This report is not to be cited without prior reference to the Council [1)]

International Council for the
Exploration of the Sea

ICES CM 1995/L:8

Report of the Study Group on Gulf III sampler efficiency calibrations

This document is a report of a Study Group of the International Council for the Exploration of the Sea and does not necessarily represent the views of the Council. Therefore, it should not be quoted without consultation with the General Secretary.

1) General Secretary
International Council for the
Exploration of the Sea
Palægade 2-4
DK-1261, Copenhagen K
Denmark

1. Introduction

1.1 Terms of references

The Study Group worked by correspondence according to ICES Council Resolution 1994/2:54 on the following term of references:

a) evaluate results of recalibration of Gulf III type samplers in current use in ICES coordinated surveys;

b) assess the implications of recalibration on historical data base;

c) define a standard procedure for in situ calibration of flow meters in present use;

d) evaluate available information on non-intrusive means of measuring volume filtered by plankton samplers;

e) decide on revisions to be made in the design of standard samplers for ichthyoplankton surveys.

Activities required to address these terms of references have been carried out with financial support through a "Concerted Action" project of the EU. On the basis of existing standard equipment and two new prototypes of flowmeters for non-intrusive means of measuring volume filtered, two types of calibration trials have been carried out: 1) Towing tank experiments started last year for comparative calibration of three basic types of Gulf III samplers have been continued according to the demands specified in the previous Study Group Report (Anon. 1994). 2) Flume tank experiments employing Laser/ Doppler method for measuring flow profiles have been taken up for comparing the Gulf III and Bongo type sampler, and for assessing the new non-intrusive flow meter devices. According to restrictions in the availability of the equipment, personal and working time in the tanks, the timing of the trials did not yet allow any final analysis of the obtained results. Thus, the terms of references b), c), and e) require further discussions, which are planned to be taken up during coming meetings of the "Concerted Action".

1.2 Participation

Information and contributions for presenting results and discussions related to the terms of references were communicated to the Chairman (D. SCHNACK, Germany) by a great number of participants of the "Concerted Action" project and the following members of the Study Group:

G. ELTINK	The Netherlands
J. NICHOLS	UK
M. REPECAUD	France

2 Calibrations in towing tank

For comparing the filtration efficiencies of the three basic Gulf III types regularly used in ICES coordinated ichthyoplankton surveys, it had been decided previously (Anon. 1993) to carry out standard format calibration tests for the English, the Dutch and the German models of the Gulf III sampler in a towing tank at Hamburg. The flow profile across the mouth opening should be measured precisely in the entrance plane by employing a miniature flowmeter

(Miniflo). It was accepted that at the edge of the nose cone the Miniflo measures would probably include a bias, due to the expected narrow gradient in the current at this place and the dimension of the impeller of 10 mm in diameter. Also the direction of flow might be critical at the edge when measured by an impeller. The achieved calibration factors could thus be slightly biased but they should be comparable among the three samplers tested. The more accurate means of calibration by Laser/ Doppler measurements, is very expensive and had to be restricted to trials with one Gulf III sampler only, which was compared to a Bongo type net as explained in section 3.

The methods used in the towing tank trials have been described in the previous report, which also contains a summary and discussion of the last years results. During the reporting period it was possible to further complete these measurements for an improved comparability. The data still contain some inconsistencies and puzzles, which have to be discussed and might require additional measurements. As a final analysis of the complete data set has not yet been achieved, this presentation is restricted to some general trends which have become obvious.

Total filtration efficiency of the sampler including filtering net, but without a mechanical flowmeter in the nose cone, appears to be slightly less than 100% in the Dutch model and above 100% in the English and the German models. Flow profiles of the latter two models in this configuration have been given in the previous report. Mounting a mechanical flowmeter into the nose cone, as done in the routine surveys work, reduces the efficiency close to 100%, depending on the size and shape of this device (Brander et al. 1993, Blendermann 1969). This reduction was not obvious in the Dutch sampler, but rather a slight increase became apparent. This inconsistency may be due to differences in the shape of the nose cone, the flow meters and the effect they have on the flow profile. One individual measurement in the Dutch sampler with the Miniflo not oriented perpendicular to the towing path but turned to an angle of 15° towards the side, resulted in a 6% increase in the velocity value. This may indicated that the current direction in the entrance plane deviates from towing direction not only very near to the edge of the cone but also at some distance apart from the edge. In the Dutch model, with a comparably wide nose cone angle, this effect may be more pronounced than in the two other models with a narrow cone angle. When adding a large flow meter into the nose cone, a change in flow profile has been observed; this might also reduce the deviation in current direction so that the Miniflo values are less biased in this configuration and a reduction in velocity may be masked by a more efficient measurement.

The general impression appears that in the configuration used for the routine survey work, the total efficiencies of the three samplers are in fact not very different and close to 100%. However, different calibration methods and efficiency assumptions have been used for calculating the abundance values for fish eggs and larvae in the historical data set. The re-calibration of the Dutch flowmeter mounted in its standard position in the nose cone, resulted in a difference compared to the routinely used value for the historical data set. On this basis the given calculations imply a filtration efficiency of about 116% instead of an assumed 100%. For the English, the Scottish and the Danish samplers a 90% efficiency has been applied in the past. Depending on the specific method of flowmeter calibration used, the abundance data derived from these samplers may have been overestimated and may have to be reduced by about 10 %, whereas the Dutch abundance values have to be raised by about 16%. The flowmeter used in the German sampler has been calibrated in free flow and a 100% efficiency has been assumed for calculating abundance values. Field data, using ship speed and duration of tow for comparison, indicate that the flow values measured inside the nose cone in fact provide an unbiased measure of the distance towed with the given calibration factor. However, exceptions have been observed and a confirmation by tank trials is still required.

A final decision on correction values required for the historical database has to be made on the basis of a complete analysis of the results from the towing tank trials and after having an unbiased measure of filtration efficiency available from the Laser/ Doppler measurements (see below).

3 Laser Doppler measurements in flume tank

Within the frame of the "Concerted Action" it was possible to conduct trials in the HYKAT flume tank at the Hamburgische Schiffbau-Versuchsanstalt, HSVA, using a Laser/ Doppler system for measuring the flow profile across the mouth opening of the English Gulf III model and a bongo type net in different configurations. Two new non-intrusive means of measuring the average flow velocity through the net entrance could be evaluated in parallel, so that the obtained values can be compared to integrated value from the Laser/ Doppler profiling measurements.

3.1 Methods

The HYKAT flume is a large circulation tunnel designed for hydrodynamics and cavitation measurements. The test section of the tunnel is 2.8 m wide, 1.6 m high and 11 m long. The flow speed can be regulated up to 12.6 m/s. During measurements the top of the chamber is closed by a lid to which the test-objects are mounted. The experiments can be watched through windows in the side walls, through which also the laser measurements are made.

The two new non-intrusive methods for measuring volume of water filtered by plankton nets are based on acoustic and electromagnetic principles respectively. Both require a tube like entrance to the net, so that the nose cone of the Gulf III sampler had to be modified accordingly by adding a cylindrical part in front. The experimental design as initially planned for testing the two plankton sampler types included 27 configurations for each sampler and 12 Laser/Doppler (L/D) point measurements for each configuration on a vertical transact of half the diameter across the entrance area. The points, which related to a control volume of 0.4 mm diameter, were set 2 to 3 mm in front of the entry plane; the intervals along the transact were selected to represent a series of annuli of equivalent areas. The different configurations of the sampler included three means of flow measurement to be tested (standard mechanical flow meter, acoustic and electromagnetic device); three flume speeds and three net stages (standard, 50% and 75% clogged). Due to restrictions in the available flume time, the 50% clogged net was not used and only median speed runs were done with the 75% clogged net. The acoustic sensor was tested only on the Bongo sampler and with standard net only.

3.2 Results

Despite the given restrictions, sufficient data were collected to describe the flow patterns into the mouth openings of each sampler and also to evaluate the efficiency of each of the measuring devices tested. The data have not yet been fully analyzed and no final conclusion can be draw at this stage. However, some differences were already noted between comparable Miniflo profiles of the Gulf III from towing tank trials and those obtained with the L/D system. They suggest that the Miniflo calibrations may have underestimated the volume accepted by the samplers.

Moreover, it can be stated that both the electromagnetic and acoustic devices worked well and appeared to produce consistent flow profiles over the range of conditions tested. The prototype of the acoustic system gave reliable results even though adjustments were made in both receiver sensitivity and transmitter power for the use in the HYKAT flume, where

reverberation in the enclosed space required the receiver sensitivity to be reduced substantially. Tests of the system in open sea conditions and adjacent to ships hulls, marina pontoons etc. have shown no false signal pick up from potentially reflective surfaces using full signal strength and receiver sensitivity. The present prototype will have to be ruggedised and the transceiver housed in a pressurised underwater housing. An example of the logged output from the system used as a Bongo with net is shown in Figure 1.

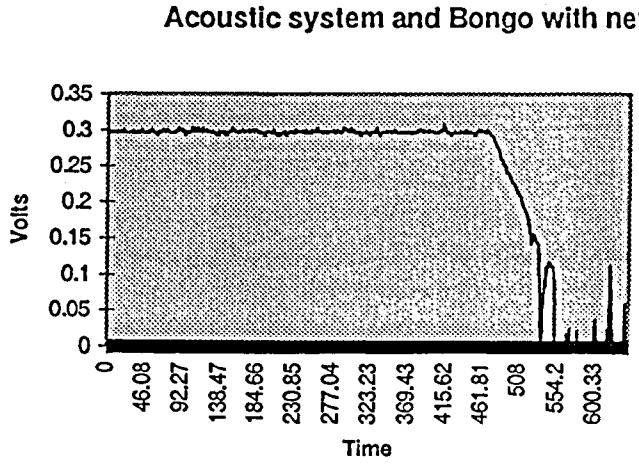

Figure 1. The results from the acoustic system in the flume at a speed of 2.25m/s with net attached. The graph was plotted using the analogue data output from the Acoustic Doppler system and was obtained through modifications to the electronic circuitry, (the normal output is a frequency output).

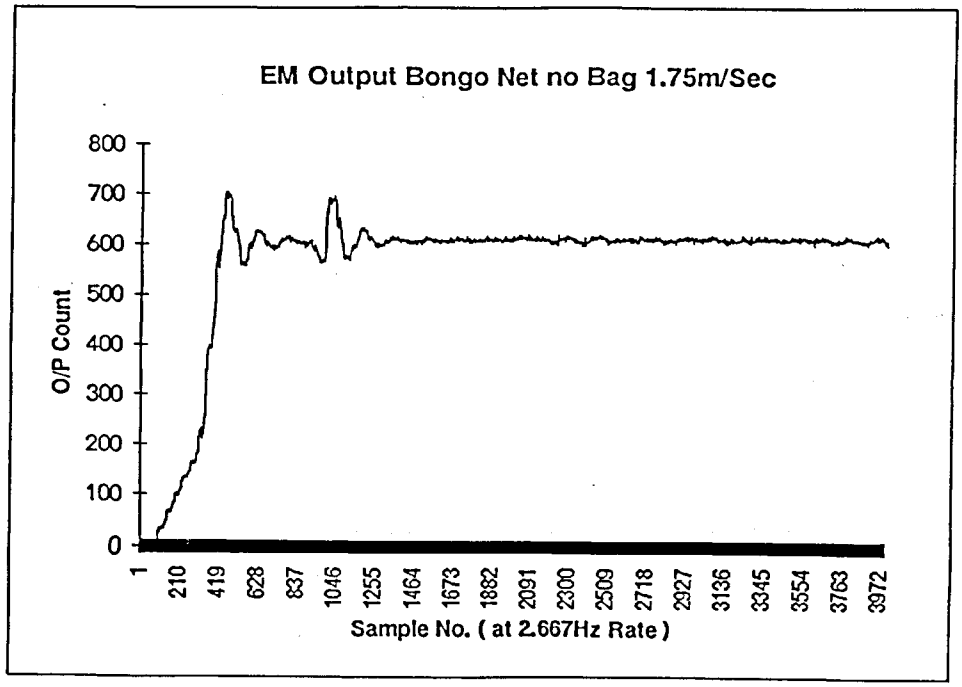

Fig 2. shows a typical output from the system mounted on the Bongo Net.

The electromagnetic device tested is a variant of the flowmeter developed for the Continuous Plankton Recorder system. The sensor consists of a coil which generates a magnetic field in the water. A pair of pins in contact with the water detect the voltage generated by movement of the water through the magnetic field. The unit is powered via the data lead. For the purpose of the trials the output data from the unit were stored in a PC for a period during the runs. This was initially done using different low pass filter / data rate settings. Figure 2 presents an example output from the system mounted to a Bongo net.

For regular use the voltage output would be processed to produce a digital number proportional to the flow rate. A data logger would be used which would average 10 or more outputs to reduce the noise.

4 Conclusion

In general, both new non-intrusive flowmeter systems seem to offer favourable alternatives to standard mechanical flowmeters. A more definite conclusion considering also the sensitivity to chances in the flow profile across the sampler entrance, e.g. due to clogging, requires a complete analysis of the measurements first. The adequacy for the use in routine survey work will then have to be tested at sea.

The recalibration of the three basic Gulf III type sampler in present use did not indicate substantial differences in the filtration efficiencies among the sampler in their configuration used for routine survey work. However, differences in the flowmeter calibrations and assumed sampler efficiency seem to be substantial and may require a corresponding correction of the historical database on fish egg and larval abundances. As the data analysis has not yet been completed, the terms of references a), b), and d) have been addressed in this report on a preliminary basis only. The final results will be discussed in the frame of further meetings of the "Concerted Action". This basis will provide then a suitabel basis for reasonable discussions on the terms of references c) and e) .

5 References

Anon. 1993. Report of the Study Group on Gulf III sampler efficiency calibrations. ICES C.M. 1993/L:8.

Anon. 1994. Report of the Study Group on Gulf III sampler efficiency calibrations. ICES C.M. 1994/L:15.

Blendermann 1969. Windkanalmessungen an einem Planktonnetz. Institut für Schiffbau der Universität Hamburg, Schrift Nr. 2152, 16pp

Brander,K.M., Milligan,S.P. and Nichols, J.H. 1993. Flume tank experiments to estimate the volume filtered by high speed plankton samplers and to assess the effect of clogging. J. Plankton Res., 13(4), 385-401.