RESTRICTED

International Commission for the Northwest Atlantic Fisheries

Serial No. 3732
(D.c.3)

ICNAF Res.Doc. 76/I/1

EIGHTH SPECIAL COMMISSION MEETING - JANUARY 1976

Distribution of herring from the Nova Scotia Shelf

by

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INTRODUCTION

Herring in the Northwest Atlantic is one of the major fishery objects for the USSR and a number of the other countries. Therefore, the studies on the distribution, biology and stock size of herring are regularly carried out, in particular, by ICNAF member countries.

In this paper the distribution and behaviour of herring from the Nova Scotia Shelf and ICNAF Subareas 4V and 4W, as well as from the southern Subarea 4X are considered.

According to statistical data (table 1), the herring catches sharply increased there beginning from 1968, and exceeded 100 thous. tons in 1969-1970. In subsequent years the fishing somewhat declined.

Such a sharp increase in herring catches can be attributed to the fact that the Nova Scotia Shelf herring was fished at a low intensity level, and its stock size was relatively large. The intensive fishing resulted in a somewhat decreased stock size of herring and the catches taken were at lower level.

In prospect it is supposed to control the herring stock size on the Nova Scotia Shelf by the echometric survey method, which is practically impossible without good knowledge of distribution and behaviour of the object under studies.

TABLE 1

The fishing of herring in 4VS and 4W according to ICNAF data (in tons)

COUNTRY :	Y E A R S						
	1966	1967	1968	1969	1970	1971	1972
U S S R	1777	570	1900	65586	71559	28876	16568
CANADA	1199	1028	1204	27744	29151	53583	18002
POLAND	-	17	491	4593	1165	3	28
WEST GERMANY	-	-	7005	15187	3321	-	589
T O T A L	2976	1615	10600	111110	105196	83960	35887

METHOD AND MATERIAL

For the analysis of herring distribution on the Nova Scotia Shelf in territorial waters the papers of the following authors were used: Tibbo S.N. (1957), Leim A.H. (1957), Tibbo S.N. and McKenzie R.A. (1963), Tibbo S.N. and Lauzier L.M. (1968), McKenzie R.A. (1964), Percins F.E. and Antony V. (1969), Iles T.D. and Tibbo S.N. (1970), HodderV.M. and Parsons L.S. (1971), Boyar H.C., Perkins F. (1971), Decamps Ph. (1971), Schubert K. (1970), Sameoto D.D. (1971), Winters C.H. and Parsons L.S. (1972), Iles T.D. (1972).

The material obtained by the Soviet scouting and fishing ships for the period from 1963 to 1972 was used as a base for designing of a scheme of herring distribution beyond territorial waters. Based on this material at first the monthly schemes of herring distribution were designed followed by a more general scheme of distribution and migration of Scotian Shelf herring which is given in the paper (fig. 1a,b).

The schemes of herring distribution depending on the depth and temperature were designed based upon the cruise reports of hydrologists and the data observed and inserted in the logs (fig. 2,3).

In fig. 4 the grapgic presentation of the depth of herring occurrence in the light and dark hours of the day is given. The light hours of the day continued from 6 a.m. to

18 p.m. (local time). The dark hours of the day continued from 18 p.m. to 6 a.m. The graphs were constructed based on the data inserted in the logs. The depth and time were calculated as a mean value during the whole period of hauling. The points obtained were connected by straight lines.

A total of 600 haulings was analysed and approximately 145000 herring specimens were measured.

RESULTS

1. Seasonal distribution and migration of herring

In fig. 1 a general scheme of herring distribution and migration in the Nova Scotian Shelf region if presented.

In January the bulk of herring from Banquereau Bank generally occurs in the Scatari Bank region and along the eastern and south-eastern coast of Cape-Breton Island (Schubert K., 1970, Decamps Ph., 1971, Iles T.D., and Tibbo S.N. 1970). Here herring feeds at the depths of 40-70 m. The bottom in these areas is rough, as a rule, (Vialov YU.A. and Karasev B.E., 1967), therefore, it is difficult to catch herring by trawls. The concentrations of herring often occur near the coast in territorial waters (Iles T.D. and Tibbo S.N. 1970). The herring is dispersed as small schools above the bottom and forms mixed aggregations without any trend towards a distribution by size (Yudanov I.G. 1963).

In the midst of January, or somewhat earlier or later in some years, a division of herring into two size groups is observed which migrate in different directions. Larger herring of 32 to 40 cm in length move substantially away from the Nova Scotia shore towards the area of eastern and south-eastern slopes of Banquereau Bank. It is suggested that the migration is caused by outlet of cold water with the temperature below 2°C from the Gulf of St. Lawrence. However, a total cooling of shelf water during the winter period is evidently of great importance. Herring seems to retreat from feeding grounds before the front of cold water in search of new feeding grounds in the gradient zone. Cold water tonque

of low intensity may drive herring back for an insignificant period only. It is just the moment for appearing of herring schools in the fishing zone for a short period of time. Powerful tonque of cold water stipulated by annual meteorological conditions to a great degree, which is accompanied by cooling of inshore water in the area of Cape Breton Island, Scatari and Canso Banks, where feeding Banquereau herring occurs in prolonged migration of herring to the open Scotian Shelf. Depending on the period of outlet of such cold water tonque and the temperature of the inshore water around Cape Breton Island, considerable fluctuations are observed in the period of herring appearance: January - February in 1971 and March in 1972.

Following the distribution of cold water from the north to the south, this group of herring performs a kind of circular migration. At first it moves across Misaine and Artimon Banks towards the eastern slopes of Banquereau Bank (Chuksin Yu.V., Vialov Yu.A. 1963) gradually shifting in the south-west direction along the southern slopes of Banquereau Bank, so that in April the bulk of herring appears on the western slopes of Banquereau Bank. At the end of April - beginning of May this herring leaves for an inshore zone where prespawning feeding takes place (fig.1a).

The migration path of smaller size Banquereau herring (L= 28 - 32 cm) is somewhat different (fig. 1b). It does not move far from the shore. From Cape Breton Island it migrates along the coastline in the south-west direction. During this period it may occur in the Chedabucto Bay over a long period of time. At the end of March this herring appears in the area of Middle Bank and western slopes of Banquereau Bank where it generally stays till the second decade of May. In May this group of herring migrates to territorial waters.

The youngest length-age groups of Banquereau herring of 27 cm in length are not fished by the Soviet fishing and scouting ships. This herring is most likely to occur in Canadian territorial waters, in particular, in the Chedabucto Bay. (Iles T.D., Tibbo S.N. 1970).

In the area of the Nova Scotia shelf another population of herring can be distinguished (Konstantinov K.G. and Noskov A.S. 1971). Its spreading and migration paths are schematically given in fig. 1b.

Till now neither distribution, nor spawning grounds of this herring were known because of inadequate number of observations.

From special literature it is evident that a number of spawning grounds of fall and spring spawners can be observed along the south-eastern coast of Nova Scotia (Tibbo S.N. and McKenzie R.A. 1963, Sameoto D.D., 1971). However, the ichthyological surveys showed that all these spawning grounds are too small to be the only ones for the whole population of Nova Scotian herring (Sameoto D.D., 1971).
Besides, in January - February 1972, and then in March - April large concentrations of young herring of age 2+ were discovered which gradually moved from the northern slopes of Browns Bank to the eastern ones and further to the Sambro and Emerald Banks area. A large spawning ground of herring is also known to be in the area of southern extremity of Nova Scotia (McKenzie R.A. 1964, Iles T.D. 1972). There the spawning of herring was observed in September 1961 (McKenzie R.A. 1964) while in July 1962 large concentrations of young herring were discovered on Browns Bank (Vialov Yu.A. and Karasev B.E. 1967).

From comparison of all the data on Nova Scotian herring distribution during the year it can be suggested that this very spawning ground is the major one for the population of Nova Scotian herring. Besides, on additional consideration of herring larvae distribution along the Nova Scotia coast, the extra spawning grounds around Cape Sable, in the area of St. Margaret Bight and eastwards of Halifax can be distinguished (Sameoto D.D. 1971) (fig. 1b).

2. Herring distribution in connection with the depth, temperature and time of day.

Banquereau herring is observed within a rather wide

temperature range from 2° to 8°C (fig 2). However, a seasonal character of temperature in the areas of herring aggregations is evident. The depths of herring occurrence also differ. Thus, in January-February the concentrations of Banquereau herring kept to the areas with the temperature of 2° - 4°C (fig. 2a, b, c), while in March herring occurred at the depth level with the temperature of 4° - 8°C (fig. 2d,e). In January - February the greater part of Banquereau herring concentrations kept to somewhat lesser depths (50-150 m) than in March (120 150 m).

A correlation is observed between the depth and temperature distribution of herring. So, in March 1972 the nothern winds had driven large masses of cold water with the temperature below 2°C to the southern slope of Banquereau Bank where the aggregations of Banquereau herring occurred. These masses of cold water intruded into the upper water levels down to 50-100 m. This may be the reason why herring did not rise to the surface in that period (Zusser S.G. 1971). Just insignificant diurnal movements of herring on the slope were observed. The phenomenon of negative responce of herring to water masses with the temperature of 2° - 3°C has already been recorded in other areas (Khritonova O.A. 1968).

A similar distribution depending on the depth and temperature is observed in the population of Nova Scotian herring. The bulk of the herring, however, inhibits the lesser depths at higher temperatures (fig. 3).

Successful fishing of herring is greatly influenced by such peculiarities of diurnal herring behaviour as vertical migrations and the changes in concentration structure (Zusser S.G. 1971, Kharitonova O.A. 1968).

In March 1972 the changes which take place in herring schools in the light and dark hours of the day are strongly pronounced (fig. 4). Together with moving of herring to greater depths in the morning, the formation of more dense schools with distinct boundaries was observed. At nightfall herring moved at lesser depths. Simultaneously, the schools became

loose. Many schools merged forming a layer of herring in water column 5-20 m above the bottom. Such concentrations covered a considerable area reaching sometimes 1.5 miles in length and 0.2 miles in width.

CONCLUSIONS

1. The populations of Banquereau and Nova Scotian herring inhibiting the area of the shelf water of Nova Scotia have their own distribution areas, feeding and spawning grounds.

A division into two length-age groups with different paths of migration occurs in the Banquerau herring stock during winter-spring period.

The stock of Nova Scotian herring is characterized by an extremely complicated structure, and evidently consists of a number of herring groups which have various spawning grounds, but may become mixed in the period of feeding.

2. The distribution and behaviour of herring from the Nova Scotia Shelf, in particular, of Banquereau is greately influenced by hydrometeorological conditions on the Nova Scotia Shelf in winter-spring period.

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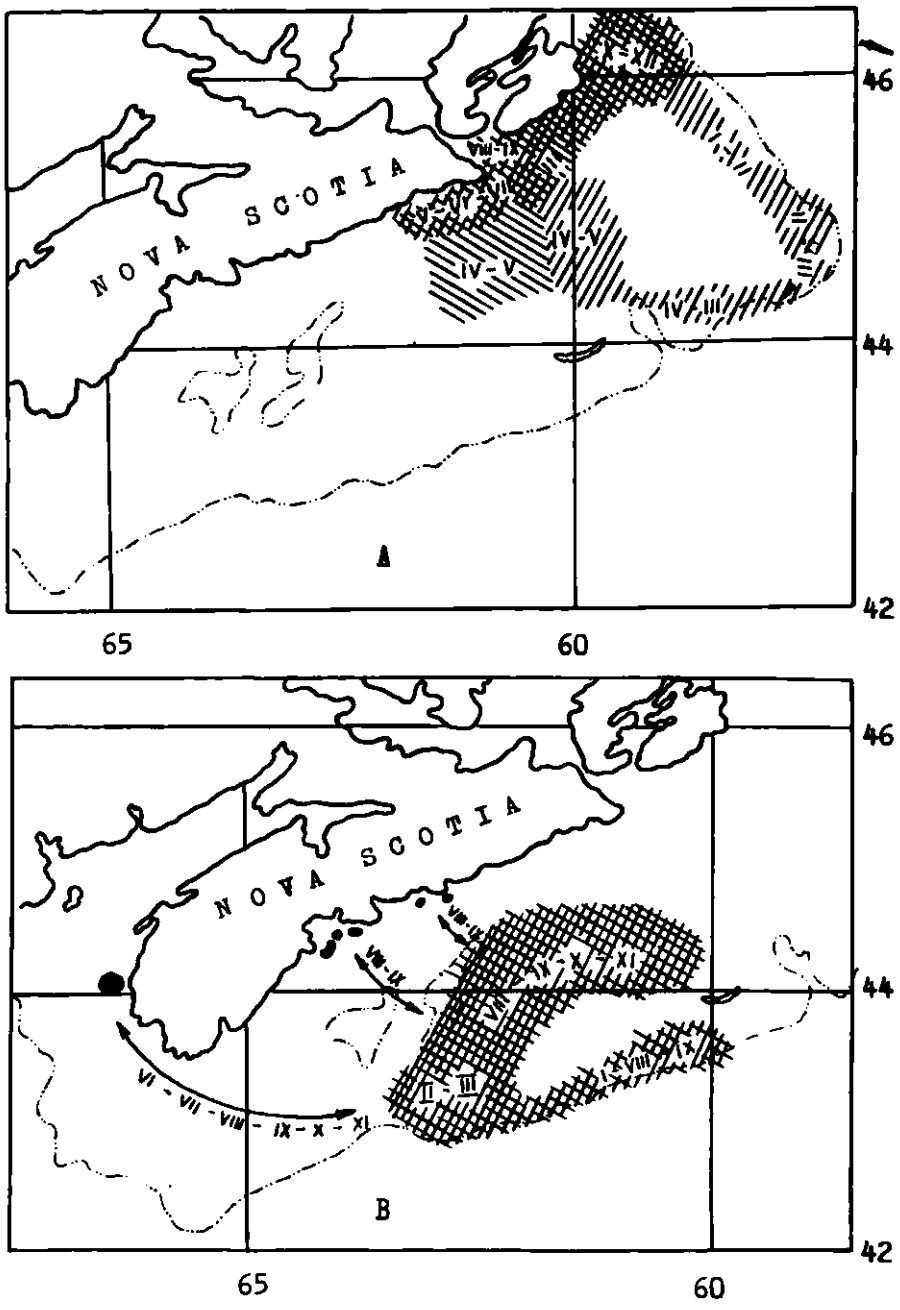

Fig.1. A scheme of distribution and migrations of Banquereau (a) and Nova Scotian (b) herring populations

herring over 32 cm in length

herring below 32 cm in length

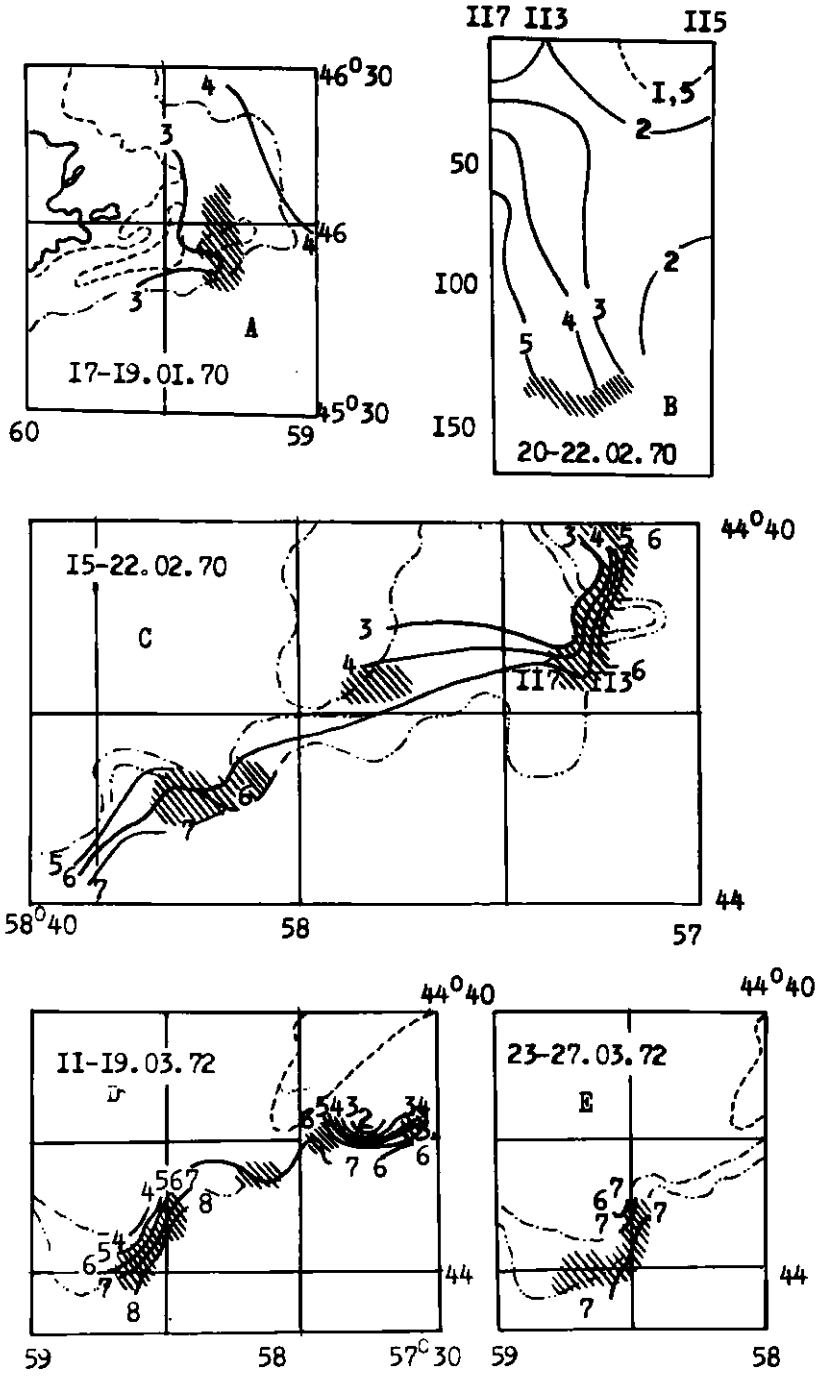

Fig. 2. The dependence of Banquereau herring distribution on the depth and temperature.

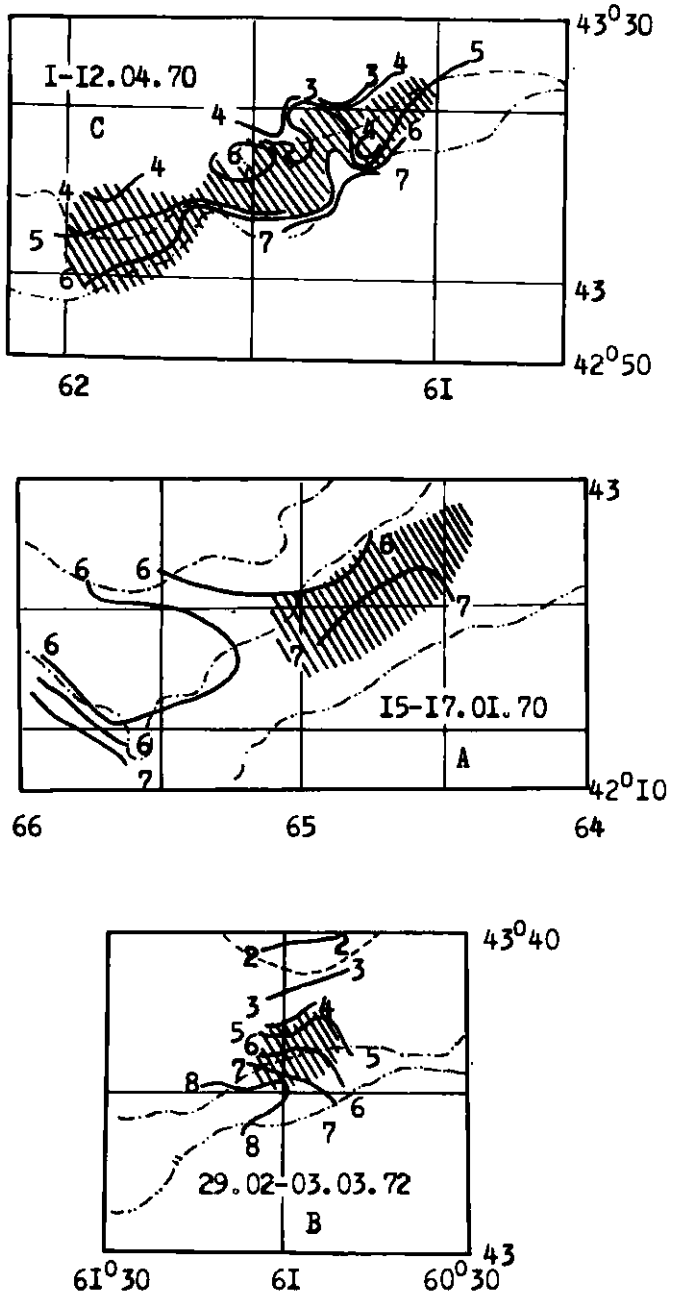

Fig. 3. The dependence of Nova Scotian herring distribution on the depth and temperature.

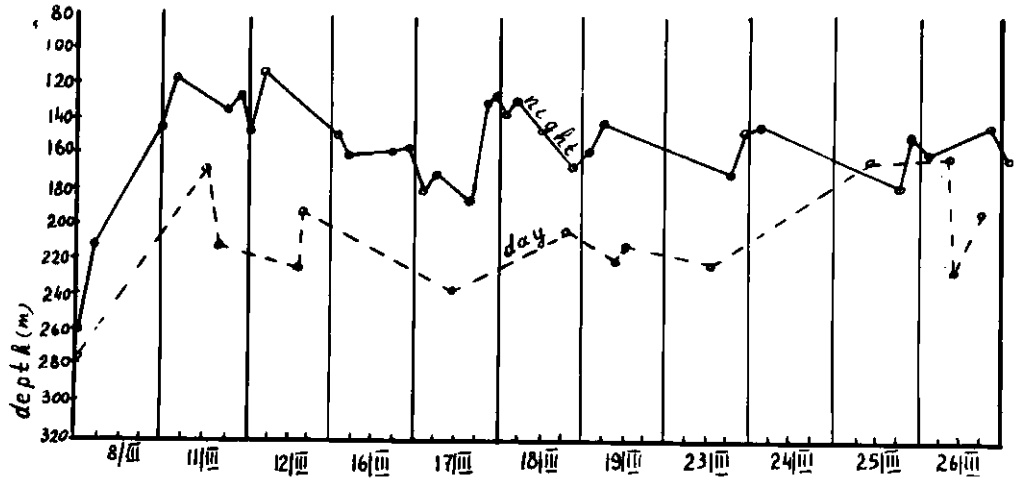

Fig. 4. The distribution of herring in the light and dark hours of the day.