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International Council for the
Exploration of the Sea

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Report of the Study Group on Gulf III sampler efficiency calibrations

3 February 1993

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1. Introduction

1.1 Terms of reference and participation

The Study Group met in Aberdeen UK on 3 February 1993. Its terms of reference, from ICES Council Resolution 1992/2:54 were:

- a) Define and initiate a standard calibration of the Gulf III samplers presently used;
- b) Initiate the design of a new standard sampler according to the criteria given in the 1991 report of the Study Group;
- c) Prepare a proposal for the application of new technology to measure the volume filtered;
- d) Review new results on filtration efficiency and avoidance problems from tank and field tests;

1.2 Participation

The meeting was attended by the following participants:

A. Corten	Netherlands
J. Dunn	UK (Scotland)
C. Glass*	UK (Scotland)
J. Nichols	UK (England)
B. 'O'Neill	UK (Scotland)
K. Patterson*	UK (Scotland)
D. Schnack (chairman)	Germany
J. Simmonds	UK (Scotland)
K.J. Staehr	Denmark
R. Toresen	Norway

* part time

2. Calibration procedures

2.1 Review of problems and progress

A brief historical review of the developments in the use and calibration of high speed plankton samplers was presented. This subject was comprehensively covered at the last meeting of the study group and documented in the respective report (Anon 1991).

In the context of sampler calibration, the major problem highlighted in the review was the discrepancy in the volumes accepted by the Gulf III sampler when measured by a miniature flowmeter and by Prandtl (Pitot-static) tubes. The two methods of calibration also show different flow profiles across the mouth of the sampler. The Prandtl tubes give the highest flow at the edge of the mouth opening whilst the miniature flowmeters suggest a reduction in flow at the edge. (Anon 1991, Fig 1). This together with other differences have led to higher apparent efficiencies for the samplers when calibrated with Prandtl tubes compared with the efficiencies when calibrated by miniature flowmeters. Details of the differences between the two methods and the results from various national versions of the modified Gulf III sampler are described in the report of the previous Study Group. (Anon, 1991).

As a result of the discussion at that Study Group further comparisons between the two calibration methods were carried out using the German HAI sampler in a towing tank in Hamburg. The results of these comparisons which were presented at the ICES Statutory meeting in 1992 (Schnack, 1992) were also presented to this Study Group. Briefly, the flow profiles using the two methods were exactly the same as in previous observations on the HAI sampler in the entrance plane. However in these experiments flow profiles in different planes, both ahead of the sampler and inside the nose cone, were also examined. These profiles clearly demonstrate a horizontal flow gradient (Figure 1) with a reduction in flow ahead of the sampler (a bow wave) and an increase in flow inside the nose cone (funnelling) in the centre of the mouth opening. It was concluded that such a gradient would inevitably generate problems in obtaining an accurate measure of velocity using Prandtl tubes. This method relies on two measurements of pressure, the dynamic head at one point and the static head at a point 1.45cm behind the first measuring point. The differences between these two measurements is then used to compute the water velocity. Quite clearly from these experiments it has been shown that the two measuring points in some parts of the measuring plane will be subjected to different water velocities. This inevitably results in an inaccurate computation of the water velocity at the tip of the Prandtl tube. Schnack (1992) concluded that these errors were likely to be greater at the edges of the mouth opening than in the centre, because the longitudinal velocity gradients were steeper at the edge. The Study Group welcomed these experiments and accepted the conclusion that the Prandtl tube was not a reliable means of measuring water velocity entering the nose cone of a Gulf III type sampler.

The Study Group accepted that the miniature flowmeter could give a reasonable measure of water velocity entering a sampler provided that it was measuring in the entry

plane of the nose cone. However there may be an underestimate of velocity from observations taken very close to the edge of the mouth opening. There is also an underestimate of volume entering the sampler when the miniature flowmeter is positioned in front of the mouth opening.

The Study Group concluded that part of the difference in reported efficiencies between the national Gulf III versions is due to the measuring problems in tank calibration tests, reported above. Another part can be explained by differences in the angle of the nose cone, which can be seen from the Dutch calibration experiments (Corten, 1990). The German HAI sampler has a total enclosed front angle of 31.3° compared with 30.8° for the English version and 49.7° for the Dutch and Scottish samplers.

The bias included in the calibration factors that are being used for the national Gulf III versions appears to be in the order of up to or less than 10%. It was concluded that this bias was unlikely to create problems for the use of the herring larvae data base. This is because the larvae data have only been used as indices in the past, and in general the same countries have regularly sampled at the same times and in the same areas. However, for the Western mackerel and horse mackerel egg surveys the problem is potentially more serious. In this case an error of 10% in the estimation of volume filtered by one country will transfer directly through to a 10% error in the estimation of egg production.

2.2 Standard calibration procedures

Slightly different procedures have been used for field calibration of samplers and flowmeters and for the subsequent calculation of volume filtered. These procedures have been discussed in detail at the previous Study Group meeting (Anon, 1991). Briefly, some countries make free flow flowmeter calibrations during a survey and use the number of counts per metre obtained in this way to calculate volume filtered during a tow. The Netherlands and Germany make no further adjustment for sampler efficiency, assuming a 100% efficiency of the sampler. Scotland and Denmark reduce these calculated volumes to take account of the reduced efficiency observed in the tank tests. The English have used readings direct from flowmeters calibrated to provide litres per count. These flowmeter calibrations are made in situ during towing or flume tank observations of volume accepted by the sampler. This method also incorporates the apparent reduction in efficiency observed in these tests.

The Study Group agreed that in situ flowmeter calibrations were desirable using a standard procedure. However this could not provide a solution to the potential problems of the past. In order to decide whether the various assumptions made about sampler efficiencies in the past are valid, further towing tank calibrations must be made. In this way it can be decided whether or not those assumptions have led to major errors in the estimation of volumes filtered.

There are three basic Gulf III type systems that have been used on ICES coordinated plankton surveys since 1967. These are the Dutch Gulf III, the German HAI sampler and the English 50 cm sampler. It was agreed that each one should be recalibrated in the

towing tank in Hamburg with their standard flowmeters in situ. Profiles of water velocity entering each sampler would be obtained using high speed miniature flowmeters. These miniature flowmeters would be transected across the plane of the mouth opening to provide the best possible estimate of volume accepted. Germany would provide the towing tank facility whilst England and The Netherlands would provide some experienced assistance. These calibrations would be done as soon as was practicable. Communication of the results and subsequent discussion would be done by correspondence. This would include any necessary decision on how to apply the results to past data sets.

3. New technology to measure volume filtered at sea

The desirability of a non moving, non intrusive or less intrusive flow measuring system was accepted. Of the potential systems for calibration, listed in the previous report (Anon, 1991), only acoustic Doppler, laser Doppler and electromagnetic devices appear to have any potential for routine flow measurement in the field. Little progress has been made in the investigation of their potential since the previous meeting of the Study Group. Mr J Dunn did show an electromagnetic device, manufactured by Valeport UK which appeared to have some potential. However this had not yet been tried out in a plankton sampler. It was recognised that any new device would almost certainly operate better in a straight tube rather than in a conical nose cone. It was agreed that progress on this front should be made on a national basis, keeping in close touch with any promising developments.

4. Visibility and avoidance problems

Some further progress had been made in Scotland since the Study Group which discussed these problems in 1989 (Anon, 1989). Practicable solutions to the problem of making high speed plankton samplers less visible to plankters in their path had been sought. Some of the current ideas for sampler camouflage have been obtained from a careful study of the internal mouth structure of some plankton eating fish and sharks. The major problem with existing Gulf III type samplers are the angled nose cone and the construction of the filtering net which cause it to act as a light collector making it very visible under water. The first of these problems had been alleviated by using a Bongo style straight tube mouth opening. The absence of a nose cone does considerably reduce the frontal visual stimulus. An attempt to camouflage the filtering net was made using an orange coloured polythene cover with holes over its surface. The size of these holes was carefully calculated and designed to break up the pattern of light falling on the surface of the net. Field deployments of the system have been made but these have not included exhaustive comparisons of its performance against other samplers. Observations of the frontal visibility of this experimental system, both in a tank and at varying depths in the field, are planned for the near future.

5. The design of a new standard sampler

It was decided that a new standard sampler should be developed and that this should be a system which did not have a nose cone. The design of the new sampler should

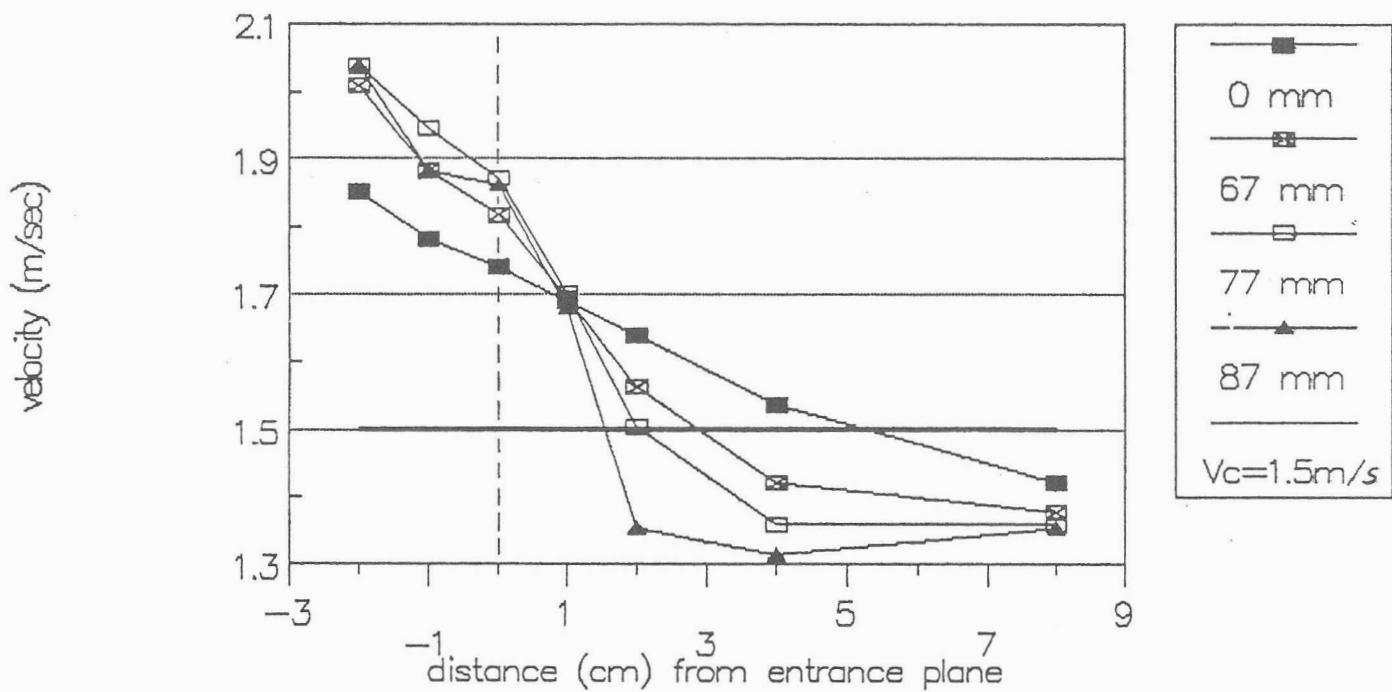
take into account all the knowledge about frontal visibility of samplers. The aim should be to camouflage the sampler and render it invisible to plankters in its path. The new sampler should incorporate the latest technology available for non moving, non intrusive or less intrusive flow measurement. The Study Group recognised that developing such a system was beyond the individual financial means of any of the organisations represented. It was therefore agreed to put forward a proposal for the EEC to fund the research and development of such a system for use on all ICES coordinated surveys in the future. The initial proposal would be formulated by J.Nichols (UK) and circulated to participants as soon as possible.

6. References

- Anon. 1989. Report Of The Study Group On Plankton Sampling Problems. ICES C.M. 1989/L:21. 10pp, appendix I&II (mimeo).
- Anon. 1991. Report Of The Study Group On Gulf III Sampler Efficiency Calibrations. ICES C.M. 1991/L:58. 10pp (mimeo).
- Corten, A. 1990. Efficiency Measurements Of Gulf III And Hai Plankton Samplers In A Towing Tank. ICES C.M. 1990/L:107. 11pp (mimeo).
- Schnack, D. 1992. Comparative Measurements Of Flow Profile Across The Mouth Opening Of A Gulf III Type Sampler. ICES C.M. 1992/L:35. 12pp (mimeo).

Longitudinal flow profiles

A) Projection ahead nose cone (Prandtl)



B) projection into nose cone (Miniflo)

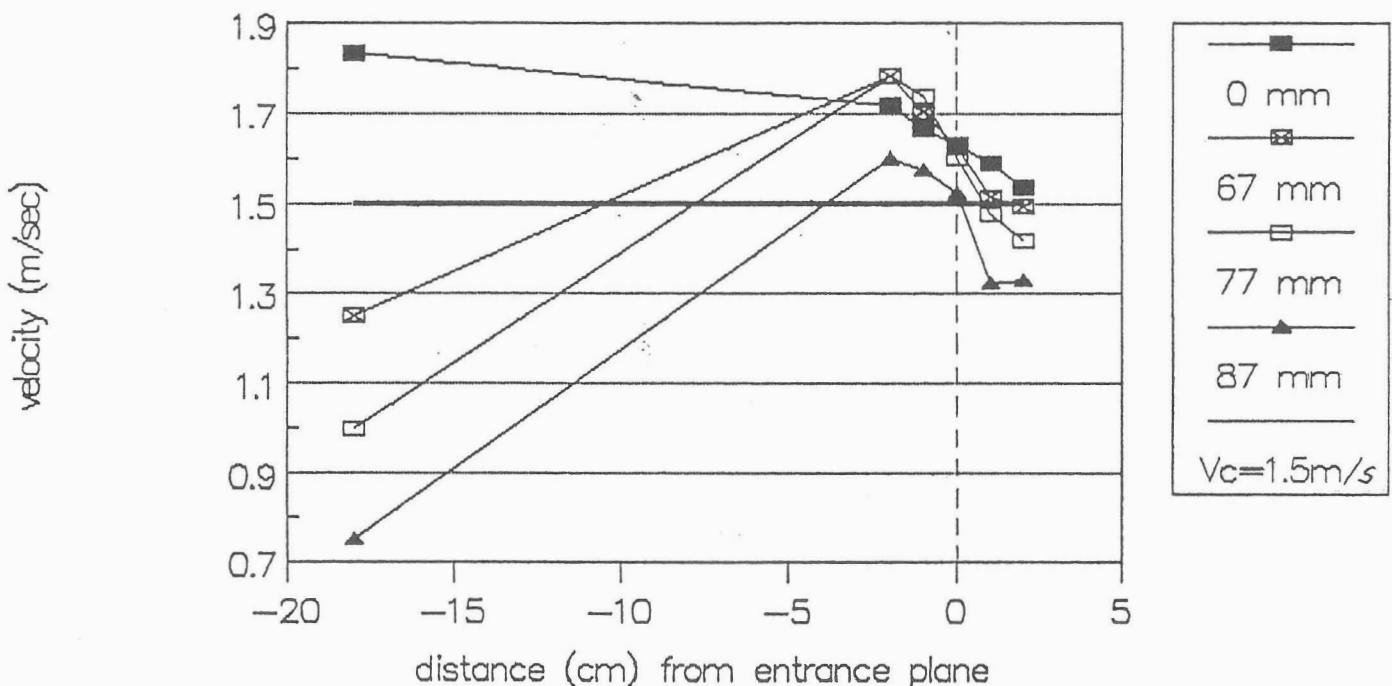


Fig. 1: Flow profiles along towing direction through mouth opening of the sampler at different distances (given in mm) from the centre of the nose cone

- A) PRANDTL-tube measurements with and without net combined, projecting ahead of nose cone
- B) MINIFLO measurements with net installed projecting into nose cone

