31·36
	25	1·9	32·16
	50	−0·9	32·99
	75	−1·4	33·21
	100	−1·5	33·26

Station 356.

Date and Position	m.	t°	S°/°°
1934 VI 28 No sounding 49°03′N. 52°53′W	0	6·7	30·49
	10	3·8	32·19
	25	1·0	32·55
	50	−1·4	33·21
	75	−2·1	33·29
	100	−2·2	33·34
	200	−2·0	33·49

Station 357.

Date and Position	m.	t°	S°/°°
1934 VI 29 118 m. 49°48′N. 53°08′W	0	5·5	30·07
	10	0·7	31·46
	25	−0·8	32·68
	50	−1·5	33·14
	75	−1·7	33·28
	100	−1·7	33·31

Station 358.

Date and Position	m.	t°	S°/°°
1934 VI 29 No sounding 50°14′N. 54°18′W	0	6·7	30·88
	10	6·6	30·88
	25	1·8	32·73
	50	−1·0	33·08
	75	−1·5	33·16
	100	−1·6	33·28
	200	−1·7	33·40

Station 359.

Date and Position	m.	t°	S°/°°
1934 VII 2 45 m. 50°55′N. 55°41′W	0	2·4	32·01
	10	2·2	32·05
	25	1·7	32·10
	40	0·8	32·41

Station 360.

Date and Position	m.	t°	S°/°°
1934 VII 2 55 m. 51°22′N. 55°29′W	0	3·3	31·50
	10	3·0	31·61
	25	3·0	31·64
	50	−0·9	32·99

Station 361.

Date and Position	m.	t°	S°/°°
1934 VII 2 44 m. 51°34′N. 55°22′W	0	3·5	32·01
	10	3·2	32·03
	25	0·5	32·48
	40	−0·1	32·71

Station 362.

Date and Position	m.	t°	S°/°°
1934 VII 3			
131 m.			
51°59′N. 55°33′W	0	3·3	31·29
	10	3·2	31·34
	25	2·7	31·54
	50	2·0	31·89
	75	–0·4	32·79
	100	–1·2	32·99
	125	–1·4	33·05

Station 363.

Date and Position	m.	t°	S°/°°
1934 VII 5			
229 m.			
52°48′N. 55°30′W	0	3·0	30·63
	10	2·2	31·64
	25	1·6	32·21
	50	1·4	32·37
	75	0·3	32·68
	100	–0·7	32·88
	200	–1·6	33·28

Station 364.

Date and Position	m.	t°	S°/°°
1934 VII 5			
63 m.			
53°02′30″N.	0	4·4	29·77
55°41′W	10	4·0	29·77
	25	1·8	31·99
	50	1·3	32·57

Station 365.

Date and Position	m.	t°	S°/°°
1934 VII 6			
79 m.			
53°29′N. 55°33′W	0	3·8	29·75
	10	2·5	31·68
	25	1·1	32·25
	50	–0·4	32·75
	75	–0·8	32·88

Station 366.

Date and Position	m.	t°	S°/°°
1934 VII 6			
36 m.			
53°47′N. 56°27′W	0	4·8	26·90
	10	4·0	29·09
	25	1·5	31·64
	35	0·8	32·10

Station 367.

Date and Position	m.	t°	S°/°°
1934 VII 8			
94 m.			
52°22′N. 55°34′W	0	4·2	30·28
	10	4·1	30·30
	25	2·2	31·77
	50	1·4	32·55
	75	–0·9	33·05
	90	–1·3	33·12

Station 368.

Date and Position	m.	t°	S°/°°
1934 VII 10			
82 m.			
52°02′N. 55°37′W	0	3·8	31·00
	10	3·8	31·02
	25	3·0	31·50
	50	1·9	32·19
	75	0·8	32·61

Station 369.

Date and Position	m.	t°	S°/°°
1934 VII 11			
22 m.			
51°39′N. 55°47′W	0	4·0	31·54
	10	4·0	31·54
	20	4·0	31·54

Station 370.

Date and Position	m.	t°	S°/°°
1934 VII 11			
45 m.			
51°23′30″N.	0	2·6	31·89
57°00′W	10	2·3	31·92
	25	1·3	32·17
	40	1·2	32·16

Station 371.

Date and Position	m.	t°	S°/°°
1934 VII 11			
83 m.			
51°13′N. 57°12′W	0	2·8	32·01
	10	2·7	32·03
	25	2·4	32·03
	50	–1·2	32·30
	75	–1·2	32·32

Station 372.

Date and Position	m.	t°	S°/°°
1934 VII 12			
251 m.			
50°31′N. 57°54′W	0	6·2	30·71
	10	6·2	30·78
	25	–1·4	31·70
	50	–1·6	32·16
	75	–1·4	32·34
	100	–1·0	32·61
	200	2·3	33·74
	225	2·8	34·09

Station 373.

Date and Position	m.	t°	S°/°°
1934 VII 13			
73 m.			
49°10′N. 58°35′W	0	10·9	30·95
	10	9·8	31·13
	25	7·8	31·27
	50	0·2	31·83
	70	–1·0	32·30

Station 374.

Date and Position	m.	t°	S°/°°
1934 VII 13			
39 m.			
48°47′N. 59°00′W	0	9·4	31·27
	10	8·8	31·32
	25	7·8	31·33
	35	0·8	31·75

Station 375.

Date and Position	m.	t°	S°/°°
1934 VII 13			
84 m.			
48°23′N. 59°04′W	0	12·2	31·17
	10	5·2	31·50
	25	0·8	31·85
	50	–0·7	32·35
	75	0·0	32·71

Station 376.

Date and Position	m.	t°	S°/°°
1934 VII 13			
85 m.			
48°01′N. 59°24′W	0	11·0	31·20
	10	9·8	31·22
	25	1·1	31·75
	50	0·1	32·08
	75	0·2	32·41

Station 377.

Date and Position	m.	t°	S°/°°
1934 VII 14			
440 m. (approx.)			
47°27′N. 59°47′W	0	12·0	31·24
	10	8·5	31·39
	25	−1·4	31·90
	50	−0·8	32·30
	75	−0·2	32·61
	100	1·0	33·21
	200	3·7	34·43
	300	4·1	34·78
	400	4·1	34·97

Station 378.

Date and Position	m.	t°	S°/°°
1934 VII 14			
214 m.			
47°20′N. 57°52′W	0	9·5	31·66
	10	4·2	31·81
	25	0·1	32·17
	50	0·2	32·32
	75	0·0	32·61
	100	0·7	33·05
	200	3·6	34·39

Station 379.

Date and Position	m.	t°	S°/°°
1934 VII 16			
117 m.			
46°20′N. 55°52′W	0	10·1	31·85
	10	10·1	31·85
	25	3·2	32·32
	50	−0·5	32·59
	75	−1·0	32·71
	100	−1·1	32·85

Station 380.

Date and Position	m.	t°	S°/°°
1934 VII 17			
207 m.			
46°29′N. 54°50′W	0	10·1	32·16
	10	10·1	32·16
	25	2·0	32·62
	50	−1·0	32·73
	75	−1·0	32·88
	100	−1·1	32·96
	200	−1·2	33·21

Station 381.

Date and Position	m.	t°	S°/°°
1934 VII 17			
141 m.			
46°18′N. 53°30′W	0	9·6	32·43
	10	9·6	32·43
	25	6·8	32·55
	50	1·4	32·81
	75	−1·0	33·07
	100	−1·6	33·16
	135	−1·4	33·26

Station 1.

Date and Position	m.	t°	S°/°°
1934 VII 18			
111 m.			
Off Bay Bulls	0	9·0	30·97
	10	8·7	30·97
	25	5·9	31·94
	50	1·2	32·73
	75	−1·1	33·08
	100	−1·4	33·16

(*e*) *FALL RESEARCH CRUISE*

August 23–*September* 9, 1934.

Station 382.

Date and Position	m.	t°	S°/°°
1934 VIII 23			
100 m.			
Off Bay Bulls	0	12·3	31·18
	10	12·0	31·20
	25	2·8	32·07
	50	−0·4	32·74
	100	3·1	32·19

Station 383.

Date and Position	m.	t°	S°/°°
1934 VIII 24			
117 m.			
46°27′N. 52°55′W	0	12·8	31·18
	10	12·5	31·31
	25	2·0	32·32
	50	−0·4	32·90
	100	−1·5	33·17

Station 384.

Date and Position	m.	t°	S°/°°
1934 VIII 24			
52 m.			
46°32′N. 53°54′W	0	14·5	31·66
	10	14·4	31·70
	25	7·5	32·71
	50	0·3	31·83

Station 385.

Date and Position	m.	t°	S°/°°
1934 VIII 24			
135 m.			
46°43′N. 54°36′W	0	15·4	31·85
	10	15·1	31·96
	25	7·0	32·28
	50	−0·1	32·66
	100	−1·5	33·14
	135	−1·0	32·99

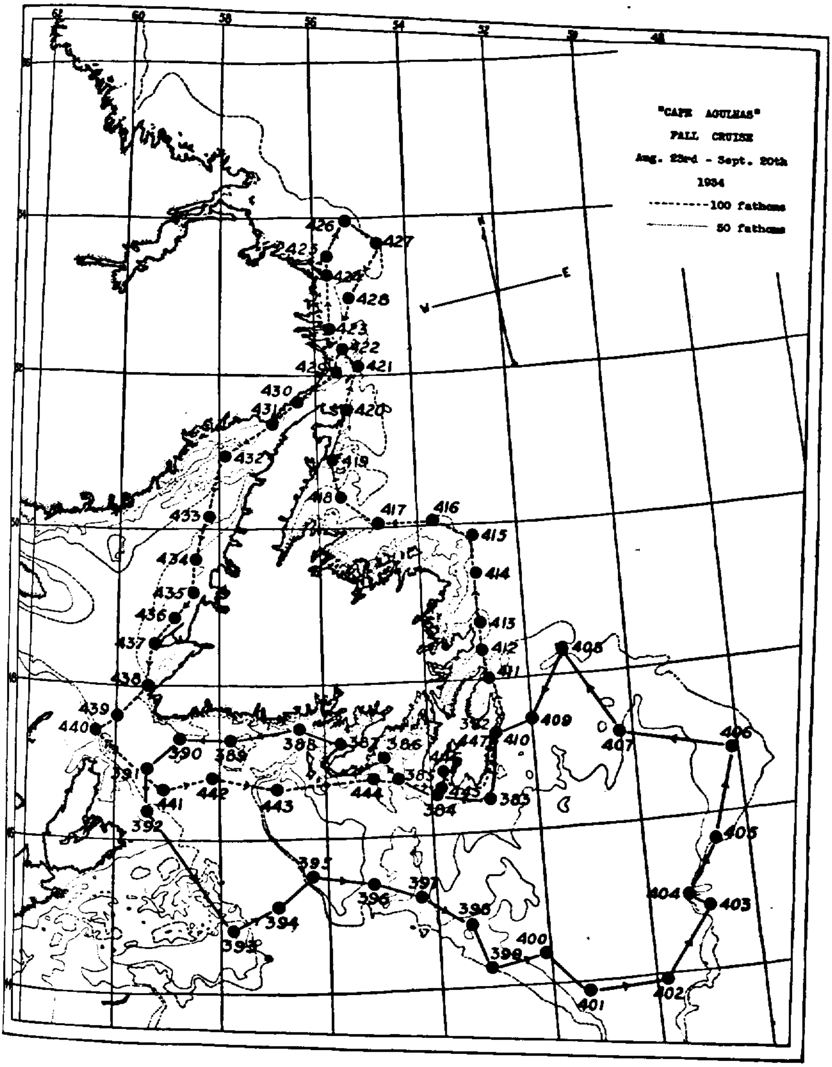
"CAPE AGULHAS"
FALL CRUISE
Aug. 23rd - Sept. 20th
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FIG. 9

Station 386.

Date and Position	m.	t°	S°/°°
1934 VIII 24			
65 m.			
47°00′N. 55°00′W	0	12·8	31·89
	10	7·9	32·30
	25	2·0	32·50
	50	–0·6	32·59
	65	–0·2	32·77

Station 387.

Date and Position	m.	t°	S°/°°
1934 VIII 25			
205 m.			
47°14′N. 55°40′W	0	14·2	31·22
	10	13·0	31·31
	25	1·7	32·12
	50	0·0	32·30
	100	–0·2	32·48
	200	–0·5	32·59

Station 388.

Date and Position	m.	t°	S°/°°
1934 VIII 27			
300 m.			
47°26′N. 56°30′W	0	14·9	31·13
	10	14·1	31·18
	25	5·3	31·81
	50	1·5	32·14
	100	1·1	33·03
	200	4·0	34·13
	250	4·0	34·30

Station 389.

Date and Position	m.	t°	S°/°°
1934 VIII 27			
165 m.			
47°12′N. 57°50′W	0	13·9	31·26
	10	13·6	31·15
	25	4·5	31·85
	50	1·0	32·39
	100	1·0	33·05
	150	3·8	33·88

Station 390.

Date and Position	m.	t°	S°/°°
1934 VIII 28			
250 m.			
47°18′N. 58°40′W	0	15·3	30·54
	10	14·3	30·65
	25	2·0	32·01
	50	0·6	32·19
	100	0·5	32·64
	200	4·0	34·32

Station 391.

Date and Position	m.	t°	S°/°°
1934 VIII 28			
No sounding			
46°55′N. 59°22′W	0	16·2	29·75
	10	15·0	30·14
	25	3·7	31·13
	50	0·2	31·95
	100	1·0	32·92
	200	3·8	34·16
	400	4·0	34·79

Station 392.

Date and Position	m.	t°	S°/°°
1934 VIII 29			
103 m.			
46°25′N. 59°26′W	0	17·7	28·52
	10	17·6	28·62
	25	15·9	29·57
	50	3·0	31·26
	100	0·5	32·88

Station 393.

Date and Position	m.	t°	S°/°°
1934 VIII 30			
40 m.			
44°49′N. 57°46′W	0	17·2	30·76
	10	17·1	30·84
	25	12·1	31·24
	35	7·5	31·55

Station 394.

Date and Position	m.	t°	S°/°°
1934 VIII 30			
350 m.			
45°06′N. 56°58′W	0	16·8	31·24
	10	16·5	31·33
	25	11·4	32·30
	50	3·2	32·64
	100	4·3	33·72
	200	6·1	34·62
	300	5·0	34·61

Station 395.

Date and Position	m.	t°	S°/°°
1934 VIII 30			
68 m.			
45°28′N. 56°16′W	0	16·0	31·26
	10	16·0	31·44
	25	9·7	31·87
	60	0·3	32·44

Station 396.

Date and Position	m.	t°	S°/°°
1934 VIII 31			
140 m.			
45°21′N. 55°09′W	0	16·5	31·73
	10	15·8	31·83
	25	4·0	32·46
	50	0·6	32·57
	100	–1·0	33·05
	135	–0·3	33·29

Station 397.

Date and Position	m.	t°	S°/°°
1934 VIII 31			
108 m.			
45°12′N. 54°17′W	0	16·0	31·64
	10	16·0	31·73
	25	13·8	31·92
	50	1·4	32·35
	100	1·1	32·85

Station 398.

Date and Position	m.	t°	S°/°°
1934 VIII 31			
94 m.			
44°46′N. 53°22′W	0	16·5	30·86
	10	15·9	30·91
	25	11·7	31·92
	50	0·7	32·37
	90	–0·5	32·55

Date and Position	m.	t°	S°/°°
Station 399.			
1934 VII 31			
No sounding			
44°18′N. 53°06′W	0	17·5	32·17
	10	17·5	32·10
	25	11·9	32·64
	50	6·0	33·36
	100	6·8	34·06
	200	7·1	34·57
	400	5·0	34·76
Station 400.			
1934 IX 1			
82 m.			
44°21′N. 52°05′W	0	17·7	31·83
	10	17·5	31·83
	25	8·0	32·66
	50	2·2	33·16
	75	4·8	34·00
Station 401.			
1934 IX 1			
78 m.			
43°55′N. 51°20′W	0	18·1	32·05
	10	18·0	32·05
	25	3·7	32·79
	50	2·0	33·07
	75	2·7	33·67
Station 402.			
1934 IX 1			
48 m.			
43°56′N. 49°50′W	0	16·7	31·94
	10	16·7	31·94
	25	2·8	32·92
	45	2·7	32·98
Station 403.			
1934 IX 2			
No sounding			
44°50′N. 48°56′W	0	12·0	32·19
	10	8·0	32·46
	25	3·2	32·85
	50	−2·0	33·38
	100	−1·9	33·43
	200	−0·3	33·80
	300	1·6	34·32
Station 404.			
1934 IX 2			
72 m.			
44°59′N. 49°20′W	0	15·6	32·21
	10	14·0	32·21
	25	1·7	32·85
	50	−1·3	33·12
	70	−1·3	33·21

Date and Position	m.	t°	S°/°°
Station 405.			
1934 IX 2			
90 m.			
45°38′N. 48°41′W	0	13·6	32·35
	10	12·7	32·35
	25	5·0	32·68
	50	−1·4	33·21
	90	−1·5	33·34
Station 406.			
1934 IX 3			
108 m.			
46°51′N. 48°06′W	0	13·2	32·39
	10	13·0	32·41
	25	11·4	32·46
	50	−0·3	33·05
	100	−1·2	33·34
Station 407.			
1934 IX 3			
100 m.			
47°13′N. 50°19′W	0	14·6	31·51
	10	14·0	31·51
	25	10·0	32·43
	50	1·4	32·87
	100	−1·2	33·31
Station 408.			
1934 IX 4			
162 m.			
48°17′N. 51°15′W	0	13·2	31·50
	10	13·2	31·50
	25	3·5	32·81
	50	−1·5	33·25
	100	−1·9	33·34
	160	−1·3	33·47
Station 409.			
1934 IX 4			
139 m.			
47°22′N. 52°00′W	0	13·7	31·57
	10	13·6	31·61
	25	6·8	32·46
	50	−0·5	33·03
	100	−1·6	33·34
	135	−1·5	33·36
Station 410.			
1934 IX 4			
102 m.			
1 mile off Bay	0	12·4	31·39
Bulls Lighthouse	10	12·2	31·52
	25	6·0	32·07
	50	1·4	32·48
	100	−1·6	33·21

Date and Position	m.	t°	S°/°°
Station 411.			
1934 IX 6			
144 m.			
48°01′N. 52°47′W	0	12·2	31·09
	10	11·7	31·13
	25	10·0	31·26
	50	1·9	32·47
	100	–0·7	32·94
	140	–1·4	33·33
Station 412.			
1934 IX 6			
No sounding			
48°22′N. 52°51′W	0	12·0	30·99
	10	10·8	31·11
	25	3·7	31·78
	50	1·4	32·32
	100	–1·0	32·79
	200	–1·2	33·29
	250	–0·5	33·72
Station 413.			
1934 IX 6			
131 m.			
48°46′N. 52°52′W	0	11·2	31·27
	10	11·0	31·66
	25	5·0	32·30
	50	0·5	32·62
	100	–1·6	33·12
	130	–1·7	33·21
Station 414.			
1934 IX 7			
No sounding			
49°23·N. 52°55·W	0	11·4	30·99
	10	7·9	31·39
	25	2·1	32·44
	50	–1·0	32·90
	100	–1·7	33·14
	200	–1·3	34·09
	300	0·9	34·09
Station 415.			
1934 IX 7			
No sounding			
49°53′N. 52°56′W	0	11·4	31·11
	10	11·0	31·22
	25	2·8	32·57
	50	–1·0	32·87
	100	–1·5	33·33
	200	–0·5	33·79
	250	0·0	33·89
Station 416.			
1934 IX 7			
171 m.			
50°04′N. 53°43′W	0	11·4	31·44
	10	10·1	31·55
	25	0·7	33·21
	50	–1·5	33·21
	100	–1·6	33·26
	170	–1·3	33·56
Station 417.			
1934 IX 7			
216 m.			
50°04′N. 54°45′W	0	11·0	30·97
	10	8·8	31·46
	25	1·8	32·73
	50	–1·2	33·07
	100	–1·5	33·38
	200	–1·0	33·71
Station 418.			
1934 IX 8			
234 m.			
50°26′N. 55°30′W	0	10·7	30·95
	10	10·0	31·08
	25	1·1	32·53
	50	–0·9	32·90
	100	–1·3	33·17
	200	–1·2	33·47
	230	–1·1	33·69
Station 419.			
1934 IX 8			
42 m.			
50°54′N. 55°41′W	0	11·2	30·84
	10	11·0	30·86
	25	8·0	30·97
	40	2·2	32·43
Station 420.			
1934 IX 8			
41 m.			
51°33′N. 55°22′W	0	10·1	30·94
	10	9·6	30·94
	25	9·3	31·06
	40	7·7	31·31
Station 421.			
1934 IX 8			
138 m.			
52°08′N. 55°04′W	0	8·6	30·69
	10	7·0	31·63
	25	0·6	32·50
	50	–1·0	32·88
	100	–1·4	33·03
	135	–1·3	33·33
Station 422.			
1934 IX 9			
172 m.			
52°21′N. 55°23′W	0	8·0	31·34
	10	5·5	31·87
	25	1·0	32·43
	50	–0·5	32·77
	100	–1·3	32·96
	170	–1·4	33·19
Station 423.			
1934 IX 9			
52 m.			
52°36′N. 55°41′	0	9·2	29·73
30″W	10	6·9	31·35
	25	2·6	32·21
	50	0·0	32·57

Date and Position	m.	t°	S°/°°
Station 424.			
1934 IX 10			
50 m.			
53°17′30″N. 55°40′W	0	8·2	29·54
	10	8·2	29·55
	25	6·1	30·72
	50	1·6	32·19
Station 425.			
1934 IX 11			
56 m.			
53°32′N. 55°41′W	0	7·9	29·52
	10	7·8	29·81
	25	5·7	31·41
	55	1·8	31·98
Station 426.			
1934 IX 11			
130 m.			
53°58′N. 55°15′W	0	6·1	32·28
	10	6·0	32·28
	25	5·0	32·39
	50	−1·0	33·08
	100	−1·0	33·31
	125	−1·0	33·45
Station 427.			
1934 IX 11			
140 m.			
53°42′N. 54°34′W	0	5·2	32·27
	10	5·0	32·28
	25	4·7	32·30
	50	−1·0	33·05
	100	−0·7	33·54
	130	0·0	33·82
Station 428.			
1934 IX 12			
145 m.			
53°00′N. 55°12′W	0	5·3	32·48
	10	5·2	32·50
	25	5·2	32·35
	50	−1·0	33·19
	100	−1·0	33·14
	140	−0·6	33·54
Station 429.			
1934 IX 12			
105 m.			
52°04′N. 55°32′W	0	8·2	30·08
	10	8·1	30·01
	25	6·0	31·39
	50	1·0	32·35
	100	−0·4	32·64
Station 431.			
1934 IX 12			
73 m.			
51°25′N. 56°55′W	0	6·8	31·39
	10	5·8	31·70
	25	4·7	31·82
	50	1·8	32·16
	70	1·9	32·25

Date and Position	m.	t°	S°/°°
Station 432.			
1934 IX 13			
153 m.			
50°57′N. 57°57′W	0	11·0	30·72
	10	10·9	30·60
	25	4·8	31·66
	50	0·5	32·08
	100	−1·2	32·57
	150	−1·0	32·64
Station 433.			
1934 IX 14			
250 m.			
50°11′N. 58°12′W	0	12·8	30·54
	10	12·1	30·62
	25	6·7	31·17
	50	−1·2	31·98
	100	−0·4	32·68
	200	3·0	33·86
	250	3·7	34·24
Station 434.			
1934 IX 14			
82 m.			
49°39′N. 58°26′W	0	13·2	30·49
	10	13·0	30·49
	25	−0·5	31·82
	50	−1·3	32·14
	80	−0·5	32·53
Station 435.			
1934 IX 14			
41 m.			
49°13′N. 58°29′W	0	15·8	30·19
	10	14·4	30·40
	25	8·3	31·13
	40	0·3	31·90
Station 436.			
1934 IX 14			
48 m.			
48°53′N. 58°54′W	0	15·2	30·49
	10	14·3	30·49
	25	2·8	31·70
	40	1·8	31·73
Station 437.			
1934 IX 14			
72 m.			
48°34′N. 59°17′W	0	15·4	30·58
	10	14·5	30·60
	25	5·8	31·43
	50	0·0	32·32
	70	0·2	32·34
Station 438.			
1934 IX 15			
148 m.			
48°00′N. 59°30′W	0	15·3	30·76
	10	14·5	30·90
	25	3·2	31·87
	50	0·7	32·19
	100	0·2	32·50
	145	1·5	33·17

Date of Position	m.	t°	S°/°°
Station 439.			
1934 IX 15			
No sounding			
47°37′N. 60°00′W	0	14·4	30·89
	10	12·4	30·98
	25	1·6	31·87
	50	0·2	32·23
	100	0·9	32·92
	200	3·9	34·28
	300	4·0	34·61
Station 440.			
1934 IX 15			
162 m.			
47°16′N. 60°24′W	0	16·4	29·06
	10	14·8	29·57
	25	0·9	31·61
	50	−0·4	32·25
	100	0·3	32·64
	160	2·5	33·72
Station 441.			
1934 IX 18			
No sounding			
46°41′N. 59°00′W	0	17·1	29·17
	10	14·8	30·21
	25	5·2	31·18
	50	0·0	32·10
	100	−0·3	32·61
	200	3·5	34·22
	300	4·2	34·61
Station 442.			
1934 IX 18			
216 m.			
48°50′N. 59°09′W	0	16·8	30·05
	10	16·0	30·51
	25	9·9	31·68
	50	1·4	32·33
	100	0·0	32·87
	200	4·5	34·11

Date of Position	m.	t°	S°/°°
Station 443.			
1934 IX 18			
72 m.			
46°42′N. 56°57′W	0	15·0	31·44
	10	14·0	31·64
	25	4·6	32·21
	50	1·8	32·50
	70	0·6	32·68
Station 444.			
1934 IX 19			
145 m.			
46°47′N. 55°05′W	0	15·4	31·79
	10	15·1	31·79
	25	7·3	32·21
	50	0·6	32·78
	100	−1·1	33·01
	140	−1·3	33·12
Station 445.			
1934 IX 19			
55 m.			
46°35′N. 53°52′W	0	13·3	31·38
	10	12·7	31·39
	25	7·4	31·83
	50	1·5	32·46
Station 446.			
1934 IX 20			
102 m.			
46°48′N. 53°48′W	0	14·0	31·13
	10	13·3	31·39
	25	12·4	31·52
	50	0·8	32·71
	100	−0·5	32·85
Station 447.			
1934 IX 20			
85 m.			
Off Bay Bulls	0	13·0	
	10	12·6	
	25	9·5	31·54
	50	2·3	32·34
	80	0·1	32·73

APPENDIX C

TWO NEW SUBSPECIES OF *LUMPENUS LAMPETRAEFORMIS* (*WALBAUM*) FROM NORTH AMERICA

By V. D. Vladykov, Biological Board of Canada

THROUGH the kindness of Dr. Harold Thompson, Director of the Fishery Research Laboratory, St. John's, Newfoundland, two specimens of **Lumpenus lampetraeformis** were obtained from the latter area. They were caught with V.D. Trawl on June 21, 1934, at Station 336 (45°14'N ; 53°27'W), depth 79 m.

These specimens were different in some respects from those studied by Vladykov and Trembley (1935) from the Gulf of St. Lawrence region. Table 1 (p. 77) summarizes the difference between specimens from the above two regions.

The information on the **Lumpenus lampetraeformis** from European waters is given in detail by Collett (1880). Table II (p. 78) illustrates the difference in respect to the number of vertical fin rays in specimens from various regions.

It is evident that European specimens possess the smallest number of rays in the dorsal and anal fins, whereas the Newfoundland fish show the greatest values. The Laurentian form occupies the intermediate position. This difference between the above three samples seems to us to be of sufficient importance to consider each form as a separate subspecies.

Due to the fact that Walbaum (1792) offered the name **lampetraeformis** to the specimen from Iceland, previously described and figured by Mohr (1776), the European form must retain the name **L. lampetraeformis lampetraeformis** *Walbaum*.

It may be noted that Mohr indicated for the Iceland specimens 72 rays in the dorsal fin, which is practically similar to the number of rays found by Collett (*loc. cit.*) in fish from Norway and Greenland.

The specimens from the Gulf of St. Lawrence may be considered as belonging to a new subspecies **L. lampetraeformis americanus** *Vladykov*. The Newfoundland region is characterized by the presence of a particular form, which we may call **L. lampetraeformis terrae-novae** *subsp. nov.*

The principal differences between the St. Lawrence and Newfoundland forms consist in the number of dorsal and anal fin rays, as well as in body proportions. The body depths in the latter specimens are considerably smaller, being from 4·0 to 4·6 per cent of the body length, whereas in the former the variation was found from 6·1 to 7·0 per cent. The Newfoundland specimens have the dorsal and anal fins located closer to the head than is the case in the Laurentian specimens.

A striking difference was found in the lengths of the caudal fin. The subspecies **terrae-novae** has an extremely elongated caudal fin, which is much longer than the head, while in the subspecies **americanus** the head is as a rule longer than the caudal fin. The shape of this fin in the former subspecies is acute, while in the Laurentian form the outline of the caudal fin is more rounded. The other minor differences between these two forms, summarized in Table I, may be partially due to the differences in sizes of the specimens examined.

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Table I

Comparative data on **Lumpenus lampetraeformis** from two regions.

Character	Gulf of St. Lawrence										Newfoundland	
Sex	Male	Male	Male	Female	Female	Female	Female	Female	Female	Female	Male	Female
TL in mm. ..	230	230	180	245	235	215	190	190	190	185	389	415
L. in mm. ..	205	200	160	220	212	193	170	170	170	165	350	368
B/L % ..	6·1	6·3	–	–	6·6	7·0	–	–	–	–	4·0	4·6
H/L % ..	12·7	13·5	13·7	12·5	12·3	13·5	14·7	14·1	13·5	15·1	9·5	9·5
C/L % ..	12·2	15·0	12·5	11·8	10·9	11·4	11·8	11·8	11·8	12·1	11·2	12·8
H/C % ..	104·0	90·0?	111·0	111·0	113·0	118·0	125·0	120·0	115·0	125·0	85·0	75·0
O/H % ..	23·1	26·0	–	–	26·0	25·0	–	–	–	–	21·2	20·0
S–D/L % ..	13·7	13·5	–	–	12·8	15·0	–	–	–	–	10·0	10·3
S–A/L % ..	39·6	36·0	–	–	38·2	39·6	–	–	–	–	31·7	31·3
P./P–A % ..	38·5	43·0	–	–	43·6	49·0	–	–	–	–	33·8	36·0
P/L % ..	9·8	10·8	–	–	11·2	12·7	–	–	–	–	7·7	8·6
Fin formulae:												
Dorsal ..	LXXVI	LXXIX	LXXVII	LXXIX	LXXV	LXXVI	LXXVIII	LXXVI	LXXVI	LXXVII	LXXXV	LXXXV
Anal ..	52	56	55	55	52	53	54	53	53	54	62	62
Pectoral ..	15	15	16	15	14	15	15	15	15	15	15	15

TL = total length (with caudal fin); L = body (without caudal fin); B = maximal body depth at basis of ventral fin ; H = length of head ; C = length of caudal fin ; O = horizontal diameter of eye ; S–D = distance between tip of snout and beginning of dorsal fin ; S–A = distance between tip of snout and beginning of anal fin ; P = length of pectoral fin ; P–A = distance between bases of pectoral and anal fins.

Table II

Number of rays of vertical fins in **Lumpenus lampetraeformis** from different regions

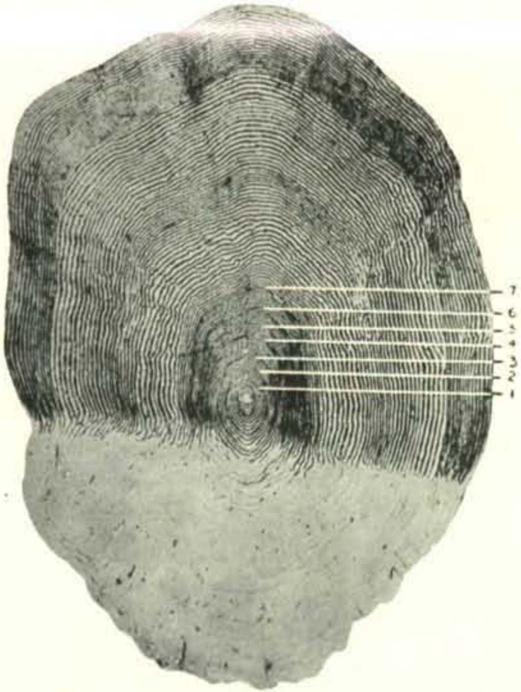
Region	Dorsal Fin		Anal Fin		No. of Specimens	Authorities
	Range	Average	Range	Average		
Norway–Greenland	68–74	71–72	49–52	?	?	Collett, 1880
St. Lawrence	75–79	76·9	52–56	53·7	10	Vladykov, 1935
Newfoundland	85	85	62	62	2	Vladykov, 1935

APPENDIX D

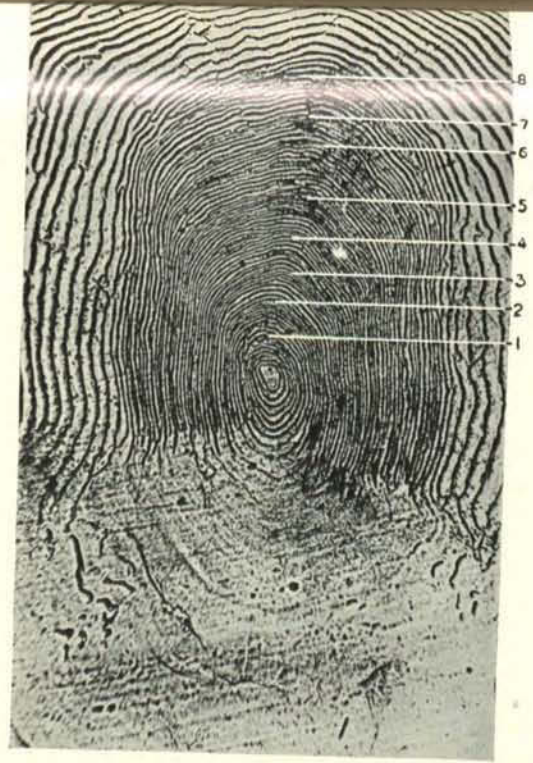
FOURTH LIST OF FISHES IN THE NEWFOUNDLAND FISHING AREA

Sufficient data regarding the distribution of the commoner fishes have been given in previous reports. Further reference need now be made only to rarer fish (more especially to those straying into the area from more southerly waters and, naturally, occurring more frequently in 1934), and to species not hitherto met with in these surveys (e.g. Nos. 77 to 79 and in the following list).

2. **Blue Shark** (*Galeus glaucus*). One, at Lat. 44°40'N ; Long. 53° 10'W.
4. **Big Skate** (*Raja diaphanes*). Station 331.
14. **Pearlsides** (Probably *Myctophum glaciale*). Pelagic, Station 399.
15. **Billfish** (*Scombresox saurus*). Station 341. Also at Stephenville.
38. **Snake Blenny** (*Lumpenus lampetraeformis*). Station 336.
41. **Wrymouth** (*Cryptacanthodes maculatus*). Station 370. Pelagic, Station 422.
44. **Arctic Eelpout** (*Lycodes reticulatus*). Station 349. Also at Lat. 44°40'N ; Long. 52°20'W.
46. **American Pollock** (*Pollachius virens*). Station 337.
64. *Paralepis borealis*. Pelagic, Station 339.
67. **Sun Fish** (*Mola mola*). Station 440. Also at Curling.
68. **Mackerel Shark** (*Isurus punctatus*). In trawl at Whale Deep, Grand Bank, March, 1934.
77. **Greenland Shark** (*Somniosus microcephalus* Bloch and Schneider), 16½' long. At Lat. 44°31'N ; Long. 52°25'W. March, 1934.
78. **Basking Shark** (*Cetorhinus maximum*, Gunner). At Petty Harbour, near St. John's and Placentia. The Petty Harbour specimen was entangled in a codtrap and towed ashore. Length 32 feet. (Plate 2.)
79. **Georges Bank Flounder** (*Pseudopleuronectes dignabilis* Kendall). Stations 331, 337, 338.



(a)



(b) *Photo: A. Proctor.*

PLATE 1.

Basking Shark.

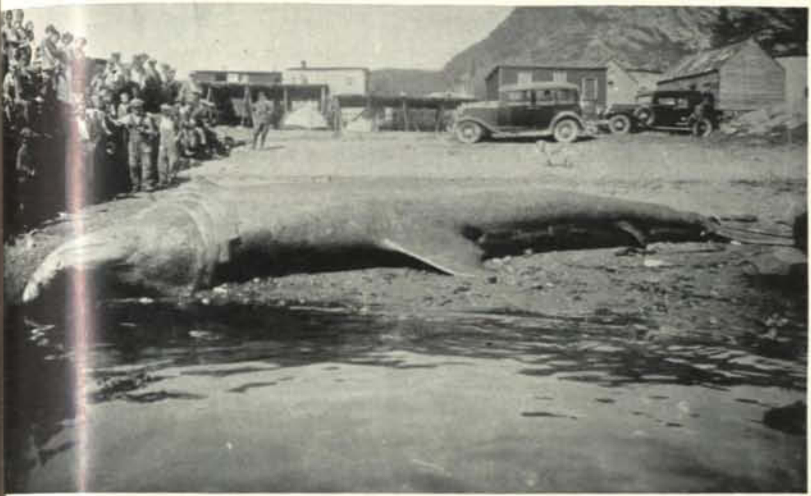
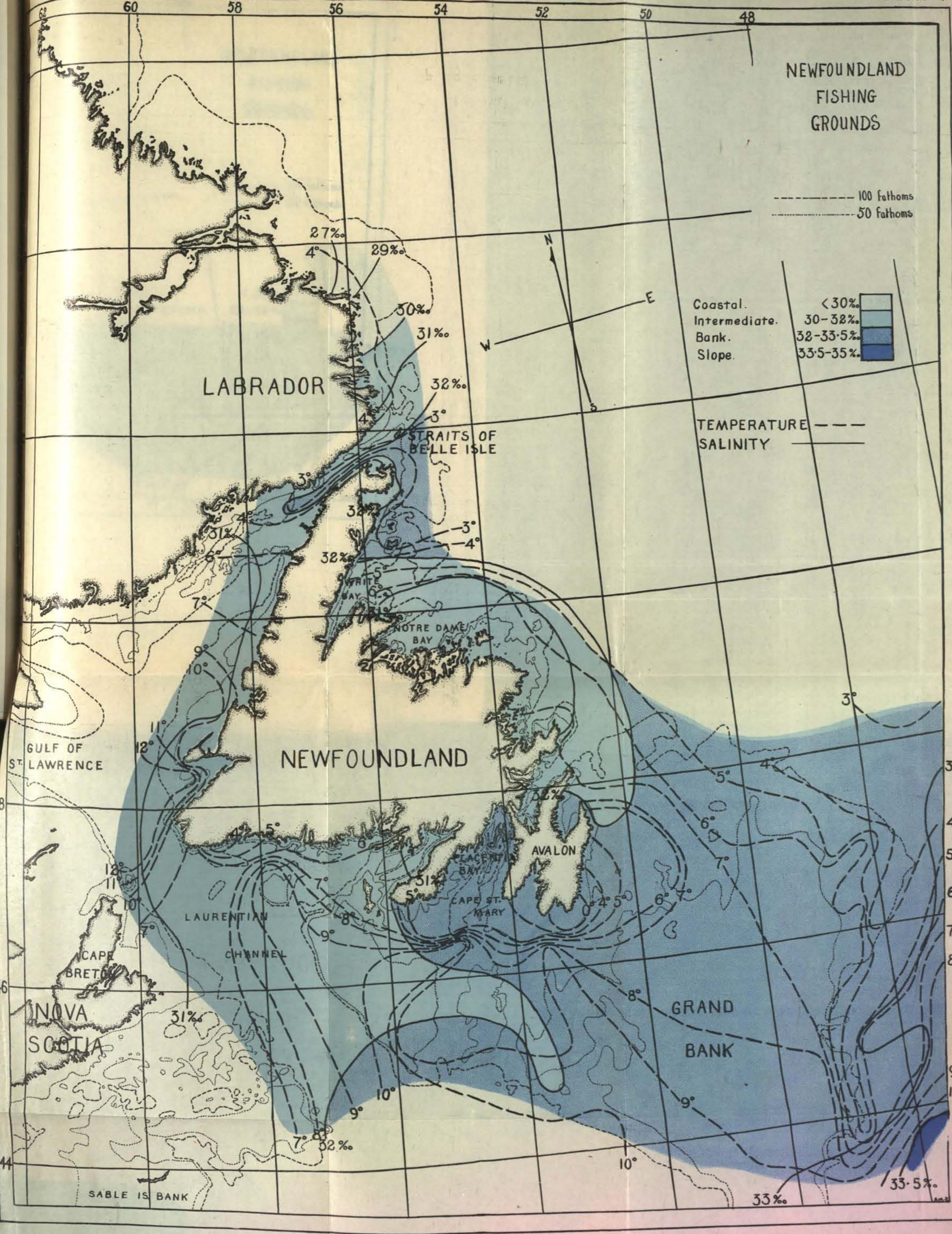
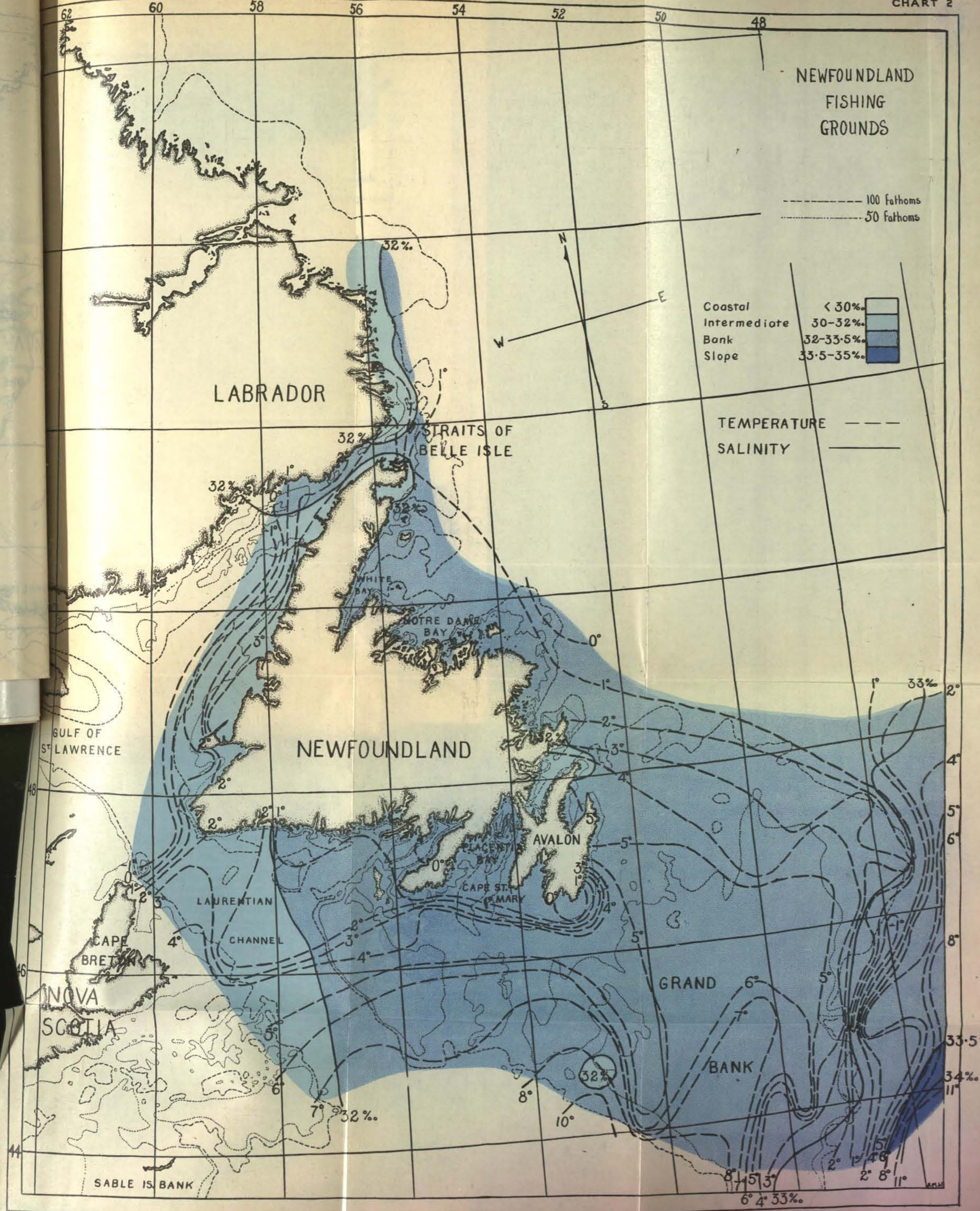


PLATE 2. *Photo: A. Proctor.*

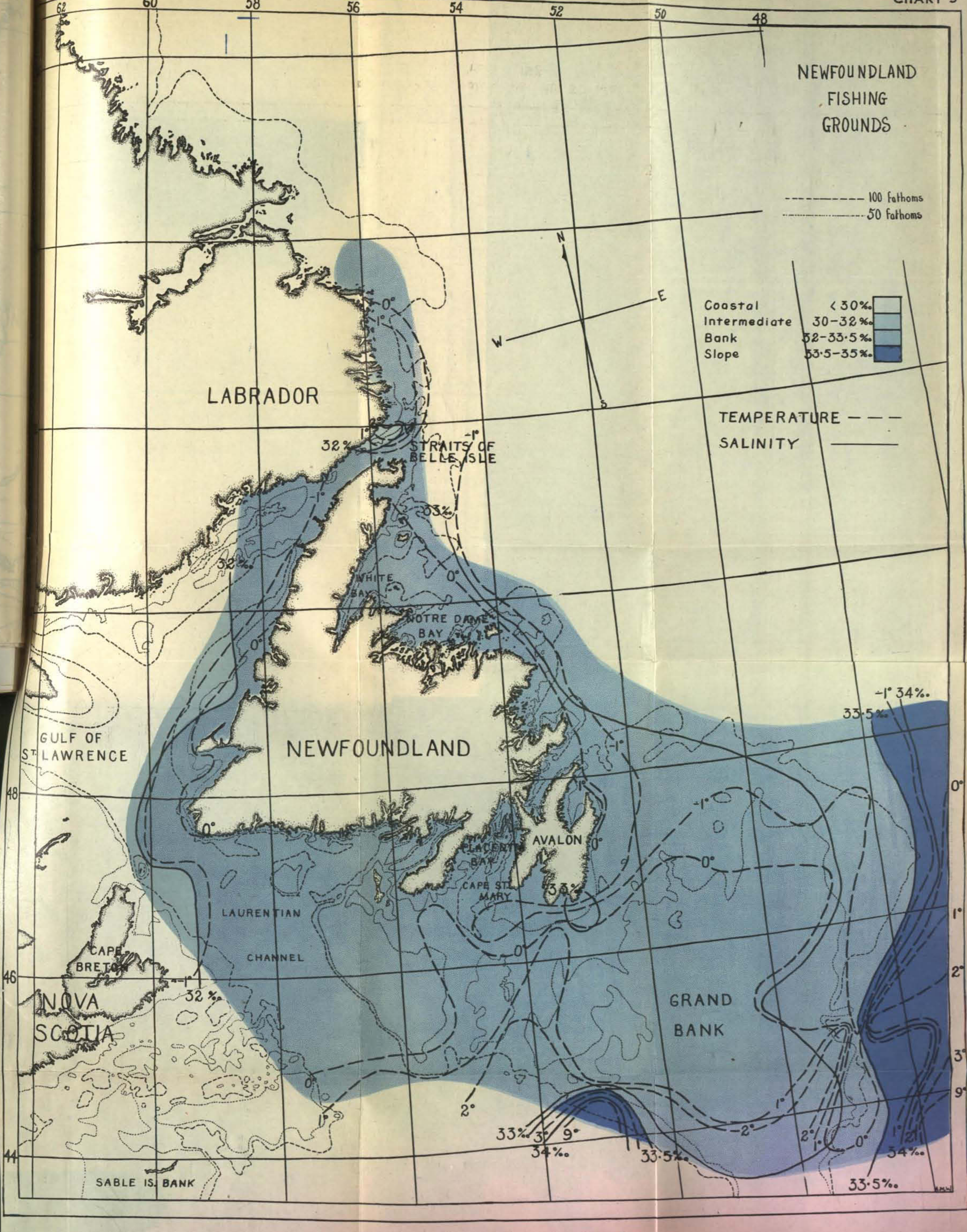


Temperatures and Salinities at Surface.
Spring Cruise 1934.

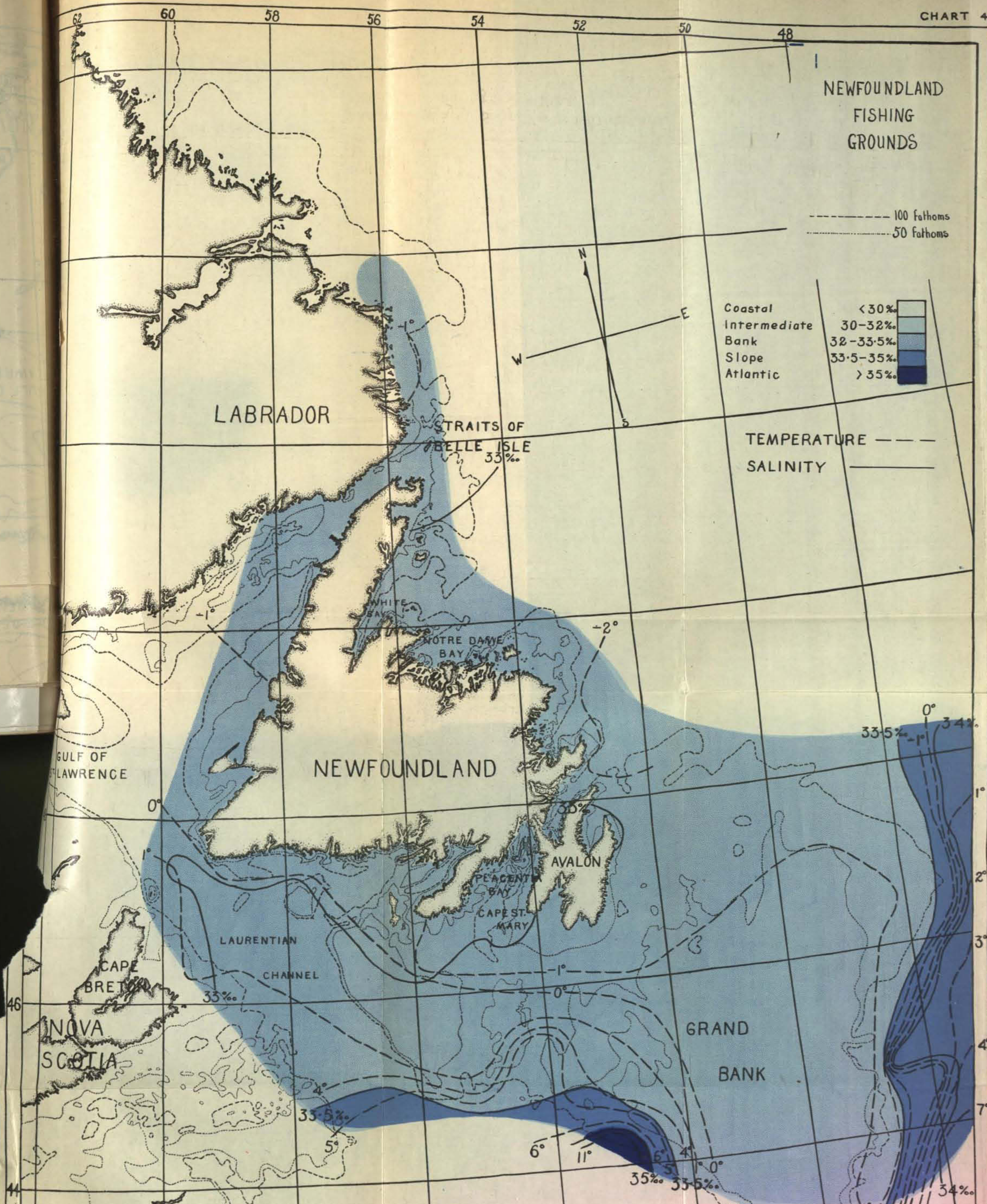


Temperatures and Salinities at 25 metres
Spring Cruise 1934.

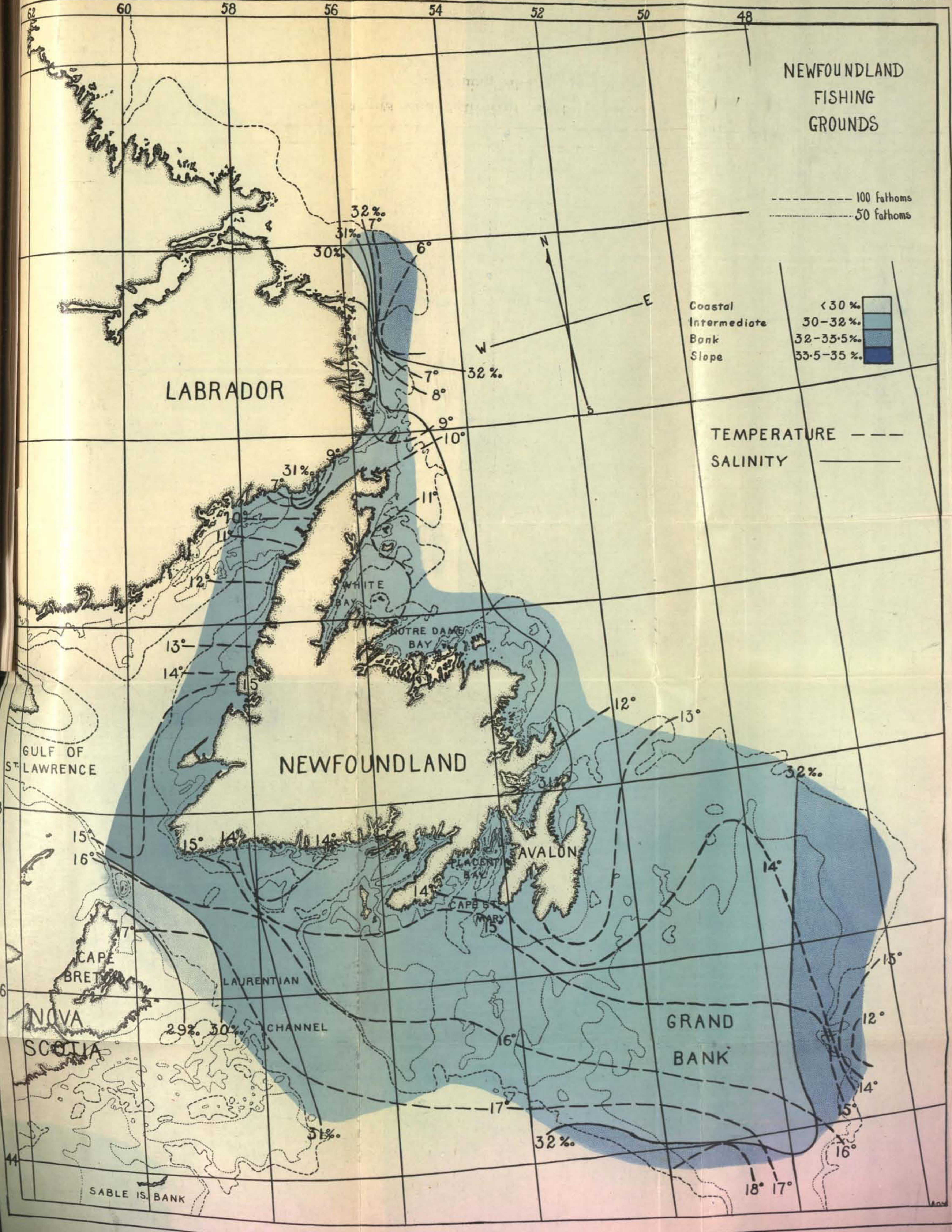
CHART 3



Temperatures and Salinities at 50 metres
Spring Cruise 1934.



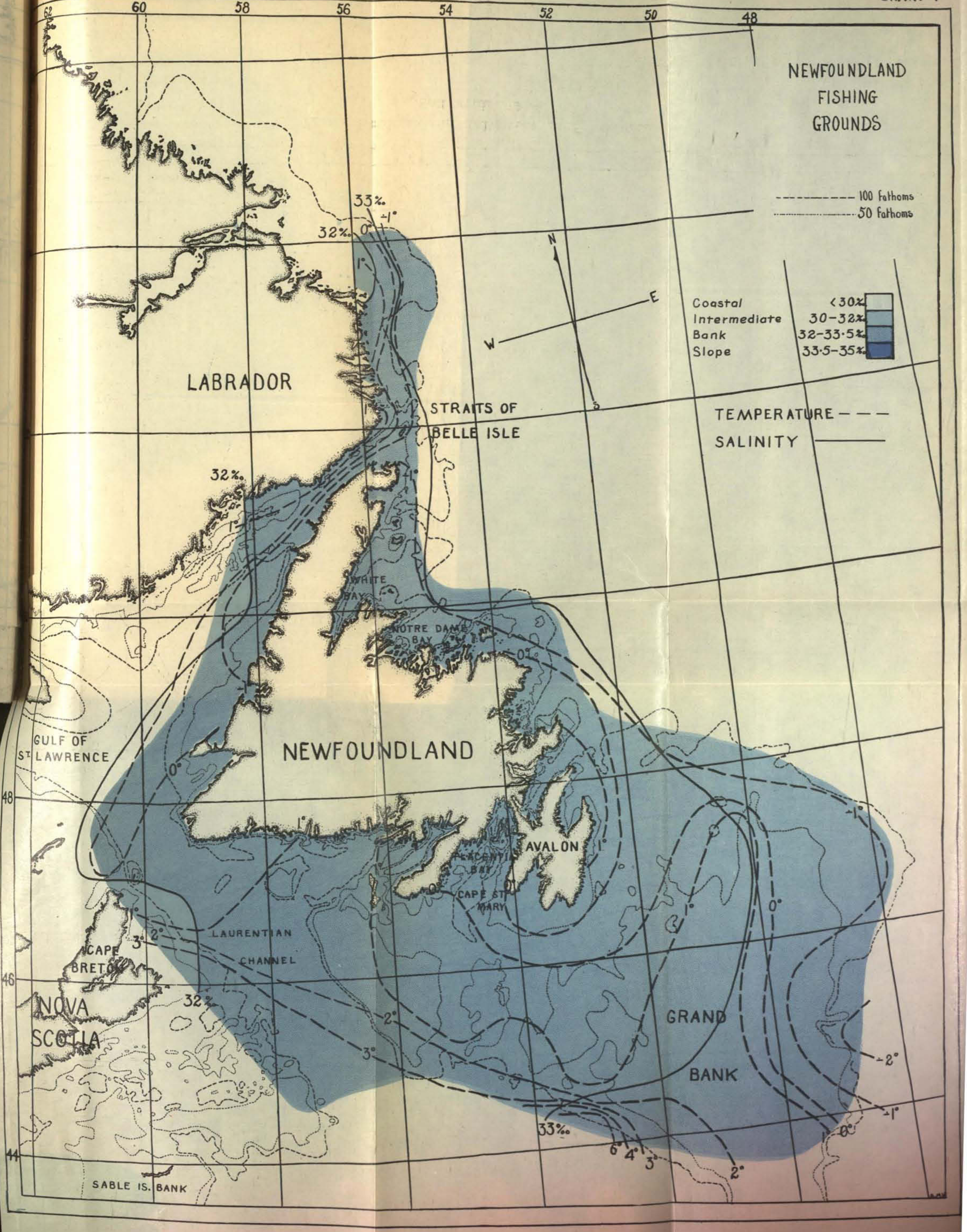
Temperatures and Salinities at 100 metres.
Spring Cruise 1934.



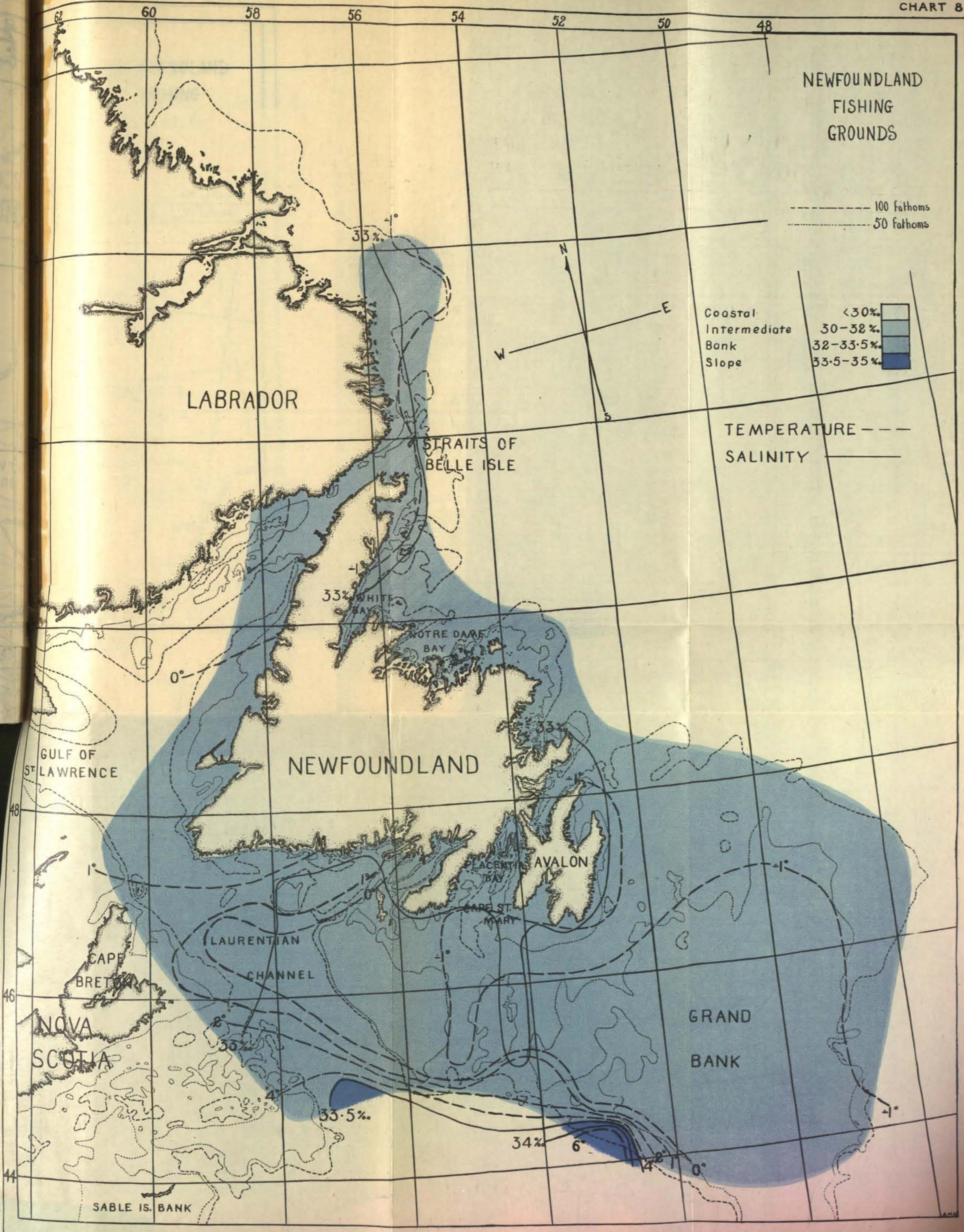
Temperatures and Salinities at Surface.

Temperatures and Salinities at 25 metres.
Fall Cruise 1934.

CHART 7



Temperatures and Salinities at 50 metres.
Fall Cruise 1934



Temperatures and Salinities at 100 metres

Fall Cruise 1934

CHART 9

Movements of Drift Bottles.
1934.

REPORTS OF THE NEWFOUNDLAND FISHERY RESEARCH LABORATORY

1935

DEPARTMENT OF NATURAL RESOURCES

NEWFOUNDLAND

DIVISION OF FISHERY RESEARCH

ANNUAL REPORT

YEAR 1935

(APRIL, 1935—MARCH, 1936)

With 19 *Figures and* 9 *Charts*

This Report may be referred to as

Vol. II, No. 5

of the

"Reports of the Newfoundland Fishery Research Laboratory, Division of Fishery Research, Department of Natural Resources, Newfoundland."

Price $0.75

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APPENDICES

I. GENERAL REPORT.

By H. Thompson

THIS report covers the fifth year of the operations of the Newfoundland Fishery Research Laboratory and marks the conclusion of the first phase of its work. During this period the attempt has been to make a general survey of the fishery situation and its possibilities. It was, of course, desirable to adhere as closely as possible to a definite plan so that result, would be based on data amassed on a uniform system. It has, fortunatelys proved possible to overcome the many difficulties which from time to time threatened continuity, and to reserve to the conclusion of the period the task of effecting desirable changes. At the same time it has proved possible to give consideration to pressing trade problems as they arose from time to time.

A scheme of fishery investigation, such as was called for in the case of Newfoundland, where little in this direction had previously been attempted, involves the prosecution of two distinct enquiries—the first being concerned with *the nature and quantities* of available raw material, the second with the *utilisation* of that material in the most effective fashion.

In the preliminary stages it was essential to devote most attention to the appraisal of just what materials are more or less readily to hand, and what quantities can be relied upon. Once such facts are known it is a comparatively simple matter to apply or adapt the most modern and acceptable methods of treatment of these materials. As a matter of fact, looking back, one can say that both before and during the five-year period we are considering, more fishery developmental projects broke down owing to lack of prevision in the matter of ensuring the necessary supplies of raw material, than owing to imperfections of processing technique. It is necessary to emphasize this point, since there is a popular tendency, not shared by those who have real experience of the fish trade or of fisheries' science, to consider that great forward steps could be made by the expenditure of large capital sums and the application of what are vaguely called formulae. As a matter of fact, capital and methods are almost always readily available or forthcoming whenever it can be shown that fairly continuous operations can be guaranteed as far as the supply of raw materials is concerned. The preliminary decision to give a full measure of attention to the study of the distribution of the marine fauna, and to fluctuations from year to year in the local and general appearance of fish shoals, requires no justification. Such work has led to commercial experiments which are now in progress, and can be now considerably reduced pending further developments which might call for its renewal at full pressure. At the same time what may be called the processing side of the fishery has been given such attention as appeared to be called for by the more evident possibilities. Some discussion of the conclusions to be drawn on these—the biological and technical sides of the work respectively—can now be entered into.

THE FISHERY RESOURCES OF NEWFOUNDLAND

In the first instance it was necessary to enumerate and correctly name the fish species. This has been done in previous reports, and, in addition, the distribution and the amounts available have been given. Regular survey cruises of the research trawler have covered the whole area twice a year, in spring and in the fall respectively, and, if we except strictly inshore areas, which are now to receive prior attention, it is certain that the search has been so thorough as to preclude the possibility of failing to detect any large-scale feature. It is sometimes stated that Newfoundland's fishery resources are virtually limitless and that, over and above cod, many other species of fish should be utilised. There is a deal of truth in this statement. Potentially, the material exists to provide an income far in advance of that normally extracted from the fisheries, assuming always that certain difficulties could be overcome. *Most of the latter arise from the highly seasonal nature of the inshore runs of fish* (cod, salmon, herring, caplin, etc.) so that it is difficult to centralise operations or adequately to employ efficient machinery. Pre-eminently the fishery is one for *codfish*, which abound at certain times in inshore waters. It is safe to say that this inshore fishery, in which the catch is practically 100% cod, is unique, and that it will survive indefinitely. This is so since, as far as the evidence goes, a state of overfishing does not exist, and no cheaper method of catching fish exists than that of trapping. The fish do not abound on the same parts of the coast year in year out, on account of changes in the prevailing water temperatures, and it would be advantageous if the fishing units were more mobile—i.e. if more of the trapping were done by vessels moving from place to place as runs developed. As things stand centralisation for curing purposes is difficult to arrange. In addition, the present scattered nature of the fishery and its comparatively short duration in any one place make the operation of efficient by-product plants well-nigh impossible. *If, then, no change in, or addition to, the present method of fishery can be made, there is little* *prospect of developing fish-meal production.* Here really lies the crux of the situation, and it has been the constant effort of the Laboratory to direct attention to the advantages of the vessel fishery, as only thus, apparently, is the situation capable of being radically altered in the direction of securing more continuous supplies of fish at any one port.

THE DEEP SEA FISHERY.

Schooners and Trawlers. There has been a serious decline in the number of schooners prosecuting the deep-sea fishery, and this decline seems likely to go further unless a higher average catch, or a higher average price for fish, can be secured. The latter eventuality can certainly not be anticipated with confidence, so that attention is inevitably directed to increase of catch. This implies increased efficiency, whether this be achieved by lessening outfit costs, avoiding waste time in locating good fishing grounds or in port—e.g. while securing a supply of bait—installation of power units, improvement in curing methods, co-operative marketing, utilisation of fish other than cod, or a combination of some or all of these factors. It is often stated that schooner-fishing does not pay, and it is obviously in the interests of the country to have this statement put to a thorough official test or investigation. Such a test has been advocated before. Meanwhile, it is illuminating to consider the record catches being obtained by a first-class powered schooner recently added to the fleet. In Newfoundland, as elsewhere, it may prove to be the case that high initial cost of equipment is more than offset by results. The alternative to a deep-sea schooner fishery is to turn consideration to the possibilities of steam or motor trawlers, which under most circumstances are the most efficient fish-catching units of the day. In this connection perhaps the chief immediate requirements are that the operations should be remunerative, and that they should not cause an embarrassing decrease in employment. This implies limitation in the number of trawlers allowable, since approximately 80 modern trawlers would have an output equivalent to Newfoundland's normal production, but would employ not more than 10,000 people, all operations inclusive. Even so, the income would be considerably greater than that presently secured, since not only would by-product manufacture become a reality, but plentiful fish like haddock and the American plaice (which is really a dab) would be utilised to advantage. Even from the salt codfish point of view, if the decline in the prosecution of the deep-sea fishery by schooners were to go much further, there could be no objection to filling the breach by the operation of a sufficient number of trawlers (from 12 to 20) to fetch in the average quantity of fish which Newfoundland has in years past taken from the banks. Distributed over a few ports these trawlers would, as we have seen from experiments with one vessel, galvanise such ports into activity in the early spring, facilitate the provision of central curing and by-product industries, and, above all, produce, during the best fish-drying weather of the year, a high average quality of dried salt cod. If, then, it be proven that schooner-fishing on the banks cannot be made lucrative under existing conditions, one cannot fail to advocate that as schooners drop out they be, it at all possible, replaced by trawlers, built preferably for the particular purpose they are to serve—that is, the landing of salt cod and chilled fresh fish (chiefly haddock) the latter for disposal in foreign markets. This subject is of such pre-eminent importance that it should be exhaustively studied from every standpoint, and without prejudice.

It is unlikely that local capital can be found for a trawler venture on a large enough scale to alter the situation to the extent outlined. More probably, with the growing scarcity of fish, and the increasing recurrence of years of lean catches in other North Atlantic waters, association with a great fishing country like Great Britain will solve the problem.

Experiments by British Trawlers. Already, as a result of this survey, experimental voyages have been made from Hull to Newfoundland waters. One is informed that in 1935 eight voyages were made in quest of haddock, which is, of course, one of the chief species asked for by the British market, largely on account of its scarcity in waters which have been well fished. It is disappointing that these trials were made in the mid-summer months, when not only are fish taken in soft condition from the warmer water then prevailing, but when the larger haddock are in poor condition after spawning in May. On the market, therefore, a poor price was realised. Moreover, the grounds fished were not those advocated in the Newfoundland survey reports as being high-yielding. It is understood that the trials are to go on again in 1936, but unless both the seaon of trial and the method of preserving the fish are altered it is difficult to anticipate better than the mixed results achieved in the previous year. Ideally the trawlers should use a west British port, such as Fleetwood, and, fishing from Newfoundland bases, should operate in the best-yielding months of the year—say, up to mid-June, landing their salt cod, oil, and raw material for fish-meal, and transhipping haddock, halibut, whitches, etc. by refrigerated vessel. Short fishing trips would, owing to the great abundance of fish described in another portion of this report, produce sufficient catches to make return to port worth while. No consideration is given here to the probability of finding a market in the U.S.A. for a portion of the catch, suitably processed. It is probable that experimental voyages will be made from Fleetwood, employing fast trawlers which will take their catches home in ice. Thus, in the initial stages it would appear that Newfoundland would derive no benefit from the operations. Ultimately, however, the experiment cannot fail to lead to the operations being very largely conducted from Newfoundland bases.

Training Ships. Obviously it is desirable that, even as things stand at present, there should be available in Newfoundland some personnel familiar with operations on board trawlers. There has been some difficulty in finding adequate crews for the very restricted recent demand, and success in the initial stages can very easily be jeopardised on this score. If a system of training in fisheries is to be introduced—and everyone will agree that there is a very great need of giving the young fisherman the proper sort of education to fit him for his task—it is definitely to be advocated that part of this training should be at sea, on schooner or trawler. Even those who are to follow the inshore fishery would benefit from such experience. The opportunity exists to utilise the s.s. "Cape Agulhas" for this purpose in the spring months, when it has been proved that expenses can be recovered from the fishing results, and when young men are most available. Men so trained could more easily secure berths in trawlers operating out of other countries.

Importance of regular Supplies and of utilising Haddock. The opinion has been expressed above that the greatest promise for introducing those changes which will lead to a definite and considerable augmentation of the income to be derived from the fisheries lies in, by one means or another—most probably by a moderate development of trawling—securing regular landings of fish at several centres. A very large proportion of this increase would be derived from *haddock*, without interference with the rather delicate salt-cod marketing situation. From the results of this survey it is clear that, in the southern portion of the area, there are great shoals of a fast-growing type of haddock which would sustain a considerable trawling industry. The details are given in the sections of these reports dealing with haddock. Fortunately also, it has been possible to show that the skilful fisherman can by the use of instruments largely avoid cod concentrations and fish his gear among the haddock shoals. At present the latter are of very little value to Newfoundland, as haddock fetch a meagre price in the salted form. It is no exaggeration to say that, if the proper connections can be made, Newfoundland can derive from the haddock which lie well within a day's steaming from her south-eastern harbours, an income equivalent to that yielded at present from cod. *Thus it is that after a five years' enquiry into the fishery resources of the country it can be definitely stated that by far and away the principal resource at present unutilised is that of haddock. In conjunction with the necessity for developing regular landings of fish this is the major finding resulting from the survey.*

Other Deep Sea Species of Fish. Other fish species, of which little is seen inshore, go to augment trawler catches. In point of numbers the most prolific is the *rough dab,* locally called "plaice" and termed the "American plaice" in Canada. In certain localities this flat-fish is more plentiful than cod. There is little doubt that a foreign market for the fillets which can be prepared from this fish could be developed *pari passu* with a haddock traffic, but if not, the species could be untilised for the preparation of first-class fish-meal. Other flat-fish caught by the trawl are the *halibut* (a score or two a day on the average) and the *whitch.* The latter is in good demand in fresh fish markets, but like the halibut, is not really plentiful in Newfoundland waters. Fair numbers of *skate* are also captured, as are occasional *smooth dabs, monkfish,* and *silver hake. Pollack* are scarce. The so-called *turbot* (really the Greenland halibut) is a feature of thc fishery of the large deep bays rather than the outer banks, and would not affect trawl catches. Of the whole group of fish mentioned in this paragraph, halibut, as a prime fish, would be the most valuable component in the trawl catch, while the rough dab, on account of its extraordinarily large numbers, would inevitably prove invaluable in by-product manufacture.

Suspension of Deep-Sea Investigations. The above is a very general discussion of the deep-sea aspect of the investigations. It is the intention, as time goes on, to publish separate reports of the biological studies on cod, haddock, and the subsidiary species. Deep-sea work, which is expensive to carry out, can be suspended for the time being, pending some alteration in the fishery situation which would call for or justify its continuance for commercial reasons.

THE INSHORE FISHERY

Increase of Controls Requisite in the Codfishery. Reference has already been made to the great inshore fishery for cod. On different parts of the coast, which vary from year to year according to the varying degree of suitability of water conditions, large catches are taken. From three-quarters to seven-eighths of the total catch is made inshore. The advantage of this fishery is that results are easily obtained in certain years, and this advantage is so pronounced that it outweighs a whole series of accompanying disadvantages. Among the latter is the distinct element of uncertainty as to whether fish will run in any one place (it has already been shown that on the south-east coast only one-sixth of the quantity was obtainable in a "warm" year—1934—as was to be had in a "cold" year—1933. The highly seasonal nature of the run of fish is also a drawback—the great bulk of the catch is taken within about two months, and even within this period, on a round dozen of especially favourable days—hence congestion occurs in fish-curing operations, and it is well-nigh impossible to manufacture by-products, apart from cod-liver oil. The best curing weather of the year, which occurs in the cold spring months, is past before operations begin, and warm humid weather, or even excessive sun-heat, interferes with the cure. This type of fishing is openly acknowledged to be a gamble. Too many of the factors which make for success are beyond control, and costs of supplies are correspondingly high. As, however, the inshore fishery is certain to continue it is essential to introduce every possible improvement making for increased control. What these improvements are has been clearly shown in previous reports. They most obviously include the thorough washing of the fish, adequate salting and a measure of artificial drying. The necessity for the latter has been clearly shown during the last five years, in only two of which did good average drying weather occur. At such times it is customary to claim that the cure is improving. Nothing of the sort is, however, happening, as the sequel is inevitable—the next year of poor average drying weather places the fisherman in the helpless position of being unable to dry most of his fish sufficiently. Hence the necessity, *in every fishing outport*, of a simple and inexpensive drying chamber such as that constructed in the commercial premises adjoining the Laboratory, and used chiefly for completing fish-drying which has been carried to the proximate stage out of doors. The chamber referred to has twice been enlarged, and is in constant use. By the institution of a control such as this it is simpler to produce a standard cure and to aid the marketing situation, which can never be stablised if the quality of cure is to vary considerably from year to year.

Other Inshore Species. The chief inshore fish other than cod are salmon and herring, while among the invertebrates the lobster is of very considerable importance.

Salmon. It has previously been stated that the fresh-frozen salmon industry is, on the technical side, highly efficient, although it was mentioned that some spoilage was apt to arise owing to the universal practice of freezing the round fish without evisceration. It was, therefore, not surprising that quite a proportion of the salmon are now gutted before being frozen. Preferential treatment has been secured for this commodity in Empire markets, and the chief objective of salmon investigations appears to be to conserve, or if possible, increase the stocks. This implies the obtaining of a fairly full knowledge of the biology of the fish, and also the improvement wherever possible of the spawning facilities in the rivers, some of which are difficult or impossible of ascent as things stand. It is now clear that this fishery cannot be very greatly extended in its intensity, and that the total stocks, while they appear to be capable of supporting the industry as it is at present conducted, are subject to natural fluctuations which require further study. Up till the present a rather complete classification of the types of salmon in the various portions of the area has been made. It is now the intention to undertake tagging operations and to study the annual cycle in the life history of the salmon of typical rivers.

Herring. Some preliminary but not intensive study of the herring has disclosed the fact that, as is the case at Norway, the very young herring occur all round the coast. At the age of two or three years a departure is made from the coast and for several years a more or less oceanic existence is followed, until a return to the coast occurs at an age of approximately six or seven years, when maturity is reached. Only the larger of the very young are, therefore, taken normally inshore along with great numbers of the returning adults. Few of the former are large enough for curing, but they are of prime quality. The large herring, which are common, are generally considered to be scarcely of the quality of the large West Scottish herring. Those of intermediate age, which are out of range at sea, would most probably be ideal for curing purposes, but they have proved to be difficult to locate in numbers, except possibly in the southern portion of the Gulf of St. Lawrence. Enormous numbers of large herring are, however, taken at certain seasons. If some care is exercised in the selection, a proportion is suitable for Scotch cure, and a variety of other less common types of cure is also possible. At times when the demand has risen the exports have been much greater than at present, and every effort should be made, by strict regulation, to cater to the trade by supplying a standard cure. It would, however, be an excellent thing if herring meal and oil could be manufactured. The difficulty in the way appears to be that the runs of herring, while prolific in numbers, do not endure for a sufficient length of time in any one locality to justify the installation of a reduction plant. From time to time the matter has been considered by commercial interests, but, probably for the reason mentioned, the productive stage has not been reached. Possibly the use of a floating plant, capable of shifting its base of operation, would solve the difficulty. One is not prepared to say it would, since this is the type of activity whose likelihood of success cannot be worked out on paper, but can only be decided by actual trial. Some initial difficulties would certainly have to be overcome.

Increased use of herring is being made for bait purposes, the prejudice against the more general use of this form of bait having been broken down. This subject has been discussed previously. As to the use of a first-class food like herring by the populace generally, it must be admitted that this ought to be on a much larger scale. Many Newfoundlanders, including fishermen, appear to disdain herring as a food. In a country where under-nourishment is rife, there is room for a campaign of instruction to secure the very greatly increased consumption of herring in the fresh, salted, or smoked form.

Lobsters. The lobster, like the salmon, is a most valuable fisheries' resource, and as events have shown one even more susceptible to destruction, unless protected by suitable regulations. This subject has been dealt with in a published memorandum, and is further considered in a paper included at the end of this report. It would appear that the recently imposed regulations are having beneficial results. Obviously, the lobster fishery is capable of being nursed back to something approaching its pristine dimensions, but, as in the case of the salmon, measures of conservation or propagation require to be based on the results of reliable biological inquiry. It is for this reason that the salmon and lobster are now scheduled to receive more detailed study. They are among the most tangible of the fishery resources.

Caplin. Subsidiary fisheries are those for caplin, smelts, squid, and shell-fish. *Caplin* play an essential part in the economy of the codfish in more easterly regions. They are most regular in their appearance, but do not remain inshore in any one region for a sufficiently long time to form the basis of a fish-meal manufacturing industry, although were the organisation of regular supplies of codfish possible caplin, along with herring, dogfish, etc., would play their part in such an industry. Since the local manifestations of great numbers of caplin are impressive for a few weeks each year, it is natural to think that here is a resource which could be exploited to great purpose. However, since caplin form almost exclusively the food supply on which cod gorge and recover condition after the winter and after spawning, they already serve a very definite purpose, and if large quantities were removed for reduction purposes some unforeseen complication might arise with regard to the maintenance of stocks. The further utilisation of caplin beyond, perhaps, the drying of increased quantities for domestic use, need cause little concern. The fish is not so attractive as the sardine or young herring in the canned form and will never compete with these prolific species. Trial shipments of frozen caplin have been poorly received abroad. It is used locally as manure, distributed over the surface of young hay or between potato drills. As has before been mentioned, it would be better practice to use it, along with codfish waste and the local peat-moss, to form compost manure.

Smelts. An open market for *smelts* exists in the U.S.A., and the development of the fishery beyond its existing dimensions is rather bound up with the improvement of cold storage and transportation facilities. The life-history of the smelt in Newfoundland waters remains for future study, and it may be possible to accord this during salmon investigations on the rivers.

Squid. The erratic and independable nature of the runs of squid have previously been commented on. Pre-eminently, this is the best available bait for codfish at the stage when the latter, in the early fall, recommence feeding some time after the caplin have moved off. As a result the fisherman has become rather too much beholden to squid, and many a fall fishery has been largely lost as a result. The difficulty has to some extent been overcome by the provision of sharp-frozen herring and caplin exefficient bait stores kept supplied by a refrigerated bait-supply vessel. As things are this is an essential proviso and constitutes a real step in advance. These bait stores should as time goes on become more generally useful and their economical working should become the charge of fishermen's co-operatives. *They constitute another element of control* favouring the more continuous operation of the inshore fisherman.

In years when good runs of squid occur fair quantities are dried for export. It has not proved easy to anticipate whether or not a good squid season is ahead, largely because the breeding ground and the young stages of this particular species have not been definitely located. There is some reason to suppose that breeding occurs in deep water on the continental slope off the eastern coast of the United States. Acknowledgement is gratefully made of the assistance being rendered in this respect, through interchange of material, by the scientific staff of the Woods Hole Oceanographic Institute.

Shell-Fish. As has been stated, the greater part of the Laboratory's biological investigations has been concerned with the study of the offshore region, hence it is not possible at this stage to state definitely what are the possibilities of the greater utilisation of certain constituents of the inshore fauna and flora. On the whole, however, one is not impressed at first sight with the available quantities of shell-fish or of seaweeds. Among the shell-fish *scallops* and *clams* occur in sandy bays. Whether the numbers and the rates of reproduction and growth are sufficiently great to sustain a considerable fishery is not known. A canning factory operates partially on the scallops and the clams of Port-au-Port Bay on the West Coast. A claim that noteworthy supplies of shell-fish existed at places at the head of Fortune Bay was investigated in the fall of 1935. It was found that the ordinary scallop dredge captured on the average 250 live scallops per hour. This is the most favourable result achieved to date in what might have been rather spasmodic trials, and it is intended to make a more intensive survey in future.

Seaweeds. Various species of bladder-wrack cluster the rocks in the tidal region, but heavy growth of tangles, which are more reliable as a source of raw material for a kelp industry, have not been detected except in the region of Belle Isle Straits (e.g. in Pistolet Bay). There are also areas in which eel-grass is fairly common, but although orders for this material appear to be forthcoming there has, for some reason (which may be that the source of supply is not sufficiently great) been no commercial development. Domestic use of the various seaweeds might be increased, without consideration of the more problematical development of an export trade.

Hydrographic Factors. Details of the results of the biological and hydrographical work undertaken during the past year are to be found in the body of this report. The year 1935 saw the welcome return to the eastern area of colder water conditions, as had, indeed, been anticipated, but the coastal water in the south-west, where cod are acclimatised to warmer conditions than in the east, negatived anticipation by remaining sub-normally cold for the second successive season, although not far offshore warmer conditions prevailed. Improved results were obtained only on the east and south-east coasts, where also the marked fall in the average size of cod exhibited in 1934 was checked; the average size caught approximating very closely to that predicted from a study of the age-and-size-composition of the catches in 1934. As far as can be discerned, a period of normal balance between Arctic and Atlantic water influx appears to have commenced, a situation which should be favourable to the fishery as a whole.

Throughout these investigations it has been the attempt to show that in estimating the degree of availability of the raw materials of the fisheries account must be taken not only of the actual density of fish stocks, but also of the variation in the physical conditions of the sea-water. The latter consideration is a potent factor in causing local fluctuations. It is hoped to keep in touch with the major changes in sea-water conditions by means of reports from regional operators of fishermen's deep-sea thermometers, and from regular observations from a coastal cruise carried out each fall. Acknowledgement is again made of the prompt receipt of the hydrographic data obtained in the Newfoundland region on board the Ice Patrol Cutter, "General Greene."

THE UTILISATION OF THE FISHERY RESOURCES

In the lay mind the idea is apt to prevail that a Fishery Research Laboratory should concern itself solely with the development of products. In the recent years of economic depression the other equally essential aspects of research programme have had less than normal opportunity of making popular appeal.

Given a reliable source of fish, there is no difficulty in applying or adapting existing and well-known methods of processing. The one thing swiftly follows the other. On the contrary, no one, however well-equipped in the matter of technical processes, can by means of these make an industry flourish where the necessary supply of raw material is inadequate. For example, the Laboratory has developed a satisfactory process for canning fresh and smoked cod fillets. Yet, in the outport in which the Laboratory is situated—and it is considered one of the best of the fishing harbours—there is no available supply of cod before mid-June, and little that is dependable after mid-August. Working even on a small scale, it was difficult to obtain anything like a reliable supply of fish outside the period named. Obviously, then, the existing methods of fish-catching do not lend themselves to the introduction of a canning industry—or, indeed, of any industry involving much expenditure on adequate machinery. Hence the emphasis in this report of the necessity, if new products are to be introduced from the fishery, of effecting such alteration in the incidence of the fish-landings that the latter will be more continuous over a greater portion of the year. As things stand the curing of the fish by salting and drying is the obvious method, and one that is largely dictated by circumstances.

Salt Cod and Other Products. Salt fish is the staple product, and the principles underlying its production have been studied in general fashion. A pamphlet has been published giving a critique of the existing procedure, and hints for the effecting of improvements. Further and more detailed studies on this important subject are being initiated. Analyses of the raw materials and the products of the fishery are performed gratis. It is suggested that an important and variable commodity like salt should be purchased on its analysis, which could be verified. To a certain extent the Laboratory acts as a bureau of standards for food products, and will probably do so to an increasing extent in future.

Discussion often centres round the possibility of processing cod by methods other than salting and drying. It has already been pointed out that the nature of the inshore fishery—carried on as it is at places scattered over a huge coast-line, and dealing with brief but at times prolific runs of fish—practically dictates the method of cure. That is to say, it is natural to rely on varying methods based on the readily available method of salting. Possibly the investigation of marketing possibilities now proceeding will show that a greater proportion of the catch can go out in other forms (boneless cod, shredded cod, or cod flakes—or even in salt bulk without drying), but primarily these forms are based on preliminary salting. Even were fresh-frozen cod acceptable in the fresh fish markets and capable of being marketed economically, only a fraction of the cod, as caught by existing methods of fishery, would be available. An additional difficulty lies in the fact that cod is not so highly esteemed as many other white fish, and not only is a low price brought by it, but the small demand is easily supplied from local fisheries. (Haddock, on the contrary, are in short supply everywhere and more highly rated; buyers still prefer this fish landed in ice, however. They admit that the well-frozen article will ultimately hold the field, but only after a pioneer stage like that passed through by frozen salmon and halibut. The latter have definitely succeeded, probably on account of being more highly-priced fish and, therefore, capable of carrying the necessary expenditure. There appears to be some difficulty in smoking frozen haddock. If this can be overcome a prospect will open up of a haddock export industry based on Newfoundland. At the outset, however, British trawlers will likely prefer to take back their haddock catches in ice.)

Canning. If a cheap and acceptable article can be produced, the canning of cod fillets, both fresh and smoked, presents possibilities—though, here again, it is essential to work upon steady supplies of fish. Nowhere can strictly fresh codfish be landed more cheaply than in Newfoundland, and *prima facie* the field appears favourable. Some experimental work has been done in the Laboratory with the object of testing out possibilities. The net result is that codfish products have been turned out which are considered satisfactory in the markets, but which would require to be produced on a massive scale to be priced sufficiently low to command a broad market. The immediate outlook is for slowly increasing sales of these products, and for no considerable development until there is some change in methods of fishery, when canning and fish meal production would doubtless fit into place along with other operations.

Apart, however, from the desirability of testing the possibilities, these experiments have been worth while in their general tendency to establish standards in local canning practice. There is much need for a pamphlet, now in course of preparation, giving precise instructions covering the canning of the available local materials, including not only fish but fruit. There is also need for provision of equipment for securing satisfactory exhaust and sterilisation in canned products. Consideration is therefore being given to the design of equipment suitable for very small factories. It has also been found that, in order to produce a standardised canned smoked fish product, some control must be introduced into the preliminary drying process, since, as is the case with the drying of salt codfish, climatic conditions are not to be entirely relied upon.

Cod Liver Oil. Perhaps it is in the Cod Liver Oil industry that the influence of the work of the Laboratory has been most effective. The objective in this industry must always be to produce the maximum possible proportion of the oil in the highest grade (non-congealing oil), which commands a very considerably higher price than the next grade (poultry oil). Through the Laboratory's effort an economical system of preparing non-freezing oil was installed on a portion of the premises leased to a commercial concern, and up to 70,000 gallons of oil have been passed through this system per year, most of which would not otherwise have been so processed. Incidentally, the loss of stearine in the process has been reduced to what is probably near the minimum possible, and further consideration is to be given to the study of stearine formation and loss. A preliminary note on the subject appears in this report. It has also been urged from the outset that, owing to the increasing importance of determining the Vitamin A and D content of oils before their sale, all oil should be blended in large quantities so that on the whole an average or standard oil can be quoted to the market, and superfine oils sold at a premium. It is a matter for satisfaction that the large producing companies have adopted this recommendation which *inter alia* makes it an economic proposition to effect tests for Vitamin D. The position of Newfoundland oil in the markets has been protected by the issuing of Government Laboratory certificates showing the vitamin values of the oils exported. At the present time an effort is being made, in conjunction with authorities in other countries, to establish the minimum vitamin potencies for oils marketed, and to standardise tests on chickens (for poultry oil certification). Exaggerated claims for competing oils, not easily disproved on account of the variation in the testing standards of different countries and firms, have in the past made it appear that Newfoundland cod liver oil was to be at a relative disadvantage with reference to its Vitamin D content (the Vitamin A content is admittedly greater than in most competing cod liver oils, although contrary to the age-potency relationship normally existing it was lower by 12½% in 1935 than in 1934, whereas the cod were actually larger in the year 1935. This anomaly was probably due to the ill-nourished condition of the cod in the early part of the season, when the fish were found to be in the poorest condition seen at any time during the five-year period). As was anticipated, a scaling down of claims has occurred, and it is probable that the British minimum standard for Vitamin D, like that of the United States will be set at 85 International Units, slightly above which the average Newfoundland oil will range. The high Vitamin A content of the latter is of considerable importance in the light of recent research on the beneficial properties of this vitamin. It is noteworthy also that even Halibut Liver Oil is now being graded as to price on its Vitamin A content. Even in the case of this oil the high Vitamin D values originally claimed are proving difficult to sustain in trade practice.

Pharmaceutical Products. There is scope in Newfoundland, where a highly protected market exists, for the production *of cod liver oil derivatives* and other medicinal products, all of which are at present imported and, incidentally, are very expensive. As described in the report for 1935, this matter is receiving attention. Preliminary difficulties in altering the direction of this trade are being encountered but need not prove formidable. It is the intention, on principle and for business reasons, to take full advantage of the possibilities of instituting this minor industry. Grateful recognition is made of the co-operation of the Department of Public Health, which has adopted in the institutions under its control the use of the standardised oil and of the emulsion preparations so far produced.

EDUCATION.

If it be conceded that this summary of the general fishery situation, as it is seen from the more scientific aspect, presents a fairly accurate picture of the facts, it will be agreed that there is much need of *education* and of apprenticeship training in fishery matters and practice. It appears to be difficult to institute this in an effective fashion, and mere reiteration of the necessity is all that can be made here. By means of consultations, courses of instruction as and when they have been requested, and the issue of pamphlets, the Laboratory has made some progress in this direction. A great deal depends on the training of the younger members of the community along the proper lines, and in this connection appreciation should be expressed of the successful and quite independent effort of Mr. Andrew Proctor, Technician on the Staff, to organise the Sea Scout movement in the district in which the Laboratory is situated.

II. HYDROGRAPHIC AND BIOLOGICAL INVESTIGATIONS

(A) HYDROGRAPHIC CONDITIONS IN 1935

By H. Thompson and A. M. Wilson

In the report on water conditions in 1934 it was stated that temperatures were unusually high in the eastern area, where they are usually tempered by the cold Arctic current, which had decreased in intensity. However, it was noted that in the fall this current showed, in the north, some signs of increase. This increase continued in 1935. Definite signs of increase were, however, largely confined to the Labrador and north-eastern section including the Straits. Thus, sub-surface waters in this area were in spring colder than at any time in recent years, and less saline. On Grand Bank (Chart 6 at the end of this report) there was a marked change from the previous year, the warm Atlantic water influx from the south being much more restricted. Thus, in the fall, at a depth of 25 metres, the 10°C. isotherm did not advance beyond the southern edge of the Bank, whereas in 1934 it reached the northern edge. As a matter of fact, the Atlantic water influx had, in 1935, its greatest influence in the region of the Gulf of St. Lawrence, the 10°C. isotherm (at 25 metres) reaching practically to the Straits of Belle Isle. The effect of this influx was felt beyond the Straits and into White and Notre Dame Bays. Unfortunately for the fishery in the south-west region, this warm water, which normally brings with it a good fishery, was prevented from reaching the coast (as it did in 1932 and 1933) by the accumulated cold water from the previous year, augmented possibly by new Arctic water flowing down the west coast.

On the whole, then, temperatures in the eastern area fell to more normal figures during the year, whilst the south and west inshore region failed to register the desirable increase, although offshore waters showed a considerable rise in temperature, which may extend to the coastal waters in 1936. A period of fairly even balance between Arctic and Atlantic water conditions appears to have commenced.

The recovery in the proportion of Arctic water present in the more eastern area is seen from the drop in the level of occurrence of the coldest water layer. This level occurred at the following depths :—

	North Grand Bank	South Grand Bank	Laurentian Channel
Spring, 1932 ..	50–150 m.	50–100 m.	100 m.
Spring, 1933 ..	50–125 m.	75 m.	75 m.
Spring, 1934 ..	50–90 m.	50–75 m.	50–75 m.
Spring, 1935 ..	50–200 m.	50–100 m.	50–100 m.

Salinities also fell during the year, especially in the north-east section, where in the upper water layers the lowest salinities were recorded for the five-year period. This effect was less evident in the south, and in the west became apparent only later in the year.

A complete report on the hydrograpic data collected in the period 1931–1935 will be issued at a later date, when the correlated work on plankton and fisheries is completed and available for comparison. Tables of temperature and salinity data are given below.

MEAN TEMPERATURES

SPRING.

Year	Depth	Labrador	Straits	White Bay	Notre Dame Bay	N. Grand Bank	South East	C. St. Mary's	Placentia Bay	S. Grand Bank	South West	West
1932	Surface ..	1½	3½	1½	1½	2½	3½	5	6	6	5½	4
1933	,, ..	2½	1	3	4	3	6	5½	6½	7½	7½	6
1934	,, ..	4	3½	4	6	5	5	2	5½	9	5	7
1935	,, ..	4	6½	6	8	7½	7	6	7	11½	7½	13
1932	25 metres ..	0	½	0	½	2½	2½	3	3	4	1	1
1933	,, ..	–1	½	0	1½	1½	1	2½	2½	5	4	3½
1934	,, ..	1½	1½	1	1	3½	3½	0	0	7½	1	5
1935	,, ..	–1	3	0	–½	3	3	3	2	5	2	5½
1932	50 metres ..	–1	–½	–1	–1	0	0	1	½	1	½	–1
1933	,, ..	–1	–½	–1	–1	–½	–1	–½	–½	2½	½	–½
1934	,, ..	½	0	–1	–1	–½	0	–1	0	5½	–½	–½
1935	,, ..	–1½	–1½	–1	–1	0	–½	½	1½	3½	½	0
1932	100 metres ..	–1	–1	–1	–1	–1	–1	–1	–1	0	–1	–1
1933	,, ..	–1	–1	–1	–1	–1	–1	–1	–1	2½	0	–½
1934	,, ..	–1	–1	–1½	–1½	–1	–1½	–1½	–1	6	–½	–1
1935	,, ..	–1½	–1½	–1	–1	1	–1½	–	–½	6	0	–½

MEAN TEMPERATURES

FALL.

Year	Depth		Labrador	Straits	White Bay	Notre Dame Bay	N. Grand Bank	South East	C. St. Mary's	Placentia Bay	S. Grand Bank	South West	West
1931	Surface	..	6½	9	9½	12	14½	13	14	14½	18	15	13
1932	,,	..	6½	8	11	12½	15	13½	15	17	18½	16½	10
1933	,,	..	5	8	6	10	12½	11½	12	14	16½	16	11
1934	,,	..	7	8½	11½	11	13½	12½	14½	14	17½	14½	12½
1935	,,	..	6	6	10	9	13	11½	14½	14½	17	14	9½
1931	25 metres	..	–	–	–	–	–	–	–	–	–	–	–
1932	,,	..	5	4½	5	4	5½	3	4	5½	13½	10	9
1933	,,	..	3	5½	3½	3	4	4½	3	8	9½	7½	10
1934	,,	..	5	7½	6	1½	7	6	7½	4	8½	4	6
1935	,,	..	5	5	7	5½	5	4	3½	6½	9½	3½	4
1931	50 metres	..	–½	2	–½	–	–½	–½	½	½	–	2	1½
1932	,,	..	–½	0	–½	–1	–½	0	1	2	5	2	7
1933	,,	..	1	½	1½	–½	–½	0	0	½	2	3	1½
1934	,,	..	1	0	–1	–½	–½	1	0	0	4	½	–½
1935	,,	..	1½	4	2	–1	–½	0	–½	1	4	1	1½
1931	100 metres	..	–1	–½	–1	–	–1	–1	0	–½	–	–½	–½
1932	,,	..	–1	–½	–1	–1	–1	–1	–1	–½	1½	0	–½
1933	,,	..	–1	–½	–1	–1	–½	–1	–1	–1	2	0	–½
1934	,,	..	–1	–1	–1	–1	–1	–1	–1	–1	3	½	–½
1935	,,	..	–1	–	–1	–½	1	–1	–	–1	6	0	0

RANGE OF SALINITY

SPRING.

Year	Depth		S. Grand Bank	N. Grand Bank	White Bay	Labrador	S. West	West
1932	Surface	..	32–33	32–33	32	28–30	31–32	31–32
1933	,,	..	32	32	30	28	31–32	30–31
1934	,,	..	32–33	32–33	31–32	27–31	31	31–32
1935	,,	..	32	32	28–29	24–28	31–32	30–31
1932	25 metres	..	33	33	32–33	31–32	32	31–32
1933	,,	..	32	32	31–32	32	31–32	31–32
1934	,,	..	32–33	32–33	32–33	32	32	32
1935	,,	..	32–33	32–33	31–32	30–32	32	31–32
1932	50 metres	..	33–33½	33	32–33	32	32–33	32
1933	,,	..	32	32	31–32	32	31–32	31–32
1934	,,	..	33½–34	33	32–33	32	32	32
1935	,,	..	32–33½	32–33	32–33	32	32	31–32
1932	100 metres	..	33–33½	33–33½	33	33	33	33
1933	,,	..	33–33½	33	32–33	–	32–33	32–33
1934	,,	..	33½–35	33–33½	33	33	33	33
1935	,,	..	33–34	33–33½	33	33	32	32–33

RANGE OF SALINITY

FALL.

Year	Depth	S. Grand Bank	N. Grand Bank	White Bay	Labrador	S. West	West
1931	Surface ..	32-33	32	31	30-31	31-32	31
1932	,, ..	32-33	31-32	30	28-29	31-32	30-31
1933	,, ..	32	31-32	31	31	31	31
1934	,, ..	32	31-32	31	30	31	30
1935	,, ..	32	31-32	30	27-31	30-31	30-31
1931	25 metres ..	–	–	–	–	–	–
1932	,, ..	32-33	32	31	30-31	32	31
1933	,, ..	32	32	31-32	31-32	32	31
1934	,, ..	32	32	32	31-32	31-32	31-32
1935	,, ..	32-33	31-33	30	30-32	31-32	30-32
1931	50 metres ..	–	32-33	32-33	32	32	32
1932	,, ..	33	32-33	32-33	32	32-33	32
1933	,, ..	33	32-33	32-33	32-33	32	32
1934	,, ..	33	33	32-33	32-33	32-33	32-33
1935	,, ...	32-33	33-33½	32	30-32	32	31-32
1931	100 metres ..	–	33	33	33	33	33
1932	,, ..	33-34	33	33	33	33	33
1933	,, ..	33-34	33	33	33	33	33
1934	,, ..	33-34	33	33	33	33	33
1935	,, ..	33-34	34	33	32-33	32	32-33

Drift-Bottle Experiments

During 1935 four hundred and thirty surface drift-bottles were liberated in localities closely corresponding to those in which liberations were made in previous years. It is anticipated that when transatlantic returns come in, rather more than 7% of these bottles will have been returned. Chart 9 at the end of this report shows the approximate courses followed by the recovered bottles.

No very strong southerly flow is indicated, since few bottles were picked up in the bays of the south-east region, although some stranding occurred in Notre Dame Bay. Returns from the western portion of the south-west coast indicate somewhat similar conditions to those described for 1934, while the stronger Atlantic influx into the Gulf of St. Lawrence is indicated by a pronounced northerly trend of bottles recovered from that region.

(B) PLANKTON INVESTIGATIONS

By H. Thompson and N. Frost

In the report for 1934 it was stated that the pronounced influx of warm Atlantic water conditions, most evident in the eastern portion of the area, had probably culminated in the latter part of 1934, and that a return to colder conditions would likely first be in evidence in 1935.

Indeed, first signs of this increase were noted in the north in the fall of 1934, when, off Labrador and in White Bay, water salinities became

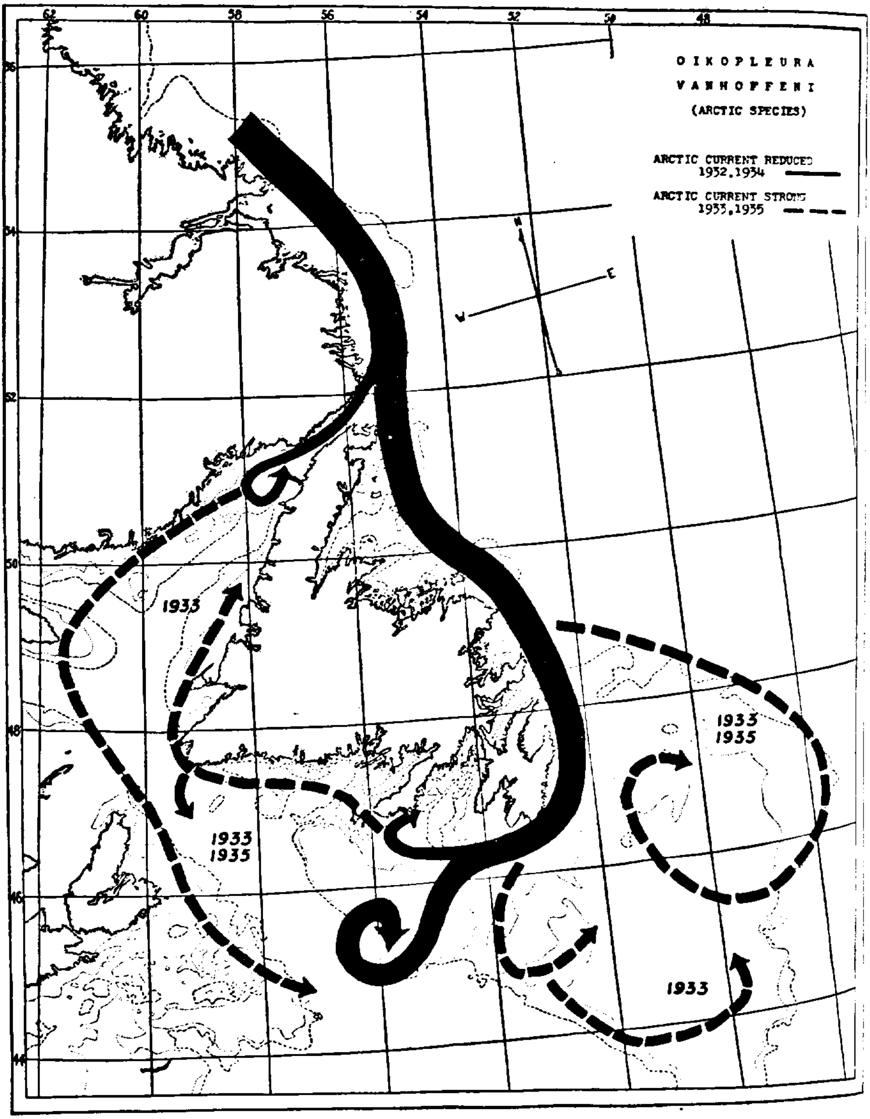


Fig. 1

lower, and the Arctic species *Oikopleura vanhöffeni* increased in numbers, for the first time since the spring of 1932. On account of the fact, now proven beyond doubt, that this species occurs only in water derived directly from the Arctic current, it is of interest to note the average numbers taken at representative points all over the area. The hauls were made with the Hjort fine silk net, drawn from a depth of 100 metres to the surface, at approximately 60 points in both spring and fall.

Oikopleura vanhöffeni

1931	1932		1933		1934		1935	
Fall.	*Spring*	*Fall.*	*Spring.*	*Fall.*	*Spring.*	*Fall.*	*Spring.*	*Fall.*
26	**722**	**104**	**1,144**	24	252	**96**	**385**	23

As this species occurs in cold water it is much more plentiful in the spring than in the fall, hence the smaller numbers in the latter season. Also, since the 1935 spring cruise was some weeks later in starting than usual, the average figure for that cruise, while it shows an increase over that for the spring cruise of 1934, should probably be greater. Bearing these facts in mind, we see that the species increased in numbers twice during the period—first, and most strongly, between the spring of 1932 and that of 1933, when the maximum was reached, and again between the fall of 1934 and the spring of 1935, when a secondary maximum was attained.

The actual course of the Arctic current, as deduced from the occurrence of this species, is shown in Fig. 1. There are two phases—those of normal and increased intensity respectively. The normal flow is down the east coast, culminating in the south-eastern portion of the area in eddies caused by the barrier formed by the Burin Peninsula and the eastern edge of St. Pierre Bank. Some penetration into the Straits of Belle Isle is also effected. In a flood season, however, comparatively unmixed Arctic water spreads all over the area, including the regions of the banks, the Gulf of St. Lawrence and the northern portion of the Western Banks. This occurred most noticeably in 1933, and to a lesser extent in 1935, when neither the south of Grand Bank nor the west Newfoundland coast were reached, although the Western Banks were. Incidentally, it may be mentioned that, although in 1935 cod fry had the southerly distribution of 1932, they did not extend so far south as southern Grand Bank. (Fig. 2.)

While, therefore, an increase of the current is always noticeable in spring, the amount of increase varies considerably, and it would seem that by a study of the relative numbers of *O. vanhöffeni* we can forecast in the preceding fall whether the increase is to be pronounced—note for example the increased occurrence of this species in the falls of 1932 and 1934 respectively. Work on this subject will, therefore, be continued in the fall seasons. Meanwhile a complete analysis of the planktonic material obtained in the period 1931–1935 is being made, and a full discussion will be entered into the various correlations already referred

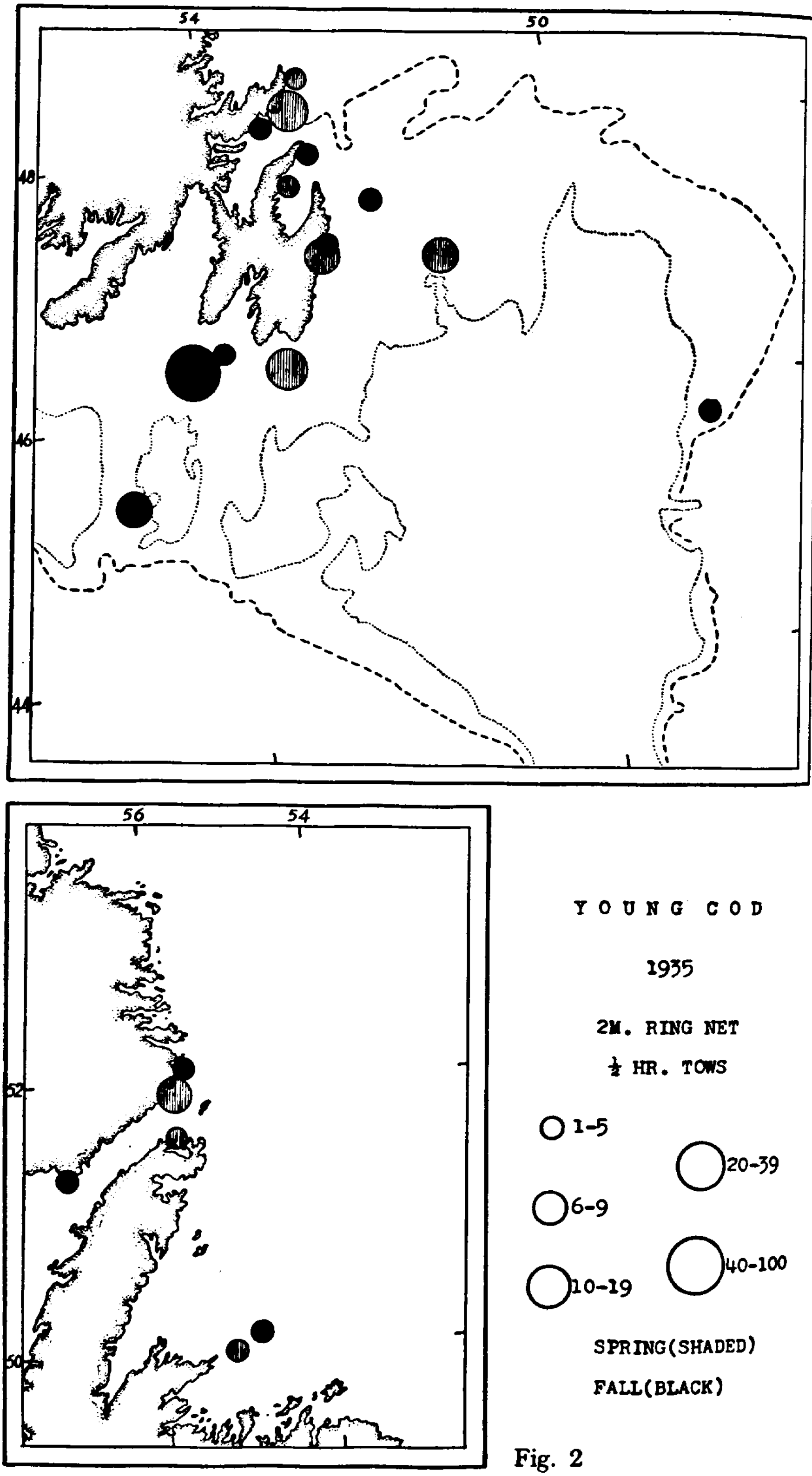

54
50
48
46
44
56
54
52
50
Y O U N G C O D
1935
2M. RING NET
½ HR. TOWS
1-5
20-39
6-9
40-100
10-19
SPRING(SHADED)
FALL(BLACK)

Fig. 2

to briefly in these reports. It will suffice at this stage to complete for 1935 the table showing the average volumes of total plankton taken by the Hjort net, hauled from a depth of 100 metres to the surface at representative points all over the area :—

Year.	*Spring.*	*Fall.*
1931 ..	—	3·0 (cubic centimetres)
1932 ..	8·4	6·8 ,, ,,
1933 ..	23·6	7·6 ,, ,,
1934 ..	6·6	3·8 ,, ,,
1935 ..	7·0	6·4 ,, ,,

It is to be noted that there was, in 1935, a tendency for the total plankton —as sampled by this net—to increase, with the contemporaneous increase in the intensity of influx of arctic water. The high point was reached in 1933, when the influx was greatest, and values dwindled in 1934, when opposing Atlantic water influences prevailed. Thus, it would appear that this ready method of sampling—the only one available under the conditions—has served to provide a clue to the major changes in the amount of plankton present in the area. Like any other method of plankton analyses, it has its drawbacks. For example, the figure for the spring of 1935 should probably be larger, since swimming bells were plentiful and tended to interfere with the normal action of the net. The point which it has been sought to make is that major and obvious changes in the amount of plankton should be capable of being followed by the adoption of a simple but uniform method of sampling.

(C) HADDOCK INVESTIGATIONS

By H. Thompson

1. *QUANTITIES OF HADDOCK AVAILABLE*

From the study of the distribution of sizes and the relative frequency of occurrence of year classes during 1934 it was predicted in the report for that year that haddock would again be plentiful (on Grand Bank, where they chiefly occur) in 1935. This was amply shown by the results of commercial and investigational fishing. Thus, if we compare the results of the four commercial voyages of s.s. "Cape Agulhas" in spring with those of the previous year, when haddock were considered to be plentiful, an actual improvement in the average number of quintals (of approximately 400 lbs.) taken per two hours' haul is observed :—

	—1° *to* +1°	1° *to* 3°	3° *to* 4°	4° *to* 5°	5° *to* 6°	6° *to* 7°	7° *to* 9°
Year 1934 ..	—	4·0	4·5	7·0	8·5	9·5	6
Year 1935 ..	0·5	4·0	8·2	17·4	19·7	17·7	1
	(49)	(196)	(9)	(18)	(3)	(3)	(1)

(The water temperatures at which hauls were made are given above in degrees Centigrade, and the number of hauls giving the 1935 results are given below in brackets; it will be seen from the latter that the great bulk of the hauls were made in cold water between 1° and 3°C., as cod, not haddock, were being sought. Highest catches of haddock were, however, obtained between 4° and 7°C., as in the previous year.) Results just to hand from 1936 observations are confirmatory of the above figures. Seventy-seven hours' trawling at 1° to 3°C. yielded an average of 4 quintals, and 62 hours' trawling at 2° to 3°C. yielded an average of 10½ quintals.

The results of investigational trawling show a similar trend, although they are based on very few hauls taken at random over the whole area of southern Grand Bank. If the results for previous years are compared with those of 1935, an increase is shown in the spring, followed possibly by a slight decrease in the fall. The number of hauls giving the average number of haddock caught per 10 hours' fishing are quoted in brackets:—

Year	*Spring.*	*Fall.*
1931	—	255 (5)
1932	3,726 (5)	782 (5)
1933	2,772 (4)	5,292 (4)
1934	3,242 (4)	—
1935	6,533 (7)	3,386 (4)

It is of interest to note that several British trawlers made experimental voyages to the Newfoundland area during the summer, the chief object being to secure voyages of haddock. The exact locations in which they operated do not appear to have been those indicated in these reports. According to information received from Mr. Albert Close (London), publisher of Fishermen's Charts, it appears that fishing was conducted during the summer months, when the larger haddock are out of condition after spawning, and that no adequate measures of preserving the catches in good condition were taken, so that the fish were very soft by the time they were marketed in Hull. Thus, while the haddock in the fresh condition were superior to Iceland and Murman Coast haddock, they fetched at landing little more than half the price of the latter. Mr. Close states that the trawl-owners were, on the whole, satisfied with the results, which were mixed; the experimental trips yielding between £500 and £2,000 each. In three or four days of actual fishing 60 tons of haddock were to be caught—a result of similar order to that to be expected from the Newfoundland investigations. It is considered that the latter have proceeded far enough to show the possibilities of these grounds, which are richly stocked with a fast-growing race of haddock of excellent quality and comparatively large size. The problem is now one of finding means to convey these fish in first-class condition to the ready markets awaiting them. Probably the use of entrepots in Newfoundland would assist towards the attainment of this end, especially if short trips were specialised in from Newfoundland bases. There is also the distinct possibility of developing a trade with the United States in smoked haddock fillets.

2. *SIZES AND AGE-COMPOSITION OF THE SHOALS.*

It was also predicted in the 1934 report that the average size of the haddock to be captured in 1935 would be larger than in 1934. In the latter year the average fish length was around 46 centimetres, and, knowing from the age-composition of the stock that two or three broods (those born in the years 1927–1929) would continue more or less to predominate, it was reasonable to anticipate an increase of size, corresponding to one-year's growth of fish of the ages attained by these broods. The actual probable size was placed at around 52–53 centimetres. This anticipation was amply borne out. Out of 15,000 haddock measured the great bulk lay between 47 and 57 centimetres in size with 52 as a mode. It will be seen from the figures (representing actual age-determination from the scales of the fish) that the 1928 and 1929 broods (7 and 6 years' old respectively) were again predominant, but that, as compared with the dominant age-groups occurring in the previous year (1934) the 1927 brood was much more weakly represented. As this brood would, in 1935, be in its ninth year, it is probable that at this age, on Grand Bank, year-classes of haddock cease to influence the catches in a dominant manner. This appears to be borne out by the fact that in 1936 the peak numbers were obtained at a size of 54½ centimetres—an increase of only 2½ centimetres from the figure of 52 noted in 1935. (In the North Sea —which is much more heavily fished—the elimination of haddock has proceeded far by the fourth or fifth year.)

The numbers of haddock determined by random sampling, were :—

Year Classes.	*In* 1934.	*In* 1935.
1933	135	8
1932	5	3
1931	3	0
1930	28	26
1929	198	237
1928	411	204
1927	227	31
1926	42	11
1925	31	13
1924 and older	6	4

Two plentiful new broods, those of 1933 and 1934, were reported in 1934, but, on account of the very small size of such young fish, were not in that year sampled in a representative fashion. Large quantities of these small haddock were discarded during the commercial voyages. These new broods will appear in the commercial catches within the next year or two as they reach the requisite length of 40 centimetres, and will then more or less replace the 1928 and 1929 broods. *The prospect is, therefore, for good haddock fishing on Grand Bank for a further period of years at least, with at first a decrease in the average size of fish caught.*

Little work was done in 1935 on grounds other than Grand Bank. Single hauls on Banquereau in spring and fall respectively yielded haddock at the rate of 5,900 and 2,680 per 10 hours respectively. The 1929 year class predominated, but the prolific catches of the previous year were not repeated, so that possibly this brood of haddock has to some extent moved to other portions of the Western Bank area. It was, for example, the chief constituent of haddock trawled at Sable Island Bank in spring. A single haul on St. Pierre Bank in spring yielded few haddock (90 per 10 hours) and these, of large size and advanced age, possibly represent migrants from Grand Bank. A detailed treatment of the results of the Newfoundland haddock investigations will form the subject of a separate publication.

(D) THE RELATIVE PRODUCTIVITY OF FISHING GROUNDS

By H. Thompson

It is of importance, at the conclusion of the five years' survey of the Newfoundland fishing grounds, to draw a comparison between the yield they give and the yield currently given by other fishing areas. This comparison is based on the assumption that vessels normally fish in those portions of an area which are, season by season, the best yielding. It also refers, in the case of Grand Bank, which is naturally the chief Newfoundland deep-sea fishing area, only to the period mid-February to mid-June, during which the experiments were carried on, and during which fish are most plentiful on the areas of the bank which are trawlable. In July and August, after spawning, fish move to other portions of the bank (or possibly to other banks or inshore) and trawling operations would require to be transferred to the colder eastern and northern portions of the bank, where there is less suitable trawling ground, but where cod have been shown to be very plentiful ; or to St. Pierre Bank, the Western Banks, or the Gulf of St. Lawrence. No suitable trawling ground has been located off the Labrador Coast.

The following were the results secured by British steam trawlers in 1934[1]) :—

Average Catch per 100 Hours' Fishing

	Hundredweight
Bear Island	1,625
Norwegian Coast	1,195
Barents Sea	1,139
Iceland	940
Faroe	397
Rockall	315
West of Scotland	279
West of Ireland	177
South of Ireland	173
North Sea	106
Irish Sea	100

From the Newfoundland experiments it has been found that in the four months cited the average catch on southern Grand Bank was 15 quintals of cod and 4 quintals of haddock per haul (standard V.D. Otter Trawl) of 2 hours' duration. In addition, varying amounts of flat-fish (halibut, witches, skate, and dabs) and of sundry species (monkfish, silver hake, Norway haddock, etc.) were taken. However, taking into account only cod and haddock, the proportions of which can be varied almost at will by selection of ground according to water temperature, we obtain per 2 hours :—

Cod—15 quintals (of 3 cwts.)	45 cwts.
Haddock—4 quintals	12 cwts.
	57 cwts.

This is equivalent to 2,850 hundredweight per 100 hours, which may be considered a conservative estimate since fish other than cod and haddock are omitted, great quantities of fish of less than 40 centimetres are rejected and not taken into the calculation, and the weight per quintal is taken at three hundredweight, whereas it is often four.

Assuming that the British statistics refer to time spent in actual fishing, it appears clear that the density of the fish stocks on Grand Bank is considerably greater than that on any other ground, and that it is of first-class importance that Newfoundland, singly or in conjunction with outside interests, should give the most serious consideration to devising means of exploitation of what seems *prima facie* to be a very favourable situation.

[1] Quibbon : "Fish Trades Gazette," Vol. 53, No. 2737

(E) RELATIONSHIP BETWEEN CATCH OF COD AND WATER TEMPERATURE

By H. Thompson

1. *ON THE FISHING BANKS*

Further data of a representative nature were obtained from four commercial fishing voyages of the research trawler during the spring of 1935. The area fished over was the southern portion of Grand Bank, near Whale Deep, so that the results are capable of comparison with those of 1934, when the same area was fished over. That cod were plentiful is indicated by the fact that the four trips of salt cod and haddock yielded approximately $25,000 ex vessel, the average catch being at the same level as that of 1934. The lucrative and dependable nature of this fishery is now considered to have been clearly indicated by the experiments of the last three years, since hydrographic conditions have, within that period, varied very considerably. In 1933 cold conditions prevailed, and the catches were obtained in water of between 1° and 2½°C. In 1934 warm conditions supervened, cold water was difficult to locate, and the catches were obtained in water of between ½° and 7°C. (although only small fish were taken at the higher temperatures). In 1935 colder conditions were again experienced, and the catch was obtained between 1° and 4°C., the smaller fish again being noticeable towards the higher limit of temperature. Thus, while the average bottom temperatures during the three 1934 experiments were 5·7°, 4·87° and 2·5° respectively, those for the four 1935 voyages were 2·7°, 1·9°, 1·3°, and 1·4° respectively.

Since further work on this subject is not immediately contemplated, it is worth while to give the analysis of the catches in relation to water temperature, as was done in the case of the 1934 experiments.

Average Number of Quintals per Haul

Temperature (°C.).	*Voyage I.*	*Voyage II.*	*Voyage III.*	*Voyage IV.*	*Totals.*
-1° to 0° ..	**2** (5)	**7** (12)	**7** (1)	—	**5** (18)
0° to 1° ..	**17** (4)	**5** (8)	**6** (3)	**12** (14)	**10** (29)
1° to 2° ..	**14** (14)	**14** (30)	**14** (72)	**18** (70)	**15** (186)
2° to 3° ..	**19** (24)	**13** (15)	—	—	**17** (39)
3° to 4° ..	**11** (8)	**21** (8)	—	—	**16** (16)
4° to 5° ..	**8** (7)	**1** (11)	—	**4** (3)	**4** (21)
5° to 7° ..	**5** (5)	**6** (4)	—	—	**5** (9)

Temperature Avr. 2.7° (Feb.) ; 1.9° (March) ; 1.3° (April) ; 1.4° (May).

The figures within brackets represent the number of hauls, each of approximately two hours' duration, which went to give the average number of quintals of cod shown in each case.

It appears that the average catch per haul can be reckoned at around 15 quintals. This figure has been averaged during two spring seasons, exhibiting quite different types of hydrographical conditions, and was, in fact, exceeded by another trawler—s.s. "Imperalist"—in 1936. It should also be recorded that later in the year 1935 (August–September), while only four catches (500–600 cod per 10 hours' fishing) were to be had in this region on southern Grand Bank, considerable catches were taken by the research vessel on the east and north of the bank. Thus, at Stations 530, 534, and 539 (Fig. 6) up to 10,000 cod per 10 hours' could be caught—i.e. up to 40 quintals per two hours' haul. This occurred in water having a temperature of below zero—actually minus ½° Centigrade.

2. *INSHORE.*

In the report for 1934 it was anticipated that, since colder water conditions appeared to be increasing in the easterly section,

(*a*) the Labrador fishery would be best towards the south (this proved to be the case; in fact, ice prevented much fishery down to the north, and a splendid fishery, which, from movements shown by Labrador tagged cod, may be assumed to have been based partially on Labrador type cod, was obtained as far south as White and Notre Dame Bays).

(*b*) on the east coast the best trap fishery would occur in the south-east (actually, taking Bay Bulls as a typical centre in the latter region, results were approximately four times as good as in 1934, when water conditions were too warm).

(*c*) since the cold water conditions which occurred in 1934 on the south-west coast were unlikely to recur, the fishery should improve, since the cod in this section favour warmer water conditions than do those of the banks or of the east coast. Unfortunately, this anticipation was not justified by results, for, as has been shown in the section on hydrographical conditions, the incursion of warm Atlantic water towards the south-west and Gulf regions did not quite reach the actual coast line, which was still bathed by a residue of camparatively cold water. The fishery was excellent during the normal cold season (winter and spring), but was a complete failure in the summer and fall. It was, however, reported that a good fishery was to be had several miles offshore, where, of course, the requisite warmer conditions would be encountered.

(F) SIZES OF COD AND DISTRIBUTION OF THE AGE-CLASSES IN 1935

By H. Thompson

It has previously been shown that two factors chiefly determine the availability of a good supply of cod to the fishery—suitable water conditions, and the existence of series of year-classes of cod which are present in satisfactory numerical proportions. The water-conditions prevailing in 1935 have been dealt with above. We will now examine the size and age-distribution of the cod which were taken in the fishery. From knowledge gained in 1934 it was predicted that—

(*a*) on southern Grand Bank (the usual trawling ground) good catches of medium and small cod (mostly 24 to 34 inches in length) would occur. This anticipation was confirmed by results. In 1934, when 20,686 cod were measured on the Bank, 14,318, or 69% of the whole, were between 21 and 31 inches in length. In 1935, when 32,484 cod were measured, 20,389, or 63% of the total, were between 24 and 33½ inches in length. Thus, the bank cod were some three inches larger than in the previous year.

(*b*) inshore, small and medium-sized cod, mostly between 18 and 34 inches in length, would predominate. Actually 4,501 out of 4,920 cod measured at Bay Bulls (or 91% of the total) lay between 16½ and 33 inches in length, i.e. were about an inch or an inch and a half smaller than anticipated. In the previous year a similar proportion lay between 13 and 29 inches in length, so that a gain of from three to four inches was registered, equivalent to one year's growth in a body of cod composed of certain year-classes (given below) and not recruited by the entry of a fresh lot of very young fish. *The situation is, therefore, that in the whole south-east section there is the probability of the average size of cod increasing over the next year or two,* or until a fresh accession of young fish occurs (as it did in 1934, after a period of increasing size had occurred between 1931 and 1933).

During the 1935 season age-assessment from scale samples was made on 885 cod from Grand Bank, 234 cod from Bay Bulls, and 435 cod from Fortune. Lesser numbers of scales were examined from cod from other regions and are not dealt with here. The following are the comparative proportions of the various age-classes, calculated per 1,000 cod, over a period of years :—

	Bay Bulls.					Grand Bank.		Fortune.	
Season :	**1931**	**1932**	**1933**	**1934**	**1935**	**1934**	**1935**	**1934**	**1935**
Born 1932 ..	–	–	–	–	9	6	9	1	5
„ 1931 ..	–	–	–	22	12	17	23	31	46
„ 1930 ..	–	–	4	173	68	24	72	117	310
„ 1929 ..	–	18	51	**279**	**234**	149	223	**416**	**379**
„ 1928 ..	124	117	110	**241**	**263**	217	**282**	202	182
„ 1927 ..	**185**	**195**	**173**	**170**	**234**	**315**	195	129	48
„ 1926 ..	102	90	137	50	62	121	94	64	23
„ 1925 ..	120	125	174	27	55	46	47	31	7
„ 1924 ..	**277**	**235**	**223**	24	34	40	43	6	–
„ 1923 ..	122	135	67	5	17	28	5	4	–
„ 1922, etc.	70	115	61	0	12	19	7	1	–

The improvement in the numbers of older fish is obvious in the Bay Bull's figures for 1935, and it is to be noted that the 1927 class was, as anticipated, represented in greater numbers than in the warm season of 1934. However, the number of fish scale-sampled was small and more reliance is now being placed on making measurements of large numbers of cod, since the size attained at the various ages is known. From these measurements it was clear that, on Grand Bank, the predominating broods were those of 1927 and 1928; while in other portions of the area the 1927, 1928, and 1929 broods were most numerous, singly or in combination. At Labrador, however, the chief broods were those of 1926, 1929, and 1930—this for the second successive year being the only region in which the 1926 brood were prominent.

(G) RACIAL GROUPS OF COD

By H. Thompson

Although the results of tagging experiments show that a minor proportion of the codfish of one region can migrate out of that region and into another where conditions are recognisably dissimilar, there is reason to suppose that the main shoals do not habitually carry out such broad movements, especially during the adolescent stage. Support for this assumption is derived from several considerations, including the differential growth rates exhibited by cod from different regions, and from the determination of body characters. In Vol. I, No. 4 (1931) of these reports it was shown that by examining the first year's growth as depicted on the scales of the fish it was possible to conclude that, on the whole, the amount of growth put on diminished in the direction from south-west to north-east. Thus, cod from the Western Bank showed an average of from 12 to 15 growth rings (sclerites) in the first year scale, while those of Labrador showed as few as eight such rings. This characteristic has been further studied each year since 1931 with confirmatory results, which will be summarised at a later date. Two points of interest may, however, be mentioned here.

In the fall of 1935 the research vessel visited Flemish Cap—the outermost Newfoundland Bank, and one that has not been fished for many

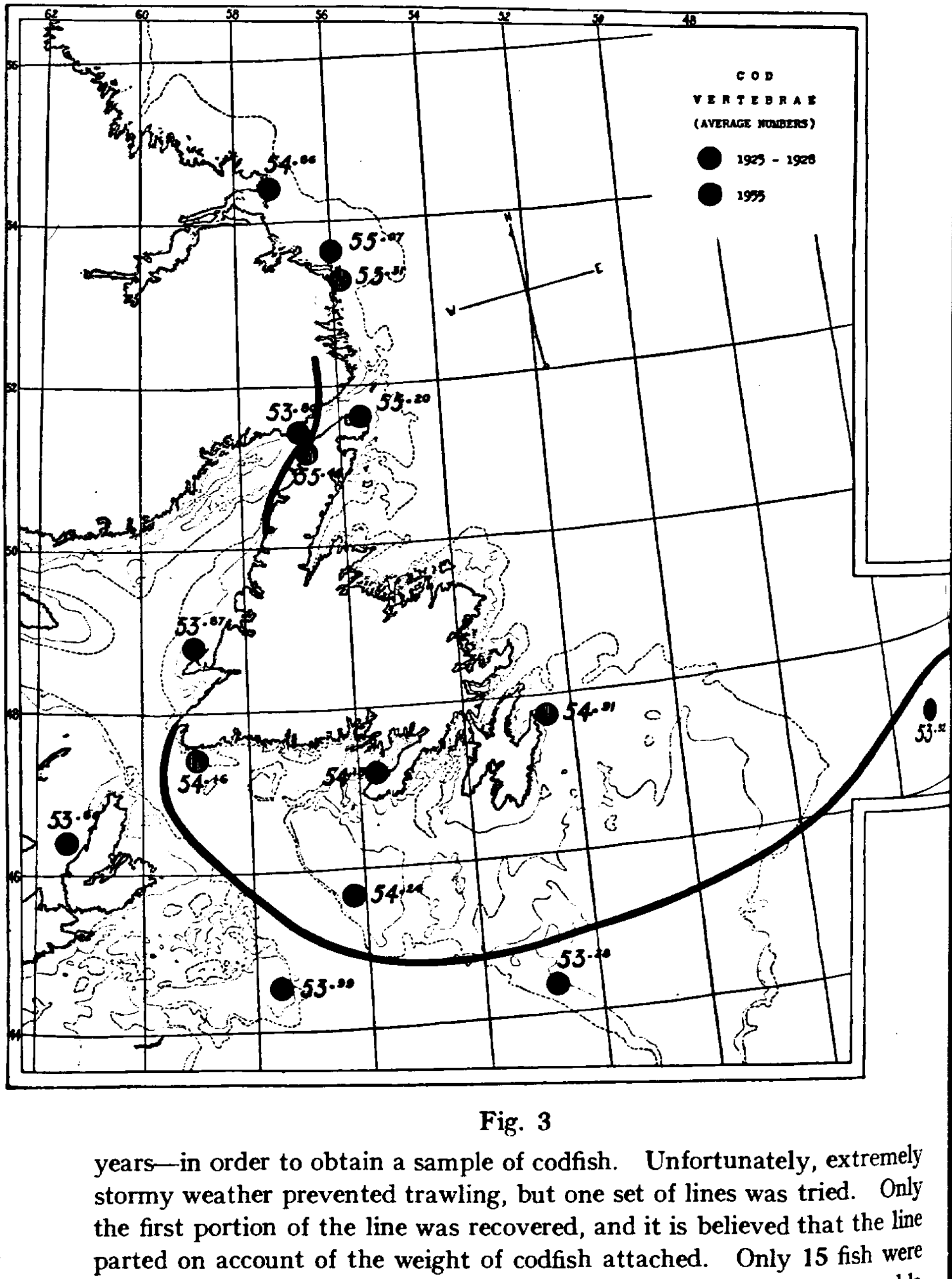


Fig. 3

years—in order to obtain a sample of codfish. Unfortunately, extremely stormy weather prevented trawling, but one set of lines was tried. Only the first portion of the line was recovered, and it is believed that the line parted on account of the weight of codfish attached. Only 15 fish were secured, but these gave an average of 12·4 first-year sclerites, comparable with the result obtained (12·6) from cod at Banquereau in the same month. It is possible that the conditions on Flemish Cap are somewhat similar to those on this outer portion of the Western Banks.

A second point of interest was the similarity of the average for St. Pierre Bank cod (13·0) with that for Banquereau cod (13·1) during the spring experiments. We have seen from the tagging results that cod can make broad migrations from St. Pierre Bank, and it is possible that a large portion of such interchange as occurs between the Newfoundland and the Nova Scotian Banks takes place by way of this bank. The depth of the channel between these banks varies from 120 to 270 fathoms, and occasional cod might conceivably negotiate the passage.

During the past year a commencement was made in the enumeration of the vertebral segments in the backbones of the cod in different portions of the area. Similar work is being done extensively by the Biological Board of Canada, and Dr. Johs. Schmidt[1] has previously given a general summary of the characteristic number of vertebrae of cod from different portions of the North Atlantic. He states that the North Atlantic cod consists of a mosaic of populations dissimilar to one another. Some of these, particularly those belonging to the open seas, are distributed to a considerable extent, while others are far more local and, on the whole, it would appear that the cod is a more local species than was hitherto realised. For the West Atlantic the average number of vertebrae was found to be highest in the Straits of Belle Isle (55·46) and to diminish both towards the south-west (52·90 at Nantucket) to the north (53·60 at Greenland), and towards the warmer and shallower waters of bays (53·58 in the inner Gulf of St. Lawrence). Yearly variation in one locality can be as much as 0·5. Water temperature appears to be the primary factor.

As a first contribution to this subject the following results from vertebral counts made in 1935 are given :—

VERTEBRAL COUNTS ON COD.

No. of Vertebrae :	51	52	53	54	55	56	57	58	Average No. of Vertebrae.	No. of Cod.
Indian Harbour, Labrador ..	–	–	2	7	13	7	–	–	54·86	29
Ferret Island, Labrador ..	–	–	3	25	32	25	6	–	55·07	91
Raleigh, North Coast (Nfld.) ..	–	–	5	16	32	31	5	1	55·20	90
Anse Eclair (Straits)	–	5	17	30	12	1	–	–	53·80	65
Port-au-Port (West Coast) ..	–	–	12	11	8	–	–	–	53·87	31
St. Pierre Bank	–	–	17	23	22	4	1	–	53·24	67
Banquereau (Station 460) ..	–	1	14	53	13	1	–	–	53·99	82
Flemish Cap Bank	–	1	4	4	3	1	–	–	53·92	13
South Grand Bank (Sta. 468)	2	7	24	20	7	–	–	–	53·38	60
Fortune Bay	–	–	–	88	11	1	–	–	54·13	100
	(———— Number of Cod ————)									

[1] Comptes-Rendus d. trav. du Laboratoire Calsberg, Vol. 8, No. 6. Copenhagen 1930.

A tendency is shown for the average number of vertebrae to diminish towards the north on Labrador. (Fig. 3.) The similarity between Western Bank cod and those of the west Newfoundland area is notable—both types are within the 53 group, along with Flemish Cap and South Grand Bank cod ; but, on opposite sides of the Straits of Belle Isle, the difference between Anse Eclair cod, which belong to this group, and Flowers Cove cod, which belong to the 55 or Labrador group is, striking, and further work in the Straits region is necessary to show whether this is a consistent feature.

(H) COD TAGGING EXPERIMENTS

By H. Thompson and B. Blackwood

TOTALS TAGGED AND RETURNED

A further total of 5,041 cod was tagged in 1935, bringing the total tagged since 1933 to 8,336. Up till February, 1936, there had been recaptured and reported some 680 of these fish, or slightly over 8%, made up as follows :—

	Tagged.	*Recaptured*	% *Recaptured.*
Year 1933 ..	273	28	10
Year 1934 ..	3,022	361	12
Year 1935 ..	5,041	291	6
	8,336	680	

DEEP-SEA TAGGING

A feature of this work has been the very meagre return from tagging of codfish on the Banks (Grand Bank, St. Pierre Bank, Cape Ballard Bank). Of 2,061 fish tagged only 18 (0·9%) have been reported as being recaptured. While it is possible, but improbable, that fish were less effectively tagged in the deeper water over the Banks, it seems safe to deduce that the intensity of fishing is not great and that the stocks of cod on the Banks are unlikely to suffer depletion under present conditions. Incidentally, no fish tagged near the coast were recaptured on the Banks, nor was any inshore movement shown from the Banks.

INSHORE TAGGING

On the other hand the results from tagging of cod in inshore waters indicate that in places there is a fairly intense degree of fishing. Of

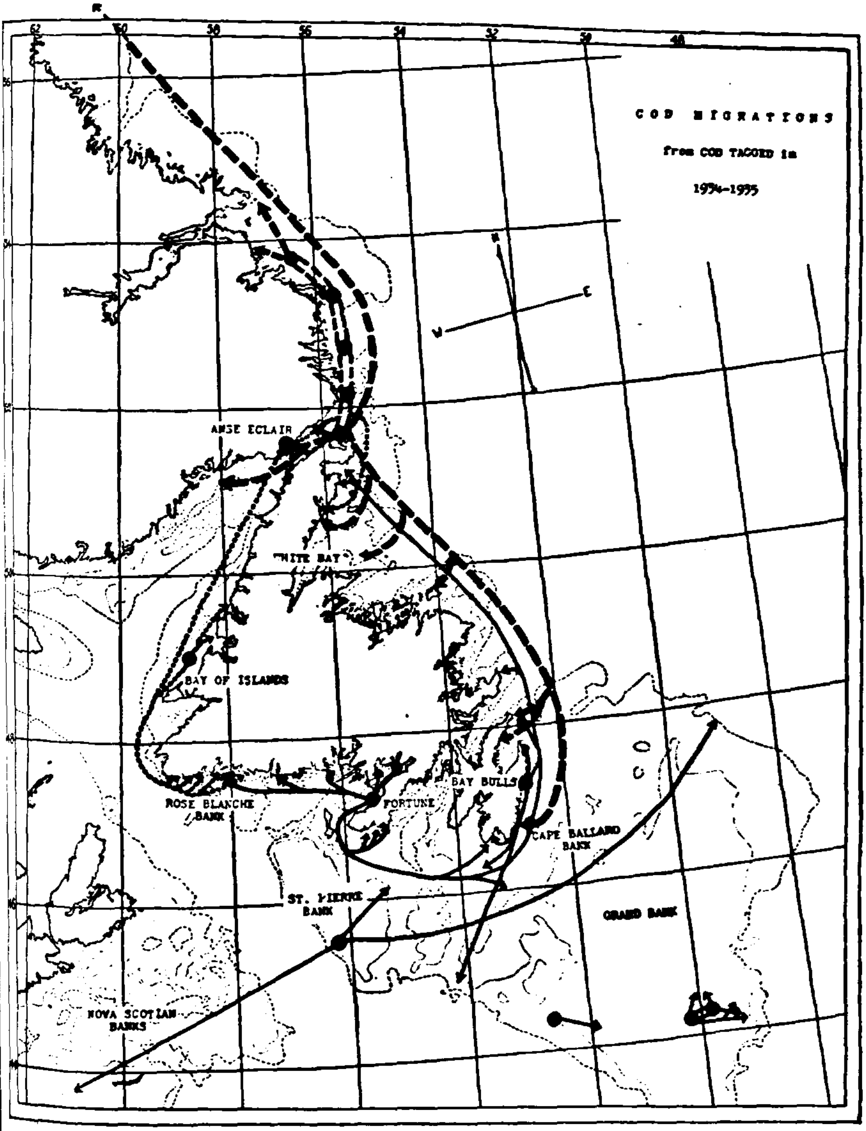


Fig. 4

6,280 fish tagged some 617 (9·8%) were recaptured within a year, and of 2,998 fish tagged during 1933 and 1934 some 42 (1·4%) were retaken in the second year after release, so that all over 11·2% of the tagged fish have been recaptured within a year and a half of release. In several cases, in regions where traps are operated, the percentage of returns has been from 20 to 25%, indicating a very intense local fishery. In other cases a comparatively small rate of return has occurred, indicating that the fishery (carried on by lines) is of a less intense nature. Thus, of 790 cod tagged in the Bay of Islands region, only 18 (2·3%) have been recaptured, mostly at a considerable distance from the point of tagging.

EXTENT OF MIGRATIONS

It was shown in the report for 1934 that, on the whole, tagged codfish did not travel far within the first year after release. This has been confirmed by a second year's work, but it has also been found that, during the second year of freedom, tagged fish were recaptured at greater distances from the point of tagging.

Percentage of Tagged Cod Recaptured :—

	First Year.	*Second Year.*
1. Within 25 miles of point of release	84½	42
2. ,, 50 ,, ,, ,, ,, ,,	94	65
3. ,, 100 ,, ,, ,, ,, ,,	98½	77
4. ,, 250 ,, ,, ,, ,, ,,	99½	91
5. ,, 500 ,, ,, ,, ,, ,,	100	100

However, more than three-quarters (77%) of the returns still came from within a radius of 100 miles. The chief movements so far detected are shown on Fig. 4. Some of the features are noted below :—

Bank Cod. Cod tagged on the southern edge of Grand Bank show only local movement, but the three St. Pierre Bank cod which have been recaptured have all made considerable migrations, one having reached the northern edge of Grand Bank and one the Nova Scotian Banks.

Labrador Cod. These appear to be capable of moving to various points on the east Newfoundland coast, and in the reverse direction a return has come from as far north on the Labrador coast as Port Manver. The slight movement into the Straits occurs on the west side and does not proceed much farther than Blanc Sablon.

Gulf of St. Lawrence Cod. Tagging done in this region (at Anse Eclair and near Bay of Islands) shows a movement limited between the region of Groais Island (White Bay) and Rose Blanche Bank. This confirms the opinion of the local fishermen as to the extent of the movement of this group.

Fortune Bay Cod. These have been found to be capable of moving along the south-west coast to the Rose Blanche region, where the Gulf cod coming from the opposite direction are met with, as shown above. A lesser number travel east and reach points on the east coast of the Island.

East Coast Cod (tagged at Bay Bulls) move chiefly in a northerly direction, and have been traced as far as White Bay.

(J) SALMON INVESTIGATIONS

By H. Thompson

During 1935, the fifth year during which a general biological and statistical study was made of the commercial and the river catches of salmon, sufficient material was collected to complete the broad classification of salmon in the Newfoundland region. In a supplementary publication to that (Vol. I, No. 2 of these reports) which dealt with the biological analysis of the 1931 catch, a complete review of the salmon stocks will be made. This will serve as a background for the more specialised investigations now contemplated in the case of the individual rivers. The duration of early river life and of sea life, together with the average growth-rates in the different regions, have been determined with sufficient thoroughness to formulate a scheme in relation to which more particularised local data can be related with ease. The following are, perhaps, the more important preliminary conclusions which may be drawn from the general study.

1. Progressively in a northerly direction (implying decrease in the duration of summer conditions) the rate of the regeneration of the stock is probably at a lower and lower level. This would appear to follow from the fact that, whilst the sea-going smolt stage is attained in the most southerly rivers at three years of age, the average smolt age rises to four years in the mid-eastern region and to five years (with an observed maximum of eight years) some way down the Labrador coast and near the effective limit of successful commercial fishing. These latter are easily the highest average smolt ages yet recorded for the Atlantic salmon. The comparatively long preliminary period of years that must be passed through by the tiny fry and parr before the smolt stage is attained and the foraging life at sea commenced must inevitably lead to severe reduction in numbers. Measures of conservation would, therefore, have to be contemplated if any considerable increase of fishing activity were to develop down to the northward, where the season of possible interchange between river and sea is so short that it has been found that spent salmon which have just left the rivers are taken in very considerable numbers along with salmon coming in to the rivers to spawn. Ordinarily, in more southerly regions, kelts are uncommon in the catches made for

commercial purposes. It remains for future investigation to determine what proportion of spent fish descend the river to the sea in the late fall and early spring respectively, but clearly the descent is, except in the north, practically completed by the early part of May, when incoming salmon first strike the coast.

The growth of the fresh-frozen salmon industry in recent years at the expense of what was largely a pickled-salmon trade raises the question of the limits to which the new method of exploitation can be pushed without depleting a stock of salmon which does not regenerate rapidly. The marketing situation has not yet become so promising as to encourage operations on a greatly increased scale, and, even so, it has not always proved easy to secure the stipulated quantity. As a matter of fact the readily available quantity varies, within limits, from year to year from natural causes. Among the latter, physical conditions (presence or absence of ice, and water-temperature conditions) may affect the time of appearance of salmon on the coast, and even the proportion of salmon appearing on various sections of the coast. But salmon may be more or less than normally plentiful in any case as a result of the degree of success attending the survival of fry in certain years, or for other and more obscure reasons. It is obviously of importance to study these matters and to attain to as great a foreknowledge of the occurrence of fluctuations as possible.

2. If grilse (salmon which have spent only one complete year at sea) return to the coast in proportionally large numbers in a certain year, it appears to follow that salmon (of the same year of birth, but after spending two years at sea) will tend to be plentiful on the coast in the succeeding year. This has proved to be the case, in the local sense, on the part of the south-east coast over which direct observations could be made from the Laboratory. More broadly, studying the returns kindly supplied by the Hudson's Bay Company, from the factory-ship "Blue Peter," the relationship appears to have applied for the whole eastern seaboard, so far as the observations go.

Year.	Percentage of Grilse.	Success of Salmon Fishery in succeeding year.
1929 ..	35	Highest for the whole period.
1930 ..	8	Moderate.
1931 ..	3	Lowest for the whole period.
1932 ..	19	Good.
1933 ..	9	Moderate.
1934 ..	7	Moderate.
1935 ..	17	Good.

While these data must be accepted with certain reservations, there is little reason to doubt that they show distinct trends. Undoubtedly, the best catches of salmon were to be obtained in 1930. There was a considerable excess of supply over demand. To a lesser extent 1933 and 1936 provided good catches, after comparatively good grilse years, whilst the other years yielded poor or moderate catches in conformity with the low level of grilse taken in the preceding years. This correlation should be studied over a longer period of years to determine its degree of reliability. **J. A. Hutton** (*Wye Salmon*, 1935. Salmon and Trout Magazine, March, 1936) states that he does not think that, in the English river Wye, there has been a poor run of salmon after a *good* grilse year. On the other hand, he states that a good run of small spring and summer fish can also follow in the year succeeding a *poor* run of grilse. If this proves to be the general finding, then while a good run of grilse will *always* indicate a good run of salmon in the next year, a moderate or poor run of grilse *may or may not be* followed by a good run of salmon.

3. Tentative predictions during the last few years have been based on the above-mentioned considerations and have been well justified by the course of events. To what has been said on this subject in previous reports may be added the fact that the forecast for 1935, published in the report for 1934, again proved to be quite accurate. The time of commencement of the fishery was normal, no definite improvements in results occurred in the south-eastern section, but a normal fishery occurred in the north-east.

The absence of unusually cold water conditions in the latter part of 1935, taken together with the relatively large proportion of grilse present in that year, indicated a normal, or rather earlier than normal, time of commencement of the 1936 salmon fishery, and a degree of success of the order of year 1933, when better catches were obtained than in any year since 1930. These indications have also been justified.

FURTHER INVESTIGATIONS

Attention should now be turned to the correlation of the runs in the rivers with the facts which have been determined for the sea phase of the life of the salmon. It is necessary to undertake extensive tagging operations, and to determine the annual cycle of events in characteristic rivers of the different regions—the time of ascent and descent of the river by salmon, the approximate numbers of fish carried by the rivers, the proportion failing to return to the sea after spawning, and the sizes and times of departure of smolts. Accurate knowledge of these subjects is quite lacking. It is, however, necessary in the consideration of protective measures. It is also of vital import, taken in conjunction with knowledge to be gathered regarding the areas available for spawning, or capable of being made available by the construction of ladders or passways in determining measures to be taken for the increase of the valuable salmon resources of the country. Incidentally, as *a period when* particular attention is being focussed on developing the country's natural resources, this division is co-operating with the division of Government and Midland Fisheries with respect to improvements to Rocky, Beaver, La Manche, Terra Nova, Gander, Exploits and Humber Rivers suggested by **W. L. Calderwood** ("*Notes on Newfoundland Salmon Fisheries,*" St. John's, 1930)—this merely as a first step to similar improvements where required in the rivers of the country generally.

III. NOTES ON TECHNICAL INVESTIGATIONS

1. NOTE ON ANALYSES OF MEAL MADE FROM LABRADOR DRIED CODFISH

FROM time to time the question arises as to the desirability of removing surplus or even inferior salt codfish from market competition. At the request of the Newfoundland Fisheries Board the possibilities of freshening (de-salting) such material were examined according to the following procedure :—

Portions A, A_1, and A_2 ..	Ground and soaked in changes of water for 0, 16, and 24 hours.
Portions B, B_1, and B_2 ..	Fish cut in two and soaked for 0, 16, and 24 hours.
Portion C	Soaked whole in running water for 16 hours.

Analyses of the resulting materials, dried and powdered gave :—

	A.	A_1	A_2	B.	B_1	B_2	C.
Ash%	36·4	10·8	11·9	38·4	17·1	12·8	13·6
Salt%	31.7	3·1	2·2	33·2	10·2	6·8	9·3
Albuminoids% ..	59·4	—	86·3	—	—	80·0	82·0

The requirments set forth by the leading British manufacturers and agreed upon by them for "white fish meal" are :—

Salt	Not greater than 4%.
Albuminoids	Not less than 55%.

A good average fish meal should contain from 60 to 65% albuminoids.

From the above analyses it is clear that, if the fish be not chopped or ground up before freshening, well over 24 hours would be required to get the salt content down to below 4% in the resulting meal. In fact, danger of spoilage would occur.

It would, therefore, appear to be necessary to chop, grind, or shred the whole fish, in which case the desired effect could be obtained within 16 hours (A_1 above). The resulting material could be drained free of water on wire gauze and passed to the fish meal plant. A meal with notably high albuminoid content will result. (**Alan Johnston.**)

2. NOTE ON THE AMOUNT OF "STEARINE" SEPARATING FROM COD LIVER OIL AT 0° AND —5°C.

Preliminary measurements of the amount of "stearine" separating from cod liver oil on cooling from 0° to —5°C. show that the amount increases at the rate of about 5% per degree lowering of temperature. The amounts separated at 0° and —5°C. were respectively 21·5 and 46·2% of the original weight of the oil.

The method consisted merely of storing a weighed amount of the oil for at least 12 hours at the desired temperature and then filtering through a porous glass filter (pore size 20–30 microns) using suction. All the apparatus was at the temperature of the experiment. Trial experiments showed that 5 to 6 hours' storage was sufficient to effect maximum separation of "stearine" from a 10 gm. sample at 0°C. The filtrate was collected and weighed and the loss in weight taken to represent the amount of "stearine" separated. The "stearine" residue was white and crystalline and on draining appeared to be free from oil. Further work is, however, necessary to determine what proportion of the oil, if any, is still retained and capable of being expressed. To make the determinations at —5°C. it was found necessary first to filter off the fraction separating at 0°C. The original oil at —5°C. was very viscous and would not pour.

N.B.—This work was done at Torry Research Station, Aberdeen. The author wishes to acknowledge his indebtedness to the Food Investigation Board for permission to work there and to the Superintendent and members of the staff for much help and advice during his visit. (**W. F. Hampton.**)

APPENDIX A.

RESEARCH CRUISES OF STEAM TRAWLER "CAPE AGULHAS."

1. *Spring Cruise* 22/6/35–26/7/35 Stations 448–511.
2. *Fall Cruise* 23/8/35–30/9/35 Stations 508A–567.

Plankton Nets. No. 1. Hjort, fine silk, 27½ inches diameter.
No. 2. 1–metre cheese cloth.
H=horizontal.
V=vertical.
No. 3. 2–metre Stramin.

Dredges and Trawls. O.T.=Otter Trawl.
V.D.=Otter Trawl. French pattern.
m=metres.

on	Dpth at bot-tom (m.)	Plankton Nets Time towed and depth	Dredges and Trawls	Station	Dpth at bot-tom (m.)	Plankton Nets Time towed and depth	Dredges and Trawls
Bay lis 22nd	75	No. 1 (50 m.) No. 2 (H. 25 m. ½ hr.) No. 3 (50 m. ½ hr.)		453. 46°52′N. 56°01′W. June 26th	59	No. 1 (50 m.) No. 2 (V. 50 m.) No. 3 (25 m. ½ hr.)	
3′N. 4′W. 22nd	43	No. 1 (40 m.) No. 2 (V. 40 m.)		454. 47°15′N. 56°56′W. June 26th	240	No. 1 (50 m.) No. 2 (H. 25 m. ½ hr.) No. 3(50 m. ½ hr.)	
6′N. 5′W. 22nd	77	No. 1 (50 m.) No. 2 (H. 25 m. ½ hr.) No. 3 (50 m. ½ hr.)		455. 47°10′N. 57°51′W. June 27th	81	No. 1 (50 m.) No. 2 (H. 25 m. ½ hr.) No. 3 (50 m. ½ hr.)	
0′N. 2′W. 23rd	90	No. 1 (50 m.) No. 2 (H. 25 m. ½ hr.) No. 3 (50 m. ½ hr.)		456. 47°25′N. 58°51′W. June 27th	161	No. 1 (50 m.) No. 2 (H. 25 m. ½ hr.) No. 3 (50 m. ½ hr.)	
7′N. 0′W. 23rd	153	No. 1 (50 m.) No. 2 (H. 25 m. ½ hr.) No. 3 (50 m. ½ hr.)		457. 46°57′N. 59°29′W. June 28th	–	No. 1 (50 m.) No. 2 (H. 25 m. ½ hr.) No. 3 (50 m. ½ hr.)	
0′N. 9′W. 26th	216	No. 1 (50 m.) No. 2 (H. 25 m. ½ hr.) No. 3 (50m. ½hr.)		458. 46°24′N. 59°23′W. June 30th	113	No. 1 (50 m.) No. 2 (H. 25 m. ½ hr.) No. 30 (50 m. ½ hr.)	

Station	Dpth at bot-tom (m.)	Plankton Nets Time towed and depth	Dredges and Trawls	Station	Dpth at bot-tom (m.)	Plankton Nets Time towed and depth	Dredges and Trawls
459. 46°07′N. 58°57′W. June 30th	145	No. 1 (50 m.) No. 2 (H. 25 m. ½ hr.) No. 3 (50 m. ½ hr.)		471. 43°54′N. 51°23′W. July 4th	83	No. 1 (50 m.) No. 2 (H. 25 m. ½ hr.) No. 3 (50 m. ½ hr.)	V.D. [illegible]
460. 44°42′N. 57°53′W. July 1st	44	No. 1 (40 m.) No. 2 (V. 40 m.) No. 3 (25 m. ½ hr.)	V.D. 1 hr.	472. 44°08′N. 49°54′W. July 4th	44	No. 1 (40 m.) No. 2 (V. 40 m.) No. 3 (25 m. ½ hr.)	V.D. [illegible]
461. 44°56′N. 56°54′W. July 1st	415	No. 1 (100 m.) No. 2 (H. 25 m. ½ hr.) No. 3 (50 m. ½ hr.)		473. 45°35′N. 50°05′W. July 5th	72	No. 1 (50 m.) No. 2 (V. 50 m.) No. 3 (25 m. ½ hr.)	
462. 45°31′N. 56°15′W. July 1st	55	No. 1 (50 m.) No. 2 (V. 50 m.) No. 3 (25 m. ½ hr.)	V.D. 1 hr.	474. 45°46′N. 48°33′W. July 5th	99	No. 1 (50 m.) No. 2 (H. 25 m. ½ hr.) No. 3 (50 m. ½ hr.)	V.D. [illegible]
463. 45°16′N. 55°03′W. July 2nd	126	No. 1 (50 m.) No. 2 (H. 25 m. ½ hr.) No. 3 (50 m. ½ hr.)		475. 45°40′N. 48°16′W. July 5th	–	No. 1 (50 m.) No. 2 (H. 25 m. ½ hr.) No. 3 (50 m. ½ hr.)	
464. 45°22′N. 54°20′W. July 2nd	112	No. 1 (50 m.) No. 2 (H. 25 m. ½ hr.) No. 3 (50 m. ½ hr.)		476. 46°20′N. 48°10′W. July 5th	94	No. 1 (50 m.) No. 2 (V. 50 m.)	V.D. [illegible]
465. 45°21′N. 53°22′W. July 2nd	74	No. 1 (50 m.) No. 2 (V. 50 m.) No. 3 (25 m. ½ hr.)		477. 46°56′N. 48°06′W. July 6th	110	No. 1 (50 m.) No. 2 (H. 25 m. ½ hr.) No. 3 (50 m. ½ hr.)	
466. 44°48′N. 53°18′W. July 2nd	103	No. 1 (50 m.) No. 2 (H. 25 m. ½ hr.) No. 3 (50 m. ½ hr.)	V.D. 1½ hrs.	478. 47°32′N. 48°38′W. July 6th	147	No. 1 (50 m.) No. 2 (H. 25 m. ½ hr.) No. 3 (50 m. ½ hr.)	
467. 44°34′N. 52°43′W. July 3rd	86	No. 1 (50 m.) No. 2 (H. 25 m. ½ hr.) No. 3 (50 m. ½ hr.)	V.D. 2 hrs.	479. 47°00′N. 50°14′W. July 6th	110	No. 1 (50 m.) No. 2 (H. 25 m. ½ hr.) No. 3 (50 m. ½ hr.)	V.D. [illegible]
468. 44°21′N. 52°34′W. July 3rd	103	No. 1 (50 m.) No. 2 (H. 25 m. ½ hr.) No. 3 (50 m. ½ hr.)	V.D. 1 hr.	480. 47°10′N. 51°32′W. July 7th	130	No. 1 (50 m.) No. 2 (H. 25 m. ½ hr.) No. 3 (50 m. ½ hr.)	
469. 44°03′N. 52°36′W. July 3rd	200	No. 1 (50 m.) No. 2 (H. 25 m. ½ hr.) No. 3 (50 m. ½ hr.)	V.D. 1 hr.	1. Off Bay Bulls July 7th	81	No. 1 (50 m.) No. 2 (H. 25 m. ½ hr.) No. 3 (50 m. ½ hr.)	
470. 44°14′N. 52°12′W. July 3rd	84	No. 1 (50 m.) No. 2 (H. 25 m. ½ hr.) No. 3 (50 m. ½ hr.)	V.D. 1 hr.	1. Off Bay Bulls July 8th	50	No. 1 (40 m.) No. 2 (V. 40 m.)	

...ation	Dpth at bot-tom (m.)	Plankton Nets Time towed and depth	Dredges and Trawls
...38'N. ...38'W. ...ly 9th	70	No. 1 (50 m.) No. 2 (V. 50 m.) No. 3 (25 m. ¼ hr.)	
...48'N. ...01'W. ...ly 9th	144	No. 1 (50 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	
...07'N. ...45'W. ...ly 9th	144	No. 1 (50 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	
...22'N. ...57'W. ...ly 9th	–	No. 1 (50 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	
...37'N. ...55'W. ...ly 9th	93	No. 1 (35 m.) No. 2 (V. 35 m.) No. 3 (25 m. ¼ hr.)	
...00'N. ...52'W. ...ly 9th	300	No. 1 (100 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	
...55'N. ...08'W. ...y 10th	230	No. 1 (50 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	
...58'N. ...03'W. ...y 10th	162	No. 1 (100 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	
...04'N. ...35'W. ...ly 10th	172	No. 1 (50 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	
...26'N. ...44'W. ...y 11th	234	No. 1 (50 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	
...55'N. ...42'W. ...y 11th	61	No. 1 (50 m.) No. 2 (V. 50 m.) No. 3 (25 m. ¼ hr.)	
...21'N. ...30'W. ...y 11th	66	No. 1 (50 m.) No. 2 (V. 50 m.) No. 3 (25 m. ¼ hr.)	

Station	Dpth at bot-tom (m.)	Plankton Nets Time towed and depth	Dredges and Trawls
493. 51°34'N. 55°23'30" W. July 11th	73	No. 1 (50 m.) No. 2 (V. 50 m.) No. 3 (25 m. ¼ hr.)	
494. 51°38'N. 55°44'W. July 12th	39	No. 1 (25 m.) No. 2 (V. 25 m.) No. 3 (25 m. ¼ hr.)	
495. 51°59'N. 55°32'W. July 12th	162	No. 1 (50 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	
496. 52°52'N. 55°37'W. July 15th	169	No. 1 (50 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	
497. 53°20'N. 55°25'W. July 17th	135	No. 1 (20 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	
498. 53°26'N. 55°31'W. July 16th	94	No. 1 (50 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	
499. 53°39'N. 56°10'W. July 16th	45	No. 1 (25 m.) No. 2 (V. 25 m.) No. 3 (25 m. ¼ hr.)	
500. 53°15'30" N. 55°39'30" W. July 15th	45	No. 1 (25 m.) No. 2 (V. 25 m.) No. 3 (25 m. ¼ hr.)	
501. 52°32'30" N. 55°26'W. July 15th	128	No. 1 (50 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	
502. 52°11'N. 55°35'W. July 13th	64	No. 1 (50 m.) No. 2 (V. 25 m.) No. 3 (25 m. ¼ hr.)	
503. 51°23'30" N. 57°00'W. July 19th	45	No. 1 (25 m.) No. 2 (V. 25 m.) No. 3 (25 m. ¼ hr.)	V.D. ½ hr.
504. 51°11'N. 57°24'W. July 19th	112	No. 1 (50 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	

Station	Dpth at bot-tom (m.)	Plankton Nets Time towed and depth	Dredges and Trawls
505. 50°26′N. 57°55′W. July 20th	250	No. 1 (50 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	
506. 49°09′N. 58°29′W. July 20th	75	No. 1 (50 m.) No. 2 (V. 50 m.) No. 3 (25 m. ¼ hr.)	
507. 48°47′N. 58°59′W. July 20th	39	No. 1 (25 m.) No. 2 (V. 25 m.) No. 3 (25 m. ¼ hr.)	
508. 48°24′N. 59°01′W. July 21st	93	No. 1 (50 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	
509. 48°24′N. 59°40′W. July 22nd	440	No. 1 (100 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	
510. 45°40′N. 56°21′W. July 25th	45	No. 1 (25 m.) No. 2 (V. 25 m.) No. 3 (25 m. ¼ hr.)	
511. 46°22′N. 53°08′W. July 26th	100	No. 1 (50 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	
1. Off Bay Bulls July 26th	99	No. 1 (50 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr.)	
1. Off Bay Bulls Aug. 23rd	63	No. 1 (55 m.) No. 2 (H. 25 m. ½ hr.) No. 3 (50 m. ½ hr. Obl. 50 m.)	
508A. 46°36′N. 53°00′W. Aug. 23rd	65	No. 1 (60 m.) No. 2 (H. 25 m. ½ hr.) No. 3 (50 m. ½ hr. Obl. 50 m.)	
509A. 46°41′N. 53°52′W. Aug. 23rd	74	No. 1 (70 m.) No. 2 (H. 25 m. ½ hr.) No. 3 (50 m. ½ hr. Obl. 50 m.)	

Station	Dpth at bot-tom (m.)	Plankton Nets Time towed and depth	Dredges and Trawls
510A. 46°28′N. 54°14′W. Aug. 24th	75	No. 1 (70 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr. Obl. 50 m.)	
511A. 46°43′N. 54°54′W. Aug. 24th	224	No. 1 (100 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr. Obl. 50 m.)	
512. 47°21′N. 55°41′W. Aug. 27th	165	No. 1 (100 m.) No. 2 (H. 50 m. ½ hr.) No. 3 (100 m. ½ hr. Obl. 100 m.)	
513. 47°27′N. 56°32′W. Aug. 27th	–	No. 1 (100 m.) No. 2 (H. 50 m. ½ hr.) No. 3 (100 m. ½ hr. Obl. 100 m.)	
514. 47°11′N. 57°50′W. Aug. 28th	74	No. 1 (70 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr. Obl. 50 m.)	
515. 47°11′N. 58°47′W. Aug. 28th	150	No. 1 (100 m.)	
516. 46°40′N. 59°35′W. Aug. 29th	80	No. 1 (75 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr. Obl. 50 m.)	
517. 45°43′N. 58°57′W. Aug. 30th	230	No. 1 (100 m.) No. 2 (H. 50 m. ½ hr.) No. 3 (100 m. ½ hr. Obl. 100 m.)	
518. 44°50′N. 57°40′W. Aug. 31st	41	No. 1 (35 m.) No. 3 (35 m. ½hr. Obl. 35 m.)	[illegible]
519. 45°06′N. 56°57′W. Aug. 31st	432	No. 1 (100 m.) No. 2 (H. 50 m. ¼ hr.) No. 3 (100 m. ¼ hr. Obl. 100 m.)	

Station	Dpth at bottom (m.)	Plankton Nets Time towed and depth	Dredges and Trawls
45°46′N. 56°08′W. Aug. 31st	48	No. 1 (45 m.) No. 3 (25 m. ½ hr. Obl. 25 m.)	
45°27′N. 55°06′W. Sept. 1st	113	No. 1 (100 m.) No. 2 (H. 25 m. ½ hr.) No. 3 (50 m. ½ hr. Obl. 50 m.)	
45°11′N. 54°21′W. Sept. 1st	111	No. 1 (100 m.) No. 2 (H. 25 m. ½ hr.) No. 3 (50 m. ½ hr. Obl. 50 m.)	
44°55′N. 53°36′W. Sept. 1st	84	No 1 (75 m.) No. 2 (H. 25 m. ½ hr.) No. 3 (50 m. ½ hr. Obl. 50 m.)	
44°26′N. 53°19′W. Sept. 1st	–	No. 1 (100 m.) No. 2 (H. 50 m. ½ hr.) No. 3 (100 m. ½ hr. Obl. 100 m.)	
44°29′N. 52°53′W. Sept. 2nd	112	No. 1 (100 m.) No. 2 (H. 25 m. ½ hr.) No. 3 (50 m. ½ hr. Obl. 50 m.)	V.D. 1 hr.
44°29′N. 52°23′W. Sept. 2nd	88	No. 1 (75 m.) No. 2 (H. 25 m. ½ hr.) No. 3 (50 m. ½ hr. Obl. 50 m.)	V.D. 1 hr.
44°07′N. 52°00′W. Sept. 2nd	90	No. 1 (85 m.) No. 2 (H. 25 m. ½ hr.) No. 3 (50 m. ½ hr. Obl. 50 m.)	V.D. 1 hr.
43°48′N. 51°05′W. Sept. 2nd	72	No. 1 (65 m.) No. 3 (40 m. ½ hr. Obl. 40 m.)	
44°22′N. 50°13′W. Sept. 3rd	56	No. 1 (50 m.) No. 3 (40 m. ½ hr. Obl. 40 m.)	
43°53′N. 49°22′W. Sept. 3rd	46	No. 1 (40 m.) No. 3 (25 m. ½ hr. Obl. ½ hr.)	V.D. 1½ hrs.

Station	Dpth at bottom (m.)	Plankton Nets Time towed and depth	Dredges and Trawls
531. 44°46′N. 49°17′W. Sept. 3rd	58	No. 1 (50 m.) No. 3 (40 m. ½ hr. Obl. 40 m.)l	
532. 44°52′N. 49°06′W. Sept. 4th	–	No. 1 (100 m.) No. 2 (H. 50 m. ½ hr.) No. 3 (100 m. ½ hr. Obl. 100 m.)	
533. 45°44′N. 49°57′W. Sept. 4th	61	No. 1 (50 m.) No. 3 (40 m. ½ hr. Obl. 40 m.)	
534. 45°56′N. 48°21′W. Sept. 4th	97	No. 1 (90 m.) No. 2 (H. 25 m. ½ hr.) No. 3 (50 m. ½ hr. Obl. 50 m.)	V.D. ½ hr.
535. 46°20′N. 48°00′W. Sept. 4th	103	No. 1 (95 m.) No. 2 (H. 25 m. ½ hr.) No. 3 (50 m. ½ hr. Obl. 50 m.)	
536. 47°07′N. 44°58′W. Sept. 5th	146	No. 1 (100 m.) No. 2 (H. 50 m. ½ hr.) No. 3 (100 m. ½ hr. Obl. 100 m.)	
537. 47°20′N. 47°50′W. Sept. 6th	190	No. 1 (100 m.) No. 2 (H. 50 m. ½ hr.) No. 3 (100 m. ½ hr. Obl. 100 m.)	
538. 47°10′N. 48°35′W. Sept. 6th	115	No. 1 (100 m.) No. 2 (H. 25 m. ½ hr.) No. 3 (50 m. ½ hr. Obl. 50 m.)	
539. 47°18′N. 50°00′W. Sept. 6th	84	No. 1 (75 m.) No. 2 (H. 25 m. ½ hr.) No. 3 (50 m. ½ hr. Obl. 50 m.)	V.D. ½ hr.
540. 47°40′N. 52°00′W. Sept. 6th	163	No. 1 (100 m.) No. 2 (H. 25 m. ½ hr.) No. 3 (50 m. ½ hr. Obl. 50 m.)	

Station	Dpth at bot- tom (m.)	Plankton Nets Time towed and depth	Dredges and Trawls
1. Off Bay Bulls Sept. 7th	132	No. 1 (100 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr. Obl. 50 m.)	
541. 48°04′N. 52°50′W. Sept. 10th	102	No. 1 (95 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr. Obl. 50 m.)	
542. 48°23′N. 52°57′W. Sept. 10th	–	No. 1 (100 m.) No. 2 (H. 50 m. ¼ hr.) No. 3 (100 m. ¼ hr. Obl. 100 m.)	
543. 49°04′N. 52°42′W. Sept. 11th	–	No. 1 (100 m.) No. 2 (H. 50 m. ¼ hr.) No. 3 (100 m. ¼ hr. Obl. 100 m.)	
544. 49°13′N. 53°17′W. Sept. 12th	54	No. 1 (50 m.) No. 3 (25 m. ¼ hr. Obl. 25 m.)	
545. 50°02′N. 53°42′W. Sept. 12th	164	No. 1 (100 m.) No. 2 (H. 50 m. ¼ hr.) No. 3 (100 m. ¼ hr. Obl. 100 m.)	
546. 50°07′N. 54°41′W. Sept. 12th	216	No. 1 (100 m.) No. 2 (H. 50 m. ¼ hr.) No. 3 (100 m. ¼ hr. Obl. 100 m.)	
547. 50°21′N. 55°33′W. Sept. 13th	–	No. 1 (100 m.) No. 2 (H. 50 m. ¼ hr.) No. 3 (100 m. ¼ hr. Obl. 100 m.)	
548. 50°57′N. 55°42′W. Sept. 13th	54	No. 1 (50 m.) No. 2 (V. 50 m.) No. 3 (25 m. ¼ hr. Obl. 25 m.)	
549. 51°34′N. 55°22′W. Sept. 13th	60	No. 1 (50 m.) No. 2 (V. 50 m.) No. 3 (25 m. ¼ hr. Obl. 25 m.)	
550. 52°06′N. 55°17′W. Sept. 13th	141	No. 1 (100 m.) No. 2 (H. 50 m. ¼ hr.) No. 3 (100 m. ¼ hr. Obl. 100 m.)	
551. 52°37′N. 55°38′W. Sept. 13th	230	No. 1 (100 m.) No. 2 (H. 50 m. ¼ hr.) No. 3 (100 m. ¼ hr. Obl. 100 m.)	
552. 53°04′N. 55°23′W. Sept. 14th	142	No. 1 (100 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (75 m. ¼ hr. Obl. 75 m.)	
553. 53°28′N. 55°35′W. Sept. 14th	94	No. 1 (90 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr. Obl. 50 m.)	
554. 53°48′N. 56°39′W. Sept. 18th	58	No. 1 (50 m.) No. 2 (V. 50 m.) No. 3 (25 m. ¼ hr. Obl. 25 m.)	
555. 55°22′N. 57°08′W. Sept. 19th	28	No. 1 (25 m.) No. 2 (V. 25 m.) No. 3 (0 m. ¼ hr. Obl. 25 m.)	
556. 54°15′N. 56°28′W. Sept. 19th	154	No. 1 (100 m.) No. 2 (H. 50 m. ¼ hr.) No. 3 (75 m. ¼ hr. Obl. 75 m.)	
557. 52°11′N. 55°31′W. Sept. 26th	100	No. 1 (95 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr. Obl. 50 m.)	
558. 51°40′N. 56°20′W. Sept. 27th	58	No. 1 (50 m.) No. 2 (V. 50 m.) No. 3 (25 m. ¼ hr. Obl. 25 m.)	
559. 51°23′N. 57°00′W. Sept. 28th	55	No. 1 (50 m.) No. 2 (V. 50 m.) No. 3 (25 m. ¼ hr. Obl. 25 m.)	[illegible]

Station	Dpth at bot-tom (m.)	Plankton Nets Time towed and depth	Dredges and Trawls	Station	Dpth at bot-tom (m.)	Plankton Nets Time towed and depth	Dredges and Trawls
50°45′N. 57°55′W. Sept. 28th	95	No. 1 (90 m.) No. 2 (H. 25 m. ¼ hr.) No. 3 (50 m. ¼ hr. Obl. 50 m.)		564. 48°33′N. 59°17′W. Sept. 29th	54	No. 1 (50 m.) No. 2 (V. 50 m.) No. 3 (25 m. ¼ hr. Obl. 25 m.)	
50°18′N. 58°02′W. Sept. 28th	265	No. 1 (100 m.) No. 2 (H. 50 m. ¼ hr.) No. 3 (100 m. ¼ hr. Obl. 100 m.)		565. 48°02′N. 59°37′W. Sept. 30th	–	No. 1 (100 m.) No. 2 (H. 50 m. ¼ hr.) No. 3 (100 m. ¼ hr. Obl. 100 m.)	
49°58′N. 58°20′W. Sept. 29th	190	No. 1 (100 m.) No. 2 (H. 50 m. ¼ hr.) No. 3 (100 m. ¼ hr. Obl. 100 m.)		566. 47°36′N. 60°05′W. Sept. 30th	430	No. 1 (100 m.) No. 2 (H. 50 m. ¼ hr.) No. 3 (100 m. ¼ hr. Obl. 100 m.)	
48°51′N. 58°52′W. Sept. 29th	31	No. 1 (25 m.) No. 2 (V. 25 m.) No. 3 (25 m. ¼ hr. Obl. 25 m.)		567. 47°22′N. 60°23′W. Sept. 30th	161	No. 1 (100 m.) No. 2 (H. 50 m. ¼ hr.) No. 3 (75 m. ¼ hr. Obl. 75 m.)	
				1. Off Bay Bulls Oct. 6th	56	No. 1 (50 m.) No. 2 (V. 50 m.)	

APPENDIX B.

HYDROGRAPHIC DATA.

TEMPERATURES AND SALINITIES AT DEPTH m (METRES)

(a) *FIRST COMMERCIAL CRUISE*

m=depth in metres; t°=temperature, centigrade; S°/°°=salinity (parts per 1000); I-XXII=trawling stations.

Off Bay Bulls. I.

Date and Position	m.	t°	S°/°°
1935 II 26 59 m. Off Bay Bulls	0	-1·7	
	10	-1·8	32·55
	25	-1·8	
	50	-1·8	

Southern Edge of Grand Banks. II.

Date and Position	m.	t°	S°/°°
1935 II 27 89 m. 44°51′N. 53°19′W.	0	0·8	32·79
	50	0·8	32·79
	85	0·6	32·85

Grand Bank. III.

Date and Position	m.	t°	S°/°°
1935 II 28 85 m. 44°32′N. 52°40′W.	0	1·0	
	25	1·0	
	50	1·1	
	75	1·5	

Sable Island Bank. IV.

Date and Position	m.	t°	S°/°°
1935 III 3 90 m. 43°37′N. 59°30′W.	0	0·1	32·37
	50	0·5	32·71
	75	1·3	33·28
	85	1·4	33·28

Grand Bank. V.

Date and Position	m.	t°	S°/°°
1935 III 15 90 m. 44°43′N. 52°55′W.	0	-0·7	
	25	-0·7	
	50	-0·6	
	80	-0·6	

Grand Bank. VI.

Date and Position	m.	t°	S°/°°
1935 III 15 93 m. 5 ml. W. of last position	0	-0·5	
	25	-0·5	
	50	-0·5	
	80	-0·4	

Grand Bank. VII.

Date and Position	m.	t°	S°/°°
1935 III 15 94 m. 5 ml. W. by S. of last position	0	-0·5	
	25	-0·5	
	50	-0·5	
	80	-0·1	

Grand Bank. VIII.

Date and Position	m.	t°	S°/°°
1935 III 15 144 m. 5 ml. W. of last position	0	-0·2	
	25	-0·2	
	50	0·2	
	100	8·0	
	125	7·1	

Grand Bank. IX.

Date and Position	m.	t°	S°/°°
1935 III 16 104 m. 44°32′N. 53°27′W.	0	-0·2	
	50	-0·2	
	75	1·2	
	100	2·9	

Grand Bank. X.

Date and Position	m.	t°	S°/°°
1935 III 17 114 m. 44°45′N. 53°48′W.	0	0·0	
	50	-0·1	
	75	-0·1	
	100	-0·1	

Date and Position	m.	t°	S°/°°
Grand Bank. XI.			
1935 III 17			
104 m.			
8 ml. S. by E. of last position	0	-0·2	
	50	-0·2	32·85
	75	1·2	33·19
	100	2·8	33·61
Grand Bank. XI.			
1935 III 18			
104 m.	0	-0·2	
	50	1·5	
	75	1·6	
	100	2·3	
Grand Bank. XII.			
1935 III 20			
110 m.			
44°23′N. 53°00′W.	0	0·0	
	50	0·3	
	75	3·8	
	100	4·5	
Grand Bank. XIII.			
1935 III 20			
112 m.			
2½ ml. N. of last position	0	0·0	
	50	-0·1	
	75	0·1	
	100	2·5	
Grand Bank. XIV.			
1935 III 23			
95 m.			
44°44′N. 53°32′W.	0	-0·9	32·77
	50	-1·0	32·81
	75	-1·0	32·81
	90	-1·1	32·83
Grand Bank. XV.			
1935 III 23			
104 m.			
44°32′N. 52°31′W.	0	-0·8	
	50	-0·7	
	75	2·0	
	100	4·9	
Grand Bank. XV.			
1935 III 24			
98 m.	0	0·0	
	50	-1·1	
	75	-1·1	
	95	3·0	
Grand Bank. XV.			
1935 III 24			
104 m.	0	0·0	
	50	-0·8	
	75	1·0	
	100	4·6	

Date and Position	m.	t°	S°/°°
Grand Bank. XVI.			
1935 III 24			
100 m.			
44°35′N. 53°15′W.	0	-0·7	
	50	-0·9	
	75	-1·1	
	95	1·0	
Grand Bank. XVII.			
1935 III 26			
95 m.			
44°48′N. 52°23′W.	90	-0·9	
Grand Bank. XVIII.			
1935 III 26			
99 m.			
44°33′N. 53°06′W.	0	-0·8	
	50	-1·0	
	75	4·0	
	90	6·6	
Grand Bank. XVII.			
1935 III 26			
95 m.			
44°48′N. 52°23′W.	0	-0·7	
	50	-0·9	
	75	-1·1	
	90	3·2	
Grand Bank. XIX.			
1935 III 27			
94 m.			
44°15′N. 52°16′W.	0	-0·7	
	50	-0·8	
	75	6·3	
	90	6·8	
Grand Bank. XIX.			
1935 III 27			
92 m.	0	-0·7	
	50	-1·2	
	75	0·6	
	90	5·4	
Grand Bank. XX.			
1935 III 27			
90 m.			
44°30′N. 52°32′W.	0	-1·1	
	50	-1·3	
	80	1·0	
Grand Bank. XXI.			
1935 III 28			
90 m.			
44°20′N. 52°17′W.	0	-0·8	
	50	-1·2	
	75	-1·3	
	85	2·0	

Grand Bank. XXII.

Date and Position	m.	t°	S°/°°
1935 III 29			
90 m.			
44°18′N. 52°16′W.	0	−0·8	32·87
	50	−1·1	33·42
	75	1·4	–
	85	2·0	33·54

Off Bay Bulls. I.

Date and Position	m.	t°	S°/°°
1935 III 31	0	−1·5	32·75
	25	−1·7	32·81
	50	−1·7	32·85
	75	−1·9	32·85
	85	−1·9	32·87

(*b*) *SECOND COMMERCIAL CRUISE*

Grand Bank. I.

Date and Position	m.	t°
1935 IV 7		
94 m.		
44°20′N. 52°00′W.	85	4·7

Grand Bank. I.

Date and Position	m.	t°
1935 IV 8		
95 m.	0	−0·9
	50	−0·9
	75	−1·0
	90	−0·3

Grand Bank. I.

Date and Position	m.	t°
1935 IV 8		
95 m.	0	−1·0
	50	−1·0
	75	−0·9
	90	−0·1

Grand Bank. II.

Date and Position	m.	t°
1935 IV 8		
95 m.		
44°20′N. 52°55′W.	90	4·5

Grand Bank. II.

Date and Position	m.	t°
1935 IV 9		
99 m.	0	−0·8
	50	−0·9
	75	0·5
	95	4·2

Grand Bank. III.

Date and Position	m.	t°
1935 IV 9		
98 m.		
5 ml. N. of last	0	−0·9
position	50	−0·9
	75	−1·0
	90	0·0

Grand Bank. III.

Date and Position	m.	t°
1935 IV 9		
100 m.	0	−0·7
	50	−0·8
	75	0·9
	90	1·5

Grand Bank. III.

Date and Position	m.	t°
1935 IV 10		
98 m.	0	−0·8
	50	−0·8
	75	−0·9
	95	−0·3

Grand Bank. IV.

Date and Position	m.	t°
1935 IV 10		
100 m.		
44°27′N. 53°10′W.	0	−0·6
	50	−0·8
	75	−0·4
	95	2·0

Grand Bank. V.

Date and Position	m.	t°	S°/°°
1935 IV 12			
100 m.			
44°30′N. 53°11′W.	0	−0·9	33·05
	50	−0·8	33·05
	75	−0·8	33·01
	95	0·3	33·17

Grand Bank. VI.

Date and Position	m.	t°
1935 IV 12		
44°28′N. 52°11′W.	0	−0·9
	50	−0·8
	75	−0·3
	100	0·0
	120	3·1

Grand Bank. VII.

Date and Position	m.	t°
1935 IV 13		
100 m.		
44°40′N. 52°32′W.	95	−0·8

Grand Bank. VII.

Date and Position	m.	t°
1935 IV 13		
93 m.	0	−0·3
	50	−0·7
	75	−0·5
	90	−0·4

Grand Bank. VIII.

Date and Position	m.	t°
1935 IV 13		
115 m.		
6 ml. S. of last	0	0·0
position	75	0·3
	100	6·3
	110	6·5

Grand Bank. IX.

Date and Position	m.	t°
1935 IV 13		
95 m.		
3 ml. N. of last		
position	95	2·6

Date and Position	m.	t°	S°/°°
Grand Bank. X.			
1935 IV 15			
95 m.			
44°27'N. 53°03'W.	90	3·2	
Grand Bank. X.			
1935 IV 15			
103 m.	95	3·7	
Grand Bank. X.			
1935 IV 16			
103 m.	90	–0·5	
Grand Bank. X.			
1935 IV 16			
103 m.	75	–1·0	
	90	–0·5	
Grand Bank. XI.			
1935 IV 16			
93 m.			
2½ ml. S.W. by W.			
of last position	90	–0·9	
Grand Bank. XII.			
1935 IV 16			
100 m.			
44°35'N. 53°33'W.	0	1·4	
	25	2·3	
	50	5·0	
	75	5·0	
	95	5·2	
Grand Bank. XII.			
1935 IV 16			
140 m.	0	2·0	
	50	1·5	
	100	6·4	
	130	6·4	
Grand Bank. XIII.			
1935 IV 16			
44°40'N. 53°48'W.	85	0·4	
Grand Bank. XIV.			
1935 IV 16			
93 m.			
9 ml. S.E. ½ E.			
from last position	0	1·5	
	50	0·4	
	75	0·0	
	90	0·0	
Grand Bank. XV.			
1935 IV 17			
100 m.			
44°28'N. 52°40'W.	0	1·5	
	50	0·6	
	75	0·4	
	95	3·0	

Date and Position	m.	t°	S°/°°
Grand Bank. XVI.			
1935 IV 17			
85 m.			
44°37'N. 52°44'W.	50	0·0	
	75	–0·9	
	85	–0·9	
Grand Bank. XVI.			
1935 IV 17			
75 m.	50	1·4	
	75	1·4	
Grand Bank. XVI.			
1935 IV 18			
85 m.	0	1·5	
	50	0·6	
	85	1·4	
Grand Bank. XVI.			
1935 IV 18			
85 m.	0	1·7	
	50	1·4	
	85	1·6	
Grand Bank. XVI.			
1935 IV 18			
95 m.	0	1·8	
	50	1·6	
	75	1·4	
	90	2·8	
Grand Bank. XVI.			
1935 IV 19			
90 m.	0	1·9	
	50	2·3	
	85	2·4	
Grand Bank. XVI.			
1935 IV 19			
90 m.	0	2·2	
	50	2·3	
	85	2·6	
Grand Bank. XVII.			
1935 IV 20			
83 m.			
44°21'N. 51°52'W.	0	1·9	
	50	1·3	
	80	0·5	
Grand Bank. XVII.			
1935 IV 21			
88 m.	0	2·0	—
	25	1·9	32·96
	50	1·5	33·01
	75	0·7	33·12
	85	1·8	33·40

Grand Bank. XVIII.

Date and Position	m.	t°	S°/°°
1935 IV 22 90 m. 44°10′N. 51°40′W.	0	2·0	
	50	1·4	
	85	1·9	

Off Bay Bulls. I.

Date and Position	m.	t°	S°/°°
1935 IV 23 80 m.	0	0·1	32·58
	10	–0·2	32·58
	25	–0·2	32·64
	50	–2·0	32·90
	75	–2·0	33·01

(*c*) *THIRD COMMERCIAL CRUISE*

Grand Bank. I.

Date and Position	m.	t°	S°/°°
1935 V 2 44°22′N. 52°10′W.	85	1·5	

Grand Bank. I.

Date and Position	m.	t°	S°/°°
1935 V 2 44°22′N. 52°10′W.	85	2·0	

Grand Bank. I.

Date and Position	m.	t°	S°/°°
1935 V 2 84 m. 44°22′N. 52°10′W.	0	2·6	
	50	0·3	
	80	2·0	

Grand Bank. II.

Date and Position	m.	t°	S°/°°
1935 V 3 80 m. 44°20′N. 52°00′W.	0	2·7	32·44
	25	2·2	32·44
	50	0·9	32·57
	75	1·4	32·98

Grand Bank. III.

Date and Position	m.	t°	S°/°°
1935 V 4 81 m. 44°04′N. 52°20′W.	0	2·6	
	25	2·6	
	50	1·7	
	75	1·6	

Grand Bank. III.

Date and Position	m.	t°	S°/°°
1935 V 5 80 m.	0	2·5	
	25	2·4	
	50	1·9	
	75	1·0	

Grand Bank. III.

Date and Position	m.	t°	S°/°°
1935 V 5 80 m.	0	2·5	
	25	2·2	
	50	1·8	
	75	1·7	

Grand Bank. IV.

Date and Position	m.	t°	S°/°°
1935 V 6 80 m. 44°25′N. 51°50′W.	0	2·6	
	25	2·4	
	50	1·9	
	75	1·3	

Grand Bank. IV.

Date and Position	m.	t°	S°/°°
1935 V 7 79 m.	0	2·1	
	25	1·9	
	50	1·0	
	75	1·2	

Grand Bank. V.

Date and Position	m.	t°	S°/°°
1935 V 8 74 m. 44°05′N. 51°30′W.	0	2·1	
	25	1·6	
	50	1·1	
	70	1·1	

Grand Bank. VI.

Date and Position	m.	t°	S°/°°
1935 V 11 85 m. 44°19′N. 52°15′W.	0	1·6	
	25	1·5	
	50	1·1	
	80	0·1	

Grand Bank. VII.

Date and Position	m.	t°	S°/°°
1935 V 11 81 m 44°13′N. 52°07′W.	0	2·1	32·55
	25	2·0	32·55
	50	2·0	32·55
	75	1·6	33·26

Grand Bank. VII.

Date and Position	m.	t°	S°/°°
1935 V 12 87 m.	0	2·2	
	25	2·0	
	50	1·8	
	80	1·7	

Grand Bank. VIII.

Date and Position	m.	t°	S°/°°
1935 V 13 80 m. 4 ml. E of 44°10′N. 52°05′W.	0	1·8	
	25	1·6	
	50	0·9	
	80	–0·3	

(repeated)

Grand Bank. VIII.

Date and Position	m.	t°	S°/°°
1935 V 13 80 m.	0	2·0	
	50	1·9	
	80	1·7	

Grand Bank. VIII.

Date and Position	m.	t°	S°/°°
1935 V 14			
83 m.	0	1·8	
	25	1·8	
	50	1·2	
	75	1·6	

Off Bay Bulls.

Date and Position	m.	t°	S°/°°
1935 V 15			
81 m.			
1 ml. N. of light-			
house	0	0·2	32·71
	10	0·1	32·71
	25	–0·1	32·71
	50	–1·0	32·79
	75	–1·1	32·79

(*d*) *FOURTH COMMERCIAL CRUISE*

Grand Bank. I.

Date and Position	m.	t°	S°/°°
1935 V 24			
94 m.			
44°21′N. 52°26′W.	0	3·6	
	25	3·5	
	50	3·5	
	75	2 4	
	90	4·7	

Grand Bank. II.

Date and Position	m.	t°	S°/°°
1935 V 25			
85 m.			
44°27′N. 52°25′W.	85	1·0	

Grand Bank. II.

Date and Position	m.	t°	S°/°°
1935 V 25			
90 m.	0	2·9	
	25	2·8	
	50	2·0	
	75	1·2	
	85	1·3	

Grand Bank. II.

Date and Position	m.	t°	S°/°°
1935 V 26			
85 m.	0	2·9	32·73
	10	2·9	32·73
	25	2·8	32·81
	50	2·6	32·81
	75	0·6	32·90

Grand Bank. II.

Date and Position	m.	t°	S°/°°
1935 V 27			
85 m.	0	3·1	
	50	2·9	
	80	1·0	

Grand Bank. II.

Date and Position	m.	t°	S°/°°
1935 V 28			
90 m.	0	3·3	
	25	3·2	
	50	2·9	
	75	1·1	
	85	1·1	

Grand Bank. II.

Date and Position	m.	t°	S°/°°
1935 V 29			
88 m.	0	3·4	
	25	3·3	
	50	2·9	
	75	1·0	
	85	1·0	

Grand Bank. III.

Date and Position	m.	t°	S°/°°
1935 V 31			
83 m.			
44°30′N. 52°26′W.	0	3·7	32·75
	10	3·7	32·71
	25	3·6	32·70
	50	2·9	32·71
	75	1·3	32·85

Grand Bank. III.

Date and Position	m.	t°	S°/°°
1935 VI 1			
83 m.	0	4·0	
	25	3·8	
	50	2·6	
	75	1·2	

Grand Bank. IV.

Date and Position	m.	t°	S°/°°
1935 VI 3			
81 m.			
44°10′N. 51°32′W.	0	4·9	32·66
	10	4·7	32·68
	25	3·9	32·71
	50	2·5	32·73
	75	1·5	32·85

Grand Bank. VI.

Date and Position	m.	t°	S°/°°
1935 VI 4			
80 m.			
43°57′N. 51°50′W.	0	4·5	
	25	3·6	
	50	2·6	
	75	0·9	

Grand Bank. VIII.

Date and Position	m.	t°	S°/°°
1935 VI 5			
81 m.			
44°04′N. 51°58′W.	0	4·3	
	25	3·7	
	50	2·9	
	75	1·2	

Grand Bank. IX.

Date and Position	m.	t°	S°/°°
1935 VI 6			
85 m.			
44°13′N. 52°08′W.	0	5·4	
	25	4·2	
	50	3·0	
	75	1·3	

(e) *SPRING RESEARCH CRUISE*

June 22–*July* 26, 1935.

Station I.

1935 VI 22
75 m.
Off Bay Bulls

Date and Position	m.	t°	S°/°°
	0	6·2	32·30
	10	5·3	32·35
	25	4·9	32·43
	50	0·9	32·79
	70	–1·2	32·90

Station 448.

1935 VI 22
43 m.
46°33′N. 53°04′W.

Date and Position	m.	t°	S°/°°
	0	6·1	32·44
	10	6·0	32·46
	25	4·6	32·46
	40	1·7	32·66

Station 449.

1935 VI 22
77 m.
46°26′N. 53°45′W.

Date and Position	m.	t°	S°/°°
	0	6·3	32·43
	10	6·3	32·43
	25	3·6	32·50
	50	0·4	32·77
	75	–0·3	32·83

Station 450.

1935 VI 23
90 m.
46°30′N. 54°32′W.

Date and Position	m.	t°	S°/°°
	0	5·9	32·55
	10	5·4	32·59
	25	2·9	32·62
	50	0·3	32·83
	75	–0·4	32·90
	85	–1·1	32·98

Station 451.

1935 VI 23
153 m.
46°37′N. 55°10′W.

Date and Position	m.	t°	S°/°°
	0	7·0	32·34
	10	6·8	32·36
	25	2·0	32·62
	50	1·3	32·73
	75	0·2	32·77
	100	–0·6	32·81
	125	–1·0	32·88
	150	–1·1	32·98

Station 452.

1935 VI 26
216 m.
47°20′N. 55°40′W.

Date and Position	m.	t°	S°/°°
	0	7·0	31·68
	10	6·7	32·07
	25	2·3	32·44
	50	0·8	32·53
	75	–0·2	32·57
	100	–0·3	32·62
	200	–0·5	32·73

Station 453.

1935 VI 26
59 m.
46°52′N. 56°01′W.

Date and Position	m.	t°	S°/°°
	0	6·0	32·23
	10	5·0	32·34
	25	0·1	32·68
	50	–0·3	32·68

Station 454.

1935 VI 26
240 m.
47°15′N. 56°56′W.

Date and Position	m.	t°	S°/°°
	0	8·0	32·05
	10	7·0	32·07
	25	3·0	32·44
	50	0·5	32·64
	75	–0·1	32·83
	100	0·0	32·99
	200	3·8	34·24

Station 455.

1935 VI 27
81 m.
47°10′N. 57°51′W.

Date and Position	m.	t°	S°/°°
	0	7·0	32·05
	10	6·0	32·07
	25	2·5	32·32
	50	0·3	32·61
	75	0·3	32·75

Station 456.

1935 VI 27
161 m.
47°25′N. 58°51′W.

Date and Position	m.	t°	S°/°°
	0	8·7	31·59
	10	4·5	31·92
	25	0·6	32·28
	50	0·1	32·46
	75	–0·2	32·64
	100	0·0	32·88
	150	2·1	32·61

Station 457.

1935 VI 28
No sounding
46°57′N. 59°29′W.

Date and Position	m.	t°	S°/°°
	0	7·5	30·51
	10	5·2	30·58
	25	0·2	31·77
	50	–0·9	32·28
	75	–0·4	32·48
	100	–0·3	32·52
	200	3·3	33·97
	300	4·3	34·59
	400	4·1	34·75

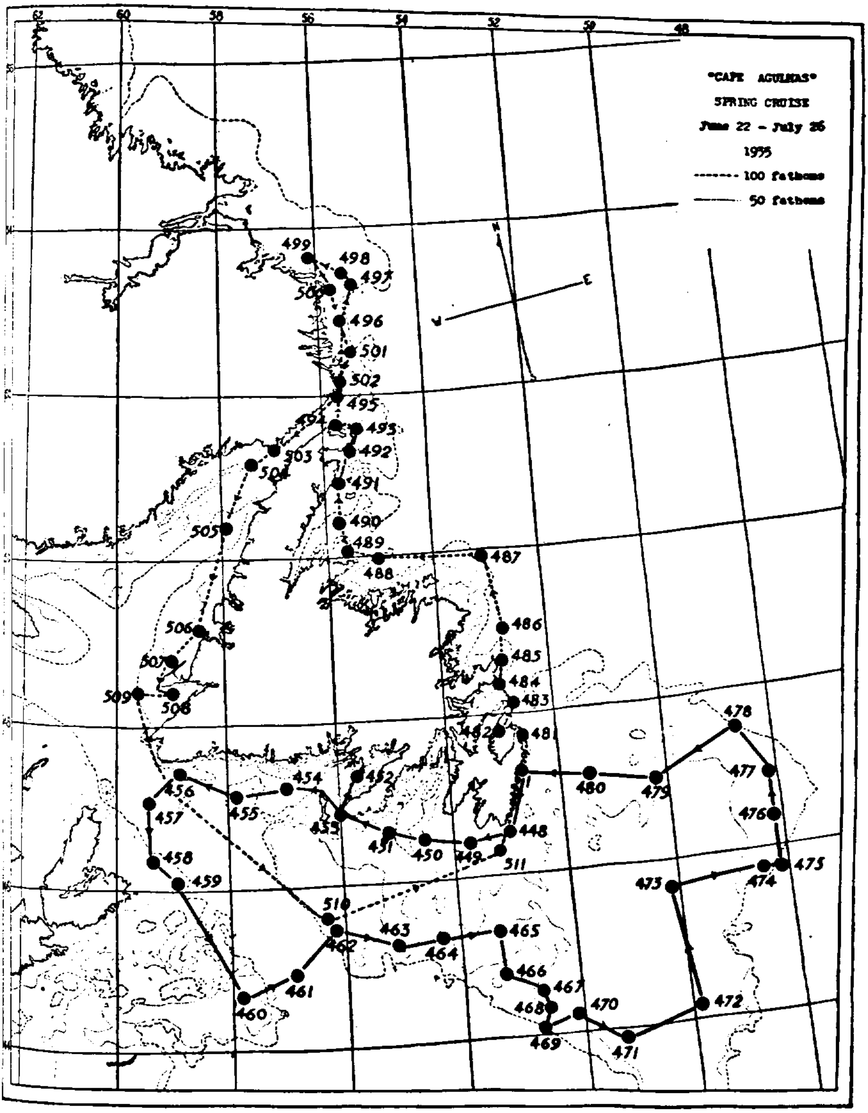

"CAPE AGULHAS"
SPRING CRUISE
June 22 - July 26
1955
100 fathoms
50 fathoms
N
E
W

Fig. 5

Date and Position	m.	t°	S°/°°
Station 458.			
1935 VI 30			
113 m.			
46°24'N. 59°23'W.	0	9·7	30·44
	10	2·0	31·64
	25	–0·3	31·89
	50	–0·9	32·16
	75	0·2	32·87
	100	1·1	33·21
Station 459.			
1935 VI 30			
145 m.			
46°07'N. 58°57'W.	0	9·0	30·31
	10	9·0	30·31
	25	3·4	31·99
	50	–0·3	32·35
	75	–0·3	32·68
	100	1·4	33·29
	140	2·7	33·84
Station 460.			
1935 VII 1			
44 m.			
44°42'N. 57°53'W.	0	9·1	31·83
	10	7·2	31·96
	25	6·4	32·03
	40	3·0	32·19
Station 461.			
1935 VII 1			
415 m.			
44°56'N. 56°54'W.	0	7·6	32·08
	10	4·8	32·44
	25	1·0	32·85
	50	0·5	33·14
	75	0·9	33·67
	100	3·3	34·37
	200	5·9	34·62
	300	5·5	34·73
	400	4·6	34·76
Station 462.			
1935 VII 1			
55 m.			
45°31'N. 56°15'W.	0	8·0	32·34
	10	6·1	32·46
	25	3·6	32·46
	50	3·5	32·57
Station 463.			
1935 VII 2			
126 m.			
45°16'N. 55°03'W.	0	6·7	32·73
	10	3·9	32·87
	25	2·2	32·99
	50	0·4	33·03
	75	0·3	33·10
	100	0·3	33·23
	120	2·3	33·47

Date and Position	m.	t°	S°/°°
Station 464.			
1935 VII 2			
112 m.			
45°22'N. 54°20'W.	0	9·1	32·35
	10	7·9	32·48
	25	5·3	32·81
	50	2·9	32·88
	75	1·5	33·14
	100	2·8	33·17
Station 465.			
1935 VII 2			
74 m.			
45°21'N. 53°22'W.	0	9·1	32·50
	10	6·6	32·70
	25	3·4	32·85
	50	2·3	32·83
	70	2·3	32·88
Station 466.			
1935 VII 2			
103 m.			
44°48'N. 53°18'W.	0	10·5	32·48
	10	10·4	32·48
	25	5·5	32·62
	50	2·7	32·87
	75	1·6	32·94
	100	1·4	33·10
Station 467.			
1935 VII 3			
86 m.			
44°34'N. 52°43'W.	0	11·3	32·46
	10	11·3	32·55
	25	4·8	32·73
	50	2·3	32·94
	75	2·7	33·38
Station 468.			
1935 VII 3			
103 m.			
44°21'N. 52°34'W.	0	12·2	32·75
	10	12·1	32·75
	25	6·7	32·64
	50	3·4	32·99
	75	4·1	33·49
	100	5·2	34·22
Station 469.			
1935 VII 3			
200 m.			
44°03'N. 52°36'W.	0	12·7	32·92
	10	13·3	33·23
	25	6·6	33·23
	50	6·2	33·77
	75	5·9	34·18
	100	7·0	34·52
	190	6·3	34·78

Station 470.

Date and Position	m.	t°	S°/°°
1935 VII 3			
84 m.			
44°14′N. 52°12′W.	0	11·8	32·52
	10	9·1	32·53
	25	5·7	32·61
	50	2·6	32·73
	75	1·6	32·08

Station 471.

Date and Position	m.	t°	S°/°°
1935 VII 4			
83 m.			
43°54′N. 51°23′W.	0	11·3	32·43
	10	9·2	32·52
	25	4·7	32·61
	50	2·7	32·71
	75	2·1	32·81

Station 472.

Date and Position	m.	t°	S°/°°
1935 VII 4			
44 m.			
44°08′N. 49°54′W.	0	11·3	32·64
	10	11·2	32·63
	25	2·3	32·85
	40	2·1	32·83

Station 473.

Date and Position	m.	t°	S°/°°
1935 VII 5			
72 m.			
45°35′N. 50°05′W.	0	8·3	32·62
	10	8·3	32·64
	25	1·9	33·10
	50	–0·5	33·34
	65	–0·6	33·34

Station 474.

Date and Position	m.	t°	S°/°°
1935 VII 5			
99 m.			
45°46′N. 48°33′W.	0	7·8	32·66
	10	7·6	32·68
	25	3·3	33·12
	50	–0·1	33·49
	75	–0·7	33·51
	90	–0·6	33·56

Station 475.

Date and Position	m.	t°	S°/°°
1935 VII 5			
No sounding			
45°40′N. 48°16′W.	0	6·5	32·88
	10	5·8	32·96
	25	1·0	33·29
	50	0·0	33·47
	75	–1·0	33·63
	100	–0·8	33·65
	200	0·0	33·91
	300	1·6	34·32

Station 476.

Date and Position	m.	t°	S°/°°
1935 VII 5			
94 m.			
46°20′N. 48°10′W.	0	7·1	32·70
	10	7·1	32·70
	25	3·4	33·07
	50	0·0	33·29
	75	–0·5	33·52
	90	0·4	33·54

Station 477.

Date and Position	m.	t°	S°/°°
1935 VII 6			
110 m.			
46°56′N. 48°06′W.	0	6·1	32·70
	10	6·0	32·70
	25	0·8	32·70
	50	0·0	32·70
	75	5·9	32·90
	100	6·3	33·03

Station 478.

Date and Position	m.	t°	S°/°°
1935 VII 6			
147 m.			
47°32′N. 48°38′W.	0	6·7	32·71
	10	6·6	32·70
	25	3·7	32·98
	50	–0·2	33·29
	75	0·7	33·52
	100	–0·2	33·60
	140	–0·4	33·80

Station 479.

Date and Position	m.	t°	S°/°°
1935 VII 6			
110 m.			
47°00′N. 50°14′W.	0	8·4	32·43
	10	8·3	32·50
	25	7·0	32·52
	50	–0·1	32·85
	75	–0·5	33·03
	100	–0·5	33·21

Station 480.

Date and Position	m.	t°	S°/°°
1935 VII 7			
130 m.			
47°10′N. 51°32′W.	0	8·5	32·28
	10	8·5	32·32
	25	0·4	32·77
	50	–0·4	33·12
	75	–0·6	33·26
	100	–0·9	33·40
	125	–1·0	33·61

Station 1.

Date and Position	m.	t°	S°/°°
1935 VII 7			
81 m.			
½ ml. E. of Light-	0	8·6	31·92
house, Bay Bulls	10	8·9	32·01
	25	9·0	32·07
	50	–1·1	32·99
	75	–1·4	33·16

Station 1.

Date and Position	m.	t°	S°/°°
1935 VII 8			
50 m.			
¾ ml. E.N.E. of	0	9·5	31·98
Lighthouse, Bay	5	9·0	31·99
Bulls	10	8·1	32·01
	15	7·8	32·14
	20	2·5	32·52
	25	7·0	32·19
	30	0·0	32·77
	35	–0·3	32·79
	40	–0·6	32·87
	45	–0·7	32·94

Date and Position	m.	t°	S°/°°
Station 481.			
1935 VII 9			
70 m.			
47°38′N. 52°38′W.	0	8·5	32·64
	10	8·3	32·64
	25	7·0	32·68
	50	0·0	32·79
	60	–0·5	32·81
Station 482.			
1935 VII 9			
144 m.			
47°48′N. 53°01′W.	0	9·8	32·05
	10	8·7	32·14
	25	1·5	32·59
	50	–1·0	32·88
	75	–1·4	33·25
	100	–1·4	32·26
	130	–1·3	33·28
Station 483.			
1935 VII 9			
144 m.			
48°07′N. 52°45′W.	0	8·4	31·89
	10	8·3	31·92
	25	1·7	32·48
	50	–0·6	33·01
	75	–1·0	33·19
	100	–1·2	33·33
	130	– 1·3	33·42
Station 484.			
1935 VII 9			
No Sounding			
48°22′N. 52°57′W.	0	7·8	31·68
	10	7·6	31·89
	25	0·3	32·92
	50	–0·9	33·17
	75	–1·2	33·21
	100	–1·2	33·29
	200	–0·7	33·56
Station 485.			
1935 VII 9			
93 m.			
48°37′N. 52°55′W.	0	8·7	31·41
	10	8·6	31·41
	25	–0·1	32·62
	40	–0·5	32·77
	60	–0·8	33·03
	80	–1·0	33·12
Station 486.			
1935 VII 9			
300 m.			
49°00′N. 52°52′W.	0	9·0	31·43
	10	8·8	31·57
	25	0·5	32·88
	50	–0·5	33·21
	75	–0·9	33·29
	100	–1·2	33·29
	200	–1·2	33·58
	280	2·6	34·70
Station 487.			
1935 VII 10			
230 m.			
49°55′N. 53°08′W.	0	8·7	30·60
	10	6·3	31·94
	25	0·4	32·77
	50	–0·7	33·21
	75	–0·7	33·51
	100	–1·0	33·69
	200	–0·9	34·06
Station 488.			
1935 VII 10			
162 m.			
49°58′N. 55°03′W.	0	6·8	28·69
	10	0·0	31·57
	25	–1·3	32·77
	50	–1·1	33·01
	75	–1·0	33·14
	100	–1·3	33·29
	150	–1·2	33·52
Station 489.			
1935 VII 10			
172 m.			
50°04′N. 55°35′W.	0	6·6	29·08
	10	2·8	30·82
	25	0·2	31·94
	50	–1·2	32·77
	75	–1·2	32·98
	100	–1·1	33·14
	150	–1·2	33·19
Station 490.			
1935 VII 11			
234 m.			
50°26′N. 55°44′W.	0	5·5	28·30
	10	1·1	30·19
	25	–0·2	32·44
	50	–0·4	33·05
	75	–0·6	33·25
	100	–1·2	33·43
	200	–0·7	33·80
Station 491.			
1935 VII 11			
61 m.			
50°55′N. 55°42′W.	0	5·4	30·01
	10	5·6	30·51
	25	0·6	31·83
	50	–1·1	32·85
Station 492.			
1935 VII 11			
66 m.			
51°21′N. 55°30′W.	0	3·8	29·06
	10	3·3	29·45
	25	3·3	29·72
	50	–0·2	32·34
	60	–0·5	32·53

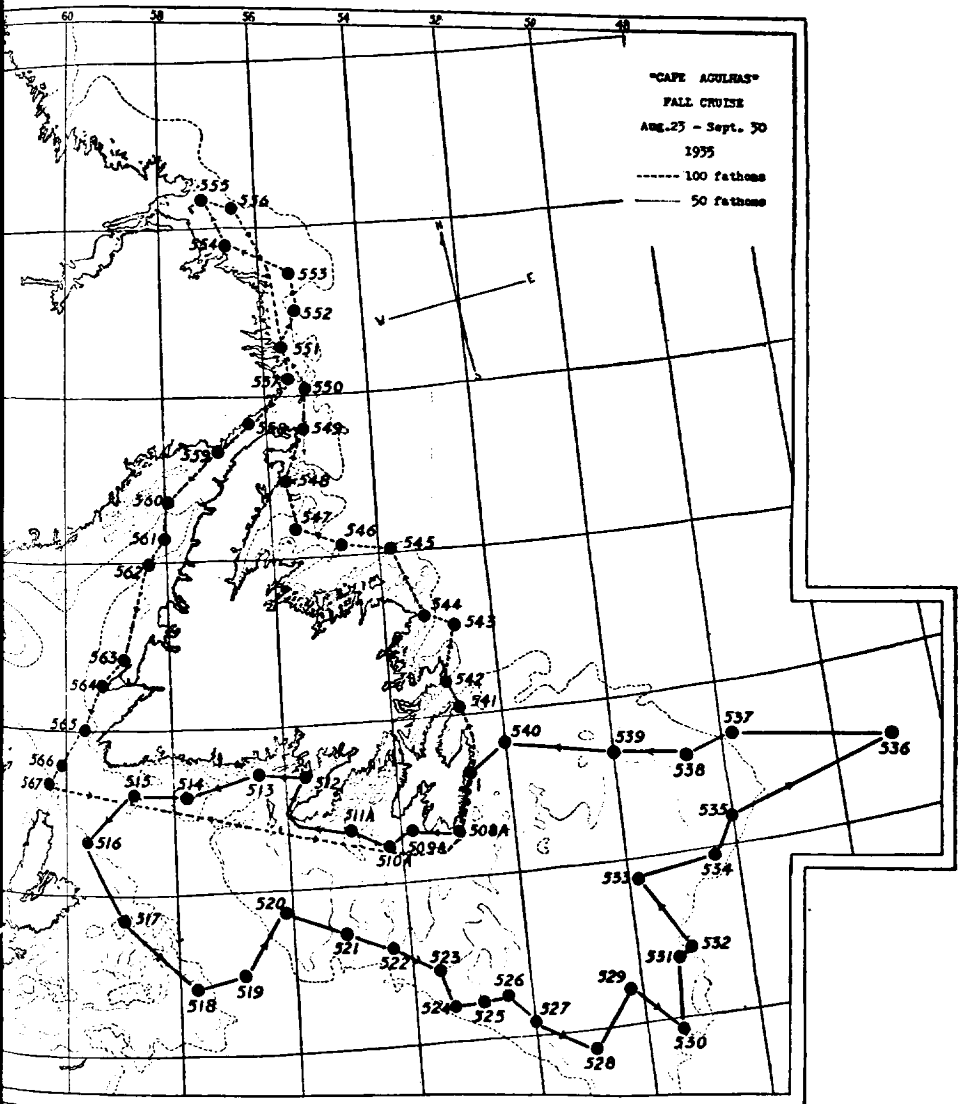
Date and Position	m.	t°	S°/°°
Station 493.			
1935 VII 11			
73 m.			
51°34′N. 55°23′30″ W.	0	3·5	28·86
	10	3·2	28·95
	25	3·3	30·14
	50	0·9	32·25
	60	0·3	32·44
Station 494.			
1935 VII 12			
39 m.			
51°38′N. 55°44′W.	0	4·2	28·37
	10	4·0	28·73
	25	5·8	30·44
	30	3·8	31·02
Station 495.			
1935 VII 12			
162 m.			
51°59′N. 55°32′W.	0	4·8	27·76
	10	0·4	29·54
	25	–1·2	32·25
	50	–1·6	32·59
	75	–1·7	32·99
	100	–1·7	33·12
	150	–1·6	33·19
Station 502.			
1935 VII 13			
64 m.			
52°11′N. 55°35′W.	0	2·5	28·51
	10	–1·2	31·50
	25	–1·1	32·05
	50	–0·6	32·68
Station 501.			
1935 VII 15			
128 m.			
52°32′30″N. 55°26′W.	0	4·0	25·84
	10	0·3	29·33
	25	–1·0	31·50
	50	–1·5	32·98
	75	–1·6	33·03
	100	–1·6	33·14
Station 496.			
1935 VII 15			
169 m.			
52°52′N. 55°37′W.	0	5·2	25·88
	10	3·3	27·92
	25	0·4	31·68
	50	–1·4	32·79
	75	–1·5	32·99
	100	–1·6	33·01
	150	–1·4	33·29
Station 500.			
1935 VII 15			
45 m.			
53°15′30″N. 55°39′30″W.	0	4·7	25·17
	10	0·3	29·37
	25	–1·5	29·96
	35	1·3	32·48

Date and Position	m.	t°	S°/°°
Station 498.			
1935 VII 16			
94 m.			
53°26′N. 55°31′W.	0	3·6	24·54
	10	–0·4	29·39
	25	–1·4	32·59
	50	–1·6	32·94
	75	–1·6	33·01
	90	–1·6	33·03
Station 499.			
1935 VII 16			
45 m.			
53°39′30″N. 56°10′W.	0	6·5	23·74
	10	0·1	28·85
	25	–1·6	32·57
	40	–1·6	32·73
Station 497.			
1935 VII 17			
135 m.			
53°20′N. 55°25′W.	0	3·0	25·86
	10	0·0	30·34
	25	–1·3	32·39
	50	–1·5	32·85
	75	–1·6	32·94
	100	–1·6	33·10
	125	–1·5	33 14
Station 503.			
1935 VII 19			
45 m.			
51°23′30″N. 57°00′W.	0	10·6	30·58
	10	5·9	31·24
	25	4·9	31·39
	35	4·7	31·41
Station 504.			
1935 VII 19			
112 m.			
51°11′N. 57°24′W.	0	10·5	30·40
	10	6·6	30·99
	25	0·0	31·00
	50	–1·0	31·85
	75	–1·2	32·59
	100	–1·4	32·73
Station 505.			
1935 VII 20			
250 m.			
50°26′N. 57°55′W.	0	12·2	30·45
	10	7·4	31·61
	25	0·6	32·05
	50	–0·7	32·34
	75	–0·6	32·71
	100	0·0	33·10
	200	3·5	34·09
Station 506.			
1935 VII 20			
75 m.			
49°09′N. 58°29′W.	0	14·3	31·06
	10	12·7	31·29
	25	10·6	31·41
	50	0·6	31·83
	70	–0·6	32·44

Date and Position	m.	t°	S°/°°
Station 507.			
1935 VII 20			
39 m.			
48°47′N. 58°59′W.	0	14·0	30·90
	10	13·8	30·92
	25	7·2	31·52
	30	1·8	31·85
Station 508.			
1935 VII 21			
48°24′N. 59°01′W.	0	14·1	31·02
	10	13·1	31·02
	25	–0·3	32·02
	50	–0·3	32·37
	75	–0·1	32·57
Station 509.			
1935 VII 22			
440 m.			
48°24′N. 59°40′W.	0	14·1	31·04
	10	14·0	31·06
	25	1·0	32·16
	50	0·9	32·53
	75	0·5	32·66
	100	0·1	32·96
	200	4·3	34·26
	300	4·3	34·59
	400	4·1	34·79
Station 510.			
1935 VII 25			
45 m.			
45°40′N. 56°21′W.	0	14·1	31·94
	10	14·0	32·01
	25	3·6	32·43
	35	3·3	32·53
Station 511.			
1935 VII 26			
100 m.			
46°22′N. 53°08′W.	0	13·2	32·12
	10	12·1	32·14
	25	0·8	32·66
	50	–0·9	32·94
	75	–1·3	33·10
Station 1.			
1935 VII 26			
99 m.			
Off Bay Bulls	0	11·9	31·79
	10	9·8	31·96
	25	1·8	32·53
	50	–0·6	32·88
	75	–1·0	33·21
	90	–1·1	33·21

(*f*) *FALL RESEARCH CRUISE.*

Date and Position	m.	t°	S°/°°
Station 1.			
1935 VIII 23			
63 m.			
Off Bay Bulls	0	13·5	30·21
	10	13·3	30·42
	25	8·0	31·06
	50	1·4	32·43
Station 508A.			
1935 VIII 23			
65 m.			
46°36′N. 53°00′W.	0	13·5	30·38
	10	13·0	30·64
	25	2·8	32·21
	50	0·0	32·81
	60	0·0	32·79
Station 509A.			
1935 VIII 23			
74 m.			
46°41′N. 53°52′W.	0	14·5	30·54
	10	12·8	30·63
	25	6·2	31·90
	50	0·3	32·77
	70	–0·9	33·03
Station 510A.			
1935 VIII 24			
75 m.			
46°28′N. 54°14′W.	0	14·8	31·46
	10	12·0	32·50
	25	1·0	32·64
	50	–1·0	32·90
	70	–1·1	32·96
Station 511A.			
1935 VIII 24			
224 m.			
46°43′N. 54°54′W.	0	15·3	31·92
	10	15·2	31·96
	25	8·5	32·26
	50	1·2	32·62
	75	–0·5	32·74
	100	–0·8	32·87
	200	–1·2	33·03
Station 512.			
1935 VIII 27			
165 m.			
47°21′N. 55°41′W.	0	13·6	31·59
	10	13·3	31·59
	25	7·4	31·97
	50	1·6	32·44
	75	0·6	32·52
	100	0·4	32·52
	150	–0·4	32·52
Station 513.			
1935 VIII 27			
No sounding			
47°27′N. 56°32′W.	0	14·0	31·99
	10	12·8	31·61
	25	2·6	32·08
	50	0·5	32·44
	75	0·0	32·59
	100	–0·1	32·57
	200	3·2	33·88


"CAPE AGULHAS"
FALL CRUISE
Aug.23 - Sept. 30
1935
------ 100 fathoms
——— 50 fathoms

Station 514.

Date and Position	m.	t°	S°/°°
1935 VIII 28			
74 m.			
47°11′N. 57°50′W.	0	14·2	31·59
	10	13·2	31·57
	25	2·7	32·27
	50	0·4	32·59
	70	0·3	32·70

Station 515.

Date and Position	m.	t°	S°/°°
1935 VIII 28			
150 m.			
47°11′N. 58°47′W.	0	14·0	31·66
	10	13·2	31·72
	25	4·5	32·21
	50	0·8	32·32
	75	0·3	32·50
	100	0·0	32·55
	140	0·3	32·58

Station 516.

Date and Position	m.	t°	S°/°°
1935 VIII 29			
80 m.			
46°40′N. 59°35′W.	0	17·3	29·66
	10	14·7	30·62
	25	6·4	–
	50	0·0	32·50
	75	0·3	32·77

Station 517.

Date and Position	m.	t°	S°/°°
1935 VIII 30			
230 m.			
45°43′N. 58°57′W.	0	17·9	30·36
	10	17·3	30·25
	25	14·3	30·53
	50	0·5	32·25
	75	0·2	32·57
	100	0·6	32·81
	200	2·7	33·74

Station 518.

Date and Position	m.	t°	S°/°°
1935 VIII 31			
41 m.			
44°50′N. 57°40′W.	0	17·0	30·93
	10	16·0	30·95
	25	6·0	31·96
	35	5·9	34·70

Station 519.

Date and Position	m.	t°	S°/°°
1935 VIII 31			
432 m.			
45°06′N. 56°57′W.	0	16·8	30·60
	10	16·7	30·78
	25	13·5	31·98
	50	1·7	32·16
	75	0·3	32·79
	100	0·4	33·08
	200	5·1	34·55
	300	4·4	34·66
	400	4·0	34·79

Station 520.

Date and Position	m.	t°	S°/°°
1935 VIII 31			
48 m.			
45°46′N. 56°08′W.	0	16·0	32·05
	10	15·9	32·07
	25	5·0	32·43
	45	4·9	32·44

Station 521.

Date and Position	m.	t°	S°/°°
1935 IX 1			
113 m.			
45°27′N. 55°06′W.	0	14·1	32·10
	10	14·0	32·13
	25	7·3	32·64
	50	0·6	33·05
	75	0·0	33·05
	100	–0·1	33·19

Station 522.

Date and Position	m.	t°	S°/°°
1935 IX 1			
111 m.			
45°11′N. 54°21′W.	0	11·9	32·39
	10	7·9	32·39
	25	3·8	32·40
	50	0·8	32·63
	75	–0·7	33·05
	100	–0·7	33·34

Station 523.

Date and Position	m.	t°	S°/°°
1935 IX 1			
84 m.			
44°55′N. 53°36′W.	0	12·8	32·39
	10	11·4	32·41
	25	8·4	32·55
	50	3·6	32·79
	75	0·7	33·07

Station 524.

Date and Position	m.	t°	S°/°°
1935 IX 1			
No sounding			
44°26′N. 53°19′W.	0	14·1	32·99
	10	11·1	33·12
	25	8·9	32·99
	50	6·0	33·08
	75	4·7	33·63
	100	6·4	34·28
	200	7·2	34·84
	300	5·4	34·84

Station 525.

Date and Position	m.	t°	S°/°°
1935 IX 2			
112 m.			
44°29′N. 52°53′W.	0	14·1	32·88
	10	14·0	32·88
	25	9·5	32·88
	50	6·4	32·93
	75	2·6	33·43
	100	5·7	34·16

Date and Position	m.	t°	S°/°°
Station 526.			
1935 IX 2			
88 m.			
44°29′N. 52°23′W.	0	13·6	32·37
	10	12·8	32·64
	25	12·5	32·67
	50	3·1	32·83
	75	2·5	33·31
Station 527.			
1935 IX 2			
90 m.			
44°07′N. 52°00′W.	0	16·1	32·30
	10	15·9	32·50
	25	13·2	32·76
	50	2·6	32·85
	75	1·5	33·16
	85	1·5	33·03
Station 528.			
1935 IX 2			
72 m.			
43°48′N. 51°05′W.	0	18·2	32·30
	10	18·1	32·32
	25	8·5	32·79
	50	2·7	33·03
	65	2·6	33·05
Station 529.			
1935 IX 3			
56 m.			
44°22′N. 50°13′W.	0	18·1	32·37
	10	18·0	32·37
	25	3·8	32·90
	50	2·6	32·98
Station 530.			
1935 IX 3			
46 m.			
43°53′N. 49°22′W.	0	17·4	32·41
	10	17·3	32·41
	25	2·0	33·10
	40	2·0	32·87
Station 531.			
1935 IX 3			
58 m.			
44°46′N. 49°17′W.	0	15·0	32·88
	10	4·0	32·83
	25	−0·6	33·38
	50	−0·4	33·40
Station 532.			
1935 IX 4			
No sounding			
44°52′N. 49°06′W.	0	14·2	31·65
	10	13·8	31·66
	25	5·0	33·03
	50	1·1	33·93
	75	1·5	34·26
	100	1·9	34·30
	200	2·3	34·41
	300	2·6	34·46

Date and Position	m.	t°	S°/°°
Station 533.			
1935 IX 4			
61 m.			
45°44′N. 49°57′W.	0	15·4	32·19
	10	15·3	32·85
	25	1·8	33·25
	50	−0·6	33·29
Station 534.			
1935 IX 4			
97 m.			
45°56′N. 48°21′W.	0	14·4	31·24
	10	14·2	31·26
	25	2·6	32·96
	50	0·5	33·49
	75	0·5	33·88
	90	0·1	33·91
Station 535.			
1935 IX 4			
103 m.			
46°20′N. 48°00′W.	0	13·6	31·35
	10	13·5	31·35
	25	12·8	31·48
	50	−1·0	33·28
	75	−0·6	33·49
	95	−0·5	33·63
Station 536.			
1935 IX 5			
146 m.			
47°07′N. 44°58′W.	0	15·4	33·67
	10	15·3	33·67
	25	12·8	34·07
	50	5·1	34·11
	75	3·5	34·26
	100	3·1	34·37
	135	3·1	34·43
Station 537.			
1935 IX 6			
190 m.			
47°20′N. 47°50′W.	0	12·2	31·46
	10	12·0	31·54
	25	7·7	33·11
	50	−1·2	33·38
	75	0·0	33·86
	100	1·2	34·07
	175	2·2	34·44
Station 538.			
1935 IX 6			
115 m.			
47°10′N. 48°35′W.	0	13·9	31·34
	10	13·9	31·15
	25	1·2	32·96
	50	−0·6	33·19
	75	−0·6	33·38
	100	−0·2	33·64

Station 539.

Date and Position	m.	t°	S°/°°
1935 IX 6			
84 m.			
47°18′N. 50°00′W.	0	13·9	31·85
	10	13·9	31·65
	25	9·3	32·12
	50	–0·3	33·17
	75	–0·5	33·32

Station 540.

Date and Position	m.	t°	S°/°°
1935 IX 6			
163 m.			
47°40′N. 52°00′W.	0	11·0	30·80
	10	11·0	30·88
	25	0·8	32·52
	50	–0·9	33·08
	75	–1·0	33·14
	100	–1·1	33·37
	150	–0·6	33·65

Station 1.

Date and Position	m.	t°	S°/°°
1935 IX 7			
132 m.			
Off Bay Bulls	0	12·9	30·82
	10	12·6	30·82
	25	2·9	32·03
	50	–0·8	32·79
	75	–0·9	32·99
	100	–0·9	33·08
	125	–1·0	33·23

Station 541.

Date and Position	m.	t°	S°/°°
1935 IX 10			
102 m.			
48°04′N. 52°50′W.	0	11·4	30·62
	10	10·0	30·67
	25	5·9	31·43
	50	0·1	32·25
	75	–0·5	32·35
	95	–0·9	32·61

Station 542.

Date and Position	m.	t°	S°/°°
1935 IX 10			
No sounding			
48°23′N. 52°57′W.	0	11·7	30·19
	10	11·4	30·28
	25	1·5	31·82
	50	–0·8	32·40
	75	–1·0	32·57
	100	–1·0	32·83
	200	–0·1	33·43

Station 543.

Date and Position	m.	t°	S°/°°
1935 IX 11			
No sounding			
49°04′N. 52°42′W.	0	9·4	30·97
	10	8·9	30·97
	25	3·0	31·82
	50	–1·0	32·85
	75	–1·3	32·96
	100	–1·1	33·20
	200	1·4	33·46
	300	1·5	34·02

Station 544.

Date and Position	m.	t°	S°/°°
1935 IX 12			
54 m.			
49°13′N. 53°17′W.	0	9·3	–
	10	9·2	30·60
	25	3·9	31·37
	50	0·3	32·14

Station 545.

Date and Position	m.	t°	S°/°°
1935 IX 12			
164 m.			
50°02′N. 53°42′W.	0	9·4	31·09
	10	9·0	31·12
	25	3·6	31·92
	50	–0·6	32·96
	75	–0·4	33·24
	100	–0·4	33·34
	150	0·1	33·65

Station 546.

Date and Position	m.	t°	S°/°°
1935 IX 12			
216 m.			
50°07′N. 54°41′W.	0	8·9	30·59
	10	8·9	30·58
	25	5·6	31·70
	50	–0·8	32·96
	75	–0·8	33·14
	100	–0·9	33·28
	200	0·4	33·91

Station 547.

Date and Position	m.	t°	S°/°°
1935 IX 13			
No sounding			
50°21′N. 55°33′W.	0	10·0	30·19
	10	9·3	30·34
	25	7·0	30·84
	50	2·0	32·16
	75	–1·0	32·88
	100	–1·0	33·03
	200	0·0	33·67

Station 548.

Date and Position	m.	t°	S°/°°
1935 IX 13			
54 m.			
50°57′N. 55°42′W.	0	9·6	30·25
	10	9·4	30·28
	25	3·8	31·64
	50	–0·9	32·68

Station 549.

Date and Position	m.	t°	S°/°°
1935 IX 13			
60 m.			
51°34′N. 55°22′W.	0	8·5	30·00
	10	5·2	31·13
	25	4·0	32·31
	50	–0·6	32·47

Date and Position	m.	t°	S°/°°
Station 550.			
1935 IX 13			
141 m.			
52°06′N. 55°17′W.	0	7·5	31·70
	10	7·0	32·19
	25	5·2	32·18
	50	−0·9	32·62
	75	−0·9	32·88
	100	−0·7	33·10
	135	−0·4	33·21
Station 551.			
1935 IX 13			
230 m.			
52°37′N. 55°38′W.	0	6·5	30·69
	10	6·0	31·32
	25	3·3	31·50
	50	−0·4	32·07
	75	−0·8	32·30
	100	−1·1	32·41
	200	−0·5	33·34
Station 552.			
1935 IX 14			
142 m.			
53°04′N. 55°23′W.	0	5·6	31·22
	10	5·6	31·33
	25	3·3	31·63
	50	−0·7	32·12
	75	−1·0	32·44
	100	−1·1	32·61
	135	−1·0	32·75
Station 553.			
1935 IX 14			
94 m.			
53°28′N. 55°35′W.	0	6·2	30·03
	10	5·5	30·62
	25	5·7	31·27
	50	0·3	31·87
	75	−0·9	32·39
	90	−1·0	32·44
Station 554.			
1935 IX 18			
58 m.			
53°48′N. 56°39′W.	0	6·8	26·57
	10	6·7	26·57
	25	6·0	29·20
	50	4·7	30·56
Station 555.			
1935 IX 19			
28 m.			
54°22′N. 57°08′W.	0	6·2	30·19
	10	6·0	30·16
	25	5·8	30·23

Date and Position	m.	t°	S°/°°
Station 556.			
1935 IX 19			
154 m.			
54°15′N. 56°28′W.	0	4·2	31·44
	10	3·4	31·48
	25	3·4	31·72
	50	1·1	32·13
	75	−0·4	32·48
	100	−0·7	32·64
	150	−0·9	32·75
Ferret Island.			
1935 IX 21	0	7·2	
	10	6·3	
	25	4·3	
Station 557.			
1935 IX 26			
100 m.			
52°11′N. 55°31′W.	0	5·7	30·25
	10	5·6	30·30
	25	5·2	30·74
	50	4·9	31·70
	75	3·9	31·81
	95	0·8	32·09
Station 558.			
1935 IX 27			
58 m.			
51°40′N. 56°20′W.	0	5·7	30·97
	10	5·2	31·13
	25	4·4	31·44
	50	4·0	31·71
Station 559.			
1935 IX 28			
55 m.			
51°23′N. 57°00′W.	0	6·0	30·95
	10	6·0	31·12
	25	5·1	31·59
	50	4·1	31·75
Station 560.			
1935 IX 28			
95 m.			
50°45′N. 57°55′W.	0	7·3	31·31
	10	7·3	31·39
	25	4·3	31·85
	50	0·5	32·50
	75	0·1	32·57
	90	0·0	32·73
Station 561.			
1935 IX 28			
265 m.			
50°18′N. 58°02′W.	0	10·4	30·91
	10	10·4	30·90
	25	10·0	30·93
	50	7·6	31·34
	75	−0·5	32·64
	100	−0·3	32·96
	200	3·1	33·86
	250	3·7	34·55

Date and Position	m.	t°	S°/°°
Station 562.			
1935 IX 29			
190 m.			
49°58′N. 58°20′W.	0	8·7	31·26
	10	8·7	31·27
	25	3·4	31·85
	50	−0·5	32·49
	75	−0·5	32·81
	100	0·0	33·06
	175	3·2	33·88
Station 563.			
1935 IX 29			
31 m.			
48°51′N. 58°52′W.	0	9·8	30·91
	10	9·8	30·98
	25	2·5	31·99
Station 564.			
1935 IX 29			
54 m.			
48°33′N. 59°17′W.	0	10·8	31·00
	10	10·8	31·04
	25	9·5	31·25
	50	1·6	32·25
Station 565.			
1935 IX 30			
No sounding			
48°02′N. 59°37′W.	0	10·8	31·06
	10	10·8	31·18
	25	3·1	32·09
	50	−0·3	32·44
	75	−0·4	32·59
	100	−0·3	32·87
	200	3·0	33·73

Date and Position	m.	t°	S°/°°
Station 566.			
1935 IX 30			
430 m.			
47°36′N. 60°05′W.	0	11·0	30·65
	10	10·9	30·63
	25	4·3	31·57
	50	0·9	32·30
	75	0·3	32·66
	100	0·3	32·92
	200	1·2	33·46
	300	4·2	34·43
	400	4·2	34·59
Station 567.			
1935 IX 30			
161 m.			
47°22′N. 60°23′W.	0	11·7	30·07
	10	11·7	30·07
	25	11·0	30·53
	50	1·1	31·81
	75	0·3	32·41
	100	0·3	32·67
	150	−0·2	32·80
Station 1.			
1935 X 6			
56 m.			
Southern Ledge, off Bay Bulls	0	8·7	30·76
	10	8·3	30·78
	25	8·2	31·04
	50	1·2	32·13

APPENDIX C.

NEWFOUNDLAND LOBSTER INVESTIGATIONS

By George C. Whiteley

SUMMARY

(1) A study of the measurements of male and female lobsters reveals that in the ordinary fishermen's catches the proportion of the sexes changes. At lower limits more males are caught than females, at intermediate sizes females prevail, and finally males again predominate. Among the larger sizes the crossing over to predominance of females is believed to coincide with the onset of maturity occurring at a lobster size of from 8·5 to 9·5 inches (22 to 24 cms.).

(2) Because female growth is checked after spawning size is reached a female one foot long is much older than a male of the same size, and thus must have run the risk of capture for a longer period. Hence fewer females than males survive to reach a large size. This shows that an "upper" size limit would be valueless from a conservation standpoint.

(3) Conditions affecting lobsters in Placentia, Fortune and Port-au-Port Bays, and the South-west Coast (Harbour Breton to Grand Bruit) appear to be essentially similar.

(4) Conditions affecting lobsters in Bay St. George appear to differ from those in the other areas. Lobsters here may mature at smaller sizes than those in the other fishing districts. If this finding is confirmed the legal size limit may be made lower here than elsewhere.

(5) The end of the spring season for lobster catching should coincide with the rise in water temperatures to the level which permits extensive hatching of lobster fry.

(6) Owing to the slow growth rate of local lobsters and the many physical disadvantages of the Newfoundland area as a breeding centre, no part of the lobster population can successfully withstand both a spring and a fall fishing period.

(7) The necessity is suggested of keeping in mind the time-temperature relationship with respect to moulting and the development of lobster fry, when it is considered that around Newfoundland summer warming of surface water to as high as merely 16°C. (60°F.) seldom occurs.

The time required for lobster fry to develop into the fourth stage is 12 days at 20°C. (68°F.) and 120 days at 5° to 8°C. (41° to 46°F.).

Small differences in temperature below 20°C. (68°F.) produce wide differences in their effect on lengthening the time of fry development.

(8) The legal size limit of 9 inches (23 cms.) is probably effective to within one or one and one-quarter inches. Equally important with the imposition of a rigid size limit is the necessity of enlightening fishermen about the fundamental significance of berried females, upon whose productivity the whole fishery depends.

1. *Introduction*

The data upon which this report is based were gathered during the summer of 1935, but some measurements from Fortune and Placentia Bays, taken in June–July, 1931, are also incorporated in the tables.

The report is a preliminary account, attempting only to make a first examination of conditions existing on various parts of the Newfoundland coast and their effect on the lobster in its various stages. Lengths of lobsters were measured to the nearest centimetre, from the tip of the rostrum to the distal edge of the telson. Approximately 5,700 specimens were examined.

At certain villages the number of lobster measurements is small owing to poor catches and to the shortness of time the investigator could stay over. The lobsters were measured while alive and the whole catches of various fishermen were examined. Sizes are correct to within one-half centimetre.

2. *Comparative Length of the Lobster with respect to first egg-extrusion.*

The success of natural lobster breeding depends on the age and size at which the majority of females begin to bear eggs. Areas where lobsters mature and carry eggs at an early age can be expected to withstand more intensive fishing than areas where the period of egg-production is longer delayed. This is especially true because environmental conditions which produce early maturity are, as a rule, most favourable to the survival and growth of lobster fry.

Attempts to limit the size at which lobsters can be legally caught in Canada are considered by Canadian biologists to have failed in areas where lobsters are canned. The size limit prevailing in Newfoundland has undoubtedly prevented the taking of pronouncedly undersized lobsters, and at the present time Newfoundland lobster-men assert thay they are conscientious in returning all the undersized, which they measure by ruled sticks kept at hand in their dories. Actually the revised limit of nine inches is probably effective within one or one and a quarter inches. That is, all lobsters under 7¾ inches are returned to the sea. In some areas the probability of all under eight inches being returned may be quite high. On an exposed shore where the average size of lobsters is well above the limit, there is less temptation for fishermen to break the nine inch regulation. In the bays, where the average size is near the legal limit, likelihood of the law being disregarded increases considerably.

From a conservation point of view the chief aim of a size limit is to enable enough lobsters to reach spawning size to maintain the lobster population at or near its maximum point. That is, there should be enough lobsters present to utilize the greater part of the available food supply.

Thus, regions in which lobsters mature early and extrude eggs at a relatively small size can have a lower size limit than regions where the lobsters have to grow to a larger size before bearing eggs, and yet in both regions the ideals of conservation could be achieved.

3. *Breeding Areas.*

No single factor has as much influence upon determining how successful an area will be for lobster breeding as the temperature of the water surrounding the developing eggs or the hatched lobster fry. We have at the present time no precise data concerning the hydrographic conditions of the restricted areas where the Newfoundland lobsters might be expected to breed. The merits of sanctuaries—areas where no lobster fishing is allowed—have frequently been discussed. The value of these sanctuaries would depend not only upon the successful production of free-swimming larvae in the sanctuary areas but largely on the dispersion of these larvae by currents.

For example, an intensive planktonic survey of the heads of such bays as St. John Bay, Arms of the Bay of Islands, Bay St. George, La Poile, Connoire, Fortune, and Placentia Bays, should throw some light on the effectiveness and importance of some of the Island's lobster breeding areas.

4. *Dates of Egg Extrusion, Hatching, and Moulting.*

Dr. Wilfred Templeman has kindly furnished me with a table showing the effect of changes in temperature on developing lobster eggs and larvae.

Material—Lobster Eggs

Temperature	Length of time for eye pigment to appear.
20°C.	26 days (Herrick)
12·5°C.	65 ,, (Templeman)
10·5°C.	78 ,, ,,
4·5°C.	406 ,, ,,
1·0°C.	970 ,, ,,

At the two lower temperatures the experiments were only carried to about the 800 cell stage. The final result was calculated and is estimated to be correct within two to four days. All eggs eyed during June in the colder waters of Newfoundland (10° to 12°C., or 50° to 53°F.) will probably hatch out larvae that same season before the end of September.

Templeman has found that the length of time taken by lobster fry to develop into the fourth stage, that is, to reach about 1 to 1·5 centimetres (approximately ½ inch) in length, when they have definitely changed from floating on surface or in mid-water to crawling on the bottom, is :—

At 5° to 8°C.	..	About 120 days.
At 20°C. ..	..	About 12 days.

This means that at 5° to 8°C. it takes 120 days from the time of hatching of the fry until the fourth stage is produced. It is very necessary to keep in mind this time-temperature relationship when considering the Newfoundland area, where even summer surface water warming to as high as 16°C. is very seldom found. Probably the bulk of the lobster fry have not reached the fourth stage before the end of October, when winter cooling usually increases sharply. Growth is thus at a standstill during the winter months until water warming in June and July again produces favourable conditions for growth.

Nothing is definitely known of the times of egg-extrusion in any Newfoundland coastal region. During the summer of 1935 about 50 females carrying eggs were examined.

Place.	*Date.*	*Conditions of Eggs.*
Placentia Bay, Arnold's Cove	May 13th ..	Five females carrying eggs not yet eyed.
Placentia Bay, Haystack	June 7th ..	Of two females, one had eyed eggs, the other not eyed.
Connaigre Bay, Great Harbour	June 14th ..	Two females, eggs eyed on both.
Burgeo	June 19th ..	Eleven females, all carrying eyed eggs.
Port-au-Port	June 26th ..	Eight females carrying well-developed eyed eggs. Hatching had probably taken place on one individual.

Summer surface temperatures along the West and South Coasts of Newfoundland rarely rise above 15°C. while the temperature at 25 metres averages approximately 10°C. Due to these conditions the development of lobsters after hatching obviously cannot proceed very rapidly.

The following temperatures were taken among lobster pots in Placentia Bay :—

Station 1. *Arnold's Cove.*

Near pots at mouth of harbour ; 20 yards from shore.

	May 11th.	May 13th.
0 metres	1·0°C.	1·5°C.
9 ,, (bottom)	–0·5°C.	0·5°C.

Station 2.—¼ mile from harbour out into the Bay.

	May 11th.	May 13th.
0 metres	0·6°C	1·0°C.
14 to 16 ,, (bottom)	–0·3°C	–0·7°C.

Haystack.

May 26th.—In Harbour, 50 yds. off-shore, South Head.		May 28th.—Outside East Head, 50 yards from shore.	
0 metres	3·8°C.	0 metres	2·8°C.
Bottom, 10 metres	2·4°C.	Bottom, 10 metres	2·5°C.

If we assume that moulting takes place in August, then if a female mates successfully and receives a supply of sperm, the dropping water temperature which prevails by the time the shell has hardened, allowing six or eight weeks for recovery, will probably prevent any egg-extrusion at that time. Eggs will not then be extruded until the sea warms sufficiently in the following spring. Thus, if the area is a favourable one with high summer temperature, hatching may occur that summer. But in a great many cases where colder conditions prevail a further 10 to 12 months are required before hatching takes place, making a full two years since mating.

In the warmest Canadian waters, where a good deal of lobster investigation has been conducted, egg extrusion does not begin until about June 20th, and practically all the egg-laying occurs during July and August. In colder Canadian waters where the July and August temperature is only about 10 to 11°C. (that is, similar to Newfoundland conditions) egg extrusion does not start until about the middle of July. It takes about 25 days at from 18 to 20°C. and about 50 days at from 12 to 15°C. for any part of the eye pigment to appear. All eggs eyed even in the colder waters, during June or July, will hatch that same year before September. In the warmest Canadian waters (20° to 22°C.) hatching is over by mid-August, and in colder waters by mid-September.

5. *Composition of the Catch.*

(With regard to proportions of males and females at various sizes.)

In June, 1931, measurements were made in Placentia Bay at three places, and in Fortune Bay at two places.

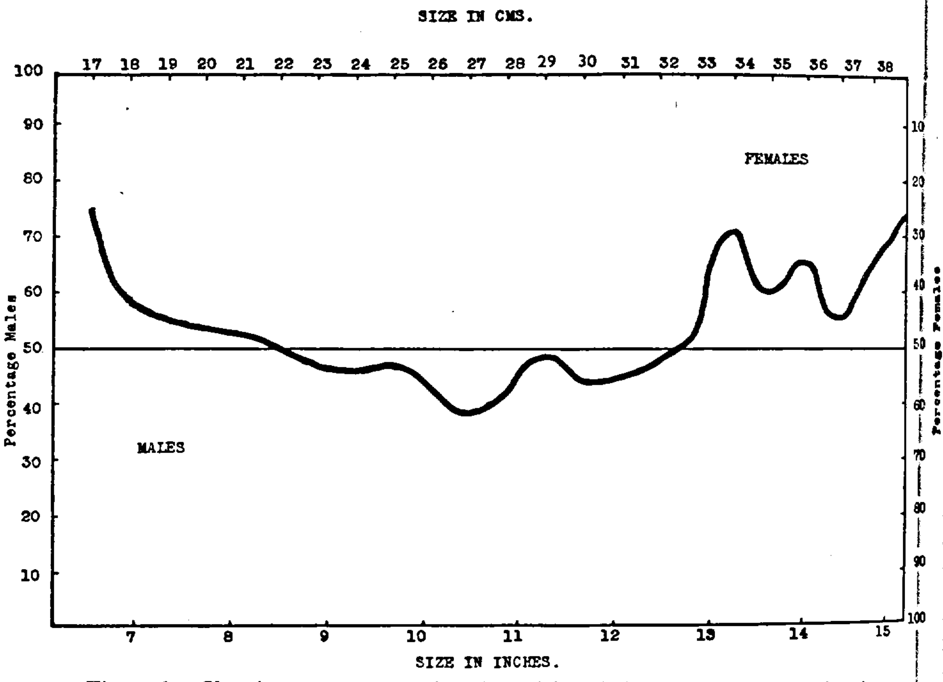


Figure 1.—Showing percentage of male and female lobsters of various sizes in 5,700 lobsters measured in May—June, 1925, on south and west Coasts of Newfoundland.

During 1935 measurements were taken at six places in Placentia Bay and at two in Fortune Bay in May, and at nine places along the South Coast and at three places in Bay St. George and Port-au-Port during June.

In examining the catch five regions will be considered separately: Placentia Bay, Fortune Bay, South Coast, Bay St. George, and Port-au-Port. On adding up all males and females of similar sizes in the five regions investigated the percentage of males and females at each size can be determined. The result is shown in Figure 1.

This graph shows a greater proportion of males than females from 17 to 21 cms. (7·5 to 8·4 inches); and a greater proportion of females than males from 22 to 32 cms. (8·6 to 12·6 inches), whereupon the proportion of males again increases, few females above 38 cms. (15·5 inches) being present in the catches. This alternate increase and decrease in the proportion of males to females is a general phenomenon observed by Dawson and Templeman working on Canadian lobsters.

Factors which cause more males than females or *vice versa* to be caught at various sizes are held to be :—

(1) The greater proportion of males to females at the lower sizes is explained by the (experimentally proved) superior activity on the part of the males. Thus, within the same size range the chance of males being caught by traps is greater than that of females.

(2) The crossing over causing female predominance between 22 to 33 cms. (8·6 to 12·9 inches) results from the slowing down of female growth upon the onset of maturity and the accompanying egg-bearing functions. This check on female growth causes a bunching together of year classes between these limits, so that there is a greater proportion of females than males at each size.

(3) The percentage of females decreases in the catches after 32 cms. (12·5 inches). From this size onwards the females are a great deal older than males of the same size and have run the risk of capture for a longer time. Thus, there have survived fewer females than males at these larger sizes.

6. *Percentages of Male and Female Lobsters.*

Placentia and Fortune Bays.

Figure 2 shows that conditions affecting the lobster population in Placentia Bay and Fortune Bay are essentially the same. Had the number of individuals measured been larger the two graphs would smooth out and more nearly coincide. Females cross over or become predominant between 22·5 and 23·5 cms. (8·8 to 9·4 inches). Thus, the onset of maturity occurs at practically the same length for the lobsters in either Bay.

South Coast, Port-au-Port, and Bay St. George.

Figure 3 compares the percentage graphs from the South Coast, Port-au-Port, and Bay St. George.

The curve for the *South Coast* is similar to that of Placentia or Fortune Bay. Crossing over at female maturity occurs at practically the same size. Females remain dominant for a longer time, probably because the growth of females is not checked as much as in more protected areas like the bays ; females on the rough grounds of the exposed outer coast do not carry eggs as frequently as do bay lobsters. This is probably due to low water temperatures together with the reduced chances of successful mating occurring where population is scattered over a wider area. Thus, females are not much smaller or older than males at the same size.

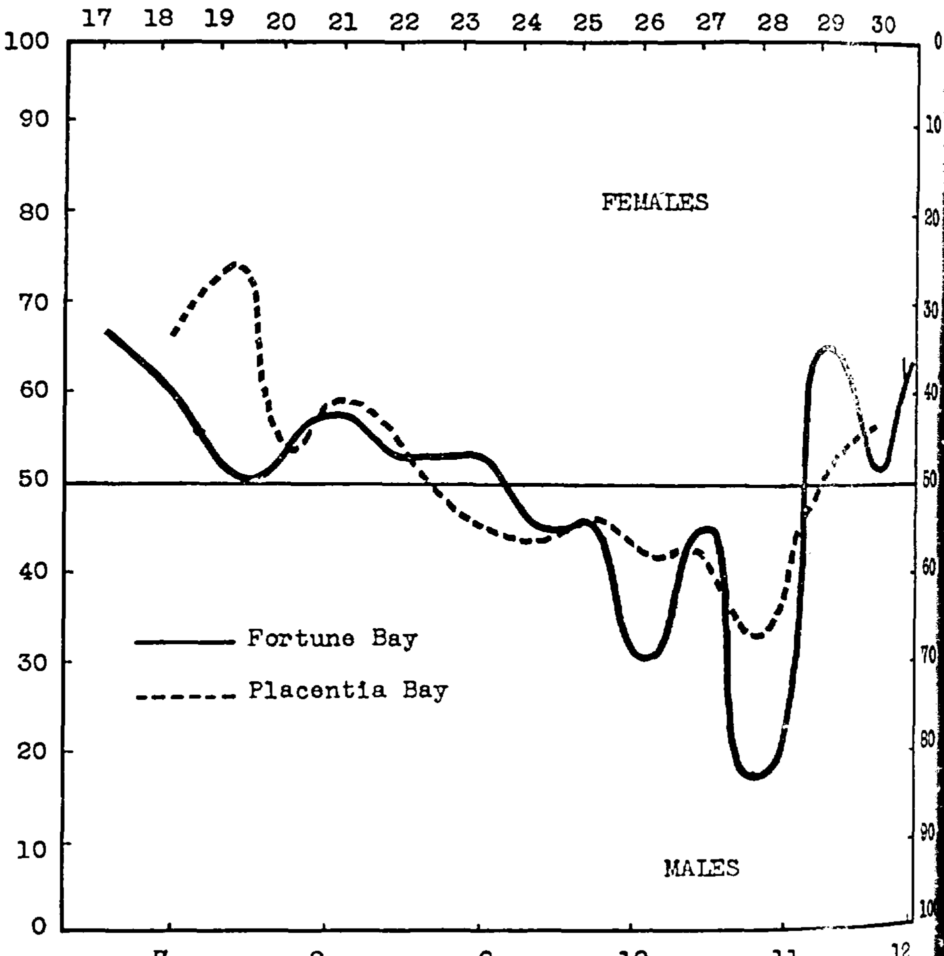


Fig. 2

It, therefore, takes a longer time in such areas before the number of females is reduced so that males can again predominate in the catches. The sudden rise in the percentage of males at 25 cms. is probably due to insufficient measurements, and can be disregarded.

The *Port-au-Port* graph is likewise similar in outline to the curves from the large bays, except that females cross over and males regain predominance at sizes from 1 to 2 cms. less than in the case of the bay lobsters. The proportion of large lobsters caught is also rather higher.

These facts can be explained by considering the hydrographic conditions existing in Port-au-Port Bay. In the first place, the summer water

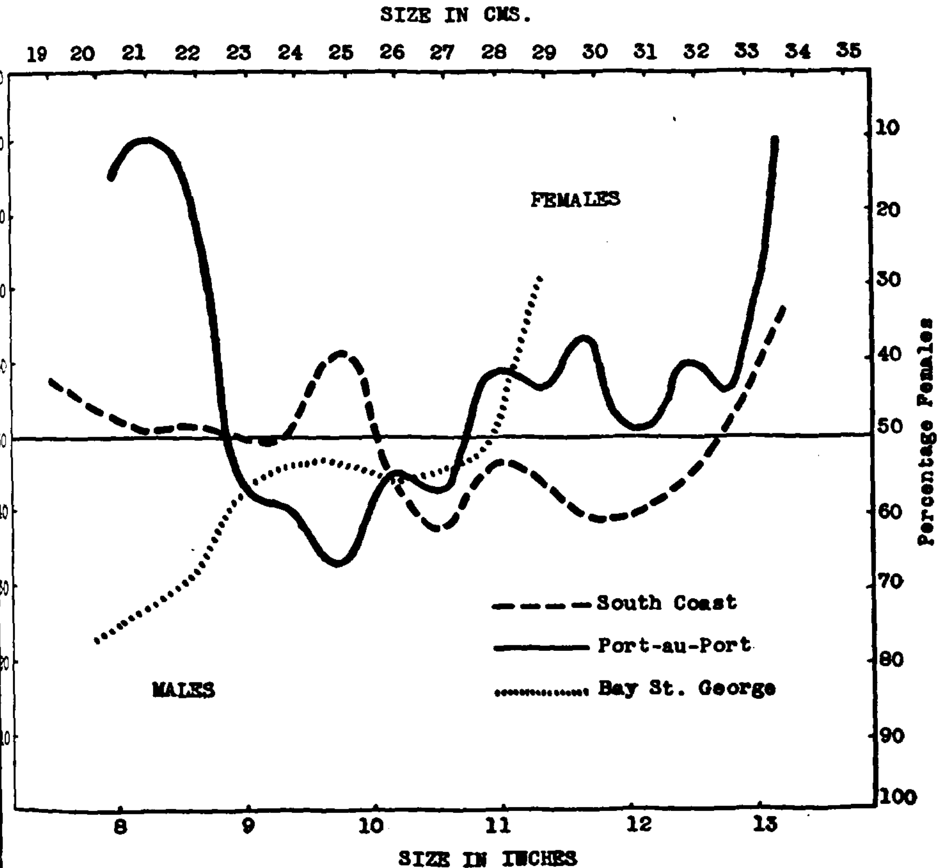


Fig. 3

Figure 3.—Showing percentage of male and female lobsters of various sizes in catches of lobsters measured along the South Coast (Harbour Breton to Grand Bruit), Bay St George and Port-au-Port.

temperatures are higher here than in the South Coast bays. This would enable lobsters to mature earlier, moult oftener, and would also stimulate mating and egg-bearing activity. Female growth-rate would thus be retarded by these factors. Year-classes would bunch together as to size and the crossing over resulting in recovery of male predominance would consequently come at a lower size.

Lobsters of larger sizes, chiefly male, appear in the catches because the shoalest water in which fishermen set their pots is about three fathoms. The possibility of large lobsters being trapped is thereby increased.

The curve of the *Bay St. George* measurements tells a different story however. It is unfortunate that no data could be obtained covering the smallest sizes in this bay. Nevertheless, we may assume that the point of transition in this region would probably occur between 17 cms. and 19 cms. (6·7 and 7·5 inches).

This would afford a parallel with southern Nova Scotian areas with hydrographic conditions resembling those of St. George's Bay.

Thus, it appears that of the five fishing regions investigated, Bay St. George is the only one where suitable water temperatures, optimal food supply, or a combination of both, produce conditions in which lobsters will mature at size limits comparable to the Canadian maritime lobster.

7. *Number of Lobsters at Various Sizes in the Catches.*

In Table 1 are set forth the numbers of lobsters at the different sizes from the various places in the bays along the Newfoundland coast. The average sizes are of course artificial and have a doubtful relation to the actual average size of the lobster population in the sea. The presence of a nine inch size limit sets up a selective process preventing a normal sampling. The measurements of individuals under nine inches represent what fishermen choose to overlook in their catches. In a few cases, at the request of the investigator, a complete catch was brought in and measured regardless of size, after which the undersized were returned to the sea.

Placentia Bay.

The lobster population in Placentia Bay shows a moderately well-defined and progressive increase in mean size from the head of the bay seawards. Thus the extreme range is shown if we compare Arnold's Cove (males 23·3 cms., females 22·4 cms.) and Ship Harbour (males 27·6 cms., females 27·4 cms.). This is naturally to be expected and is the result of two probable causes. (1) Suitable breeding conditions are more likely to be localised in the sheltered regions at the head of the bay. Numbers of smaller-growing lobsters will thus reduce the average size of the catch here. (2) As the lobsters grow older their random wanderings increase. Individuals caught at the entrance to the bay are migrants; their larger size results from having eluded capture for a longer time. They are older lobsters.

TABLE 1.

Number of Lobsters at Various Sizes

M = Male. F = Female.

	PLACENTIA BAY																FORTUNE BAY					
	Arnold's Cove. May, 1935.		Sound Island. May, 1935.		North End Long Island. May, 1935.		Spenser's Cove. May, 1935.		Haystack. May, 1935.		Port Royal. May, 1935.		Ship Harbour. June, 1931.		Clatice Harbour. June, 1931.		Little Bay East. June, 1935.		Belleoram. June, 1935.		Belleoram. July, 1931.	
Size in Cms.	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
15	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–
16	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–
17	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	2	1
18	1	1	–	–	–	–	–	–	–	–	–	–	1	–	1	1	–	–	–	–	17	11
19	1	1	–	–	–	–	–	–	–	–	–	–	2	–	4	2	–	–	2	2	11	18
20	5	9	–	–	–	–	–	–	–	–	–	–	2	3	6	4	9	4	5	2	37	36
21	11	13	–	–	–	–	–	–	–	–	–	–	4	2	5	4	26	19	12	6	17	15
22	18	22	2	1	24	17	–	–	7	4	2	–	9	15	33	20	53	32	29	28	42	64
23	20	19	9	5	33	29	2	7	21	23	15	33	25	24	16	22	55	39	46	36	38	47
24	18	23	7	11	17	23	2	1	31	30	21	20	14	17	13	17	22	28	22	34	30	22
25	16	8	6	13	22	22	4	4	14	17	15	34	31	22	19	22	13	9	22	25	18	25
26	9	11	5	8	6	16	5	4	15	15	20	20	3	5	3	2	2	5	8	27	3	2
27	2	1	4	5	4	12	3	4	5	12	18	18	21	15	5	13	2	3	8	9	8	10
28	1	2	1	2	4	10	2	4	6	10	3	14	9	21	8	6	–	1	1	11	2	2
29	2	4	–	–	2	9	2	2	3	2	8	6	14	8	4	2	2	–	2	4	5	1
30	–	2	–	–	2	2	–	1	–	5	–	2	15	10	1	4	–	–	1	1	5	5
31	–	–	–	–	1	–	2	–	–	2	–	2	5	2	–	–	–	–	–	1	2	–
32	–	–	–	–	–	–	–	–	–	1	1	–	4	10	2	2	–	–	–	–	–	–
33	–	–	–	–	–	–	–	–	–	–	–	1	6	7	1	–	–	–	–	1	1	–
34	–	–	–	–	–	–	–	–	–	–	–	–	4	4	3	1	–	–	–	–	–	–
35	–	–	–	–	–	–	–	–	–	–	–	–	2	–	1	–	–	–	–	–	–	–
36	–	–	–	–	–	–	–	–	–	–	–	1	5	2	1	1	–	–	–	–	–	–
37	–	–	–	–	–	–	–	–	–	–	–	–	5	2	1	–	–	–	1	–	–	–
38	–	–	–	–	–	–	–	–	–	–	–	–	2	1	–	–	–	–	–	–	–	–
39	–	–	–	–	–	–	–	–	–	–	–	1	2	1	1	–	–	–	–	–	–	–
41	–	–	–	–	–	–	–	–	–	–	–	–	3	2	–	–	–	–	–	–	–	–
42	–	–	–	–	–	–	–	–	–	–	–	–	1	1	–	–	–	–	–	–	–	–
43	–	–	–	–	–	–	–	–	–	–	–	–	2	1	–	–	–	–	–	–	–	–
48	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	–	–	–	–	
50	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–

Fortune Bay.

The mean size at Little Bay East (males 22·6 cms., females 22·9 cms., or 8·6 and 8·9 inches respectively) is slightly lower than the Belleoram values (males 23·4 cms., females 24·2 cms., or 9·3 and 9·6 inches respectively). At fishing centres near the mouth of the bay, e.g. Garnish and English Harbour West, individuals are said to be of larger average size. The size of the majority of lobsters caught in the Fortune Bay region, however, appears to be between 22 and 24 cms., or 8·5 and 9·5 inches.

South Coast.

Here the lobster grounds are usually in deep water and on an exposed shore so that the average size, about 26 cms. (10·3 inches) is quite in accord with what the habitat conditions would lead one to expect.

Bay St. George.

When the nine inch (23·0 cms.) lobster size limit was set in 1935 packers in this area complained that "Bay St. George lobsters had always been small." Hence the regulation would greatly restrict their pack and at the same time have little effect on permitting an average increase in lobster size.

Our measurements were taken at the head of the bay, from fishing grounds along the south shore of Port-au-Port peninsula, and the values (males 24·2 cms., females 23·8 cms., or 9·3 and 9·7 inches) compare with similar values from the head of Fortune Bay and Placentia Bay. Unfortunately, no measurements were obtained from villages on the south side of Bay St. George towards Cape Anguille, although there is held to be little difference in size between the lobsters near the mouth and at the head of the bay.

The Bay St. George curve in Figure 3 indicates female predominance in the lower size range and points to the interesting possibility of lobsters mating earlier here than elsewhere.

Should this be so, the stock of Bay St. George lobsters could maintain itself even were the legal size limit lower than nine inches. But to decide definitely whether the Bay St. George lobsters have a slower growth than lobsters in the other Newfoundland areas will require subsequent investigation. More measurements from different points in the bay are necessary. The data at hand are, however, probably significant as far as they go.

8. *Berried Females.*

The return to the sea of female lobsters carrying eggs is essential to the successful maintenance of the lobster population. For a long time in Newfoundland berried females were caught and packed indiscriminately. The practice is not as prevalent to-day. But of the 30 berried females examined during the spring of 1935 nearly all were illegally caught and were being packed.

In many cases fishermen do not appreciate the relation between the egg-bearing female and the future lobster catch. Nor do they realise the long span of time (probably at least four to six years) necessary for Newfoundland lobsters to grow into marketable size. If these facts were widely known and accepted there is no doubt that most fishermen would very readily abide by the conservation regulations.

9. *Length of Season.*

The problem of obtaining the maximum commercial yield of lobsters from a fishing ground year after year, with little or no resulting depletion of the stock, depends to a great degree on the adjustment of the fishing season so as not to interfere with egg-extrusion, hatching, and moulting.

The fishing season should be long enough to give fishermen the opportunity of catching as many lobsters as possible when the shells are full of meat—that is, before moulting begins, or at least six weeks after moulting has occurred.

The end of the spring season should coincide with the beginning of the hatching period and should overlap it as little as possible. The hatching period probably begins during July in Newfoundland, in localities where the sea has warmed sufficiently. Moulting is known to take place during August. But the duration either of hatching or moulting is still an unstudied problem in Newfoundland waters.

10. *Returns on the Base of Catch per* 100 *Traps.*

Table 2 sets forth the catch per 100 traps at the various places visited by the investigator. But as the number of days spent in each village varied from one to seven days, and as the time interval extended from early May to late June, these data are probably not very significant. It would be incorrect to accept the returns as characteristic for the average fishing returns in each village throughout the season.

TABLE 2

Catch per set, per 100 Traps.

Placentia Bay ..	Arnold's Cove	36
	Port Royal, Harbour Buffet ..	78
	Haystack	42
	Bread and Cheese Island	33
	Spenser's Cove	43
	Sound Island	46
Fortune Bay ..	Little Bay East	166
	Belleoram	35
Connaigre Bay ..	Deadman's Cove	58
	Great Harbour	52
South Coast ..	Ramea	33
	Red Island	47
	Burgeo	57
	Wreck Island	46
	Otters' Point	58
	Grand Bruit	40
	Barrachois Island	40
West Coast.. ..	St. George's Bay	40
	Port-au-Port Bay (East Bay) ..	63
	Port-au-Port Bay (Fox Island) ..	250
	Woody Island, Bay of Islands ..	40

APPENDIX D.

A FURTHER SPECIES OF GIANT SQUID (*Architeuthis sp.*) FROM NEWFOUNDLAND WATERS

By Nancy Frost, M.A.

Introduction

On November 12th, 1935, a giant squid was seen floundering in the water at some little distance from the shore at Harbour Main, Conception Bay, Newfoundland. The animal must have been in the last stages of exhaustion, for Jos. Exekiel, a young fisherman, was able to drag it to the beach with the aid of a small boat. The specimen thus obtained was in an excellent state of preservation and was quite intact but for the tentacular clubs, the eyes, and the outer body cuticle. The last is, apparently, very easily rubbed off.

Examination of the specimen showed it to be an immature female of the genus *Architeuthis*, the form of the fins differentiating it at once from that described previously from Dildo, Newfoundland.[1] It would appear that in many respects the specimen resembles *Architeuthis clarkei*, Robson, a species described from a specimen stranded on the coast of Yorkshire.[2] The measurements taken of the two are hardly comparable, however, and these data are being published without any attempt to refer the animal to a particular species.

It is worthy to note that, of the two recent Newfoundland specimens, that from Harbour Main is a female, whilst that from Dildo was a male. The species of the genus *Architeuthis* are not yet clearly defined because of insufficient data, and nothing is known regarding sexual variations.

Description of a Giant Squid (*Architeuthis sp.*)
Captured at Harbour Main, C.B., Newfoundland

Dimensions.

The following measurements are given in comparison with those taken of *Architeuthis clarkei* :—

	Architeuthis clarkei Robson	Harbour Main Specimen
Mantle length (dorsal)	5′ 5″	7′ 2″
,, ,, (ventral)	5′ 0″	—
,, width (maximum)	1′ 10″ (+1)	—
,, (at aperture)	1′ 8″	—

	Architeuthis clarkei Robson	Harbour Main Specimen
Circumference of body (widest part) ..	—	6' 10"
Funnel, length (aperture to base, mid-ventral)	—	1' 1"
,, breadth between cartilages ..	—	1' 2½"
Fins, length	2' 1·5"	2' 9"
,, width (total)	1' 7"	2' 1"
Tentacle, left	11' 6" (with manus +2' 0" ?)	17' 3"

Arms (base to tip) :—	*Left.*	*Right.*	*Left.*	*Right.*
1st pair	3' 3·5" (+ ?)	5' 1" (+ ?)	4' 4"	7' 9"
2nd ,, ...	4' 9" (+ ?)	4' 3·5" (+ ?)	7' 11½"	(arms equal)
3rd ,, ...	7' 2·5"	4' 11" (+ ?)	8' 8"	,, ,,
4th ,, ...	7'2"	7'2"	7' 9" (+6" ?)	,, ,,

	Architeuthis clarkei Robson		Harbour Main Specimen	
Head (length)	1' 4"		1' 7"	
,, (width)	1' 2"		—	
Distance between eyes (dorsal)	—		1' 7"	
Diameter of eye socket (eye gone)	—		24 cms.	
Diameter of 10th Sucker :—	*ext. diam.* (mm.)	*ap. diam.* (mm.)	*ext. diam.* (mm.)	*ap. diam.* (mm.)
Dorsal arm ..	17	10·5	20	15
2nd ,, ..	17	10·5	26	16
3rd ,, ..	18	10·5	22	15
4th ,, ..	13	7	14	8

It will be seen that the Newfoundland specimen is considerably larger than that described by Robson, but that in those cases in which the measurements are comparable the relative proportions are approximately the same.

Body.

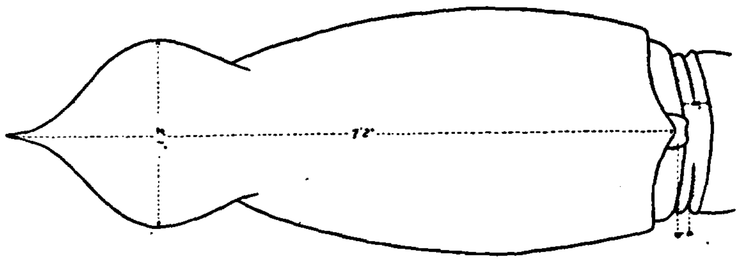


FIG. 1. Diagram of body. (*a*) Neck fold ; (*b*) Dorsal cartilage, seen because mantle is somewhat displaced.

The form of the body is shown very diagrammatically in the figure. It was difficult to determine the exact circumference because the animal had been dead some time when examined and was quite limp. The figure given is, however, probably fairly accurate.

The neck region exhibited a very prominent vertical fold as figured. The proportion of the length of the head to that of the body was 1 : 4·5.

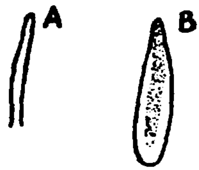


FIG. 2. Adhesive organs. (A) Mantle cartilage; (B) Funnel cartilage (× ½).

The adhesive organs are figured.

Fins.

The fins (see Fig. 1) immediately differentiate this specimen from the species *Architeuthis harveyi* Verrill[4], and *Architeuthis princeps* Verrill, and relate it to *Architeuthis clarkei* Robson. Their form is ovate with no anteriorly projecting lateral lobes. Robson[(2)] states that there is little information regarding the fins of the other species.

Tentacular Arms.

Unfortunately, the manus of each arm was missing, though it appeared that only the surface bearing the suckers had been removed. Thus, it is very probable that, when intact, the arm would have measured little more than 17 feet 3 inches. As was the case in *Architeuthis clarkei*, a few diminutive suckers were found along the stem.

Sessile Arms.

As stated, the arms of a pair, other than the dorsal arms, were of about equal length.

Dorsal (first) Pair.

The left arm which measured only 4 feet 4 inches decreased in circumference very suddenly, so that the distal 6 inches was relatively very small and bore very minute suckers. Its appearance can be explained by saying that, if such a thing as has been shown to occur in the arm of the Octopus[3] were possible in the giant squids, it would be at once concluded that the arm had suffered an injury and was regenerating.

The following measurements were taken at 5 inches from the base of the arm :—

Dorsal Pair ..	Breadth of front,	excluding membranes	8 cms.
	„ „ „	including membranes	15 cms.
		Circumference ..	26.5 cms.
Second Pair ..	Breadth of front,	excluding membranes	9 cms.
	„ „ „	including membranes	14 cms.
		Circumference ..	28·5 cms.

Third Pair ..	Breadth of front,	excluding membranes	8·5 cms.
	,, ,, ,,	including membranes	17 cms.
		Circumference ..	35 cms.
Fourth Pair ..	Breadth of front,	excluding membranes	8 cms.
	,, ,, ,,	including membranes	14 cms.
		Circumference ..	35 cms.

Suckers.

As found by Robson for *A. clarkei*, the suckers increased in size from the base of the arm to about the fifth sucker, after which the size diminished. As the suckers decreased in size the adoral denticles became

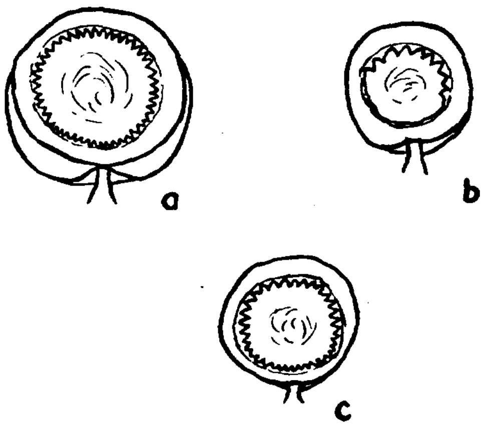


FIG. 3. Suckers. (*a*) Second arm, eighth sucker ; (*b*) Second arm, eighteenth sucker ; (*c*) Fourth arm, eighth sucker (natural size).

smaller and finally disappeared. In *A. clarkei* this condition was attained by the twenty-fifth sucker, whereas in the Harbour Main specimen the eighteenth sucker showed only nine large teeth on the distal edge (see Fig. 3b). Unfortunately, drawings were not made of the sucker rings. The suckers of the ventral arms were notably smaller than those on the other arms and the adoral denticles disappeared more quickly.

Radula.

As far as the data can be compared, the only difference between this specimen and *Architeuthis clarkei* which it is difficult to explain as an

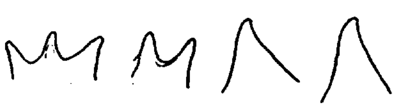


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FIG. 4. Radula.
FIG. 5. Lateral view of second lateral tooth.

individual variation was found in the radula. As is shown in the figure, the teeth rather resembled those of the Dildo specimen which was related to *A. harveyi* or *A. princeps.* It is possible that further material may reveal the fact that this variation is due either to sex or to age.

Mandibles.

The mandibles are figured. As in *A. clarkei* they were very fragile structures although supported by muscles of great strength. The line (*a*)

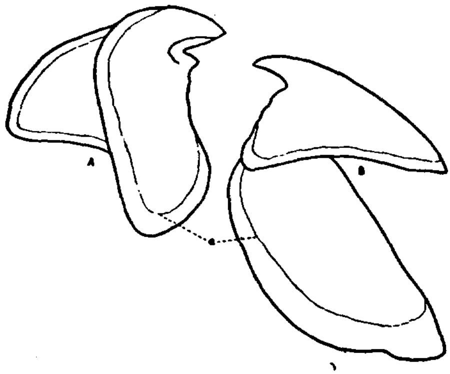

FIG. 6. Mandibles. (*a*) Ventral; (*b*) Dorsal (× ½).

in the diagram indicates the termination of the brown pigment, leaving the outer edge of the mandibles colourless.

Notes on the Internal Structure.

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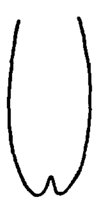

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FIG. 7. Diagram of digestive system. (*a*) Muscle at base of jaws; (*b*) gland; (*c*) oesophagus (dorsal to liver); (*d*) rectum; (*e*) sac with central columnellar; (*f*) area of stomach lined with heavy rugae and covered by darkened epithelium; (*g*) thin walled portion of stomach.

FIG. 8. Liver.

A median ventral incision was made along the whole length of the mantle and the internal organs were found to be in an excellent state of preservation.

The relative position of the viscera of the squid is well known and only a few very diagrammatic sketches of particular organs of this species are given here.

Fig. 9. Terminal portion of rectum. (*a*) anus ; (*b*) indicates level at which ink sac enters on dorsal side.

Considerable glandular tissue was seen in the dorsal mesentery towards the anterior end of the stomach and in the post-oesophageal region. There was no opportunity to examine this histologically.

No trace of food was found in the stomach and the epithelial lining resembled that described in the Dildo specimen.

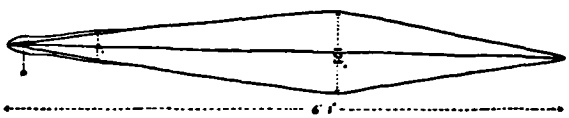

Fig. 10. Pen. (*a*) Indicates more flexible area.

The ink sac was a single tube lying dorsal to the rectum on the ventral surface of the liver. As shown the ink sac and the rectum coalesced to form a common tube for a short distance before terminating in the anus.

The pen is shown in Fig. 10. This organ was extremely fragile.

Summary.

1. A giant squid (♀ imm.) was captured at Harbour Main, C.B., Newfoundland, in November, 1935.

2. This specimen differs, notably in the shape of the fins, from the specimen previously described from Dildo, Newfoundland.

3. In many respects the specimen resembles *Architeuthis clarkei*, Robson, but the radula differs considerably.

4. In view of the lack of comparable data and because at present the species of the genus *Architeuthis* are not well defined, the specimen is described but no attempt is made to determine the species.

5. Brief notes accompanied by diagrammatic figures are given on the internal structure.

Acknowledgements.

I am indebted to Dr. Harold Thompson for the opportunity of examining this specimen and for helpful advice. Especially am I indebted to Dr. G. C. Robson, of the Bristish Museum of Natural History, for fully discussing this matter with me and making helpful suggestions.

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[3] *Lange, Mathilde M.* On the Regeneration and Finer Structure of the Arms of the Cephalopods. Universität Zurich, 1920.

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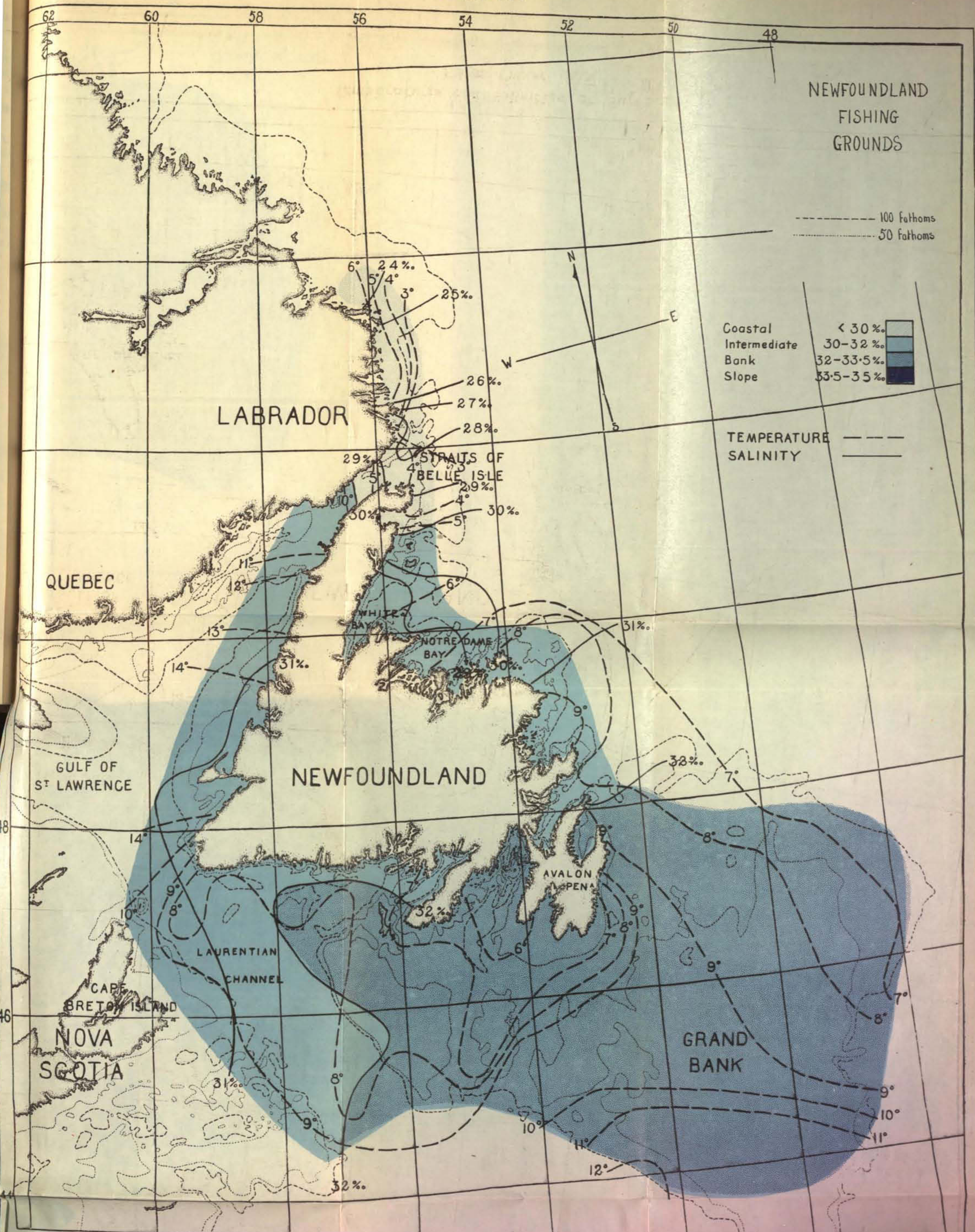
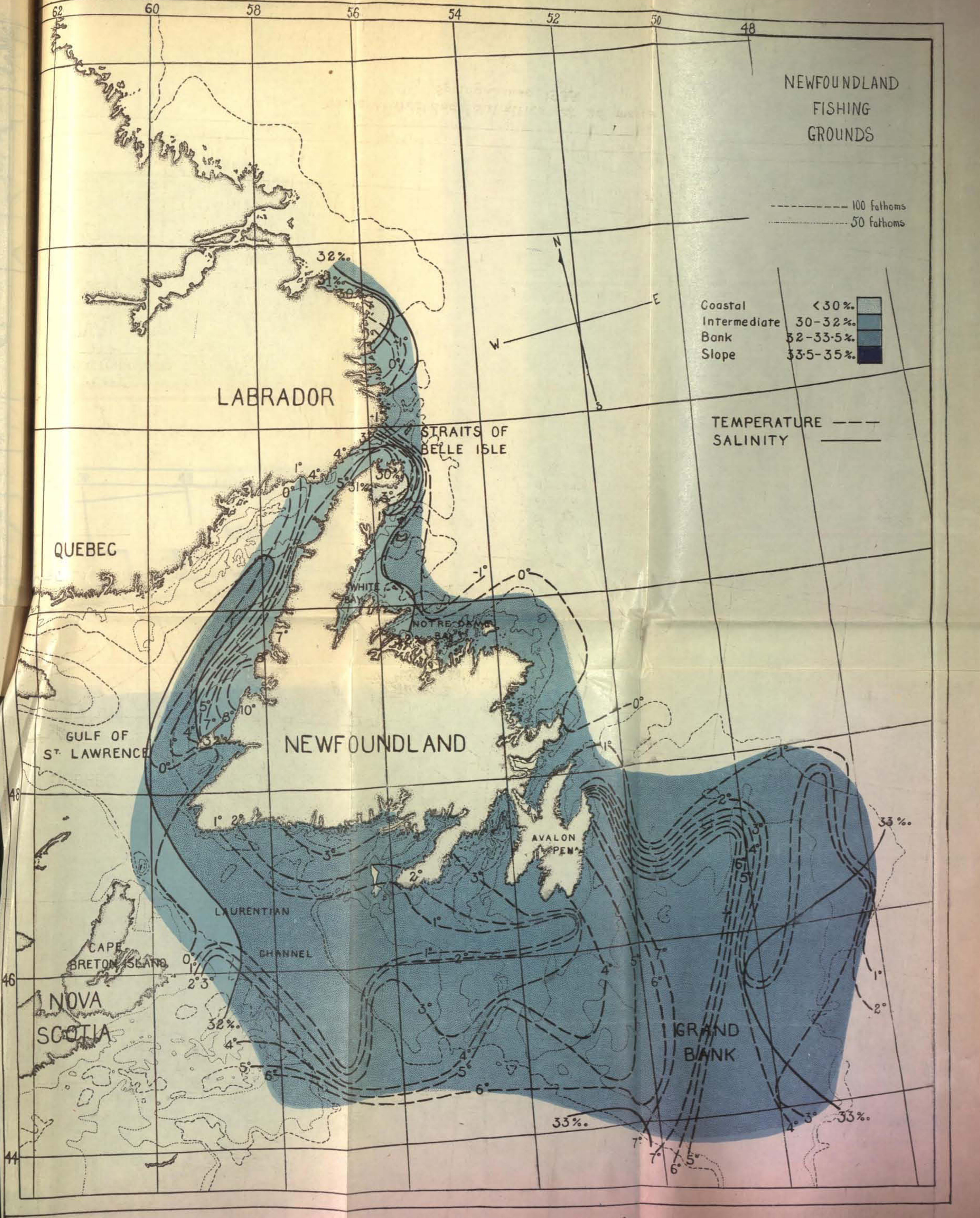
Chart No 1



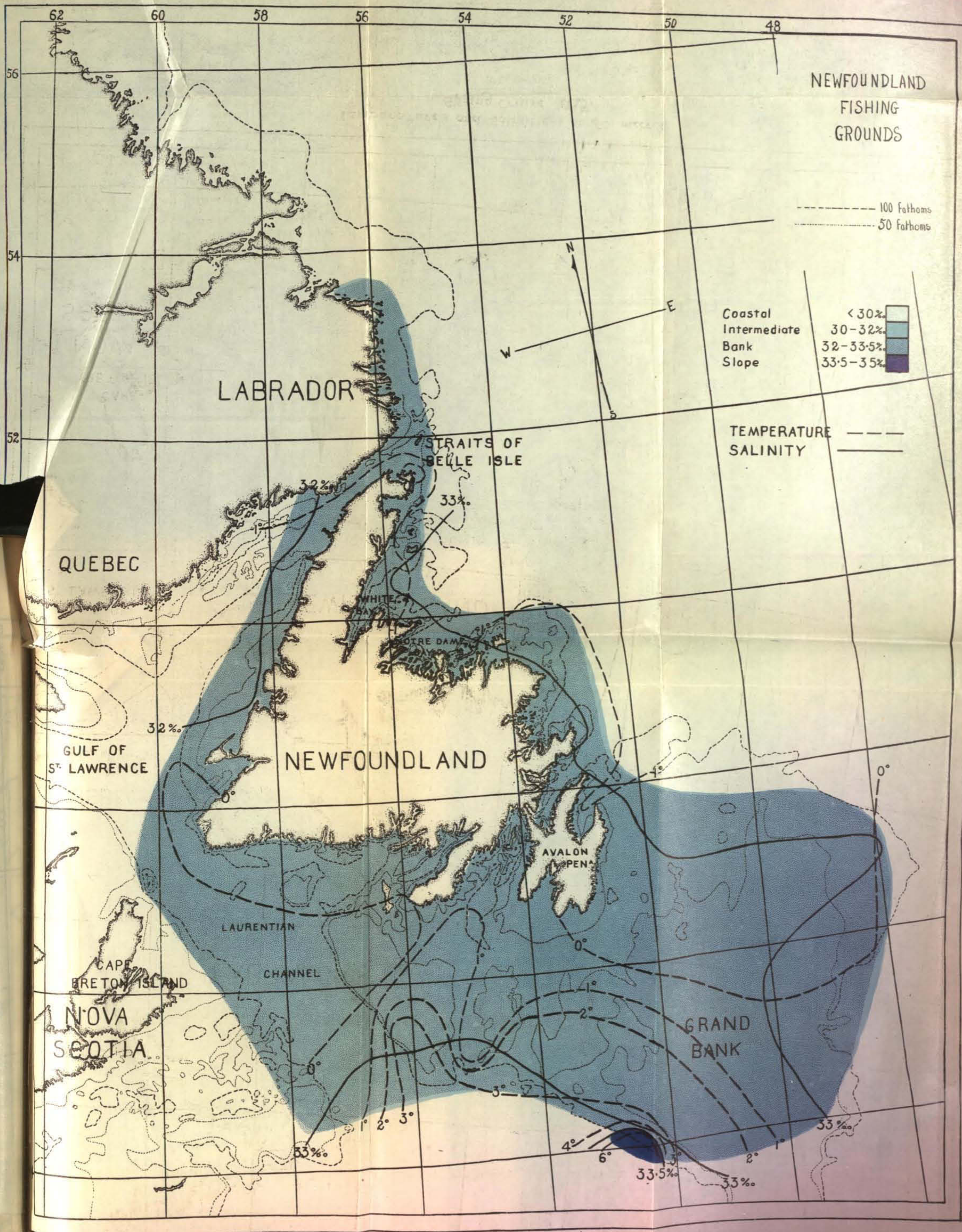
Temperatures and Salinities at Surface
Spring Cruise 1935.

Chart No 2



Temperatures and Salinities at 25 metres
Spring Cruise 1935.

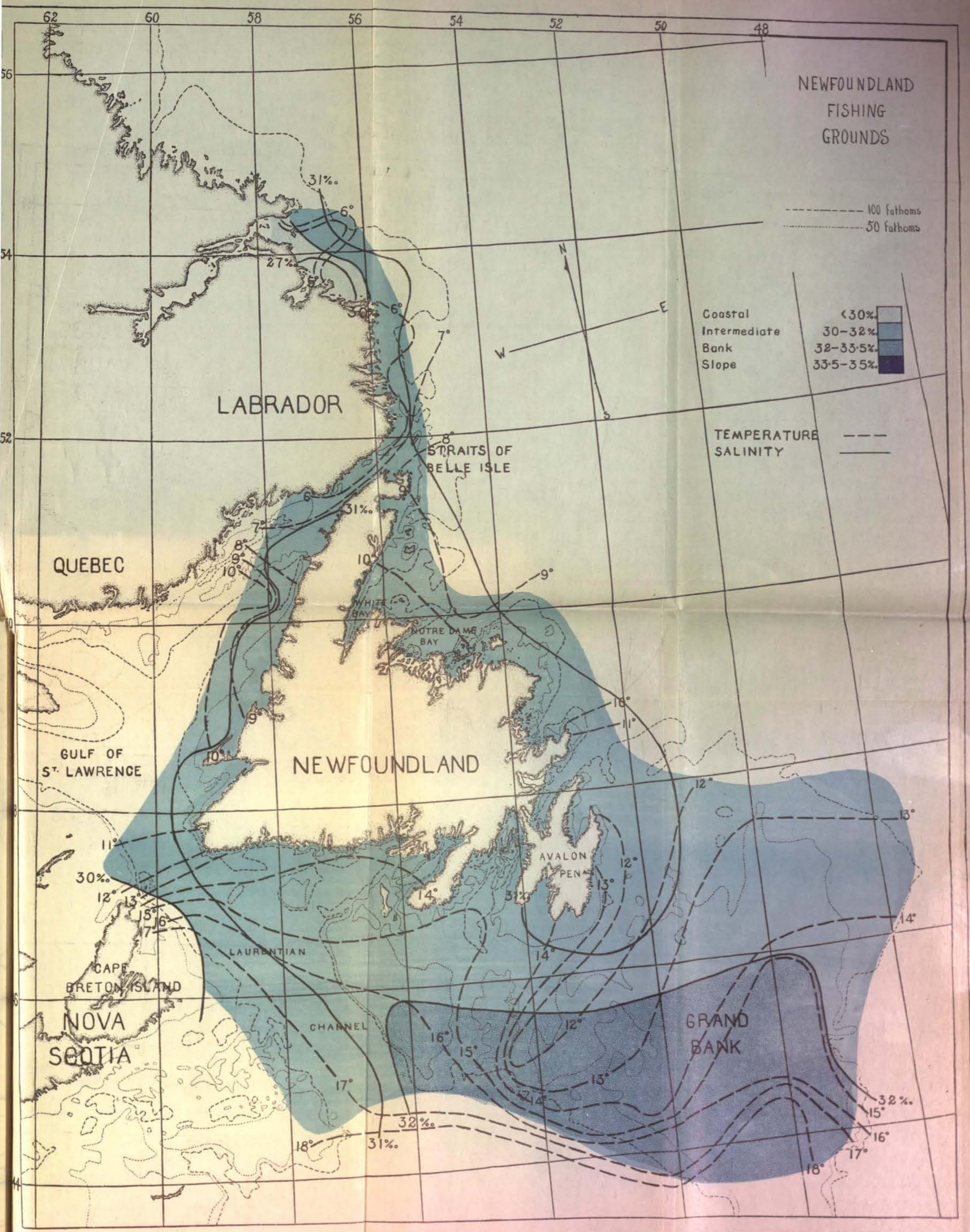
Chart No3



Temperatures and Salinities at 50 metres
Spring Cruise 1935.

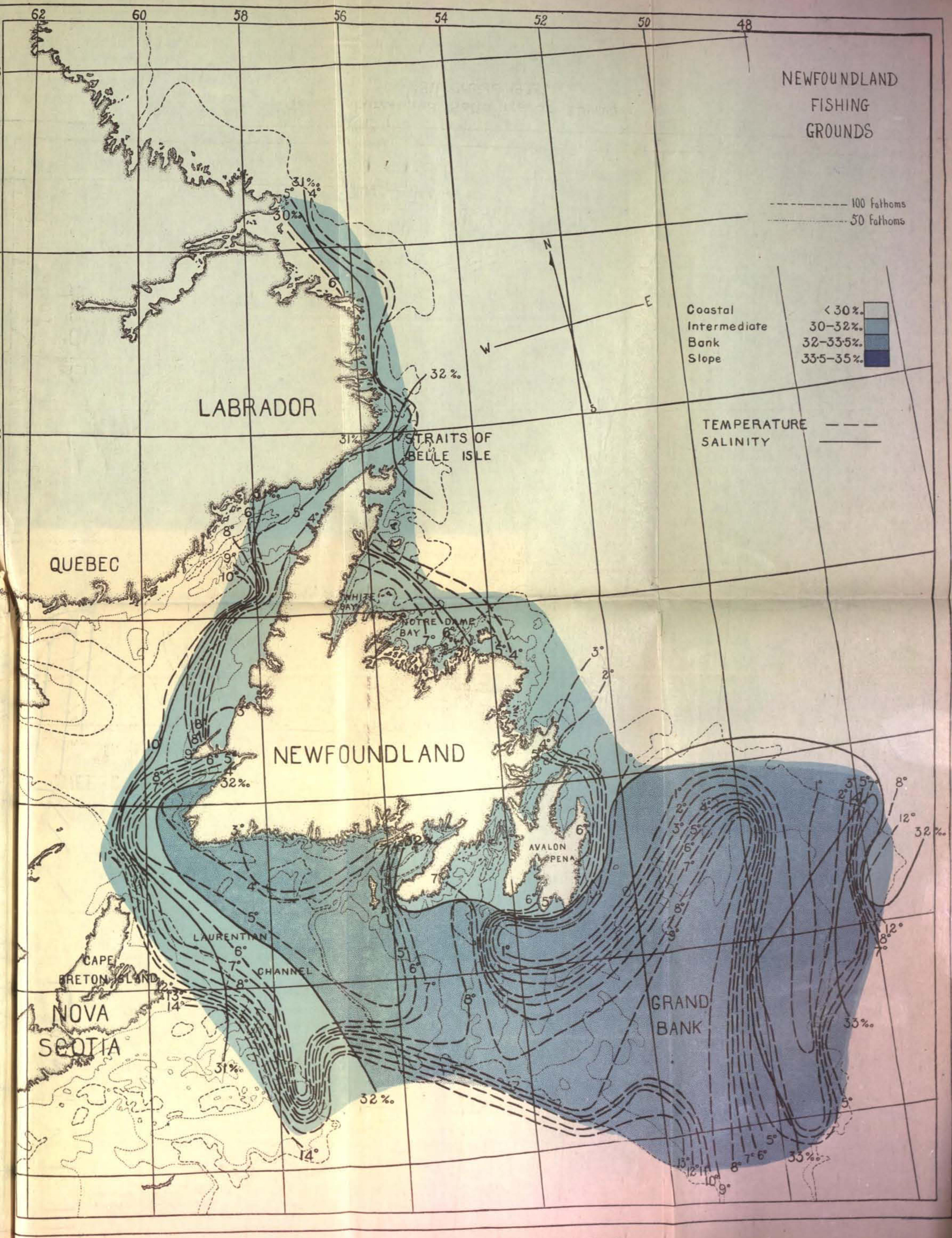
Temperatures and Salinities at 100 metres
Spring Cruise 1935.

Chart No 5



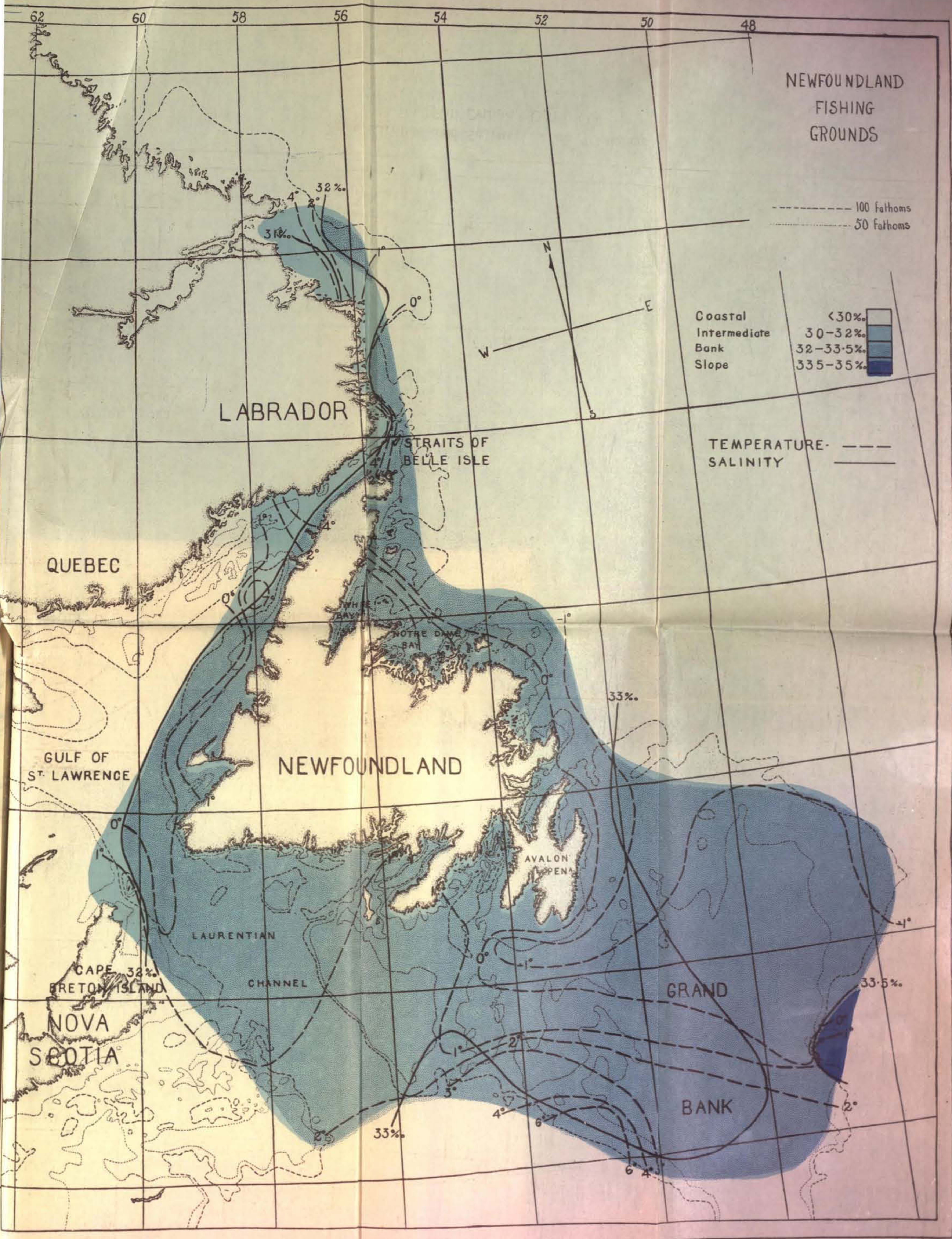
Temperatures and Salinities at Surface.
Fall Cruise 1935.

Chart No 6



Temperatures and Salinities at 25 metres.
Fall Cruise 1935.

Chart No 7



Temperatures and Salinities at 50 metres.
Fall Cruise 1935.

Chart No8

Temperatures and Salinities at 100 metres
Fall Cruise 1935.

Chart No9

Movements of Drift Bottles
1935

NEWFOUNDLAND

Department of Natural Resources

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DIVISION OF FISHERY RESEARCH

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CONTENTS.

I. INTRODUCTORY OBSERVATIONS

Since the preparation of its fifth Annual Report which covered the activities during the fifth year of operation and discussed the conclusions drawn from the initial five years' survey, a series of events has upset the programme of the Research Division. In the first place considerable changes have taken place in the personnel of the staff. The Director, Dr. H. Thompson, tendered his resignation on appointment to a similar position in Australia. In all, four members of the staff have left the organization since 1935 so that, since only one position has been filled, the staff has been considerably reduced. Furthermore, the complete destruction by fire of the Laboratory premises at Bay Bulls, with loss of equipment, which occurred on the night of April 19th, 1937, constituted a severe loss. The present Report is intended to avail of the opportunity of the position created to take stock of the situation in the fishing industry, to discuss future requirements, and to report upon the efforts that have been made, under very adverse circumstances, to maintain the services provided by the Division.

PRESENT SITUATION

Any conclusions concerning the future of the fisheries in Newfoundland must hinge upon the existing economic situation, so that a brief account of the framework of the fishing industry is a necessary preamble to the discussion. A clear-cut picture of prevailing conditions is essential. The industry embraces cod, salmon, lobster, herring, caplin, smelt and miscellaneous fisheries, the term miscellaneous including squid and shell fish. The cod fishery is by far the most important and is, indeed, so pre-eminent that by traditional usuage the expression "fish" means codfish and no other species. It is essential always to bear in mind the credit supply system whereby supplies of necessary gear and of living essentials are, season by season and year by year, given out to fishermen in advance of the fishing activity for which they are outfitting. Only relatively few fishermen pay cash against supplies. The majority hope for a "voyage" sufficiently successful to clear their contracted obligations.

COD. By far the major portion of the fishery export value is due to the export of dried codfish, and some twenty to thirty thousand fishermen and their dependents derive their means of subsistence from codfish. Codfish are taken on the Banks, inshore in Newfoundland, and inshore on the coast of Labrador.

BANK FISHERY. On the Banks during the spring and summer the fishery is prosecuted with schooners. Some fifty sailing schooners, running from fifty tons up, and about ten auxiliary motor schooners clear regularly from Newfoundland for the fishing Banks. Another fifty smaller schooners make occasional summer trips to the Grand Banks but fish mainly on the nearer Banks. The actual fishing is done by hook and line trawls from dories, small flat-bottomed boats easy to stow and very seaworthy. The proportion of the fishing population engaged in this branch has decreased steadily and considerably in the past thirty years. These fishermen avoid taking haddock since dried salted haddock is not a valuable product and salt is their only means of preservation. They discard cod livers and also the cod roe which in the spring is, of course, plentiful. Any halibut or other species which they may take cannot be preserved and, consequently, is not much sought after. The product of this effort of capital and labour consists essentially, therefore, of salted codfish which is brought to port and dried for export. The marketing of the dried product at a remunerative figure is becoming increasingly difficult. In recent years efforts have been made to test the practicability of steam trawlers engaging in the production of dried salt codfish. That the trawler is a more efficient catcher there is no doubt, but that she is a more economical unit seems to be a moot question. Doubtless a second-hand vessel obtained with comparatively low capital investment may be able to show profits, but a newly built trawler will require a capital investment likely to require allowance for heavy overhead charges. The essential necessity again lies in the need for obtaining a greater gross reward for the catching effort.

SHORE FISHERY. In the summer months there occurs a migration of codfish to the coasts of the Island of Newfoundland which is unparalleled in any other place in the world. Enormous quantities of codfish congregate for a short period for a post-spawning recuperative feeding migration in the comparatively shallow waters close inshore. They are, of course, pursuing caplin, in the early summer at all events. Most of the catching of this inshore run of fish is done by cod-trap. A leader net, up to fifty fathoms in length and from ten to twenty fathoms deep, runs out from the shore to the centre of the door of the trap, which consists of four square or rectangular walls of net with a net bottom. Traps vary in size from fifty to eighty fathoms on the round, as the expression is, and from ten to twenty fathoms in depth. Open motor-driven trap boats, with a crew of up to six, visit these stationary traps from time to time to haul them and secure the catch. Little fishing ingenuity is necessary with this method. The trap-berth is permanent and stationary for the season, having usually been allocated by drawing lots. Enormous quantities of codfish may be taken if inshore conditions have resulted in the inshore occurrence of large quantities of fish. If, however, codfish fail to show up inshore the setting of the trap and the preparations and operations connected therewith constitute so much wasted effort, in that the method does not permit of any adjustment to retrieve the situation. In addition to the trap method, hook and line trawls and hand lines are used in the prosecution of shore fishery. Boats, motor-boats and even dories operating from shore bases are used in the very slightly more mobile hook and line fishery. These inshore operations are conducted over a great portion of the coastline, and the products of these efforts are turned into dried salt codfish. The oil of the livers is either steam-rendered or rendered for common cod-oil by allowing the livers to decompose. The waste of the cod is not utilized. A feature of great significance which is not generally emphasized is the local reservation of the coast fishery for local residents. As might be surmised, extensive activities have necessitated the forming of suitable controlling regulations. By traditional custom a regulatory system has developed which makes it difficult, indeed almost impossible, for a resident of one place to engage in activities in a shore area other than his local area. In the past, the best of the shore cured product found remunerative outlet in the markets of Spain and Italy. Today these markets are difficult and too much of the qualities required would necessitate diversion to other markets with consequent interference there.

LABRADOR FISHERY. To prosecute the Labrador fishery schooners come from Newfoundland and anchor in convenient harbours; these are called "floaters." Alternatively, a temporary land site may be taken as a base of operation and, in this case. the operators are called "stationers." To some extent, also, residents called "liviers" prosecute the fishery. As in the shore fishery traps and hook and line are used. The bulk of the result of the fishing effort is taken south to be dried and exported, or exported in salt bulk. The product is a heavily salted one, and although as a consequence the yield for the same catching effort is greater than for the Newfoundland shore catch, the smaller price obtained makes it difficult to obtain a remunerative return for the capital and labour effort involved.

SALMON. Salmon occur on the coasts of Newfoundland in the spring of the year, at which season water conditions are normally such as to be suitable for their congregation inshore. The late fall run of salmon is of no commercial significance. In recent years a valuable industry has developed. The salmon are caught in stationary gill nets moored to the shore. Drift netting has developed in recent years in the Port aux Basques area. The salmon caught by the fishermen are brought to a mother ship or to suitable centres at which they are picked up by a mother ship. They are either packed in ice for export to Canada and the U.S.A. or frozen for export to the United Kingdom. The refrigerated mother ship has proven a great success in this case and a healthy, if small, frozen salmon industry now exists. As remarked in the fifth Report the practice of freezing round salmon recently prevalent because of the market demand has now been substituted by the technically more satisfactory freezing of the gutted salmon. Canning, particularly of a considerable number of the grilse portion of the catch, is done aboard the mother ship and this arrangement is very satisfactory because grilse are more suitable for canning and are not in great demand as a frozen article. The technical processes are well understood and well controlled, so that this industry is without doubt highly satisfactory. What difficulties there are in the industry centre around occurrence of salmon and possible conservation requirements of a species which does not regenerate rapidly in this area owing to the long average river life. In the more localised small scale canning operations, adequate technical procedure is not everywhere adopted.

LOBSTERS. A valuable little industry to the country is the lobster industry. Lobsters are put up in cans in some five hundred

(500) small factories scattered over the South and West coastlines, and the small volume of output of each factory militates against successful operation. Last year's export volume of about 16,000 cases indicates the average output per factory, and the figure given is a high one. Adequate equipment is not feasible, as the output does not justify large capital investment. Lobsters are caught in lobster pots or traps at depths up to 12 fathoms on the South and West coasts of Newfoundland in the spring months, the fall pack of soft shelled lobsters having now fortunately been entirely suspended. The main difficulties of the lobster canning industry arise out of (1) inadequate equipment due to small scale operations, (2) inadequate care with the can sealing operations, and (3) too high a cost for cans. An appalling percentage of spoilage of canned lobsters is reported. The sale of live lobsters for shipment to Canada and the U.S. is increasing yearly, and the problem of maintenance of stocks is of some urgency. As recently as 1928 a close season of three years ended. At the present time regulations forbid the taking of spawn bearing lobsters and lobsters of less than 9½ inches in size.

HERRING. It has been pointed out in a previous Report that, as is the case in Norway, inshore herring runs consist of very young fish and mature fish of six or seven years or more, the intervening stage of life being spent offshore and never, so far, located in quantity. The present fishery centres around Bay of Islands, Fortune Bay, Placentia Bay and Green Bay. Intensive operations occur during the months of November, December and January. Stationary gill nets set well inshore in the bays are used as a means of capture. Not more than sixty per cent. of the catch, and often much less, can be used for the Scotch Cure pack which is the main outlet, although split herring and special vinegar cures are exported to some extent. Herring is also, of course, stored for bait purposes. A good many thousands of fishermen depend on this fishery to supplement their income from other sources, but a variety of causes has caused a steady decline in the value received. Marketing difficulties have been countered by efforts at organized group marketing without much success. Complaints of the quality of product and package have resulted in heavy claims on shipments, and financial returns to the fishermen have been, to say the least of it, disappointing. An agreement has recently been made with a private company to grant certain exclusive privileges for the manufacture of herring oil and meal in certain areas including the coast of Labrador, where it is known immense quantities—if somewhat sporadic in occurrence, however—of herring are to be found. These operations are likely to effect improvements in the fishing effort, calling for more mobile and more extensive catching. Briefly, then, the herring industry suffers from low returns for the catching effort and marketing difficulties. It is pertinent to remark here, and the remark applies throughout all fishing activities, that the number of fishermen in Newfoundland is not large for the large sea area available, and even a slightly improved return for the fishing effort would have immense significance in the welfare of the people.

SMELTS. The availability of freezing and cold storage facilities at several centres has enabled a small development to take place in the smelt fishery. Over 270,000 lbs. were exported last year, bringing a relatively high return to the fisherman and demonstrating the advantage in other activities if better gross returns could be had for the effort expended. More mobility enabling the catch to be taken to freezing centres would improve the efforts at exploitation. Following upon that, optimum possibilities should be ascertained by the investigation of the stocks and this, therefore, shows another difficulty confronting the industry.

MISCELLANEOUS FISHERIES. The squid fishery is prosecuted because of the value of squid as a bait. Although the examination of the stomach contents of codfish has never revealed the presence of squid, nevertheless it is generally believed by fishermen that squid bait is the bait par excellence in the fall months. Herring is only substituted for squid in the absence of the latter. The squid come into the bays in the fall months and are caught by hand "jiggers," mushroom shaped instruments with jagged edges on which the squid fastens its tentacles. The squid is jerked quickly from the water. Large numbers of dories and boats crowd the waters of the bays jigging squid. Very marked fluctuations, amounting some years to complete failure to appear, occur in the abundance of squid each year, but in years of abundance a large quantity is dried for export. Dried squid is a much prized article of food in the Orient and fetches good prices. The industry, however, needs stringent supervision to maintain a high quality product. Government refrigerated bait depots store squid for fishermen, as well as caplin and herring, on a basis of giving fifty per cent. of the quantity in exchange for storage. The bait depot share is available for purchase.

Various other species are actually caught in the area and they include halibut, haddock, turbot or Greenland halibut, scallops, clams and dabs. The utilization of these resources, giving remunerative returns, is difficult because no satisfactory means of preservation exists. It must be remembered that the total number of people engaged in the fisheries is not large and the utilization of resources, even if these are not available in quantities comparable to the quantities required in large wholesale fish markets, will add considerably to the well being of the fishermen. **The very fact that available quantities, if utilized, would not add appreciably to those already available would constitute a more hopeful prospect than if excessive quantities capable of producing a glut in the markets were produced.**

By-products include the liver oil of codfish, and a separate booklet has been prepared dealing with this industry. Other fish oils are also produced. Fresh, pickled, and canned cod tongues and pickled sounds are put up from time to time. Markets exist for these products, and it is possible that a more adequate organization for processing them and new methods of processing would add considerably to the value of the main industry. The difficulties accompanying the attempted utilization of by-products centre around the lack of technical knowledge for controlling processing methods, maintaining standards, and finding and developing new methods.

No great commercial significance attaches to the inland fisheries of Newfoundland apart from the fact that a considerable local demand for native trout exists during the winter months after the opening of the season in January. Fishermen catch trout under the frozen surface of the ponds and add to their income by selling quantities in St. John's. The development of this means of income is desirable, but it must not occur at the expense of the stocks of fish. The tourist traffic is catered to in a small way, and this also is a valuable source of income which should be fostered. The difficulties are concerned with lack of knowledge of the life histories of the species, and intelligent regulation of the re-stocking of ponds as well as of the intensity of fishing. The relative merits of native and rainbow trout in local waters in relation to utility requires systematic study.

FUTURE REQUIREMENTS

In discussing future requirements, it is difficult to divorce the requirements of fisheries other than the codfishery from that major branch of activity. Indeed, the solution to the problem of the future of the codfishery automatically solves many of the difficulties inherent in the adequate development of other fishery resources. The discussion immediately following, therefore, whilst specifically applicable to codfish can be seen to embrace development of other species.

In the present situation, the fact which stands out most convincingly is the constant possibility of an unremunerative return for the effort expended. There are certain causes which immediately come to mind, the elimination of which might counteract the effect. The cost of production may be too high; the quality of the product may not be as high as desirable for best prices; and the losses during storage and shipment to market, due to deterioration in quality, may represent too large a proportion of the total production. While it is true that material improvements can yet be made in these factors, as will presently be discussed, it would seem that **the major necessity and the lines along which successful development of the industry must evolve is an increase in the gross value of the products of exploitation.** Consider the relative returns from the salt fish industry and the fresh or frozen fish trade. Four hundred and fifty (450) lbs. of codfish from the sea yield one quintal of lightly salted dry fish. For his quintal the fisherman receives at the present time anything from one and a half dollars to five or six dollars, depending on the quality produced. His average quality probably fetches about $3.50 per quintal. From this there has to be deducted the cost of salt and the cost of drying, estimated at 25c. and 40c. per quintal respectively. The gross value to the exporter varies according to market conditions, but may be said to run from $3.00 to $8.00 per quintal, striking an average between those two values. Four hundred and fifty (450) lbs. of fish from the sea are equivalent to about four hundred (400) lbs. of codfish with the heads on for which quality, in British and American wholesale fresh fish markets, less than $2.50 per cwt. is seldom paid. The advantage is obvious. The possibility of development along these lines comes to mind immediately. Four hundred and fifty (450) lbs. of fish produce twenty-nine per cent. (29%) of that weight of fillets, or about one hundred and thirty (130) lbs. fillets Fresh fillets, frozen fillets, smoked fresh fillets, or smoked frozen fillets are likely products. Assuming a price of seven cents (7c.) per pound, which is reasonable, the gross income to the country of the equivalent of a quintal of fish would be $9.10. The value to the fisherman would be not less than eighty cents (80c.) per one hundred (100) lbs. or $3.60 per quintal with no salting or drying expenses attendant, and a quick turnover. Assuming, further, a diversification of the catch to include ten per cent. prime fish such as halibut and haddock, the average return would probably be raised to ten cents (10c.) per pound, giving the equivalent of $13.00 per quintal. There is the additional possibility of preparing the products of the fishery in canned form. Canning experiments already made show that probably even more than in the case of freezing, a diversification of canned products to include species other than cod is essential for successful development.

What has now to be considered is the question of what part scientific work is likely to play and can play in bringing about a diversion of the industry into these channels. The problem is, in many respects, an economic problem and revolves around the means of changing the existing methods. Can these methods be changed with the existing set-up and distribution of fishing methods, or, is it necessary to turn to large scale capital developments? From the point of view of employment it is probable that the best method of tackling the problem consists of imposing the new method on the existing framework. Tabulation of requirements from the end of the chain serves to expose the situation for better appraisal. The requirements are:—

(1) Markets for more valuable products new to Newfoundland and intrinsically new.

(2) Adequate means of transportation from Newfoundland to the markets. To be adequate, a dependable regularity is necessary, and, of course, refrigeration facilities are an imperative necessity.

(3) A minimum number of centres at which processing or packing facilities are concentrated. Canning, smoking, cold storage and warehousing facilities are necessary.

(4) Adequate technical control of methods of processing, effecting satisfactory preservation and maximum utilization of raw material.

(5) Readjustment of methods, so that the fishing fleet may acquire that mobility necessary to bring the fresh fish caught, to the centre.

(6) Intensive training of fishermen in methods available for short-term preservation. This includes education in the use of ice, in filleting and other methods, and in the smoking of the products for delivery at the centre.

(7) The increased mobility of delivery of the catch, mentioned in (5) above, will and must at the same time extend to increased mobility in the fishing effort.

(8) Increased mobility of the fishing effort will in itself make possible an accumulation of data on the occurrence and abundance of marine species and provide necessary statistical information. Alongside this should go continued regular attempts at correlating physical conditions in the sea with abundance of fish and a routine check on the composition of the fish stocks.

Little fault is likely to be found in the foregoing chain of requirements. It is true that link number (3) might conceivably be substituted by the alternative provision of floating centres which would at the same time satisfy the requirements of the fifth link. In the salmon freezing industry, (2), (3), and (5) are merged together, since mobile mother ships move near fishing activities, process the salmon and transport the product to the market. In a wider development, however, the necessity would arise for more frequent and more regular shipments to market than would be possible for factory ships. It is safe, therefore, to assert that the tabulated list of requirements gives an adequate general picture. The solution to the question of getting the maximum value from the fisheries of Newfoundland involves the gradual forging together of these necessary links. The opinion has often been expressed in past Reports that many development efforts have failed through lack of a steady supply of fish. This point cannot be over-emphasized and its solution, of course, demands an adequate fishing effort, i.e. an adequate number of vessels adequately equipped for a longer annual fishing effort and sufficiently mobile to search for fish; but, big catches and large-scale production of new products would be embarrassing in the absence of transport facilities and ready markets, and it is probable that, even assuming a steady supply, a large scale organization suddenly entering production would soon find itself in financial difficulties, owing to heavy overhead costs. The development must be gradual, with catching methods spreading to individual fishermen, with markets gradually being obtained and the provision of transport facilities by Government. Furthermore, a gradual evolution would mean that at first the existing situation in the salt fish industry would be eased. Over a period the utmost value would still be obtained from this source, with which the fishermen are so familiar. Time is necessary to guide them into other channels.

The more immediate requirements are:

(1) **To endeavour to ensure the utmost efficiency in existing operations so as to avoid losses.** Better control of the drying of codfish would eliminate much loss by raising the average quality, and regulation of the storage conditions would obviate claims against shipments. The lobster industry, the herring industry, and the dried squid industry are yielding considerably less than they would if adequate means of preservation and packaging were employed. The consultative requirements of the trade must be attended to and certification of products as, for example, cod liver oil maintained.

(2) **To conduct an intensive educational programme explaining and demonstrating new methods of fish processing.** The use of ice for short period preservation is not understood; the principles of canning are not understood; the methods of smoking are not understood, and so on. Everywhere lack of knowledge and information is to be found, and the need for demonstration of fish processing is as urgent in

Newfoundland as demonstrational farming is elsewhere. Demonstrational drying stations have been advocated and are desirable.

(3) **The encouragement of more mobile fishing efforts.** Lack of mobility of fishing effort is a great handicap not only for following the occurrence of fish but for bringing the catch to convenient centres of operation. There could be no better way of obtaining information about fish movements than by the private efforts of individual fishermen, mobile enough to be able to push their fishing efforts farther afield. Scientific study of conditions at the same time will open enormous possibilities of control. Hand in hand with increased mobility must go the better utilization of the diversified catch thereby made available. A diversified catch will be useless if the other links in the chain are neglected. The extent of mobility demanded must cover the provision of decked boats capable of riding stormy seas and of being comparatively independent of wind conditions.

(4) **The experimental small scale production of products new to Newfoundland and new to the fishing industry for trying out in the markets.** This is a programme which should proceed at the same time as, and should keep abreast of the increase in mobility. The programme fits in very well with the demonstrational requirements and the need for utilizing mackerel, herring, haddock, flatfish and other species.

(5) **The provision of transport facilities to take the products to market.** Bait requirements are gradually being attended to by the provision of refrigerated depots and a refrigerated transport vessel. Efforts by private individuals at developing the frozen fish trade on a scale consistent with gradual infiltration into the markets are rendered futile because of the lack of transport facilities. The provision by private individuals of adequate, regular transport to handle the volume of traffic in the initial years, and this traffic must for success have small beginnings, would constitute an unprofitable overhead charge and is impossible. Nevertheless, its existence is essential for development.

The importance attached to the study of the physical conditions in the sea as a guide to the habits of fish life is emphasized below and reference is invited to the Report of the Committee of Enquiry appointed after the fire to make recommendations on the future of fishery investigations. Part One of that Report urges the recognition of the policy of catering to the immediate consultative, experimental and educational requirements of the industry and of utilizing the staff necessary for that purpose as a nucleus for hydrographic and biological survey work. The advantages of obtaining temporary investigators from sources other than the permanent staff are urged. The writer, as a member of the Committee in question, endorses the opinions expressed in the Report. It is believed that the recommendations are such as to meet the situation in the most efficient manner, holding forth prospects of bringing the maximum return for the least amount of money.

Brief reference must now be made to individual requirements always, of course, bearing in mind the general policy recommended above.

COD. Routine examination of stocks, with continued tagging experiments to investigate migration, is called for. So far as seasonal occurrence is concerned, the extension of hydrographic investigations is necessary with the establishment of inshore recording stations as well as the major programme of research offshore referred to below. Detailed statistics of catch, not export, must be obtained. Continued investigation of salting, drying and storage factors together with experimental production of new types must be maintained.

SALMON. The work called for in the case of salmon centres around conservation problems and demands detailed study of the life history and habits in individual typical rivers. The river life and rate of reproduction are the limiting factors which dictate the intensity of commercial activity permissible.

HERRING. The recent conclusion of an agreement with a commercial firm anent the production of herring oil and meal includes a condition calling for the firm to make investigations of herring movements. At the moment, therefore, the experimental production of lightly salted cures, vinegar cures, and canned products is desirable. Combination of some possible methods with cold storage holding offers hope of development.

LOBSTER. The canning of lobsters still leaves much room for experimentation. This is apart from the control and improvement in existing methods presently in use and available for use. It is still not quite clear how much and what type of liquid there should be in the can with the meat. Detailed investigation of the life history of lobsters in these waters is urgently required, and above all, statistics of catch and fishing effort by areas must be obtained. Export statistics are relatively valueless for scientific investigations.

CAPLIN. It has not yet been demonstrated whether or not a caplin product, canned, frozen or otherwise preserved is acceptable in the fish consuming markets of the world. Little effort has been made in this problem, for only what can be called unsatisfactory products have so far been offered. The effects of physical conditions in the sea on the occurrence of caplin have still to be studied, especially in view of the scarcity of caplin on the South West Coast. Whether or not this apparent depletion is really a depletion of stocks or merely a non-appearance is not known and efforts to ascertain should be made. The general importance of hydrographic conditions is apparent in all spheres of investigational activity.

HADDOCK. Haddock occurs definitely on the banks. With a suspension of deep-sea activities no investigations would be possible, but arrangements to place an observer on board a steam trawler could be made. However, as mobility increases so will information and the opportunity for study.

MISCELLANEOUS. A check on the occurrence of squid in relation to conditions is all that can be expected in view of their reproduction in distant waters. This again fits into the demand for extending hydrographic investigations. In the miscellaneous fisheries, attention should be directed to the best possible processing of what is available. Development is bound up with the general development along the lines previously indicated. Products capable of development from marine materials include glue, leather, anti-anaemic extract from livers, as well as many others. For example, quite recently it has been shown that the oil from the entrails of halibut is richer in vitamin than the liver oil. Continued efforts at getting new products and new uses for materials are desirable in view of the immense effect upon the financial return now available. The certification of oil products, the maintenance of uniformity of quality and the provision of technical advice are imperative, and these requirements have all been included in the recommendations of the Committee referred to above.

INLAND FISHERIES. Trout and eels are abundant in the ponds and rivers of Newfoundland. The possible development of a greater local consumption of trout is worth considering. In the case of eels, there must be a potential export industry. The increasing tourist trade may mean increased catching of trout, and in any case, stocks should not only be maintained but, if possible, increased against possible expanding local and tourist requirements. The study has commenced and should be continued of the life history of trout in the inland waters of Newfoundland. The effects of restocking should be studied by the establishment of test ponds where systematic investigations can be made. Fertilization of ponds with food material, the optimum feeding of fry, the correct season for planting fry or fingerling, the optimum number of fry or fingerling to be planted per acre of surface and in relation to available food, are only a few of the practical problems requiring attention.

STATISTICS. No reference to requirements would be complete without attention being specially called to the urgent necessity for maintaining statistical records of fishing activities and catches. Vague surmises as to whether or not the numbers of any one species caught per unit fishing effort are increasing or decreasing, are insufficient. Only upon more exact information can conclusions be based. Export figures are not enough for the purpose, since so many intervening factors such as home consumption and loss from deterioration may alter the facts considerably. Furthermore, export figures fail to supply the vital local variations such as are given in catch statistics.

—N. L. Macpherson.

II. THE REPORT

A GENERAL REPORT

During the winter of 1936-37 the Laboratory premises at Bay Bulls were closed and the scientific staff were accommodated in the Government Analyst's Laboratory in St. John's. This was an experimental procedure designed to avoid the isolation at Bay Bulls during the winter months, to lessen costs by cutting out the heavy heating expenditure, and to bring the staff into more direct touch with trade interests during the winter. Continuing the policy carried out during the previous winter when members of the staff visited other institutions extending their work and studying methods, one member of the staff spent some time at Woods Hole Oceanographic Institution familiarising herself with the methods employed by that Institute. This visit indicates the importance attached to the study of the physical and chemical oceanographic conditions in the area. During the winter also, routine consultative services such as examination of cod liver oil samples were maintained, and the Laboratory again produced a quantity of Cod Liver Oil with Malt Extract which was available to the trade. This production was undertaken to utilise the raw materials taken over from the commercial firm which discontinued its production programme of the previous year. A note on these production experiments is given below amongst the individual reports of the members of the staff.

Opportunity was taken of the presence during the winter months of the refrigerated bait supply vessel, M.V. "Malakoff" at Rose Blanche on the South-west Coast to station on board that vessel an observer from the Laboratory. A record of conditions in that area at the season was kept for the first time. Efforts to tag codfish in the area did not prove very successful owing to continued frosty weather during which it was impossible to assure the survival of the tagged fish. During normal conditions, however, a sufficient number of mild days should intervene to allow of tagging work. The coast in question offers great possibilities as a base of operations for future developments. The area is ice-free for the greater part of the winter; it is the centre of a winter fishery; it has an inshore summer fishery, and is reasonably near for bank fleet operations. Mention must also be made of the desirable fusion of interests of investigational activities with other services. The M.V. "Malakoff" served a triple purpose, as a bait supply vessel, as a fishery protection vessel, and as a floating base for scientific investigations.

The re-occupation of the Bay Bulls premises by the staff had been arranged in mid-April when the disastrous fire occurred which completely destroyed the Laboratory. This severe loss, including practically all equipment, upset plans completely and necessitated a review of the programme for the season. The staff remained at the Analytical Laboratory, St. John's, and first efforts were directed towards maintaining existing services. Orders were despatched for necessary equipment and chemicals, and so far as routine salt and oil analyses were concerned little interruption was experienced. A note of the extent of this work is included below. Certification of the Vitamin A content of oils was maintained, and in the case of Vitamin D arrangements were made for assays to be done by a Laboratory in New York. Furthermore, a programme of work was arranged in order to ensure some degree of continuity in the work of the staff.

Compilation of fundamental data concerning salting and drying of fish was continued, albeit with considerable inconvenience through lack of appartus and space to the member of the staff concerned. However, interesting observations are being made, and it is hoped to be able to tackle the problem of artificial drying on a more detailed scale. Plans for experimental procedure have been made and will be followed up as soon as circumstances permit. It has been asserted time and again that every outport should have its artificial dryer to ensure controlled drying of fish without dependance on weather conditions. The technical aspects of this conception will soon be realised, and the economic aspects may then be tackled by the interests concerned. A considerable annual loss occurs because of claims against shipments of salt codfish. The fish is shipped in apparently good condition, but in transit deterioration of quality takes place. This problem of adequate storage of salt codfish is an outstanding one, the solution of which would contribute considerably to increased gross receipts to the salt codfish trade. With this in mind, investigation of the effects of humidity and temperature on keeping qualities is being made. In due course, when optimum storage conditions for different cures are known, it is hoped to check the actual conditions prevailing in the ship's hold during transoceanic shipment. Ultimately it will be possible to rectify any deficiency in these storage conditions by suitably controlling them in the hold of the vessels.

The preparation for routine examination of cod and haddock data collected during 1935 was in hand, but all the material was destroyed in the fire. Later continuation of fish tagging offered scope for active field employment during a time when apparatus was limited, and this was done. Fortunately records of previous tagging are intact and recaptures have been attended to in routine fashion. In Trinity Bay and at Bay Bulls quite a number of cod have been tagged, and further work is on hand in the area between Quirpon and Heart's Desire. No tagging has been undertaken in this area before, and recaptures from this area of fish tagged in Labrador indicate interesting possibilities. Wherever possible, records of temperature have been taken, but only one reversing thermometer has been available to date. Such temperatures as have been taken at inshore points reveal a phenomenal increase of temperatures above anything hitherto experienced. For example, at Bay Bulls at fifteen fathoms or approximately 27 metres a temperature of 52°F. was recorded on the 16th August, and at Rencontre West at eight fathoms or approximately 14 metres a temperature of 54°F. on August 17th. Records are incomplete because of absence of apparatus, and consequently sampling has been sketchy, but there is sufficient evidence to justify the assertion that a considerable decrease in the volume of Arctic water has taken place. The records of the ice patrol boat "General Greene" were again kindly placed at our disposal, and they reveal the prevalence of warm temperatures on the eastern edge of the Grand Banks in the spring months. The small returns in the inshore fishery are probably attributable to the prevailing warm water conditions which have driven the codfish to deeper and colder offshore waters. Furthermore, considerable temperature fluctuation at depths occurred. Once more the importance of the influence of physical conditions on the abundance of species is revealed. In order to give fishermen a guidance, the causes of the periodic variation in the pulse (to use the expression of Professor E. W. MacBride) of the cold Arctic current and of the warm Gulf Streams must be solved. An intensification of physical and chemical investigation of oceanographic conditions is desirable. A regular methodical cross-sectional examination of the Labrador current from season to season and year to year must be made. The salt content, an indicator of the type of water prevailing, and in particular the phosphate content, of the waters must be taken as well as a routine check made of the quantitative occurrence of cold and warm water planktonic forms. New factors likely to prove of value for purposes of correlation should be closely watched for. It is now suggested that the cross-section may most conveniently be cut by making a triangular voyage. Starting at approximately Lat. 49°N., Long. 53°W., thence by the great circle to approximately Lat. 50°N., Long. 48°W., in order to sample the main current, the sampling should be continued on the eastern leg of the current to the tip of the Grand Banks at Lat. 47°N., Long. 50°W. By returning to Lat. 49°N., Long. 53°W. the triangle will be completed with a cross-section of the western leg. That there is a division of the current into two branches is evident from the contour of the sea bottom. Cross-sections must be taken to ensure representative sampling and unless that is done much of the data will be useless. In connection with the hydrographic data of the past, there is given below for purposes of record a synopsis of conditions in the area for the years 1931 to 1935 inclusive.

For some time past considerable interest has been evidenced amongst Canadian fishery authorities in the increase of offshore drift netting for salmon in the Port aux Basques area. Salmon anglers of the rivers of New Brunswick and Quebec fear a depletion of salmon stocks in the rivers, and this new development might cause further depletion if these selmon migrate to the Maritime rivers. Last year Dr. David L. Belding, Boston University School of Medicine, collected data of physical characteristics from the various areas in an effort to establish the possible identity of stocks in areas of the Gulf of St. Lawrence. No convincing proof of identity could be obtained and a programme of intensive tagging was suggested in order to establish migrations. An extensive programme was considered necessary, and a Commission of three was appointed by the Quebec Provincial Government in collaboration with Anglers Associations and the Canadian Federal authorities. A sum of $1,500 was voted for tagging in the Newfoundland area, provided the Newfoundland authorities co-operated. Dr. Belding visited Newfoundland to discuss the matter and co-operation was gladly given. Under the co-operative programme a member of the staff of the Laboratory took charge of tagging operations. It was thought that the tagging of salmon taken from drift nets might be impossible, but this proved no obstacle, justifying the prediction made by Dr. Belding. During the months of May and June 600 salmon were successfully tagged. Recaptures of extraordinary interest are being made. At the same time, scale samples and measurements were obtained of the off-shore and inshore runs of fish, and a renewed programme of data collection from individual rivers was begun. One member of the staff indicates below the programme of work on the specialised investigation of individual rivers which is now necessary after the general work of previous years.

No special work has been undertaken in connection with cod liver oil. A fifty page booklet on Newfoundland cod liver oil is now being printed and various aspects of the industry are discussed in detail. A paragraph is devoted to a discussion of future requirements and the results of previous investigations are recorded. The collected information should prove of value as a starting point for future investigations, for which there is still much room. A discussion of the age potency theory is included. Some samples of oil are now being taken for further assay of Vitamin D, since it is felt more extensive data is required. In the future chicken assays will be resumed, because the trend of the cod liver oil industry shows a big increase in world consumption of poultry oil. The necessity for the maintenance of a routine vitamin assay service has been demonstrated forcibly as a result of the suspension of the Vitamin D assay. Vitamin A certification is, of course, being maintained. It is becoming more necessary each year to supply certificates of vitamin content in order to effect sales. In connection with the industry the Newfoundland Fisheries Board has been assisted with the reframing of the rules governing production and export of oil. The importance of tanking large quantities to improve the uniformity of quality being exported has been recognised in the new rules under consideration and minimum quantities for which vitamin certificates will be given are laid down. Stringent rules have been drawn up covering the taking of samples for assay from the tanked bulk quantities and demanding the sealing of tanks after sampling. The reason, of course, for these regulations is to ensure that the oil shipped is none other than the oil certified.

During the past year the work on plankton material previously collected has been continued. Reference is made below to the losses sustained in the fire and there is recorded a list of identifications made. Publications already made and in the course of preparation are set forth. In the general confusion that has been caused it is considered advisable to define the present position. In the absence of facilities during 1936 no collections were, of course, possible, and this also applies to the spring of 1937.

The inland trout fisheries of Newfoundland are now being systematically studied. Claims are made from time to time that trout fishing is excessive, with consequent decrease in stocks, and various legislative measures have been suggested on such lines as limiting the catch per rod per day, setting a minimum size limit for fish which can legally be taken, and restricting the season of fishing. The fundamental facts concerning the natural history of trout in this area must be established before any intelligent recommendations can be made and the accumulating of such facts is now receiving attention. Some of the problems involved are discussed below by the member of the staff engaged on the work. Stress must be laid on the necessity for conducting observations in "test" ponds, about which all available data can and must be obtained. Statistical records of the yield from the pond and the effects of restocking on the age composition of the stocks as time goes on are to be kept, and this work is planned to include a study of both Native (**Salvelinus fontinalis**) and Rainbow Trout (**Salmo irideus**).

—N. L. Macpherson.

B. HYDROGRAPHIC AND BIOLOGICAL INVESTIGATIONS

(1). FURTHER PLANKTON INVESTIGATIONS

During the five-year period of 1931 to 1935 a considerable amount of plankton material was collected and but little data regarding its constituents has been included in the Annual Reports. When in the fall of 1935 the working-up of the material was contemplated it was evident that the limited library facilities would make a visit to another institution imperative. This visit was arranged, and the work was undertaken at the Marine Biological

Laboratory, Plymouth, England, during the first four months of 1936. The publication of October, 1936, **"Faunistic Series, No. 1, (1) Amphipoda from Newfoundland Waters, with a Description of a New Species, (2) Decapod Larvae from Newfoundland Waters,"** is the result of the work at Plymouth. At Plymouth also identifications were obtained for some of our common marine forms—medusae, copepods, isopods, etc.—but further study on these groups, contemplated before publication, is now impossible owing to the loss of all collections in the fire. As a matter of record only identifications are now given. For the identification of the medusae I am indebted to Dr. F. S. Russell and to Mr. W. J. Rees of the Marine Biological Laboratory, Plymouth, and for the copepods to Dr. J. L. Tremblay of the Station Biologique du St. Laurent.

Medusae.

Leuckartiara nobilis, Hartlaub.
Halitholus cirratus, Hartlaub.
Euyphysa flammea (Linko).
Sarsia princeps (Haeckel).
Sarcia tubulosa (M. Sars).
Hybocodon prolifer, L. Agassiz. (**prolifer** tentative).
Tiaropsis multicirrata (M. Sars).
Aglantha digitalis, O. Fabr.
Periphylla hyacinthina, Steenstrup.
(One specimen from Straits of Belle Isle).
Bougainvillia superciliaris, L. Agassiz.
Staurophora mertensii, Brandt.
Obelia, sp.
Lucernaria quadricornis, Muller.
Halimocyathus platypus, Clark. (**platypus** tentative).

Copepods.

Metridia longa, Lubbock.
Calanus hyperboreus, Kroyer.
Anomalocera patersoni, Templeton.
Euchaeta norvegica, Boeck.
Calanus finmarchicus, Gunner.

Pareuchaeta norvegica, Boeck.

Centropages typicus, Kroyer.

Euchirella rostrata, Claus.

Parasitic Copepods.

Nogagus borealis (parasitic on shark).

Orthagoriscicola muricatus, (Kroyer). (Parasitic on Sunfish.)

Isopods.

Aega psora (Linne).

Ostracods.

Halocypris globosa, Claus.

During the year an analysis of the Hjort net collections of the year 1935 was made to determine the possible use of **Ceratium** as an indicator of water conditions, the completed work covering the five-year period, 1931-35. As a result, a paper entitled, **"The Genus Ceratium and its Use as an Indicator of Hydrographic Conditions in Newfoundland Waters"** is now completed. Briefly this paper shows that the six species of this genus (**C. arcticum, C. longipes, C. fusus, C. tripos, C. macroceros,** and **C. lineatum**) commonly encountered in Newfoundland waters, form a closely allied series which may be of great use as indicators of general hydrographic conditions from year to year. The data are based upon an analysis of standard Hjort net collections made at some eighty stations during each spring and fall research cruise, from fall 1931 to fall 1935. A series of charts is given to illustrate the annual distribution of each species and a comparison is made with the hydrographic conditions pertaining over the same five-year period.

The annual distribution of the eggs and larvae of our common edible fish has also been determined from their occurrence in the plankton tow samples. Although this study is necessarily incomplete, the data which covers a five-year period is of undoubted value and almost ready for publication. The paper is illustrated by numerous charts and includes also information on the distribution and quantities available of commercial fish other than cod and haddock, as derived from trawling records.

—N. Frost.

(2) HYDROGRAPHIC CONDITIONS IN THE NEWFOUNDLAND AREA FOR THE YEARS 1931, 1932, 1933, 1934, 1935.

This summary of the temperature and salinity distribution in the Newfoundland area from the autumn of 1931 to the autumn of 1935 inclusive is based on data obtained during the cruises of the "Cape Agulhas", as described in previous Annual Reports.

1931. From the 1931 data, which was very limited in comparison with that for similar periods of the years following, it would appear that 1931 had been a fairly warm year compared with 1932 especially in the surface waters, though the subsurface waters were comparatively cold. At 100 metres on the east coast there was evidence of water from the Labrador sea fairly near the coast, and this was present, to a greater or less degree, throughout the period. Low temeperatures also in the Straits of Belle Isle indicated the presence of that branch of the Labrador Current.

1932. In the spring of 1932, judging by the temperatures and salinites in the east and over the Grand Banks, the Labrador current was flowing strongly, causing sub-zero temperatures to predominate over the whole area except on the southern slope of the banks, where warmer, slope (33.5—35°/oo) water appeared. By the fall, Arctic water was still running down from the north, and though the surface layers were considerably warmer, conditions from 50 metres down were much as in the spring. Slightly warmer and more saline conditions in the south-west, however, gave indications of an increased influx of Atlantic water from the south.

1933. The effect of the large influx of Arctic water from 1932 was still apparent in 1933 in the intermediate water layers over the banks, but temperatures otherwise were much as in the spring of 1932. Temperature and salinity distribution indicated that, though Arctic water was entering the Straits of Belle Isle, it was not nearly as prevalent on the east coast as it had been the year before. The slight warming apparent on the southern edge of Grand Bank in the fall of 1932 over the conditions prevailing in the spring, was maintained in the spring of 1933, in the lower layers, and at those depths was spreading over the banks. Warmer conditions prevailed also in the south and south-west regions. The outstanding feature of the fall of this year was the extension of warm southerly water up the west coast of Newfoundland and out through the Straits of Belle Isle, causing unusually high temperatures on the north coast at all depths down to 100 metres. While the temperature of the surface waters was generally somewhat below that of the previous fall, at depths below fifty metres warmer conditions prevailed, and the temperature of the slope water on the southern slope of the banks continued its steady rise.

1934. During the spring of 1934 the warmest spring surface temperatures for the period were experienced, and for the first time slope water was found at 50 metres on the southern slope of the banks, while at greater depths its extent was greatly increased over the previous years, and true Atlantic water was present at 100 metres for the only time during the period of study. At intermediate depths cold water flooded into the Straits of Belle Isle and could be traced as far south as Cape Breton, Nova Scotia, while on the south-east section it was pressed in close to the land. By the fall the area, through mixing, had recovered to a great extent from the warm spring conditions, and temperatures and salinities were much as they had been in the previous years. On the south coast, however, insufficient mixing had taken place and that section of the coast was still surrounded with cold water, while in the east temperatures and salinities pointed to a renewed increase of Actic water inshore. On the southern slope of the banks the slope water slackened somewhat with a slight drop in temperature.

1935. From the extent of coastal water and the distribution of temperature in the spring of 1935 it would appear that inshore there was an increase of cold water from the north, though the cold influx running into the Straits of Belle Isle had decreased very markedly in relation to its intensity in 1934. Furthermore, the definite branches round Grand Bank were not so marked. Cold water from the previous year was still present in the south-west region and prevented the warm offshore water from reaching the coast. In the south the extent and temperature of the slope water was much as it had been in the fall of 1934. By the fall sufficient mixing had taken place in the west to produce more uniform temperature distribution, very little cold water having entered the Straits of Belle Isle. In the east, although temperatures indicated that the Labrador current was running fairly strongly, it had not flooded the Grand Bank. The slope water on the southern edge of the banks was still on the wane, its temperature having dropped slightly but consistently since the spring of 1934. It had, however, made an incursion over the eastern edge of Grand Bank, where it moved well inside the 50-fathom line. This was the only time during the five years that this had occurred.

—A. M. Wilson.

(3) FRESHWATER INVESTIGATIONS.

(a). Biological Investigations at Murray's Pond.

Previous to 1936 no freshwater work had been done other than a few plankton tows in scattered localities. In the summer of 1936, however, on Gull Pond, near Bay Bulls, some preliminary work was attempted including a series of plankton tows and a detailed examination of many mud trout. The results were sufficient to indicate the problems involved with regard to food, growth-rate, breeding seasons and parasites. After the fire the reorganisation of work permitted an opportunity to specialise on the problem of trout.

The ultimate aims of these trout investigations are:—

1. To gain a knowledge of the life history of the trout on which to base suitable fishing regulations.
2. To determine the type of pond and of food best suited to the propagation and growth.
3. To study the economy of present hatchery methods and the re-stocking of ponds.

By arrangement with the private club at Murray's Pond, Murray's and Butler's Ponds were selected for this investigation. Situated about 7 miles from St. John's and very easy of access, the ponds contain both mud trout (**Salvelinus fontinalis**) and rainbow trout (**Salmo irideus**). In addition they are comparatively small, surrounded by woods and connected by a small stream along which are a series of spawning pools. A hatchery, used for rainbow fry, is fed from the outlet stream of Murray's Pond. A portion of the outlet arm (about 70 feet by 30 feet) had previously been screened off and very little additional work was required to prepare it as a fry pond for experimental purposes.

To date the work undertaken has followed this programme:—

1. Weekly plankton tows on Murray's and Butler's Ponds.
2. Sampling of bottom food available.
3. Examination of stomach contents.
4. Scaling and measuring of fish.
5. Examination of fish for external and internal parasites.

Items 3 to 5 have not been confined to speciments from Murray's and Butler's Ponds but many, chiefly mud trout, from a variety of districts have been brought into the Laboratory by interested anglers.

Two contrasting experiments were begun with rainbow fry:

(1) 750 fry were placed in the small fry pond at Murray's Pond Club to test their survival rate, the factor of cannibalism by adult fish having been eliminated.

(2) Approximately 130 fry per acre were introduced into Bay Bulls Long Pond, this Pond having first been screened. Long Pond already contains mud trout and possibly some land-locked salmon, so that the experiment in survival rate is very different from that attempted on a small scale at Murray's Pond.

Heretofore the economy of stocking a pond with rainbow fry has never been considered, so that such experiments would seem to be a necessary part of this work. Later it may be possible to compare the expense and results of stocking with rainbow fry with those of stocking with mud trout.

—N. Frost.

(b). Hydrographical Investigations at Murray's Pond.

A study of the physical and chemical conditions in the water is an essential accompaniment to the work on trout. Murray's and Butler's Ponds are considered to be typical of the trout ponds in the vicinity of St. John's, and a continuous survey of these ponds throughout the season was undertaken. Discussions of methods and possible factors of importance with members of the staff of Woods Hole Oceanographic Institute during the winter of 1936-37 helped greatly in deciding a programme of work for this phase of freshwater investigations. A series of determinations of the temperature, hydrogen ion, dissolved oxygen, and phosphate contents of the water throughout the season was therefore planned in order to furnish adequate data for the study of the life histories of trout.

Temperature readings were begun as soon as the pond was free from ice. Destruction of the Laboratory by fire caused delay in the procuring of the necessary chemicals and apparatus for the hydrogen ion and dissolved oxygen determinations, and these, therefore, were only begun in July. Up to date it has not been found possible to begin the phosphate tests, but useful data has been collected and work will be continued until winter conditions necessitate discontinuation for the season.

—A. M. Wilson.

(4) SALMON INVESTIGATIONS ON THE SALMONIER RIVER

The fifth Annual Report records that a survey of the salmon stocks was made and sufficient material collected to complete a broad classification of the salmon of the Newfoundland area. This broad classification serves as a background for a more specialised investigation of individual rivers. Until recent years very little work had been done on the freshwater life of salmon, but this stage of the life history is particularly important because the supply of salmon depends ultimately on the factors governing early life in the river. During 1936 Dr. Belding investigated six rivers of the west coast of Newfoundland, paying particular attention to the study of parr. Investigations made by Dr. Belding had a three-fold purpose:—

(1) To supplement work already done on the adult salmon of the West Coast and to verify the river ages and lengths of the parr, as calculated by the scale readings of the adult salmon.

(2) To compare the age, growth and characteristics of the parr of the several rivers in respect to river environment.

(3) To compare the growth of Newfoundland parr with parr of the Canadian rivers of the Gulf of St. Lawrence.

An investigation of the Salmonier River, St. Mary's Bay, has now been undertaken, having as its immediate objects the following general purposes:—

1. To compare the parr of this river with those of the West Coast rivers.

2. To correlate sea life data with river life data.

3. To determine the relationship, if any, between the duration of river life and the duration of subsequent sea life.

Over a period of time collected information will supply answers to the more general questions of the approximate stocks of salmon in this area, of the practicability of salmon net mesh regulations for this and similar areas, and of the extent of conservation necessary.

Detailed information from the area is being collected from as many sources as possible, and river wardens are supplied with equipment for measuring, weighing, and taking scale samples of any material available to them in the course of their regular patrol duties. Regular weekly visits are made to the three wardens and information obtained concerning river conditions, approximate numbers of fish in pools, number of rods fishing, and number of fish caught. Arrangements are also made for the warden at Pinsent's Falls to record daily temperatures and water heights in that section of the river. On these weekly trips 250 parr have been caught by angling with very fine gear. The parr have been scaled, measured, weighed, sexed, and preserved in formalin for future work, including an examination of stomach contents and vertebral counts. The collection of data on the growth of parr, on the smolt age, on the return of the grilse, and on the percentage of spawners and repeated spawners with particular reference to the size of the fish, will continue, and it is proposd to include in the programme a study of the hydrographic conditions of the river and the location of spawning beds, and of the practical feasibility of installing a counting fence.

—A. R. Johnston.

(5) NOTE ON COD TAGGING.

Since the account of cod tagging given in the previous Report considerable returns have come to hand. A complete record of the

1936 returns was made but was lost in the fire. Fortunately, however, copies are in existence and can be recovered, but in their absence it is not possible to bring the results up to date. Records of actual tagging are fortunately intact. Returns of interest include one from Rose Blanche in April, 1937, of a cod tagged in July, 1934, at Anse Eclair, Straits of Belle Isle, and another from Joe Batt's Arm in June, 1937, which was tagged at White Islands, Labrador, in September, 1934. On the banks a cod tagged at St. Pierre Bank in July, 1935, was recaptured on the south edge of Grand Bank, August, 1936. This would seem to be a long migration for one year in this area, but the longest of all is a return from Lat. 43° 19'N., Long. 61° 56'W., i.e., well to the south-west of Sable Island, of a cod tagged at Fortune three years previously (in 1934).

—B. G. Blackwood.

(6) EDUCATIONAL ACTIVITIES.

Three weeks of the summer of 1935 and ten days of 1936 were spent in educational work in various outports where Summer Schools were being conducted. The time was spent in a brief study of common sea-shore animals and their life histories, the purpose being an attempt to arouse interest in those things upon which the livelihood of the community depends. Several evening lectures on natural history, illustrated with lantern slides, were given and were largely attended. During the five weeks from July 6th to August 6th, 1937, the writer was placed in charge of the zoological part of the Nature Study Course at the Teachers' Summer School held at the Memorial College, St. John's. Nature Study was one of the nine courses, four of which were compulsory for all students.

In a country whose main industry is fishing, a course of lectures stressing particularly the life in the sea, can be most profitable to teachers whose field of work lies chiefly in fishing communities. The course was arranged with this idea in view and covered such topics as the following:—

1. The evolution of the animal kingdom from the lowest to the highest groups, as illustrated by the common animals of the sea-shore.

2. Adaptation to environment as seen in our common sea animals.

3. The interdependence of all life, as exemplified in the food chain of the cod.

4. The life histories of our common fish, such as cod, haddock, dab, herring, smelt, caplin, mackerel, launce, salmon, trout, eel, etc.

5. The elements of oceanography and fishery research, including fish tagging, the use of deep-sea and reversing thermometers, the purpose of drift bottles, etc.

6. The identification of common birds, insects, and freshwater life.

Practical work paralleled the lectures and included organised field trips, microscopic examination of fish scales, of fish eggs and of living plankton.

More than 150 student teachers completed the course and the discussions, particularly in those lectures dealing with fish, **indicated that much more educational work is required.** One actual example will serve to show the urgent necessity for educational work. Few knew the difference between a young salmon and a trout, and one instance was cited of a river which as far as possible had been cleared of all so-called "salmon peel". These fish, not supplying the same degree of sport as trout, were considered a nuisance. No one had known that they were young salmon, and therefore held the future of the salmon fishery in that region.

—N. Frost.

C. TECHNICAL INVESTIGATIONS AND SERVICES.

(1) SALT COD INVESTIGATIONS.

The previous work of the Laboratory in this field has been published in bulletin form (1). This bulletin consists of an examination of the methods of salting and drying employed in Newfoundland for the production of various types of cures. It includes a discussion of the principles involved in the preservation of fish by salting and drying, and a discussion of the principles of evaporation and their application to the problem of fish drying. A method was described for the operation of a fish drier on the principle that the best means of drying fish artificially is to reproduce good outdoor drying conditions as closely as possible. In June, 1936, plans were approved for the continuation of this work on a more detailed experimental scale than had been attempted before. These plans were designed especially for the quantitative study of the various factors which act during the processing of dried, salted cod. Owing to the absence of suitable scientific data upon which to plan the details of certain phases of this work some preliminary experimentation was necessary for only by this method of approach could the information desired be obtained and methods developed which were most suited for attacking the problems. In spite of the succession of setbacks which have been experienced, such as delay in obtaining suitable supplies and equipment, lack of raw materials with which to work, and finally, loss of equipment in the fire, much of this preliminary information has been obtained. Had suitable space and equipment been available this phase of the work would undoubtedly have been completed. For the purpose of this report it is intended only to revise the work which has been done to date. More detailed publications will appear in due course.

(a) **The Salting of Codfish.**

It is desired to establish the mechanism of the salting process using pure salt and, following upon this, to study quantitatively the effect upon this mechanism of the various impurities which occur in commercial salts. Experiments have been performed to determine the effect of variation in the amount of salt used and of the temperature and humidity conditions under which the salting process is carried out.

Macpherson (1) has calculated that the amounts of salt used in practice to produce "light" and "heavy" salted fish are respectively 20 and 30 lbs. per 100 lbs. of dressed green fish. Using analyses for the salt and water contents as criteria, it has been found that when pure salt is used, these quantities yield exactly the same result. From the curve given in Fig. 1 it is seen that in both cases the salt "strikes through" in just about 8 days and the water and salt contents after this period remain constant at about 54.0% and 17.0% respectively. By making appropriate calculations from Macpherson's figures, the corresponding values for "light" salted fish are found to be 70% and 5.9%, and for "heavy" salted 57% and 14.7%. It is evident that to reproduce the articles of the trade with pure salt requires quantities less than 20 lbs. per 100 lbs. of dressed

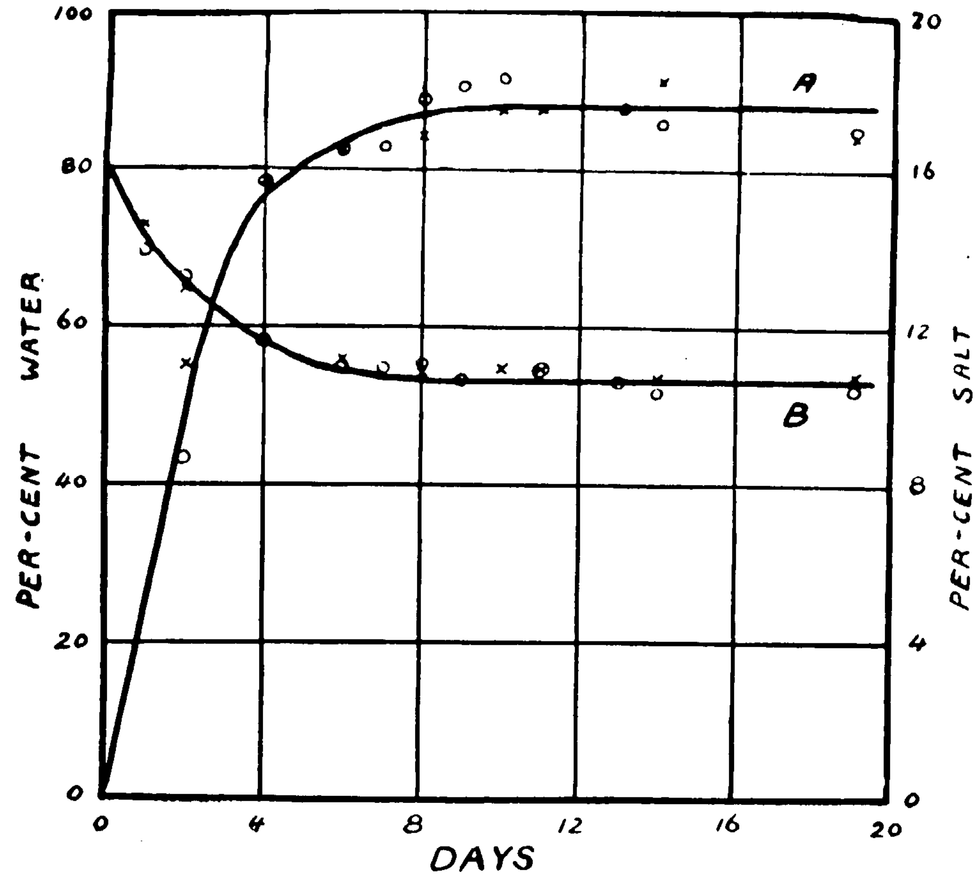

Fig. 1. Dehydration and Salt Penetration Curves.

A—Salt Penetration Curve.
B—Dehydration Curve.

O—Using 20 lbs. salt per 100 lbs. green fish
X—Using 30 lbs. Salt per 100 lbs. green fish

green fish. It is necessary to record, however, that the cod tissue used was from inshore Newfoundland codfish.

Investigation of the effects of temperature and humidity indicates that, for the purposes of the present work at any rate, the latter is the more important. Temperatures between 40° and 80°F. are found to have relatively little effect on the final equilibrium with respect to the water and salt content of the salted fish. Humidity, on the other hand, exerts a marked effect which is not surprising in view of the hygroscopic nature of salted fish muscle. In future work some measure of control will have to be exerted over this factor.

(b) The Drying of Salted Codfish.

The process of drying fish which have been salted forms perhaps the most important, and, at the same time, the most difficult and uncertain stage in the production of salted codfish. The uncertainties of the process as carried out at present are due to the fact that, almost invariably the drying is carried on outdoors by rule-of-thumb methods so that no control can be maintained over the variables which influence the drying mechanism. These variables are temperature, humidity and wind velocity. For the drying of many materials such as lumber, paper and textiles, the optimum conditions have been worked out and driers which are entirely automatic in operation are on the market. In the case of the drying of salted tissue, on the other hand, information concerning the mechanism of the process is at best very sporadic. It is purposed, therefore, to try to obtain this information by undertaking a detailed study of the whole process and thus to settle the question of whether or not the use of artificial drying in the salt codfish industry is feasible. Progress in this particular field is, however, attendant upon the availability of an experimental drier in which any combination of temperature, humidity and wind velocity can be maintained constant, over a fairly wide range and irrespective of outdoor weather conditions. Plans for such a drier have been practically completed and it had been decided to proceed with construction and trial. The loss of the Laboratory precluded any such move however. Some preliminary experiments had been carried out at the Torry Research Station, Aberdeen, but these results were lost in the fire.

(c) The Storage of Dried, Salted Codfish.

In the study of the effect of conditions of storage on the dried, salted product, particular attention is being paid at the moment to the effect of humidity. The preliminary experiments have been nearly completed and, at present, the relation between the humidity of the air in the storage chamber and the moisture content of the fish (hygroscopic moisture content) is being studied. For this purpose it has been necessary to design and construct a special chamber in which the temperature and the humidity can be maintained constant at almost any desired values. The following figures for heavily salted fish may be taken as indicative of the results being obtained:—

Temperature.	Relative Humidity.	Moisture Content of Fish.
79°F.	83%	54.3%
79°F.	73	29.7
79°F.	57	11.5

An examination of these figures (Fig. 2) shows that in order to maintain the moisture content of the product at a constant level of about 47%, corresponding to heavily salted fish, it is necessary to maintain the relative humidity at about 81%. Also it is found that, in the region of 47% moisture content, a difference of about 5% in the relative humidity will produce a difference of about 10% in the moisture content.

It is interesting to mention the changes in the appearances of the product during storage under various conditions. All the samples which dried out as a result of storage at humidities less than 80% appeared crumby and yellowish-brown in colour. The samples stored above 80% relative humidity soon became soggy, and in the case of some samples stored at about 93% relative humidity, decomposition had been so rapid that the samples became putrid in about two weeks. The study of the rate of decomposition of the finished product under various conditions of temperature and humidity will be the subject of future investigations.

—W. F. Hampton.

(1) Macpherson. N.L. "The Dried Codfish Industry", St. John's, 1935.

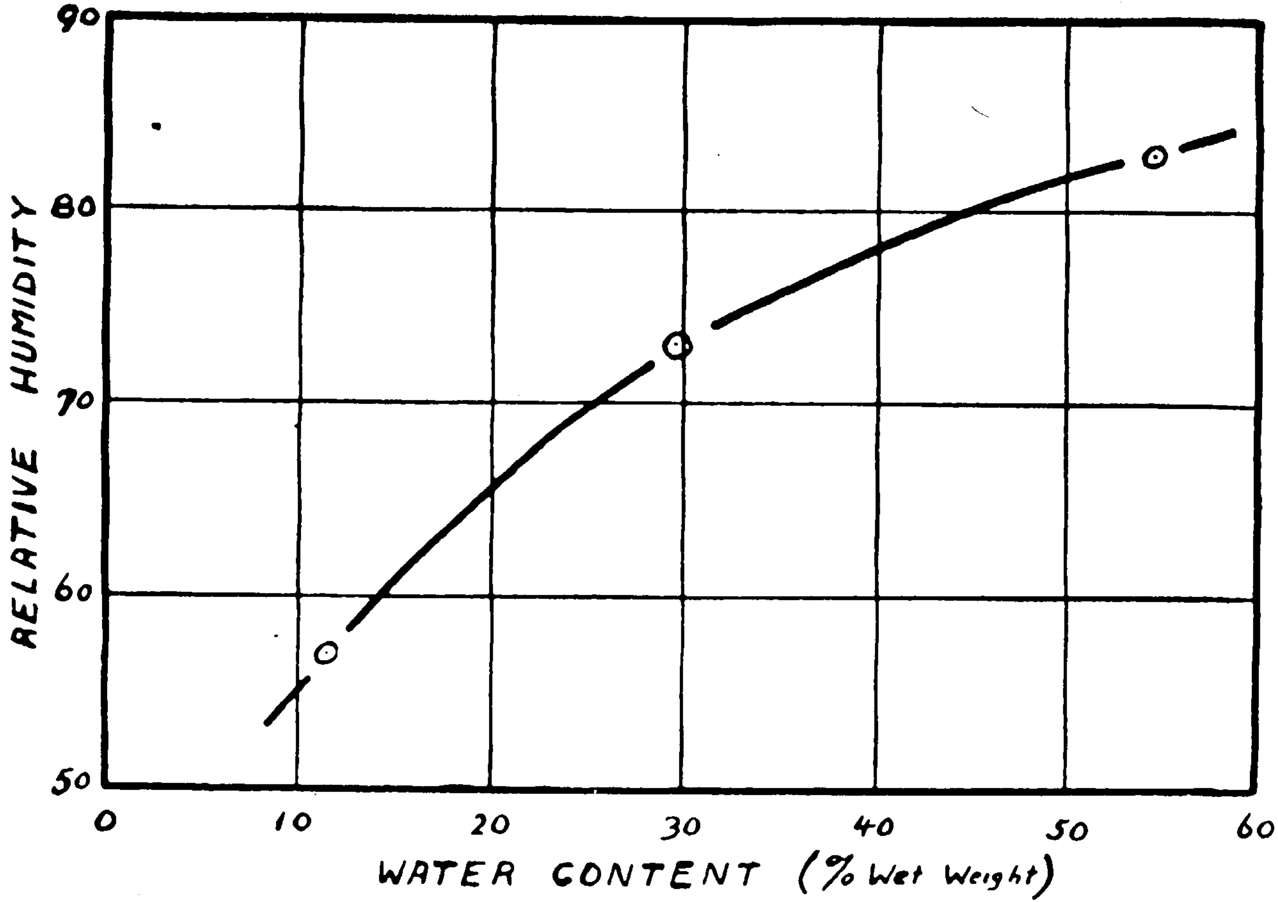

Fig. 2. Effect of Humidity on Water Content of Heavily Salted Codfish.

(2) SOME CALCULATIONS RELATIVE TO THE SALTING AND DRYING OF CODFISH.

When fish are salted in bulk, i.e., kench salted, the pickle drains away. It is frequently found too, especially with the "heavy" salted type of cure, that a considerable residue of salt is left on the fish after the salting stage has been completed. From the figures which have been given by Macpherson (1) it is interesting to calculate the amounts of salt and water in the fish at the end of the salting stage and again at the end of the drying stage, and to deduce from these calculations how much salt is lost during the processing and where it goes. It is to be remembered that these calculations are subject to the reservations mentioned by Macpherson.

Shore Cure.

Considering shore cure, the available data are given in Table 1, all figures being given as per cent. of the wet weight. It is seen that the fresh muscle contains 81% water and, by difference, 19% protein. At the end of the salt bulk stage the water content is 70% while in the product it is 41%. The amount of salt in the product averages 11.8%. Also, according to Macpherson (1, p. 40) 249 lbs. of dressed green fish give 196.6 lbs. of salt bulk, and in turn, 100 lbs. of product.

TABLE 1.

	Fresh Fish Dressed.	At end of Salt Bulk Stage	Finished Product.
Water	81	70	41
Salt	—	—	11.8
Protein	19	—	47.2

Commencing with 100 lbs. of dressed green fish and making use of the above data to make the appropriate calculations, the results given in Table 2 are obtained. The method of making the calculations is as follows: 100 lbs. of dressed green fish will give 79 lbs. of salt bulk and 40.2 lbs. of product. Since salt bulk contains 70% water there are 70% of 79 (70/100 x 79) i.e., 55.3 lbs. of water in the fish at the salt bulk stage. Similarly, since the product contains 41% water, then 41% of 40.2, i.e., 16.5 lbs. of water remain with the product. Since we started with 81 lbs. of water, this means that (81—55.3)=25.7 lbs. have been lost during the salting process and a further (55.3—16.5)=38.8 lbs. during the drying. The amount of salt in the fresh muscle is negligble whereas the product contains 11.8% salt. In weight, therefore, the amount of salt in the product will be 11.8% of 40.2, which is 4.7 lbs. Since no salt is lost during the drying process, this must have been the weight of salt in the fish at the end of the salt bulk stage. Expressed as a percentage of the total weight of fish at the salt bulk stage this amounts to 5.9%.

The amount of muscle (protein) lost during the process is negligible. Consequently for the purposes of the calculations it is taken as constant.

TABLE 2.

	Fresh Fish Dressed		At end of Salt Bulk Stage		Finished Product	
	Wt. (lbs.)	%	Wt. (lbs.)	%	Wt. (lbs.)	%
Water	81	81	55.3	70	16.5	41
Salt	—	—	4.7	5.9	4.7	11.8
Protein	19	19	19	24.1	19	47.2
Totals	100	100	79	100	40.2	100
Concentration of salt solution			8.5%		28.5%	
% saturation of salt solution			24		79	

Since the whole process of salting and drying is simply a removal of water and an addition of salt, it is interesting to express the salt in terms of its concentration in the water remaining in the fish. At the salt bulk stage this works out to be 8.5% while in the product it is 28.5%. The latter figure is very interesting. A saturated solution of salt in water contains 36% salt, i.e., 36 parts of salt to 100 parts of water. The figure 28.5 is then, 79% of total saturation assuming the solubility of salt in fish muscle juice is the same as that of salt in water. Investigations at the Fisheries Experimental Station in Halifax (2) have shown that the concentration of a salt solution in muscle juice must be greater than 73% of saturation if spoilage is to be prevented. Evidently in shore cure the salt concentration is just above this danger point. Consequently if the fish are stored in a warm room spoilage may take place fairly readily. At the end of the salt bulk stage the salt concentration is only about 24% of saturation. This indicates why shore cure, after it is removed from salt bulk and washed, cannot be left too long before it is dried. According to the investigations referred to above, about five days is the limit of time for keeping such fish before decomposition sets in. After this it may be very rapid.

From Table 2 it is seen that 100 lbs. of dressed green fish will give 40 lbs. of shore cure, and that about 5 lbs. of salt remain with this amount of product. Assuming 20 lbs. of salt had been used originally (1, p. 40) this means that 15 lbs. or 75% have been lost. Some of this may remain on the fish as solid salt but most of it drains away in the pickle. Assuming that the 26 lbs. of water lost during the salting process consists of saturated pickle, this will carry with it about 9.5 lbs. of salt. Thus of the 15 lbs. of salt lost, about 10 lbs. drain away with the pickle and 5 lbs. may remain on the fish as solid salt.

Labrador Cure.

The calculations for Labrador cure are made in exactly the same way using the data in Table 3 and the fact that 186 lbs. of dressed green fish give 125 lbs. of salt bulk, and in turn, 100 lbs. of product. The results are given in Table 4.

TABLE 3.

	Fresh Fish Dressed.	At end of Salt Bulk Stage.	Finished Product.
Water	81	57	47
Salt	—	—	17.7
Protein	19	—	25.3

TABLE 4.

	Fresh Fish Dressed		At end of Salt Bulk Stage		Finished Product	
	Wt. (lbs.)	%	Wt. (lbs.)	%	Wt. (lbs.)	%
Water	81	81	38.3	57	25.3	47
Salt	—	—	9.5	14.7	9.5	17.7
Protein	19	19	19	28.3	19	25.3
Totals	100	100	67.2	100	53.8	100
Concentration of salt solution			24.8%		37.6%	
% saturation of salt solution			69		100	

It is seen that the salt concentration at the end of the salt bulk stage is just on the danger line. Again, according to the investigations in Halifax, fish salted to such a degree should keep for about three weeks even at higher temperatures before decomposition sets in. In the finished product it is seen that the concentration of salt corresponds to that of a saturated salt solution.

The loss of salt in the production of this cure can be traced as with the shore cure. It is found that, of the 30 lbs: of salt applied originally, 10 lbs. remain with the product, 15 lbs. are lost in the pickle, and 5 lbs. may remain on the fish as solid salt. In this case the percentage salt lost is 66. These results for shore cure and Labrador cure are collected together in Table 5.

TABLE 5.

	Salt applied per 100 lbs. dressed green fish.	Residue on Fish.	Amt. in Product.	Amt. lost in pickle.	Total % Lost
Shore Cure	20 lbs.	5 lbs.	5 lbs.	10 lbs.	75
Labrador Cure	30	5	10	15	66

—W. F. Hampton.

(1) Macpherson, N.L., "The Dried Codfish Industry", St. John's, 1935.
(2) Finn, D.B., Progress Reports, Atlantic Fisheries Experimental Station, No. 18, Note No. 49 (Nov. 1936).

(3) THE EFFECT OF PACKING ON THE WEIGHT OF SALT CONTAINED IN A GIVEN VOLUME.

It is recognised in the fishing industry that the same volume of different fishery salts will not have the same weight, but that due to differences in composition and crystal size the weight of the hogshead measure of salt may vary from about 500 to 600 pounds(1).

No account, however, seems to have been taken of the possible variation in the weight of equal volumes of any one salt due to the degree of packing of the salt, e.g., loosely or tightly. The degree of packing will depend on a number of factors, as, for instance, the way the salt is measured into the container—by shovelling or from a shute whether the salt is allowed to settle by agitation of the container, and so on.

In view, then, of the lack of information on this point, preliminary experiments were carried out for the purpose of detecting any significant variations due to this packing, and obtaining an estimate of its magnitude. Samples of two commercial salts, Cadiz and Torreveija, were obtained, and measurements were made of the weights of these samples when packed to varying degrees of tightness in a container, the volume of which was about one pint. Using average values of thirty weighings of each salt, the weight of one hogshead was computed, assuming the conditions of packing would be the same for the larger volume. The results of these calculations give the following figures:—

	Calculated min. wt. in lbs./hsgd. 1	Calculated max. wt. in lbs./hsgd. 2	Calculated wt./hsgd. Mean of 1 and 2	Av. wt. in lbs./hsgd. (Macpherson)	Variation from Mean.	Percentage variation from mean.
Cadiz	479½	565½	522½	510	±43	±8.2
Torreveija	566	660½	613¼	625	±47¼	±7.7

The total difference may thus be as much as sixteen per cent. It will be noticed that the figures obtained using the small volume container are in fairly close agreement with the trade figures as supplied by Macpherson.

From the foregoing figures it is possible to obtain the average maximum and minimum number of **hogsheads** of salt that might be procurable from one **ton** of salt. If the number of pounds in a ton are divided by the number of pounds in a hogshead, the following figures are obtained:—

	Min. No. of Hsgds./ton.	Max. No. of Hsgds./ton.
Cadiz	4 (3.89)	4½ (4.59)
Torreveija	3 1/3 (3.33)	4 (3.89)

From the above figures, a simple calculation will show that, whereas the purchasing value of salt, based on a unit of weight, may be fixed, the selling value may vary considerably since it is based on a unit of volume.

The original assumption that the results obtained from a one-pint volume can be applied directly to the volume of a hogshead is probably not entirely justified. The actual variation likely to be found with volumes of one hogshead can be determined accurately only by actual experiments with this volume.

Critical examination of trade practice based upon the above figures and considered from the point of view of the amount of salt used in the trade (measured by volume) and the amount necessary to prevent decomposition of fish, have yielded interesting results of a speculative nature. It is hoped to be able to link these results with experiments on the salting and storage of fish. In the meantime the experiments are being continued.

—A. M. Wilson.

(1) Macpherson, N.L., "The Dried Codfish Industry", St. John's, 1935.

(4) REPORT ON TECHNICAL SERVICES.

As has been the policy of the Laboratory for the past few years, the testing of fish oils for the trade was continued through 1936, the tests required being for the most part for cod liver oils, with a small number for halibut, hake, turbot and pilchard oils.

The number of tests done was as follows:—

	Free Patty Acid	Carr-Price Blue Units	International Units of Vit. A.	Saponification Value.
No. of Tests	160	86	116	2

Thus in all three hundred and sixty-four tests were made.

For the first eight months of 1937 the following tests have been made:—

	Free Patty Acid	Carr-Price Blue Units	International Units of Vit. A.	Saponification Value.
No. of Tests	102	10	85	2

The total in this case is one hundred and ninety-nine tests. As usual the majority were for cod liver oil samples, with a small number for samples of halibut, seal and dogfish liver oils. The Vitamin A values of the latter compared very favourably with similar values for this year's cod liver oil samples. On the average the Vitamin A values of cod liver oils tested so far this year are higher by several hundred units than those of 1936, only one 1937 sample being less than 1,000 units of Vitamin A.

During 1936, trouble was experienced with the Vitamin D testing of the cod liver oils, the rat colony failing to react normally to the test. Consideration was given to the possibility of changing the colony over from the "bone-ash" test as previously used, to the "line test", but experiment showed this to be impracticable, a finding which was confirmed by Mr. A. L. Bacharach of the Glaxo Laboratories. Later it was found, on examination, that the rats had become subject to contagious bronchial infection, due to extremely varying conditions of both temperature and humidity in the living quarters of the colony, and it was necessary to destroy it completely.

Other analyses undertaken for the trade by the Laboratory included, during 1936, two samples of fish meal, eleven fishery salts, and one seaweed, and during part of 1937, five fishery salts.

—A. M. Wilson.

(5) NOTES ON COMMERCIAL PRODUCTION EXPERIMENTS-

Mention has been made in the various Annual Reports that smoked fillets of cod and haddock, fresh cod and fresh halibut had been canned successfully. Samples were distributed to Great Britain, Canada, and the U.S.A., as well as locally. Comments were favourable, particularly so in the case of the smoked articles and fresh halibut, but one common complaint was that prices were not commercially satisfactory. The most interesting findings of this experimental production work can be summarised as follows:

(1) White fish can be canned in such a manner as to be acceptable in the British market. The American market has not been tried to any appreciable extent.

(2) An economic outlet for these products depends upon a guaranteed supply of raw materials.

(3) The economic operation of a cannery for white fish products would appear to demand a more diversified production, and a more regular supply than is possible under the existing method of prosecuting the fishery.

Reference to previous Annual Reports will show that the development was tried of a local product of Malt Extract with Cod Liver Oil. The product was well received locally, and its manufacture and distribution was taken over by a commercial firm under the supervision of the Laboratory. This project has since been abandoned by the firm, the main reason given being the assertion that the royalty imposed was excessive. Production was again handled by the Laboratory during last year and the product was available to the trade. The main results of the undertaking can be summarised as follows:—

1. It has been demonstrated that a preparation of malt extract and Newfoundland cod liver oil could be manufactured in Newfoundland after paying Customs duty on all raw materials and containers, and taking into account all charges including capital outlay, depreciation, operating, labour and supervision costs, at a price which compares favourably with the landed value of products procurable elsewhere.

2. Production led to increased local consumption of such products.

3. Local production caused a depression of the retail price of similar products.

4. There is a local outlet for such a product containing local cod liver oil.

In addition to the work on Malt Extract with Cod Liver Oil, an Emulsion of Cod Liver Oil with Glycerophosphates has been developed. The small amount of this emulsion which was prepared was stable over a period of three months. It was destroyed in the fire, but work had progressed sufficiently far to demonstrate the practical possibility of producing such an emulsion at a price highly competitive with similar products containing foregn cod liver oil now used extensively in Newfoundland.

The following miscellaneous activities indicate the value of a consultative service such as has been supplied throughout the year: In 1936 a visit was made to the Port-au-Port Peninsula where technical advice was given in canning practice to the Land Settlement Board's Branch at Lourdes and to firms at Port-au-Port and Piccadilly. Incidentally advantage was taken of the opportunity afforded by this trip to collect information at Port-aux-Basques. Again, in 1936 a week was spent at Branch, St. Mary's Bay, where instructions and demonstrations in the practice of home canning were given the Women's Committee of the Cape Shore Development Society. In addition, experiments were conducted on the perishability of a fishery product developed by a local firm, and chemical analyses and bacteriological tests were carried out. Findings and recommendations were made. Numerous enquiries concerning the methods of canning various products were attended to, technical advice being given where necessary. Finally, help was given in redrafting the Rules and Regulations for the packing of rabbits.

—A. R. Johnston.