International Council for the Exploration of the Sea

C.M. 1996/B:11 B:12
Fish Capture Committee

A STATIONARY ACOUSTIC SYSTEM FOR MONITORING UNDISTURBED AND VESSEL AFFECTED FISH BEHAVIOUR

by

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ABSTRACT

Thorough knowledge of the dynamics of natural fish behaviour and distribution within a survey and among surveys is fundamental for reliability of time series of abundance indices. Further, vessel/trawl affected avoidance may greatly affect density estimates from trawl and acoustic surveys. Means for monitoring behaviour of fish during surveys or in special experiments have been limited, time consuming and expensive.

This paper describes an acoustic buoy system for monitoring undisturbed distribution and behaviour of fish as well as avoidance reactions of fish in relation to passing surveying or trawling vessel. Operation and results from the first trials are described.

The buoy could easily be operated in connection with a standard trawl haul, prolonging the haul time with approximately 30 minutes for launching, retrieval and extra cruising distance. Information on fish distribution and behaviour, i.e. vertical and horizontal movements, is stored in the buoy and can easily be downloaded for later processing and analysis. Observations on cod demonstrated avoidance away from the vessel of variable intensity.

INTRODUCTION

Thorough knowledge of the dynamics of natural fish behaviour and distribution within a survey and among surveys is fundamental for reliability of time series of abundance indices (Godø 1994). Further, vessel/trawl affected avoidance may greatly affect density estimates from trawl and acoustic surveys (Aglen 1994, Godø 1994, Misund 1994). Means for monitoring behaviour of fish during surveys or in special experiments have been limited, time consuming and expensive. Typically, observations have been obtained from survey vessel acoustic systems (Misund 1994, Aglen 1994), or from stationary acoustic systems aboard a small vessel passed by the survey vessel (Olsen 1979, Ona and Godø 1990, Nunnallee 1991). Also, comparison of measures from towed and hull mounted transducer have been tried. Nevertheless, several questions still relates to

- observation of an undisturbed natural distribution of fish

  and

- observation of variability of vessel/trawl affected fish behaviour.

This paper describes an acoustic buoy system for monitoring fish distribution and behaviour which potentially may serve as a tool to resolve several of the difficulties mentioned above.

CONCEPT

The development of the buoy system has been governed by five main demands:

1. The system must be easy to handle, and uncomplicated to operate to secure the possibility of frequent operation during a routine survey
2. The buoy must tolerate operation in rough weather
3. The settings of the acoustic system must be remote controllable
4. The storage capacity has to be large enough to record changes in distribution over a diurnal period.
5. The acoustic system is to produce data compatible to those generated by the hull mounted system aboard the survey vessels.

The last demand limits the choice of acoustic equipment. As Simrad EK-500 already is the chosen standard on our research vessels, the only small compatible system available on the market, which satisfy our demands, is the Simrad EY-500 system. The acoustic buoy (EYB) has therefore been built up around this sounder connected to a 12° 38kHz splitbeam transducer. A laptop PC facilitate echo sounder software and data management. A second PC is used for remote communication and logging transducer direction. Remote PC (vessel) to PC (buoy) communication is established via an UHF system (Fig. 1).

SOLUTION

Demand 1. The design of the buoy unit is based on experience from production of ARGOS buoys for current measurements. An instrument pod inside a metal cage is surrounded by ball-shaped floating material (devinicel) (Fig. 1). The metal cage has a heavy iron bottom (80 kg) which secure correct floating position of the buoy. The instrument pod is made of stainless steel. Transducer, antenna and other instrument connections are fit through the top cover of the pod. As the construction is based on known technology, the handling aboard the survey vessels can be done according to experience from the ARGOS drift buoys. Additional procedures for retrieving the transducer must be decided based on experience.

Easy operation is acquired by system and data access after retrieval, through a direct monitor/keyboard/comport connection. As the battery also can be charged through an external connection (Fig. 2), the system can be operated through a complete routine survey without opening the top cover.

Demand 2. Decisions on size, dimensions, gaskets etc. were made based on experience with the ARGOS buoys. Appropriate arrangements have been designed to secure the pod and the plugs from damage during set and retrieval. Further, routines for set and retrieval have to be developed according to experience. To limit the damage caused by a small leakage, a current cut circuit was designed, i.e. the current from the battery to the electronic unit is cut if small quantities of water enter the buoy (Fig. 2).

Demand 3. For experimental purposes remote control of sounder settings are important for the functionality. This is solved by a PC to PC connection through modem and UHF communication. All major sounder settings can be manipulated as well as start and stop of compass logging. Changes in settings are logged with the EY-500 time variable as reference.

Demand 4. At present data storage is limited by the hard drive of the PC with the echo sounder software. The extent of the observation period can partly be manipulated by the ping rate. Recording 24 hours of sample data at 300 m depth at 1s ping rate will need about 1 gigabyte. Storage capacity can also be improved by use of e.g. a zip-disk or an additional hard drive. Storage capacity of PC based systems develops fast, and at present the major limitation of long term observation will be the battery capacity.

Demand 5. The EY-500 system produce data of the same type as the vessel systems based on EK-500. However, with a free moving transducer as in this buoy system (Fig. 1), the positioning of the recorded target within the beam will not be valid. To make target tracking (Ona 1995) possible, it is necessary to compensate for transducer directional movements. The transducer rig has been equipped with a compass (Fig. 1). The transducers' direction is continuously recorded with the EY-500 time as reference. Thus, the angle information from the recorded targets can be corrected accordingly during data treatment and analysis.

FIELD EXPERIMENTS

The EYB was tested during a cruise with R/V Johan Hjort during August 7-22 1996. The trials were done as part of a routine survey on demersal fish in the Barents Sea and conducted in the Bear Island area (Fig. 3).

Operation

After deciding position for trawling, the buoy transducer was first lowered over the side by hand. The buoy was subsequently launched by a crane, and finally a flag buoy with a radar reflector followed. From the experience obtained during the 7 trials, the whole procedure of setting and retrieval of the buoy prolonged the time at the standard trawl station with approximately 30 minutes. The weather during operation was calm, but it is believed that operation of the buoy is possible under reasonable rough weather conditions. The radar reflector was not good enough for controlling the buoys' position during the experiments. New trials with a radar transponder or an ARGOS transmitter will be done later.

A main operational problem of such a buoy system is the stability of the transducer during observation. In the first tests the compass direction of the transducer was logged every 10 sec. In Fig. 4a is shown a typical picture of the variability of transducer heading during one experiment along with outputs from a exponential smoothing model (SAS 1995). Model - observation difference was normally (90%) equal or less than 10^{o} (Fig. 4b). We found this encouraging when model results have to be used for angle correction for correct tracking. In later experiments we will test the system for compass logging rate towards the ping repetition rate to avoid use of model data.

Observations

A total number of 7 sets with the buoy were carried out. Except for some problems connected to streamlining the procedures for data retrieval, the buoy worked well till the second last test. At this trial the compass cable was damaged. Consequently the last trial was made without recording transducer directional data. The main objectives of the experiments were to test the functionality of the EYB. As such the buoy certainly fulfilled our expectations. In addition, we did several buoy observations on acoustic recordings, which according to trawl catches contained 80-95% cod and the rest haddock.

The buoy was tested on deep (depth>100m) and shallow (depth<100m) locations. In shallow waters cod were distributed very close to bottom. In deeper water more pelagic recordings were found. Cruising speed passages and trawl passages were conducted on all test sites. Due to lack of time, the material has not yet been fully analysed. However, visual inspection of the data could be done immediately after buoy retrieval. So far these studies indicated that a homogenous reaction pattern can not be expected on the same site even over a short period of time (5 days). In both types of recordings and both types of passages avoidance reaction as well as no reaction was indicated. Fig. 5 demonstrate avoiding fish during passage of the EYB without (a) and with (b) the trawl. Conclusions can, however, not be drawn before more thorough analysis of the data - including the TS-data - has been completed.

Potential

When the experience from the conducted cruise have been included in the routines and procedures for operation the EYB, the system will be ready for use as a standard tool for fish behaviour studies. The system can be used during routine surveys to improve understanding of the effect of fish behaviour on survey estimates. Further, the data can be used to build a quantitative basis for compensating, e.g. calculating the effective catching hight of bottom trawls (Aglen 1996). Target strength measurements of fish passing through the beam under natural condition as well as when affected by a cruising or a trawling survey vessels may become important for understanding variability of TS.

The durability of the system was tested, and found to survive a recording period of 17-18 hours when pinging every 0.7 s. Consequently, it is possible to study diurnal changes in distribution and target strength of stationary concentrations of fish which are not affected by vessel noise and/or light.

Further development of the system is planned. The buoy will be equipped with recovery system so that it can be left drifting without being constantly watched. Also, various alternatives for buoy - ship data transfer, e.g. from the echo sounder - echo integration system, will be developed. A continuous update of echo density in a certain layer would be helpful in avoidance experiments to choose time for passing the buoy.

ACKNOWLEDGEMENTS

This project has to a great extent been dependent on a good team work. During idea development, at choice of technical solutions and during the assembly of the buoy and development of soft ware, we have been dependent on exploiting the pool of knowledge, technical skills and experience from both the scientific and technical staff of the Institute of Marine Research. Also, the development could not have been completed without financial goodwill. Particularly we want to express our thanks to (alphabetic order) A. Aglen, L. Austgulen, H. Fitje, O. M. Gjervik, T. Haugland, E. Klæt, H. P., Knudsen, S. Lemvig, E. Ona, I. Svellingen, L. Søras, and C. Wilson (Alaska Fisheries Science Center), as well as the skipper and crew on R/V Johan Hjort. The project has received financial support from the Research Council of Norway (project 111262/120).

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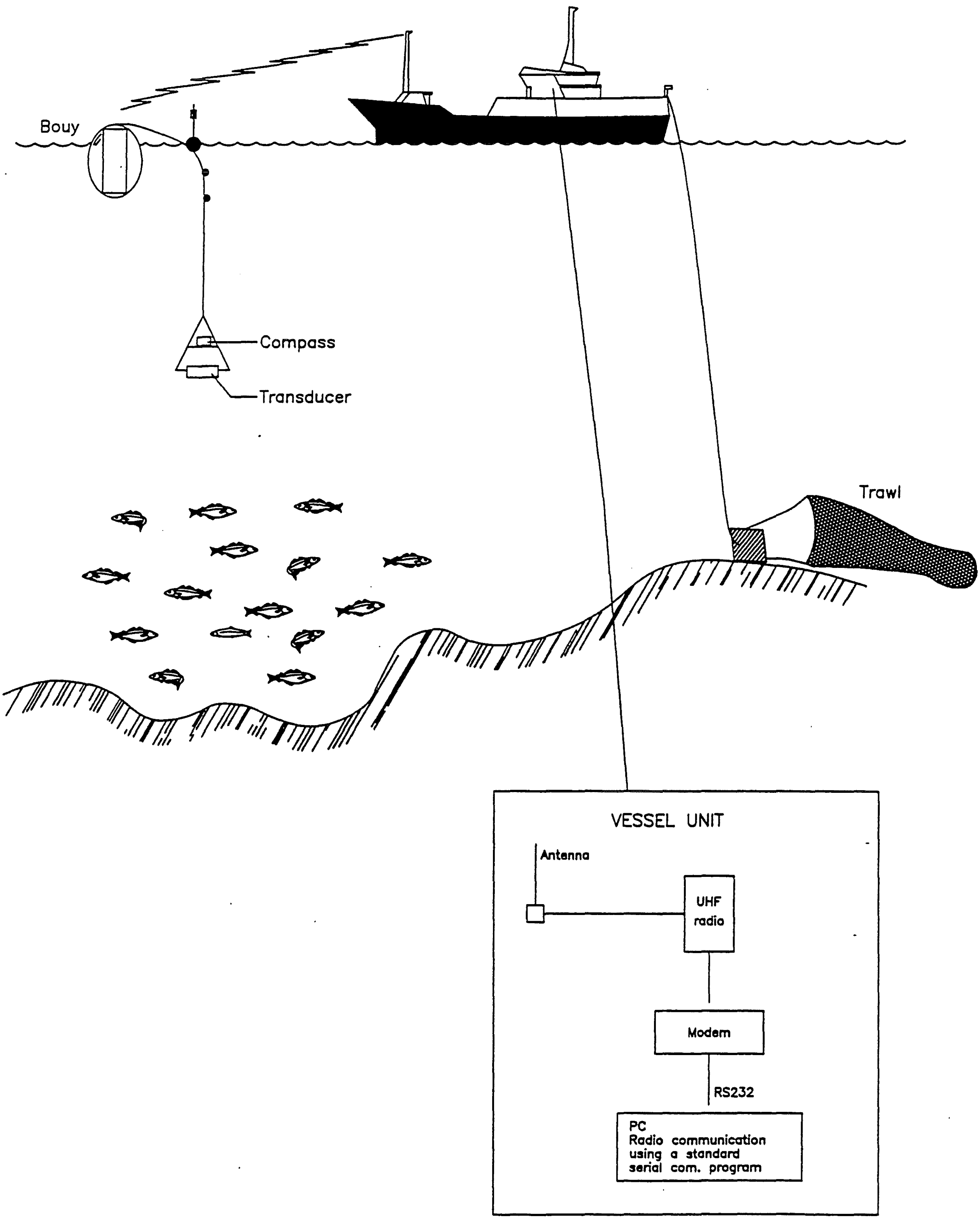


Fig. 1. The buoy system. Design and use for avoidance experiments.

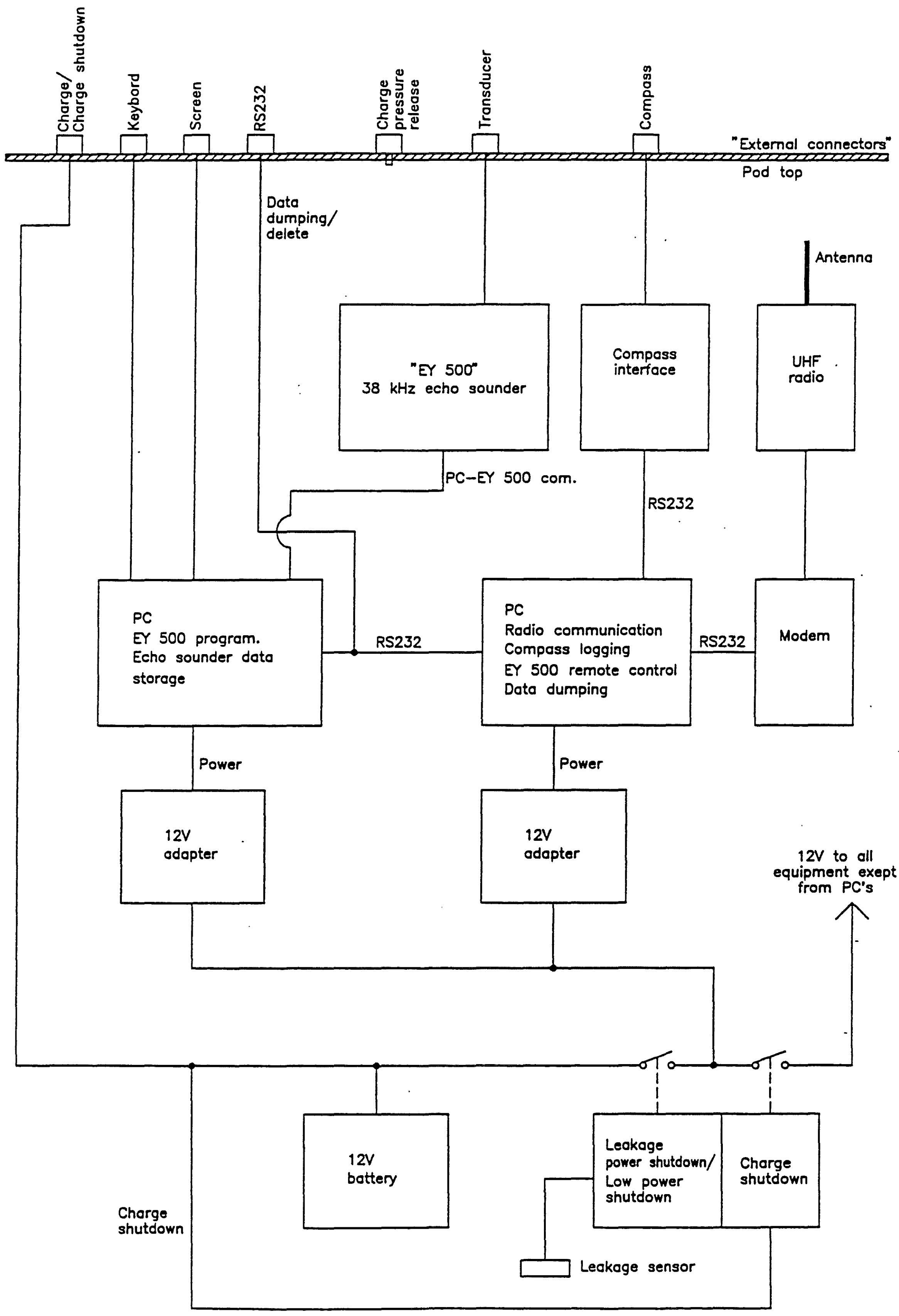


Fig. 2. Schematic presentation of the components of the buoy system.

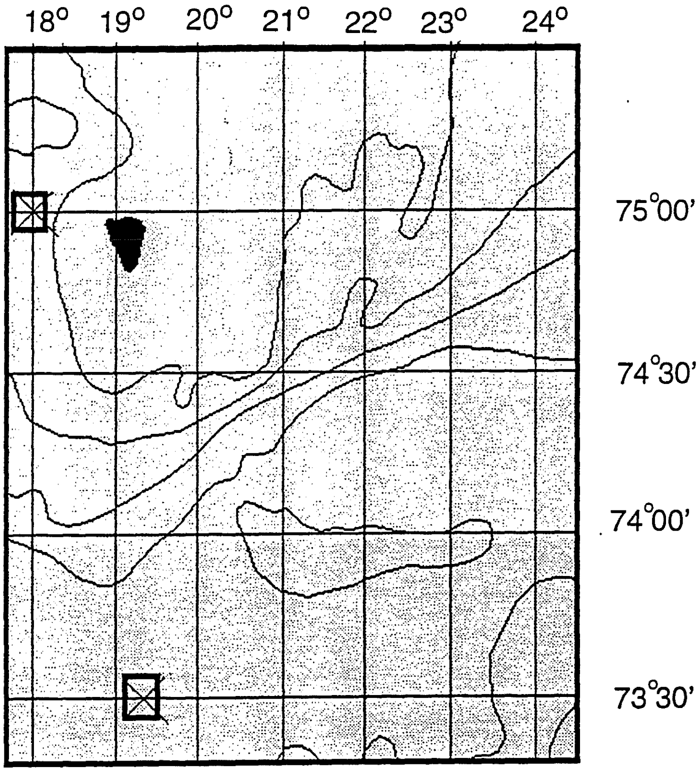
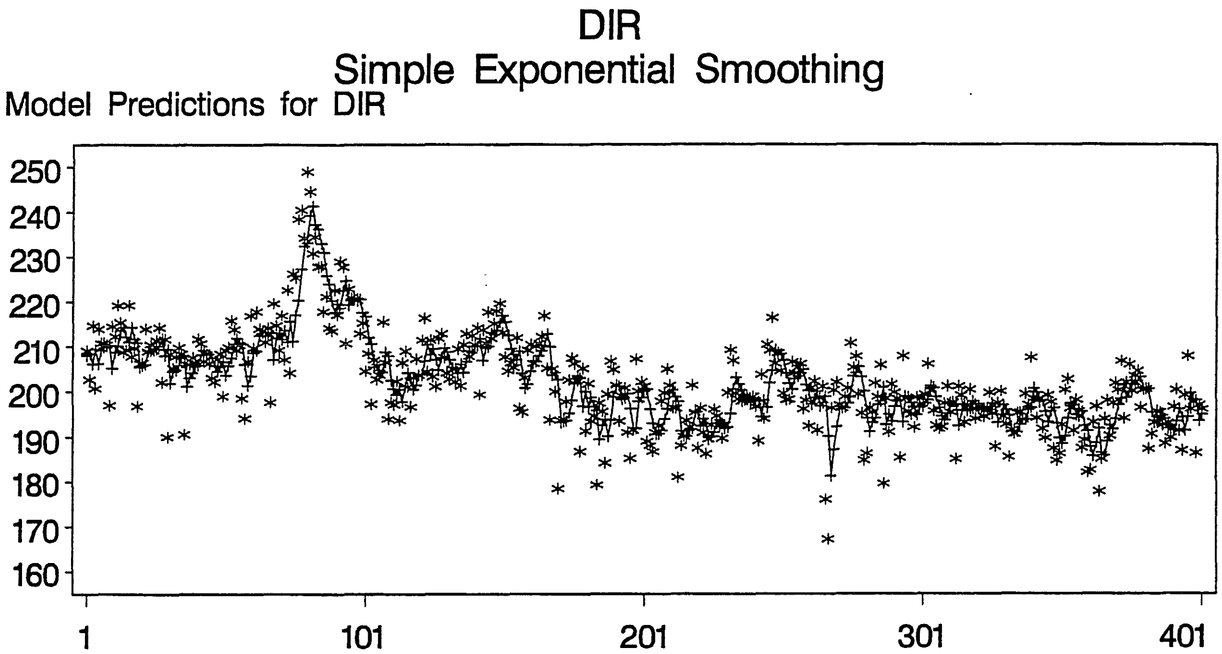


Fig. 3. Experimental locations.

A.



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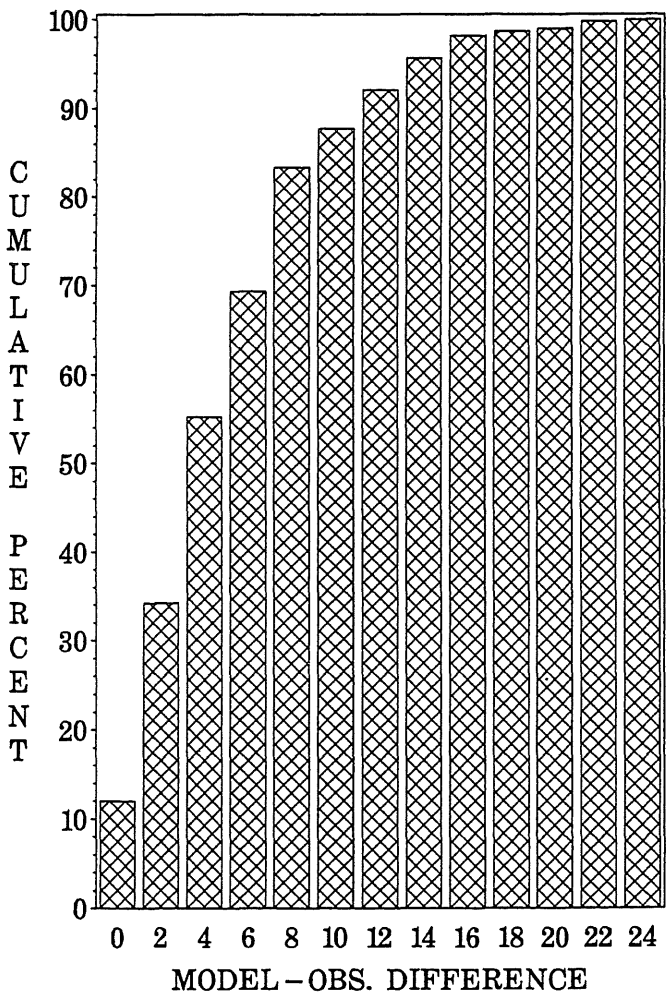

Fig. 4. a) Directional movements of the transducer during test 3 (*), together with a exponential smooting mode (line) (SAS 1995). b) Cumulative percent of model – observation difference by every 2 degree.

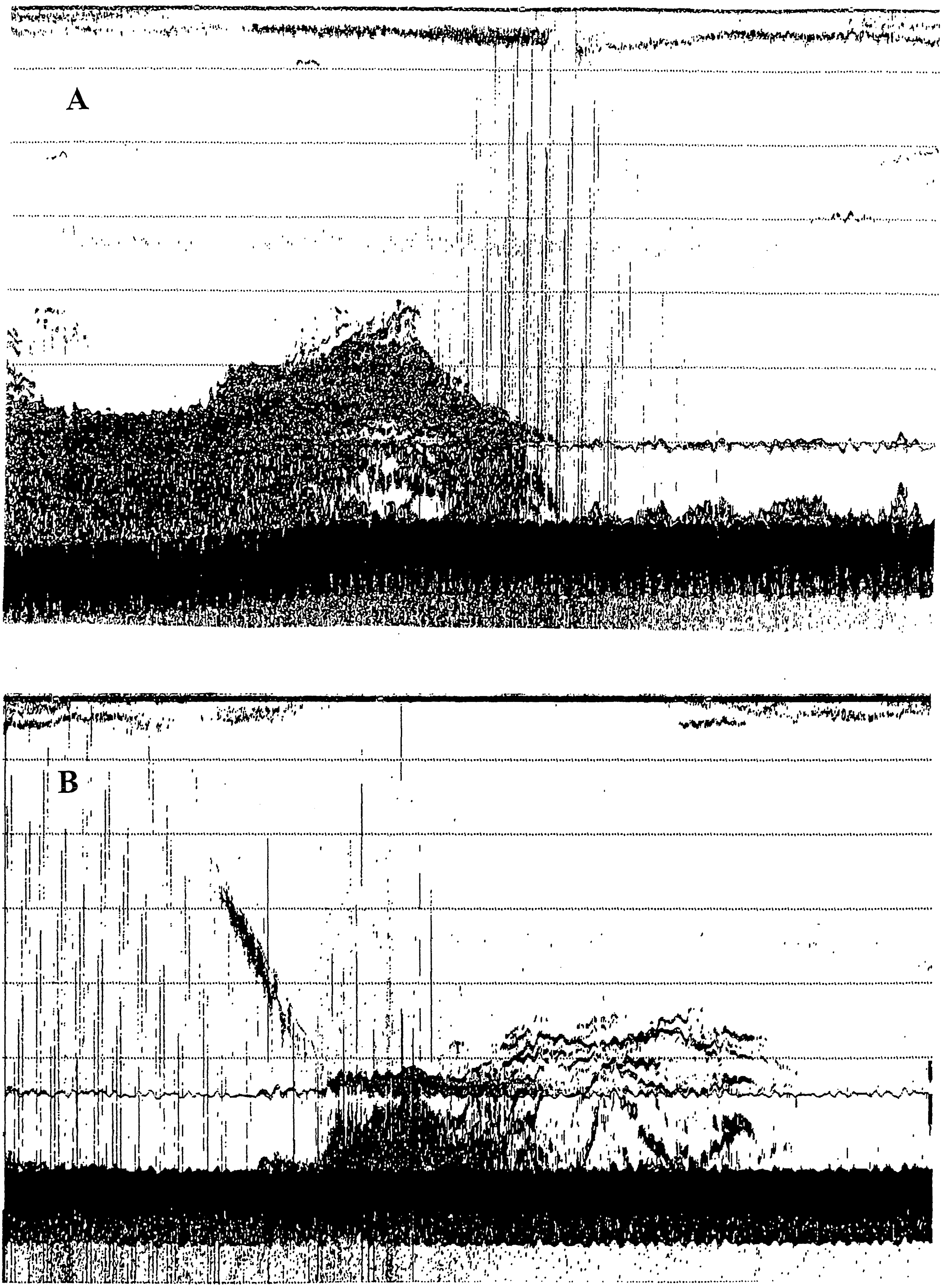

Fig. 5. Avoidance of cod at cruising speed (a) and during trawling (b) at shallow waters (90m).