International Council for ICES CM 2001/Q:07
The Exploration of the Sea Theme session on Catchability and Abundance Indicators
-the Influence of Environment and Fish Behaviour (Session: Q)

In situ determination of bottom trawl ground gear contact

by

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Abstract

Exact definition of towed distance with proper ground gear contact is an essential parameter in bottom trawl swept area estimates of fish abundance. Errors in this key parameter may lead to a first order bias in abundance estimates of demersal fish. The paper describes the results obtained with a new sensor for measuring the exact timing of trawl ground gear bottom contact and departure, as well as monitoring of the ground gear contact during the haul. Measured towed duration with the new system is compared with the traditional survey measures of this parameter on a number of hauls, and the results are discussed with respect to survey bias.

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Introduction

Trawl surveys provide important estimates of the abundance or relative abundance of demersal fish stocks and the relative frequency of several population characteristics, such as length, age and stomach content (Azarowitz, 1981; Gunderson, 1993; Godø, 1994). Several investigations concludes that a well designed survey-based assessment appear to provide more accurate prognosis of the status of a stock than catch-based assessments (Nakken, 1998; Pennington and Strømme, 1998; Korsbrekke et al. , 2001). One of the advantages in survey-based assessment is that the uncertainties associated with the estimates can be studied and quantified. Survey methodology, and ultimately, the derived stock estimates and assessment may therefore carefully be improved (Godø, 1994; Engås, 1994). Fishing gear and procedures are standardized on bottom trawl surveys for reducing variation in catch per unit effort (CPUE) that is due to variations in trawl efficiency. When gear geometry, i.e. headline height, wing spread and door spread are monitored, or even locked using warp restrictors, (Engås & Ona, 1993) the main sources of uncertainty in a swept area estimate is variability in towing speed and effective tow duration or towed distance. Speed over ground, as measured from the global positioning system is commonly used method for determining these parameters. Exact tow duration is usually recorded manually, where start of a tow is judged from predefined definitions of when the correct trawl geometry on the bottom is established, as measured by the trawl instrumentation. In the Norwegian ground fish surveys, start time is recorded when the headline height and door spread sensors have reached stable, acceptable values, and subsequently, retrieval time is then 30 minutes after start time on a standard haul. Although skilfully conducted, significant differences in bottom trawl shooting and retrieval procedures, affecting effective trawl duration have been recorded between different crews, and between different persons on the same crew (Unpublished data). Ground gear contact during the entire trawl haul is also considered as especially important, as escapement of fish under the footrope of the trawl may have an important effect on trawl capture efficiency (Engås, 1994; Dickson, 1993; Walsh, 1991). Statistical evaluation of the survey results (Pennington & Vølstad, 1991; 1994, Pennington & Strømme 1998, Goddard, 1997, Kingsley et al. 2001, Hjellvik et al. 2001), strongly suggest that the sample size on each station is too large and that the tow duration should be reduced to 15 minutes. The accumulated the saved effort should further be allocated to increased sampling in the high-density areas. However, reducing tow duration may increase the error in effective tow duration, and the demand for improved instrumentation for an exact and objective definition of effective duration is needed. This paper describes the first results from trials of a new bottom contact sensor, developed for this purpose.

Material and Methods

The trawl experiments were conducted between March 13 to 19, 2001 at Trømsøflaket, Barents Sea from the Institute of Marine Research (IMR) research vessel R/V G.O.Sars, a 70 meter, 1600 tons, 2300 hp, stern trawler. The standard Campelen 1800 bottom trawl (Engås, 1994) was towed after standard procedures for the bottom trawl survey (Jakobsen et al. 1997). A new prototype bottom contact sensor, the Simrad PI32, was tried on acoustic link together with the standard vessel mounted Scanmar receivers for depth, height and door spread sensors. A series of 23 trawl hauls with different tow duration were conducted, first for trials on sensor adjustments and later for monitoring of tow duration and ground gear contact.

The sensor:

The bottom contact sensor is a modified stretch cell sensor normally used as catch indicator. The sensing chain was in this rigging equipped with a steel spherical ground weight, designed to activate and the stretch cell in water, and with sufficiently stable flow drag to avert deactivation of the stretch cell when pulled through water at all trawl speeds from 0 – 5 knots. The sensor was mounted to the fishing line and to the bottom panel of the trawl, in the centre of the ground gear (Fig.1). It was further equipped with a stay, attached to the fishing line to receive the tension as soon as the weight touched and dragged along the ground. Appropriate averaging and filtering of the stretch cell signals were made within the sensor itself to prevent transient dragging movement to be accepted, and a coded signal transmitted back to the vessel where it could be displayed and logged on a PC. A picture of the sensor and mountings are shown in Fig.2.

After some trawl hauls with initial adjustments of stay and sensing chain length to correct lengths for the rockhopper ground gear, standard trawl hauls, but with varying trawl duration was conducted. The skipper and crew followed the standard procedures, and noted (registered) trawl duration and other parameters as recorded on the regular Scanmar trawl sensors, while the bottom contact sensors was logged and displayed in another position on the vessel. In this way, it was possible to register the difference between actual bottom contact and registered bottom contact. The registered trawl durations shown here have been retrieved from the IMR trawl database after the cruise. Exact trawl duration, as measured by the bottom contact sensor was logged separately for each station, along with comments to each haul.

Results and discussion

The new bottom contact sensor proved full functionality after a few adjustments of the length of the stay chain, and bottom contact was instantly registered within the filter response time set in the sensor, 3 seconds. This filter also enabled registration of jumps by the rockhopper gear, either as a result of walking over stones or as a result of natural jumps of the trawl as the trawl doors lifted slightly above the bottom. As the sensor only has a binary coding, either “stretched” or “slack”, [1,0], loss of bottom contact or repeated losses appears as spikes in the logged bottom contact sensor diagram (Fig 3). Further, comparing registered tow duration with measured tow duration by the effective ground gear contact (Fig. 4) show that the standard procedure generally underestimates the effective sampling time at bottom. At one of the shorter trawl hauls, an erroneous registration was also recorded; A 20 minutes trawl haul was registered by the start and stop times and positions to have lasted for 18 minutes, while the trawl only had proper ground gear contact for 6 minutes. Trawling against the current with too low warp/depth ratio left the trawl gear light on the bottom for most of the haul, until detected on the height sensor and corrected for by the crew. In a full scale trawl survey a station like this would have been tagged for imperfect trawl performance and removed from subsequent analysis. Using the bottom contact sensor, the non-normal behaviour of the trawl would have been detected immediately and corrected for, or, the logged files would have given a better, objective criterion for tagging station quality.

On the rest of these few trials, most of the data indicate that the bottom contact was detected about one to two minutes before start of the haul was registered on the bridge, and that bottom contact extended for several minutes after start of retrieval (stop time registered). Effective tow duration was 6.9 (SD = 6.2) minutes longer, when computed from the ground gear contact than from normally registered tow duration.

Observations and registration of loss of ground gear contact, as from passage of stones with the rockhopper was seen on several hauls, and should be registered along with trawl duration parameters. However, very rapid changes are now filtered in the sensor software.

As bottom trawl surveys mainly are used to estimate indices of abundance, keeping the methodology constant from year to year is important. Introducing a new practice with respect to how tow duration is defined should always be conducted in an experiment. It is therefore suggested that the new sensor is introduced in the survey in a two-steps. In the first survey, the sensor should be used in the same manner as we have used it here, with the display and logging of the information from the bottom contact sensor screened for the bridge crew. The information from this survey may then be analysed to account for the effect when fully introducing the sensor for measuring tow duration in the next survey.

As the bottom trawl will fish as long as the ground gear are on the bottom, very short tows will be variably affected by the tardiness of the trawl operation, in particular in the start and end of a haul. An opening and closing device on the cod end seems to be the only alternative on very short hauls, and a refinement of the "multisampler" (Engås et al. 1997), for bottom trawling may then be the next step. As the length of the stretch and stay chains may be regulated individually, the sensor can be used as bottom contact indicator for most bottom trawls, pelagic trawls working close to bottom and probably also on Danish seine. The use of several sensor mounted simultaneously in different positions along the ground gear was also tried for monitoring proper ground gear bottom contact.

Conclusions

The new bottom contact sensor was tried on 23 bottom trawl hauls, and showed stable performance on the Campelen 1800 survey trawl.

Exact timing of ground gear contact and lifting could be measured with the new sensor with an accuracy of 3 – 5 seconds. Ground gear contact and lifts from the bottom could be monitored and logged in real time.

Trawl duration, as measured from ground gear contact is significantly longer, 5-8 minutes, than when judged by standard procedures for the bottom trawl survey.

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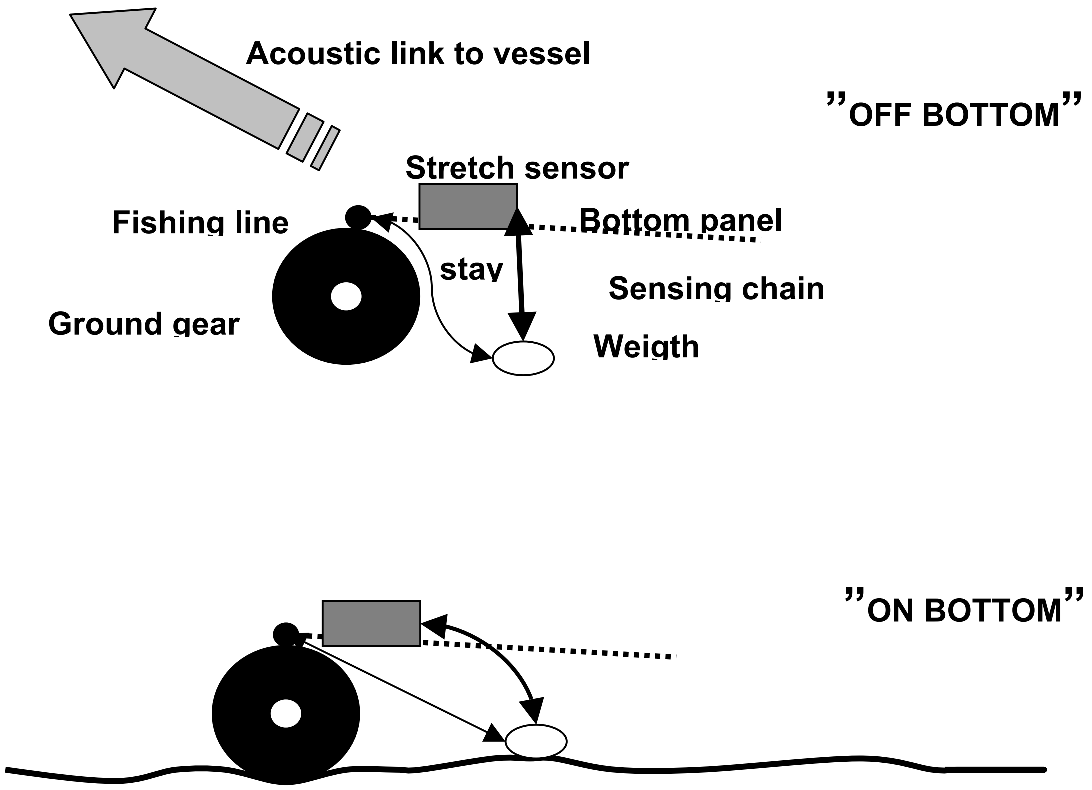
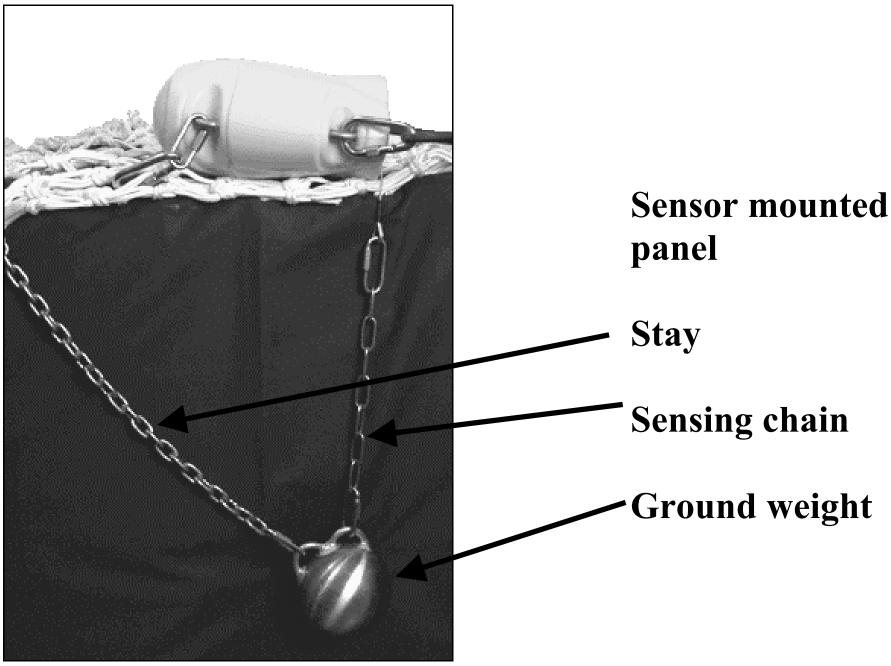
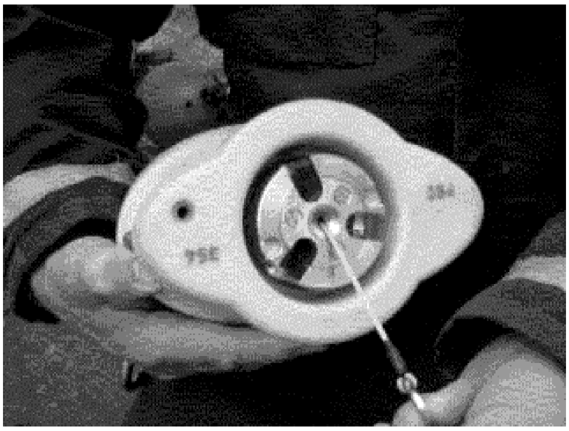


Figure 1. Sketch of the new bottom contact sensor principle with mountings. Upper panel: The sensor with sensing chain and stay, mounted to the bottom panel and fishing line in "off bottom position". Lower panel, similar in "on bottom position.





Stretch cell
With sensing wire

Actual mounting on Campelen 1800 bottom trawl

Figure 2. Pictures of the bottom contact sensor with sensing chain, stay and bottom weight.

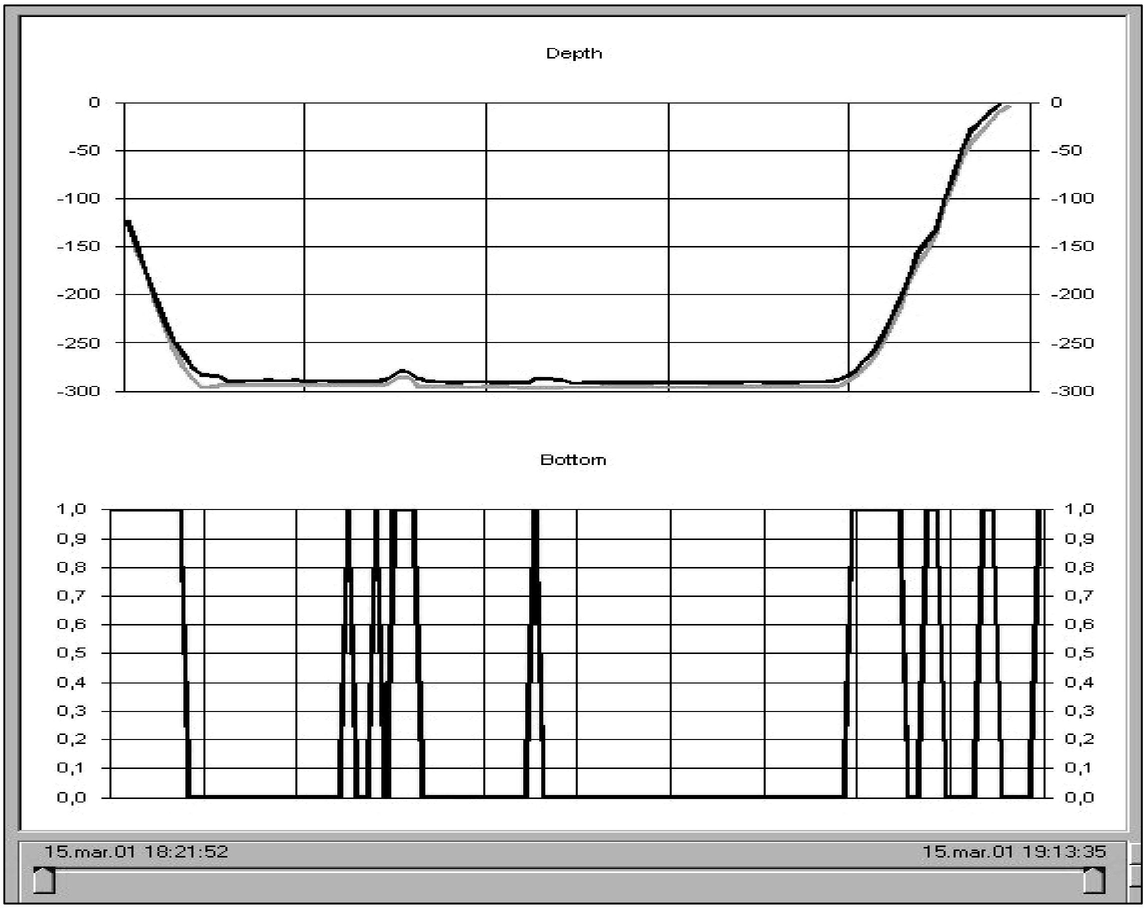


Figure 3. Display of logged data from a bottom trawl haul at 290 m depth where the ground gear contact was lost in two periods in the middle of the haul. Upper panel: :output from depth sensor, 10 minutes between vertical lines. Lower panel: bottom contact sensor: 5 minutes between vertical lines.

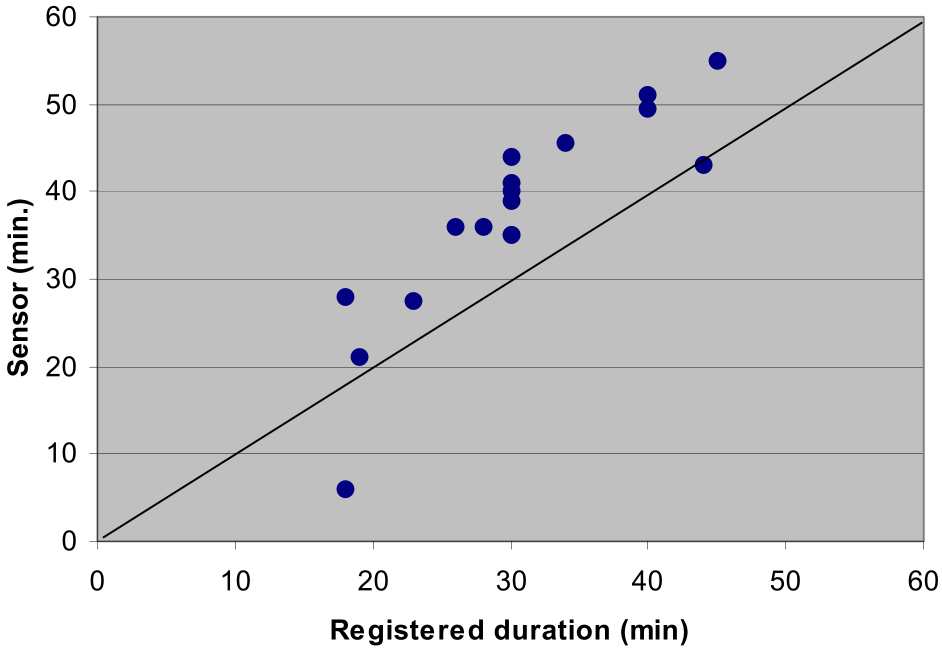


Figure 4. Measured trawl duration by the by the bottom contact sensor, as compared with the standard registered trawl duration by the crew on 16 trawl stations of varying length. The line indicates 1:1 ratio.