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Calibrations of hydro-acoustic instruments onboard *FORV Sagar Sampada*

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ABSTRACT

Calibration is carried out to keep up the precision of the instruments by determining their calibre. Calibration of hydro acoustic equipments onboard *FORV Sagar Sampada* was carried out periodically and the performance records were maintained. Deviation and the deficiencies were noted down for applying the correction while interpreting the output of the instruments.

INTRODUCTION

FORV Sagar Sampada is engaged in fishery research work since 1985 in Exclusive Economic Zone (EEZ) of India. The vessel is equipped with most modern hydro acoustic instruments used for acoustic survey in the assessment of fish resources. Fish resources assessment is vital for fishery management in planning for harvesting, processing, marketing and setting up of fish based industries. Acoustic survey is considered to be more reliable and advantageous among many other methods available for fish resources estimation, since it gives the results quickly, covers larger area without destruction or damage to the resources during the survey and expenditure is comparatively less.

The major equipments used onboard *FORV Sagar Sampada* for resources estimation are the scientific echosounder EK-400 operating on 38 and 120 kHz and echointegrator Simrad QD coupled with data printer TI 703. The accuracy of the resources estimation depends on the performance of these instruments. Therefore, the calibration of these instruments are vital for maintaining the high standard of accuracy of the research findings.

Calibration in general means the process of determining the calibre of instruments. It involves: i) the measurement of the equipment parameters (transmitter power output, frequency, band- width, beam-width, pulse-width etc) to confirm that they are within the specified limit, ii) the measurement of absolute value of noise level which is one of the limiting factors in the use of hydro acoustic equipments and iii) the measurement of received echo level to determine the back-scattering strength of the reflecting object, the target. The calibration was carried out on the acoustic survey equipments onboard *FORV Sagar Sampada* and the results, since 1985, are described below.

MATERIALS AND METHODS

Cruises were arranged exclusively for the purpose of calibration during the calm weather season, along west coast, mostly off Trivandrum. Acoustic equipments were switched on continuously for 12 hours and ensured stable operations before commencing any measurements. Other heavy electrical equipments such as winches were switched off to minimise external noises. The equipment parameters like transmitter output power, frequency, band-width, pulse-width, TVG attenuation etc were measured and corrected to the specified level by adjusting the pre-set controls. The test equipments used were oscilloscope, digital voltmeter, signal generator; function generator, frequency counter, attenuator, AC voltmeter and test hydrophone. The performance of the echo- integrator was tested selecting test transducer and confirmed that it was functioning to the specified level.

The vessel was anchored at 40 m depth. The 60 mm copper sphere of -33.6 dB target strength was placed below the transducer along the axis of the beam. The amplitude of the echo signal was measured on the oscilloscope and the SL+VR was calculated using the formula of (Foote *et al.* 1983).

$$SL+VR = EL-TS+20 \log R+2\alpha r - G+40 \log R$$

where SL is source level, VR is voltage response. VL is echo level, TS is target strength, R is range of the target, r is effective range of TVG, α is absorption co-efficient and G is gain or attenuator settings.

The rigging arrangement to position the standard target (copper sphere) is shown in Fig.1. In order to bring the copper sphere to the centre of the beam around 20 m below the vessel's hull, 3 electrically operated winches were used. The winches were locally fabricated using a 12 V DC motor (whiper motor) with a small cable drum fixed to the shaft of the motor. The cable drum was wound with 0.60 mm diameter steel wire used to suspend the copper sphere. The winches were fixed on to the pre-fabricated triangular aluminium frame with a small pully at one end. Two frames were fixed on the star board side of the gun-wale (raised edge of the deck of the ship)

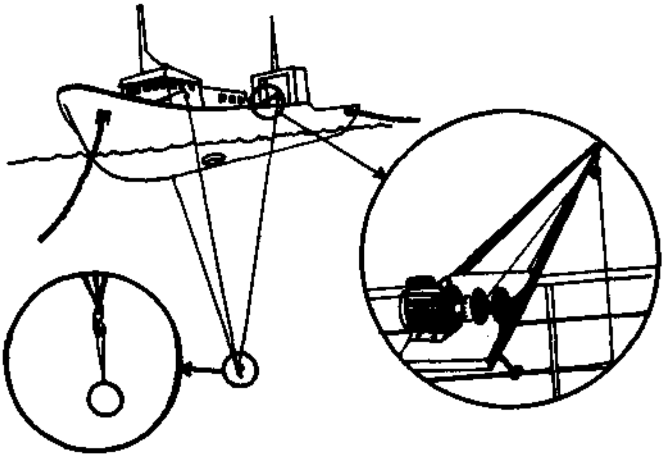

Fig.1 - Rigging of a research vessel for calibration using copper sphere as target

and one in the port side. The suspension lines from the winch drum were passed through the respective pully and fastened to the copper sphere with affixed loop. The supply for the winch motor was connected through a double pole, double throw spring loaded switch which can change the polarity of the supply to the motor in turn the direction of the rotation of the cable drum. The winch control system was located in acoustic room. By observing the oscilloscope for the maximum echo signal level and the echo mark of the copper sphere on the echo-gram of the echosounder. Three suspension lines were either released or heaved to position the copper sphere to the centre of the beam.

RESULTS AND DISCUSSION

Values of the SL+VR obtained are given in Table 1. The value obtained during the year 1993 is considerably less. As the performance and other measurements on equipment parameters were satisfactory, the low value could be attributed to the non-alignment of the standard target with the axis of the beam due to underwater current. The calibration is carried out annually and or whenever some vital parts of the equipments such as transducer, transmitter-receiver printed circuit board etc are changed. The values of the SL + VR are documented so as to effect the correction in the estimation as and when required while carrying out acoustic survey for resources estimation and for the future reference.

Calibration using standard target

The voltage amplitude of the signal appearing at the output terminal of the receiver of an echo ranging system depends on the reflecting properties of the target, receiving sensitivity and transmitting power. When characteristics of the transmitter and the

Table 1 - Source level + voltage response value obtained during different calibrations onboard *FORV Sagar Sampada* using copper sphere as standard target (Diameter = 60 mm, TS = 33.6 dB)

Echosounder - EX 400
Transducer No. 1

Date	Power	Attenuation setting (dB)			
		0dB	10dB	20dB	30dB
15.10.1984	High	137.6	128.1	118.1	108.1
	Low	129.3	119.3	109.6	097.7
07.09.1985	High	137.5	128.1	118.1	108.1
	Low	129.1	119.3	109.6	077.9
12.04.1990 to	High	124.1	124.1	114.1	104.2
14.04.1990	Low	-	-	-	-
16.05.1992 to	High	136.9	126.9	116.9	106.9
20.5.1992	Low	130.1	120.1	110.1	100.1
07.01.1993 to	High	111.5	101.5	091.5	081.5
09.01.1993	Low	-	-	-	-

receiver are known, the properties of the target could be judged from the amplitude and the shape of the echo signal received (Forbes & Nakken, 1972). For the measurement of the parameters of the transmitting and the receiving system, hydrophone is used. Hydrophone is very sensitive to external temperature. As the measurements are undertaken in the ambient condition, maintaining the constant temperature is not practicable. Hence, the precision in the measurement becomes poor. The method of measuring SL + VR using standard target do not involve the use of hydrophone and the inaccuracy caused by the instability of the hydrophone is avoided resulting improved precision in the measurement.

Live fish calibration

An echointegrator connected to the echosounder sums up the echo signals received. The output of the echointegrator per nautical mile covered is an index of the amount of fish recorded, and therefore a measure of relative density of fish in the area. The magnitude of the output of the integrator depends on the equipment parameters and the acoustic characteristic of the fish parameters, called calibration constant. This is established through live fish calibration by considering the integrator deflection for the insonified fish of the known species and quantities (Johanneson & Losse, 1977) and used for converting the relative biomass into absolute biomass.

Live fish calibration experiment was carried out onboard *R V Rastrelliger* and calibration constant was obtained for mackerel and sardine (Vittulo *et al.* 1980). As the type of instruments used onboard *R V Rastrelliger* are different from *FORV Sagar Sampada*, these constants cannot be used. Therefore to have the absolute biomass estimate of fishery resources, live fish calibration need be carried out onboard *FORV Sagar Sampada* in future for the commercially important species, following the methods of Vittulo *et al.* (1980).

Calibrating integrator using trawl catch data

Another method of establishing calibration constant, 'C' used in fish resources estimation is by calibrating the integrators reading against the corresponding trawl catch (Anon. 1973). The calibration constant established onboard *FORV Sagar Sampada* based on above method was 1327 kg/n.mile^2/mm, which means if the vessel has sailed one nautical mile distance and integrator deflection is 1 mm then the fish biomass will be 1327 kg in that one square nautical mile area. However, this method may lead to under estimation of resources as it is assumed that the fishing efficiency is 100% which is not practicable.

Target strength measurement

The target strength (TS) of the underwater object is defined as ratio of the reflected sound intensity to the incident sound intensity at 1 m from the object expressed in decibels. The magnitude of TS of fish relates to fish size, morphology, physiology and orientation (Johannesson, 1983). Target strength of 100% reflecting sphere (diameter 12 cm) is -30dB (Bodholt, 1970).

The TS measured for the catfish (Anon. 1974) is as follows:

Mean length (cm)	Mean TS(dB)	Fish (no/kg)
23	-40	11
33	-33.5	3.7

The TS informations help the fishery scientists to know the size of the fish while carrying out the survey and to preserve fish stock for optimum exploitation. Also the knowledge of the target strength of the fish concerned provides another independent means of estimating absolute biomass by the volume back-scattering method (Anon, 1973).

This study could be carried out onboard *FORV Sagar Sampada* for all other commercially valued species utilising the existing equipments in future. Ofcourse with the additions of the latest generation of scientific echosounder ES 400 with the colour printer will give colour hard copy of echogram and size distribution diagram.

The distribution diagram will show number of fish/weight of fish in percentage on Y-axis and fish length or TS values on the X- axis. To sum up the conclusion the calibration need be carried out regularly once in a year or whenever any major part of the equipment are changed during the fair weather season and documented. Live fish calibration and target strength measurement for the commercially important species need be attempted.

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