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REPORT OF THE ATLANTO-SCANDIAN HERRING WORKING GROUP

Contents

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TERMS OF REFERENCE AND PARTICIPATION

In accordance with a recommendation made at the Herring Symposium in 1961 and confirmed by the Herring Committee at its subsequent Annual Meetings in 1961 and 1962, the terms of reference of the Working Group were as follows:-

> "In view of the recent serious decline in the fisheries based on the Norwegian spring-spawning tribe and of the complexity of the scientific problems involved, the Symposium recommends that a Working Group be set up, composed of representatives from all countries with fisheries based on this tribe, to examine all available data relating to the elucidation of its causes, including the part played by the fisheries for juvenile, pre-recruit herring" (see Report of Herring Symposium).

Since 1957 the total yield of this stock has shown a serious decline which caused considerable concern within the Norwegian, Icelandic and Soviet fisheries. In 1961 the total yield was only $\frac{1}{3}$ of the record yield in 1956. The decline was most serious in the Norwegian winter-spring fishery, where the catch dropped from 1146 thousand tons (1956) to 69 thousand tons (1961). The Working Group, consisting of scientists from all countries with fisheries based on the Atlanto-Scandian herring, met twice under the chairmanship of Mr. Finn Devold (Norway). The first meeting was held at the Institute of Marine Research, Bergen, from 22nd-26th April, 1963, the second meeting took place at the Fisheries Institute, Reykjavik, from 4th-10th April, 1964.

A preliminary report was given after the first meeting in 1963. At the second meeting it was decided to prepare this report which includes results and conclusions of both meetings.

Participation

Mr. F. Devold (Norway), CHAIRMAN
Dr. G. Hempel (Germany), Chairman of Herring Committee
Mr. B. B. Parrish (Scotland), Rapporteur (1963)
Mr. J. Jakobsson (Iceland), Rapporteur (1964)
Mr. E. Jónsson (Iceland)
Mr. S. Gunnarsson (Iceland)
Mr. O. Dahl (Norway)
Mr. O. Dragesund (Norway)
Mr. P. T. Hognestad (Norway)
Mr. O. J. Østvedt (Norway)
Dr. S. S. Fedorov (U.S.S.R.)
Dr. K. A. Lyamin (U.S.S.R.).

The Working Group appreciated the presence of the General Secretary of ICES, Dr. Á. Fridriksson, who made his special experience with these herring stocks available to the Working Group.

The thanks of all participants are due to the Norwegian and Icelandic hosts for the excellent meeting accommodation and facilities and for their kind and generous hospitality.

AGENDA AND SUBJECT MATTER

In view of the wide and complex distribution of the Norwegian spring-spawning group and of the known existence of other spawning groups within its total range of distribution, the Working Group's discussions were not confined to this group alone, but included an appraisal of the available information on the distribution, composition and biology of the whole Atlanto-Scandian "race", and of the status of the fisheries based on it. The following main agenda items were, therefore, discussed:-

I. Description, identification and mixing of the various stock units within the Atlanto-Scandian "race".

II. The present status of the stocks and the fisheries exploiting them.

III. Possible causes of recent changes and fluctuations in the abundance of the stock units.

In Bergen, 1963, the Working Group considered mainly items I and II. At the second meeting new information had to be added on the present status of the stocks and on the exploitation in earlier periods. Furthermore, striking changes in the distribution and migratory pattern of the Norwegian spring spawners together with an increase in yield were observed in 1963 and 1964. In Reykjavik, 1964, the Working Group considered also in detail the approaches to elucidate the effect of the fishery of juvenile herring and the adult stock. The data available were compiled and discussed. In the light of this information joint investigations were recommended.

I. DESCRIPTION, IDENTIFICATION AND MIXING OF STOCK UNITS

A. Description of stock units

The Working Group examined the available information on the distribution, general biological characters and life-history of the Atlanto-Scandian herring, which were defined as the population of large, oceanic herring living in the Norwegian Sea and adjacent areas, with widespread spawning grounds situated on the neighbouring continental shelves. Detailed attention was paid to:-

(a) the time and location of spawning

(b) the biological characters of the spawners in each area

(c) the distribution and movements of the spawning products and adolescent pre-recruit herring

(d) the distribution and movements of the adult herring during the feeding and immediate pre-spawning periods.

Detailed statements on these biological features of the herring spawning at Iceland, Faroe, off the Norwegian west coast and along the northern and eastern edges of the North Sea shelf and to the west of the British Isles were presented by the participants from Iceland, U.S.S.R., Norway and Scotland. Summaries of these statements, relating to the Norwegian spring spawners, the Icelandic spring and summer spawners and the North Sea-Scottish West Coast spring spawners, prepared by the U.S.S.R., Iceland and Scottish representatives are given in Appendices I-IV.

From the data available in published documents and those presented at the meeting, the Working Group drew the following conclusions regarding the distribution of spawning and the characters of the spawners within the range of distribution of the tribe.

(1) The race is composed of groups of both spring and summer spawners. The main spawning centres for the spring spawners occur off the west coast of Norway, along the south coast of Iceland, on the Faroe plateau and along the eastern and northern edges of the North Sea shelf and to the north and west of Scotland.

The main centre of summer spawning is along the south and west coasts of Iceland in the same general localities as the spring spawners, but some summer spawning also takes place around the Faroes.

The Group noted with interest data showing that in 1963 and 1964 the Norwegian spring-spawning stock spawned at two main localities in Norwegian waters. Thus, the older part of the stock and a part of first- and second-time spawners spawned off western Norway in similar localities as in previous years, whereas large concentrations (especially in 1964) of recruit spawners invaded Vestfjord in the Lofoten area and spawned there during March. The possible effect on subsequent distribution of the feeding migrations due to this difference in spawning localities was discussed.

By tabulating tagging data the fact emerged that Norwegian fat herring tagged off northern Norway in 1961 and 1962 were caught during the summer fishery off Iceland in 1962 and 1963 as well as on the new Westfjord spawning grounds in 1963 and 1964.

The spawning centres for both spring and autumn spawners are shown in Figure 1.

(2) The biological characters of the spring spawners from each of these localities are very similar, the main difference, used by Icelandic, Soviet and Norwegian workers to distinguish Icelandic from Norwegian spring spawners (especially the "Northern" type) in mixed samples, being the winter-ring and growth zone patterns on the scales (or otoliths) - (see Report of Atlanto-Scandian Methods Working Group, 1962). Although possessing some close similarities to the spring spawners (e.g. size, longivity, etc.) the summer spawners differ from them in a number of important respects, especially in maturation cycle, fecundity, egg size, otolith type and scale (otolith) ring pattern. This is shown in Table 1 (page15) which summarizes some of the main biological characters of the spring and summer spawners from the different areas.

(3) The distribution of the adolescent, pre-recruit herring derived from the Norwegian spawning concentrations is widespread, ranging from the fjords in the northern Norway to the open oceanic regions of the Norwegian and Barents Seas, extending to as far north as Spitzbergen; in general, their distribution in these areas varies between different year-classes, depending on the intensity and extent of larval drift, the hydrographic conditions in the area and year-class strength.

Detailed information, presented by the Soviet scientists, on the distribution of the pre-recruit year-classes in the typical year of 1963 showed e.g. that during the early summer months the 1959 year-class was concentrated in the central part of the Norwegian Sea. In August the year-class migrated into the Jan Mayen area where 9o% of the samples originated from this year-class. Throughout the autumn the 1959 year-class was found in great quantities in the oceanic areas NE and E of Iceland. The Soviet investigations also showed that the 196o year-class was distributed in the central part of the Norwegian Sea during the first half of 1963, whereas during the second half it did not migrate as far west as the 1959 year-class, but was mainly found in the area of Mohn ridge NE of Jan Mayen, where 46% of the samples taken in November originated from this year-class. The 1961 year-class had a similar distribution in 1963 as 196o year-class, but the 1962 year-class was only met with in very small quantities in the Norwegian Sea.

Recent detailed investigations have shown that the size and extent of the oceanic concentrations of the 0-group, relative to the coastal (fjord) concentrations, appears to be larger for rich year-classes than for poor ones (e.g. Dragesund and Hognestad, 196o, 1963). Thus the 1959 and 196o year-classes had a wide oceanic distribution during their first year of life, whereas the oceanic distribution of the 1961 and 1962 year-classes, which in general are considered small year-classes, was negligible although the size of their coastal concentrations was of the same order as that of the much larger 1959 and 196o year-classes.

The main centres of distribution of the adolescent Icelandic spring spawners probably occur in Icelandic coastal waters, and unlike those of the Norwegian spring spawners do not appear to extend extensively into the open ocean, at least during the first 2 years of life.

As with the Icelandic spring spawners, the main centres of distribution of the Icelandic summer spawners are probably also in Icelandic coastal waters, especially in the coastal bays and fjords along the south-west, west and north coasts.

Little is known of the centres of distribution of the adolescent herring derived from spawning at the Faroes and along the edge of the continental slope to the north and west of the British Isles. However, from the known current system in this area, it seems likely that those of the youngest herring are mostly in the south-eastern parts of the Norwegian Sea extending northwards with age and size to mix in the Barents Sea with those derived from the Norwegian spawning concentrations.

(4) The main feeding areas of the adult Norwegian spring spawners are located in summer and autumn in the region to the north and east of Iceland, where they are fished by the Icelandic, Norwegian and Soviet fishing fleets. The Norwegian spawners migrate to this area as recovering spents during the early summer. In general, the range of distribution of these groups during the feeding phase increases with age.

The distribution of the adult Icelandic spring spawners during the feeding phase is almost mostly to the north of Iceland. In the main the younger age-groups have in recent years occupied the western part of the area where mixing with Norwegian spawners is small, while the older ones have a wider, more easterly distribution, where they mix with the Norwegian spawners.

The adult Icelandic summer spawners have two major feeding periods, before spawning in spring and early summer, and after spawning in autumn and early winter. The distribution of fish older than 7-8 years at both times is again mostly to the north of Iceland, along the western edge of the east Icelandic current where they mix with the spring spawners. The younger age-groups (4-7 years-old pre-spawners) on the other hand, feed mostly off the south and west coasts.

B. Identification and mixing of stocks

The Working Group considered the available evidence on the important question of the unity and degree of mixing of the three main spawning groups described above both on the spawning and feeding grounds. The Group noted the following results of research, of special relevance to this problem:-

(1) Adult herring tagged in summer, off the north coast of Iceland have been recaptured subsequently on each of the major spawning grounds (Norwegian west coast and Icelandic south and west coasts).

(2) Spawning herring tagged on the spawning grounds off the SW coast of Iceland in spring have been recaptured on the north coast feeding grounds in summer and again subsequently on the SW coast spawning grounds, but not on the Norwegian spawning grounds. Further, the recaptures of these herring in the north coast area are taken almost entirely in the Icelandic fishery which is sometimes more coastal and further to the west than the Norwegian and Soviet fisheries.*)

(3) Whereas within each spawning group most of the year-classes generally retain their relative strengths throughout their fished life-spans, the occurrence of rich and poor year-classes is not the same for all of the groups. Thus, during post-war years, the 1943, 1947 and 1950 and 1959 year-classes have been dominant amongst Norwegian spring spawners, while the 1945, 1949, 1950 and 1956 year-classes have been the strongest amongst Icelandic spring spawners. (Fridriksson, 1958). On the other hand, during the post-war period, there has been general agreement between the occurrence of rich and poor year-classes among the Icelandic spring and summer spawners (Fridriksson, 1963).

(4) Whereas the biological characters of the two main spring-spawning groups are similar (but see paras. (5) and (6) below), they differ from those of the summer spawners in a number of important respects (see Table 1), chief amongst which are spawning time and maturation cycle, fecundity and egg size, average VS, scale and otolith type, and growth pattern (Einarsson, 1958; Fridriksson, 1958).

(5) Although having similar general biological characters, differences exist between the characters of the scales (and otoliths) of members of the Norwegian and Icelandic spring-spawning groups. Amongst the Norwegian spawning concentrations two scale (otolith) types are found - the so-called "Northern" (N) type and a "Southern" (S) type. Generally, no "N" type scales are found amongst the Icelandic spring-spawning concentrations, their scale type being similar to (but distinguishable from**) the Norwegian "S" type.

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*) It must, however, be noted that at least three returns of herring liberated off SW-Iceland have been made during the winter fisheries at the west coast of Norway, viz.:

	Liberation		Return	
(1)	SW-Iceland	21.August 1953	Norway	30.January 1956
(2)	SW-Iceland	28.August 1953	Norway	March 1958
(3)	SW-Iceland	10.May 1959	Norway	13.March 1960

The last return is especially interesting. Árni Fridriksson.

**) See Section IV for further consideration of this item.

(6) Although the "N" and "S" scale types occur together amongst the Norwegian spawning herring and amongst the summer, oceanic-feeding concentrations, their relative proportion differ between year-classes and with age (Østvedt, 1958). Thus, in all year-classes hatched during the 193o's, the "N" type predominated, in all but the youngest age-groups (4-5 years old), whereas in several of those hatced during the 194o's the "S" type was the dominant one. In general, the "N" type is found to be predominant in rich year-classes of Norwegian spawners, and the "S" type in poor ones. Further, Soviet observations on the distribution of the "N" and "S" types amongst the oceanic concentrations of adults suggest that the "S" type scales are formed in the herring which spend their adolescent life in the warm waters of the south-eastern part of the Norwegian Sea, and the "N" type in those growing up in the more northerly colder sub-arctic waters of the Barents Sea and the East Icelandic Arctic current.

Conclusions

The Group , agreed that, although many features of the distribution, movements and general biology of the spawning groups are still not clear, and require further detailed investigation, the following tentative conclusions can be drawn regarding their identities and interrelations:-

(1) The Icelandic summer spawners are mostly distinct, biologically, from the spring-spawning groups and constitute an independent racial group.

(2) The interchange of adult spring spawners between the Icelandic and Norwegian spawning grounds appears to be small, so that, for fishery assessment purposes, these spawning groups can probably be treated as independent stocks.

(3) The relationship between these stocks and the Faroese and N. North Sea - NW Scotland spring spawners is not clear. It seems likely that members of the Norwegian stock contribute to the N. North Sea and NW Scotland spawning concentrations and Icelandic spring spawners may contribute to the Faroese spawning group, but in the main these spawners (especially the NW Scotland group) can be treated as independent of the other spawning groups.

(4) The Norwegian stock is composed of two well-defined "growth" types (N and S) which probably originate in different "nursery" areas.

(5) The distributions of these spawning groups during the post-spawning, feeding phase, in the region to the north and east of Iceland overlap, the degree of overlap and range of distribution increasing with age.

II. PRESENT STATUS OF THE STOCKS AND FISHERIES

The Group considered the status of the spawning stocks and the fisheries exploiting them, separately with special reference to the Norwegian spring-spawning stock.

A. Norwegian spring-spawning stock

Information on the changes in the catches of adult, Norwegian spring spawners were presented by the Norwegian, Soviet and Icelandic representatives. These are given for the years 1925-1964 in Table 2 (page 16). The data in Table 2 show that the Norwegian winter fishery dominates in the total yield throughout the pre-war period 1925-194o. During this period the total catch of the Norwegian spring spawners increased from the 28o-4o4 thousand tons level in the twenties to the 5oo-6oo thousandt level in the late thirties (1936-1939). The data show that this development results from simultaneous increase in both the Norwegian winter fishery and the Icelandic and Norwegian summer fishery. During the war-period the Icelandic catches increased further, reaching a peak level in 1944. During the post-war period 1945-1951 the Norwegian winter fishery increased rapidly, while unlike the twenties and thirties, the Icelandic and Norwegian summer fishery collapsed.

The most striking changes during the period 1951-64 are shown in the Norwegian fishery, which has declined dramatically since 1956, to reach less than loo,ooo tons in 1961 and 1962. On the other hand, the Soviet fishery increased steadily up to 196o, when its catch exceeded that of the Norwegian fishery, but it also decreased in 1961 and 1962. The catch of Norwegian spawners in the Icelandic and Norwegian summer fishery remained relatively small and showed no upward or downward trend between 1952-196o, but in 1961, 1962 and 1963 the estimated catches increased markedly.

The data in Table 2 also show that from 1952-1956 the total catch of Norwegian spring spawners increased due to further flourishing of the Norwegian winter fishery as well as that of a new open-sea fishery carried out by the Soviet drift-net fleet, but after 1956 the total yield decreased to reach in 1961-1962 approximately $\frac{1}{3}$ of the 1956 level.

Information on catch-per-unit effort were presented by the Soviet, Norwegian and Icelandic representatives, as shown in Table 3.(page 17). Table 3 shows that during the period 1950-1963 the Soviet annual catch-per-haul or net fluctuates without a definite trend. Considering, however, the catch per net in February (pre-spawning concentrations) there is a maximum in 1958 and 1959. Thereafter the catch per net dwindled considerably to reach a minimum of 55 kg in 1962. This was followed by a slight recovery of 87 kg per net in 1963. The Norwegian data in Table 3 show that during the winter fishery the purse-seine catch per vessel, although fluctuating, remains high and without a general trend in the period 1946-1956. During the period 1957-1962 the purse-seine catch per vessel decreased rapidly, and in 1961 and 1962 the catch per vessel was 4-7 times smaller than in the period prior to the decline. The Norwegian drift-net data in Table 2 show that the drift-net catches showed a slight decrease until 1953, an increase in 1954-56 and after 1957 there is a marked decline of the catches. In 1959 and 1960 they decrease even further, so that the catches per net in 1947-1957 are generally more than twice as high as in 1960.

Table 3 shows that the recent decline in catch per net during the winter period started in 1958 in the Norwegian drift-net fishery, whereas in the Soviet fishery the decline starts two years later. This difference is probably due to the fact that the Soviet fishermen generally set their nets at a greater depth than their Norwegian colleagues, and thus the former had a better chance of catching the deep-swimming older year-classes that predominated during the years under consideration.

Throughout the period 1946-1960 the Icelandic purse-seine catch per vessel remained very low, but during 1961-1963 they increase dramatically. Since this purse-seine fishery is based on migratory feeding shoals it has been subject to great variations in availability as well as radical changes in the fishing power of the fleet (Jakobsson, 1963). The Icelandic purse-seine catch per vessel data are, therefore, not suitable for population estimations.

Table 4 (page 18) shows the frequency of different size of catches in the total yield of the Soviet drift-net fleet 1952-1963. It should also be noted that:-

(1) During the period of marked decline in total catch per unit effort im the Norwegian winter-spring fishery after 1956, recruitment to the spawning stock was at a very low level (Østvedt,1963), with the result that the average age of the exploited stock increased progressively and the extent of the spawning area decreased.

(2) In the Soviet fishery on feeding herring in the open sea in summer, the area of productive fishing dwindled progressively after 1956. Whereas in the years up to 1956 the main fishing area extended into the Barents Sea, to as far north as Spitzbergen, since 1956 it has become restricted to the south-western part of the Norwegian Sea (Figure 1c of J. Marty and S. Fedorov, 1963). At the same time the density of the exploited concentrations within the feeding area has also decreased to such a level that the Soviet fishery on the feeding concentrations ceased after 1960. The decrease in recruitment to the feeding concentrations is also shown by Soviet age-composition data from this fishery.

(3) In the Soviet autumn-winter fishery on the pre-spawning concentrations in the open sea, catch data and the results of extensive echo-sounder surveys, accompanied by under/water photography have also shown a decrease between 1958-1962 in the wintering area and in the size of the adult stock (Marty and Fedorov, 1963).

(4) Estimates of the absolute abundance of the adult stock of Norwegian spring spawners made from the total catch data (see Table 2) and returns over the years 1953-1959 from tagging experiments in Icelandic waters (Dragesund and Jakobsson, 1963) show a large decrease in stock size after 1956. Soviet estimates of stock size from echo-surveys and underwater photography over the pre-spawning, winter concentrations in 1958, 1961 and 1962 also show a further decline between 1958 and 1962. These two sets of estimates are given in Table 5 (page 19).

Thus, it is evident from the tagging estimates that between 1955-1956 and 1959 the adult stock size decreased by more than half, and the echo-surveys estimates indicate (see Table 5) that it declined even further between 1958-1962.

When considering the stock estimates (see Table 5) from tagging data, it should be stressed that although probably giving a good relative measure of the decline of the stock, these data tend to overestimate the absolute size of the stock and must, therefore, as such, only be used with some reservations.

In addition to these considerations of changes in stock size and composition, the Working Group also examined the available information on changes in the mortality rates for the adult stock. Estimates of total mortality rate obtained from age-composition (Østvedt, 1963) and the tag-return data (Dragesund and Jakobsson, 1963) and of fishing mortality rate from the catch and stock size estimates (see Tables 2 and 5) are given in Table 6 (page19).

Although subject to several possible sources of bias and error, e.g. due to overestimation of the stock, the estimates in Table 6 suggest that in the period 1953-1958 the fishing mortality rate (F) and rate of exploitation (F/F+M) remained approximately constant at about o.1o-o.13, and <o.5respectively. However, they point to an increase in the fishing mortality rate since 1958.

Conclusions

The Working Group, therefore, drew the following conclusions regarding the status of the Norwegian spawning stock:-

(a) In the post-war period up to 1956 the average adult stock size remained high, but thereafter decreased progressively to reach in 196o-1962 between 1o-25% of its level in the early fifties.

(b) This major decrease was due principally to a succession of poor recruit year-classes. This has resulted in a progressive increase in the average age of the stock, which has been dominated throughout the period of decline by the rich 195o year-class.

(c) The decrease in stock size has been reflected in a substantial shrinkage in the size of the spawning and feeding areas and of a decrease in the density of the main concentrations in each. Since 1956 the centre of spawning has moved progressively further north, and started later.

(d) During the period of increased fishing and greater yields during the early fifties, and the commencement of the decline after 1956, the fishing mortality rate remained approximately constant at about o.1o-o.13, but in more recent years it has tended to increase somewhat.

B. Icelandic Spring Spawners

Like the Norwegian fishery, the summer-feeding fishery off the north of Iceland has also been subject to large fluctuations in yield. This is reflected by the data in Table 7 (page 19), which gives the average annual yields from the north, east and south-west coasts of spring spawners caught by purse-seine during the period 1949-1963. (Data from Jakobsson, 1963).

The data in Table 7 show that following a period of very low yields of Icelandic spring spawners (as estimated by scale typing) during the period of 1949-54 there is a considerable increase after 1955 and especially in the period 1959-1962 when a peak level of 17o.4 thousand tons was reached. In 1963 there is a sharp decline although the total yield of the fishery did not decrease correspondingly due to higher proportionof Norwegian spring spawners in the catch than in previous years.

While this recent increase in yield was due partly to the corresponding introduction of more efficient fishing methods and to an increase in fishing effort, the results of echo-sounder and Asdic surveys show that there was also an increase in the total abundance of the available stocks on the grounds.

Since the concentrations on these grounds are known to consist of members of both the Norwegian and Icelandic spring-spawning stocks and of Icelandic summer spawners, in order to determine to which of these stocks the recent increase in stock size is attributable, the Working Group examined the results of scale-type analyses for this area (Fridriksson, 1963) and estimates of stock size from tagging data.

Fridriksson's scale analyses show that, during the period of high yields in the 194o's, Norwegian spawners were the dominant component of the stock, but that during the period of fishery decline during the late 194o's and 195o's, they were replaced by Icelandic spring spawners as the dominant group, which, in the recent period of recovery of the fishery (since 1958) constituted over 6o% of the stock, and would seem to be mainly responsible for the recovery. This is also indicated by estimates of the abundances of Norwegian and Icelandic spring spawners in the north coast stock, made from Icelandic tagging data. These are given in Table 8 (page 2o).

The estimates given in Table 8 indicate that while the abundance of Norwegian spring spawners has shown no major trend during this period (although it has increased since 1958), the Icelandic spring spawners have increased since 1958 to about three times the earlier level.

The Working Group noted that a productive Icelandic winter and spring fishery on the spawning grounds also started in 1961.

It is also noted that the return of tags per unit weight caught in the south-west coast spawning fishery is much greater than that of the Icelandic spring spawners in the north coast summer fishery. This suggests that the spawning stock is smaller than the feeding stock of these fish, pointing to additional spawning areas for the older members of this stock.

Conclusions

With regard to the present status of the Icelandic spring-spawning stock, the Working Group drew the following conclusions:-

(1) In recent years the stock of Icelandic spring spawners has increased in size, and has contributed to the increased yields in the north coast fishery. At the same time the stock of Norwegian spawners in the north coast area, although relatively smaller than the Icelandic stock, has also increased, especially in 1963, due - presumably - to its concentration and higher availability on the fishing grounds and to the invasion of young year-classes in 1962 and 1963.

(2) The stock of Icelandic spring spawners on the north coast feeding grounds appears to be larger than on the SW coast spawning grounds. This suggests that part of the stock, especially the older age-groups, spawns in other areas.

C. Icelandic Summer Spawners

The Working Group examined the available data on the proportions of Icelandic summer spawners, as judged by stages of maturity, in the north coast fishery. According to Icelandic data they appear irregularly in the fishery, mostly as spents in the extreme western and eastern fringes of the fishing grounds, and only rarely penetrate in large concentrations on to the main central, north and east coast grounds. Therefore, it is difficult to obtain accurate estimates from the catch data of the relative size of this stock and its changes from year to year. However, Fridriksson's estimates (Fridriksson, 1963) point to a gradual increase in the proportion of this stock on the north coast grounds throughout the 1950's, constituting over 10% of the total stock in the period 1958-60. On the other hand, Soviet investigations (Lyamin, 1956) claim that the relative size of the summer-spawning stock is larger than that indicated by these Icelandic observations, due to the particular distribution and timing of the Icelandic north coast fishery. Their observations indicate that in 1960 and 1961, summer spawners made up 50-60% of the stock on the western part of the north coast, 20-30% in the central part and 25-30% in the eastern part. However, like the Icelandic ones, the Soviet observations point to an increase in the size of this spawning stock, in recent years. Both sets of observations also show that, as in the Icelandic spring-spawning stock, the 1950 and 1956 year-classes were strong ones, and contributed to the build-up of the stock.

During the recent all-year-round Icelandic purse-seine herring fishery the summer spawners have dominated in the catches taken off the SW coast of Iceland during the late spring (i.e., in May and June), as well as in the autumn (October-December), as shown by comparison of Tables 7 and 9 (pages 19-20).

The Working Group agreed that more information, especially of the over-wintering areas of this stock, and of the range of distribution of the feeding concentrations in relation to the area fished is required before a proper assessment can be made of its size relative to that of the spring-spawning groups.

III. CAUSES OF RECENT CHANGES AND FLUCTUATIONS IN ABUNDANCE OF STOCK UNITS

On this item the Working Group confined its attention to the causes of the recent decline in the Norwegian spring-spawning group. It agreed that from Norwegian and Soviet evidence collected over a number of years (see Section II A), it is clear that the main cause of the decrease, since 1956, in the size of this stock was due to a succession of 7-8 years of poor recruitment (i.e., since the rich 1950 year-class was first recruited to the stock in 1954). This had led to a gradual ageing of the stock, which in 1960-62 had an average age of 10-12, a shrinkage

of the feeding and spawning areas and a shortening of the spawning (and winter fishing) season. At the same time, no major change has been detected in the range of age-groups in the catches. Furthermore, the total and fishing mortality rates of the fully recruited age-groups remained approximately the same during the early years of the decline (up to 1959), but thereafter tended to increase.

The possible causes of the decline in recruitment were discussed, with special reference to the possible effect of the Norwegian "Small" and "Fat" herring fisheries in the fjords of northern Norway.

Norwegian data on the catches from these fisheries since 19oo (Dragesund, 1963) show that between 195o and 1959 the average annual yield of these fisheries increased, but no clear relation could be found between the increase in catch and the decrease in recruitment to the adult stock. Also, the return of tags from tagging experiments conducted on the small herring (0-group) in a number of fjords in 196o-61, ranged between 2% and 26% *). Since it is known that the exploited fjord concentrations only constitute a part of the total stock of pre-recruits and the natural mortality rate at these stages is probably high, these estimates suggest that the proportion of the total stock removed by this fishery is too small to account for the recruitment failure during the past 7-8 years. However, the Working Group noted that tag shedding and mortality of tagged 0-group herring may be high, so that these estimates of the proportion of the exploited 0-group stock taken by the fishery are probably substantial understimates. It also recognized that the relative sizes of the exploited and unexploited parts of the adolescent stock are unknown. It, therefore, concluded that while the recent fishery and stock decline could definitely be attributed to a sustained failure in recruitment, it was not possible from current evidence to determine the part played by the fishery for "Small" and "Fat" herring as a governing factor in it. However, the Soviet representatives expressed the view that this fishery has influenced the level of recruitment in recent years.

The possible influence of other factors on recruitment was also considered, with special reference to:-

(a) the relation between recruitment and the size of the adult spawning stock,

(b) the possible effect of changes in the timing and location of spawning,

(c) the effect of adverse environmental conditions on the dispersal and survival of the spawning products.

Of these, the Working Group considered that (a) could probably be discounted as a major contributory factor, since most of the poor year-classes had been produced in years (1951-56) when the adult spawning stock size was high, while the rich 1959 year-class, which had not yet recruited the spawning stock, had been derived from a much smaller stock size. It was agreed, however, that the influence of changes in spawning stock size could not be assessed properly until the form of the spawning stock size-egg production-recruitment is known. The Working Group emphasized the need for more detailed studies of this relationship, including

(a) the possible effect on the survival of spawning products (including eggs) of the shrinkage, northward shift and retardation of spawning in recent years,

(b) the differential survival of larvae from recruit and adult spawners, in relation to variations in the food supplies and other environmental factors subsequent to the spawning season.

The importance of the apparent, recent increase in fishing mortality rate of the exploited adult stock was also noted by the Group and especially stressed by the Soviet representatives. Although it was generally agreed that the decrease in total stock size from 1956-1962 and the recruitment failure could not be directly attributed to this factor, the increase in fishing power of the fishing fleets (especially the Icelandic purse-seiners) and the extension during the 195o's of the fishery on the Norwegian stock into the open sea, provided a large, additional exploitation potential which could lead to further serious depletion of the reduced adult stock.

*) (Dragesund & Røgnestad, 196o, 1963).

IV. RECOMMENDATIONS FOR FUTURE RESEARCH

In the course of the discussions, the Working Group paid special attention to important gaps in our knowledge of the biology, inter-relationships and dynamics of the exploited stocks of the Atlanto-Scandian tribe, which prevented firm conclusions being drawn regarding aspects of especially the present status of the component stocks and fisheries and the causes of the recent decline in the Norwegian spawning stock. Items of special relevance were:-

(a) the relations between the spring- and summer-spawning stocks and the means for identifying the members of each,

(b) aspects of the distribution and biology of the adolescent and adult members of these groups,

(c) the pre- and post-war changes in total fishing effort on the different spawning stocks, and especially on the Norwegian spawning stock, the effects of fishing on it, and the magnitudes of its fishing and natural mortality rates,

(d) the relation between spawning stock size, egg production and recruitment and the factors governing egg and larval survival.

The Working Group stressed the need for further studies of the interrelations between the Norwegian and Icelandic spring-spawning stocks, and of the validity of the "scale type" method, currently used for identifying members of each of them. This is of importance not only to allow a more complete picture to be drawn on the distribution and life cycles of each group, but also because, with the growth of the open-sea fisheries on mixed stocks, the reliability of estimates of the total fishing effort exerted on each stock is governed by the accuracy with which the total catches in these fisheries can be split into the component spawning groups. This is evident from Table 2, which shows that in recent years the open-sea fisheries have contributed a major share of the total catch of Norwegian spawners. The Working Group agreed that the greatest difficulty with this method is in distinguishing the Norwegian "S" type from the Icelandic spring spawners (see "Report on Meeting on Scale and Otolith Typing and other Methods in Atlanto-Scandian Herring"). It, therefore, recommends that scale and otolith reading experts of countries with fisheries in this region (Iceland, U.S.S.R., and Norway) should continue to collaborate closely in the study of these criteria and should exchange further material at regular intervals to compare their criteria and methods of analysis, and if possible standardize them. Other possible characters for distinguishing the members of these groups should also be sought. At a later date a meeting of the scale-readers of the different laboratories will be needed. In relation to this problem it also recommends that

(i) further comprehensive tagging experiments should be carried out on the Norwegian and Icelandic and Faroese spawning grounds, and feeding and over-wintering grounds in the open sea, to determine the zones of mixing of the members of the different spawning groups during the feeding and pre-spawning seasons and their subsequent passages to the spawning grounds.

(ii) countries with fisheries based on the open-sea feeding concentrations should prepare data on catch and fishing effort, age and maturity composition and "spawning type" in small area and time sub-divisions.

The need for a better understanding of the origins of and relations between the "N" and "S" type Norwegian spawners was also stressed. The Working Group accordingly recommends that an examination of the scale- and otolith-characters of adolescent herring in the Norwegian coastal and open-sea areas should be undertaken with a view to determining the range of distribution of the two types, their areas of origin and the subsequent movements of each.

The importance of detailed information on the abundance, distribution, condition and survival of larvae in relation to the recent decline in recruitment to the Norwegian spawning stock was noted by the Group. The distribution and abundance of larvae might also give clues to the causes of fluctuations in the "små-sild" fishery. It, therefore, recommends that:-

(i) the data collected by Norway and U.S.S.R. in the course of extensive larval surveys along the west coast of Norway and in the open sea in past years should be combined and compared to provide a comprehensive picture of the main centres of production and dispersal,

(ii) close collaboration should be maintained between Norwegian and Soviet workers in the planning of future larval sampling programmes and in the analysis of the results so as to ensure as complete a coverage as possible of the area of larval distribution, both in space and time,

(iii) detailed studies of condition (wt/length relationship), growth and survival of larvae in different parts of the area should be made,

It also stresses the need for extensive larval surveys in

(i) the Icelandic area following both the spring- and summer spawning seasons,

(ii) the Faroese area in spring,

(iii) in the northern North Sea and to the west of the British Isles in spring.

The Working Group noted that the projected ICES "Fjord Station", should it be established, might provide important facilities for studying aspects of larval condition and survival, of importance in understanding the factors governing the fluctuations in recruitment in the Norwegian stock.

The Working Group took notice of the various regulations introduced by the governments of Norway and the U.S.S.R., which aim to restrict the "små-sild" fishery in Norwegian waters and in the Barents Sea.

The Working Group considered the present state of knowledge as to the fishing mortality in the "små-sild" population. The extent to which the catch of adult fish will be reduced due to the "små-sild" fishery, will depend on the strength of the year-class and its distribution during its first autumn and winter. Strong year-classes with a wide oceanic distribution may be far less affected than small year-classes which are often more confined to the coastal waters. Information on the relative size of the inshore and offshore parts of the population are insufficient. They do not permit any estimates of the actual reduction of recruitment due to the "små-sild" fishery.

Tentative considerations were made about the possible effects of a cessation of the "små-sild" fishery on the yield of the adult fishery. In herring the optimum age at first capture is lower than in most of the groundfish in the eastern Atlantic, i.e., the total yield of a herring stock might be increased by a moderate fishing in relatively young age. Further investigations in the population dynamics of the adolescent stage are needed to apply these considerations to the Norwegian spring spawners and the "små-sild" fishery.

The Working Group recommends to the Herring Committee that the effects of the fishery on adolescent herring in the adult stock of Norwegian spring spawners should be intensively investigated by joint effort of different nations. As immediate steps the Working Group recommends in detail:-

(1) The tagging experiments on 0-group herring in Norwegian fjords should be continued on the same lines as established by the "Havforskningsinstitutt", Bergen, during the years 1959 to 1963. Special emphasis should be given to the estimation of tag loss and tagging mortality.

(2) Information on the relative size of the exploited inshore and unexploited offshore part of the "små-sild" population in different areas is badly needed. Methods for comparable measurements of abundance in the coastal waters and in the open sea have to be developed,

(3) Those estimates of abundance have to cover the main areas of distribution of young herring in a comparable way, i.e., the investigations carried out by Soviet research vessels in the Norwegian Sea and the Norwegian investigations in the Barents Sea and in the inshore and offshore waters off northern Norway have to be co-ordinated by technical meetings of Norwegian and Soviet scientists on board research vessels which take part in the joint investigations. The first meeting is scheduled for the second half of September 1964 in Murmansk. The second meeting should preferably be in May 1965. At the second meeting the results of the first year of joint investigations on young herring should be considered. In advance

of these meetings methodological questions concerning the discrimination between adolescent herring of different origin should be discussed by correspondance,

(4) Although the main emphasis has to be laid on the investigation of 0-group herring and its exploitation, similar investigations should be envisaged covering the older adolescent herring, including "små-sild" of the I-group and "feit-sild",

(5) Special attention should be paid to the most recent change in the spawning area of part of the Norwegian spawning stock. The effect of this change on the distribution and survival of the larvae and on distribution and abundance of the adolescent herring should be followed up. The changes in migratory pattern should be investigated.

REFERENCES

Much of the material examined by the Working Group was taken from papers which had already been published or were in press (especially contributions to the 1961 Herring Symposium). The following is a list of those which were specially consulted:-

Baxter, I. G.	1958	"The composition of the Minch herring stocks". Rapp.Cons.Explor.Mer, 143(II):81-94.
Devold, Finn	1963	"The life-history of the Atlanto-Scandian herring". Ibid., 154:98-108.
Dragesund, O.	1963	"The Norwegian small and fat herring fishery; changes in size and composition". Ibid., 154: 118-22.
Dragesund, O. & Jakobsson, J.	1963	"Stock strength and rate of mortality of the Norwegian spring spawners as indicated by tagging experiments in Icelandic waters". Ibid., 154:73-83.
Dragesund, O. & Hognestad, P. T.	1960	"Småsildundersøkelsene og småsildfisket 1959/60". Fiskets Gang: 703-714.
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Fridriksson, Árni	1958	"The tribes in the North Coast herring of Iceland with special reference to the period 1948-1955". Ibid., 143(II):36-44.
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Lyamin, K. A.	1959	"Investigations into the life cycle of summer-spawning herring of Iceland". U.S.Fish. and Wildl.Serv., Spec.Sci.Rep.Fish., No.327. Transl. from "Polyarnyy nauchno-issledovatelsky institut morskogo rybnogo khozyaystva i okeanogr.,Murmansk, 1956,9.
Marty, J. J. & Federov, S. S.	1963	"The peculiarities of the population dynamics of sea herrings, as seen from the Atlanto-Scandian race". Rapp.Cons.Explor.Mer, 154:91-98.
Østvedt, O. J.	1958	"Some considerations concerning the homogeneity of the Atlanto-Scandian herring". Ibid.,143(II): 53-57.
Østvedt, O. J.	1963	"Catch, effort and composition of the Norwegian winter herring fishery". Ibid., 154:109-17.

Appendix I

Norwegian spring spawners

This group is the biggest spawning group in the Atlanto-Scandian tribe. Its high abundance is determined by the fact that the spawning stock consists of many age-groups, that they spawn many times during their life-cycle and that they have an extensive feeding area.

The information available points to the existence of three main routes which adult herring take when they migrate to the feeding grounds. The first (the most easterly one) lies along the edge of the Scandinavian shelf north-eastward and northward; the second is along the western branch of the Norwegian Current northward; and the third (the most westerly one) takes the herring to the southern edge of the East-Icelandic Current. From here some herring move northward to the Jan-Mayen area whereas others migrate north-westward and are distributed north and north-east of Iceland.

There seem to be three main nursery areas for the adolescent (small and fat) herring, viz.: the Norwegian fjords, the Barents Sea and the southern and north-eastern areas of the Norwegian Sea. However, it is difficult to estimate the proportions of young fish in each of these areas due to the lack of sufficient data. The young, immature herring leave the Norwegian fjords and move to the open sea at 2 to 3 years of age, and those distributed in the open sea, (where they were brought as larvae) occupy a very large area by 3-7 years of age, extending from the central area of the Norwegian Sea to the Polar Front area.

With the onset of sexual maturity (which is a lengthy process) these young herring concentrate in more southern areas nearer to the spawning grounds, and after first spawning begin to perform regular feeding and spawning migrations. Both feeding and spawning migrations become longer with age for the herring derived from all of the nursery areas mentioned above (i.e. Norwegian fjords, Barents Sea and Norwegian Sea). The older herring occupy the extremities of the spawning and feeding grounds. There is a decrease in the distribution area with a decline in the stock abundance and vice versa.

Appendix II

Icelandic spring spawners

These herring are typical spring spawners with a spawning season during March and the first third of April, and an intensive feeding season during the summer and resting season in the autumn and winter months. The spawning areas extend along the whole of the south coast of Iceland and since 1961 a commercial fishery has been based on spawning herring on the western part of the spawning grounds. Samples from this fishery show that the average age of the population in this part of the spawning area is at present between 6-7 years with an average length of 32-34 cm. At present the 1956 year-class dominate in the samples.

Recent tagging experiments have confirmed the results of earlier scale analyses of a clockwise feeding migration of those younger adult herring during summer from the western part of the south coast along the west coast to the north coast. Icelandic scale analyses further show that the older year-classes which probably spawn off the eastern part of the south coast also migrate towards the north-east and north coast in an anti-clockwise direction and this older part of the population is found mixed with the Norwegian spring spawners throughout the summer. However, these large herring only constitute a minor part of the herring fished off the south-west coast in winter and in spite of the fact that they have a typical Icelandic scale pattern and year-class ratios it is not clear whether their spawning area is limited to the eastern part of the Icelandic south coast waters.

Thus, while the life-history of the younger Icelandic spring spawners is reasonably clear more information is needed on the distribution and movements of the older part of the population.

Appendix III

Icelandic summer spawners

Icelandic summer spawners spawn from July to September along the south coast of Iceland from Snæfellsnes in the west to Stoksnes in the east. In some years spawning begins earlier, in the second half of June and in other years it ends later. Sometimes some specimens with running sexual products occur as late as the middle of October (Russian data).

These herring have two feeding periods, before and after spawning. The herring move to their feeding areas along the western and eastern coasts of Iceland and most of them feed north of Iceland (Russian data). Some of them feeding in the Norwegian Sea migrate to their feeding areas along the western edge of the East-Icelandic Current. Their distribution is limited by latitude 71° in the north and by the 0° meridian in the east. Before spawning summer spawners constitute 1o till 3o% of the catch north of Iceland, but their numbers increase considerably in samples taken in the same area after spawning - in August.

The area north of Iceland is the feeding area of summer spawners older than 7-8 years, whereas younger herring seem to feed to the south and west of Iceland; sometimes they move to the north of Iceland in small quantities and for a short time. In September, after feeding in northern areas older herring move southward again along both the eastern and western coasts. At the western coast of Iceland, concentrations of summer spawners feed as late as the end of December. Then they move westward or southward probably to their wintering grounds. In the area of the East-Icelandic Current in winter, summer spawners constitute on the average up to 1o% of the samples. In June their numbers in the samples taken from the same area increase up to 15-2o%.

Appendix IV

Northern North Sea and Scottish NW coast spring spawners

Spawning of large spring-spawning herring of the Atlanto-Scandian type is known to take place along the northern and eastern edges of the North Sea shelf and to the north-west of the British Isles. These herring are fished as full, spawning and spent fish mixed with members of the North Sea autumn-spawning stock by continental and Russian fleets along the eastern and northern edges of the North Sea (Norwegian Deeps to the north and west of the Shetlands) in the period January-May. Other concentrations, which sometimes enter coastal spawning areas off the Scottish north-west coast are also fished by Scottish drifters and ring-net vessels in February-April.

The biological characters of these herring are similar to the main body of Norwegian spawners. Mean vertebral counts, mean length/age and scale types show close similarities, with both the northern and southern Norwegian scale and otolith types being represented in samples of spawners.

Little is known of the precise location of the spawning grounds or of the dispersal of the spawning products and the location of the main nursery areas, but the available larval data suggest that spawning varies in intensity and position from year to year.

It seems clear that after spawning the main body of these herring move out into the open ocean, as with the other members of the Atlanto-Scandian tribe, but whether they join or remain distinct from the main body of Norwegian, Faroes or Icelandic spring spawners during the oceanic feeding phase is not clear. However, some recovering spents of this group are found, mixed with maturing North Sea autumn spawners to the east and west of Shetland during the summer.

More detailed information on the biological characters and affinities of these herring are given in papers by Le Gall (1935) and Baxter (1958).

References to App.IV

Baxter, I. G.	1958	"The composition of the Minch herring stock". Rapp.Cons.Explor.Mer, 143(II):81-94.
Le Gall, J.	1935	"Le hareng Clupea harengus L. Les populations de l'Atlantique Nord-Est". Inst.Oceanogr.,15,215pp.

Appendix V.

Exchange of scale samples

During 1963 exchange of herring-scale samples took place between the laboratories in Bergen, Murmansk and Reykjavik. The results are presented in Table 1o a, b, and c. Table 1o shows that there is a good agreement between the scale-readers on the determination of total age. The Table shows further that in this respect there is a closer agreement between the Icelandic and Norwegian workers than any of these two with the Soviet workers - almost certainly due to more frequent joint working meetings of the former. The mean age is thus practically identical as shown by the Icelandic and Norwegian workers, but it is consistently lower as determined by the Soviet workers.

This problem was discussed, and this difference is probably due to difference in interpretation of certain group of the 195o year-class, the so-called N 6 type, i.e., herring with 6 coastal rings of which the last one is very close to the preceding ring. Table 1o b shows that the results of the comparative readings of age at first spawning are in good agreement between the workers, and similarly Table 1o c shows a considerable disagreement in typing. This last problem is partly due to the fact that the Icelandic reader determined a few (4) herring as ISPR, whereas the others typed those as NS.

With regard to other differences, there was no possibility of finding time during the meetings to investigate in details their causes. Until the readers get an opportunity for such an investigation it is hardly possible to make further detailed survey on the above results

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Table 1. Some biological characteristics of Atlanto-Scandian spawning groups.

Spawning Group	Average V.S.	Month of main spawning	Season of main gonad maturation	Av.fecundity *) (for herring of 32 cm) (in ooo's)	Egg.diam. *) for stageVI fish (mm)	Average l_1 (cm)
Norwegian spring spawners	57.2	March	Autumn-Winter	48	1.5-1.7	8-11
Icelandic spring spawners	57.2	March	Autumn-Winter	69	1.1-1.3	9-11
North Sea-NW Scotland spring spawners	57.o	February-March	Autumn-Winter	64	1.4-1.5	1o-12
Icelandic summer spawners	56.9	July-Aug.	Spring	14o-19o	o.8-1.1	6-7

*) From Soviet observations.

Table 2. Total catch (000's m.tons) of adult and pre-recruit Norwegian spring spawners 1925 - 1964

Year	Norw. west coast fishery	Soviet summer[x] and winter fishery	Icel. and Norw.[xx] summer fishery	T o t a l
1925	25o	-	44	294
1926	255	-	26	281
1927	282	-	68	35o
1928	3o1	-	67	368
1929	343	-	61	4o4
193o	475	-	75	55o
1931	3o5	-	92	397
1932	365	-	72	437
1933	33o	-	81	411
1934	111	-	85	196
1935	4o1	-	69	47o
1936	483	-	144	627
1937	319	-	223	542
1938	496	-	145	641
1939	412	-	131	543
194o	4o9	-	192	6o1
1941	214	-	91	3o5
1942	253	-	142	395
1943	228	-	174	4o2
1944	3oo	-	2o5	5o5
1945	35o	-	5o	4oo
1946	368	-	131	489
1947	494	-	143	637
1948	82o	-	81	9o1
1949	567	-	85	652
195o	771	14	39	824
1951	888	43	67	998
1952	82o	7o	3o	92o
1953	67o	11o	54	834
1954	1o92	16o	28	128o
1955	965	2o7	32	12o4
1956	1146	235	56	1437
1957	796	3oo	24	112o
1958	345	388	34	767
1959	416	4o8	45	869
196o	3oo	465	45	81o
1961	69 Year-class	285	127	481
1962	83 1959	2o9 (25%)	216	5o8
1963	6o (15-2o%)	33o (5o%)	242	573
1964	27o (6o-7o%)			

x) Total catches of Soviet summer and winter fisheries for adult and pre-recruit herring in Norwegian Sea.

xx) Estimated from total catch in Icelandic and Norwegian summer fisheries from analysis of the relative proportions of Norwegian and Icelandic scale types in the period 1949-63, otherwise the numbers refer to total catches.

Table 3. Catch-per-unit-effort

Year	Soviet fishery in the Norwegian Sea (Norwegian spring spawners)				Norwegian winter herring fishery (Norwegian spring spawners)		Icelandic summer fishery (Norw. spring spawners, Icelandic spring spawners and summer spawners)
	Drift-nets				Purse-seine	Drift-nets	Purse-seine
	Catch per haul Tons		Catch per net Kg		Catch per vessel Tons	Catch per net Kg	Catch per vessel
	Average pr. year	Febr.	Average pr. year	Febr.	January to April		Tons
1946	-	-	-	-	131o	-	536
1947	-	-	-	-	1894	179	478
1948	-	-	-	-	2627	239	242
1949	-	-	-	-	1621	177	3o3
195o	5.4	-	62	-	2oo3	17o	132
1951	4.4	-	55	-	2o46	153	293
1952	4.4	4.5	56	125	1731	141	54
1953	4.4	4.4	56	1o2	139o	145	233
1954	4.4	3.6	47	65	222o	182	132
1955	4.o	4.5	5o	79	1758	137	21o
1956	3.5	4.6	46	81	2o43	137	366
1957	3.9	4.7	51	77	1328	15o	38o
1958	4.1	6.9	54	13o	582	1oo	31o
1959	4.9	7.8	72	133	738	1o5	669
196o	5.2	7.7	6o	115	684	8o	42o
1961	3.8	4.8	45	76	271	?	982
1962	5.o	3.7	77	55	426	?	144o
1963	5.6	6.3	62	87	?	?	1111

Table 4. Ratio of different catches of the Soviet drift-net fishery in the total yield of herring in 1 quarter 1952-1963 (in metric tons)

Years	1952	1953	1954	1955	1956	1957	1958	1959	196o	1961	1962	1963
Negligible	48.2	28.o	24.1	14.3	19.9	2o.3	13.o	1o.4	1o.7	14.3	7.55	8.9
to o.5	15.7	21.8	18.7	18.o	15.9	15.4	13.4	1o.4	1o.o	11.8	11.9	1o.1
to 1.5	9.3	11.3	15.3	15.7	12.3	12.6	14.8	1o.2	11.5	11.o	14.6	11.o
to 3.o	8.9	13.7	16.4	19.o	16.o	17.3	18.5	17.7	21.2	2o.o	23.1	21.o
to 5.o	4.o	8.8	9.3	12.5	1o.7	12.6	12.5	15.5	17.3	15.2	15.7	16.9
6-1o	9.o	1o.o	11.o	12.7	13.2	13.7	14.6	18.2	18.o	17.6	17.6	2o.o
11-15	2.1	4.3	4.o	5.4	8.1	6.o	7.6	1o.1	7.o	7.3	7.o	9.5
16-2o	1.8	1.5	o.8	1.7	2.8	1.6	3.o	3.8	1.9	2.1	1.7	1.8
21-25	o.7	o.3	o.6	o.3	o.8	o.4	1.8	1.9	1.4	o.5	o.5	o.6
26-3o	o.2	-	o.1	o.o7	o.15	o.o6	o.4	o.9	o.53	o.2	o.o4	o.15
over 3o	o.1	o.2	o.o3	o.1	o.o7	-	o.4	o.3	o.4	o.o7	o.o6	o.o3
Total no. of drifts	657	1778	329o	3o12	4774	5888	5616	5797	5735	6219	512o	5582

Table 5. Estimates of absolute abundance of adult stock of Norwegian spring spawners 1953-1963

(Estimates of average stock size in 000's m.tons)

Year	From tagging data	From echo-surveys and underwater photography (the area east of Iceland in December)			
		Total	Year-class 1958 and older	Year-class 1959 and younger	Year-class 1959 only
1953	12.462				
1954	12.183				
1955	13.857				
1956	11.997				
1957	9.393				
1958	6.6o3	6.o46	6.oll	35	
1959	5.o22				
196o	?				
1961	?	2.5o4	2.464	4o	
1962	?	2.847	1.3oo	1547	1495
1963		3.256	655	26o1	1847

Table 6. Estimates of total and fishing mortality rate

Year	Total Mortality Rate		Fishing Mortality rate (F)
	From tagging data (F+X)	From age comp.data (F+M)	(Catch/stock size)
1953	o.26	-	o.o6
1954	o.48	o.28	o.12
1955	o.41	o.3o	o.o9
1956	o.65	o.44	o.13
1957	o.58	o.49	o.13
1958	o.62	-	o.1o
1959	o.62	-	o.17
196o	-	-	o.27
1961	-	-	o.21
1962	-		o.21
1963	-		o.2o

Table 7. Total catch of Icelandic spring spawners by Icelandic purse-seiners (in 000's m.tons)

Years	North and East Coast	SW-Coast
1949	3.2	
195o	1.3	
1951	3.5	
1952	o.9	
1953	6.5	
1954	9.8	
1955	11.o	
1956	26.4	
1957	52.2	
1958	47.o	
1959	1o8.o	
196o	61.o	
1961	128.7	42.7
1962	17o.4	58.8
1963	6o.7	3o.7

Table 8. Estimates of abundance of Norwegian and Icelandic spring spawners on north coast feeding grounds in summer (in 000's m.tons) 1953 - 196o

Year	Norwegian spring spawners	Icelandic spring spawners	T o t a l
1953	1.96	o.38	2.24
1954	1.47	o.94	2.41
1955	1.16	o.74	1.9o
1956	2.o9	1.25	3.34
1957	1.o1	1.43	2.44
1958	1.o1	(1.7o)	2.71
1959	1.38	3.24	4.62
196o	1.62	2.o7	3.69

Table 9. Total catch of Icelandic summer spawners by Icelandic Purse-seiners (in 000's m. tons)

Years	North and East Coast	SW-coast
1949		
195o	o.6	
1951	o.1	
1952	o.8	
1953	3.4	
1954	o.9	
1955	o.6	
1956	3.3	
1957	19.1	
1958	11.7	
1959	17.4	
196o	21.8	
1961	2.4	64.9
1962	2.6	9o.1
1963	7.6	97.4

Table 1o. Results of comparative scale-readings.

(A) Total Age; (B) Age at first spawning; (C) Scale type

Sample	Full agreement	Total disagreement	PARTIAL DISAGREEMENT															AVERAGE AGE		
			SOVIET					NORWAY					ICELAND							
			Tot.	Posit.[1]	Negat.[2]	Uncert.[3]	Addit.[4]	Tot.	Posit.	Negat.	Uncert.	Addit	Tot.	Posit	Negat.	Uncert.	Addit.	Soviet	Norway	Icel.
A. TOTAL AGE																				
Norway 6	6o	12	14	-	11	3	-	7	4	1	-	2	6	3	1	2	-	9.3	1o.3	1o.1
Norway 12	6o	6	25	1	2o	3	1	5	-	1	-	4	4	3	-	-	1	1o.1	1o.5	1o.6
SU 42	49	17	26	1	2o	3	2	1	-	1	-	-	7	5	2	-	-	1o.9	11.3	11.5
SU 63	29	2o	27	5	13	6	3	9	5	4	-	-	15	7	3	4	1	9.9	1o.6	1o.6
SU 186	73	3	13	-	1o	1	2	5	2	-	-	3	6	2	1	2	1	4.7	4.9	4.9
(B) AGE AT FIRST SPAWNING																				
Norway 6	24	22	23	4	5	7	7	11	6	1	4	-	19	2	5	11	1	5.4	5.9	5.5
Norway 12	25	13	14	2	8	-	4	19	11	-	3	5	16	2	9	5	-	5.6	5.9	5.7
(C) SCALE TYPE																				
			Total	N	S	?		Total	N	S	?		Total	N	S	?	IS			
Norway 6	52	6	18	2	14	2		7	2	2	3		16	2	1	9	4			
Norway 12	62	1	15	2	9	4		2	2	-	-		13	4	1	4	4			

1) Positive = Number of herring which the reader has estimated older than did his two colleagues.

2) Negative = Number of herring which the reader has estimated younger than did his two colleagues.

3) Uncertain= Age-determination not possible.

4) Additional= Age-determined by reader but deemed uncertain by his two colleagues.

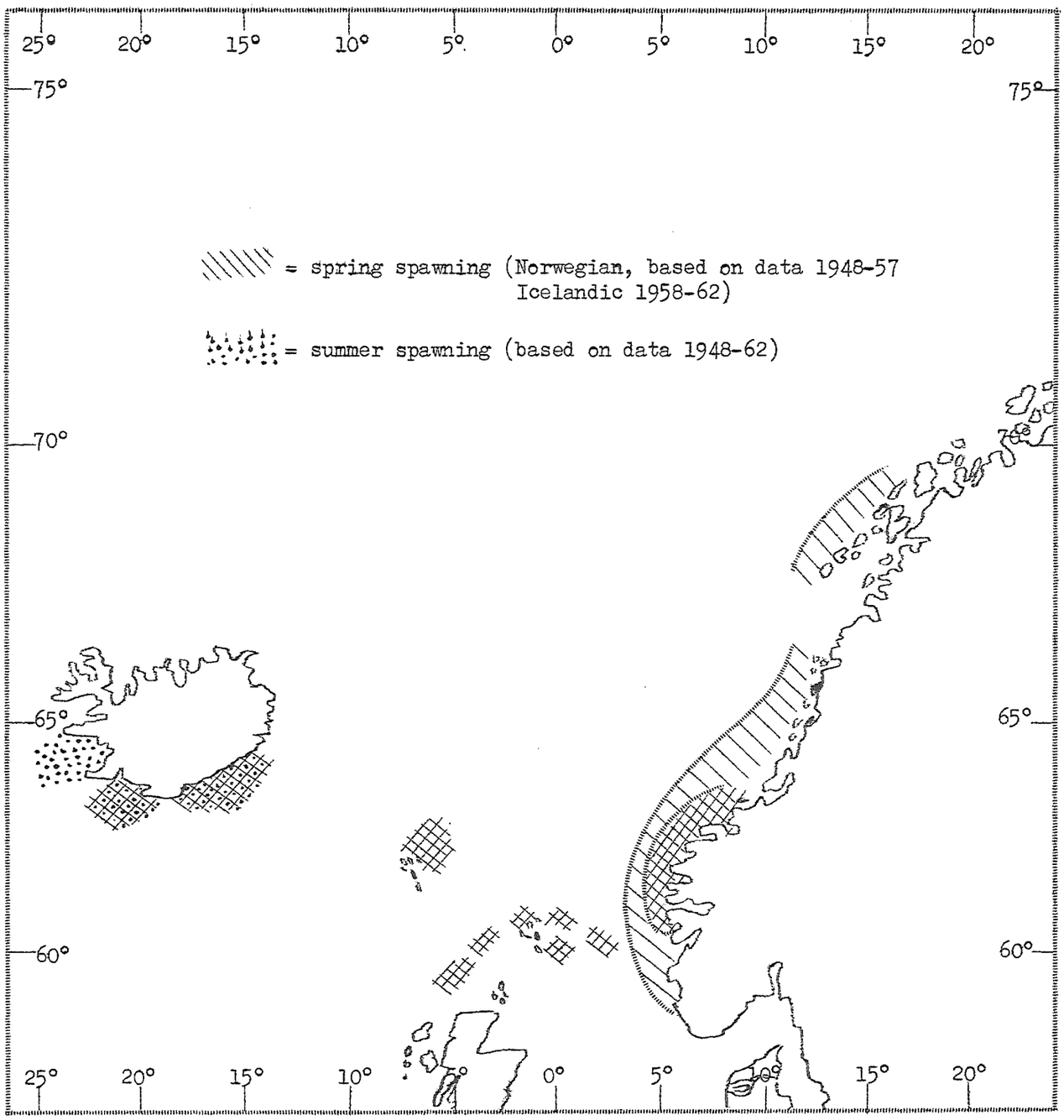

Figure 1 Distribution of Main Spawning Areas for Atlanto-Scandian Tribe