

International Council for the  
Exploration of the Sea

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**Report of the Study Group  
on Gulf III sampler efficiency calibrations**

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## 1. Introduction

### 1.1 Terms of references

The Study Group worked by correspondence according to ICES Council Resolution 1993/2:58 on the following term of references:

- a) coordinate comparative calibration tests to be made in a towing tank in Hamburg, Germany, with three basic types of Gulf III samplers presently used in ICES ichthyoplankton programmes;
- b) identify and stimulate testing of non-moving and possibly non intrusive flow measuring systems to be used as a standard device for measuring the volume of water filtered during hauls;
- c) define a standard procedure for in situ flowmeter calibrations.

The first two terms of references have been addressed by two lines of activity:

1) Development of a workplan and proposal for a "Concerted Action" to be financed by the EC. 2) Preparation of sampler types to be tested and calibration of the Dutch and the English 50 cm version of Gulf III, comparable to recent tests made with the German HAI in a towing tank at Hamburg University (Schnack 1992). The third term of reference may be handled only after tank calibrations have been completed; it requires agreement on the interpretation of tank-test results and adoption of standard procedures, to be discussed during meetings planned for the "Concerted Action".

### 1.2 Participation

Information and contributions for discussion on actions and results related to the terms of references were communicated to the chairman (D. Schnack, Germany) by:

A. Corten	Netherlands
J. Nichols	UK
S. Milligan	Uk

## 2 Development of a "Concerted Action"

A proposal for a "concerted action" has been developed and successfully submitted to the AIR programme of the EC. It is entitled "Coordination of the development of an improved method of measuring volume filtered by high speed plankton samplers". Participants are governmental research departments, universities and private companies from France, Germany, Ireland, The Netherlands, Spain, and UK. The objectives have been defined as follows:

- a) To evaluate the results of the re-calibration of the three common Gulf III type design samplers in current use, make recommendations about the implications of those results and disseminate the information to relevant ICES Workshops and Working Groups.
- b) To stimulate the development, testing and calibration of an alternative means of measuring the volume of water filtered by a plankton sampler. General specification:

Towing speed range	1.5 to 3.0 ms <sup>-1</sup>
Accuracy	± 1% for volume filtered
Duration of deployment	90 min
Configuration	<ul style="list-style-type: none"> <li>- self contained with battery pack.</li> <li>- continuous sampling with measurement at 2 sec intervals.</li> <li>- PC access to logged data with optional facility for direct logging via cored cable.</li> </ul>
Design features	<ul style="list-style-type: none"> <li>- non-intrusive or less intrusive than a mechanical meter.</li> <li>- to measure water entering the sampler.</li> <li>- rugged and practical for continuous survey use.</li> <li>- unit cost &lt; £ 7000.- per sampler.</li> </ul>

c) To evaluate the results of the development, trials and calibration of the three potential alternative methods of measuring flow, against the specification in (b) above. To identify and recommend to ICES the best solution, disseminate the technological information and to promote the manufacture and use of the new device on all ICES coordinated plankton surveys.

d) To decide whether the Gulf III or a 'Bongo style' high speed sampler should be the recommended standard for use on ICES coordinated fish egg and larvae surveys. To evaluate the results of performance at sea, visibility studies in the laboratory and to recommend accordingly.

The workplan includes tank calibration tests of the sampler types and flowmeters used in the field, and re-analysis of historical data sets accordingly, the investigation of Laser/Doppler technique with fibre optics, electromagnetic and 'time of flight' acoustic devices as means for measuring the filtered volume, and comparative sampling at sea with Bongo and Gulf III type sampler.

The proposal has generally been accepted from the EC; a final workplan and budget is being negotiated. These finances are supposed to allow for travel funds for a structured series of development meetings, trials and evaluation meetings, for the transportation of equipment, hire of facilities and administrative assistance.

### 3 Tank calibration tests

It had been agreed in the Study Group (Anon. 1993) that each of the three basic Gulf III type systems used in ICES coordinated plankton surveys should be recalibrated in a towing tank at Hamburg with their standard flowmeters in situ and also with their filtering nets mounted. A miniature flowmeter should be used to measure the flow profile across the mouth opening, exactly in the aperture plane, to provide the best possible estimate of volume accepted.

At present, two series of tests have been carried out with a Dutch and an English 50 cm Gulf III version, respectively, in February/March 1994. They correspond in the methods used to those made before with the German HAI (Schnack 1992), but include a more complete resolution of the flow profiles measured at different towing speeds.

### 3.1 Methods

The tank is 80 m long, 5 m wide and 3 m deep. A towing carriage is mounted on rails running along one side of the tank and another track suspended from the roof. This carriage, powered by an electric motor, has a maximum towing speed of  $3.6 \text{ ms}^{-1}$ . The samplers were prepared to be attached to the towing carriage and held rigid by two aluminium poles. The nose cones were modified by a slot cut to allow the mini-flowmeter to be positioned at any place along a transect within the aperture plane. There were slight differences in the mounting of the mini-flowmeter among the tested Gulf III versions: In the English and the German versions, the slots were cut into the top side of the nose cone and the flow profiles were measured vertically across the upper half of the aperture. In the Dutch version the slot was cut into the left side of the cone and the flow profile was measured horizontally across the right half of the aperture. The standard flowmeter, used during routine sampling, was mounted only in case of the Dutch version.

The most relevant differences in the sampler design refer to the shape of the nose cone: The total enclosed front angle is very similar in the English and German versions ( $30.8^\circ$  and  $31.3^\circ$  respectively) and larger in the Dutch version ( $49.7^\circ$ ). The latter has in addition a thickened reinforced front edge of the nose cone. The German Hai version differs in general from the usual Gulf III models by the fact that the filtering net is not enclosed.

Additional measurements have been made with ring nets of the same mouth opening of 20 cm, with only a short cylindrical front piece and no conical expending part. These data, though yet restricted to the center of the aperture, may provide some indication of the effect of the nose cone.

### 3.2 Results

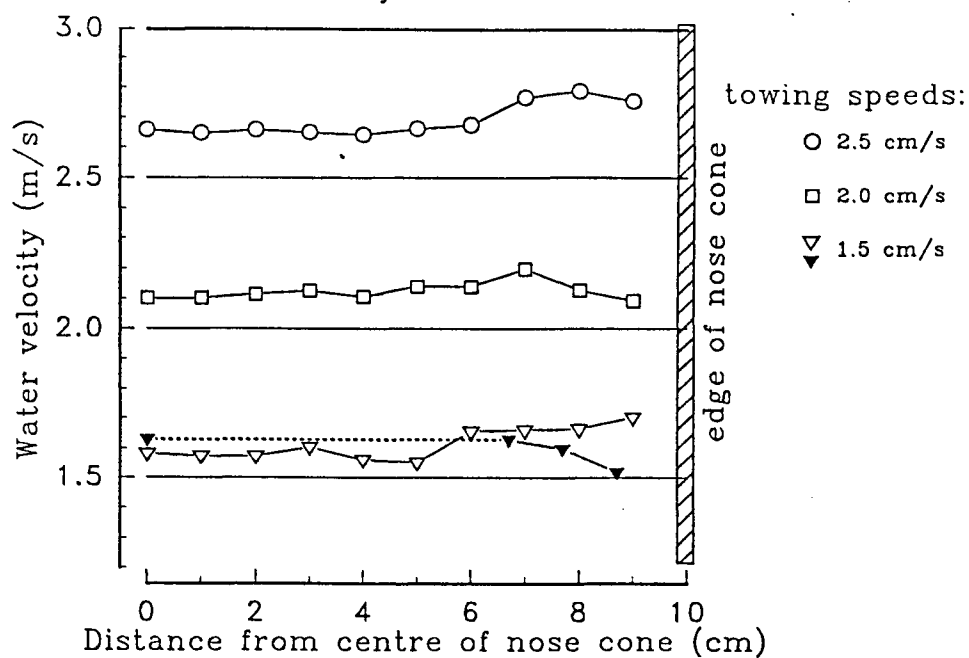
The flow profiles obtained for all three sampler versions and different towing speeds are summarized for comparison in figure 1. Results for the German sampler are restricted to one speed yet. In general, there is a tendency for an increase in velocity from the center of the aperture out to the rim and a decrease near the edge of the cone. This trend is pronounced in the Dutch version, where the measured velocities varied around the towing speed, with lower values in the center and near the edge, but higher values inbetween. Integrated over the aperture area the velocity profile indicates a total efficiency very near 100 %.

The English version shows a more flat flow profile except near the edge. The measured velocities were always above towing speed, indicating an integrated efficiency of about 106-109%. The values presently available for the German Hai fit very well to the English values at the respective towing speed, with some deviations close to the edge of the cone. The integrated efficiency amounts to about 107%.

In figure 2, the flow velocities measured in the center of the Gulf III apertures at different towing speeds are compared with corresponding values for a net aperture of the same size but without conical expansion (small Bongo type net). The flow velocities in this Mini-Bongo net are slightly above the towing speeds and inbetween the values for the Dutch Gulf III version as the lowest and the English and German versions as the highest. The measurements have still to be completed for the German Hai version and for the Bongo type net to provide complete flow profiles at the different speeds.

Lowestoft: open symbols

IfM Kiel: closed symbols



RIVO-DLO:

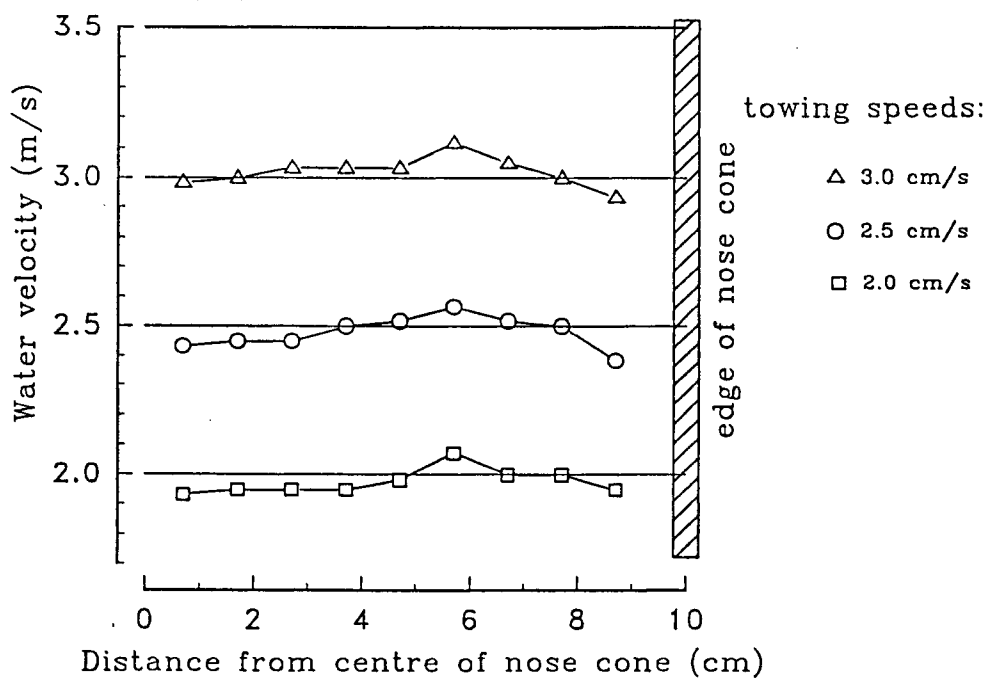


Figure 1: Flow profiles across the aperture of Gulf III sampler models from Fisheries Laboratory Lowestoft, Rivo-dlo IJmuiden, and IfM Kiel at different towing speeds.

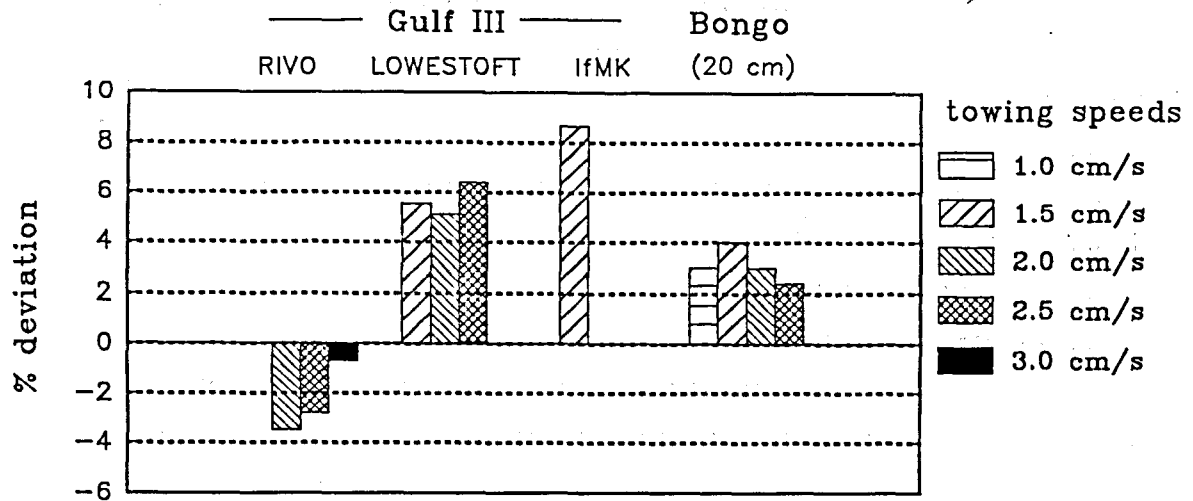


Figure 2: Flow velocities in the centre of sampler apertures as percentage deviation from towing speed.

#### 4. Discussion and Conclusions

It had been pointed out in the previous Study Group report, that the mini-flowmeter used in this calibration exercise may not work properly close to the edge of the nose cone. At least the variability in the measurements has been observed to increase towards positions near the edge and the slightly different methods used for recording and averaging the flow data may introduce some uncertainties into these data under the given conditions.

In general, the results confirm earlier observations (e.g. Blendermann 1969) showing that Gulf III sampler may have filtration efficiencies in the range of above 110%. The efficiencies of the English 50 cm version and German unencased Hai appear to be similar, when considering the uncertainties in the data near the edge. But the measurements for the Hai have still to be completed. Additional measurements, showing reduced velocities in centimeter distances ahead of the aperture, are now available for both the English and the German versions. They solve the discrepancy that lower efficiency values (less than 100%) have been obtained in earlier English tank measurements with comparable sampler versions. It has been confirmed that the results are very sensitive to the exact positioning of the flowmeter relative to the aperture plane.

The lower efficiency values and the differences in the flow profile obtained for the Dutch Gulf III may be attributed to the larger angle of the nose cone in this version, but may also be explained in the present case by the regular flowmeter for routine survey work being installed.

The present tests have to be completed so that comparisons of total flow profiles and thus volume filtered can be made with and without the routinely used flowmeters installed. It will also be important to study the effect of net clogging on the flow profile (Brander et al. 1993). If non-intrusive methods for measuring the volume filtered can be achieved and the disturbance by the mechanical flowmeter thus be omitted, it would be of interest to know whether the flow profile in the aperture plane would remain sufficiently flat even in case of

some clogging effect. This information may be important for the possibility to stay with the traditional sampler design or the need to abandon its nose cone in a revised standard sampler. The filtration efficiency appears to remain high even without any nose cone in front of the net (as shown in Fig.2), but the aperture/net open area ratio becomes less favourable.

It is expected that the required technological developments and tests can be carried out with the financial support by the "Concerted Action" of the EC.

## 5 References

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- Blendermann 1969. Windkanalmessungen an einem Planktonnetz. Institut für Schiffbau der Universität Hamburg, Schrift Nr. 2152, 16pp
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- Schnack, D. 1992. Comparative measurements of flow Profile across the mouth opening of a Gulf III type sampler. ICES C.M. 1992/L:35