SAMPLING GEARS*

by

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INTRODUCTION

When doing a job, the quality of the result is dependent on the applied tools. For a long time standardisation of gear and procedures have been more emphrsised than development of improved sampling tools. In fact I use to say that survey methodology is the only «scientific method» where ignorance is preferred for knowledge. This has the basis from survey development when possibilities to observe the underwater reality was very limited. To day the situation has changed. A leaping technological development have opened new possibilities to enter into «new rooms» with exiting new information about the «unseen» underwater scene where the standard trawl has "wandered its own ways" for several decades.

Bottom trawls of different types are the most frequently used quantitative sampling tools for demersal fish. Normally a commercially developed trawl has been used and sometimes adjusted for sampling application. The simplest adjustment is an insertion of small meshed liner in the codend.

The vision for the future is to develop equipment, procedures, routines and selection models which enable estimation of absolute density of fish based on trawl samples.

OBJECTIVES

There is a long way to go before this vision can be achieved. Firstly, we need to develop a trawl with known efficiency by species and size. Presently we know a lot about selection and loss of fish in the catching phase, but the coherence to absolute numbers is still unknown.

Just as important is the development of sampling routines and strategies adjusted to the above. To achieve this goal, there is need for a much broader internationally co-ordinated development effort.

STATUS

Today we to a great extent set the trawl and hope the best. At least this was the case at the start of survey time series. To avoid effects on the unknown variability, normally rigid standardisation is designed. Development of technology and general knowledge of fish behaviour and distribution very well demonstrate that the old strategy is sub-optimal. Earlier ignorance could be used as an excuse for inaccurate estimates. Today we have to use available technology and knowledge to optimise sampling gears and routines.

Surveys originated during a period with much less knowledge. The standardisation strategies developed under those conditions have been maintained. There is still a very strong resistance towards any change in fear of invalidating long time series.

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* This paper was never presented as a proper manuscript but was a last minute jump-in for Stephen Walsh who was absent from the Symposium (*Editor's note*).

The catching process starts at the moment the fish are affected by the vessel. Several studies have shown that this occur for several species in front of the vessel - at least when they are distributed close to surface or in shallow waters. The next phase is in the zone between the vessel and the trawl. The fish are subsequently affected by the «doors and sweeps» before they enter the «trawl opening» and the «trawl» itself (Fig. 1).

When fish are distributed close to the surface or in very shallow water they can be herded by the «butterfly» sound distribution of the propeller (Fig. 2).

In the vessel -trawl zone avoidance reactions towards the bottom for gadoids and to the side for herring has been documented. The escarpment towards the bottom will improve the catchability of a bottom trawl, but this reaction can also be associated with some sideways movement with potential loss to the area swept by the doors. To what extent the warps affect fish movements in the catching process is unknown (Fig. 3,4,5).

The next direct stimuli the fish get is from the trawl doors. Reaction patterns in front of the doors are uncertain. The doors have a direct herding effect and later an indirect through the sand clouds they generate. In the sweeping zone the sand clouds together with the sweeps herd the fish towards the path of the trawl (Fig. 6,7).

A critical phase for representative sampling is when the fish enter the trawl opening. The fish often stop here and try to keep up with the speed of the trawl. Potentially, fish may escape both under and over the trawl (Fig. 8).

Within the trawl, the only possibility for escape is through the meshes.

Based on what we know on behaviour of target species decision should be taken towards trawl construction and operation which minimise number of escapes.

The mesh size of the codend has to be small enough to retain all size groups of interest. Small mesh size reduce water filtering capacity and may cause unwanted water flow in transition zones, particularly in front of the codend. Smooth transitions in mesh sizes between panels and proper filtering capacity is important to avoid loss of fish in this area. Also the panel angles must be kept smooth to avoid collision of small fish against the netting and subsequent loss.

We want the trawl as large as possible to filter as much water as possible. The size of the opening is, however, decisive for the lift of the trawl and, hence its bottom contact. The ground gear weight has to be related to the size of the trawl opening to maintain bottom contact. Further, the construction of the gear (discs, rollers and spacers) is important for the loss of small fish under the trawl. A dense rockhopper ground gear - as heavy as possible - has appeared the best solution in many areas where this problem has been studied

To avoid loss of fish in the sweeping zone the angle of the sweeps must be small enough (12-15°) to keep the sand clouds from the doors close to the sweep wires.

The doors must be heavy enough and constructed for running on bottom to maintain a ***constant*** bottom contact and sand cloud.

Current methodology normally set standards demands on

- trawl construction and rigging,
- the geometry and performance, and
- procedure and routines.

The following up of standardisation has, however, not always been the best. To maintain a constant sampling unit a strict control of all details which affect geometry and performance is needed.

It is known that small deviance from the standard construction and rigging may have severe effects on trawl performance and efficiency. Standardisation need a well specified manual on the construction and strict control routines on how to control the standard and what actions to set under different circumstances.

Trawl geometry and performance can now be monitored through use of trawl instrumentation. This help substantially in improving standardisation of a trawl sampling unit.

Trawl instrumentation has become a very valuable tool in understanding variability of trawl geometry and performance. The data also form a much better basis for improving the sampling tool. Door or wing spread gives good measures of the area swept by the trawl (Fig. 9, 10).

The height sensor gives the vertical opening of the trawl and hence the sampling volume together with a spread sensor. In addition, this sensor has been the most important source of information on trawl performance. Bad bottom contact can be detected and when comparing with the spread sensor, it is easy to see when something is seriously wrong.

The speed sensor can be used to measure speed through water instead of the usual speed over ground.

Without any action trawl geometry will normally change with depth, or more correctly, with length of warp paid out. This lead to substantial differences in swept area if the survey area vary much in depth.

This can be tackled through:

- post sampling compensation based on actual measures of swept area,
- during sampling compensation in warp length to keep swept area constant as measured by trawl instruments,
- use over sized doors and a constraint rope to maintain constant door spread under all conditions.

Constraint rope has been introduced in the Norwegian winter survey over a period of 3-4 years (Fig. 11). A height or depth sensor is used to keep height of rope and, hence, angle of warp constant.

We have had paradigm shift in survey methodology: from standardisation based on ignorance to standardisation based on knowledge. It is important to develop the needed procedures for this approach. When an inefficiency of the sampling gear is detected, development to avoid the problem should be initiated. When this is available it should be properly calibrated with the old standard before introduced in surveys. The calibration results can be used to correct history. This approach will improve the future, while the past maintain its bad quality. Most important is, however, that we still have a valid time series. The time series maintain in theory a constant accuracy over time while precision obtained with the new development is improved.

Survey sampling, i.e. representative (and quantitative) sampling, is a relative new branch of science. We have now entered a new era when development of observation tools are very rapid. Hence, the potential for improvements in methodology is enormous. In fact is to much for one institution and one country to manage. I think there is a large potential for improvement if international co-ordination and standardisation was chosen as strategy for fast improvement. A good example is the first step of such co-operation between Canada and Norway. A good start would also be to organise and co-ordinate such work between Russia and Norway in the Barents Sea.

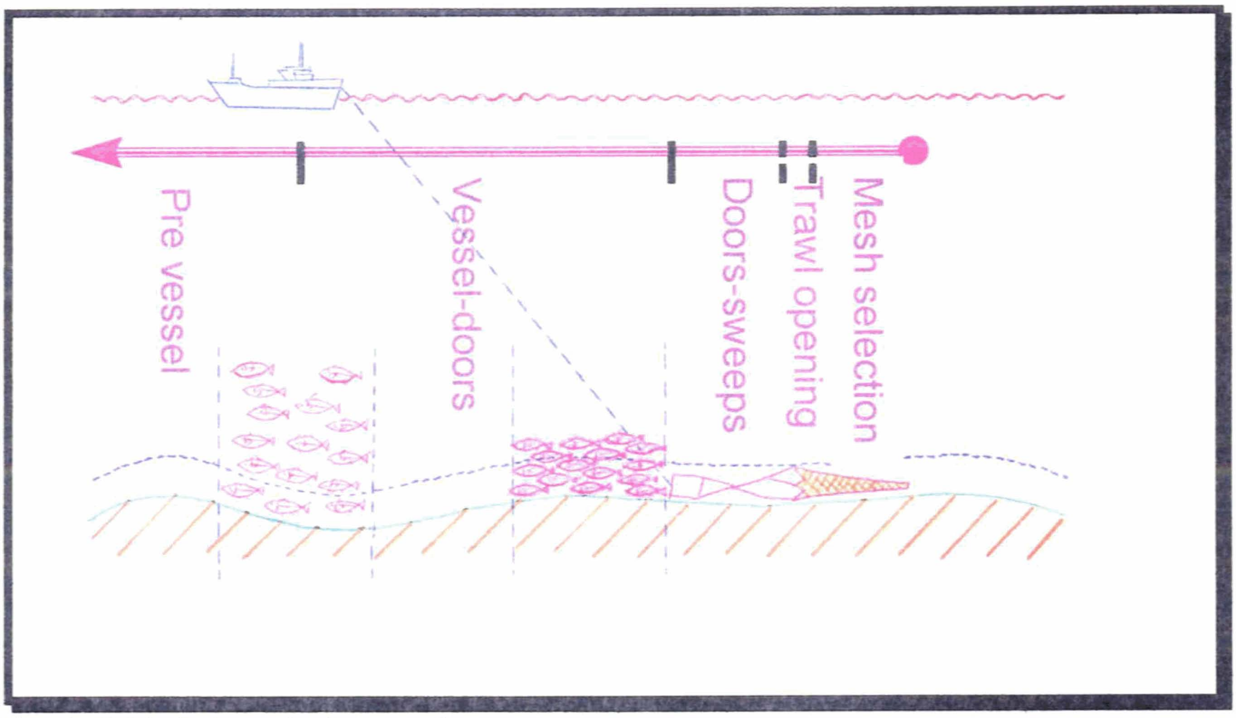

Fig. 1. Critical phases in the sampling process.

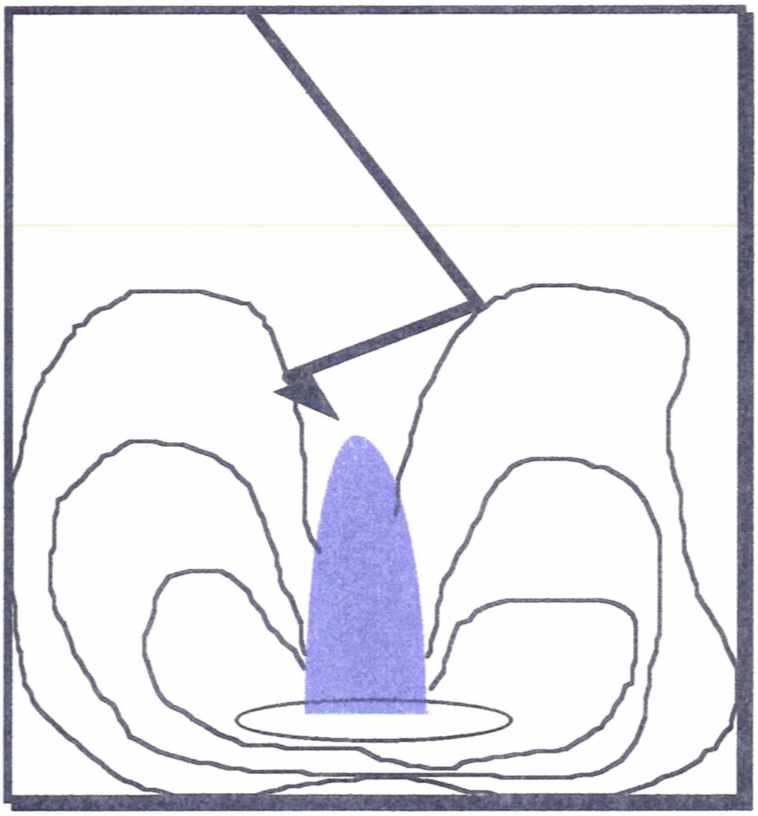

Fig. 2. Horizontal herding in the "butterfly" sound field created by the survey vessel propeller.

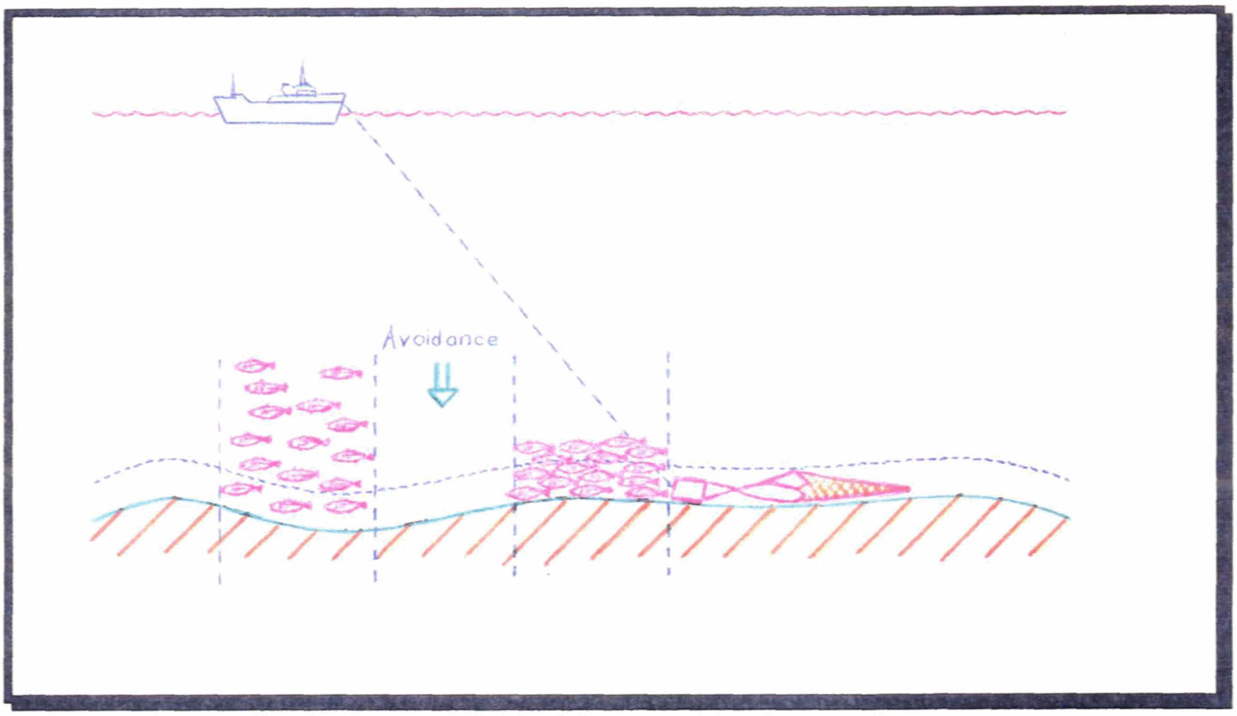

Fig. 3. Vertical herding in the sound field of the created by the propeller.

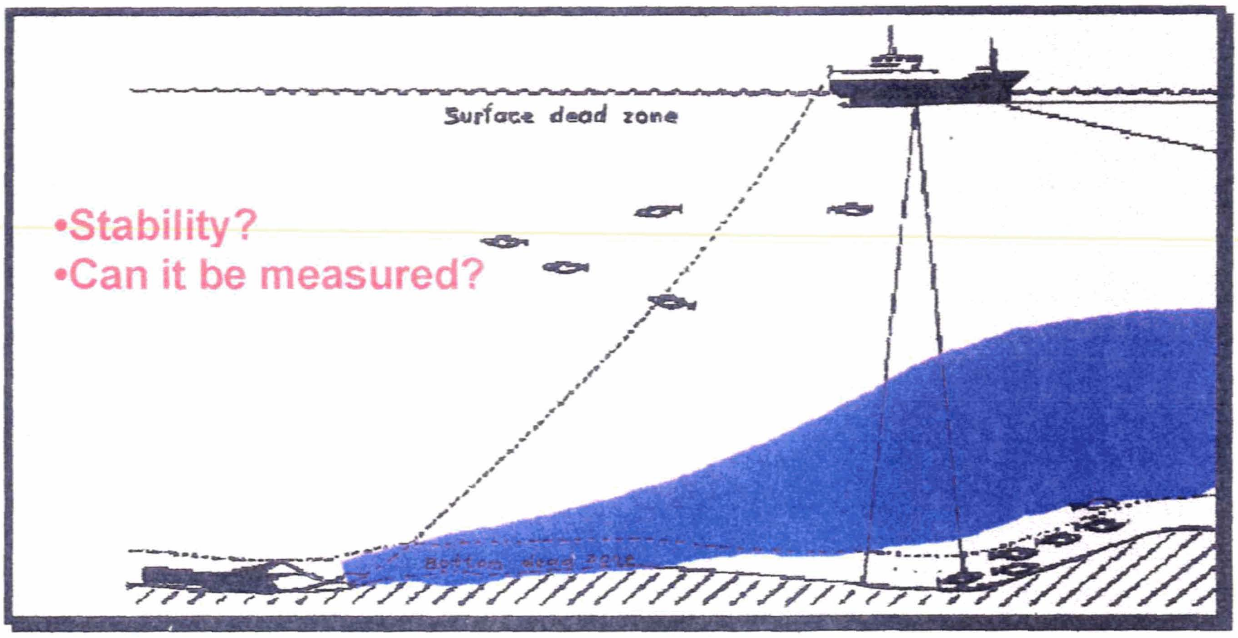

Fig. 4. Vertical herding can channel pelagically distributed fish into the bottom sampling trawl. A main question is how stable this reaction pattern is and to what extent it can be measured and modelled.

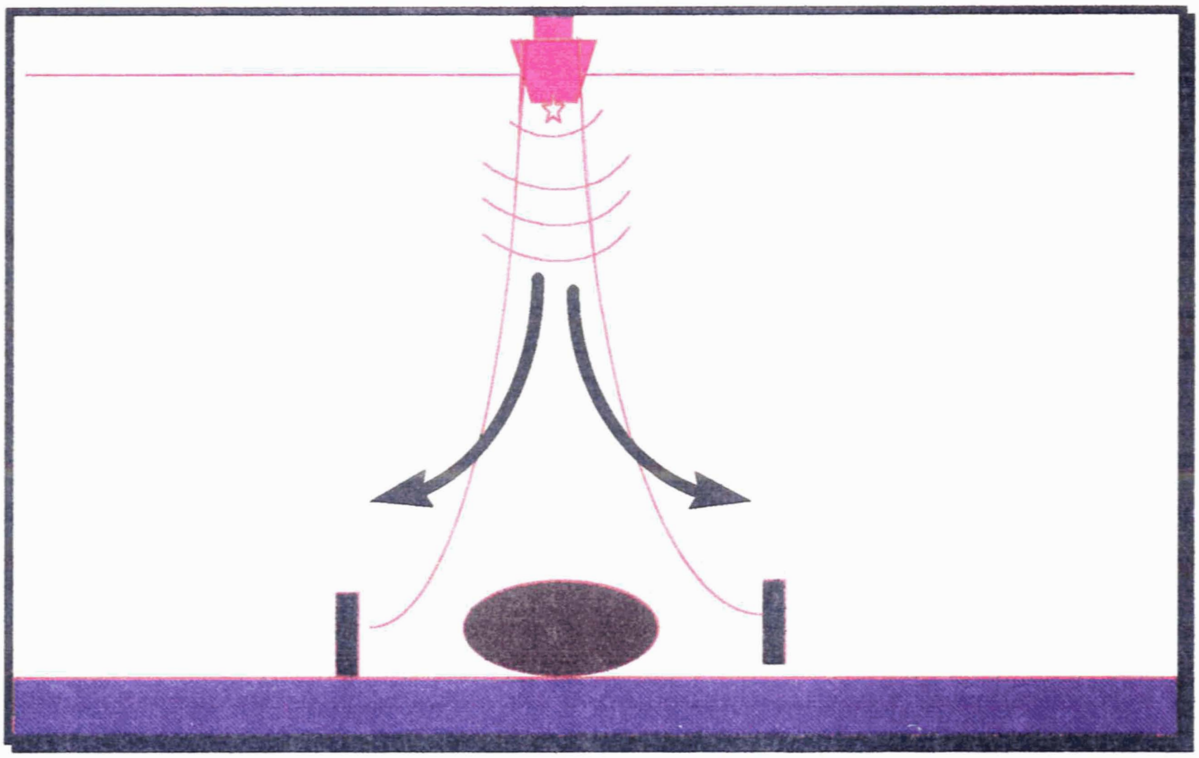

Fig. 5. Vertical herding may also guide pelagic fish to outside the path of the trawl.

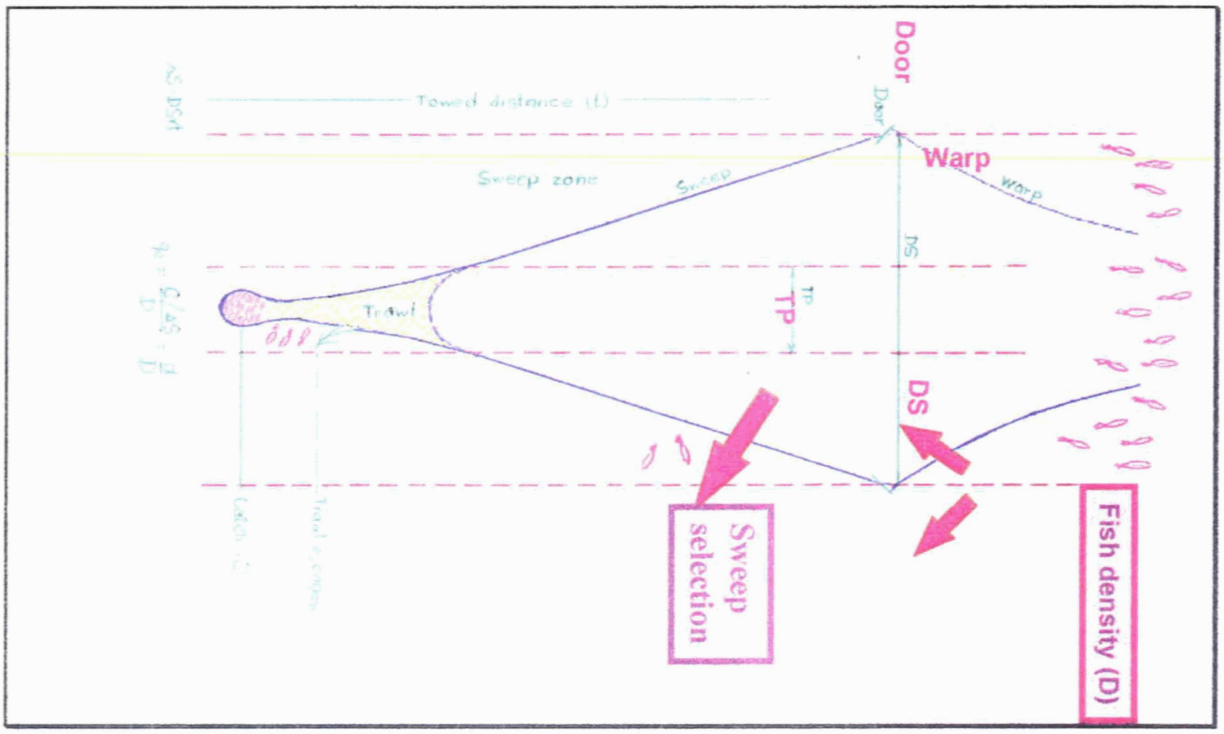

Fig. 6.Selection at the doors and in the sweeping zone.

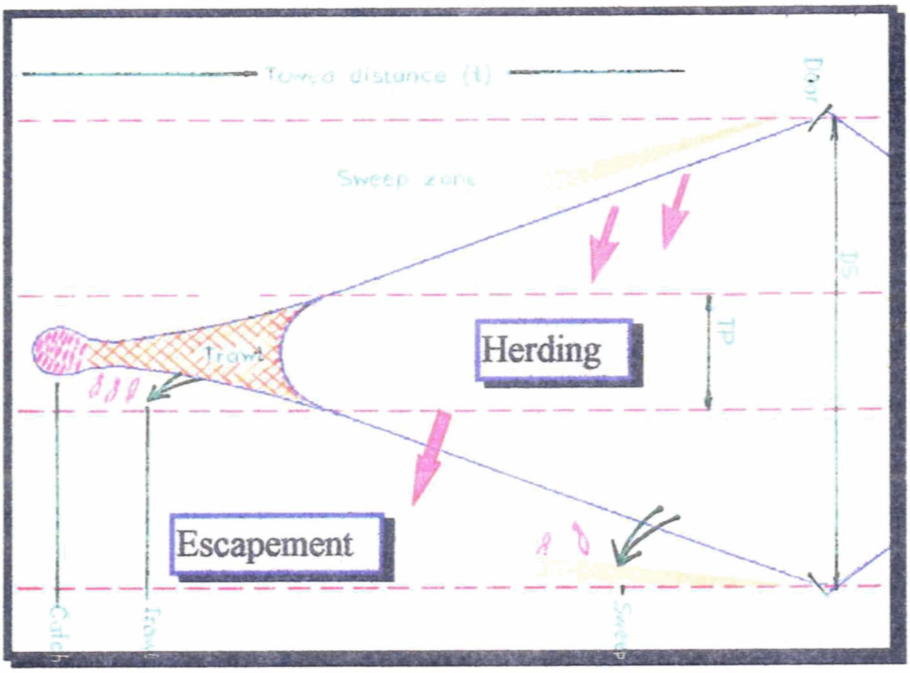

Fig. 7. Procedures to maintain correct sweep angles are important for the sweeping efficiency.

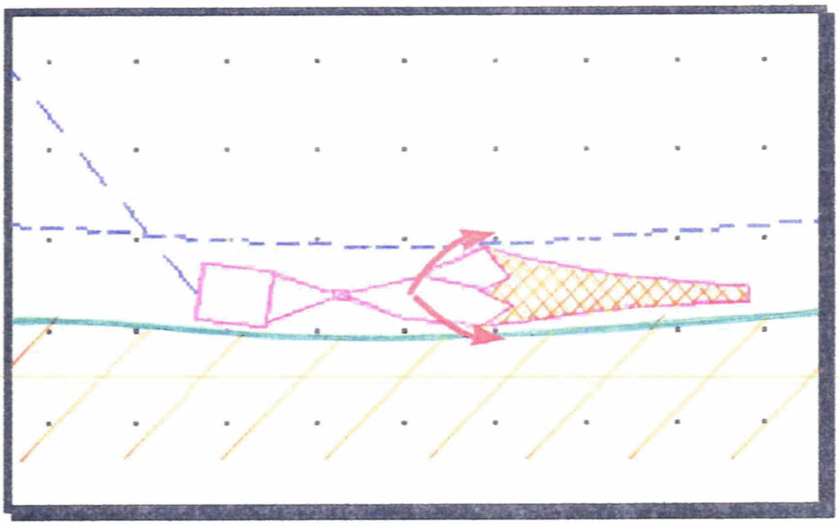

Fig. 8. Selection in the trawl opening has been shown to be the most critical phase for representative sampling of a lot of species in many areas.

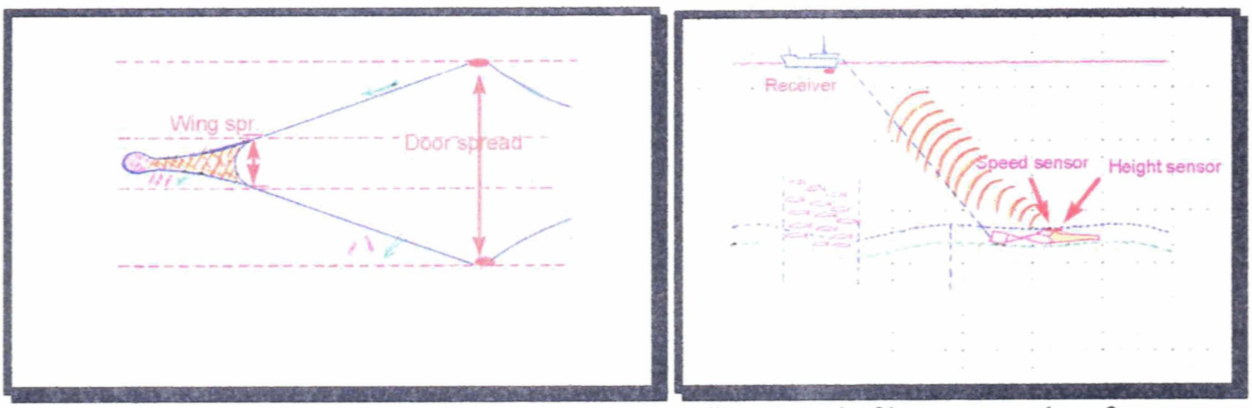

Fig. 9. Monitoring trawl geometry is crucial for the quality control of bottom trawl performance.

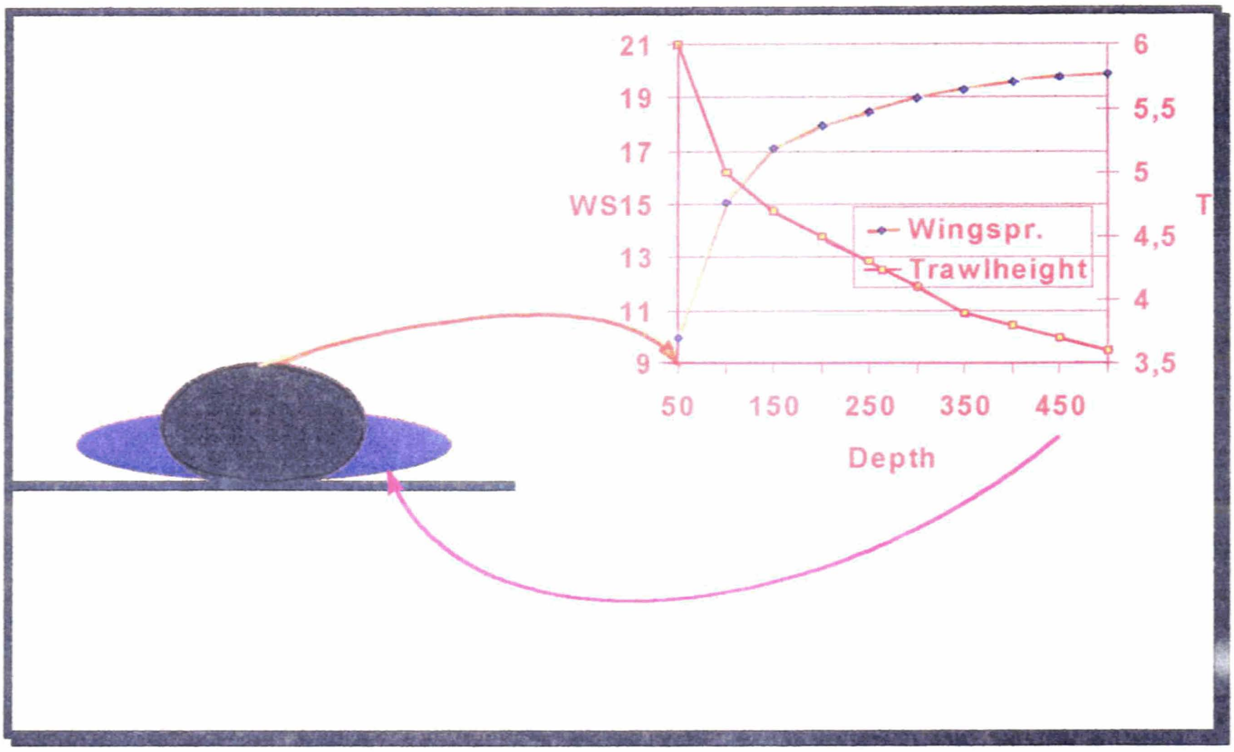

Fig. 10. When depth change substantially during the survey trawl geometry will change systematically.

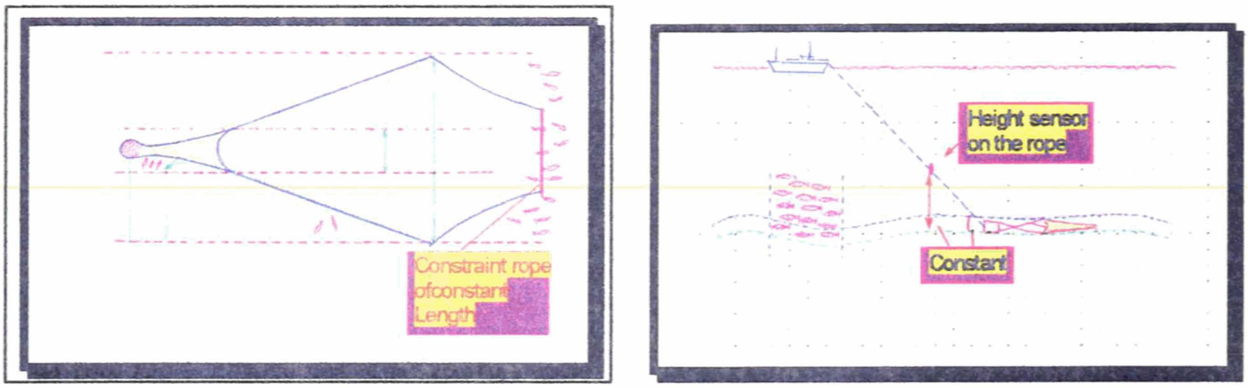

Fig. 11. The use of constraint rope and trawl instrumentation to secure correct warp angle.