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Sampling herring in the Norwegian Sea by pelagic trawl

by

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Abstract

When the stock of Norwegian spring-spawning herring is distributed in the Norwegian Sea in summertime, pelagic trawl sampling may be rather challenging because of substantial variation in vertical distribution (from surface and down to 400 m depth), and avoidance of vessel and trawl gear. In this paper the operation and performance of the «Åkratrål» during pelagic trawl sampling of herring by R/V «G.O. Sars» on cruises in the Norwegian Sea 1996 - 1997 are described. The sampling results with regard to capture success, catch size and geographically segregated length distributions are presented. The implications of the sampling results on the reliability of the acoustic estimate of stock size are discussed.

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Introduction

At present, the stock of Norwegian spring-spawning herring has reached a high level of abundance after the stock collapse in the early seventies (Misund et al., 1997). Sustainable management of the stock will depend on reliable data on abundance, age structure, recruitment, catch statistics, migration pattern and distribution area. Fisheries independent data on abundance will be provided by national and ICES coordinated acoustic surveys. During such surveys, herring recordings must be identified by pelagic trawl sampling. This is an important part of the survey methodology, because reliable species identification, quantification of species composition, and age and size classification, rely on representative sampling.

Herring concentrations have been regarded to be difficult to sample by pelagic trawl during daytime due to avoidance, but rather straightforward to sample with the same gear when scattered at night. This has often been taken account of during acoustic surveys by conducting most of the sampling at night. Another common belief is that herring concentrations are rather homogeneous with respect to fish size. However, Buerkle and Stevenson (1990) showed that the size distribution of herring catches varied substantially between daytime and nighttime, and between catches taken by pelagic or bottom trawl.

In the seventies and eighties, the Norwegian fisheries research vessels were equipped with pelagic trawls of the «Harstad» and «Fotø»-types for catching herring. The former is a four panel capelin trawl with a vertical opening of about 15 m, the latter a two panel Swedish herring trawl with a vertical opening of about 17 m. In 1993 these gears were replaced by the larger, two panel «Åkra» trawl (Valdemarsen and Misund, 1995), especially to increase the efficiency and representativity when pelagic trawl sampling of herring.

The geometrical performance of the «Åkra»-trawl as a function of different rigging and operation has been described by Valdemarsen and Misund (1995). In this paper, the catching properties of the trawl during herring surveys in the Norwegian Sea are considered. The analysis is based on results of pelagic trawl sampling during surveys conducted in the Norwegian Sea in May 1996 and April 1997.

The purpose of the cruise in May 1996 was primarily to map the distribution of the Norwegian spring spawning herring on the continental shelf off western Norway and in the Norwegian Sea, and possibly to provide an estimate of abundance of the herring stock. The cruise was one of seven Norwegian cruises aimed at mapping and abundance estimation of the Norwegian spring spawning herring in the Norwegian Sea and adjacent waters in 1996. The purpose of the cruise in April 1997 was primarily to study the relationship between the physical and biological environment and the migration behaviour of herring schools in the Norwegian Sea. The cruise is the second of five Norwegian cruises aimed at mapping and abundance of the Norwegian spring spawning herring in the Norwegian Sea and adjacent waters in 1997. Both cruises were part of the ICES coordinated research activity on Norwegian spring spawning herring and the environment in the Norwegian Sea that have been established between EU, Faroes Islands, Iceland, Norway and Russia (Anon, 1997).

Rigging, trawl geometry and sampling procedure

During both cruises, acoustic recordings of fish were identified by use of the «Åkra»-trawl (Valdemarsen and Misund, 1995). By ordinary rigging the trawl can be used to catch deep recordings, but the trawl can also be rerigged to catch recordings near the surface by removing the weights, extending the upper bridles by 12 m, and attaching two large buoys to each upper wing.

According to the geometry measurements reported by Valdemarsen and Misund (1995), the depth of the headline of the trawl during ordinary rigging with 7 m² Waco-doors and 3.5 knots towing speed increases lineary with increasing warp length according to a warp length-to-depth of headline ratio of 2.55 (500 m warp length give a depth of the headline of 196 m). The horizontal door spread increases asymptotically from 75 m with 200 m warp length to 120 m with 980 m warp length. The vertical opening remain rather constant from 29 m at 400 m warp length to 26 m at 1200 m warp length. When rerigged with extended bridles, weights removed, buoys attached, and towed at surface with the same speed, the vertical opening increase from 25 m at 200 m warp length to 36 m at 350 m warp length. At longer warp length, the total pressure on the large floats become too large, they sunk and collapsed, and the trawl descended.

In cases of catches, subsamples of up to 100 specimens of herring and blue whiting were taken. The length down to nearest 0.5 cm, weight, sex, maturation stage, and stomach content were recorded. Scales from 50 herring and otoliths from 50 blue whiting were taken for age reading. The stomachs from 30 herring and 20 blue whiting from each subsample were frozen for later analysis. Other fish species were length measured, weighted or frozen for later analysis.

To avoid large catches during the April 1997 survey, a 1.5 m long split was cut in the bag about 3.5 m in front of the cod end.

Survey areas

In May 1996, an area from 62° 15' N, west to 7° W, east to the Norwegian coast and north to 71° 15' N was surveyed by transects spaced about 60 nautical miles apart. Pelagic trawl stations were taken regularly for each 60 nautical miles during most of the survey. In addition, pelagic trawl stations were taken to identify recordings both at surface and at greater depth. Totally, 90 pelagic trawl stations were taken during the cruise.

In April 1997, an area between 66° - 67° 30' N and 2° E - 4° W was surveyed by a regular grid with 30 nautical mile spacing north - south. Totally, 21 pelagic trawl stations were taken during the April 1997 cruise.

Results and Discussion

In May 1996, herring were recorded and caught by pelagic trawl sampling over a wide area in the Norwegian Sea (Fig. 1). The southern border was at about 62° 30' N in the EU-zone, the western border followed the cold front between about 6° W at 66° N to 3° W at 70° N, the most northern and eastern concentrations were found at about 71° N at about 16° E. The herring was caught in 37 surface hauls mostly in the eastern part of the survey area, and in 12 deep hauls in the western part of the survey area. Most of the surface catches (24 cases) were less than 10 kg, but the maximum catch size was up to about 50 tons. The deep hauls tend to give larger catches (50 % of these catches were larger than 1000 kg).

The herring occurred in two distinct categories of distribution. Rather young herring dominated by the 91- and 92- yearclasses were distributed in a wide areas in eastern and southern regions of the area surveyed. The herring in these areas averaged 26 - 31 cm (Fig. 2). Off northern Norway there were 4 cases where the average length of the herring was less than 26 cm. The herring that were distributed in the eastern and southern part of the area surveyed, occurred mostly in small schools or scattered in layers at about 25 to about 100 m depth. The herring in such near surface schools or scattered layers were successfully sampled by surface tows. Off the coast of northern Norway the herring occurred in distinct schools at about 100 m to about 250 m depth. The herring in these schools were difficult to sample by deep hauls with the pelagic trawl, and during several aimed attempts on distinct schools during a 4 hour station, only 34 herring were caught.

In the western part of the survey area, the herring occurred in large schools mostly between 250 m to 400 m depth. The herring in these schools avoided downwards during trawl sampling, but most stations were successful in obtaining a proper herring sample. In the north-western part of the survey area there were recordings of large schools from surface to about 200 m depth. The herring in this area were larger with up to 45 % of the 1983 yearclass in numbers in one catch. The average length of the herring in the western and north-western area were mostly between 31 and 35 cm (8 cases), but in two cases the average length of the herring exceeded 35 cm.

During the May 1996 survey, there were taken 9 trawl samples of blue whiting, 16 - 23 cm long, in the eastern part of the survey area off the Norwegian shelf. The blue whiting were distributed in layers below the herring recordings at 150 - 400 m depth, and the two species did not appear together in the trawl samples.

Thus, the trawl samples obtained during the May 1996 survey were probably rather representative for the species present, and the species allocation and size group classification were therefore probably rather accurate. This is also supported by a remarkable similarity in the age structured abundance estimate of herring based on the recordings during the survey and that assessed for Norwegian spring spawning herring by the ICES Northern Pelagic and Blue whiting Working Group (Misund et al., 1997).

In April 1997, the herring were recorded mainly between 65° 30' - 67° 30' N, 003° 30' W - 002° E. In 9 cases a proper herring sample was caught by the pelagic trawl. The split in the bag functioned properly, and none of the catches exceeded 750 kg (Fig. 3). Most catches of herring schools were 200 - 400 kg. The herring in the area averaged 31.3 cm and 0.203 kg, but there was a certain tendency to larger herring in the catches taken in the south-western area (Fig. 4).

During the April 1997 survey, blue whiting were recorded in most of the area investigated west to 0° W. There were 8 pelagic trawl catches with proper samples of blue whiting (Fig. 5), and the blue whiting averaged 20.3 cm and 0.052 kg. Most blue whiting catches were taken east of the distribution area of the herring. However, there were areas with both herring and blue whiting occurring in shoals from surface to 400 m depth, and in such cases, both species were caught in the trawl samples. In these areas the two species shoaled rather similarly, and it was difficult to differentiate the shoals according to species on the basis of echo recording and area backscattering strength (s_A -value). In 28 of the 108 five nautical mile units with recordings of herring, the two species were judged to occur together. Blue whiting were recorded in 166 of the 316 five nautical mile units observed during the cruise.

Thus for the April 1997 survey, the co-occurrence of blue whiting and herring in the same trawl catches induced a certain uncertainty with respect to species allocation for a significant part of the distribution area of both species. In about 25 % of the distribution area of herring, and 17 % of the distribution area of blue whiting, the two species occurred together. However, the exact uncertainties with respect to species allocation are difficult to assess for the two species, but it is much smaller the percentages of co-occurrence since both species were caught in substantial numbers in the trawl catches in these areas.

During both surveys, it was often experienced that pelagic trawl sampling of schooling herring or blue whiting required precise navigation and positioning of the trawl horizontally and vertically. The sampling was often made even more difficult by avoidance behaviour of the fish towards vessel and trawl gear. In many cases deep herring schools descended more than 50 m between the vessel and the trawl. This was observed by adjusting the depth of the headline to the minimum depth of the school after recording by the echo sounder. However, when first

recorded by the net sonde, the same schools were often about 20 m below the footrope. To obtain catches in such occasions, the vessel was backed up for about 30 s and the trawl lowered as fast as possible. A part of the school then appeared above the foot-rope recording on the net sonde, and by setting full speed ahead, the herring were forced back into the bag.

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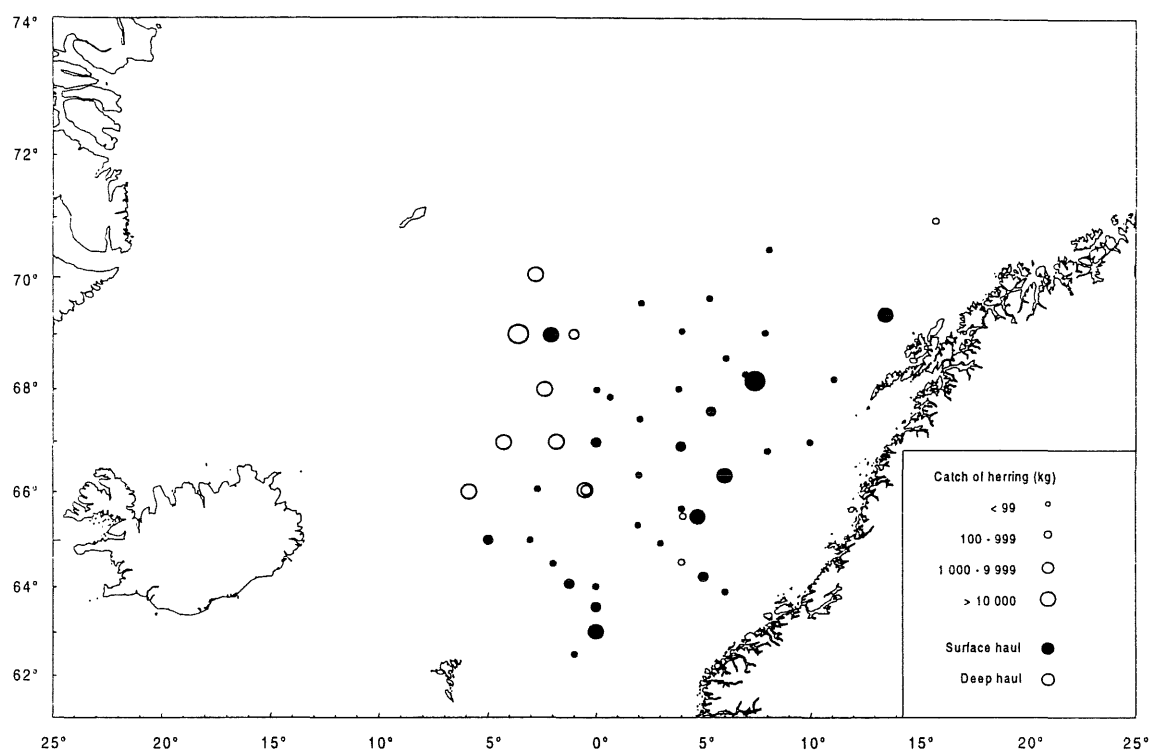


Figure 1. Distribution of pelagic trawl catches of herring in May 1996.

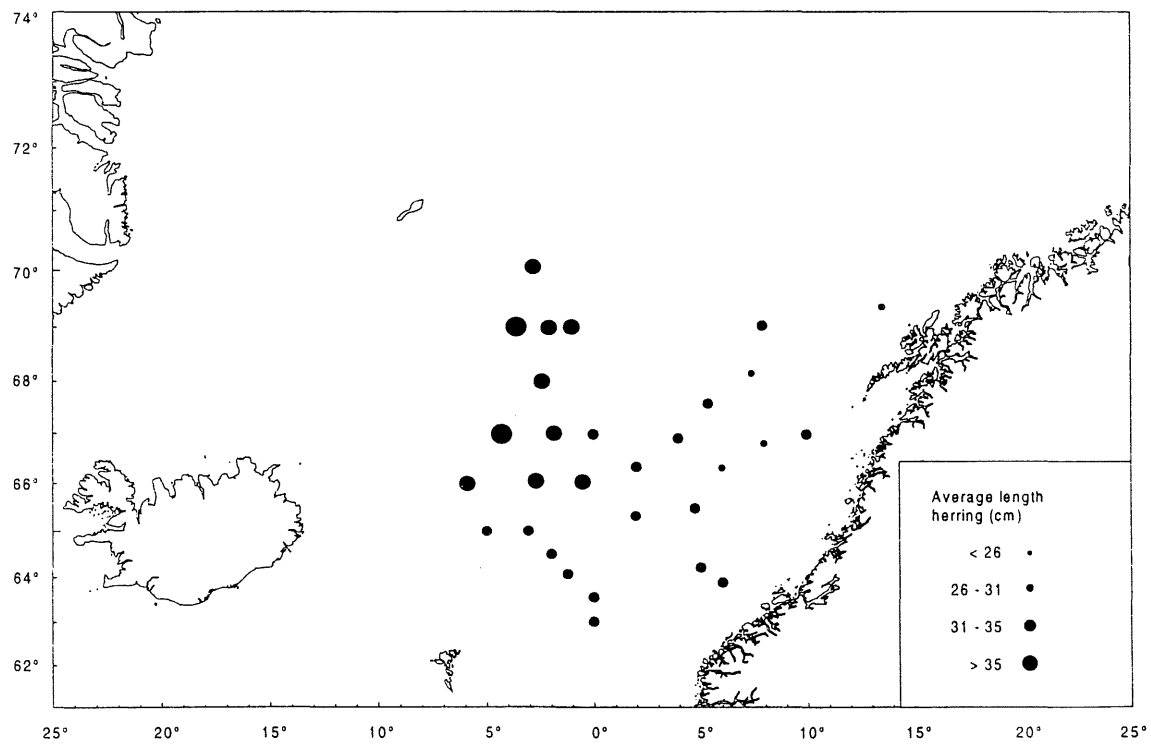


Figure 2. Average length of herring in the trawl samples taken by R/V «G.O.Sars» 29/4 - 28/5 1996.

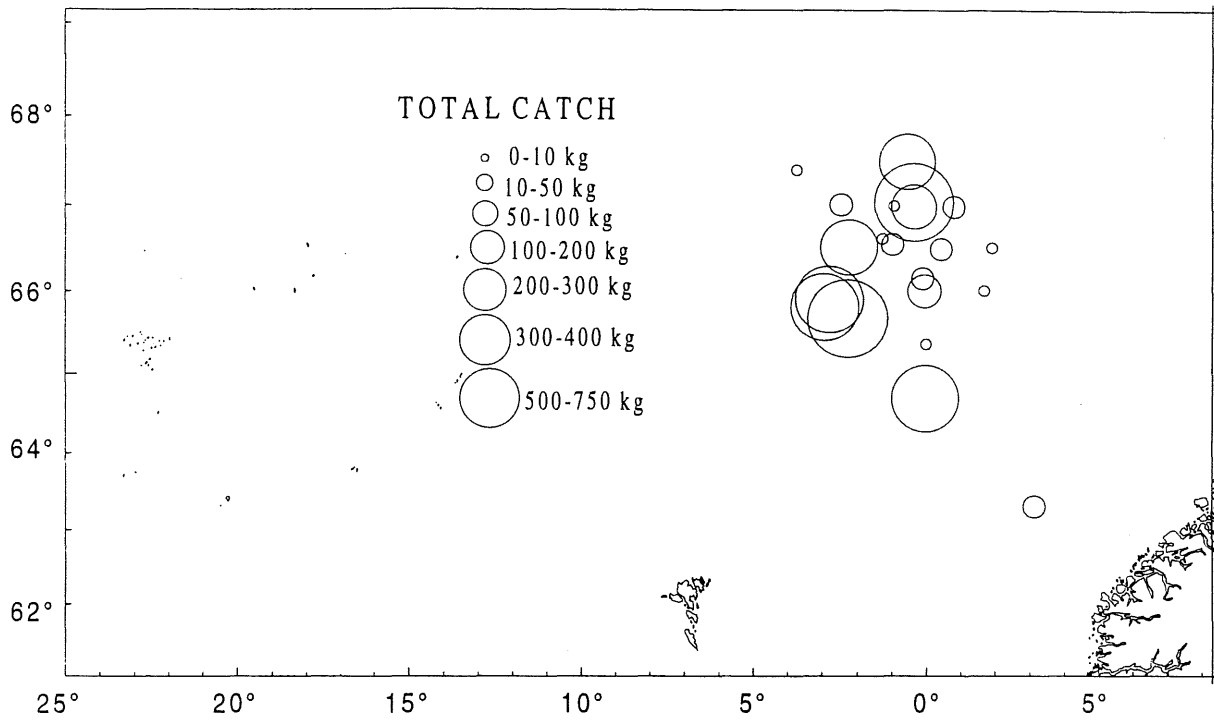


Fig. 3 Distribution of trawl catches in April 1997.

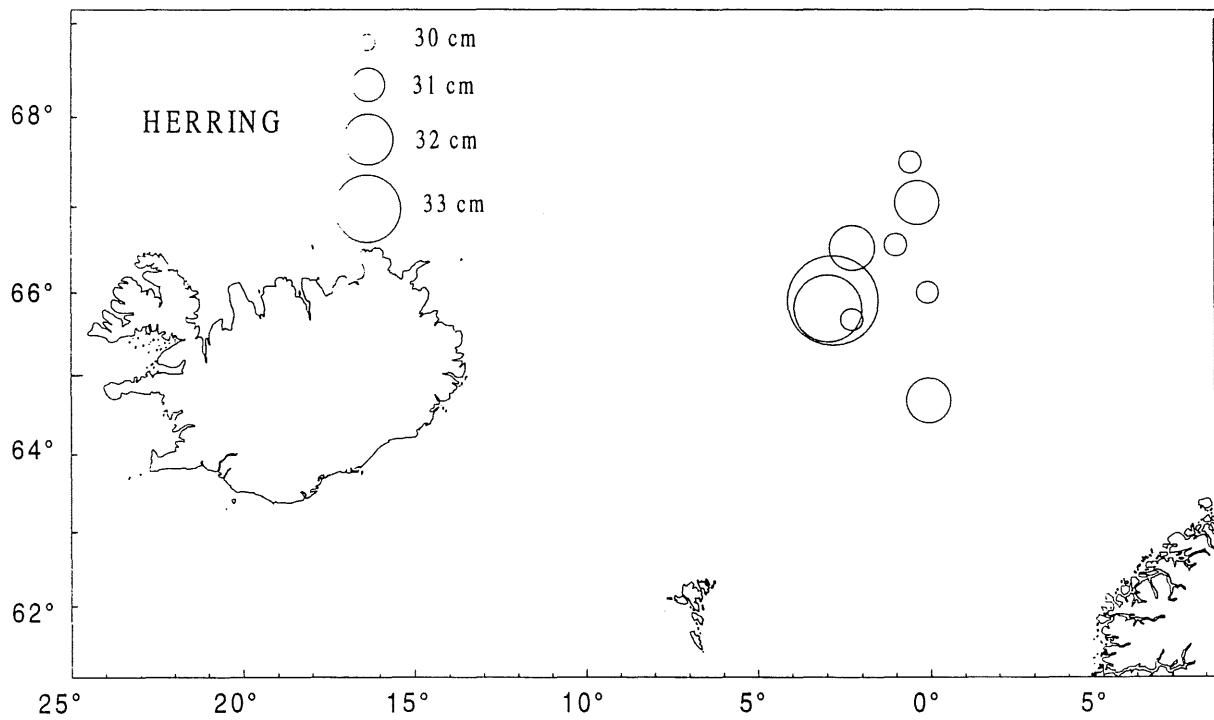


Fig. 4 Positions of herring catches with mean length groups in April 1997.

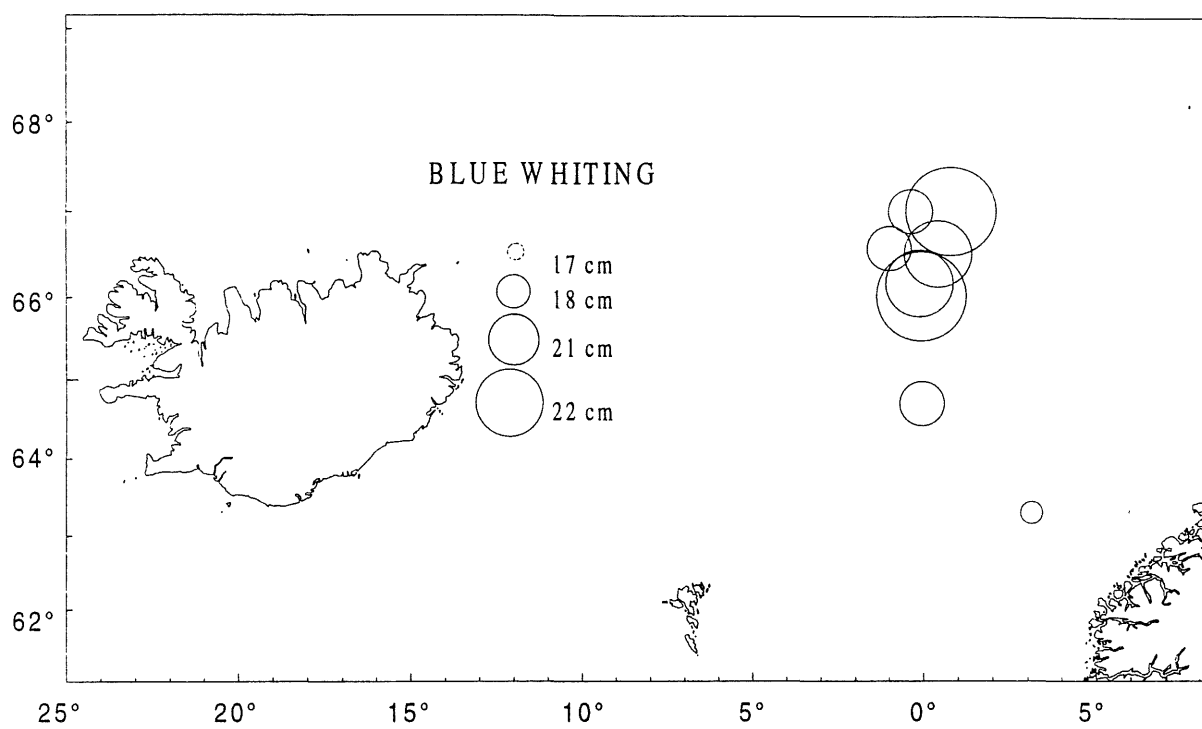


Fig. 5. Positions of Blue whiting catches with mean length groups in April 1997.