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Inter-relationship among Hawke's Bay, southwest Newfoundland and southern Gulf of St. Lawrence herring stocks

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Introduction

In order to elucidate the major migration routes and stock composition of herring supporting the summer and winter herring fisheries in the southern Gulf of St. Lawrence and southwest Newfoundland areas respectively, the Fisheries Research Board of Canada initiated an extensive tagging program in 1970. The results of the first phase of this program have already been documented (Winters, MS, 1971a, MS,1971b; Beckett MS,1971) and have confirmed the general relationships between southern Gulf herring and southwest Newfoundland herring hypothesized by Hodder (1969). The second phase of the tagging program was directed towards identifying local herring stocks which might conceivably contribute to the winter fishery along southwest Newfoundland. The northwest coast of Newfoundland was subsequently selected for tagging operations partly because of the timing of the fishery there relative to the winter fishery along southwest Newfoundland and partly because of reports from the mobile fleet which suggested a significant movement of herring southward along the west coast of Newfoundland in late fall.

Mobile fleet landings from the west coast of Newfoundland increased from 3000 metric tons in 1965 to just over 6000 metric tons in 1967 (Hodder, 1971) with most of the herring taken in November and December in or near Bonne Bay (Fig. 1) up to 1968 and since then mainly in Hawke's Bay. Landings from the Hawke's Bay - Bonne Bay area dropped to less than 1200 metric tons in 1971 (Winters and Parsons, MS,1972). Hawke's Bay was selected for tagging operations mainly because it is a protected embayment and in December 1970, 3400 herring were tagged with metallic tags. In addition, seasonal samples of herring were collected for comparison of certain biological characteristics with those from southwest Newfoundland. This document reports on the tag recaptures from the Hawke's Bay releases in relation to certain biological features of the Hawke's Bay herring.

Methods and Materials

Herring for tagging purposes were obtained from a purse-seiner on the night of December 4, 1970 and transferred to a small-meshed holding trap, 5 metres deep and supported on the surface by two diagonally secured 6 metre poles. The actual tagging operations were carried out in small boats equipped with plastic tagging tanks each capable of holding 50-75 live herring. The herring were tagged with internal metallic tags in the manner described by Winters (MS, 1971a) and individually released. Surface temperatures in the tagging locality were monitored and any tagging mortalities were recorded. The tags were recovered by magnetic separators normally installed in most reduction plants and an incentive reward of $1.00 was paid for each tag returned with the appropriate recovery information.

Herring samples consisted of 50 specimens each and were selected randomly from catches of purse-seines and gillnets. For each sample, length, sex, stage of maturity and weight were recorded and otoliths were removed for subsequent ageing. Examination of specimens for nematode incidence (percentage of specimens containing nematodes) and nematode intensity (average number of nematodes per fish) was restricted to the body cavity and viscera. The length recorded is the greatest total length and length measurement data, recorded to the nearest millimetre, were grouped into 1-cm intervals of the cm below. The ageing techniques used are as described by Hodder and Parsons (1971) and the stages of gonadal development are based on the classification adopted by ICNAF (1964). Immature herring (stages 1 and 2) were assigned to spring or autumn spawning types by otolith characteristics (L.S. Parsons, unpublished data).

Results

Tag recaptures

The tagged herring released in Hawke's Bay were not in prime condition because the drying-up process of the seine resulted in considerable scale loss and this is undoubtedly reflected in the low rate of return from the Hawke's Bay tagging experiment (Table 1) compared with the rate of return from previous experiments (Winters MS, 1971a). Nevertheless the few tags that have been returned have indicated a significant migration pattern. Three (3) of the Hawke's Bay releases were recaptured shortly afterwards along the southwest coast of Newfoundland during the 1970-71 winter fishery, and the following summer (1971) two tags were recovered from the southern Gulf of St. Lawrence fishery. During the 1971-72 winter fishery along southwest Newfoundland an additional five (5) tags were recaptured, at least four of which have been confirmed as being recovered from landings of catches made in that area with the possibility that the single tag recovered from the Isle aux Morts plant may have come from mixed landings of Hawke's Bay and southwest Newfoundland herring.

These tag returns suggest that the Hawke's Bay fishery is based on a stock of herring which is in transit from the summer feeding and spawning grounds in the southern Gulf to the over-wintering area along southwest Newfoundland. To evaluate this possibility a comparison of various biological characteristics of the Hawke's Bay herring with those from southwest Newfoundland was made and is presented below.

Length and age composition

The Hawke's Bay autumn spawners ranged in length from 25 to 40 cm with a mode at 33 cm whereas the southwest Newfoundland autumn spawners ranged from 27 to 39 cm in length with a mode at 34-35 cm (Fig. 2). The Hawke's Bay length curve has several sub-modal lengths compared with the southwest Newfoundland samples and has a greater representation of smaller fish. The length composition of the Hawke's Bay spring spawners is bimodal with peaks at 31 cm and 34 cm while the southwest Newfoundland length curve is distinctly unimodal with a peak at 33 cm. Herring of length groups less than 30 cm constituted a significant proportion of the Hawke's Bay samples but were insignificant in the southwest Newfoundland samples.

Among both southwest Newfoundland and Hawke's Bay autumn spawners old fish (> 10 years old) of the pre-1959 year-classes form the dominant age group (Fig. 2). The 1962 year-class is well represented in both areas whereas the 1965 year-class is second in importance only to the pre-1959 year-classes in the Hawke's Bay samples but is barely present in the southwest Newfoundland area. Among spring spawners the 1965 year-class is dominant in the Hawke's Bay samples whereas this year-class is almost completely absent in the southwest Newfoundland samples which are dominated by the pre-1960 year-classes (43.4%). It therefore appears from age and length composition data that there is a greater degree of similarity between autumn spawners from Hawke's Bay and southwest Newfoundland than between spring spawners from these areas.

Maturity composition

The relative proportion of spring and autumn spawning types is different in the Hawke's Bay samples compared with those from southwest Newfoundland (Table 2). Over 76% of the herring sampled from the southwest Newfoundland fishery were classed as autumn spawners compared with only 38.3% of the Hawke's Bay specimens. Within the autumn-spawning group nearly 100% of the southwest Newfoundland specimens were classified as Stage VIII (recovering spents) whereas a significant percentage (26.8%) of the Hawke's Bay herring were Stages II (immatures) and III (early maturing). Similarly within the spring-spawning component nearly 90% of the southwest Newfoundland specimens were Stage IV's whereas over 40% of the Hawke's Bay specimens were Stages II and III.

Nematode incidence and intensity

For the spring spawners the nematode incidence increases from 0% at age 4 to over 80% at age 9 for the Hawke's Bay fish and from 0% at age 5 to over 70% at age 10 for southwest Newfoundland fish (Fig. 3). For autumn spawners the difference in nematode incidence is much greater between the two areas with the Hawke's Bay herring having 100% infestation in the older fish (> 10 years old) compared with around 60% for southwest Newfoundland herring.

The differences between the two areas are even more pronounced when the mean number of nematodes per fish (intensity) is compared (Fig. 3), particularly for the older fish. For the autumn spawners nematode intensity increases from 0 nematodes per fish at age 4 in the Hawke's Bay samples to over 11.5 nematodes per fish in the > 10 year old age group. This compares with about one nematode per fish for the southwest Newfoundland autumn spawners. Similarly for the spring spawners the nematode intensity increases with age to over 5 nematodes per fish in the very old age group of the Hawke's Bay samples compared with about 1.5 nematodes per fish for southwest Newfoundland specimens.

Discussions and conclusions

The tag recaptures from the 1970 Hawke's Bay tagging experiment indicate that in the late autumn there is a movement of herring southward along the west coast of Newfoundland to the over-wintering area along southwestern Newfoundland and that at least some of these herring subsequently migrate into the southern Gulf of St. Lawrence during the summer. The recovery of tags from both the 1970-71 and 1971-72 winter fisheries along southwest Newfoundland suggests some regularity in this migration pattern.

The migration pattern indicated by the Hawke's Bay tag returns may be accounted for by several possibilities: (1) The Hawke's Bay fall fishery is based solely on herring from the southern Gulf of St. Lawrence in transit to their over-wintering area along southwest Newfoundland; (2) the Hawke's Bay fishery is based entirely on a resident population of herring which move southwards to over-winter with the southern Gulf herring along southwest Newfoundland; (3) the Hawke's Bay stock is a mixture of resident herring and southern Gulf herring, the latter of which are en route to the southwest Newfoundland coast. We shall now consider these possibilities in turn.

The first possibility can be discounted on the basis of differences in certain biological characteristics between herring from Hawke's Bay and southwestern Newfoundland presented here. The over-wintering herring concentrations along southwest Newfoundland are predominantly autumn spawners (over 76%) whereas spring spawners dominate the Hawke's Bay samples (nearly 62%). There are also distinct differences in the age composition of spring spawners from the two areas and for both spawning groups in the degree of nematode infestation. Furthermore, Parsons (MS, 1972) has found meristic differences between spring spawners from the two areas. These differences in biological characteristics also render it unlikely that the Hawke's Bay fishery is based entirely on a resident population of herring which over-winter along southwest Newfoundland. However, such differences could be masked by the large size of the southwest coast population relative to the apparent size of the Hawke's Bay population. Nevertheless, the migration pattern suggested by the recapture of Hawke's Bay tagged herring in the southern Gulf of St. Lawrence indicates that this is not so.

Considering the third possibility, it has been shown that there is a certain degree of similarity between southwest Newfoundland and Hawke's Bay autumn spawners particularly in length and age composition, more so than between spring spawners. Parsons (MS, 1972) has also shown that there are no meristic differences among Magdalen Islands, southwest Newfoundland and Hawke's Bay autumn spawners whereas spring spawners from Hawke's Bay and south western Newfoundland differ significantly in mean numbers of gill rakers and anal fin rays. The recapture of tagged herring from the Hawke's Bay releases in the southern Gulf of St. Lawrence during the summer of 1971 indicate that at least part of the southern Gulf stock of herring migrate via Hawke's Bay to over-winter along southwest Newfoundland. We therefore conclude that the autumn spawning component of the herring which support the Hawke's Bay fall fishery includes herring which are en route from the southern Gulf to southwest Newfoundland and that the spring-spawning component of the Hawke's Bay stock is basically a resident population which does not migrate southwards to southwest Newfoundland.

The main migration route of southern Gulf of St. Lawrence herring to southwest Newfoundland in the fall occurs across Cabot Strait via the Bird Rocks area (Winters, MS, 1971a). At this time the maturity, size and age composition of herring taken around the Bird Rocks are virtually identical with those of herring which subsequently appear along southwest Newfoundland a month or so later (Hodder and Parsons, 1971a). In view of this and the small size of the Hawke's Bay fishery it would appear that only a small proportion of the southern Gulf herring migrate via the Hawke's Bay route.

It is also interesting to note that there is an apparent bifurcation of the return migration pattern to the Gulf of St. Lawrence in the spring. Tag returns (Winters, MS, 1971a) have shown that there is a movement of herring across Cabot Strait to the Magdalen Islands in the spring. Maturity composition data indicate that these herring are mainly spring spawners (Hodder and Parsons 1971b) which apparently spawn there in May. Trawlers fishing along the west coast of Newfoundland in 1970 and 1971 reported the occurrence of fair quantities of herring in bottom tows in late April and early May and during this period in 1971 seiners caught 3700 metric tons along the southern portion of the west coast. Herring samples obtained from these catches consisted almost entirely (95%) of autumn spawners which were similar in size, age and meristic characteristics to southwest Newfoundland herring (Hodder et al., in preparation). It would therefore appear that at least a portion of the autumn spawners over-wintering along southwest Newfoundland move into the northern Gulf in the spring. This may partially account for the time lag between the end of the southwest Newfoundland fishery in April and the reappearance of significant quantities of autumn spawning herring in the southern Gulf of St. Lawrence in mid-July (Messieh and Tibbo, 1971). It is possible that the northern Gulf of St. Lawrence may also serve as a feeding area for a portion of the autumn spawners in addition to the known feeding area on American Bank. Such a difference in feeding area might account for the much higher nematode incidence and intensity in the Hawke's Bay autumn spawners compared with those from southwest Newfoundland.

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Table 1. Summary of tag recoveries from the Hawke's Bay tagging experiment, December 1970.

Date of Recovery	Area of Recovery	
	Southwest Newfoundland	Gulf of St. Lawrence
Dec 70	1	-
Mar 71	2	-
June 71	-	1
Aug 71	-	1
Dec 71	1	-
Jan 72	2	-
Feb 72	2	-
Total	8	2

Table 2. Percentage maturity composition of spring and autumn spawners in the 1970 Hawke's Bay fishery and during the 1970-71 winter fishery along southwest Newfoundland.

Area	Spawning group	Maturity stage					No. fish	% autumn spawners
		I	II	III	IV	VIII		
Hawke's Bay	autumn	-	15.2	11.6	-	73.2	171	38.3
	spring	0.8	10.5	29.1	59.6	-	275	
Southwest Newfoundland	autumn	-	0.3	-	-	99.7	765	76.5
	spring	-	0.5	12.1	87.4	-	235	

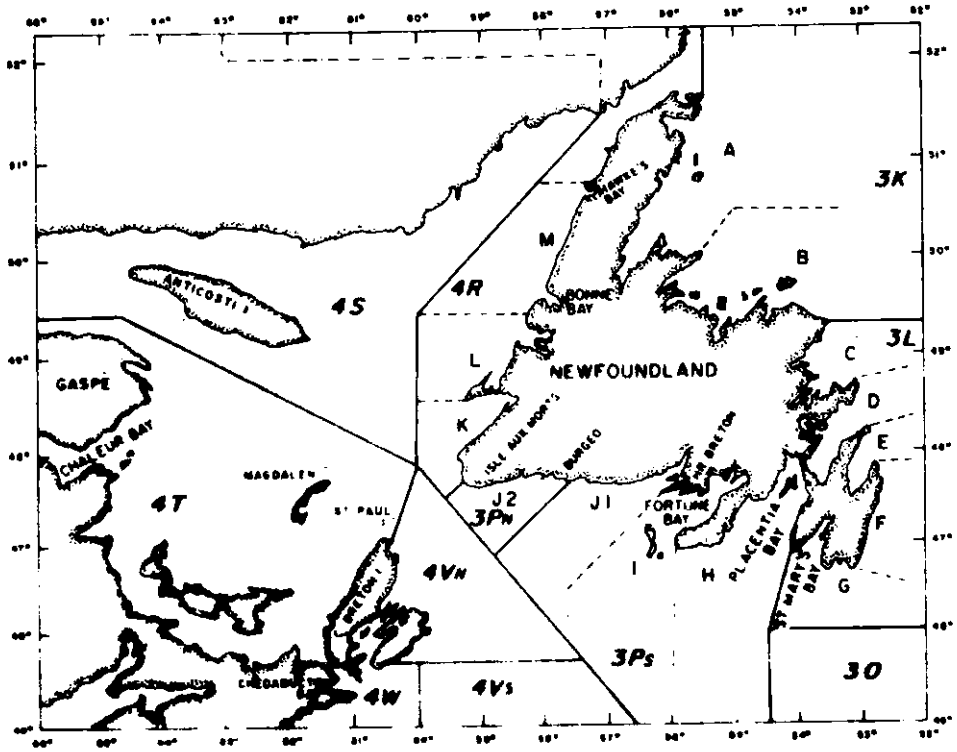

Fig. 1. Map of the Gulf of St. Lawrence-Newfoundland area with place names and statistical areas mentioned in the text.

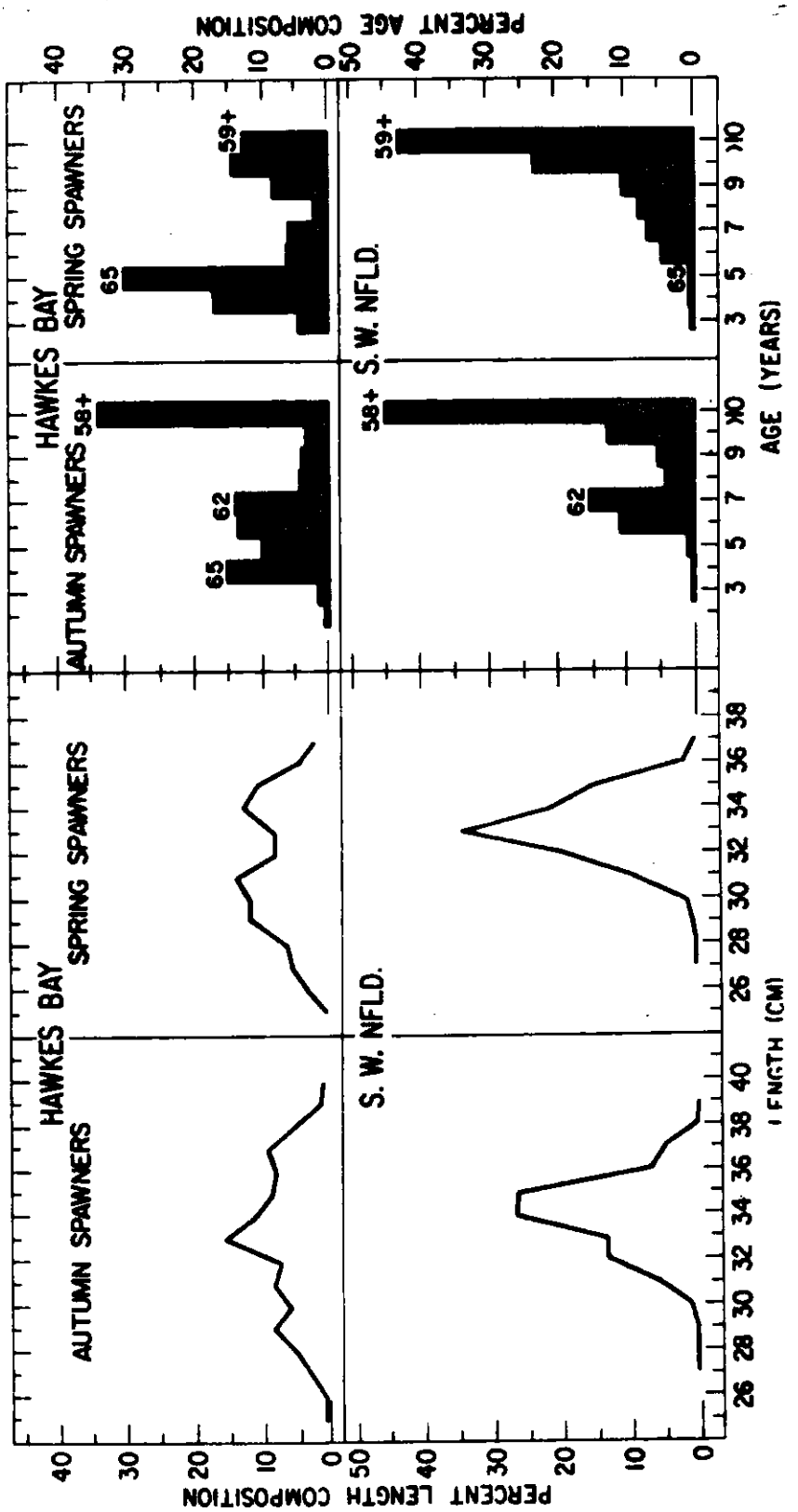

Fig. 2. Length and age composition of herring caught by purse-seine at Hawke's Bay and along southwest Newfoundland, December 1969.

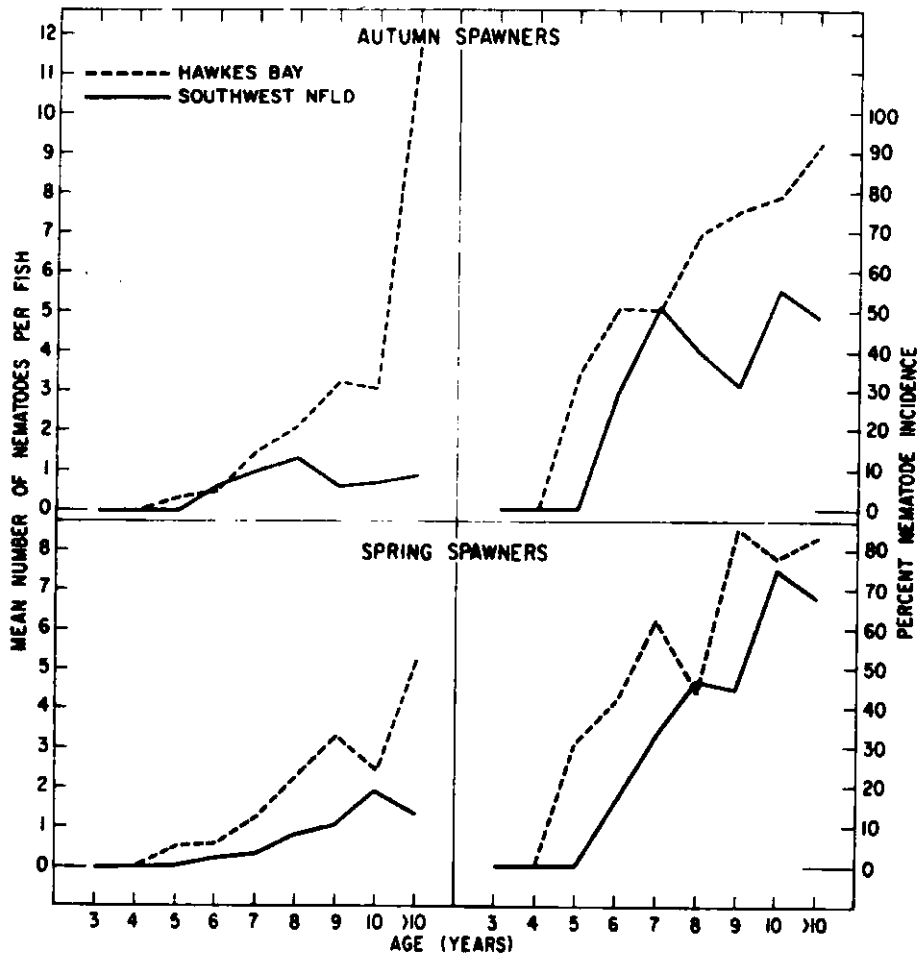

Fig. 3. Incidence and intensity of nematodes in herring from Hawke's Bay and southwest Newfoundland, December 1970.