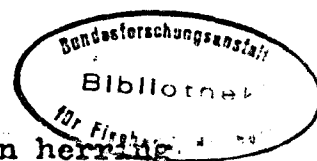


On Herring Stocks Status in the Norwegian Sea

by

C.M.1974/H.20

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Abstract. A rapid reduction of the Atlanto-Scandian herring abundance led to the stopping of their fishery conducted by Iceland and USSR since 1970, and by Norway - since 1971. By 1973 the age composition of the stock have changed efficiently: the species of the 1969 year class constituted the overwhelming majority of fish in the stock. In December 1973 an assessment on the abundance of the wintering herring, which had formed the concentrations in the eastern Norwegian Sea, was carried out. Due to the data of the echo- and photogrammetric surveys the total abundance of herring constituted 0,22 mill.t.

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A recent status of the spring spawning Norwegian herring abundance is continued to be under the serious apprehensions in relation to their future.

It is shown from documents of the ICES Working Group on Atlanto-Scandian Herring (Anon, 1972) that the total yield of adult and prespawning herring taken by all coun-

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tries was equal only to 273.1 thsd t. at the absolute abundance of adult stock amounted to 2 mill.t. in 1968 and it continued to decrease rapidly in the subsequent years.

Since 1970 Iceland and USSR have stopped their fisheries completely. Norway kept fishing on prespawning and spawning herring up to 1971 inclusive, but the catches compared to those in 1966, have reduced more than 70 times. The total Norwegian yield in 1971 constituted only 6.9 thsd t.

The estimates obtained by Dragesund and Ulltang (1973) showed, that in 1971 the stock of adult herring might be not more than 0.03-0.04 mill.t., and the abundance of 4 year olds herring and older - 0.09-0.14 x  $10^9$  specimens.

In 1970 the 9-11 year olds herring of the 1961-1959 year classes were practically predominant all over the areas of the Norwegian Sea (Seliverstov, 1971). By 1973 the age composition of the mature stock has been efficiently changed (Table 1). The species of the 1969 year class were dominant, the part of which spawned out for the first time in spring 1973.

In February 1973 the herring of the 1969 year class constituted 70.6% in prespawning concentrations on the spawning grounds of the Norwegian shelf.

Due to the data obtained from board the R.V. "Akademik Knipovich" a number of herring in this area was too insufficient.

In autumn 1973 the wintering herring concentrations were observed in the eastern Norwegian Sea; the species of the 1969 year class constituted 95.9% (Fig.1). An instrumental survey aimed at herring stock assessment was conducted in this area. A preliminary survey on distribution of shoals was undertaken from board the R.V. "Fridtjof Nansen" on 27-30 November, 1973. As a consequence the area of concentrations of the main herring schools (Fig.1) was registered. From 1 to 5 December the determination of the volumes and densities of concentrations was carried out by means of echo- and photogrammetric surveys aboard the R.V. "Alaid".

The echometric survey made on 2-3 December according to the known methods (Truskanov and Shcherbino, 1962) revealed 47 separate concentrations (Table 2). Their total volume was equal to  $830 \times 10^6 \text{ m}^3$ .

Local and average densities of the concentrations were determined by means of photogrammetric survey conducted due to the methods used at PINRO during several years (Zaferman, 1970; Truskanov and Zaferman, 1973).

On the whole, 13 series of underwater photography were carried out by means of the automatic camera "Triton", that was mounted to the trawl or lowered into the shoal during the vessel's drift.

In total, 191 pictures were taken in the shoals. The distances of photographic visibility and visible volumes of waters were determined by the photogrammetric survey (Table 3). Local densities of the shoals were obtained from a number of fish in one photo divided by the value of the visible volume in cubic metres:

$$\rho_1 = \frac{N_1}{V_1}$$

The mean value of the local density of the concentrations  $\bar{\rho}_1 = 0.88 \text{ m}^{-3}$ .

The mean values of density including the irregularity in shoals distribution were also found. These values were determined per each trawling or drifting by photo automatic and calculated due to the formula:

$$\rho_{av.} = \frac{N}{n V_1}$$

The average density for the whole area of shoals location was obtained on the basis of data on all series of photo surveys:

$$\bar{\rho}_{av.} = \frac{\sum N}{\sum n V} = 0.26 \text{ m}^{-3}$$

Calculations on herring abundance were made by two ways:

1st way. If the total shoals volume  $\sum V = 830 \times 10^6 \text{ m}^3$  and average shoal density  $\bar{\rho}_1 = 0.88 \text{ m}^{-3}$ , then the total herring abundance has been estimated:

$\sum N = \bar{\rho}_1 \cdot \sum V = 730 \times 10^6$  spec., i.e. by estimates at weight, when average weight of 1 specimen was 304 g.

$$\sum P = 304 \times 10^{-5} \times 730 \times 10^6 = 2.22 \times 10^6 \text{ centners.}$$

At the assessment on weight by separate length groups of herring the result is the same:

| l (cm)     | 27  | 28   | 29   | 30   | 31  | 32  | 33 | 34  |
|------------|-----|------|------|------|-----|-----|----|-----|
| Weight (g) | 237 | 268  | 306  | 325  | 348 | 358 | -  | 463 |
| %          | 1.7 | 16.9 | 55.1 | 24.0 | 1.7 | 0.3 | -  | 0.3 |

$$\sum P = 2.22 \times 10^6 \text{ centners}$$

2nd way. A total square of the shoals location ( $S = 20$  sq.miles), and also mean height of shoals ( $h_{av.} = 40.5$  m) was found from Table 2. Average specific abundance over this square (a number of fish per sq.mile) is the fol-

lowing:

$$q_{av.} = \bar{\rho}_{av.} \times h_{av.} \times 3.43 \times 10^6 = 36 \times 10^6 \text{ spec./sq.mile.}$$

Over the whole area occupied by the concentrations, there were

$$\sum N = 20 \times 36 \times 10^6 = 720 \times 10^6 \text{ spec.,}$$

i.e. by estimates at weight  $\sum P = 2.19 \times 10^6$  centners.

The results obtained by two ways have been coincided. Total abundance of herring in the concentrations observed in December 1973 is taken to be equal to 0.22 mill.t.

Research-scouting observations carried out in the western Norwegian Sea, from Yan Mayen to the Faroes in autumn 1973 did not show the herring concentrations on the traditional routes of migrations in that area.

This permits us to suppose that the herring concentration wintering in the eastern Norwegian Sea constituted the main part of the stocks.

#### CONCLUSIONS

1. In 1973 the age composition of the Atlantic-Scandinavian herring changed efficiently. The species of the 1969 year class constituted 70.6% of the prespawning concentrations in February on the spawning grounds and 95.9% of the wintering concentrations in November-December in the eastern Norwegian Sea.

2. The total abundance of the wintering herring concentrations in December 1973 constituted 725 mill. spec. or 0.22 mill.t. due to the echometric and photogrammetric surveys.

Table 1

Age composition of spring spawning herring  
in the Norwegian Sea in 1971-1973

| Year | Age  |      |      |      |     |     |     |      |      |      |      |     |     | n    |
|------|------|------|------|------|-----|-----|-----|------|------|------|------|-----|-----|------|
|      | 2+   | 3+   | 4+   | 5+   | 6+  | 7+  | 8+  | 9+   | 10+  | 11+  | 12+  | 13+ | 14+ |      |
| 1971 | 15,1 | 2,3  | 2,6  | 1,5  | 2,6 | 2,8 | 8,0 | 10,5 | 21,6 | 20,2 | 12,8 | -   | -   | 390  |
| 1972 | -    | 24,2 | 19,9 | 21,5 | 9,5 | 6,0 | 5,2 | 3,4  | 4,3  | 2,6  | 3,4  | -   | -   | 116  |
| 1973 | -    | 0,8  | 2,4  | 5,1  | 0,7 | 0,4 | 0,1 | 0,1  | +    | +    | +    | 0,2 | 0,2 | 2294 |

Sizes of herring shoals

Table 2

| No. of shoal | h : m | S : thsd m <sup>2</sup> | V : thsd m <sup>3</sup> | No. of shoal | h : m       | S : thsd m <sup>2</sup> | V : thsd m <sup>3</sup> |
|--------------|-------|-------------------------|-------------------------|--------------|-------------|-------------------------|-------------------------|
| 1            | 50    | 51                      | 2550                    | 25           | 25          | 500                     | 12500                   |
| 2            | 50    | 364                     | 18100                   | 26           | 100         | 126                     | 12600                   |
| 3            | 50    | 23                      | 1450                    | 27           | 50          | 108                     | 5400                    |
| 4            | 30    | 1                       | 30                      | 28           | 50          | 197                     | 9800                    |
| 5            | 15    | 2,5                     | 37                      | 29           | 15          | 32                      | 480                     |
| 6            | 30    | 1,4                     | 42                      | 30           | 15          | 32                      | 480                     |
| 7            | 30    | 12                      | 360                     | 31           | 30          | 32                      | 960                     |
| 8            | 60    | 44                      | 2630                    | 32           | 40          | 314                     | 12600                   |
| 9            | 55    | 148                     | 8100                    | 33           | 30          | 197                     | 5900                    |
| 10           | 50    | 7,4                     | 370                     | 34           | 50          | 32                      | 1600                    |
| 11           | 60    | 123                     | 7300                    | 35           | 60          | 500                     | 30000                   |
| 12           | 60    | 218                     | 13100                   | 36           | 40          | 197                     | 7900                    |
| 13           | 40    | 123                     | 4900                    | 37           | 45          | 1770                    | 80000                   |
| 14           | 40    | 2,2                     | 88                      | 38           | 45          | 1300                    | 58500                   |
| 15           | 45    | 148                     | 6700                    | 39           | 25          | 208                     | 5200                    |
| 16           | 40    | 126                     | 5000                    | 40           | 50          | 3200                    | 160000                  |
| 17           | 30    | 27                      | 810                     | 41           | 35          | 283                     | 10000                   |
| 18           | 30    | 27                      | 810                     | 42           | 40          | 1930                    | 81000                   |
| 19           | 40    | 71                      | 2840                    | 43           | 40          | 1920                    | 77000                   |
| 20           | 35    | 197                     | 6900                    | 44           | 45          | 175                     | 7900                    |
| 21           | 40    | 780                     | 31400                   | 45           | 40          | 860                     | 34000                   |
| 22           | 30    | 1770                    | 53000                   | 46           | 20          | 240                     | 4800                    |
| 23           | 30    | 500                     | 15000                   | 47           | 40          | 360                     | 14400                   |
| 24           | 25    | 197                     | 4900                    |              |             |                         |                         |
| <b>8</b>     |       |                         |                         | <b>Mean</b>  | <b>40,5</b> |                         | <b>830000</b>           |



Table 3

Assessment on densities of herring concentrations  
according to the data of underwater photogrammetric  
survey

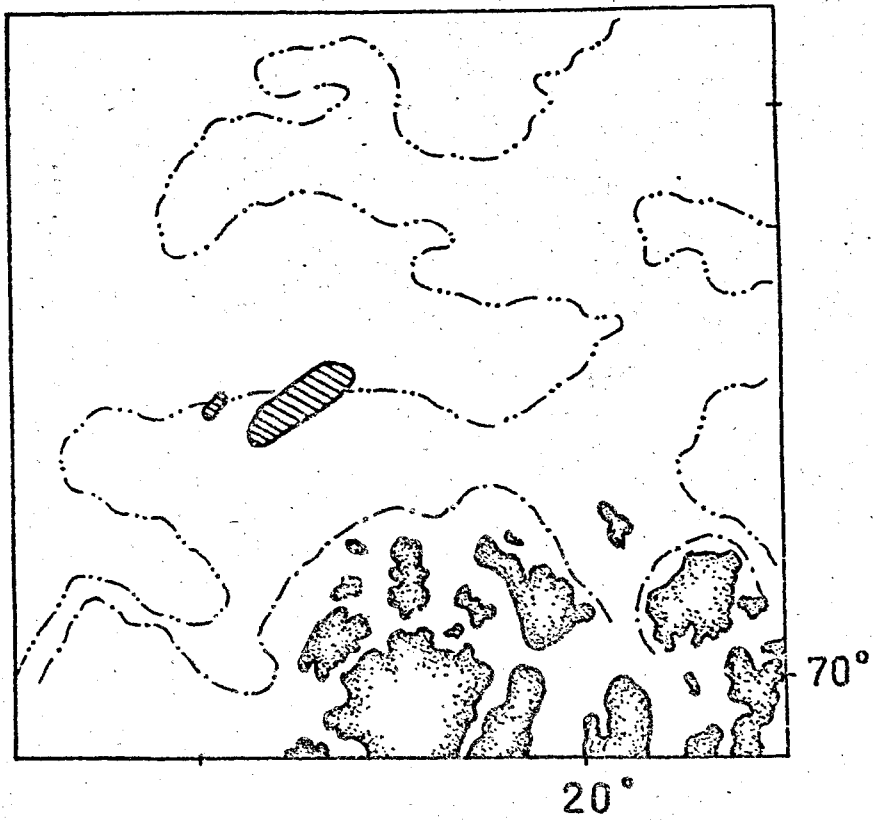
| No. of<br>lowering of<br>camera | Visible<br>water<br>volume $V_1$<br>( $m^3$ ) | Number<br>of<br>photoes:<br>n | Number of fish                   |                            | Density ( $m^{-3}$ ) |                         |
|---------------------------------|---|-------------------------------|----------------------------------|----------------------------|----------------------|-------------------------|
|                                 |   |                               | Maximum<br>in one<br>photo $N_1$ | Total<br>in<br>series<br>N | Shoal<br>$\rho_1$    | Average<br>$\rho_{av.}$ |
| I                               | Camera didn't operate                         |                               |                                  |                            |                      |                         |
| 2                               |   |                               |                                  |                            |                      |                         |
| 3                               | I,8   | 10                            | 2                                | 4                          | I,II                 | 0,22                    |
| 4                               | 5,3   | 10                            | 4                                | 16                         | 0,75                 | 0,30                    |
| 5                               | 5,3   | 16                            | 5                                | 20                         | 0,94                 | 0,24                    |
| 6                               | 5,3   | 6                             | 3                                | 5                          | 0,57                 | 0,19                    |
| 7                               | Camera didn't operate                         |                               |                                  |                            |                      |                         |
| 8                               | 5,3   | 12                            | 4                                | 13                         | 0,75                 | 0,20                    |
| 9                               | 5,3   | 10                            | 3                                | 8                          | 0,57                 | 0,15                    |
| 10                              | 0,3   | 16                            | 1                                | 4                          | unreliable           |                         |
| 11                              | 10,8  | 7                             | 17                               | 25                         | I,57                 | 0,33                    |
| 12                              | 5,3   | 2                             | 3                                | 3                          | 0,57                 | 0,28                    |
| 13                              | 0,9   | 6                             | 1                                | 3                          | I,II                 | 0,55                    |
|                                 |   |                               |                                  |                            | Av. 0,88             | Av. 0,26                |

Figure Captions  
to the paper by Seliverstov, A.S. & M.L. Zaferman  
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Fig. 1 The area of the wintering herring concentrations  
distribution in November-December 1973.

## REFERENCES

- Anon. 1972 Report of the meeting of the working group on Atlanto-Scandian herring. Coop. Res. Rep. Ser. A., int. Coun. Explor. Sea., 30:1-27.
- Dragesund O. and Ulltang, Ø. 1973. Further studies on stock size fluctuations and rate of exploitation of the Norwegian spring spawning herring, 1950-1971. Coun. Meet. int. Coun. Explor. Sea. (H:19):1-13 (Mimeo).
- Seliverstov, A.S. 1971. Soviet Investigations on the Atlanto-Scandian Herring in the Norwegian Sea in 1970. Coun. Meet. int. Coun. Explor. Sea (H:12):1-5. (Mimeo).
- Truskanov, M.D., Shcherbino, M.N. On determination of volumes of dense concentrations of the Atlantic-Scandinavian herring. Trudy PINRO, vyp. 14, Moscow, 1962.
- Truskanov, M.D. and Zaferman, M.L. 1973. Some characteristics of hydroacoustic methods of determination of fish abundance in sound scattering layers. ICES /FAO/ ICNAF. Symp. on Acoustic Methods in Fisheries Research, Bergen. (Mimeo).
- Zaferman, M.L. 1970. Stereophotographic method of the determining of density of fish concentrations. Materialy rybokhozyaistvennyh issledovaniy Severnogo basseina., vyp. 14, Murmansk.



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