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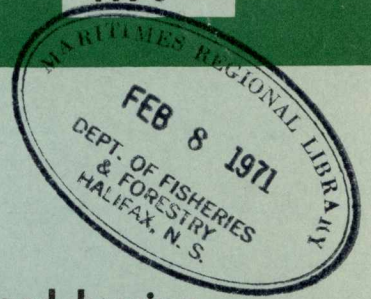
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CIRCULAR No. 18

1970



- 1. Recent developments in the Newfoundland herring fishery. V. M. Hodder**
- 2. Preliminary results of herring tagging in southwest Newfoundland coastal waters. G. H. Winters**
- 3. Herring investigations in northeast Newfoundland and Labrador. L. S. Parsons**



**FISHERIES RESEARCH BOARD OF CANADA
BIOLOGICAL STATION
ST. JOHN'S, NEWFOUNDLAND**

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1. RECENT DEVELOPMENTS IN THE NEWFOUNDLAND HERRING FISHERY. By V. M. Hodder.
2. PRELIMINARY RESULTS OF HERRING TAGGING IN SOUTHWEST NEWFOUNDLAND COASTAL WATERS. By G. H. Winters.
3. HERRING INVESTIGATIONS IN NORTHEAST NEWFOUNDLAND AND LABRADOR. By L. S. Parsons.

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PREFACE

Research on pelagic fish, primarily herring, was reactivated at the St. John's Biological Station in 1965 after a lapse of several years. Exploratory purse-seining revealed the presence of large overwintering bodies of herring in the fjords of southwestern Newfoundland between Port aux Basques and Bay D'Espoir, and facilities were organized to provide the basic data required for the monitoring and evaluation of the status of these and other herring populations in Newfoundland waters. Although emphasis has been placed on the delineation of the herring stocks and the effects upon them of the intense purse seine fisheries in the Newfoundland south coast and Gulf of St. Lawrence areas, some limited studies were carried out on mackerel, capelin and sand lance.

Since the autumn of 1965 the 82-foot research vessel *Investigator II* has been principally involved in research on herring - echosounder surveys, studies of eggs and recently-hatched herring (larvae), the studying of water temperature conditions, and gillnet surveys at places and times when herring samples for biological examination are not obtainable by other means. Highlighting research vessel activities in 1970 was the successful tagging of a large number of herring in southwest Newfoundland waters in March, just prior to the retirement of the *Investigator II* from service. The 62-foot *Marinus* contributed to herring research in April and May, and the 177-foot *A.T. Cameron* in November 1970.

Much field work, however, was conducted at the principal fishing ports. During most of the winter fishery along southwest Newfoundland herring sampling was carried out regularly at Harbour Breton and Isle aux Morts, where small field laboratories were maintained. During summer and autumn herring research in northern and eastern Newfoundland was facilitated by several overland field trips to such areas as Bay of Islands, St. Barbe North, Green Bay, Twillingate, Fogo Island, and St. Mary's Bay.

In carrying out our investigations the staff of the Pelagic Fish Division received the co-operation of fishermen, ship captains, reduction and processing plant officials and employees, and officers of the Department of Fisheries and Forestry, to all of whom we are grateful.

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Prior to 1965 the Newfoundland herring fishery was associated largely with the demand for herring as bait for the cod fishery and the periodic demand for pickled herring products as food, especially during and just after World Wars I and II. In 1946 there was a peak landing of just over 80,000 tons (1 ton = 2000 lb) all of which were taken by gillnets and beach seines. Subsequently the annual landings decreased to less than 10,000 tons in the early 1960's when most of the herring were utilized as bait. The introduction of purse-seining to southwestern Newfoundland in the autumn of 1964 and the upsurge in herring landings to 200,000 tons during the 1969-70 season is the subject for consideration in the following sections of this report.

Development of the purse-seine fishery

In the autumn and winter of 1964-65 a purse-seiner from the Pacific Coast of Canada, operating under charter for the Industrial Development Branch of the Department of Fisheries and Forestry of Canada, carried out exploratory fishing for herring in Newfoundland waters, particularly along the south coast. Large concentrations of herring were found to overwinter in the fjords between Bay D'Espoir and Port aux Basques (Fig. 1, Areas J1 and J2). These schools appeared in the area in late November and remained until April.

The initial explorations were so successful that more seiners from the Pacific Coast were attracted to the Atlantic Coast herring fishery, especially in 1967 after the failure of the British Columbia herring fishery. Also, on the Atlantic Coast increased interest in herring fishing resulted in the construction of seiners and midwater trawlers as well as the conversion of other types of fishing vessels to seiners. These and other seiners, which previously had limited their activities to summer and autumn fishing in the Bay of Fundy and the southern part of the Gulf of St. Lawrence, were attracted to the winter fishery on Newfoundland's south coast. Consequently the seiner fleet operating in southern Newfoundland increased rapidly from 4 seiners (2 others operated in the Bonne Bay area during November and December) in the autumn of 1965 to 55 seiners during the 1969-70 season. In addition a dozen or more vessels acted as carriers for some of the smaller seiners.

Coincident with the increased fishing activity was the construction of large reduction plants at Harbour Breton in 1966, Isle aux Morts in 1968 and Burgeo in 1969. Each plant has the capacity to process about 1000 tons of herring per day. A somewhat smaller plant, established in St. Mary's Bay in 1967, operated for 2 seasons but discontinued in the spring of 1969 due to its greater distance from the principal fishing areas and to an inadequate supply

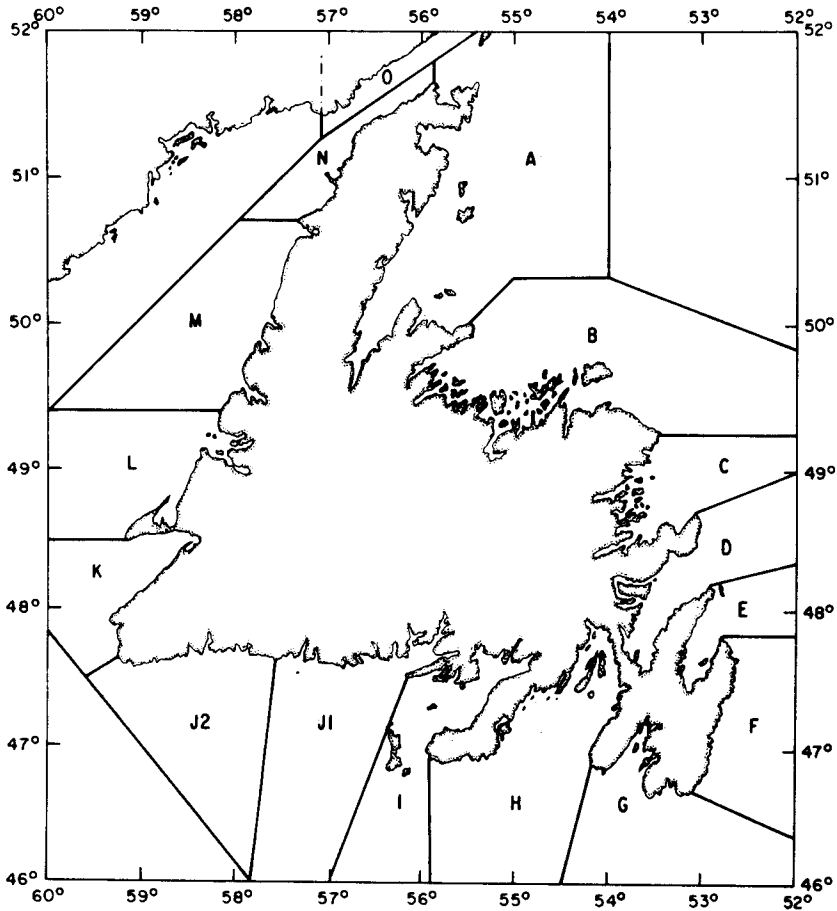


Fig. 1. Newfoundland statistical areas.

of herring in the vicinity of the plant. Smaller reduction plants, associated with fresh groundfish processing plants at Grand Bank, Fortune and Marystown, also became involved in the herring fishery and at times processed substantial quantities of herring for meal and oil. During the winter of 1969-70 storage facilities were established at Rose Blanche whereby a fleet of 8-10 seiners from southern Nova Scotia could land their catches for subsequent transport by larger vessels to a reduction plant at Pubnico, N.S. These landings are included in the Newfoundland herring statistics for the 1969-70 season.

For several years food-processing plants in Bay of Islands and Bonne Bay have utilized herring caught during November and December in the Bonne Bay area. These plants produced pickled and vinegar-cured herring almost entirely for U.S.A. markets. However, the recent decline in herring stocks of the Northeast Atlantic have caused European fish buyers to become interested in obtaining supplies of herring from the Northwest Atlantic. Consequently during the

1969-70 season many small plants were established to process herring for food, especially in western and southwestern Newfoundland. Also food-processing facilities for herring were set up at some of the reduction plants.

Mobile fleet landings

The purse seine fishery for herring now accounts for more than 95% of the Newfoundland herring yield annually. This fishery begins in autumn and continues uninterrupted until spring. Catch statistics are better compared on a seasonal basis, from July of one year to June of the next, than by calendar year, although most of the catches are made in the November to April period (Table 1). In July to October 1969 herring taken in southwestern Gulf of St. Lawrence were landed in Newfoundland for the first time.

Table 1. Monthly distribution of seiner landings (tons) in Newfoundland for the 1965-66 to 1969-70 seasons.

Month	1965-66	1966-67	1967-68	1968-69	1969-70
Jul.	...	...	...	...	1,858
Aug.	...	...	...	...	3,834
Sep.	...	...	...	...	813
Oct.	...	...	...	1,165	609
Nov.	1,691	4,423	7,988	13,923	12,203
Dec.	3,598	9,102	25,108	51,188	36,997
Jan.	3,621	18,526	25,771	46,327	56,979
Feb.	4,517	13,186	25,209	36,506	33,987
Mar.	4,900	11,086	25,148	24,248	34,186
Apr.	2,055	13,060	12,449	9,529	15,493
May	...	1,516	2,757	2,620	2,164
Jun.	...	...	...	...	...
Total	20,382	70,899	124,430	185,506	199,123

Table 2. Area distribution of seiner landings (tons)
in Newfoundland for the 1965-66 to 1969-70 seasons.

Area	1965-66	1966-67	1967-68	1968-69	1969-70
GH	675	1,435	6,920	242	320
I	...	5,005	12,677	5,348	8,966
J1	13,844	43,846	64,331	69,813	50,115
J2	2,425	12,315	28,288	83,831	103,749
K	...	1,283	1,976	265	31
M	3,438	6,559	5,907	3,886	4,056
Nfld.	20,382	70,443*	120,099*	163,385*	167,237
T	...	456	4,331	18,547	28,162
V	...	...	...	3,574	3,724
T + V	...	456	4,331	22,121	31,886
Total	20,382	70,899	124,430	185,506	199,123

* Statistics do not include substantial quantities of herring caught in Newfoundland and shipped directly by carriers to Nova Scotia ports. In 1966-67 and 1967-68 about 7,500 tons and 16,000 tons were transported there but the quantity is unknown for 1968-69.

The major winter fishery occurs mostly inshore in the fjords and bays along the south coast, between Cape Ray and Hermitage Bay in Areas J2 and J1 (Table 2). However, since the opening of the reduction plant at Isle aux Morts in October 1968, substantial quantities of herring caught near Cape Breton and the Magdalen Islands are landed at Isle aux Morts in the autumn prior to the appearance of herring in abundance in Newfoundland waters and again in the spring after the herring schools leave the Newfoundland coast. In 1968-69 and also in 1969-70 the fishery along the south coast began as usual about November 20 and ended in early April. During the 1965-66 to 1967-68 seasons the fishery took place largely in Area J1 (see Fig. 1), but in the winter of 1969 and more so in 1970 the area west of Burgeo (J2) yielded the largest quantity of herring.

Prior to the 1969-70 season all Area M herring catches were taken in the Bonne Bay area, but herring schools did not appear there in abundance in the autumn of 1969. After considerable searching

along western Newfoundland herring were found in Hawke's Bay near the northern boundary of Area M and nearly all of the 1969-70 catch by seiners in Area M was taken there in December and early January.

The Fortune Bay herring stock (Area I), which yielded nearly 13,000 tons to seiners in 1967-68 but only 5000 tons in 1968-69, showed some improvement during 1969-70 with a yield of nearly 9000 tons. However, the stock in Placentia and St. Mary's bays (Areas G and H) which yielded nearly 7000 tons to seiners in the 1967-68 season remained at a low level of abundance in 1969-70. This stock was greatly affected by phosphorus poisoning in Placentia Bay during the winter of 1969 and a high proportion of the adult population (estimated at 80% or more) died.

In recent years the seiners (and occasionally midwater trawlers) landing at Newfoundland ports have enlarged their area of fishing activity to the southern Gulf of St. Lawrence (Area T) and northeastern Nova Scotia (Area V). Area T catches came mostly from the Magdalen Islands (Bird Rocks) and northern Cape Breton (St. Paul Island), and the Area V catches from Sydney Bight and Chedabucto Bay. In 1969-70 herring landings from these areas totalled 32,000 tons, taken mostly in November and April.

Appendix Tables A to E give a monthly and area breakdown of the seasonal herring landings at Newfoundland ports by seiners. Small quantities by midwater trawlers are included.

Status of the southwest Newfoundland herring stock

Investigations began in 1965 to elucidate the size, distribution, biology and migratory behaviour of the herring stocks that support the winter purse seiner fishery (Hodder, 1967; Hourston, 1968). These were intensified in 1969. Efforts were continued to improve the collection of information on area of capture through log book records and port interviews of seiner captains. Sampling of seiner landings was carried out at Harbour Breton and Isle aux Morts, and several thousand herring were examined for information on their biology, and otoliths (ear bones) taken for age determinations.

There has been a gradual increase in the average size of herring taken along southwestern Newfoundland since the purse seine fishery began in 1965 (Fig. 2). The most abundant size group was 32 cm (12.6 inches) in total length during the 1965-66 season and this gradually increased to 34 cm (13.4 inches) in the 1969-70 season. More than 95% of the herring were 30-36 cm (11.8-14.2 inches) long. Age determinations of representative samples reveal that 6- and 7-year-old herring were the most abundant age-groups in

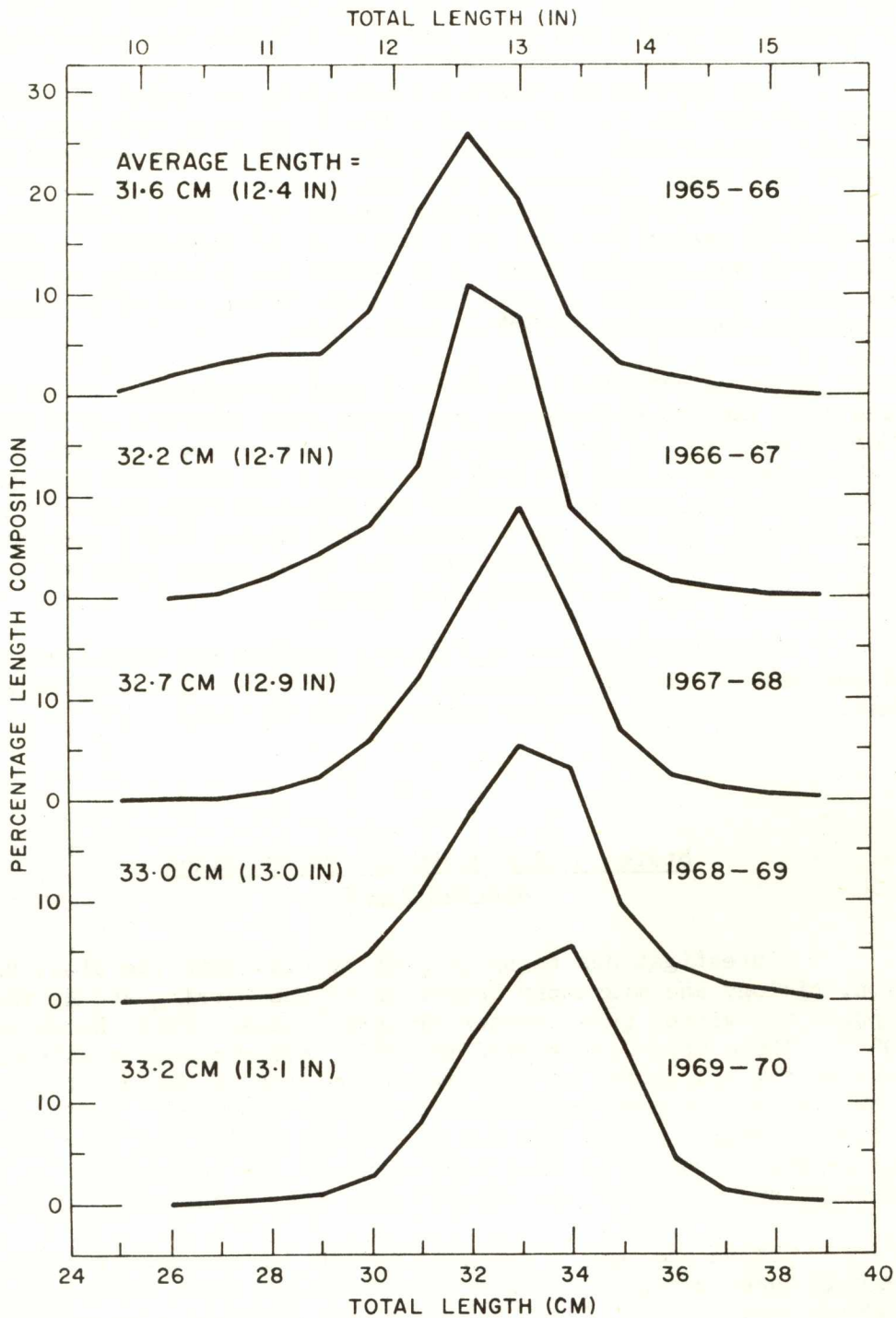


Fig. 2. Length composition of herring sampled from the southwest Newfoundland fishery, 1965-66 to 1969-70 seasons. (1 inch = 2.5 cm.)

1965-66 whereas 9- and 10-year-olds were more abundant than other age groups in the 1969-70 season. As in earlier years the composition of 1969-70 samples by maturity stages indicates a mixture of spring and autumn spawners, the latter comprising about two-thirds of the catches. Immature herring were rare in the samples.

The predominance of autumn-spawning herring in the great concentrations which arrive in southwestern Newfoundland in November indicate that autumn spawning must be very extensive in Northwest Atlantic waters. However, no extensive autumn spawning areas in Newfoundland waters were known prior to the development of the purse-seine fishery. In the autumns of 1968 and 1969 surveys along southern Newfoundland for recently hatched herring (larvae) produced no evidence of extensive spawning. Thus the south coastal waters cannot be considered a major spawning area for the great numbers of autumn spawners which overwinter in the fjords there.

The distribution of seiner catches at the start of the season indicate that herring arrive from the westward in late November and within a few days are distributed widely in the fjords between Burgeo and Bay D'Espoir. After January the fishery gradually shifts westward and the last catches for the season are usually made off the southwest corner of Newfoundland in April. The monthly distribution of seiner catches in southwest Newfoundland are shown in Fig. 3 and 4 for the 1968-69 and 1969-70 seasons. For about 3-4 weeks prior to the appearance of herring in southwest Newfoundland waters in late November, there is a fairly intense fishery at Magdalen Islands and Bird Rocks. Also, about a week after the herring leave Newfoundland in April, a short spring fishery occurs at Magdalen Islands again, followed by a substantial summer fishery in the southwestern part of the Gulf of St. Lawrence during June to September.

In 1969 herring samples from seiner catches at Magdalen Islands in November were compared with samples taken from catches in the coastal waters of southwestern Newfoundland in late November and early December. Details of the study are given by Hodder and Parsons (MS, 1970). In summary the investigation showed that there was no significant difference between areas for all of the biological characters examined (length, age, maturity condition, vertebral numbers, pectoral, dorsal and anal fin ray numbers, and *Anisakis* nematodes), although for nearly all of the characters very significant differences were apparent between spring and autumn spawners which were present in the samples from both areas in about the same proportion. The analysis thus supports the view that the winter fishery along southwestern Newfoundland is largely dependent on herring schools which migrate eastward from the southern part of the Gulf of St. Lawrence in the autumn.

An attempt to tag herring at Magdalen Islands in November 1969 was unsuccessful due to prolonged unfavourable weather conditions and the difficulty of obtaining live herring from seiners. However, 25,000 herring were tagged with internal metallic tags and released in La Poile Bay, Newfoundland in early March 1970. During the remaining 5 weeks of the Newfoundland purse seine fishery 391 tags were recovered from catches in southwest Newfoundland waters. From mid-April to mid-May 64 were recovered from catches taken between St. Paul Island and Magdalen Islands, and 70 from catches taken in the southwestern Gulf of St. Lawrence (American Bank, Gaspé, Chaleur Bay) during June to September. This confirms the westward movement of the herring schools after they leave the Newfoundland coast in the spring, as previously suggested by Hodder (1969). (For details of herring tagging, refer to article by G. H. Winters in this Circular.)

Implications concerning the resource

The recent increase in Newfoundland herring landings is due to the development of a substantial autumn and winter purse seine fishery in the fjords along the western part of the south coast. Concurrent with the development of this fishing there has been a rapid expansion of the summer fishery in the southern part of the Gulf of St. Lawrence. Consequently, the fishing industry and herring scientists are quite concerned whether or not these fisheries can continue successfully if the same stocks are being fished almost continuously at different times and places along its migratory route.

Recent studies show that herring samples taken during the autumn along southwestern Newfoundland differ in certain biological features from samples taken in other areas of Newfoundland and Labrador, but are very similar to those taken at Magdalen Islands just prior to the start of the Newfoundland fishery. In the spring the herring schools migrate westward to Magdalen Islands and later in June and July to the Gaspé Peninsula-Chaleur Bay region.

About the time that the herring leave the Newfoundland coast in the spring some separation of spring- and autumn-spawning herring is evident from samples from seiner catches near the end of the season in early April. The short but intense fishery at Magdalen Islands in late April and early May is based mostly on herring schools heading for shallow water to spawn, but a few catches consist largely of autumn spawners. However, the latter probably disperse to a large extent and ultimately move westward to the southwestern area of the Gulf of St. Lawrence, where they feed during the summer and spawn in late summer and early autumn.

The winter fishery along the southwest coast of Newfoundland is almost entirely on adult herring, that is, herring with gonads (roe) well-developed for spawning in the spring and herring which have only begun to recover from autumn spawning. The average size and age of these two spawning groups have increased slightly over the past 5 years. This together with the scarcity of immature herring in the southwest Newfoundland catches suggest that the annual recruitment to the exploitable stock must be substantial and occurs possibly during the summer in the Gulf of St. Lawrence.

The danger signs of overfishing are as yet not very evident. However, the fact that the southwest Newfoundland fishery (Areas J1 and J2) produced 153.6 thousand tons of herring in the 1968-69 season and only 153.8 thousand tons in 1969-70 (Table 1), despite an estimated 15% increase in fishing activity, may indicate that landings will not be increased without a substantial increase in fishing effort.

Acknowledgments

In compiling information and statistics on the herring fishery, the co-operation of seiner and midwater trawler captains, plant officials, staff of the Economics Branch and field officers of the Department of Fisheries and Forestry, and field technicians involved in pelagic fish investigations of the St. John's Biological Station is gratefully acknowledged.

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APPENDIX

Tables A to E

Mobile fleet herring landings (tons)
by month and area for the 1965-66 to
1969-70 seasons

Table A. Mobile fleet herring landings (tons) by month and area, 1965-66.

Area Month	GH	I	J1	J2	K	M	T	V	Total
Jul.	...	...	...	...	...	...	...	...	...
Aug.	...	...	...	...	...	...	...	...	...
Sep.	...	...	...	...	...	...	...	...	...
Oct.	...	...	...	...	...	...	...	...	...
Nov.	...	...	...	...	...	1,691	...	...	1,691
Dec.	...	...	1,851	...	...	1,747	...	...	3,598
Jan.	53	...	3,568	...	...	...	...	...	3,621
Feb.	420	...	4,097	...	...	...	...	...	4,517
Mar.	202	...	4,328	370	...	...	...	...	4,900
Apr.	...	...	...	2,055	...	...	...	...	2,055
May	...	...	...	...	...	...	...	...	...
Jun.	...	...	...	...	...	...	...	...	...
Total	675	...	13,844	2,425	...	3,438	...	...	20,382

Note: Bar-seine catches are not included.

Table B. Mobile fleet herring landings (tons) by month and area, 1966-67.

Area Month	GH	I	J1	J2	K	M	T	V	Total
Jul.	...	...	...	...	...	...	...	...	...
Aug.	...	...	...	...	...	...	...	...	...
Sep.	...	...	...	...	...	...	...	...	...
Oct.	...	...	...	...	...	...	...	...	...
Nov.	...	...	...	1,224	542	2,657	...	...	4,423
Dec.	...	...	4,899	820	...	3,383	...	...	9,102
Jan.	...	...	18,007	...	...	519	...	...	18,526
Feb.	...	...	12,891	295	...	...	...	...	13,186
Mar.	264	...	7,879	2,943	...	...	...	...	11,086
Apr.	1,167	4,529	155	6,727	482	...	...	...	13,060
May	4	476	15	306	259	...	456	...	1,516
Jun.	...	...	...	...	...	...	...	...	...
Total	1,435	5,005	43,846	12,315	1,283	6,559	456	...	70,899

Note: Bar-seine catches are not included.

Table C. Mobile fleet herring landings (tons) by month and area, 1967-68.

Area Month	GH	I	J1	J2	K	M	T	V	Total
Jul.	...	...	...	...	...	...	...	...	...
Aug.	...	...	...	...	...	...	...	...	...
Sep.	...	...	...	...	...	...	...	...	...
Oct.	...	...	...	...	...	...	...	...	...
Nov.	...	29	3,468	1,125	...	988	2,378	...	7,988
Dec.	...	...	20,528	77	...	4,503	...	...	25,108
Jan.	140	...	24,447	768	...	416	...	...	25,771
Feb.	20	5,808	11,589	7,792	...	...	...	...	25,209
Mar.	46	4,490	4,147	16,033	432	...	...	...	25,148
Apr.	5,370	2,350	152	2,493	1,544	...	540	...	12,449
May	1,344	...	...	...	...	...	1,413	...	2,757
Jun	...	...	...	...	...	...	...	...	...
Total	6,920	12,677	64,331	28,288	1,976	5,907	4,331	...	124,430

Note: Bar-seine catches are not included.

Table D. Mobile fleet herring landings (tons) by month and area, 1968-69.

Area Month	GH	I	J1	J2	K	M	T	V	Total
Jul.	...	...	...	...	...	...	...	...	...
Aug.	...	...	...	...	...	...	...	...	...
Sep.	...	...	...	...	...	...	...	...	...
Oct.	...	...	...	...	...	...	895	270	1,165
Nov.	...	...	3,911	123	...	2,564	7,325	...	13,923
Dec.	...	207	47,154	1,947	...	1,322	446	112	51,188
Jan.	...	3,713	14,536	27,640	...	...	...	438	46,327
Feb.	28	1,245	4,162	29,390	265	...	...	1,416	36,506
Mar.	91	183	50	22,629	...	...	...	1,295	24,248
Apr.	123	...	...	2,102	...	...	7,261	43	9,529
May	...	...	...	...	...	...	2,620	...	2,620
Jun.	...	...	...	...	...	...	...	...	...
Total	242	5,348	69,813	83,831	265	3,886	18,547	3,574	185,506

Note: Bar-seine catches are not included.

Table E. Mobile fleet herring landings (tons) by month and area, 1969-70.

Area Month	Area								
	GH	I	J1	J2	K	M	T	V	Total
Jul.	...	...	...	...	...	...	1,858	...	1,858
Aug.	...	...	...	...	...	...	3,834	...	3,834
Sep.	...	...	...	...	...	...	813	...	813
Oct.	...	...	...	...	...	...	386	223	609
Nov.	...	...	4,570	431	...	293	6,909	...	12,203
Dec.	...	180	23,977	10,423	...	2,286	21	110	36,997
Jan.	...	4,830	18,203	31,245	...	1,464	...	1,237	56,979
Feb.	200	1,479	1,945	27,970	...	...	603	1,790	33,987
Mar.	120	2,403	1,420	30,023	31	...	...	189	34,186
Apr.	...	74	...	3,657	...	...	11,587	175	15,493
May	...	...	...	...	...	13	2,151	...	2,164
Jun.	...	...	...	...	...	...	...	...	...
Total	320	8,966	50,115	103,749	31	4,056	28,162	3,724	199,123

Note: Bar-seine catches are not included.

Preliminary results of herring tagging in southwest Newfoundland coastal waters

G. H. Winters

Migration routes of fish have long been determined by tagging fish either externally or internally at one point along their migration route and recapturing the same fish at another point. Herring tagging, using internal magnetic tags has been successfully used to delineate the migration patterns of the herring stocks which support the long-established herring fisheries on the Pacific Coast of Canada and in the Northeast Atlantic. In an attempt to determine the various parts of the herring stocks which support an intensive purse-seine fishery along the southwest coast of Newfoundland an extensive tagging program was initiated in that area, the first phase of which took place in March 1970.

Tagging gear and equipment

The tagging operation was scheduled to take place just prior to the disappearance of the overwintering herring from the southwest coast of Newfoundland in the spring and its success or failure depended upon the availability of a continuous supply of live herring in good condition and weather and temperature conditions suitable for tagging to be carried out in small open boats. In addition it was essential that the herring be concentrated in protected bays where tagging could proceed independent of sea conditions and that a means be available which would enable shallow bays and coves to be scouted for herring.

Observer reports of seiners fishing in the south coast area in late winter 1970 indicated that herring were concentrated in small coves usually within protected bays. This type of distribution is ideal for bar seining by which large quantities of herring can be caught and barred in a cove for several days thus assuring a continuous supply of live herring in good condition. Consequently a bar seine (90 fath long and 9 fath deep) and a "dipper" seine (70 fath long and 9 fath deep) were obtained.

A 26-foot motorboat equipped with a portable Simrad echosounder was used in the search and detection of herring in coves and bays too shallow for the research vessel *Investigator II* which was used as the base for the tagging operation.

The tags obtained from Bergen-Nautik, Norway were made of #430 stainless steel and were approximately 3/4 inches long, 1/8 inches wide and 1/32 inches thick with rounded ends. These were coded in lots of 100 tags (beginning at L101) with each tag in a lot having the same code number.

Two small-meshed holding traps, a square one and a triangular one - both of which were 3 fath deep and framed out by 20-ft poles on each side were used to hold the herring for tagging purposes. These were attached to the headrope of the seine and herring were transferred from the seine into the holding traps simply by depressing the headropes and allowing the herring to flow over. The tagging operation itself took place in two small boats which were equipped with plastic or canvas tagging tanks capable of holding 50-75 live herring each.

Tagging procedure and method of recovery

The nature of the herring fishery along the south coast of Newfoundland (bulk catches by purse seiners) together with the method of processing (reduction into meal and oil) required that the tags be made of metal and inserted internally. The tagging procedure was as follows: The two small tagging boats were secured to the sides of the holding trap and live herring were then dipped from the trap into the tagging tanks of the boats. When this was completed the herring were removed individually from the tanks and held firmly in both hands by one member of the tagging team while the other member (seated opposite) using a pointed (#11) scalpel made a small incision in the belly of the herring just in front of and slightly above the pelvic fins. The metal tag, sterilized in alcohol, was then pushed forward into the body cavity. Before being released over the side, each herring was flexed several times to ensure that the tag was completely inside the belly. Under good conditions up to 300 tags an hour could be inserted by an experienced tagger.

The tags were recovered by magnetic separators which the reduction plants normally install in their meal lines to remove metal debris. These magnets were checked regularly by designated employees of the plant and any recovered tags along with the relevant recovery information were return to the Fisheries Research Board's Biological Station, St. John's. A reward of \$1.00 was paid for each tag returned.

Tagging operations

After scouting the Bay Le Moine area for several days without success, herring were finally located in quantity on March 3 at Galleyboy Head Cove, La Poile Bay where an estimated 100 tons of herring were barred and 8400 of these herring were tagged and released March 3-5. On the night of March 5 the remainder of the barred herring escaped across a sand-bar at high tide and tagging operations

did not resume again until March 7 when 30-40 tons of herring were barred at Bevan Cove located a half mile south of Galleyboy Head Cove. Due to the exposure of Bevan Cove to the open sea herring for tagging were first placed in the holding trap and towed to Galleyboy Head Cove resulting in a high mortality to the herring so that only 4800 were suitable for tagging purposes. Scouting resumed again and 50 tons of herring were barred at French Cove, Roti Bay, from which 11,800 were tagged from March 11-13 thereby bringing the total number of herring tagged to 25,000.

Weather conditions during the period of tagging were quite severe with air temperatures ranging from 23-41°F which caused frequent interruption in the tagging operations to allow personnel to return to the vessel to get warm.

Tag recoveries

Within a week after the first herring were tagged, tag recoveries were being reported at the reduction plant at Isle aux Morts and by the

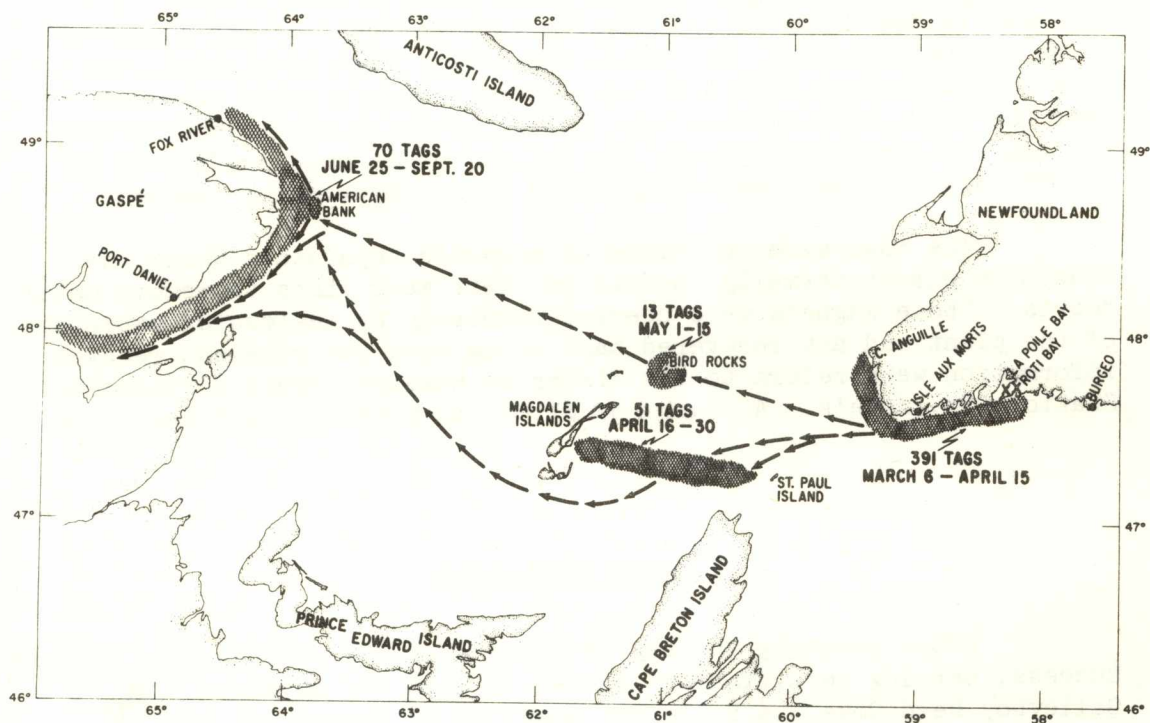


Fig. 1. Areas and dates of recapture of herring tagged along southwest Newfoundland, March 1970. Arrows indicate probable migration routes of herring as suggested by tag recoveries.

end of the herring fishery along the southwestern Newfoundland coast (April 15) 391 tags were recovered from landings of herring taken by purse seiners between La Poile Bay and Cape Anguille (Fig. 1). The majority of these tags were recovered at the Isle aux Morts plant (243) but tags were also recovered from reduction plants at Pubnico, N.S. (135) and Burgeo, Newfoundland (13).

With the disappearance of herring along southwestern Newfoundland in mid-April the seiner fleet began fishing between St. Paul Island, off Cape Breton and the Magdalen Islands and 51 tags were recovered during April 11-30 from landings (approximately 13,000 tons) of seiners fishing in that area. Forty (40) of these tags were recovered at the Isle aux Morts plant, 7 from the plant at Caraquet, N.B., 3 from the Burgeo plant, and 1 from the plant at Pubnico, N.S. From May 1-15 fishing was mainly centred around the Bird Rocks area and 13 tags were recovered from total landings of about 2500 tons from this area. Twelve of these tags were recovered at the Isle aux Morts plant and one from the plant at Lameque, N.B. Several tags were recovered June 25 from landings of seiners fishing on American Bank (Fig. 1) and 70 tags have been recovered (up to Sept. 20, 1970) from landings of herring (mainly at Shippegan and Caraquet, N.B.) caught between Fox River on the Gaspé Peninsula to the southwest area of Chaleur Bay, including the American Bank area. Total recoveries to September 20, 1970 have been 525 tags or a recovery percentage of 2.10%.

Significance of tag recoveries

The tag returns have indicated that in early April there is a rapid westward migration of herring from southwestern Newfoundland across Cabot Strait and along the southern Laurentian Channel between St. Paul Island and the Magdalen Islands. In addition some herring move north of the Magdalens to the Bird Rocks area. The herring fishery in these areas at this time is mainly based on spring-spawning fish. By late June at least some of these herring have reached American Bank which is a major feeding ground for herring (Iles and Tibbo, MS, 1970) and by July are dispersed around the Gaspé coast - Chaleur Bay region where spawning occurs in late summer and early fall.

The main significant feature of the above migration pattern is that the herring stocks which support the fall-winter fishery on the south coast of Newfoundland are not native to that area but rather represent the overwintering phase of a stock of herring derived from spring and fall spawnings in the southern Gulf of St. Lawrence. This has already been indicated by a comparison of certain biological characteristics of herring from these areas (Hodder and Parsons, MS, 1970).

References

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Herring investigations in northeast
Newfoundland and Labrador

L. S. Parsons

In recent years catches of herring in eastern Newfoundland waters with traditional gears (gillnets, bar seines) have been insignificant compared with the large quantities caught in south-western Newfoundland waters by the mobile purse seiner fleet. For this reason research on the biology of eastern Newfoundland herring stocks has been very limited. However, because of the increasing demand for herring for human consumption and a greater interest in the commercial possibilities of these stocks, studies aimed at understanding the biology, distribution, relative abundance and seasonal movements of herring in the eastern Newfoundland area were begun in 1969 and intensified in 1970.

The fishery

Notre Dame Bay supported a large herring fishery prior to 1920. Poor market conditions during the 1920's resulted in abandonment of the fishery and it has never been revived to any great extent. During the late 1950's as much as 15% of the total Newfoundland landings came from east coast waters (Notre Dame, Bonavista, Trinity and Conception bays), amounting to about 2000 to 3000 tons annually. Production from these areas dropped to 1300 tons in 1960, ranged between 1000 and 2000 tons in 1961-66 and dropped to less than 600 tons in 1967. Yield increased to 1500 tons in 1969.

During the nineteenth century large catches of herring were sometimes made in the Labrador area. The Journal of the House of Assembly, Newfoundland reports Labrador landings of 75,900 barrels in 1885 (up to Aug. 23). Apparently there have been great fluctuations in abundance of herring in this area. Landings have been erratic and there has never been an extensive fishery there. An experimental meal and oil plant established in Labrador in 1941 ceased operations after a few years because of irregular supplies of herring.

Herring surveys in eastern Newfoundland
and southern Labrador coastal waters

During 1969 three research vessel surveys were carried out along eastern and northeastern Newfoundland and southern Labrador to study the distribution, relative abundance and biology of herring in these areas.

During an August cruise by the *Investigator II* in the southern Labrador and Notre Dame Bay areas only small quantities of herring were caught and an echo-sounder survey of the areas did not record any significant herring concentrations. The largest catches were obtained in the Strait of Belle Isle near Red Bay. The few herring caught along southern Labrador between Battle Harbour and Groswater Bay had nearly ripe gonads (full of milt and roe) and appeared to be late summer or early autumn spawners, whereas those caught in Notre Dame Bay were recovering from a spring spawning. The Labrador herring were large, ranging in length from 14 to 16 inches, whereas herring caught in Notre Dame Bay were smaller, about 12 to 13 inches in length.

A late September to early October gillnet survey of Trinity and Bonavista bays, and a limited survey of Conception Bay in mid-November yielded only small catches of herring, and echo-sounding records did not reveal any significant fish concentrations. Herring caught in Trinity and Bonavista bays were slightly larger than those caught in Notre Dame Bay.

During 1970 several overland trips were made to Notre Dame Bay to obtain herring from local fishermen for biological examination (size, age, fat and moisture content, etc.) and to obtain information on the fishery and seasonal movements of herring.

Seasonal changes in distribution and biological characteristics

Since 1966, yearly reports of herring spawnings in the eastern Newfoundland area have been obtained from Department of Fisheries and Forestry officers and Fisheries Research Board field personnel. Biological examination of herring has revealed that eastern Newfoundland herring are primarily spring spawners. These herring spawn in shallow water from mid-May to mid-June depositing their eggs (roe) on the bottom. At spawning time "milky" water is usually visible in these areas and sometimes extends for miles. Reports indicate that in recent years herring in Bonavista and Trinity bays have abandoned their traditional inshore spawning grounds and now spawn in deeper water.

Eastern Newfoundland herring are not exclusively spring spawners for small proportions of late summer-early autumn spawners are found in Bonavista and Trinity bays. Also, the stage of gonad (roe) development of medium-size herring from Quirpon, and large Labrador-type herring from the Strait of Belle Isle indicates that these herring are predominantly August-September spawners. Apparently large quantities of these "Labrador" herring are taken in some years in codtraps during

June and July along the southern Labrador coast from Blanc Sablon in the south as far north as Groswater Bay. Most of the fishermen interviewed on an *Investigator II* cruise to southern Labrador in August 1969 stated that there is generally a large fall "run" of herring in the southern Labrador area beginning in late August and continuing into September and sometimes October. At present little is known of the seasonal migrations and distribution of these "Labrador" herring. Herring caught in Notre Dame Bay in late July to early August 1970 were August-September spawners similar in various biological features to those herring prevalent in the Strait of Belle Isle and along southern Labrador during June and July. These large "summer" herring, very different from the spring spawners which prevail inshore during the spring and autumn, occur in northeastern Newfoundland coastal waters generally from mid-July to mid-August, the actual time of their migration varying from year to year. A small proportion of these herring caught in Notre Dame Bay from late July to early August 1970 had apparently spawned quite recently. However, the majority appeared likely to spawn later in August or during September. These herring may spawn in deeper water than spring spawners where the spawning activity would not be noticed by local fishermen. These large late summer-autumn spawners prevalent in the Strait of Belle Isle and along southern Labrador in June and July and along northeastern Newfoundland during July and August may belong to a single herring stock which has extensive seasonal migrations.

The seasonal pattern of the gillnet fishery and other evidence indicate that eastern Newfoundland spring-spawning herring move into the bays during the fall to overwinter, spawn in shallow water during May-June when water temperatures are favourable and then disperse to feed during the summer months. After spawning in May and June the herring concentrations disappear from inshore waters. During the summer they are probably dispersed offshore in the warm surface layer and spend the summer months feeding and building up their fat reserves at a time when the small planktonic organisms (copepods and euphausiids), which are their primary food, are fairly abundant and water temperatures are proper for active feeding. As water temperatures decrease in the autumn, feeding activity becomes reduced and the herring move inshore to spend the winter. The actual time of the fall migration into the bays may vary from year to year depending on weather and water temperature conditions but herring are generally available in large quantities by November and in some years as early as September. They are fished to a limited extent in the autumn (September-December) and again in the spring (April-June) as soon as ice conditions permit. Catches have been made in January and nets set through the ice during extremely cold winters have yielded good catches of herring. During the winter the herring would be concentrated and relatively sluggish just as they are along southwestern Newfoundland from November to April.

These herring undergo a seasonal change in fat and moisture content which is related to their spawning, feeding and overwintering activities. Spring spawners have a minimum fat content of about 7-8% during the spring months just preceding and around spawning time. The fat content begins to increase and reaches about 12% by late September. The average fat content reaches a maximum of about 15-16% during November and remains relatively high throughout the early winter. Although the herring are sluggish and activities are reduced during the winter, the fat reserves are used to maintain life and as the winter and spring progresses the average fat content shows a gradual decline to a low of about 7-8% by spawning time. Autumn-spawning herring, on the other hand, have a maximum fat content in July-August prior to spawning; during the autumn the average fat content of autumn spawners is lower than that of spring spawners.

Since eastern Newfoundland herring are primarily spring spawners, they would be in excellent condition during the late fall and early winter and hence would be excellent for processing for human consumption, much more so than the herring which overwinter along southwestern Newfoundland, the majority of which are autumn spawners. Previous exploratory surveys for herring along eastern Newfoundland have been largely confined to the summer and early fall. Although the results indicate that during the summer months there are only limited quantities of herring available in inshore waters, little information has been obtained which would permit a realistic assessment of the relative abundance of herring in northeast Newfoundland waters and their commercial possibilities. Extensive echo-sounder surveys and exploratory fishing are required to determine the fatness, relative abundance, and distribution of herring in these bays during the late fall and early winter. If significant concentrations overwinter in the fjords and bays of northeast Newfoundland, these would have a good commercial potential in view of intensive pressure on presently exploited stocks and the increasing demand for herring for human consumption.