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## Drift-net Fishing For Herring 1950 to 1952

by

S. N. Tibbo and E. G. Sollows

### I. Introduction

The herring fishery on the east coast of Canada is based almost entirely on spawning groups which are found close inshore for periods of from four to six weeks during the year. There are two principal spawning seasons. In the Gulf of St. Lawrence spawning occurs chiefly during the month of May, whereas on the Atlantic coast of Nova Scotia herring spawn in the late summer and early autumn.

There are two serious disadvantages to the herring fishery as it is being prosecuted at present. One is the shortness of the season during which herring are available and the other is that herring are in their poorest condition at spawning times. These poor quality herring are suitable only for bait, for reduction to oil and meal and for low grades of pickled or otherwise preserved food products.

The Atlantic Herring Investigation Committee was formed in 1944 under joint agreement between the Governments of Canada, Newfoundland, Quebec, Nova Scotia, New Brunswick and Prince Edward Island, to investigate the herring stocks of the Canadian Atlantic area and to determine whether greater use could be made of these stocks by extending the catching of herring to other areas and longer seasons. However, in spite of persistent searching for several seasons with sonic sounders and with otter trawls, Dutch herring trawls, floating trawls and purse-seines no worthwhile catches of herring were made in offshore areas. Apparently the various types of gear which were used can be effective only if there are relatively large and concentrated schools of herring present and this condition was found only in inshore areas prior to spawning. For example, the Committee demonstrated the effectiveness of purse-seining in Bay of Islands on the west coast of Newfoundland during November and December. The Atlantic Herring Investigation Committee was dissolved on March 31, 1950, and the explorations for herring were continued by the Atlantic Biological Station.

During the summer of 1950 the efficacy of drift-nets for the capture of commercial quantities of large fat herring in offshore areas was clearly demonstrated for the southwestern portion of the Gulf of St. Lawrence. However, explorations with this gear along the west coast of Newfoundland and along the Atlantic coast of Nova Scotia failed to reveal any substantial quantities of these fish. These experiments were continued during the 1951 and 1952 seasons with particular attention being given to the commercial possibilities of this method of fishing.

This report covers the three seasons' operations with detailed descriptions of the boats and gear used; the quantities

of fish caught and the localities where the fishing was done. The relationship between the catches of herring and the abundance of planktonic animals upon which they feed is described as well as the variations in the catches under different light and temperature conditions. Data showing the condition (fatness) of herring during the summer months are included and also the length composition of samples of the catches. Finally, some consideration is given to the economic aspects of drift-net fishing together with recommendations for the guidance of fishermen who may adopt this method of fishing. The report deals chiefly with the results from the Gulf of St. Lawrence although some data from other areas are included.

## II. Acknowledgments

The authors wish to place on record their appreciation of the interest and co-operation of the crews of the vessels "Harengus" and "J. J. Cowie" in carrying out this exploratory fishing program. Captain H. F. Strum and Captain H. H. Butler both contributed much to the success of the operations by their helpful suggestions in rigging and handling the gear and by their efforts in the work which was always arduous and often entailed long hours of constant attention.

## III. Methods

### A. Boats and gear used in 1950.

In 1950 a program of exploratory drift-net fishing for herring was initiated and was designed chiefly as a survey of the Gulf of St. Lawrence and Nova Scotia coast areas in order to determine the relative distribution and abundance of herring in offshore areas during the summer months. Two boats were used for these explorations - the M/V "Harengus", an 84-foot dragger and the M/V "Eastern Explorer", a 73-foot purse-seiner. The M/V "Eastern Explorer" was assigned to this work by the Newfoundland branch of the Department of Fisheries.

The details of the program were as follows: A network of 22 stations was established within the area and the M/V "Harengus" occupied 16 of these on three cruises from June 1 to October 2. A fourth cruise was attempted but only one station was occupied and as weather conditions grew worse the work was concluded for the season on October 12. The M/V "Eastern Explorer" occupied four of the remaining six stations in September and repeated four of the "Harengus" stations in November. The approximate locations of the stations which were occupied during the three seasons are shown in Figure 1. Table 9 in the appendix gives the latitude and longitude of the stations.

Four sizes of gill-nets, viz.  $1\frac{1}{2}$ " ,  $2\frac{1}{2}$ " , 2" and 3" stretched mesh (inside knots) were used from the "Harengus". Twelve nets were included in the string. They were assembled in the above order and in the following proportions 1:2:2:1. The whole fleet was approximately  $\frac{1}{2}$  450 yards long and 8 yards deep. Three sizes of gill-nets, 2" ,  $2\frac{1}{2}$ " and 3" stretched mesh were used from the "Eastern Explorer" and there were four nets of each mesh size in the string. All of the nets used were made



of 14/6 twine and were 150 meshes deep. Corks and leads kept the nets vertical in the water and they were attached to the vessels by a rope  $2\frac{1}{2}$ " in circumference and from 50 to 100 fathoms in length.

The nets were set before sunset and hauled back immediately after daybreak. Only one night was spent at each station during each cruise. The top of the nets was at the surface and no provision was made for varying the depth at which the nets could be set.

Catches were kept separate according to mesh size and were recorded according to species and quantity or number in each net. Samples of herring for fat determinations and population studies were taken from each catch.

Surface temperatures and bathythermograph observations were taken immediately before or during the setting of the nets and again immediately before or during the hauling back of the nets. Horizontal plankton hauls were made at each station and the plankton obtained were preserved for identification in the laboratory. A record of atmospheric conditions including direction and force of winds, the state of the sea and the light conditions was kept for every hour while the nets were in the water.

#### B. Boats and gear used in 1951.

Exploratory drift-net fishing was continued in 1951 and the program was confined, for the most part, to the southwestern Gulf of St. Lawrence where large quantities of herring and mackerel had been taken in 1950. However, one cruise was made along the outer coast of Nova Scotia and one in Fortune Bay on the south coast of Newfoundland.

The program for 1951 was as follows: A fleet of gill-nets, approximately 375 yards long and 8 yards deep was fished at 20 stations, of which 13 were in the Gulf of St. Lawrence and the remainder on the Atlantic coast of Nova Scotia and on the south coast of Newfoundland. Five sizes of nets were used, viz. 2",  $2\frac{1}{4}$ ",  $2\frac{1}{2}$ ",  $2\frac{3}{4}$ " and 3" stretched mesh (inside knots). Two nets of each mesh size, or a total of ten units, made up the fleet. The fishing was done chiefly from the M/V "J. J. Cowie" and 34 sets were made from this boat during the season. The M/V "Harengus", which was made available by the Department of Fisheries, occupied two stations in the Gaspé area during the latter part of August using 10 nets, all of which were of 2" mesh. Fishing was done at night as in 1950 with the nets being set before sunset and hauled back immediately after daybreak. Plankton hauls, surface temperature, bathythermograph observations, records of light and weather conditions and samples of herring for fat determinations and population studies were taken as they were in 1950.

Attempts were made throughout the season to improve catches by making changes in the gear. These included changes in attachment of the nets to the boat, weighting alternate nets, doubling the depths of the nets, etc. Only the latter change increased the catches by any appreciable amount.

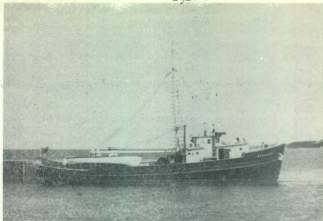


Figure 2. M/V "Harengus" used for drift-net fishing experiments in 1950 and 1951. Length overall 84.5 feet; Beam 19.9 feet; Gross tonnage 107.41; twin 135 h.p. Diesel engines.



Figure 3. M/V "J. J. Cowie" used for drift-net fishing experiments in 1951 and 1952. Length overall 65 feet; Beam 15.3 feet; Gross tonnage 48.76; 100 h.p. Diesel engine.

DETAILS OF DRIFT NET GEAR USED IN 1950, 1951 & 1952.

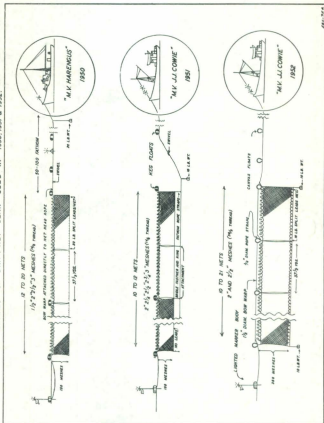


Figure 4.

### C. Boats and gear used in 1952.

In 1952 the gear which was used for drift-net fishing was purchased from a supply house in Scotland and consisted of drift-nets, canvas floats, ropes and fittings of a type regularly used in western European areas. The main difference between this gear and that which had been used in 1950 and 1951 was that the nets were 360 meshes deep instead of 150 meshes, which is a standard depth in Canada.

The fleet of nets used varied in length from 375 to 780 yards and was approximately 16 yards deep. Fishing was done in the vicinity of Magdalen Islands from May 20 to June 16 using nets of 2 $\frac{1}{2}$ " stretched mesh (from knot centres) and in the vicinity of Gaspé from July 31 to September 15 using nets of 2" stretched mesh. The other details of the program were the same as for the two previous seasons except that samples for fat determinations and population studies were taken each week instead of from each catch.

Figures 2 and 3 are photographic reproductions of the two vessels "Harengus" and "J. J. Cowie" from which most of the drift-net fishing was done and Figure 4 shows some details of the variations in the gear that was used throughout the experiments.

### IV. Distribution of herring as shown by drift-net catches.

#### A. Location and quantities of herring caught in 1950.

During the 1950 season the program for drift-net fishing was entirely exploratory in nature with the boats being directed to occupy as many stations as possible regardless of the quantities of fish taken. The purpose of the investigation was to determine the distribution of herring and to discover the most effective mesh size for drift-nets in order that during the following season or seasons a study of the commercial possibilities of this method of fishing could be made. Drift-net fishing has been carried on successfully for many years in the northeastern Atlantic and North Sea areas and we wished to evaluate its potentialities on the east coast of Canada.

The first cruise of the "Harengus" was made during the period June 1 to July 10 under ideal weather conditions and 13 of the 16 stations were occupied. The total catch at 7 southwestern Gulf stations amounted to 17,381 pounds of herring and 3,630 pounds of mackerel. The largest catches were made on Orphan Bank (HDN-7), south of Bird Rocks (HDN-3) and on LeFond George (HDN-2). At six Nova Scotia coast stations the total catch amounted to 1,050 pounds of mackerel and from 15 to 20 pounds of herring.

The second cruise (July 17 to August 16) was carried out under very adverse weather conditions and much difficulty was experienced in handling the nets in rough seas. The total catch at seven Gulf stations amounted to 7,710 pounds of herring and 1,740 pounds of mackerel. The largest catches were made on American Bank (HDN-8) and LeFond George (HDN-2). At five Nova Scotia coast stations only 35 pounds of mackerel and less than 5 pounds of herring were taken.

Table 1. Summary of drift-net catches of herring and mackerel 1950.

Station numbers	Locality	Dates	No. of sets	Total catch (pounds)		Average catch per set (pounds)	
				Herring	Mackerel	Herring	Mackerel
HDN-1	Prince Edward Island (east)	June 1, July 17, Aug. 21, Oct. 12.	4	36	250	9	62
HDN-2, 3	Magdalen Islands	June 5, 6, July 18, Sept. 5, 6.	5	15,715	3,680	3,143	736
HDN-4, 6	Prince Edward Island (west)	June 13, 15, July 27, 28, Sept. 15, 15, Oct. 30, Nov. 11.	8	7,530	875	941	109
HDN-5, 7, 8	American, Orphan and Bradelle Banks	June 19, 20, July 21, 24, 26, Sept. 6, 8, 13, Nov. 7, 8.	10	14,245	1,125	1,425	113
HDN-9, 17	Cabot Strait	Aug. 31, Sept. 5, 11.	3	8	370	3	123
HDN-10, 11, 12	Nova Scotia coast (east)	June 26, 29, July 31, Aug. 1, 2, Sept. 18, 20.	7	10	245	1	35
HDN-13, 14, 15, 16	Nova Scotia coast (west)	July 5, 7, 8, 10, Aug. 15, 15, Sept. 29, Oct. 2.	8	110	840	13	105
HDN-18, 19, 20	West coast of Nfld.	June 7, Sept. 20, 28, Oct. 11.	4	100	0	25	0
Totals			49	37,754	7,385	771	161

The third cruise (August 31 to October 2) was also carried out under generally poor weather conditions. However, three out of the seven stations in the Gulf of St. Lawrence were occupied in good weather and these accounted for the greater part of the total catch of 12,430 pounds of herring and 480 pounds of mackerel that were taken. The three most productive stations were American Bank (HDN-8), east of Alberton, P.E.I. (HDN-4) and the entrance to Miramichi Bay (HDN-6). The catches at the Nova Scotia coast stations were again small totalling only 100 pounds of herring and 50 pounds of mackerel for 4 sets.

The M/V "Eastern Explorer" occupied stations HDN-3, 9, 17, 19 and 20 in September and October and stations HDN-4, 6, 7 and 8 during the early part of November. No appreciable quantity of any species of fish was taken.

Table 2 gives a summary of the stations fished and the quantities of fish captured and Table 10 in the appendix gives the details of dates, stations, number and mesh size of the nets used as well as the quantities of herring and mackerel which were caught.

#### B. Location and quantities of herring caught in 1951.

The catches during the 1951 season were generally poor. The total amount of mackerel (8,590 pounds) was slightly higher than in 1950 (7,385 pounds). The total catch of herring, however, was only about one-tenth of the 1950 catch. At the Gulf of St. Lawrence stations in 1950 37,521 pounds of herring were taken in 21 sets using 12 nets for each set, whereas in 1951, only 4,005 pounds of herring were taken in 28 sets using 10 nets for each set. On five different occasions in 1950 more herring were caught in a single night's fishing than were caught altogether in 1951. The accompanying table (Table 2) gives a summary of the season's operations and table 11 in the Appendix gives the details of the fishing program together with the results of each set.

The factors responsible for the failure to capture herring in quantity during 1951 are not known. The overall distribution of herring and their reactions to various environmental conditions are still only vaguely understood and prediction of distribution and abundance is impossible. In addition to this, the suitability of the gear which we have been using has not been well established even though good catches were made in 1950. Some changes were made in the gear and the methods of handling in 1951 and it was expected that catches would be improved because of this but it may well have had an opposite effect. Attempts were made to improve catches throughout the season by making still more changes in the gear but these were unsuccessful until late in September when it was found that by doubling the depth of the nets good catches could again be made. By this time, however, the season was too far advanced to give these double-depth nets a thorough trial and further experiments had to be deferred until 1952. A few examples will serve to illustrate the difference in the catches by using nets of different depth. At station HDN-31 on September 3 two deep nets of 2 $\frac{1}{2}$ " and 2 $\frac{1}{2}$ " mesh caught 375 pounds of herring and mackerel

Table 2. Summary of drift-net catches of herring and mackerel 1951.

Station numbers	Locality	Dates	No. of sets	Total catch (pounds)		Average catch per set (pounds)	
				Herring	Mackerel	Herring	Mackerel
HDN-23, 12, 25	Nova Scotia coast	May 10, 17, 18.	3	200	0	67	0
HDN-33, 34, 35, 37	Fortune Bay, Nfld.	May 28, 29, 31, June 5.	4	550	15	138	4
HDN-1, 28, 26	Prince Edward Island (east)	June 12, 13, 18, July 4, 9, Aug. 7, 8, 13, 23.	9	1,500	2,550	167	283
HDN-2, 3, 27	Magdalen Islands	June 19, 20, 25, Aug. 16, 20.	5	300	950	60	190
HDN-6, 30, 4	Prince Edward Island (west)	July 10, 13, Aug. 6, 27, 28, 29.	6	450	2,050	75	342
HDN-31	Chaleur Bay	July 16, Sept. 3, 13.	3	5	1,800	2	245
HDN-5, 7, 8	American, Orphan and Bradelle Banks	July 18, Aug. 28, 29, Sept. 10, 11	5	1,750	1,225	350	245
	Totals		35	4,755	8,590	136	245

Table 3. Summary of drift-net catches of herring and mackerel 1952.

Station numbers	Locality	Dates	No. of sets	Total catch (pounds)		Average catch per set (pounds)	
				Herring	Mackerel	Herring	Mackerel
HDN-1, 26	Prince Edward Island (east)	June 3, 9, 18, 19, 23, 26, July 1, 2, 8, Sept. 22.	10	10,762	4,240	1,076	424
HDN-2, 28	Magdalen Islands	May 19, 20, 29, June 10, 25, July 7, Sept. 24.	7	12,457	835	1,779	119
HDN-31	Chaleur Bay	Aug. 7, Sept. 15.	2	425	15	212	8
HDN-8	American Bank	July 31, Aug. 4, 6, 12, 13, 14, 19, 20, 26, 28, Sept. 2, 2, 9.	13	74,485	137	5,730	11
		Totals	32	98,129	5,227	3,067	163

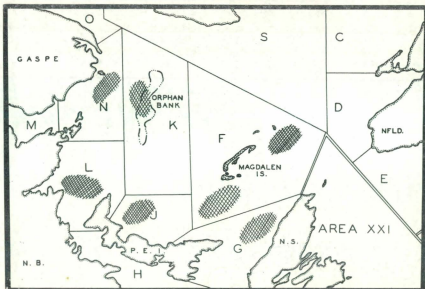


Figure 5. Chart showing areas (cross-hatched) where good catches of herring and mackerel were made in 1950 and 1952.

while four shallow nets of the same mesh size took 250 pounds or an average of only one-third as much. On September 10 one 2 $\frac{1}{2}$ " deep net took 300 pounds of herring while two shallow nets of the same mesh size took no fish. On September 11 at station HDN-8 two 2 $\frac{1}{2}$ " shallow nets caught only 3 fish while one 2 $\frac{1}{2}$ " deep net caught 310 pounds of mackerel. It has been concluded that the chief cause of the failure to capture herring and mackerel in quantity in 1951 was the unsuitability of the gear and that this was in turn due to some difference in the depth distribution of the herring. In both 1950 and 1951 the nets were fished at the surface only. No provision was made for increasing the depth at which they were set. Except for the few trials of double-depth nets to which reference has already been made fish could be caught only if they were within twenty-four feet of the surface. Throughout the season surface temperatures at the fishing stations were slightly higher in 1951 than they were during the previous year and this may have had the effect of keeping the fish deeper in the water where they could not be reached by the nets.

#### C. Location and quantities of herring caught in 1952.

The program for 1952 was designed chiefly to test the commercial possibilities of drift-net fishing in the Gulf of St. Lawrence and because of this very little exploratory work was done. When an area was found in which fish were plentiful the boats continued to fish there to determine how many herring could be caught and during what part of the season. The M/V "J. J. Cowie" was the only boat used for the 1952 program in the Gulf of St. Lawrence. A summary of the results of the experiments is given in Table 3 and the detailed catches in Table 12 in the Appendix.

The catches throughout the 1952 season were generally good. A total of 33 sets were made and from 21 of these more than 50 pounds of herring and mackerel per net (37 $\frac{1}{2}$  yards long) were boarded. On one occasion the nets were lost in a sudden storm and no measure of the catch was possible and on another occasion, when the nets sank with the weight of fish, only a minimum estimate could be made. The total catch for the season was 98,129 pounds of herring and 5,227 pounds of mackerel. Fishing was carried out in the vicinity of Magdalen Islands from May 20 to July 16 and in the vicinity of Gaspé from July 31 to September 15. The accompanying chart (Figure 5) shows the areas (cross-hatched) where good catches of herring and mackerel were made in both 1950 and 1952.

#### V. Relationship between abundance of plankton and herring catches.

Plankton samples were taken at all fishing stations immediately before or after the setting of the nets. In all cases 10-minute horizontal tows were made at approximately 3 metres below the surface with a net having an opening 30 inches in diameter and made of a cloth having from 12 to 15 meshes to the centimetre. The plankton samples were preserved in 5 to 10% formalin and were examined in the laboratory at a later date. Vertical hauls from 75 metres were attempted during the 1952 season but the quantities of plankton were too small for comparison in the field and the method was abandoned early in the season. A plankton sampler of a type frequently used by commercial

fishermen in the North Sea was used throughout the 1951 season but only very small quantities of plankton were taken and this method was also abandoned.

The quantities of plankton taken in the 10-minute horizontal tows over the three seasons varied from amounts too small to measure to 760 c.c. and consisted chiefly of Copepods (Calanus), Ctenophores (Pleurobrachia and Beröe), Chaetognaths (Sagitta), Decapod larvae (Cancer), fish eggs and fish larvae. Quantities and descriptions of each plankton tow for the three seasons are given in Tables 13, 14 and 15 in the Appendix. No comparison between the relative amounts of plankton for the three seasons can be made because of the differences in the dates and areas where the fishing was carried on. However, it appears that larger quantities of plankton were present in most of the Gulf areas in 1952 than there were in either of the two preceding years. At least, the fishing in 1952 was carried on in areas where plankton were more abundant and the larger overall catches in 1952 may have been the result of this.

There appears to be a definite relationship between the abundance of plankton and the distribution of herring in the Gulf of St. Lawrence area. For example, during the second cruise of the M/V "Harengus" in 1950 which was carried out during the period July 17 to August 16 when Calanus were very abundant and were the principal constituent of the plankton hauls the following relationships between catches of herring and mackerel and quantities of plankton were noted: at station HDN-8 there were 310 c.c. of plankton and 5,260 pounds of fish; at station HDN-2, 220 c.c. of plankton and 2,420 pounds of fish; at station HDN-5, 130 c.c. of plankton and 805 pounds of fish and at station HDN-1, 35 c.c. of plankton and 180 pounds of fish.

No relationships between plankton abundance and drift-net catches in 1951 were apparent. Catches were generally poor regardless of the amounts of food present in the water. The failure to capture large quantities of herring in 1951 has been discussed elsewhere and it is believed that because of gear failure the catches did not reflect the quantities of fish present.

For the 1952 season there was similar evidence of a relationship between drift-net catches and plankton abundance as had been observed in 1950. With one exception all of the large catches (200 pounds per net or more) were made in areas having a better than average abundance of plankton.

The overall results indicate that the abundance of plankton can be used as a guide to the setting of drift-nets to capture herring and mackerel. In more than 50 per cent of the cases large catches were made in areas which were rich in plankton whereas poor catches were almost invariably associated with small quantities of plankton.

#### VI. Variations in availability of herring under different light conditions.

A detailed record of atmospheric conditions was kept

for every hour while nets were in the water throughout the three seasons during which the drift-net experiments were carried out. These data included the direction and force of wind, the state of the sea, the proportion of sky covered with clouds, the precipitation, if any, and the light conditions. The study was made to determine whether or not there was any relationship between the amount of herring taken and the atmospheric conditions under which the fishing was done.

During the 1950 and 1951 seasons when the investigation was almost entirely exploratory in character and the boats occupied different stations each night regardless of the amount of herring caught, it was impossible to determine the effect of changing conditions on the catches although all of the large catches (1,000 pounds or more) were made on dark nights when there was no moon or when the moon was either partially or totally obscured by heavy clouds. In 1952 the program was designed chiefly to test the commercial possibilities of drift-net fishing and when an area was found where fish were plentiful the boat continued to operate there to determine how many herring could be caught and during what part of the season. Because of this the data on atmospheric conditions can be related to the catches and the effect of variations in these conditions on the amount of herring captured can be evaluated.

It is apparent that the mechanical difficulties involved in handling drift-nets in more than a moderate breeze and sea are such that it is impossible to make worthwhile catches when the wind is fresh or strong and the sea rough. The boat drifts too fast and the nets tend to roll around the headrope. Apart from this the most important factor was the amount of light and for the 1952 season fishing nights were classified into three groups, viz. moonlight, clear starlight and dark overcast nights, depending on the condition prevailing for more than 50 per cent of the period. The results show that the largest catches were made on clear starlight nights and the smallest ones on bright moonlight nights. The average catch per net per night was 82.9 pounds on moonlight nights, 236.7 pounds on dark overcast nights and 540.9 pounds on clear starlight nights. Most of the fishing was done in selected areas under all three light conditions and it is, therefore, quite apparent that light is an extremely important factor in the success or failure of this method of fishing.

It was also recorded that the herring were well distributed from top to bottom in the nets on dark overcast and clear starlight nights but on moonlight nights the fish were chiefly in the lower half of the nets. This indicates that a certain amount of flexibility is desirable in the depth at which the nets can be set and that on moonlight nights the nets should be set at greater depths than they are on dark nights.

Further support is given to the importance of light in drift-net fishing for herring by a comparison between daylight and night fishing. For example, a day set on American Bank in The Gulf of St. Lawrence on September 11, 1950, took only 11 herring, whereas on September 13, 1950, in a night set at the same station more than 5,000 pounds of herring were taken with the same gear.

VII. Surface temperatures and depths of the warm surface layer in relation to drift-net fishing.

Associated with the exploratory drift-net fishing a series of water temperature observations was made in order to determine whether any relationship existed between temperature conditions and the distribution of herring. The program varied considerably over the three seasons. In 1950 when the boats cruised over large areas surface temperatures and bathythermograph observations were taken every hour on the hour while cruising and also at the fishing stations both when setting the nets and hauling them back. In 1951 the fishing program was confined, for the most part, to the southwestern portion of the Gulf of St. Lawrence and far less cruising was done. Occasional temperature surveys were made but most attention was given to determining conditions at the fishing stations. In 1952 all of the observations were taken during actual fishing operations.

It should be pointed out that the temperatures recorded here do not necessarily reflect general temperature conditions in the Gulf of St. Lawrence during the three seasons since observations were not made in the same localities at the same time. This is particularly true for the 1952 season when the observations were made only during fishing operations. Obviously it would be invalid to compare, for example, July temperatures in the Magdalen Islands area in one season with July temperatures in the Gaspé area in another. What the records do show is the temperature conditions under which fishing was done regardless of time or place.

Tables 16, 17 and 18 in the Appendix give the surface temperatures and depths of the warm surface layer at the fishing stations in the Gulf of St. Lawrence throughout the three seasons 1950, 1951 and 1952. These data are summarized in Table 4. Additional data recorded in 1950 and 1951 will be reported elsewhere.

Table 4. Mean surface temperatures and depths of the warm surface layer in the Gulf of St. Lawrence.

Month	1950		1951		1952	
	Temperature	Surface layer	Temperature	Surface layer	Temperature	Surface layer
May					43.3°F	22 ft.
June	48.8°F	26 ft.	55.3°F	26 ft.	50.4°F	26 ft.
July	59.6°F	35 ft.	61.5°F	34 ft.	62.0°F	39 ft.
August	64.6°F	60 ft.	65.1°F	47 ft.	61.6°F	48 ft.
September	59.5°F	53 ft.	56.9°F	63 ft.	60.4°F	50 ft.
Seasonal *	54.8°F	32 ft.	60.3°F	34 ft.	57.9°F	39 ft.

\* Includes June, July and August only. Most of the fishing was done during these months.

Table 4 shows that temperature conditions were generally lower in 1950 and 1952 than they were in 1951. It has already been shown that the catches of herring in 1951 were generally poor. Since the drift-nets which were used differed in some respects in

each of the three seasons it is impossible to draw any definite conclusions as to the relationship between water temperatures and the distribution of herring. It is possible, however, that there is a relationship between the two with high surface temperatures having the effect of keeping herring deeper in the water where they cannot be reached by the drift-nets which we were using. This difficulty could be overcome by setting the nets in the intermediate water layer rather than at the surface.

The bathythermograph observations show that there is a well-defined warm surface layer of water over most of the southwestern portion of the Gulf of St. Lawrence during the summer months. This surface layer varies in depth from 10 to 95 feet. Most of the fishing was done within the surface layer and the evidence supplied by the catches, by sonic sounder recordings and by fishing under various light conditions leads to the conclusion that herring move freely in and out of the warm surface layer. This is probably true as long as the temperature of the surface layer is not too high or what may be more significant, that the difference in temperature between the warm surface layer and the colder intermediate layer is not too great.

#### VIII. The use of sonic sounders as a guide to the setting of drift-nets.

The value of echo-sounders in locating herring for commercial capture has been clearly demonstrated in recent years and these instruments are now widely used both as an aid to navigation and for determining the distribution and abundance of pelagic fishes. The use of echo-sounders as fish finders is, however, restricted chiefly to inshore areas where there are known concentrations of herring or where herring fisheries have been carried on for long periods of time. There has been little effort put forward by the industry to locate herring in offshore areas or during the off season.

Throughout the period of exploratory and experimental drift-net fishing from 1950 to 1952 constant use was made of echo-sounders to determine their efficiency in locating widely scattered schools of herring during the summer months.

The M/V "Harengus" which was used for this work in 1950 was equipped with both a Bendix DR1 model and a Husum MS21B model echo-sounder. The M/V "J. J. Cowie" used in 1951 and 1952 was equipped with a Husum MS21B sounder in 1951 and a Bendix DR1 sounder in 1952. For the three seasons the machines were operated continually while the vessels were cruising and searching for herring and at intervals while the boats were drifting with nets in the water.

Figure 6 is a reproduction of four echo-sounder recordings made during drift-net fishing operations in the Gulf of St. Lawrence. Drift-nets were set where these concentrations of herring were located and the catch per net is shown on the records together with the dates and fishing stations. It may be seen that in three out of four cases good catches of herring were made where the echo-sounder indicated the presence of large quantities of fish.

ECHO-SOUNDER RECORDINGS OF HERRING SHOALS  
IN THE GULF OF ST. LAWRENCE

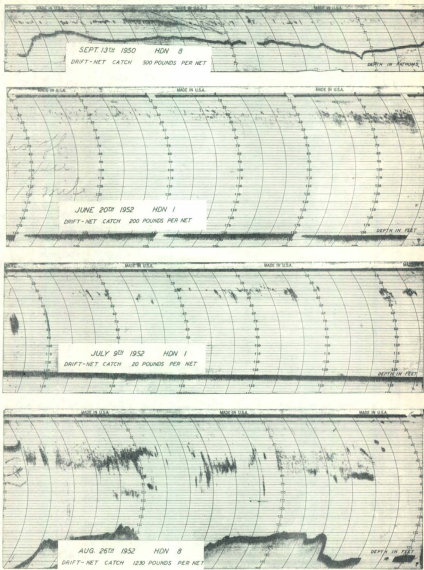


Figure 6.

The overall results for the three seasons show that an echo-sounder is an excellent but not infallible guide for actual fishing operations. Most of the good catches were associated with good recordings but some good catches were made without any indication of fish on the sounder and conversely, very poor catches were made in some areas where the sounder indicated that large schools of pelagic fish were present.

IX. The condition (fatness) of herring in the Gulf of St. Lawrence during the summer months.

In association with the exploratory drift-net fishing a study was made of the fat contents of herring and the variations in fat content throughout the summer months. Most of the samples for this study were obtained from the Gulf of St. Lawrence with the remainder being obtained from the Atlantic coast of Nova Scotia and the south coast of Newfoundland. The data for areas other than the Gulf of St. Lawrence are too few for any conclusions to be drawn and, hence, they are merely listed in Tables 19, 20 and 21 in the Appendix. These tables include the results of all the fat determinations made during the three phases.

The sampling procedure for the study of condition was to take from two to six herring from each 10 cm. size group and to grind the fish in a food chopper. After mixing thoroughly small samples (approximately 5 gm.) were taken and put in a bottle with a quantity of anhydrous Sodium sulphate. During the 1950 season the samples of ground fish were weighed before being put in the bottles. However, considerable difficulty was experienced in weighing the samples accurately on shipboard except under ideal weather conditions or when the vessel was tied to a dock and this method was abandoned in 1951 in favour of a method whereby a measured volume of fish was placed in the sample bottle with a previously weighed amount of  $\text{Na}_2\text{SO}_4$ . The weight of fish was determined later in the laboratory. The same method was used for the samples taken during the 1952 season. In all cases fat determinations were made in the laboratory by an ether extraction method and the values are given as a percentage of the wet weights of the whole fish.

Summaries of the results of the studies for each of the three years are given in Tables 5, 6 and 7 and an overall summary for the three-year period in Table 8.

Table 5. Percentage fat content of herring in Gulf of St. Lawrence from June 1 to September 15, 1950.

Size (cm.)	Date	No. of samples	Fat content	
			Range %	Average %
20-25	June 1-15	4	7.8- 9.7	8.7
	June 15-30	2	11.9-12.0	11.95
	July 15-31	8	7.1-15.3	10.9

(Cont'd.)

Size (cm.)	Date	No. of samples	Fat content	
			Range %	Average %
25-30	June 1-15	4	8.2-8.8	8.45
	June 15-30	2	10.8-11.0	10.9
	July 15-31	8	12.1-18.1	15.5
	Sept. 1-15	4	15.5-20.9	18.2
30-40	June 1-15	6	9.5-12.8	10.7
	July 15-31	12	15.9-26.8	19.8
	Sept. 1-15	8	12.7-18.4	16.3

Table 6. Percentage fat content of herring in Gulf of St. Lawrence from May 1 to September 15, 1951.

Size (cm.)	Date	No. of samples	Fat content	
			Range %	Average %
23-33	May 1-15	4	6.1-10.7	8.5
27-40	May 16-31	8	7.6-13.1	10.8
25-39	June 1-15	6	7.9-18.8	13.9
25-35	June 16-30	2	11.1-20.7	16.8
17-40	July 1-15	6	9.5-15.8	13.5
28-37	July 16-31	4	13.4-20.6	16.7
23-28	Aug. 1-15	2	14.3-14.8	14.6
27-40	Aug. 16-31	10	8.6-21.3	14.9
27-38	Sept. 1-15	6	8.8-11.7	10.3

Table 7. Percentage fat content of herring in Gulf of St. Lawrence from May 16 to September 30, 1952.

Size (cm.)	Date	No. of samples	Fat content	
			Range %	Average %
29-34	May 16-30	4	2.9-4.0	3.5
28-37	June 1-15	4	9.2-13.8	11.5
27-38	June 16-30	8	10.2-17.1	14.6
36-39	July 1-15	6	15.7-17.5	16.4
28-32	Aug. 1-15	4	11.7-15.5	13.5
29-32	Aug. 16-31	4	13.3-14.6	14.2
27-37	Sept. 1-15	4	13.2-13.8	13.6
30-35	Sept. 16-30	2	10.3-11.7	11.0

Table 8. Percentage fat content of herring in Gulf of St. Lawrence 1950 to 1952.

Period	No. of samples	Fat content	
		Range %	Average %
May 16-31	4	2.9-4.0	3.5
June 1-15	22	7.8-17.5	11.0
June 16-30	16	9.6-17.4	13.7
July 1-15	12	8.9-17.5	14.5
July 16-31	32	7.1-26.8	15.9
Aug. 1-15	6	11.7-15.5	13.6
Aug. 16-31	14	8.2-20.2	13.3
Sept. 1-15	20	8.3-20.9	14.7
Sept. 16-30	2	10.3-11.7	11.0

It is evident that herring recover rapidly from the effects of spawning and low water temperatures. Fat contents increased from 3.5 per cent during the latter half of May to 11.0 per cent during the first two weeks of June. The best condition was reached early in July and was reasonably well maintained until the end of September when there was a decrease which is believed to be associated with the development of the gonads.

During the 1950 season when several mesh sizes were used in the string of drift-nets a wide size range of herring was captured and it was possible to show both a seasonal and a size variation in condition. During 1951 and 1952 very few of the smaller sizes of herring were captured and it was impossible to check these results. However, the 1950 results showed that the large herring (30-40 cm.) were of the best quality reaching a maximum fat content of nearly 20 per cent by the end of July but not maintaining this condition beyond the early part of September when the gonads begin to develop in preparation for spawning the following May. Immature herring (25-30 cm.) were of excellent quality by mid-July (15 to 18 per cent) and were equally fat until the middle of September when the sampling was concluded. Small herring (20 to 25 cm.) had the lowest fat content (8 to 12 per cent).

The results over the three-year period show that both immature and adult herring of excellent quality and suitable for high grade food products can be taken in the Gulf of St. Lawrence throughout the period June to September.

#### X. The length composition of offshore herring populations.

Samples of herring from drift-net catches were taken regularly for population studies. These consisted chiefly of length measurements although some attention was given to age composition, vertebral counts, rates of growth and sex and maturity studies. For reasons given below this discussion will be confined almost entirely to the length composition of the samples.

Since the investigation was designed primarily to test the effectiveness of drift-nets as a method of catching herring it was essential that consideration be given to the size of herring in the various areas in order that the mesh size which would catch the greatest volume or weight of herring could be used. During the 1950 season gill-nets of  $1\frac{1}{2}$ " , 2" ,  $2\frac{1}{2}$ " and 3" stretched mesh were used and the largest catches were made from the  $2\frac{1}{2}$ " nets in the vicinity of Magdalen Islands and from the 2" nets in the Gaspé area. In 1951 the  $1\frac{1}{2}$ " mesh size was omitted and  $2\frac{1}{2}$ " and  $2\frac{3}{4}$ " mesh sizes were included in the string. Although the catches in 1951 were generally poor it was still apparent that the 2" and  $2\frac{1}{2}$ " meshes were most effective in the Gaspé and Magdalen areas respectively. On the basis of the 1950 and 1951 results only 2" and  $2\frac{1}{2}$ " nets were used in 1952 since the commercial possibilities of drift-net fishing was the chief purpose of the work.

Tables 22, 23 and 24 in the Appendix give the size ranges and mean lengths of the samples of herring taken during the three seasons 1950, 1951 and 1952. It may be seen that mean lengths vary from 40.71 to 75.95  $\frac{1}{2}$  cm. Also for any particular mesh size there is a wide variation, e.g. mean lengths from 2" nets vary from 50.82 to 65.16  $\frac{1}{2}$  cm. and even within the same season in one fishing area using only one mesh size mean lengths are shown to vary by more than 11  $\frac{1}{2}$  cm. Because of these variations a comparison between any two areas is of doubtful value on the basis of length composition alone and insufficient data on ages, rates of growth and vertebral counts were collected to demonstrate positively a segregation of populations in offshore areas. The majority of the fish taken in the Magdalens area were larger than those taken in the Gaspé area and in this respect are similar to the spring spawning groups in the same areas. It is believed that offshore migration is, in general, limited to the feeding grounds which are adjacent to the spawning grounds and that the various groups of herring in the Gulf of St. Lawrence are essentially discrete and intermingle to a limited extent, if at all.

Sex and maturity studies showed that most of the herring caught were adult fish which in May and June were recovering from spawning and throughout the summer had gonads in various stages of development in preparation for spawning the following spring. In the Gaspé area there was some evidence of immature fish joining the adult groups. There was evidence of a fall (September) spawning population in both the Gaspé and Magdalen areas and a summer (July) spawning group on the east side of Prince Edward Island.

#### XI. Some observations on the abundance of mackerel in the Gulf of St. Lawrence.

During the exploratory drift-net fishing for herring over the period 1950 to 1952 some interesting observations were made on the abundance and distribution of mackerel, particularly in the Gulf of St. Lawrence. Since drift-net fishing for mackerel might well be combined with fishing for herring and contribute considerably to the success of the operation some of these observations are recorded here.

It should be pointed out that at no time were there any special efforts made to catch mackerel and hence the catches were almost certainly far smaller than could have been made with suitable gear. Even the largest nets which were used (3" stretched mesh) were too small to hold mackerel securely and large numbers were invariably lost while the nets were being hauled. Tables 10, 11 and 12 in the Appendix show the quantities of mackerel which were actually boarded during the three seasons.

For 1950 and 1951 when some 2 $\frac{3}{4}$ " and 3" mesh nets were used more than 25 per cent of the total catches consisted of mackerel. This is quite significant in view of the fact that the landed value of mackerel is nearly four times that of herring. The value of the mackerel caught was, therefore, somewhat greater than the value of the herring.

It is also significant that some mackerel were present in a high proportion (85 %) of the catches in the Gulf of St. Lawrence which fact indicates a very wide distribution of mackerel in that area during the summer months.

In addition to the landed catches schools of mackerel were frequently seen at the surface when the boats were cruising. On July 9, 1952, for example, on a cruise from Sea Wolf Island to Souris mackerel schools were observed continuously over a three-hour period. No attempt was made to estimate the actual number but frequently 10 or 12 schools could be seen at the same time. On many other occasions mackerel schools were observed over an area which extended from 8 to 10 miles.

There is a commercial fishery for mackerel in the Gulf of St. Lawrence carried on chiefly in the spring and fall in inshore areas. It is believed that the total landings could be greatly increased by fishing offshore throughout the summer months. Drift-nets would almost certainly provide worthwhile catches but from the observed schooling habits of these fish purse-seining might be a more effective method of capture.

## XII. Some economic aspects of drift-net fishing.

It has been shown that commercial quantities of high quality herring can be taken in most of the southwestern Gulf of St. Lawrence areas throughout the period May to September. The success of the operation would, of course, depend on the value of the catches and it is apparent that this would have to be three cents per pound or more. An average of three fishing days per week can be expected and this could almost certainly be increased to four by fishing over the weekend. Catches should average from 6,000 to 10,000 pounds for a crew of four using a minimum of 750 yards of net. The amount of gear that can be handled would depend to a large extent on the total quantity of fish caught, since the removal of fish from nets is very time-consuming. For example, on June 11, 1952, it took four men 12 hours to remove 8,250 pounds of herring from 10 nets, while on August 19 the same men removed 4,875 pounds of herring from 21 nets in a little less than six hours. Without doubt, the efficiency with which fish could be removed from nets would increase with experience but it would still be a serious limiting factor.

It is believed that the efficiency of handling gear and catches could be greatly increased, perhaps even doubled, by using a boat which could be more easily manoeuvred than the "Harengus" or "J. J. Cowie" and which had less freeboard and more deck room. A Cape Island or similar type of boat 45 to 55 feet long should be satisfactory for this method of fishing both from the point of view of seaworthiness and for convenience in setting and hauling nets.

European nets are from two to three times as efficient as Canadian nets, chiefly because of their greater depth. In addition, Canadian nets are usually made of 14/6 twine which is believed to be larger than necessary and perhaps not as suitable



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Figure 7. Photographs of drift-net catches of herring in the Gulf of St. Lawrence 1952.

for drift-net fishing. However, it has the advantage of being more than twice as strong as the 36/9 twine from which the European nets were made. Some compromise between the two seems to be desirable.

Single net units cost between \$50 and \$60. A complete set of gear as recommended above would cost in the vicinity of \$1,500 and with proper care should last for, at least, three seasons.

Under present conditions it would appear that the best returns from a drift-net fishery could be had by marketing the catches as high-grade food products. It is very doubtful whether a meal and oil industry could be operated successfully if dependent wholly or for the most part on drift-net catches. The cost of raw material would be too high in spite of the very high fat content of herring which can be caught during the summer months.

Figure 7 shows four photographic illustrations of the quantities of herring which were taken on various occasions with drift-nets.

#### XIII. Summary and conclusions.

1. Explorations for herring in offshore areas which had been carried on by the Atlantic Herring Investigation Committee from 1944 to 1945 were continued in 1950 by the Atlantic Biological Station.

2. A program of exploratory and experimental drift-net fishing was initiated in 1950 and continued through 1951 and 1952.

3. The programs in 1950 and 1951 were exploratory in nature and had two main purposes. First, to determine the offshore distribution of herring and second, to determine the most effective mesh size of gill-nets. The program in 1952 was designed to test the commercial possibilities of drift-net fishing in the Gulf of St. Lawrence.

4. Herring were found to be abundant in most of the southwestern portion of the Gulf of St. Lawrence throughout the period May to September. No worthwhile catches were made anywhere else.

5. In 1950 catches per night per net (37½ yards long and 150 meshes deep) averaged 136 pounds as compared with 50 to 100 pounds in the North Sea with nets more than twice as deep. In 1951 catches were poor until late in the season when deeper nets were used and good catches were again made. In 1952 using North Sea nets 360 meshes deep, catches averaged over 300 pounds per net-night and over 400 pounds in some areas.

6. The abundance of plankton, particularly the copepod *Calanus*, can be used as a guide for setting drift-nets to capture herring. In more than 50 per cent of the cases large catches were made in areas which were rich in plankton whereas poor catches (except in 1951) were almost invariably associated with small

quantities of plankton.

7. Light conditions are shown to be important in drift-net fishing operations. A day set on September 11, 1950 took only 11 herring whereas on September 13 in a night set at the same station more than 5,000 pounds of herring were taken with the same gear. Throughout 1952 the average catch per net per night was 82.9 pounds on moonlight nights; 236.7 pounds on dark overcast nights and 540.9 pounds on clear starlight nights.

8. Surface temperatures at fishing stations were higher in 1951 than they were in 1950 and 1952. Drift-net catches were generally poor in 1951. A relationship between these two observations is suggested.

9. Bathythermograph observations showed the development of a warm surface layer during the summer months. Most of the fishing was done within this layer which varied in depth from 10 to 95 feet during the period May to September.

10. Sonic sounders were used throughout the investigation and proved to be an excellent but not infallible guide for fishing operations. Most of the good catches of herring and mackerel were associated with good recordings but some good catches were made without any indication of fish on the sounder.

11. A study of variations in fat content of offshore herring populations showed that herring recover rapidly from the effects of spawning and low water temperatures. Fat contents increased from 3.5 per cent during the latter half of May to 11.0 per cent during the first two weeks of June. The best condition was reached early in July and was reasonably well maintained until the end of September. The largest fish were of the best quality.

12. Samples of herring examined for lengths, ages, sex and maturity indicated that the offshore summer feeding populations were similar to the inshore spring spawning populations in the same areas.

13. There are both spring and fall spawning groups in the Magdalen Islands and Gaspé area and a small summer spawning group on the east coast of Prince Edward Island.

14. Some observations are recorded on the abundance of mackerel in the Gulf of St. Lawrence. In spite of the unsuitability of the gear used quantities of mackerel were taken regularly and contributed 25 per cent of the total catches in 1950 and 1951. It is believed that the present landings of mackerel could be greatly increased by fishing in offshore areas during the summer months and using either drift-nets or purse-seines.

15. Commercial quantities of high quality herring suitable for high grade food products can be taken throughout the summer months in the Gulf of St. Lawrence if the landed value is three cents per pound or more. A Cape Island or similar type of boat 45 to 55 feet long is recommended. With a crew of four using a minimum of 750 yards of net, catches should average between 6,000

and 10,000 pounds and an average of from three to four fishing days per week can be expected.

16. European nets are from two to three times as effective as Canadian nets, chiefly because of their greater depth. A stretched mesh size of 2" is recommended for the Gaspé area and 2½" for the Magdalen Islands area. If only one set of gear can be purchased 2½" mesh would be the best compromise.

17. Single net units cost from \$50.00 to \$60.00 depending on the mesh and twine sizes. A complete set of gear would cost approximately \$1,500.00 and with proper care should last for, at least, three seasons.

APPENDIX

Tables of Data

Table 9. Location of Herring Drift-net Stations 1950, 1951 and 1952.

<u>Station</u>	<u>Latitude N</u>	<u>Longitude W</u>	<u>Location</u>
HDN-1	46° 25' 00"	61° 35' 00"	East by South of East Pt., P.E.I.
HDN-2	47° 00' 00"	61° 45' 00"	Le Fond George
HDN-3	47° 46' 00"	60° 41' 00"	South of Bird Rocks, Magdalen Is.
HDN-4	46° 50' 00"	63° 35' 00"	East of Alberton, P.E.I.
HDN-5	47° 32' 00"	63° 02' 30"	Bradelle Bank
HDN-6	47° 24' 00"	64° 15' 00"	Entrance Miramichi Bay, N.B.
HDN-7	48° 14' 30"	63° 20' 00"	Orphan Bank
HDN-8	48° 38' 00"	63° 50' 00"	American Bank
HDN-9	46° 46' 00"	59° 45' 00"	Entrance Cabot Strait West
HDN-10	45° 07' 00"	60° 30' 00"	Canso Bank
HDN-11	44° 30' 00"	60° 28' 00"	Middle Ground
HDN-12	44° 40' 00"	62° 10' 00"	South of Beaver Harbour, N.S.
HDN-13	43° 43' 00"	63° 17' 00"	Sambro Bank
HDN-14	43° 12' 00"	64° 07' 00"	Le Have Bank
HDN-15	43° 25' 00"	64° 41' 00"	Roseway Bank
HDN-16	44° 10' 00"	63° 48' 00"	Entrance St. Margaret's Bay, N.S.
HDN-17	47° 24' 00"	58° 51' 00"	Entrance Cabot Strait East
HDN-18	48° 16' 00"	59° 27' 00"	Bay St. George, Nfld.
HDN-19	49° 10' 00"	58° 58' 00"	Bay of Islands, Nfld.
HDN-20	49° 49' 00"	58° 24' 00"	Northwest of Bonne Bay, Nfld.
HDN-23	43° 57' 00"	64° 28' 28"	South of Liverpool, N.S.
HDN-24	44° 34' 00"	63° 03' 00"	Southwest of Musquodoboit, N.S.
HDN-25	44° 59' 00"	61° 40' 00"	Southeast of Liscomb, N.S.
HDN-26	45° 57' 00"	62° 12' 00"	East of Pictou Island, N.S.
HDN-27	46° 57' 00"	60° 56' 00"	North of Cape St. Lawrence, N.S.
HDN-28	46° 37' 06"	62° 39' 00"	Northeast of Shipwreck Pt., P.E.I.
HDN-30	46° 46' 00"	64° 35' 00"	Northumberland Strait
HDN-31	48° 03' 00"	64° 51' 00"	Chaleur Bay, N.B.
HDN-32	49° 04' 00"	64° 22' 00"	East of Fox River
HDN-33	47° 25' 00"	55° 23' 00"	Fortune Bay, Nfld.
HDN-34	47° 10' 00"	55° 50' 00"	Fortune Bay, Nfld.
HDN-35	47° 22' 00"	56° 08' 00"	Entrance Connaigre Bay, Nfld.
HDN-37	46° 35' 00"	56° 39' 00"	Saint Pierre Bank

Table 10. Drift-net Catches of Herring and Mackerel 1950.

M/V "Harengus"

Date	Station	Total of nets used	Mesh sizes *				Total catch (pounds)	
			1 $\frac{1}{2}$ "	2"	2 $\frac{1}{2}$ "	3"	Herring	Mackerel
June 1	HDN-1	20	2	8	8	2	11	0
June 5	HDN-2	20	2	8	8	2	6,000	3,000
June 6	HDN-3	12	2	8	8	2	7,600	0
June 7	HDN-18	9	2	3	3	1	30	0
June 13	HDN-4	12	2	4	4	2	120	80
June 15	HDN-6	12	2	4	4	2	900	250
June 19	HDN-8	12	2	4	4	2	550	150
June 20	HDN-7	12	2	4	4	2	2,200	150
June 26	HDN-10	12	2	4	4	2	5	0
June 29	HDN-12	12	2	4	4	2	5	210
July 5	HDN-13	12	2	4	4	2	0	5
July 7	HDN-14	12	2	4	4	2	5	5
July 8	HDN-15	12	2	4	4	2	5	350
July 10	HDN-16	12	2	4	4	2	5	480
July 17	HDN-1	12	2	4	4	2	30	150
July 18	HDN-2	12	2	4	4	2	2,100	320
July 21	HDN-5	12	2	4	4	2	180	625
July 24	HDN-7	12	2	4	4	2	100	60
July 26	HDN-8	12	2	4	4	2	5,200	60
July 27	HDN-6	12	2	4	4	2	75	400
July 28	HDN-4	12	2	4	4	2	25	125
July 31	HDN-10	12	2	4	4	2	0	15
Aug. 1	HDN-11	12	2	4	4	2	0	10
Aug. 2	HDN-12	12	2	4	4	2	0	10
Aug. 14	HDN-15	12	2	4	4	2	5	0
Aug. 15	HDN-16	12	2	4	4	2	0	0
Aug. 31	HDN-1	12	2	4	4	2	5	50
Sept. 5	HDN-2	12	2	4	4	2	15	350
Sept. 6	HDN-5	12	2	4	4	2	10	50
Sept. 8	HDN-7	12	2	4	4	2	5	5
Sept. 13	HDN-8	12	2	4	4	2	6,000	25
Sept. 14	HDN-6	12	2	4	4	2	1,400	0
Sept. 15	HDN-4	12	2	4	4	2	5,000	0
Sept. 18	HDN-10	12	2	4	4	2	5	0
Sept. 20	HDN-12	12	2	4	4	2	0	0
Sept. 29	HDN-15	12	2	4	4	2	5	5
Oct. 2	HDN-16	12	2	4	4	2	100	0
Oct. 12	HDN-1	12	2	4	4	2	5	50

M/V "Eastern Explorer"

Aug. 31	HDN-9	13		5	4	4	0	20
Sept. 5	HDN-9	12		4	4	4	8	350
Sept. 6	HDN-3	12		4	4	4	5	10
Sept. 11	HDN-17	12		4	4	4	0	0
Sept. 20	HDN-19	12		4	4	4	0	0
Sept. 28	HDN-20	12		4	4	4	30	0
Oct. 11	HDN-20	9		3	3	3	40	0
Oct. 30	HDN-4	12		4	4	4	10	0
Nov. 7	HDN-8	12		4	4	4	5	0
Nov. 8	HDN-7	12		4	4	4	5	0
Nov. 11	HDN-6	12		4	4	4	0	20

\* Stretched mesh from inside knots. All nets 37 $\frac{1}{2}$  yards long and 150 meshes deep.

Table 11. Drift-net Catches of Herring and Mackerel 1951.

M/V "J. J. Cowie"

Date	Station	Total of nets used	Mesh sizes *					Total catch (pounds)	
			2" <sup>n</sup>	2 $\frac{1}{2}$ " <sup>n</sup>	2 $\frac{1}{2}$ " <sup>n</sup>	2 $\frac{3}{4}$ " <sup>n</sup>	3" <sup>n</sup>	Herring	Mackerel
May 10	HDN-23	15	3	3	3	3	3	75	0
May 17	HDN-12	10	2	2	2	2	2	15	0
May 18	HDN-25	10	2	2	2	2	2	110	0
May 28	HDN-35	10	2	2	2	2	2	150	0
May 29	HDN-33	10	2	2	2	2	2	340	0
May 31	HDN-34	10	2	2	2	2	2	60	0
June 5	HDN-37	10	2	2	2	2	2	<5	15
June 12	HDN-26	10	2	2	2	2	2	360	750
June 13	HDN-1	10	2	2	2	2	2	825	150
June 18	HDN-28	10	2	2	2	2	2	110	1,000
June 19	HDN-2	10	2	2	2	2	2	75	375
June 20	HDN-27	10	2	2	2	2	2	<5	450
June 25	HDN-3	10	2	2	2	2	2	225	15
July 4	HDN-1	10	2	2	2	2	2	10	110
July 9	HDN-28	10	2	2	2	2	2	<5	255
July 10	HDN-6	10	2	2	2	2	2	10	100
July 13	HDN-30	10	2	2	2	2	2	5	750
July 16	HDN-31	10	2	2	2	2	2	5	100
July 18	HDN-8	10	2	2	2	2	2	900	155
July 25	HDN-4	10	2	2	2	2	2	0	0**
Aug. 6	HDN-4	10	2	2	2	2	2	225	200
Aug. 7	HDN-28	10	2	2	2	2	2	15	175
Aug. 8	HDN-1	10	2	2	2	2	2	5	0
Aug. 13	HDN-26	10	2	2	2	2	2	<5	50
Aug. 16	HDN-2	10	2	2	2	2	2	<5	60
Aug. 20	HDN-27	10	2	2	2	2	2	0	50
Aug. 23	HDN-26	10	2	2	2	2	2	175	60
Aug. 27	HDN-30	10	2	2	2	2	2	10	300
Aug. 28	HDN-4	10	2	2	2	2	2	125	250
Aug. 29	HDN-6	10	2	2	2	2	2	75	450
Sept. 3	HDN-31	12	2	3	2	3	2	<5	700
Sept. 10	HDN-8	12	2	3	2	3	2	835	250
Sept. 11	HDN-8	12	2	3	2	3	2	0	450
Sept. 13	HDN-31	12	2	3	2	3	2	0	1,000

M/V "Harengus"

Aug. 28	HDN-7	10	10	-	-	-	-	5	150
Aug. 29	HDN-5	9	9	-	-	-	-	10	220

\* Stretched mesh from inside knots. All nets 37 $\frac{1}{2}$  yards long and 150 meshes deep except after September 2 when one 2 $\frac{1}{2}$ " and one 2 $\frac{3}{4}$ " net 300 meshes deep was included in the string.

\*\*Nets completely rolled around headrope during storm. Not included in averages.

Table 12. Drift-net Catches of Herring and Mackerel 1952.

M/V "J. J. Cowie"

Date	Station	Total of nets used	Mesh sizes *	Total catch (pounds)	
				Herring	Mackerel
May 19	HDN-2	10	2 1/2" (10)	300	-
May 20	HDN-2	10	2 1/2" (10)	1,575	-
May 29	HDN-2	10	2 1/2" (10)	2,250	-
June 3	HDN-1	10	2 1/2" (10)	110	5
June 9	HDN-26	10	2 1/2" (10)	675	40
June 10	HDN-2	10	2 1/2" (10)	8,250	10
June 18	HDN-1	10	2 1/2" (10)	4,350	40
June 19	HDN-1	10	2 1/2" (10)	2,000	30
June 23	HDN-1	10	2 1/2" (10)	1,725	350
June 25	HDN-2	10	2 1/2" (10)	75	225
June 26	HDN-1	10	2 1/2" (10)	150	1,500
July 1	HDN-26	10	2 1/2" (10)	7	1,000
July 2	HDN-1	10	2 1/2" (10)	1,500	600
July 7	HDN-28	11	2 1/2" (11)	5	450
July 8	HDN-1	11	2 1/2" (11)	225	675
July 16	HDN-1	11	2 1/2" (11)	-	**
July 31	HDN-8	10	2" (10)	150	-
Aug. 4	HDN-8	11	2" (11)	675	2
Aug. 6	HDN-8	11	2" (11)	340	15
Aug. 7	HDN-31	11	2" (11)	75	-
Aug. 12	HDN-8	11	2" (11)	2,100	15
Aug. 13	HDN-8	11	2" (11)	2,400	10
Aug. 14	HDN-8	11	2" (11)	300	-
Aug. 19	HDN-8	21	2" (21)	4,875	15
Aug. 20	HDN-8	21	2" (21)	25,830	***
Aug. 26	HDN-8	10	2" (10)	12,300	15
Aug. 28	HDN-8	10	2" (10)	1,350	20
Sept. 2	HDN-8	11	2" (10) 2 1/2" (1)	12,375	15
Sept. 4	HDN-8	11	2" (10) 2 1/2" (1)	1,125	20
Sept. 9	HDN-8	11	2" (10) 2 1/2" (1)	10,665	10
Sept. 15	HDN-31	10	2 1/2" (10)	350	15
Sept. 22	HDN-26	10	2 1/2" (10)	20	-
Sept. 24	HDN-2	10	2 1/2" (10)	2	150

\* Stretched mesh from knot centres. Numbers in parenthesis indicate number of nets of each mesh size. All nets 37 1/2 yards long and 360 meshes deep.

\*\* Nets lost during storm. Not included in averages.

\*\*\* Minimum estimate only - nets sank with weight of herring. Calculated from catch boarded on August 26 (1,230 lbs. per net) when nets did not sink from weight of fish.

Table 13. Plankton Collections 1950.

<u>Date</u>	<u>Station</u>	<u>Quantity</u>	<u>Description</u>
June 1	HDN-1	45 c.c.	Copepods, Chaetognaths (354), fish eggs (157), Decapod larvae (5), pieces of Medusae.
June 5	HDN-2	50 c.c.	Fish eggs (3,558), Chaetognaths (215), herring larvae (8).
June 6	HDN-3	50 c.c.	Fish eggs (1,207), Chaetognaths (33), fish larvae (4), small quantity of green algae.
June 7	HDN-18	500 c.c.	50% of tow contained: Medusae, Amphipods (876), Chaetognaths (231), Decapod larvae (33), fish eggs (23), fish larvae (18).
June 13	HDN-4	320 c.c.	10% of tow contained: Fish eggs (2,304), Decapod larvae (569), Chaetognaths (155), herring larvae (16), fish larvae (12), Amphipods (3), pieces of medusae.
June 15	HDN-6	40 c.c.	Fish eggs (227), Decapod larvae (178), Chaetognaths (139), fish larvae (6), Copepods, Amphipods (1).
June 19	HDN-8	40 c.c.	Fish eggs (251), Decapod larvae (121), fish larvae (13), Amphipods (5), few Copepods and fibrous debris.
June 20	HDN-7	90 c.c.	25% of tow contained: Fish eggs (4,057), Chaetognaths (430), Decapod larvae (285), fish larvae (3), Amphipods (2).
June 26	HDN-10	80 c.c.	Chiefly Copepods, a few Chaetognaths, Ctenophores, Decapod larvae, fish eggs and Amphipods.
June 29	HDN-12	180 c.c.	Chiefly Copepods, a few Chaetognaths, Ctenophores, fish eggs, fish larvae and Decapod larvae.
July 5	HDN-13	45 c.c.	Pteropods, Ctenophores, Chaetognaths and fish eggs.
July 7	HDN-14	45 c.c.	Copepods, fish eggs and Amphipods.
July 8	HDN-15	10 c.c.	Chiefly Copepods, a few Ctenophores, Chaetognaths, Amphipods and fish eggs.
July 10	HDN-16	100 c.c.	Chiefly Copepods, a few fish eggs, fish larvae, Decapod larvae, Chaetognaths and Ctenophores.
July 17	HDN-1	35 c.c.	Chiefly Copepods, a few fish eggs, fish larvae, Decapod larvae and Chaetognaths.
July 18	HDN-2	220 c.c.	Chiefly Copepods, a few fish eggs, fish larvae and Decapod larvae.
July 21	HDN-5	130 c.c.	Chiefly Copepods, a few fish larvae, fish eggs and Decapod larvae.
July 24	HDN-7	60 c.c.	Chiefly Copepods, a few fish eggs, fish larvae and Decapod larvae.
July 26	HDN-8	310 c.c.	Chiefly Copepods, a few fish eggs and Decapod larvae.
July 27	HDN-6	150 c.c.	Chiefly Copepods, a few fish eggs and Decapod larvae.

(Cont'd.)

<u>Date</u>	<u>Station</u>	<u>Quantity</u>	<u>Description</u>
July 28	HDN-4	40 c.c.	Chiefly Copepods, a few fish eggs, fish larvae and Decapod larvae.
July 31	HDN-10	25 c.c.	50% of tow contained: Copepods, Ctenophores, fish eggs (38), Chaetognaths (21), Decapod larvae (11), fish larvae (2) and Amphipod (1).
Aug. 1	HDN-11	<5 c.c.	Copepods and fish eggs.
Aug. 2	HDN-12	70 c.c.	50% of tow contained: Fish eggs (1,037), Chaetognaths (660), Cladocera (96) Copepods, Ctenophores, Decapod larvae (11), and fish larvae (9).
Aug. 14	HDN-15	14 c.c.	50% of tow contained: Copepods, Ctenophores, fish eggs (386), Amphipods (7) and Chaetognaths (1).
Aug. 15	HDN-16	100 c.c.	50% of tow contained Copepods, Ctenophores, Amphipods (99), Decapod larvae (55), fish eggs (22), Chaetognaths (4), fish larvae (1).
Aug. 31	HDN-1	<5 c.c.	Copepods (27).
Sept. 5	HDN-2	10 c.c.	Copepods, Amphipods and fish eggs.
Sept. 6	HDN-5	<5 c.c.	Chiefly Copepods, a few Medusae.
Sept. 8	HDN-7	20 c.c.	Chiefly Copepods, a few Ctenognaths, Decapod larvae, Amphipods and fish larvae.
Sept. 11	HDN-8	<5 c.c.	Copepods and fish eggs.
Sept. 13	HDN-8	<5 c.c.	Copepods (247), Decapod larvae (15), fish eggs (12).
Sept. 14	HDN-6	<5 c.c.	Copepods, Chaetognaths, Decapod larvae (2), fish larvae (1).
Sept. 15	HDN-4	<5 c.c.	Copepods, Chaetognaths, Pteropods, fish eggs and fish larvae.
Sept. 20	HDN-12	8 c.c.	Copepods, Pteropods, Decapod larvae, Amphipods and fish eggs.
Sept. 21	HDN-12	<5 c.c.	Copepods, Amphipods and Decapod larvae.
Sept. 29	HDN-15	<5 c.c.	Copepods, Cladocera, Chaetognaths and Amphipods.
Oct. 2	HDN-16	25 c.c.	Chiefly Copepods and Medusae, a few Chaetognaths and Amphipods.
Oct. 12	HDN-1	<5 c.c.	Chiefly Copepods with a few Pteropods.

Table 14. Plankton collections 1951.

<u>Date</u>	<u>Station</u>	<u>Quantity</u>	<u>Description</u>
May 10	HDN-23	51 c.c.	Copepods (35 c.c.), fish eggs (52), Appendicularians (16), Pteropods (10), Amphipods (2) and Decapod larvae (1).
May 17	HDN-12	15 c.c.	Copepods (8 c.c.), Amphipods (199), Chaetognaths (6), Decapod larvae (5), Medusae, Appendicularians (3), fish eggs (1).
May 18	HDN-25	92 c.c.	Copepods (28 c.c.), Amphipods (551), fish eggs (70), Decapod larvae (34), Schizopods (30), Medusae (26), Chaetognaths (2).
May 28	HDN-35	74 c.c.	Medusae (99), Decapod larvae (397), fish eggs (315), Amphipods (271), Schizopods (188), Copepods (111), Pteropods (66).
May 29	HDN-33	100 c.c.	Chiefly Medusae, a few fish eggs, Pteropods and Amphipods.
May 31	HDN-34	30 c.c.	Medusae (112), Decapod larvae (314), Copepods (46), Pteropods (38), Amphipods (26), fish eggs (13), Appendicularians (1) and Schizopods (1).
June 5	HDN-37	15 c.c.	Medusae (50), Decapod larvae (534), Amphipods (68), fish eggs (17) and Copepods (2).
June 12	HDN-26	90 c.c.	Chiefly Copepods, a few Chaetognaths and fish eggs.
June 13	HDN-1	62 c.c.	Decapod larvae (696), Chaetognaths (616), fish eggs (16 c.c.) and Copepods.
June 18	HDN-28	126 c.c.	Chiefly Copepods, a few fish eggs and Decapod larvae.
June 19	HDN-2	116 c.c.	Chiefly Copepods, a few fish eggs, Decapod larvae and fish larvae.
June 20	HDN-27	165 c.c.	25% of tow contained Copepods, fish eggs (7 c.c.), Decapod larvae (88), Chaetognaths (54).
June 25	HDN-3	180 c.c.	Chiefly Copepods, a few fish eggs and Decapod larvae.
July 4	HDN-1	230 c.c.	Chiefly Copepods, a few fish eggs and fish larvae.
July 9	HDN-28	110 c.c.	Chiefly Copepods, a few fish eggs, fish larvae and Decapod larvae.
July 10	HDN-6	400 c.c.	Chiefly Copepods, a few fish eggs and fish larvae.
July 13	HDN-30	310 c.c.	Chiefly Copepods, a few fish eggs, fish larvae and Decapod larvae.
July 18	HDN-8	145 c.c.	Chiefly Copepods, a few fish eggs and Decapod larvae.
July 25	HDN-4	210 c.c.	Chiefly Copepods, a few fish eggs, fish larvae and Decapod larvae.
Aug. 6	HDN-4	20 c.c.	Chiefly Copepods, a few fish larvae, Decapod larvae and Amphipods.
Aug. 7	HDN-28	28 c.c.	Chiefly Copepods, a few fish eggs and Decapod larvae.
Aug. 8	HDN-1	6 c.c.	Chiefly Copepods, a few Amphipods, fish eggs and fish larvae.

(Cont'd.)

<u>Date</u>	<u>Station</u>	<u>Quantity</u>	<u>Description</u>
Aug. 13	HDN-26	10 c.c.	Chiefly Copepods, a few fish eggs.
Aug. 16	HDN-2	45 c.c.	Copepods and fish eggs.
Aug. 20	HDN-27	45 c.c.	Copepods, fish larvae (2), a few Amphipods and fish eggs.
Aug. 23	HDN-26	45 c.c.	Chiefly Copepods, a few fish larvae and Decapod larvae.
Aug. 27	HDN-30	45 c.c.	Copepods.
Aug. 28	HDN-4	30 c.c.	Copepods.
Aug. 29	HDN-6	60 c.c.	Chiefly Copepods, Decapod larvae (25), Chaetognaths (4), herring larvae (1).
Sept. 3	HDN-31	28 c.c.	Chiefly Copepods, a few fish larvae.
Sept. 10	HDN-8	25 c.c.	Chiefly Copepods, a few Decapod larvae.
Sept. 11	HDN-8	20 c.c.	Chiefly Copepods, a few Decapod larvae.
Sept. 13	HDN-31	11 c.c.	Chiefly Copepods, a few Amphipods.

Table 15. Plankton collections 1952.

<u>Date</u>	<u>Station</u>	<u>Quantity</u>	<u>Description</u>
May 19	HDN-2	<5 c.c.	Copepods, Decapod larvae, Chaetognaths and fish eggs.
May 20	HDN-2	120 c.c.	Fish eggs, fish larvae, Ctenophores and Decapod larvae.
May 29	HDN-1	<5 c.c.	Copepods, fish eggs and Decapod larvae.
June 3	HDN-1	<5 c.c.	Copepods, Ctenophores and Decapod larvae.
June 9	HDN-2	<5 c.c.	Copepods, fish eggs, fish larvae and Decapod larvae.
June 10	HDN-2	125 c.c.	Chiefly Copepods, a few fish eggs.
June 18	HDN-1	290 c.c.	Chiefly Copepods, a few fish eggs and Decapod larvae.
June 19	HDN-1	760 c.c.	Chiefly Copepods, a few fish eggs, Decapod larvae and herring larvae (18).
June 23	HDN-1	515 c.c.	Chiefly Copepods, a few Decapod larvae, fish eggs, fish larvae and herring larvae (1).
June 25	HDN-1	460 c.c.	Chiefly Copepods, a few fish eggs, Decapod larvae and Chaetognaths.
June 26	HDN-1	505 c.c.	Chiefly Copepods, a few Decapod larvae, fish larvae and fish eggs.
July 1	HDN-26	330 c.c.	Chiefly Copepods, a few fish eggs, Decapod larvae and Chaetognaths.
July 2	HDN-1	510 c.c.	Chiefly Copepods, a few fish larvae, Decapod larvae, Amphipods and Chaetognaths.
July 7	HDN-2	300 c.c.	Chiefly Copepods, a few fish eggs, fish larvae and Decapod larvae.
July 8	HDN-1	460 c.c.	Chiefly Copepods, a few fish eggs, fish larvae and Decapod larvae, lobster larvae (1).
July 31	HDN-8	130 c.c.	Chiefly Copepods, a few fish eggs and Decapod larvae.
Aug. 4	HDN-8	540 c.c.	Chiefly Copepods, a few fish eggs, fish larvae and Decapod larvae.
Aug. 6	HDN-8	240 c.c.	Chiefly Copepods, a few fish larvae and Decapod larvae.
Aug. 7	HDN-31	310 c.c.	Chiefly Copepods, a few Amphipods and Decapod larvae.
Aug. 12	HDN-8	600 c.c.	Chiefly Copepods, a few fish larvae and Decapod larvae.
Aug. 13	HDN-8	300 c.c.	Chiefly Copepods, a few Amphipods, fish larvae and Decapod larvae.
Aug. 14	HDN-8	75 c.c.	Chiefly Copepods, a few fish eggs and Decapod larvae.
Aug. 19	HDN-8	160 c.c.	Copepods.
Sept. 4	HDN-8	125 c.c.	Chiefly Copepods, a few Pteropods and Decapod larvae, herring larvae (6).
Sept. 9	HDN-8	<5 c.c.	Chiefly Copepods and a few Decapod larvae.
Sept. 15	HDN-31	295 c.c.	Chiefly Copepods and a few fish larvae.
Sept. 22	HDN-26	<5 c.c.	Chiefly Copepods, a few Pteropods and fish eggs.
Sept. 24	HDN-1	<5 c.c.	Chiefly Copepods, a few fish larvae and Pteropods.

Table 16. Surface Temperatures and Depths of the Warm Surface Layer 1950.

<u>Station No.</u>	<u>Date</u>	<u>Temperature</u>	<u>Depth of Surface Layer</u>
HDN-1	June 1	45.7 °F.	20 ft.
HDN-1	June 2	43.3	17
HDN-2	June 5	46.9	20
HDN-2	June 6	46.8	25
HDN-3	June 6	45.5	25
HDN-3	June 7	45.1	30
HDN-4	June 13	52.7	35
HDN-4	June 14	52.3	40
HDN-6	June 15	54.1	12
HDN-6	June 16	53.6	12
HDN-8	June 19	49.3	25
HDN-8	June 20	47.8	40
HDN-7	June 20	50.9	35
HDN-1	July 17	62.1	40
HDN-1	July 18	62.1	30
HDN-2	July 18	61.2	30
HDN-2	July 19	60.4	30
HDN-5	July 21	61.2	30
HDN-5	July 22	60.4	50
HDN-7	July 24	55.8	45
HDN-7	July 25	55.6	45
HDN-8	July 26	58.1	45
HDN-8	July 27	55.9	10
HDN-6	July 27	59.0	15
HDN-6	July 28	58.5	-
HDN-4	July 28	62.1	10
HDN-4	July 29	62.6	55
HDN-1	July 29	62.6	50
HDN-1	Aug. 31	64.6	60
HDN-1	Sept. 1	62.1	60
HDN-2	Sept. 5	61.0	40
HDN-2	Sept. 6	61.3	35
HDN-5	Sept. 6	60.4	-
HDN-5	Sept. 7	60.8	50
HDN-7	Sept. 8	58.6	50
HDN-7	Sept. 9	57.9	45
HDN-8	Sept. 13	55.2	55
HDN-8	Sept. 14	53.6	75
HDN-6	Sept. 14	59.5	75
HDN-6	Sept. 15	59.9	25
HDN-4	Sept. 15	61.5	65
HDN-4	Sept. 16	61.2	65

Table 17. Surface Temperatures and Depths of the Warm Surface Layer 1951.

<u>Station No.</u>	<u>Date</u>	<u>Temperature</u>	<u>Depth of Surface Layer</u>
HDN-26	June 12	52.7 °F.	35 ft.
HDN-26	June 13	51.65	40
HDN-1	June 13	54.0	-
HDN-1	June 14	52.9	30
HDN-28	June 18	56.0	15
HDN-28	June 19	55.6	10
HDN-2	June 19	58.3	10
HDN-2	June 20	57.75	20
HDN-27	June 20	61.3	10
HDN-27	June 21	58.8	30
HDN-3	June 25	52.7	30
HDN-3	June 26	52.2	55
HDN-1	July 4	61.2	50
HDN-1	July 5	61.0	55
HDN-28	July 9	64.4	50
HDN-28	July 10	61.85	40
HDN-6	July 10	60.1	30
HDN-6	July 11	59.4	35
HDN-30	July 13	62.6	30
HDN-30	July 14	61.3	30
HDN-31	July 16	61.6	10
HDN-31	July 17	60.3	15
HDN-8	July 18	60.8	30
HDN-8	July 19	59.4	30
HDN-4	July 25	64.1	35
HDN-4	July 26	63.1	35
HDN-2	Aug. 16	65.1	55
HDN-2	Aug. 17	64.0	65
HDN-27	Aug. 21	63.7	50
HDN-26	Aug. 24	65.3	50
HDN-30	Aug. 27	65.5	40
HDN-4	Aug. 28	65.3	40
HDN-4	Aug. 29	65.1	30
HDN-6	Aug. 29	66.4	-
HDN-6	Aug. 30	65.8	45
HDN-31	Sept. 3	60.6	50
HDN-31	Sept. 4	59.9	50
HDN-8	Sept. 10	54.2	95
HDN-8	Sept. 11	54.9	75
HDN-8	Sept. 11	53.3	75
HDN-8	Sept. 12	52.7	-
HDN-31	Sept. 13	61.0	45
HDN-31	Sept. 14	58.6	50

Table 18. Surface Temperatures and Depths of the Warm Surface Layer 1952.

<u>Station No.</u>	<u>Date</u>	<u>Temperature</u>	<u>Depth of Surface Layer</u>
HDN-2	May 19	43.2 °F.	10 ft.
HDN-2	May 20	43.4	20
HDN-2	May 29	43.2	35
HDN-1	June 3	46.2	25
HDN-2	June 10	49.6	25
HDN-2	June 10	49.6	25
HDN-1	June 19	49.1	50
HDN-1	June 23	53.4	10
HDN-2	June 25	52.0	35
HDN-1	June 26	52.7	15
HDN-26	July 1	59.5	20
HDN-1	July 2	57.9	25
HDN-28	July 7	63.5	50
HDN-1	July 8	67.3	60
HDN-1	July 15	82.0*	<2*
HDN-8	Aug. 4	60.6	55
HDN-8	Aug. 6	62.4	15
HDN-31	Aug. 7	65.7	25
HDN-8	Aug. 12	62.8	50
HDN-8	Aug. 13	62.6	25
HDN-8	Aug. 14	64.8	50
HDN-8	Aug. 19	60.1	65
HDN-8	Aug. 20	60.1	60
HDN-8	Aug. 26	59.5	70
HDN-8	Aug. 28	57.4	65
HDN-8	Sept. 3	60.8	40
HDN-8	Sept. 4	59.9	25
HDN-31	Sept. 15	57.0	65
HDN-26	Sept. 21	62.2	55
HDN-2	Sept. 24	61.9	65

\* Not included in means. Record made under unusual conditions, a very warm day with no wind.

Table 19. Percentage Fat Contents of Herring 1950.

<u>Date</u>	<u>Area</u>	<u>Size range</u> <u>(<math>\pm</math> cm.)</u>	<u>No. of</u> <u>herring</u>	<u>Fat contents *</u> <u>% wet weight whole fish</u>
June 2	H DN-1	55 to 59	6	8.5, 8.3
June 6	H DN-2	40 to 50	6	7.8, 8.0
June 6	H DN-2	60 to 70	5	10.0, 9.8
June 6	H DN-2	50 to 60	6	8.8, 8.2
June 7	H DN-3	60 to 70	6	9.5, 10.0
June 13	H DN-4	40 to 50	6	9.3, 9.7
June 13	H DN-4	60 to 70	6	12.8, 11.9
June 16	H DN-6	40 to 45	6	11.9, 12.0
June 16	H DN-6	55 to 65	6	11.0, 10.8
July 11	Sable Island	73 to 74	2	16.7, 15.9
July 11	H DN-16	67 to 70	3	17.5, 17.5
July 18	H DN-1	53 to 61	6	14.7, 14.3
July 19	H DN-2	40 to 50	6	12.8, 13.3
July 19	H DN-2	50 to 60	6	12.5, 12.1
July 19	H DN-2	60 to 70	6	19.2, 20.0
July 22	H DN-5	50 to 60	6	17.2, 17.3
July 22	H DN-5	60 to 70	6	26.8, 26.3
July 22	H DN-5	40 to 50	6	7.1, 7.3
July 25	H DN-7	58 to 68	6	16.5, 15.9
July 25	H DN-7	68 to 77	6	17.2, 17.2
July 27	H DN-8	44 to 49	6	14.9, 15.3
July 27	H DN-8	53 to 62	6	17.8, 18.1
July 27	H DN-8	63 to 68	6	18.0, 18.0
July 28	H DN-6	44 to 49	6	8.1, 8.3
July 28	H DN-6	50 to 64	6	32.7, 32.0**
July 29	H DN-4	62 to 70	6	21.2, 21.0
Aug. 15	H DN-15	63 to 64	2	10.6, 11.1
Sept. 1	H DN-1	67 to 74	2	17.8, 17.7
Sept. 6	H DN-2	50 to 60	6	20.8, 20.9
Sept. 7	H DN-5	59 to 69	6	12.7, 13.1
Sept. 7	H DN-6	60 to 70	6	18.2, 18.4
Sept. 14	H DN-8	50 to 60	6	15.5, 15.6
Sept. 15	H DN-6	76 to 79	2	16.3, 16.0
Sept. 30	H DN-15	62	2	10.9, 12.2
Oct. 13	H DN-1	59 to 67	3	2.3, 2.5

\* Duplicate samples from same lot of fish.

\*\* Determinations doubtful and not included in averages.

Table 20. Percentage Fat Contents of Herring 1951

Date	Area	Size range ( $\frac{1}{2}$ cms.)	No. of fish	Fat contents *	
				% wet weight whole fish	
May 11	HDN-23	46 to 57	3	10.2,	8.8
May 11	HDN-23	56 to 66	3	5.7,	6.7
May 18	HDN-12	62 to 70	3	10.2,	10.6
May 19	HDN-25	54 to 57	3	12.4,	11.8
May 19	HDN-25	64 to 77	3	11.1,	9.1
May 28	HDN-35	54 to 80	4	9.4,	7.2
June 1	HDN-34	64 to 78	3	7.7,	7.5
June 13	HDN-26	54 to 74	6	14.5,	14.1
June 14	HDN-1	50 to 70	6	17.5,	16.7
June 19	HDN-2	50 to 70	3	17.4,	19.1
June 21	HDN-27	65 to 69	3	11.0,	9.6
July 7	HDN-4	64 to 77	3	14.3,	14.8
July 11	HDN-6	57 to 79	3	14.2,	13.0
July 14	HDN-30	33 to 63	9	10.1,	8.9
July 19	HDN-8	55 to 65	4	18.9,	16.0
July 19	HDN-8	64 to 73	4	14.0,	12.4
Aug. 7	HDN-4	45 to 55	5	13.9,	13.4
Aug. 17	HDN-2	74 to 78	2	14.5,	15.1
Aug. 24	HDN-26	62 to 77	6	12.6,	13.0
Aug. 28	HDN-30	53 to 59	7	20.2,	18.9
Aug. 30	HDN-6	57 to 68	6	9.7,	9.4
Aug. 30	HDN-6	70 to 80	3	8.6,	8.2
Sept. 11	HDN-8	65 to 75	3	9.8,	10.8
Sept. 11	HDN-8	53 to 63	3	8.5,	8.3

\* Duplicate samples from same lot of fish.

Table 21. Percentage Fat Contents of Herring 1952.

<u>Date</u>	<u>Area</u>	<u>Size range</u> ( <u>± cms.</u> )	<u>No. of</u> <u>fish</u>	<u>Fat contents *</u> <u>% wet weight whole fish</u>
May 20	HDN-2	68	2	2.9, 3.4
May 20	HDN-2	58	2	3.6, 4.0
June 4	HDN-1	55 to 75	4	9.2, 9.3
June 10	HDN-1	55 to 74	4	13.6, 13.8
June 19	HDN-2	57 to 70	6	14.2, 15.0
June 20	HDN-1	61 to 64	2	15.4, 10.2
June 24	HDN-1	75 to 76	2	15.0, 17.1
June 26	HDN-1	55 to 57	2	15.6, 14.4
July 2	HDN-1	72 to 76	2	17.5, 17.0
July 8	HDN-1	70 to 71	2	15.7, 16.0
July 9	HDN-1	76 to 77	2	16.3, 15.8
Aug. 5	HDN-8	57 to 63	4	15.5, 14.3
Aug. 13	HDN-8	57 to 62	5	11.7, 12.4
Aug. 20	HDN-8	57 to 64	5	14.4, 14.2
Aug. 29	HDN-8	55 to 64	5	13.3, 14.6
Sept. 3	HDN-8	55 to 65	6	13.2, 13.7
Sept. 9	HDN-8	64 to 74	4	13.3, 13.8
Sept. 21	HDN-1	60 to 69	3	11.7, 10.3

\* Duplicate samples from same lot of fish.

Table 22. Length Composition of Herring Samples 1950.

Date	Area	No. of fish	Length in Range	$\frac{1}{2}$ cms. Mean	Gill-net * mesh size
June 14	HDN-4	89	40-63	44.49	1 $\frac{1}{2}$ in..
June 14	HDN-4	201	43-66	52.42	2
June 14	HDN-4	24	44-71	63.58	2 $\frac{1}{2}$
June 16	HDN-6	191	40-64	44.45	1 $\frac{1}{2}$
June 16	HDN-6	279	44-65	53.20	2
June 16	HDN-6	74	54-70	62.14	2 $\frac{1}{2}$
June 20	HDN-8	22	42-62	49.00	1 $\frac{1}{2}$
June 20	HDN-8	200	42-66	56.97	2
June 20	HDN-8	61	60-70	64.39	2 $\frac{1}{2}$
June 21	HDN-7	72	39-48	44.04	1 $\frac{1}{2}$
June 21	HDN-7	187	45-68	57.31	2
June 21	HDN-7	139	47-73	63.67	2 $\frac{1}{2}$
July 18	HDN-1	61	45-62	54.43	2
July 19	HDN-2	69	43-52	45.42	1 $\frac{1}{2}$
July 19	HDN-2	280	48-65	56.33	2
July 19	HDN-2	163	54-76	64.27	2 $\frac{1}{2}$
July 22	HDN-5	185	43-51	46.61	1 $\frac{1}{2}$
July 22	HDN-5	162	46-70	50.82	2
July 22	HDN-5	19	58-73	66.37	2 $\frac{1}{2}$
July 24	HDN-7	153	47-72	60.67	2
July 24	HDN-7	34	52-70	61.77	2 $\frac{1}{2}$
July 24	HDN-7	29	62-75	71.69	3
July 26	HDN-8	245	43-56	46.64	1 $\frac{1}{2}$
July 26	HDN-8	178	46-69	59.36	2
July 26	HDN-8	204	58-69	63.33	2 $\frac{1}{2}$
July 26	HDN-8	63	58-72	65.29	3
July 28	HDN-6	64	41-60	46.59	1 $\frac{1}{2}$
July 28	HDN-6	107	46-67	52.08	2
July 28	HDN-6	14	60-68	64.71	2 $\frac{1}{2}$
July 29	HDN-4	22	55-71	61.00	2
July 29	HDN-4	25	60-74	67.28	2 $\frac{1}{2}$
Sept. 6	HDN-2	22	50-64	56.18	2
Sept. 7	HDN-5	17	59-79	64.00	2 $\frac{1}{2}$
Sept. 14	HDN-8	236	44-56	49.49	1 $\frac{1}{2}$
Sept. 14	HDN-8	272	45-66	53.74	2
Sept. 14	HDN-8	173	53-71	62.50	2 $\frac{1}{2}$
Sept. 14	HDN-8	127	60-79	65.65	3
Sept. 15	HDN-6	17	52-67	59.71	2
Sept. 15	HDN-6	115	60-82	70.42	2 $\frac{1}{2}$
Sept. 15	HDN-6	88	64-81	73.57	3
Sept. 16	HDN-4	34	39-43	40.71	1 $\frac{1}{2}$
Sept. 16	HDN-4	175	53-72	61.34	2
Sept. 16	HDN-4	114	59-81	68.35	2 $\frac{1}{2}$
Sept. 16	HDN-4	126	62-80	69.76	3
Oct. 2	HDN-16	124	52-71	51.69	2
Oct. 2	HDN-16	12	60-75	70.58	2 $\frac{1}{2}$

\* Stretched mesh inside knots.

Table 23. Length Composition of Herring Samples 1951.

Date	Area	No. of fish	Length in Range	$\frac{1}{2}$ cms. Mean	Gill-net mesh size *
May 11	HDN-23	31	45-62	55.13	2 in.
May 11	HDN-23	14	59-67	63.50	2 $\frac{1}{2}$
May 11	HDN-23	26	59-70	64.19	2 $\frac{1}{2}$
May 19	HDN-25	25	51-66	55.68	2
May 19	HDN-25	17	61-70	64.94	2 $\frac{1}{2}$
May 19	HDN-25	60	58-78	66.65	2 $\frac{1}{2}$
May 29	HDN-35	33	55-80	72.15	2 $\frac{1}{2}$
May 29	HDN-35	54	64-83	74.32	2 $\frac{1}{2}$
May 29	HDN-35	34	68-81	75.32	2 $\frac{1}{2}$
May 29	HDN-35	19	71-80	75.95	3
May 30	HDN-33	110	43-69	53.05	2
May 30	HDN-33	125	52-80	62.11	2 $\frac{1}{2}$
May 30	HDN-33	99	58-81	68.02	2 $\frac{1}{2}$
May 30	HDN-33	12	62-78	72.33	2 $\frac{1}{2}$
May 30	HDN-33	15	62-80	71.67	3
June 1	HDN-34	14	56-78	70.64	2 $\frac{1}{2}$
June 1	HDN-34	25	61-80	68.44	2 $\frac{1}{2}$
June 12	HDN-26	163	48-69	55.55	2
June 12	HDN-26	106	50-71	61.50	2 $\frac{1}{2}$
June 12	HDN-26	89	53-73	63.36	2 $\frac{1}{2}$
June 12	HDN-26	23	52-74	63.91	2 $\frac{1}{2}$
June 12	HDN-26	11	55-68	64.09	3
June 14	HDN-1	160	47-66	55.25	2
June 14	HDN-1	106	52-72	62.63	2 $\frac{1}{2}$
June 14	HDN-1	103	59-80	64.86	2 $\frac{1}{2}$
June 14	HDN-1	36	54-73	66.61	2 $\frac{1}{2}$
June 14	HDN-1	28	49-74	66.14	3
June 19	HDN-28	101	50-68	54.19	2
June 20	HDN-2	79	52-73	59.04	2
June 20	HDN-2	34	51-67	60.79	2 $\frac{1}{2}$
June 20	HDN-2	12	60-76	64.67	2 $\frac{1}{2}$
June 26	HDN-3	85	57-68	62.92	2
June 26	HDN-3	53	56-75	64.09	2 $\frac{1}{2}$
June 26	HDN-3	46	62-78	66.59	2 $\frac{1}{2}$
July 18	HDN-8	203	49-68	55.52	2
July 18	HDN-8	120	52-73	63.79	2 $\frac{1}{2}$
July 18	HDN-8	92	60-71	65.16	2 $\frac{1}{2}$
July 18	HDN-8	25	61-75	69.44	2 $\frac{1}{2}$
July 18	HDN-8	25	62-78	69.08	3
Aug. 7	HDN-4	147	45-70	52.82	2
Aug. 7	HDN-4	38	53-78	61.47	2 $\frac{1}{2}$
Aug. 7	HDN-4	22	53-75	64.27	2 $\frac{1}{2}$
Aug. 8	HDN-28	28	51-72	56.25	2
Aug. 24	HDN-26	19	51-78	65.16	2
Aug. 24	HDN-26	16	62-77	67.81	3
Aug. 24	HDN-26	22	61-74	67.96	2 $\frac{1}{2}$
Aug. 24	HDN-26	15	62-80	69.40	2 $\frac{1}{2}$
Aug. 29	HDN-4	28	58-79	67.71	2 $\frac{1}{2}$
Aug. 29	HDN-5	21	53-61	55.86	2
Aug. 30	HDN-6	32	62-77	69.81	2 $\frac{1}{2}$
Sept. 11	HDN-8	84	51-70	58.39	2
Sept. 11	HDN-8	106	54-73	63.81	2 $\frac{1}{2}$

\* Stretched mesh inside knots.

Table 24. Length Composition of Herring Samples 1952.

<u>Date</u>	<u>Area</u>	<u>Mesh size</u>	<u>No. of fish</u>	<u>Length in <math>\frac{1}{2}</math> cm.</u> <u>Range</u>	<u>Mean</u>	<u>Gill-net mesh size*</u>
June 19	HDN-2	2 $\frac{1}{2}$ in.	479	55-75	62.94	2 $\frac{1}{2}$ in.
June 20	HDN-1	2 $\frac{1}{2}$	150	51-70	59.69	2 $\frac{1}{2}$
June 24	HDN-1	2 $\frac{1}{2}$	230	54-78	63.14	2 $\frac{1}{2}$
July 3	HDN-1	2 $\frac{1}{2}$	241	53-81	67.80	2 $\frac{1}{2}$
July 9	HDN-1	2 $\frac{1}{2}$	206	55-75	63.96	2 $\frac{1}{2}$
July 31	HDN-8	2	144	50-68	60.15	2
Aug. 4	HDN-8	2	153	46-68	60.12	2
Aug. 7	HDN-8	2	214	46-66	52.17	2
Aug. 13	HDN-8	2	159	46-69	59.30	2
Aug. 14	HDN-8	2	151	51-70	60.61	2
Aug. 20	HDN-8	2	290	48-69	58.33	2
Aug. 28	HDN-8	2	275	48-69	57.88	2
Sept. 3	HDN-8	2	168	46-70	57.01	2
Sept. 4	HDN-8	2	137	53-75	63.37	2

\* Stretched mesh from knot centres.

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