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REACTIONS OF HERRING TO TRAWLING NOISE

by

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ABSTRACT

The reaction of herring during pelagic trawl sampling has been studied by use of a high-frequency scanning sonar mounted on the headline of the trawl. The difficulties of obtaining high catch rates on shallow herring layers by single-vessel trawling are demonstrated. Propeller-noise avoidance is suggested as the main reason for the low fish density observed behind the trawling vessel. Minor adjustments in trawling technique to improve catch efficiency are suggested.

INTRODUCTION

Obtaining a high catch rate on shallow concentrations of herring have long been recognized as difficult (SHARFE 1955: OKONSKI, 1969). The most obvious reason is that the path of the trawl on a single vessel will be in the path of the propeller, or just below this. During trawling, the increased noise level from machinery and propeller cavitation (CHAPMAN and HAWKINS, 1973) has been seen to stimulate avoidance reactions by fish close to this path (BUERKLE 1977, OKONSKI 1969, ONA & CHRUICKSHANK 1986, ONA & GODØ 1987, ONA 1988). Generally, fish avoidance has been studied by the use of single-beam echo sounders mounted more or less stationary, observing the fish as the vessel is passing the transducer, as by OLSEN (1979) for surveying vessels, or as by ONA & CHRUICKSHANK (1986) for trawling vessels. With optical devices and single-beam transducers it is only possible to observe the behaviour of the fish in a fraction of the interesting volume, and the horizontal pattern of avoidance becomes rather unclear. With the use of high-frequency scanning sonars, where single individuals can be resolved (ONA & EGER 1986, 1987),a new dimension can be added, giving at least slices through the three dimensional world surrounding the vessel.

The importance of knowing the pattern of fish avoidance is evident from a professional fisherman's point of view, but besides the effect on catch efficiency, avoidance reactions may also bias the trawl sample. This should be equally as important to the scientist as the actual catch rate. This paper will demonstrate vessel avoidance by herring and suggest improvements of the trawl technique on the basis of the described density distribution of fish in the path of the propeller.

MATERIAL AND METHODS

The observations were made in January in Ofotfjord, outside Narvik, Norway, on hibernating, pre-spawning herring of the 1983 year class. The mean length of the herring was 31.0 cm, S.D.= 1.3 cm.
The particular trawl experiments were made at night, when the fish spread out in a thin layer, 20 to 30 m thick, at approximately 25 m depth. Only navigation lights were used during the experiment.

A high-frequency scanning sonar, the SIMRAD FS-3300, equipped with a 2.6 deg. circular beam transducer, was mounted on the headline of the FOTØ herring trawl, mod.84, and scanned 360 degrees through the mouth of the trawl and surrounding water masses with a scan radius of 100 m.

Using the fairly light, 750 kg, LINDHOLMEN, 4.6 m^2 otter boards, a warp length of approximately four times the depth was shot in order to reach the correct fishing depth of 25 m. The distance from the stern of the vessel to the mouth of the trawl is then 230 m, including a bridle length of 110 m.
From this position, the trawl was gradually lowered backwards, below the fish layer, and only used as a platform for the sonar (Figure 1.). Scans describing the fish density distribution at the indicated positions of the trawl could then be made.

RESULTS

A typical layer which was trawled is shown in Fig.2. According to the acoustic abundance estimates , the density at survey speeds varied from 1 to 4 fish per cubic metre.

At the short warp length, 120 m, the trawl is close to the propeller, and the herring avoid the direct path of the vessel, Fig.3. The open "hole" in the layer is at this point nearly 50 meters wide. The 35 m wide trawl mouth is here fishing in the centre of the emptied space. A closer look at the situation with reduced scanning range, Fig. 4. shows that a few herring were caught, but that the density of fish entering the trawl is very low compared to the true layer density.
Lowering the trawl below the layer, Figs. 5 a,b,c, indicates that the avoidance gradually ceases with distance from the vessel, and that the evacuated space is reoccupied horizontally at a distance above 350 m. With the present rigging of the trawl, it was impossible to reach a suitable fishing depth at warp lengths above 120 m.

DISCUSSION

The increased noise level during trawling compared with that in a free-run situation is clearly demonstrated by the increased avoidance. At a survey speed of 5 knots, only a slight and local thinning of the layer could be observed by the sonar when mounted on a towed body hauled 50 - 100 m behind the vessel (ONA & TORESEN, 1988).
However, to create a "hole" in the layer horizontally, like that observed in the first section, Fig.2, the herring below the vessel only have to avoid at an average speed of approximately 0.6 body length/ sec., far below burst and sustainable speeds for this fish. Of course, the speed may be significantly higher during the moments of passage, and then gradually decreased with increasing distance from the stimuli. At full burst speed, such a "hole" in the layer could theoretically be made within ten seconds by fish of this size. As the herring presumably start avoiding before the arrival of the vessel, as observed for cod during trawling (ONA 1988), the avoidance may occur at fairly low swimming speeds.
In contrast to avoidance observations on gadoids (ONA & CHRUICK-SHANK, 1986; ONA & GODØ ,1987; ONA ,1988), where a substantial diving reaction was recorded, the herring in this particular situation only seemed to avoid horizontally. Some distance behind the vessel, at 350 - 400 m, or 5 - 6 minutes after propeller passage, the emptied space is reoccupied. This is shorter than observed for gadoids, where 9 - 11 minutes is observed as a characteristic time for a restored density situation (ONA, 1988).

As has been realized for decades, SHARFE (1955), PARRISH (1959) and OKONSKI (1969), the most suitable gear for catching herring at shallow depths is pair-trawling, where the propeller noise will act as a herding mechanism for the fish between the vessels. Operating trawls from a single vessel, as is the case for research vessels, requires a special trawling technique in order to avoid trawling in the vessels's wake at short warp lengths.
This may include forced steering of the otter boards to create the lift needed for a long warp length, elevator toads, elevator kites, or even controllable otter boards where the depth is

regulated by wires through large surface floats. The last mentioned system is in regular use in the Swedish midwater trawl fishery for herring (O.Hagstrøm, pers.comm), as well as the Swedish research vessel R/V "ARGOS".
Most of these arrangements are made in order to reach the steadily reoccupied area behind the vessel, but at long warp lengths it is also possible to steer the trawl out of the path of the vessel, exploiting the high density areas at each side of the vessel path. Significant improvements in catch efficiency have been obtained with these techniques on herring (O. HAGSTRØM pers.comm.) and on anchovy (ONA 1987, VALDEMARSEN & SKÅTØY 1988).

It is additionally reasonable to believe that a sample of the fish community at larger distances from the vessel is more representative with respect to species composition and size distribution. In the avoidance process, both the reaction sensitivity of the different species (HAWKINS 1973), and differences in swimming capacity (BLAXTER 1969; WARDLE 1975,1977), will tend to bias the sample towards the slower and smaller individuals.

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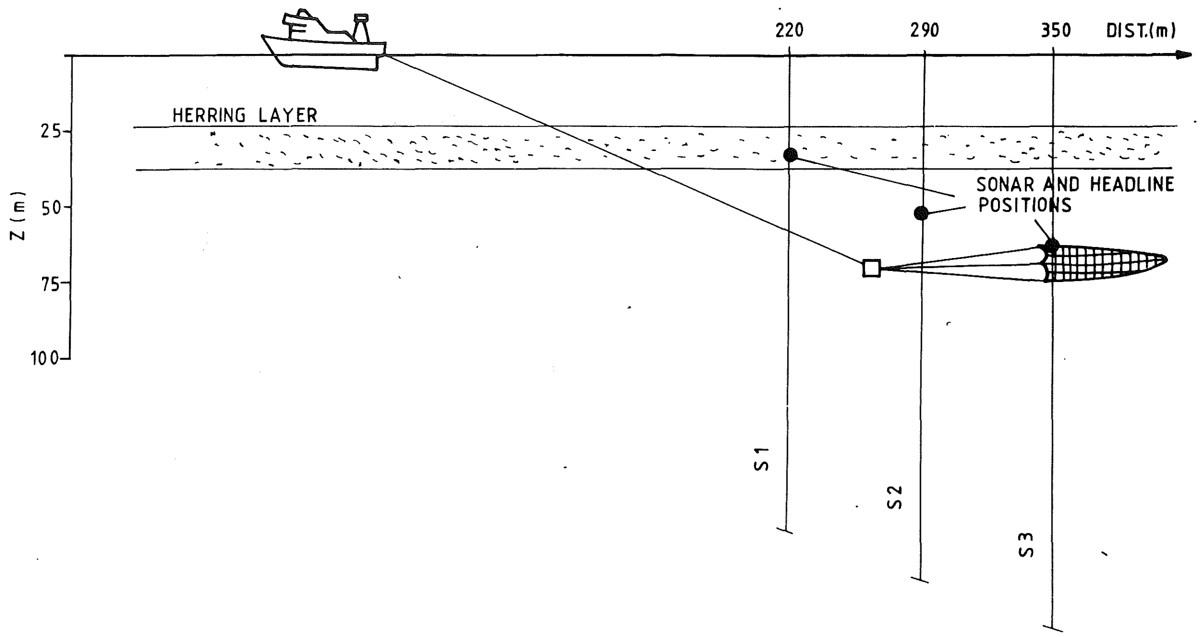

Figure 1. Towing positions of sonar and trawl relative to the herring layer, with depth and distance to the vessel indicated. Section 1 (S1), describing a slice transversly to this picture is with the trawl at correct fishing depth.

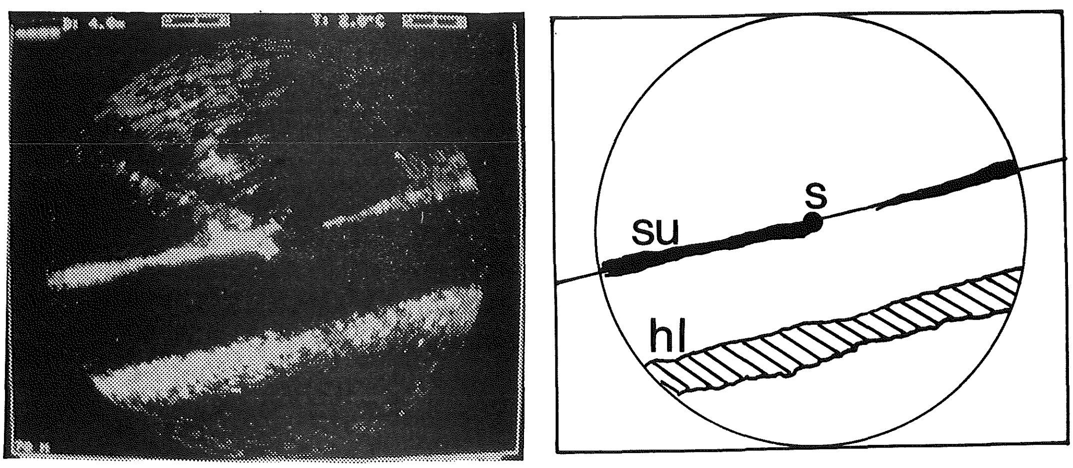

Figure 2. Sonar display of the herring layer, taken with the sonar mounted on the bow of the vessel at 3 knots. S -sonar, SU - surface, HL - herring layer.

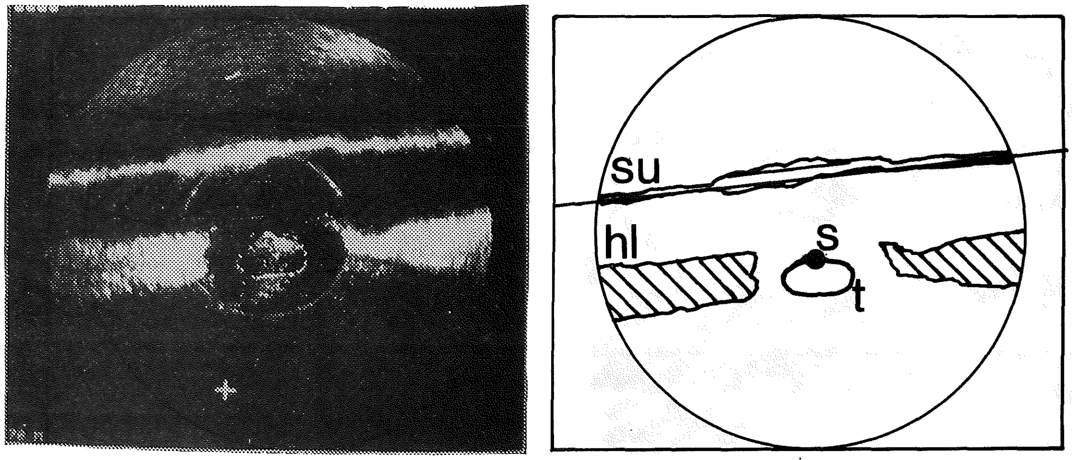

Figure 3. Section 1, rfr. Fig.1, showing the trawl (t) at correct fishing depth. Note the "hole" in the herring layer (hl) at this point, 230 m behind the vessel. Range, or radius, 70 m.

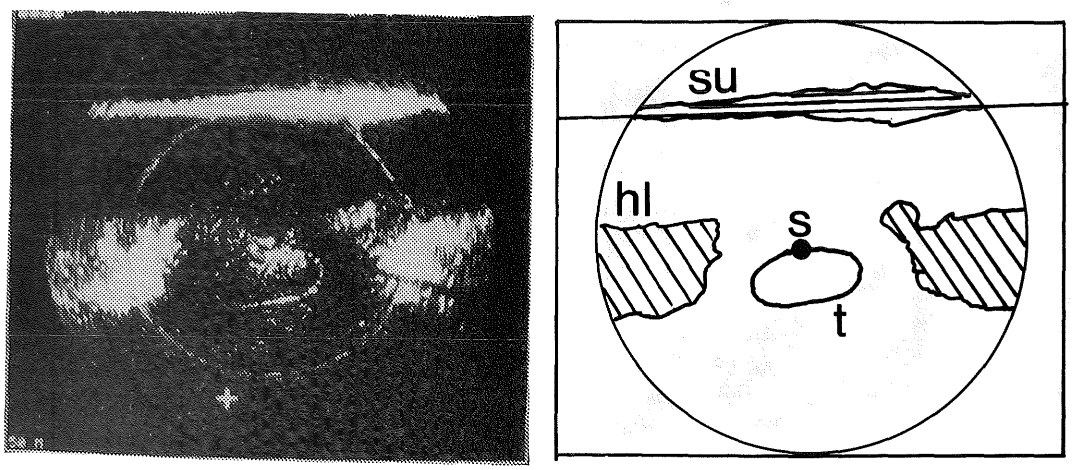

Figure 4. Section 1 at reduced range, 50 m, showing individual fish entering the trawl. Distance to vessel 230 m.

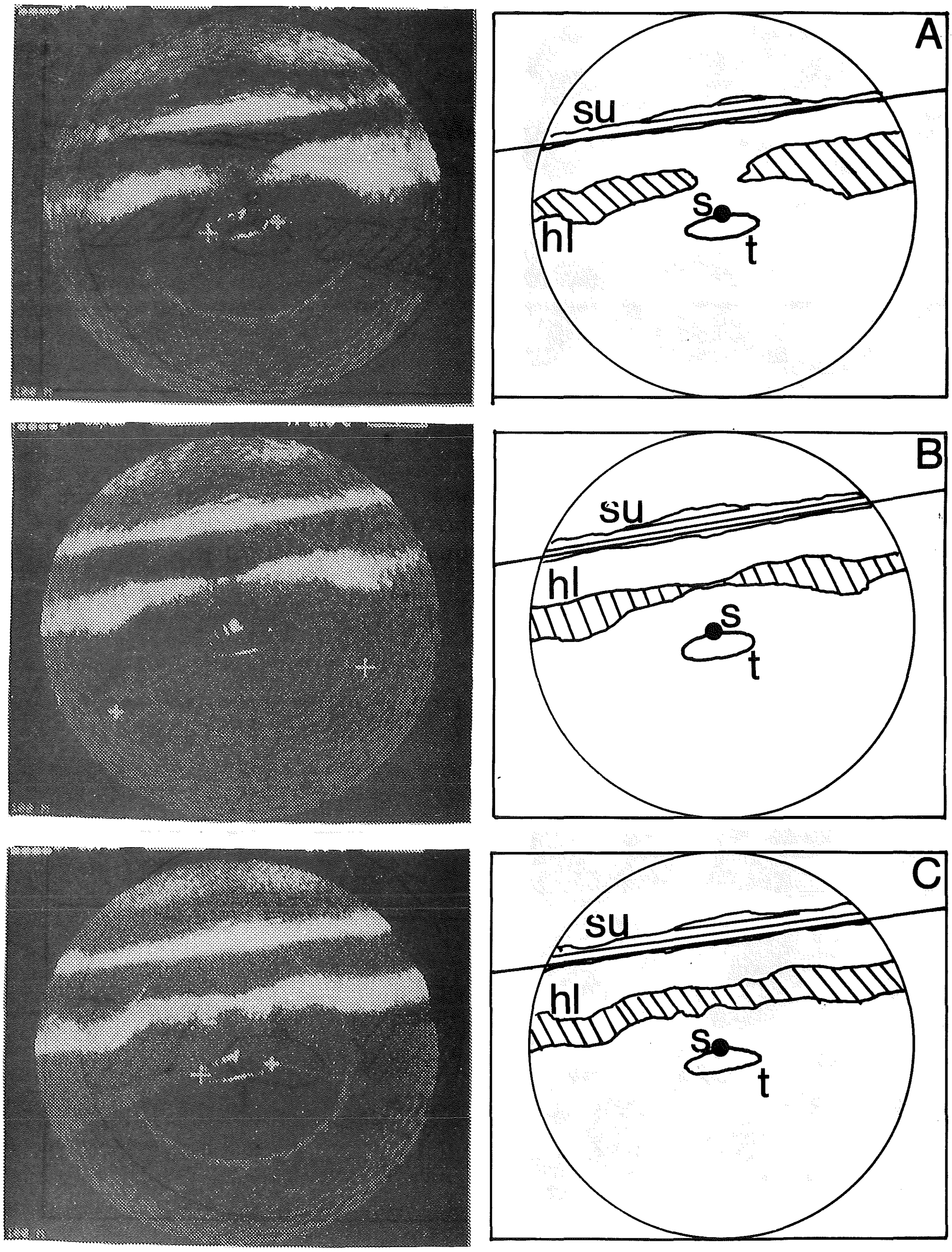

Figure 5,a,b,c. Herring layer at different distances from the vessel. A - 290 m, B and C - 350 m. Note the gradual reoccupied area in the path of the vessel. Scan radius 100 m.