International Council for the Exploration of the Sea

C.M.1980/H:62
Pelagic Fish Committee

INDICATION OF HIGH NATURAL MORTALITY FOR JUVENILE HERRING FROM ACOUSTIC AND TAGGING DATA

by

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ABSTRACT

Natural mortality for juvenile herring (Norwegian Spring spawners) is discussed on the basis of following data:

1. Acoustic estimates of the 1975 and 1976 yearclasses of herring as 0-group and estimates from tagging data of these yearclasses as 4 year old fish.

2. Acoustic abundance estimates of the 1978 herring yearclass in Lavangen fjord, Northern Norway.

These data indicate a high natural mortality for juvenile herring.

INTRODUCTION

Values on natural mortality for adult fish are often utilized when making prognosis which have abundance estimates of juvenile fish as starting points. This is, of course, due to lack of information on natural mortality of juvenile fish.

In 1977, the Working Group on Atlanto-Scandian herring made a prognosis of the 1975 and 1976 yearclasses of the Norwegian Spring spawners when entering the spawning stock as 4 year old herring (ANON. 1977). The Working Group assumed an adult instantaneous natural mortality coefficient (M= 0.16) for all juvenile age groups. The natural mortality of M= 0.16 was estimated by the Working Group on Atlanto-Scandian herring in 1969 on the basis of various data (ANON. 1970). However, the data included only adult herring which had recruited to the spawning stock

The 1975 and 1976 yearclasses have now recruited to the spawning stock, and abundance data of these yearclasses as 4 year old fish are available from the present tagging prosject. And it can be seen that the prognosis made in 1977 was far to optimistic.

On the basis of data from acoustic surveys on O- and I-group herring and from the present tagging project, this paper concludes that the main reason for the failure of the prognosis was a too low value of the natural mortality.

O-GROUP INVESTIGATION AND TAGGING EXPERIMENT

Acoustic abundance estimates of O-group herring in Norwegian coastal waters have been made on the basis of a survey carried out each year in November-December since 1975.
Integrator values are converted to herring biomass by using a length dependent conversion factor. This technique is described in NAKKEN and DOMMASNES 1975. Estimates are made for each fjord and then added together into three main areas (62^{o}N-

$65^{o}N$, $65^{o}N$ - $68^{o}30'N$ and north of $68^{o}30'N$).

In the fjords O- and I-group herring and sprat often occur together in the same echo recordings. However, in 1978 considerable concentrations of pure O-group herring were recorded in the fjord of Lavangen in Northern Norway. A map of the location is given in Fig. 1. The following year, herring of the same yearclass was the only herring to be recorded, now as I-group. Fig. 2 and Fig. 3 shows echogrammes of the recordings in 1978 and 1979 respectively, and Fig. 4 shows length distribution of the herring from trawl catches.

Table 1 gives the abundance estimates of the herring. The survey was both years made by the same vessel (R/V "Johan Ruud"), and should be directly comparable.

A tagging experiment on Norwegian Spring Spawning herring was iniciated in 1975 (ANON. 1977). The spawning stock is sampled for tagged fish, and on the basis of recoveries and biological sampling, an abundance estimate of the spawning stock, including recruit spawners is made.

The acoustic abundance estimates of O-group herring was also inicated in 1975, and therefore there is at present abundance data of the 1975 and 1976 yearclass both as O-group and as recruit spawners (4 year old herring) (ANON. 1980).

DISCUSSION

The following factors may be of importance for the failure of the prognosis made in 1977. Some of the recorded O-group may belong to local stocks, some O-group may be fished as by-catches in the sprat fishery (F=0 was assumed by the Working Group) and a delayed recruitment due to declining length at age. A preliminary discussion of these factors are found in the Working Group Report (ANON. 1979), and will be treated more in detail in a later paper

by the present author.

But the main factor may be:

A) The acoustic abundance surveys may have overestimated the O-group stock size, or

B) The natural mortality M= 0.16 is too low.

A) The possibility that the O-group estimate is a overestimate is very little due to:

1) Geographical distribution of the O-group herring: The present cruise surveys the coastal areas north of Stad (62^{o}N) in about 5 weeks. In this time it is not possible to cover every fjord and bay along the coast. Further, in some areas were O-group herring is reported, there is not possible to navigate or to take samples of recordings due to shallow waters.

   Furthermore, there is also a oceanic component (mainly Barents Sea) of the O-group herring which is not included in the O-group estimate. The oceanic distribution of the 1976 yearclass is shown in ANON. 1976.

2) Factors such as acoustic shadowing in schools, recording near bottom, saturation of equipment etc. indicate that the acoustic technique gives an underestimate rather than an overestimate (RØTTINGEN 1976).

3) The fish behaviour, i.e. avoidance during passage of survey vessel in connection with the acoustic technique, also indicates an underestimate (OLSEN 1980).

All these factors indicate that the estimate of O-group herring is an underestimate rather than an overestimate.

B) If the O-group abundance estimate is not an overestimate, an average minimum yearly instantaneous mortality coefficient for the juvenile stage can be calculated by combining these data with data from the tagging project. For the reliability of the tagging data, see ANON. 1977 and ANON. 1980.

Yearclasses	:	1975	1976
Abundance ($Nx10^{-6}$) as O-group in autumn (from acoustic surveys)	:	1075	3775
Abundance ($Nx10^{-6}$) as 4 year old in spring (from tagging project)	:	73	310
Average yearly instantaneous mortality coefficient (total time period 3½ years)	:	0.76	0.71

These instantaneous mortality coefficient represent total mortality. The natural mortality will be somewhat lower. This is due to:

1) Although there is no directed fishery for O- and I-group herring, some herring of these categories are caught as by-catch in the sprat fishery. At present, no estimate of catch in numbers can be given of this by-catch.

2) Some 3 year old herring are caught in the limited fisheries for adult herring. Further there is some unreported catches due to fisheries for bait and for own consumption. The Working Group in 1980 estimated the catch in number of 3 year old herring in 1978 (1975 yearclass) to be 3.0×10^6, and of 3 year olds in 1979 to be 6.4×10^6, (These data are not used in the above calculations of mortality).

However, it is not reasonable to except that the natural mortality is constant throughout the entire juvenile stage. Both swimming

speed and endurance increases with length. It is likely that the predator effect and, consequently, the natural mortality decreases with age. The natural mortality for the O-group may be considerable higher than for the III-group. The data from Lavangen (Table 1) gives Z= 0.95 for the mortality from O-group to I-group. This is also a total mortality. There is no sprat fishery so far north, but the number of I-group may be reduced due to emmigration from the fjord. But then one should have expected to find I-group herring elsewhere in that part of the coast. But very little I-group herring were recorded there in 1979. It is therefore expected that no substantial emmigration took place, and that 0.95 is close to the instantaneous natural mortality coefficient. The main predator in that area is cod, both juvenile and adult. Also haddock and saithe is quite abundant.

How representative are natural mortality estimates from Lavangen with regard to the entire stock of Norwegian Spring spawning herring? This stock has had mainly a coastal distribution the last decade. The herring has been distributed in scattered concentrations from fjord to fjord. Environmental conditions, number and type of predators vary, and it is probably that the natural mortality varies correspondingly. The natural mortality will probably also vary with the yearclass strength of the herring.

CONCLUSION

The data discussed in this paper can only give indications of the natural mortality of juvenile herring. And, as discussed in the paper, the true value probably varies considerable from time to time. But the data suggest that in making prognosis of stock abundance with O-group data of herring as starting point, a natural mortality coefficient nearer 1.0 rather than 0.1 should be applied from the O-group to I-group stage.

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Table 1. Abundance of 1978 yearclass of herring in Lavangen in 1978 and 1979

Year	Number of herring ($N \times 10^{-6}$)
1978	114
1979	44

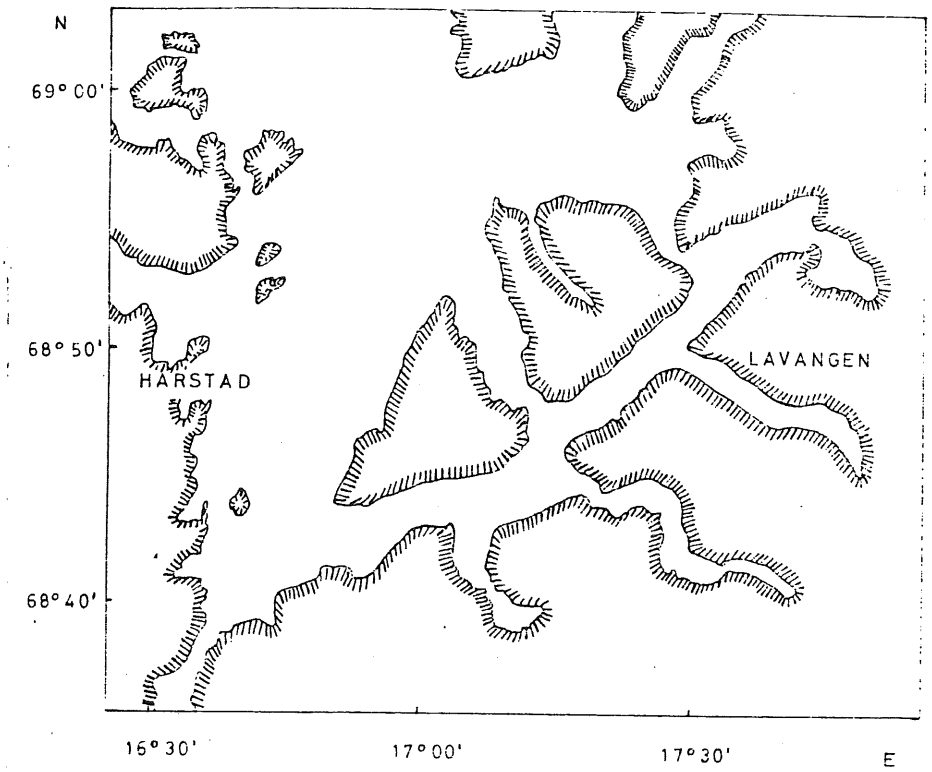

Fig. 1. Map showing the locality of Lavangen fjord, Northern Norway.

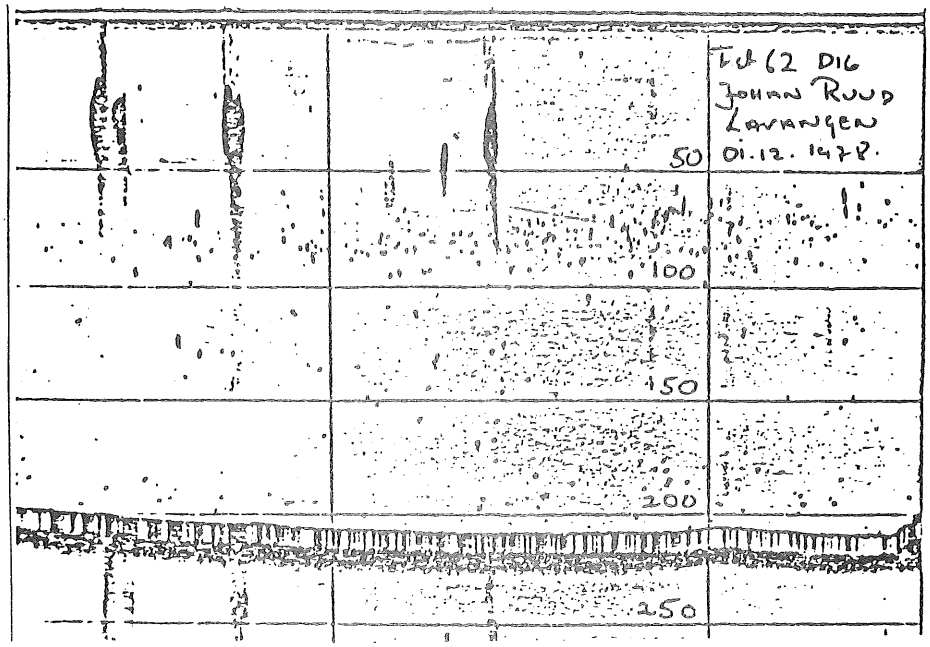

Fig. 2. Schools of 0-group herring, Lavangen 1.12. 1978.

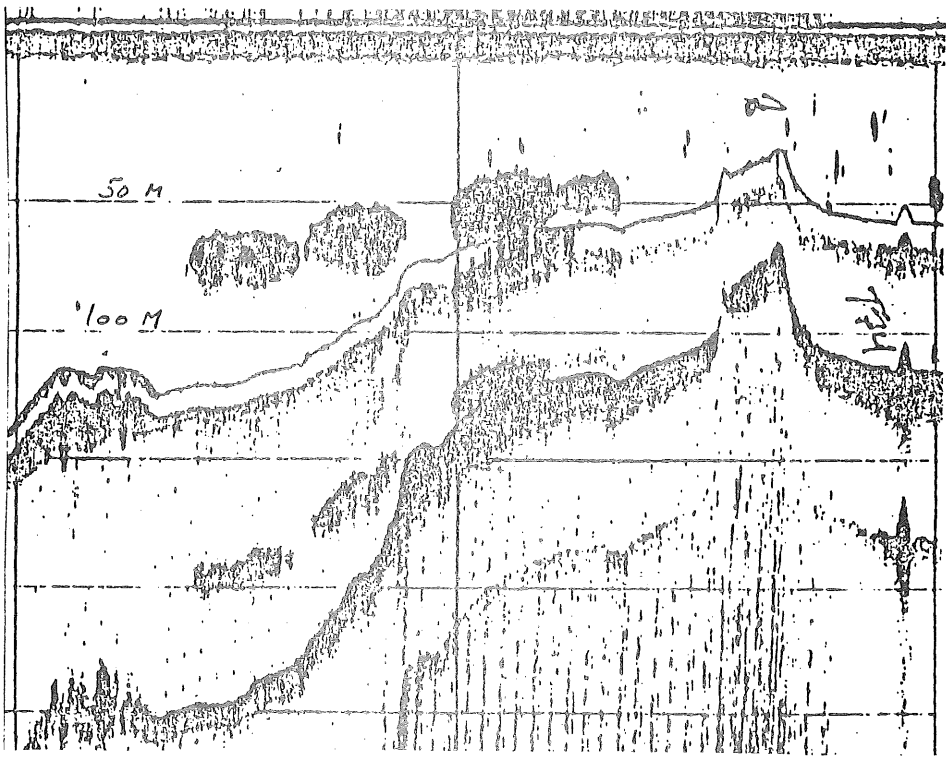

Fig. 3. Schools of I-group herring, Lavangen 29.11. 1979.

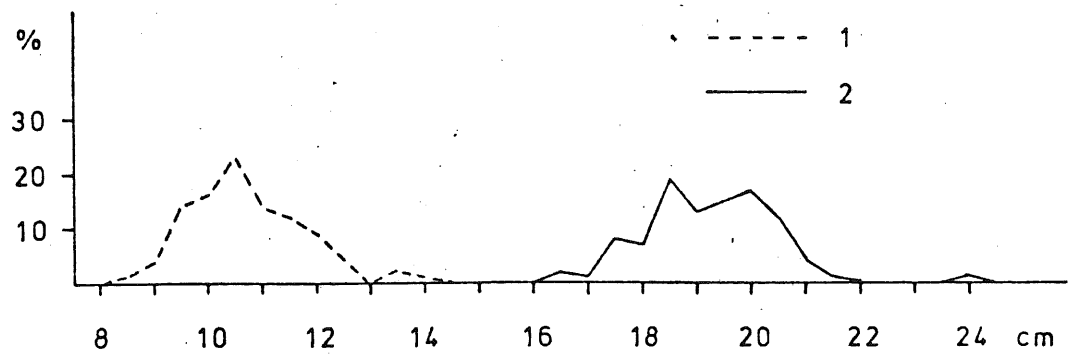

Fig. 4. Length distributions of herring, Lavangen
1) O-group, 1.12. 1978, 2) I-group, 29.11. 1979.