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GUIDE TO EXPERIMENTAL PROCEDURE
IN FISHING GEAR RESEARCH AND DEVELOPMENT

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International Council for the Exploration of the Sea
Palægade 2-4, 1261 Copenhagen K
Denmark

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1. INTRODUCTION

This report has been prepared by members of the ICES Data Collection and Gear Engineering Working Groups. There have been many contributors in the discussion and writing of the report which has evolved over several years. The principal meetings which have led to the present document, all convened under the auspices of ICES, were the data collection working groups at Hamburg (April 1977) and at Gothenburg (May 1979), and the first draft was produced by an expert group which met at Aberdeen in February 1980. The participants at these meetings are listed in Table 1 (p. 20).

The aim has been to describe the recommended procedures applied in those countries with experience of fishing gear research, as a guide for newcomers to the field, for those with a fishing rather than a scientific background who may wish to experiment with gear, and as an aid for the planning of fisheries projects in the developing countries.

The scope of this report is restricted to studies of engineering aspects of fishing gear design and performance. By this is meant the performance of the gear as a whole. Thus basic investigations of component properties such as the strength of twines are not covered. Design features of vessels and their equipment are only included in so far as they may influence the gear used or gear performance. It is recognised, of course, that fish behaviour as well as gear engineering has an important bearing on the level of fish catches, but, again, fish behaviour observations are only relevant here to the extent that they can indicate the merits or demerits of particular gear designs, when taken in conjunction with physical measurements or observations. Fish selectivity experiments are excluded.

This report is about experiments on full-scale or model gears, or on component parts of gears such as netting panels but excluding twine properties, where some physical measurements or observations are used to investigate engineering aspects of gear performance.

A previous report (ICES 1977) has dealt with comparative fishing experiments. It has not been necessary therefore for this document to cover the type of experiment where the overall performance of a gear is estimated from fish catch data alone.

There are many problems in the design and execution of fishing gear experiments which make it difficult to produce satisfactory and repeatable results. Mostly these problems have to do with the severe and variable environment in which fishing gear works, and the carefully controlled conditions under which experiments can be done in a laboratory are far removed from the circumstances that prevail on a fishing vessel at sea. Nevertheless, the important point is that fishing gear technologists should be aware of the limitations of available techniques so that the significance of their results can be readily understood. It is considered that the recommendations set out here, if carefully followed should help to achieve this aim.

The term 'fishing gear experiment' covers an extremely wide range of activities, not only because there are many different types of gear - trawls, seines, set nets and lines to mention only four - but also because the sophistication of gear work varies so much. On the one hand, there is the simple test which aims to establish that some standard gear is a satisfactory fishing tool in a particular application, although such basic work can produce valuable results notwithstanding

its simplicity. At the other extreme, there is the advanced research into gear performance which requires large investment in complex instrumentation and computing equipment. Nevertheless, the same principles can be applied to all work of an investigatory nature, the first principle being that the work should be planned and executed in a logical manner.

2. OBJECTIVES OF FISHING GEAR EXPERIMENTS

It is essential from the very start of a programme to have a clear idea about the objectives of the work to be done. The objectives must be selected bearing in mind what facilities are available, vessels and instrumentation for example, and their limitations. It is no use hoping to measure small differences between two gears if the available instrumentation is too inaccurate, when the only result will be failure. It is unwise to be too ambitious.

There is an extensive literature on how objectives should be selected and achieved through the effective management of projects, see for example Drucker 1964 and Mali 1972. The technique of "management by objectives" is of course largely concerned with industrial production, but the principles are applicable in research or indeed in any activity which involves the coordination of people and facilities in working towards a common goal.

The purpose of fishing gear research is to improve the economics of fishing and working conditions such as the safety of fishing operations. The economic return from a fishery, in so far as it is determined by the gear depends on:-

1. the quantity, quality and composition of fish catches
2. the cost of gear
3. the running cost of vessels and labour.

Any fishing gear experiment will be directed towards improvements in one or more of the above criteria. The objectives are explicit statements about what is to be achieved. They should be prepared at an early stage and communicated to all concerned so that there can be no misunderstanding about what is required as the work proceeds.

It is necessary to distinguish between the detailed objectives for a particular experiment and the broader policy aims for the parent project of which one experiment is only a part. The aims applying to fishing gear research and development will generally include one or more of the following:-

- A. to reduce operating costs
- B. to exploit underutilised resources
- C. to increase the catch per unit effort
- D. to improve the management of fisheries
- E. to improve the safety of fishing operations
- F. to overcome problems due to man's other activities in the sea.

On the other hand, the objectives for an experiment should provide a more detailed description of what is required, notwithstanding the contribution of the experiment to one of the above aims, for example:-

- (a) to compare the spreads achieved by door types A and B when fished with the same net and sweeps.
- (b) to observe the operation of a bottom set gill net, particularly the dependence of inclination angle on tidal flow and floatation.
- (c) to determine whether gear C can be worked effectively by vessel type X on fishing ground F.
- (d) to investigate the effect of floatation and rigging changes on the mouth opening area of trawl D.

A further distinction can be made between fundamental and applied objectives. The former are concerned with fundamental research which aims to understand the factors governing the performance of gear, providing essential information which can subsequently be applied in commercial gear development. For example, the study of net drag and how it relates to mesh and twine sizes is fundamental work which does not of itself result in new commercial gears. However, new principles and methods of calculation resulting from such work may be applied in the design and development of better gears for fishermen to use. On the other hand, any project which aims to produce an improved gear for an existing fishery, or to introduce an existing gear into a new fishery, has applied objectives.

3. PREPARATORY WORK

3.1 Design of experiments

A number of tasks must be done before experimental work can begin. First, some thought should be given to the design of the experiment in order to fulfil the objectives. In the case of simpler experiments, this requires no more than a logical approach and a knowledge of technique limitations. However, when precise data near the limit of measurement accuracy are required, it is necessary to consider a statistical design which will indicate the number and arrangement of tests for adequate precision. Advice on this matter will be found in Anderson and McLean 1974.

3.2 Programmes

A programme for the experiments should be prepared. Sometimes it will be possible to make a complete plan. In the case of flume tank experiments for example, it is not difficult to anticipate the time required for a series of measurements. However, there will often be an element of uncertainty, in particular the uncertain weather at sea, which makes it difficult to forecast how the work will progress. Nevertheless, it is important to start work with a definite programme in mind which can if necessary be modified as the work proceeds. The programme should be communicated preferably in writing to all personnel engaged on the experiment.

Some institutes require a standard form of programme to be issued for the work on research and commercial fishing vessels. A hypothetical programme in the form used by the Marine Laboratory, Aberdeen, is shown in Appendix A. It is recommended that a brief programme along these lines should be issued prior to all work involving vessels, since the cooperation of skipper and crew is essential for success and they may not be familiar with scientific aspects of the work. Of course, it may still be appropriate to prepare a second more detailed work programme for the benefit of scientific personnel.

The programme should include plans for the calibration of instruments (see section 6). It may be convenient to do some of the calibration work before the beginning of the experiment itself.

3.3 Logistics

A list of the gear, instrumentation, spares and other items required for the experiment should be prepared to facilitate the equipment being in the right place at the right time. It is most inconvenient to discover after the ship has sailed that some important item has been left behind.

Essential background information must be collected unless it is already to hand, for example tidal data for a proposed working area, details of the vessel and gear handling arrangements.

Drawings should be prepared of the gear to be tested and any special apparatus. It is particularly important that the skipper who has to work the gear should be provided with drawings of the gear and rigging. To be easily understood by the recipient, these drawings should be prepared according to local practice which will not necessarily be in the same form as gear illustrations prepared for a report (see section 7).

Tabulation sheets should be produced in sufficient quantity for the number of tests. These are forms on which data and observations are recorded in the course of the experiment. The design of tabulation sheets and some examples are discussed in section 5.

4. EXPERIMENTAL TECHNIQUES

4.1 Model tests

The purpose of experimenting with a model rather than with a full-scale gear is to obtain results more quickly and/or at lower cost. The model is constructed in such a way that the mechanical performance of the full-scale gear is imitated so that, from measurements on the model and a knowledge of the scaling laws, the performance of the real gear can be predicted.

In general, however, any practical model will not faithfully reproduce all the mechanical features of the real gear. For example, the scale factor for buoyancy forces may not be the same as that for friction forces. Thus it is important that measurements on models should only be used to predict those aspects of full-scale gear performance for which the scaling laws are well understood. Further information about scaling problems will be found in Dickson (1961) and Fridman (1973).

A simple method of visualising the working shape of a net is to construct a three-dimensional model from paper cut-outs representing the netting panels. Each panel is drawn on paper at a scale proportional to the horizontal and longitudinal stretched netting lengths, then the cut-outs are joined together as indicated by the net plan. Such a model cannot be used for precise measurements, but it can be a useful tool in thinking about different net designs and the planning of experiments.

Working models of complete gears or parts of gears may be tested in a wind tunnel, in a water flume or towed in a water tank. Indeed, large scale models may be operated from a small boat in open water. Errors in extrapolating from model results to the full-scale increase as the scale is reduced. Thus models should be constructed at the largest practical scale having regard to the available test facilities.

The relative motion of water and gear can be simulated by using a model in water or in air. In either case, it is necessary to consider the scaling of linear dimensions such as mesh size or otterboard length and the scaling of velocity in order to obtain the correct scaling of the forces acting on the model and the full-scale version.

It is difficult but not impossible to construct a model whose linear dimensions are all scaled by exactly the same factor say S . In the case of components such as otterboards, exact geometric scaling is simply a matter of careful engineering. In the case of nets, however, the sheet netting available from manufacturers will probably not have the exact twine diameter and/or mesh size required for the model scale. The normal practice in net modelling is to ensure that the twine area and the total surface area of each panel are scaled correctly. The following procedure may be adopted. Suppose that the scale of the complete model is to be S but that the nearest available model twine size is t^m for a full-scale twine size t . The actual scale of the model twine is therefore $S_t = (t/t^m)$ which will not equal S . To obtain the correct model dimensions for each panel, mesh size is also scaled by the factor S_t but the numbers of meshes along and across the panel are scaled by the factor (S/S_t) . Experiment has shown that the overall geometry of such a model can be a good representation of the full-scale net, but it must be accepted that features such as small areas of slackness in the netting, covering only a few meshes, may be quite different in the model.

The principal forces acting upon a gear are (1) static forces such as weight and buoyancy, (2) dynamic forces, notably the pressure drag or lift which is associated with the acceleration of fluid around a solid object and (3) friction forces. The latter include viscous forces in the fluid flowing across solid surfaces and, in the case of gears moving over the seabed, ground friction also.

The fluid velocity applied to the model is chosen to give the correct scaling factor for the most important forces. However, it is not possible to scale correctly and simultaneously all three types of forces. The ratio of dynamic to fluid friction forces is determined by the Reynolds Number:-

$$R = V l / \nu$$

While the ratio of dynamic to static forces (Froude Number) is determined by:-

$$F = V / \sqrt{g l}$$

Here V is the fluid velocity, l is a characteristic dimension of the body in question, ν is the kinematic viscosity and g is the acceleration due to gravity. Thus if R is the same for both model and full-scale, the dynamic and friction forces will be scaled correctly. And if F is the same, the dynamic and static forces will be scaled correctly, but there is no model velocity at which R and F are both the same as the full-scale values. Scaling by Reynolds Number requires the velocity in the model tests to be higher than at full-scale. Scaling by Froude Number requires the velocity to be lower.

Of course, certain forces may not be relevant to a particular model test or it may be known that some forces are negligible. The choice of whether the Reynolds or the Froude Numbers should be made the same between model and full-scale will depend upon which forces are significant in a particular experiment.

For example, measurements of drag and lift forces on model otterboards should be done at the correct Reynolds Number. The dynamic and friction forces determine drag and lift at a given attitude, while the otterboard weight (a static force) is not relevant. Thus the Froude Number is not important in this application. There is however, only a narrow range of Reynolds Numbers from 6×10^5 to 6×10^6 in which the force coefficients are independent of Reynolds Number (Walderhaug and Akre 1963). Tests should always be undertaken within this range.

On the other hand, experiments with nets are normally done at the correct Froude Number. In this case, the static forces such as buoyancy cannot be ignored, and their ratio to the fluid dynamic forces will clearly influence the shape taken up by a model net. It is generally assumed that the friction forces will not detract from the model performance provided the Reynolds Numbers (based on twine diameter) of both the model and full-scale nets are within the range 1,000 to 200,000. Within this range, the drag coefficients of spheres and circular cylinders are independent of the Reynolds Number.

Models of complete trawls are also usually tested at the correct Froude Number in order to reproduce the correct net shape. However, a probable consequence is that the Reynolds Number of the model otterboards will be less than 6×10^5 (see above) so that the otterboard forces will not be correctly scaled.

4.2 Full-scale tests

Experiments with full-scale gears are done on research ships or commercial fishing vessels. In either case, a suitable size of gear and rigging arrangements must be selected to match the power and facilities of the vessel in question. Of course it is recognised that some experiments may have the objective to compare different sizes of gear, but too great a mis-match between gear and vessel, or between gear components (eg doors and net), will not give satisfactory results. The gear should be designed having regard to significant features of the vessel, for example a stern trawler normally requires a different pennant arrangement and codend dimensions compared with a side trawler.

With the exception of work on certain research vessels, it is essential that the net construction should conform to the mesh size regulations for the relevant area and type of fishery. If there are special reasons for conducting an experiment on a commercial vessel with a net that would be illegal in commercial fishing, a permit for the work must first be obtained from the appropriate authorities.

The choice of whether full-scale tests should be done on research or commercial vessels may depend on what ships are available, or on financial considerations, but when the experimental programme is the main criterion the following points are relevant:-

1. Research vessels have facilities not normally available on fishing vessels, eg laboratories and advanced instrumentation.
2. Commercial vessels are designed for fishing and for no other role. Their crews have specialised knowledge of at least one commercial fishery.

Experiments with full-scale gear are essential at some stage in the development of any new gear for commercial fishing. Model tests alone are not enough, although they can play a vital part in the earlier stages of development.

4.3 Instrumentation for full-scale tests

While some measurements can only be made with equipment taken onboard for the purpose, the standard navigational and other instruments commonly found on fishing vessels can be put to good use by the experimenter. Most vessels have a vertical echosounder to detect fish and to measure the water depth. More advanced acoustic equipment such as searchlight sonar or a netsonde may be available which can provide geometric data (eg net depth).

Navigational aids such as Decca, Loran, Omega or perhaps a satellite navigator may be available. The ships speed relative to the ground can be determined from periodic position fixes, although the accuracy of this calculation may be poor due to random error in each fix. In shallow water, a Doppler speed log can provide very accurate ground speed measurements.

The ships speed relative to the water may be measured by other types of installed log, propellor or electromagnetic. The latter type is the more accurate since propellers are liable to fouling which can cause large errors.

Over the past two decades many instruments have been developed with which a wide range of gear parameters can be measured - loads in wires, distances on the gear, attitude angles of doors and so forth. Some of this equipment can be purchased from manufacturers, mainly items with an application in commercial fishing such as netsondes, but the more specialised instruments developed by research institutes are often not marketed because the potential sales are insufficient to justify commercial production. However, most institutes are willing to make arrangements for small production runs, although the cost for small quantities can be rather high. It should also be emphasised that the assistance of experienced technicians is essential when using advanced instrumentation.

4.4 Tide corrections

In the case of gears towed in the sea, whatever speed measurements are obtained from shipboard instruments, there is a difficulty in that the measured speed may

not be the same as the gear speed relative to water at the gear depth, due to the tide or other water currents. In some areas the tide may be known to be negligible, but otherwise the measured speeds must be corrected. This can be done using the reciprocal tow method which works as follows. The vessel tows first in one direction, preferably a direction with or against the tide. While maintaining this fixed heading, measurements are made under the various test conditions eg different engine power settings. The vessel then turns through 180° and tows on the reciprocal course when the measurements are repeated. Thus for each test condition, measurements have been obtained while towing both with and against the tide. It is then possible to calculate the tide as described in section 6.

It is recommended that the reciprocal tow method should be used in all towed gear experiments where precise speed measurements are important, unless (a) the speed of the gear relative to the water is measured directly (b) accurate tide information is available from other sources, or (c) it is known that the tide is negligible.

5. DATA ACQUISITION AND MANAGEMENT

5.1 Classification of data

This section is concerned with the information collected during an experiment. The information will consist of numerical data for the most part, but it also includes written records such as notes about gear damage, indeed any kind of fact that constitutes an experimental result.

It is important to record all relevant information at the time of the experiment. Memories fade quickly, and it may be too late to fill in gaps at a later time.

Data can be classified into three groups as described below:-

1. Information about how, where and when the experiment was conducted. A log should be maintained in which the following information is recorded:-
 - date and time (start, end and intermediate times as required)
 - ship name and haul or test reference number. This is often abbreviated to a single letter (ship reference), two digits (year), and a third digit (haul reference). Thus T79/6 means haul 6 on TRIDENS in 1979. ALL records should be labelled with the same reference code.
 - where the experiment was conducted
 - environmental data eg ships' course, wind speed and direction, sea state
 - list of instruments used, including for each an identification number, where it was used, start and stop times, remarks on how it functioned
 - any observations that may affect the validity of the experiment eg gear damage
 - details of the gear used, particularly changes made since the previous test or haul

- anything else the log book keeper can think of. In this instance, it is better to write too much than too little.

This log is often called the 'rig book'. An example is shown in Appendix B.

2. Data recorded from instruments. Some instruments produce permanent records, the echosounder being the most common example, while others display ephemeral information on dials. The latter must be written down at the time using tabulation sheets as discussed below. Permanent records need not be read immediately, but it is of the utmost importance that all records should be annotated with correct times. This is essential to allow different records to be correlated during the subsequent analysis.
3. Data in the form of notes. These might include:-
 - the polish on door keels, chains or bridles, indicating contact with the ground
 - gear damage
 - details of the catch
 - signs of fish being meshed in the net which might indicate that the meshes were not completely open.

This information will be recorded in the rig book or in tabulation sheets.

A tabulation sheet is simply a form containing a number of headings and spaces in which information is recorded. The use of such forms makes it easier to ensure that important items are not forgotten. Some examples are shown in Appendix C.

All experiments will produce data in group (1) which constitute the essential record of what was done. The quantity of group (2) and group (3) data will depend on the type and complexity of the experiment. The larger the quantity of data, the greater is the need to organise an effective system of data management. It is essential to record sufficient information to show without ambiguity what the data are and how they are cross-referenced.

Most of the emphasis in this section is on experiments at sea where data management problems are perhaps more severe, but of course the same principles apply to all experiments.

5.2 General guidelines

All data must be indexed (usually by times such as the beginning and end of actual measurements) in order to relate different measurements to one another. Instrument traces must be identified by indelible marking. Where several people are engaged in recording different measurements, they must synchronise watches or note the time from the same clock.

Instruments may fail to work during an experiment. If the instrument is a remote self recording device such as a tension meter on the gear, a failure may not be discovered until the end of the test. It is therefore advisable to produce redundant information for key parameters. For example, tension meters can be used simultaneously at the upper and lower ends of a warp, and

if one of these should fail some information on warp loads will still be available. In this way there is less chance that information from instruments that did work will be wasted owing to the failure of others.

Measurements can be taken at one instant in time (spot readings) or as an average over a period of time. It is necessary to think carefully about the kind of measurements that will be most useful. Even spot readings from a dial are in effect averaged over a short period of time since the instrument will not respond to very rapid fluctuations. Thus the real question to be considered is: over what period of time should measurements be averaged to eliminate variations that are irrelevant to the experiment in question? Unwanted variation of data can arise first because there are real changes in the parameter being measured and secondly due to random errors introduced by the instrument or measurement. In fishing gear experiments, it is usually the former source of variation which causes the greater problem, and some experience is necessary to judge the best way of taking measurements.

Consider trawling experiments as an example. These are often done by changing the engine power in steps, at each step keeping the engine power and course the same for a period of time normally between 10 and 20 minutes. The problem is to decide what measurements are appropriate to these steady state conditions. The gear parameters will change rapidly at the beginning of each period and they will tend towards the required steady values. In practice, however, towing conditions are never precisely steady. The wind and tide may change and, in bottom trawling, variable forces arise from the uneven nature of the ground. Assuming that these variations are not themselves the subject of study they must be averaged out. This is done by selecting a time interval (usually 5 minutes or so) at the end of each 'steady state' period, and all measurements are taken as averages over this time interval. It is of course essential that the same interval for averaging is applied to all data.

When calibrations are applied to measured data, it is good practice to record both the primary information (eg number of divisions on a chart) and the calibrated value. This will make it easier to apply a revised calibration should that subsequently be found necessary.

The zero reading of some instruments is liable to change. If this is possible, zero readings should be taken at least at the beginning and end of a haul. Readings should be taken relative to the most appropriate zero. If a large zero change is noted, perhaps caused by mechanical shock, the instrument must be recalibrated (see section 6.2).

Some instruments are provided with other means of checking performance, such as a "calibration check" facility which injects a known input signal. Again, checks of this kind must be done at regular intervals and adjustments made to obtain the correct response to the known input signal.

5.3 Quality of data

Some data are more useful than others, and it is a waste of time recording completely useless data. They merely divert attention from more important matters. If it becomes obvious that an instrument is giving misleading information, ignore it.

The quality of data is influenced by the care taken in recording as well as the performance of instruments. Some general remarks can be made about data derived from different types of instrument:-

- visual recordings (eg from a dial): it is vital that the correct reading should be logged at the time, mistakes cannot be rectified afterwards. The quality of such data will be poor if the random variation is a significant proportion of the average. Dial readings of towing loads are generally not useful unless the instrument has been designed to integrate readings over a reasonable period of time.
- permanent records on the ship (eg paper charts): these include for example warp tension and echosounder records. Instruments on the gear transmitting information to recorders on the ship by means of cables or acoustic links are particularly useful. They provide the experimenter with information as to whether the gear is working correctly so that remedial action can be taken if necessary. On the other hand, it has to be considered whether attaching long cables to a gear will alter the performance compared to what it would have been in the absence of such attachments.
- remote recording instruments (eg tension meters on the gear): this type of instrument requires no connecting cables on the gear, but an important disadvantage is the time delay between the recording and the results being received onboard the ship. Thus a malfunction of the instrument will only be discovered after the experiment. It is generally true that instruments attached to the gear are liable to more failures than those on board the ship, due to the severe environment in which the former have to work. On the other hand, some parameters can be measured only by attaching instruments to the gear.

Sometimes there is ambiguity in instrument recordings and unless this can be resolved with reasonable confidence the data will not be useful. For example, an echosounder recording may show two traces one of which is the desired measurement and the other arises from a spurious reflection. It may be possible by comparison with other results to select the correct trace. If not, the recording should be ignored.

When data are recorded on tabulation sheets but there is some doubt about reliability, it is good practice to indicate this by adding a question mark or some other symbol.

5.4 Storage of data

The primary data, instrument traces and so on, relating to one test should be collected together in the same folder as soon as possible, and certainly no later than the end of the day's work. Data scattered around several locations can all too easily disappear. Tabulation sheets of trace readings and calculations can later be added to this collection.

After the analysis work has been completed, the primary data (including calibration details) and the final results from analysis should be stored in a safe place. It is not essential to keep the results of intermediate working since they can, if necessary, be regenerated from the primary data.

Some institutes have adopted standard procedures for the storage of data. These schemes are normally based on standard forms on which the data are recorded. Then these forms are themselves stored, or alternatively they are used to store the data in a computer file. These computer-based 'data banks' greatly facilitate the handling of data. They enable calibration corrections to be done quickly and of course computers are essential for many of the complicated calculations done in modern analysis procedures.

6. DATA ANALYSIS

6.1 General

The primary data have to be studied and various calculations performed in order to arrive at the final results of the experiment. This work comprises the analysis. It begins with the conversion of instrument readings into the required units (calibration). Then parameters not measured directly may be calculated. The measured and calculated data must be presented in a suitable form and interpreted. For example, graphs and tables can be prepared, and statistical tests can be used to indicate the significance of differences between one set of data and another (a data set might comprise all the measurements on one gear, for example).

While full analysis of the data may take a long time, simple checks should be made during the experiment or shortly thereafter, to detect peculiarities which may indicate that something is wrong. For example, the headline height reading from a netsonde can be compared with the expected value or that from a previous haul. If the headline height is unexpectedly low, the net or sweep wires may be foul. The cause should be investigated at once, to avoid wasting time collecting invalid data.

6.2 Calibration of instruments

Data from instruments which produce an analogue reading need to be converted to the units in which the measurement is required. In the case of a tension meter for example, the output is read as divisions on a paper trace and this must be converted to the load in tonnes. The analogue reading produced by an instrument under a given load is likely to change due to damage, old age or overhaul.

A calibration is a careful test to determine the levels of analogue reading produced by a series of precisely known outputs (parameter values). These precise inputs are measured by a special standard instrument of high accuracy used only for calibrations. The calibration procedure should be decided by the expected performance of the instrument or measurement technique, particularly the accuracy and constancy of readings at a given input.

The underwater tension meters currently used on fishing gear have been found to require the most thorough calibration. The following remarks refer mainly to these instruments by way of example. It is essential that the instruments are calibrated regularly using a standard procedure. The series of loads should cover the full range of the instrument and should include an equal number of points when the load is increasing and decreasing. As far as possible the calibration should be performed under the conditions in which the instrument will operate as its performance may change with temperature and pressure and, in the case of acoustic instruments, with salinity also.

The most convenient method of presenting a calibration is on a graph (Figure 1). A quadratic or linear regression, depending on the expected linearity of the instrument, should be calculated and the regression line plotted on the graph. This line is subsequently used in reading off load values against the number of divisions. An explanation of regression calculations will be found in any statistical text book, for example Weatherburn (1961).

Before using the calibration graph, it is advisable to check that none of the following features are present, as otherwise the calibration is suspect.

- i) outlying points - usually due to human error
- ii) excessive non-linearity. At the full-scale reading the quadratic terms (Ax^2) should not be greater than 15% of the load. Here x is the number of divisions and ($Ax^2 + Bx + C$) is the quadratic regression curve - see Figure 1.
- iii) large hysteresis when the points for increasing load do not coincide with those for decreasing load
- iv) a residual R less than 0.996 which indicates that the scatter of points is not acceptable
- v) inconsistency with previous calibrations. If at the full-scale or half full-scale reading the two calibrations give values which differ by more than 4% then the reason for the change should be sought. If there is no apparent reason, the calibration should be repeated.

The calibration shown in Figure 1 is less than satisfactory. It exhibits all the features (ii), (iii) and (iv).

The details of each calibration performed on an instrument should be recorded in a catalogue to allow easy comparison between calibrations and to check the long term performance of the instrument.

Calibration should normally be done at least before and after a series of experiments. If successive calibrations are found to be significantly different, care must be taken to identify when the change occurred and the appropriate calibration used on each occasion the instrument is used.

If the cause of a change (like a shock load on an instrument) cannot be found, and therefore the two calibrations must be regarded as equally valid, the calibration nearest in time to each set of measurements should be used rather than the average of both calibrations.

6.3 Derivation of parameters which are not measured

One of the most important measurements in any fishing gear experiment is the relative speed between the gear and the surrounding water.

This is particularly true in trawl gear experiments when it is often more convenient to measure ship speed relative to water rather than gear speed, the parameter which determines gear performance. There may be a large difference between ship and gear speed relative to water because of the presence of tides or currents. However, the reciprocal tow method described in section 4.4 can provide the data required to calculate the correct gear speed.

The reciprocal tow method is based on the observation that the dominant variation of some commonly measured parameters correlates well with the speed relative to water. Such parameters are wire tensions at the net or otterboards, headline height and, for pelagic gears, otterboard and net depth. A graph of one of these parameters against measured ship speed will show a separation of the results for the first and second tow directions. If there is an approximately constant tide

or current then a best fit pair of parallel lines can be drawn through the data for the two tow directions. Half the distance between these two lines, measured in the direction of the speed axis, gives the magnitude of the tide or current (Figure 2).

The assumption that the tide or current is constant may be invalid since a haul can take up to three hours to complete. More complex calculations assuming sinusoidal variations in tide strength may be made.

Some features of a gear may be estimated by simple methods which do not require sophisticated instrumentation and computers. A description of such techniques and methods of calculation will be found in FAO 1981.

If sufficient data are available for a given experiment, more complex calculations may be done to determine the major performance parameters of the fishing gear. The book by Fridman (1973) contains a comprehensive description of the theoretical basis for fishing gear calculations.

Figure 3 tabulates a selection of parameters describing the performance of trawl gear and Danish seines and gives the measurements required to calculate them. It is assumed that information on the dimensions and weight of the gear components is available. Other assumptions may be necessary, for instance the values of wire hydrodynamic coefficients and the effect of ground contact.

The precise calculation of many parameters is only possible on a digital computer. The equations are too complicated for manual calculation unless severe approximations are introduced. When computer facilities are available, it is normally convenient to store data on magnetic tape or another medium accessible by the computer, perhaps in a data bank as described in section 5.4. It then becomes possible to run different calculation programs and to prepare tables and graphs (if a graph plotter is part of the computer system) with great speed. An example of the comprehensive output which can be produced is shown in Figure 4.

It is important to remember that computer output is not infallible. Mistakes can arise, largely it is true from faults in programming or typing errors. Small errors in results can go unnoticed if there is too much reliance on automatic computing without adequate safeguards. It is good practice to verify a sample of the results, perhaps by performing a particular calculation whose result is known. Another recommended procedure is to include sum checks with data accessed by a computer. These are sums of columns or rows of data and a simple program can check that the sums agree with the data received. This procedure will detect almost all typing errors.

7. PREPARATION OF REPORTS

The purpose of producing a report is to inform others of the work done and the results achieved. Thus it is essential while writing a report to bear in mind who will read it. The report may be intended for scientists, for practical fishermen, or indeed for some other group with different interests and background knowledge. The style of the report and the information to be included should be based on the type of presentation likely to be most acceptable to the intended readership.

A good starting point is to list section headings, together with brief notes outlining the contents of each section. In this way the complete framework of the report can be constructed as a first step which will show how each section relates to the whole, and the writing of each part is made much easier. It is generally convenient to prepare figures and tables before writing the text.

It is most desirable that a standard form of presentation should be used in reporting the results of fishing gear experiments, so that workers can communicate their results in a manner that will be easily understood by others. Of course, the form of presentation will sometimes be governed by the rules of publishers and editors, particularly in the case of papers for publication in scientific and technical journals, but such rules are intended to ensure uniform standards and comprehensive reporting. Indeed, useful advice on this matter can be found in the written guidance for authors which many journals provide on request.

The rules applying to good quality scientific papers are perhaps more rigorous than those applying to other kinds of publication, but it certainly does no harm and it is recommended that authors should strive to maintain the highest standards in all their reporting. Sound advice on the art of scientific writing will be found in Porter (1961) and in a useful booklet produced by the Royal Society (1974).

It is recommended that the SI system of units should be used in the presentation of data and experimental results. Where there are strong reasons for using other units, the units must be clearly stated and the SI equivalent should also be quoted. However, on account of common usage, it is acceptable to express speed in knots ($1 \text{ knot} = 0.514 \text{ ms}^{-1}$) and distances travelled in nautical miles ($1 \text{ nm} = 1.852 \text{ m}$). It is preferred that towing loads should be expressed in tonnes ($1 \text{ tonne} = 9.807 \text{ N}$) or in kgf ($1 \text{ kgf} = 9.807 \text{ N}$), since the Newton is rather a small unit for many practical purposes.

A particular difficulty may confront the author who has to produce a report not in his mother tongue. Care must be exercised in translation, particularly of technical terms, and some useful references are included in the bibliography.

The report must include a description of the gear, vessels and other facilities used in the experiment. It is not necessary that every minor detail should be included explicitly, but sufficient information should be provided so that the reader can find out, from other sources if necessary, exactly how the work was done and what was used. References can be given to prior publications containing additional information which need not then be repeated.

The vessel description must include the name, vessel type and main specifications such as engine power. When much additional detail is to be included, this can be presented conveniently in an Appendix to the main report. Figures may be used to illustrate the deck layout, ancillary equipment and gear handling methods. It is recommended that all vessel descriptions should accord with an internationally recognised procedure, such as that adapted by the FAO, EUROSTAT or ICNAF (NAFO).

The gear description must include an engineering drawing containing all the information required for construction and rigging (unless this is precluded for reasons of confidentiality). It is recommended that the drawing rules adopted for the FAO fishing gear catalogues (FAO 1972 and 1975) should be used. These have been summarised in Appendix D. Should there be reasons for using other drawing rules and symbols, they must be defined and the equivalent FAO symbols quoted.

The gear description prepared for the report should not be confused with the working drawings mentioned in section 3. The latter should conform with local practice to promote good communication with fishermen and gear manufacturers.

The following scheme is recommended as a logical sequence of headings which cover the essential items of a report on fishing gear experiments.

1. Title of the report, names and affiliations of authors.
2. Abstract or summary. This item is most important since it is the only part of the report that some people will read. It will consist of a brief concise statement of the work done and the results achieved.
3. Equipment. A description of the gear, vessels, instrumentation and other test facilities should be provided. The gear tested should be illustrated in accordance with the rules described in Appendix D of this report.
4. Experimental techniques. This section will describe how, where and when the tests were carried out, including notes on limitations presented by the environment (eg weather, availability of fish) and by the instrumentation or other facilities.
5. Results. This section is the heart of the report. The results may be presented as tabulated data or as graphs. Alternatively, if the numerical results are few, they may be incorporated in the text. When computed results as opposed to directly measured data are presented, a description of the analysis methods should be provided.
6. Conclusions. This section should begin with a brief statement of the conclusions reached as a result of the experiments. It is useful to state the limitations of and the confidence in the results obtained, leading to a discussion of the need for further work to be done. Longer term aims such as the application of the work in commercial fishing should also be covered.
7. References. Whenever previous work or publications are mentioned in the report, a reference to the source should be made and a list of all such references collected in this section. One of the standard methods for describing references must be used, as described in Royal Society (1974).

8. REFERENCES

- | | | |
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ISO	1973c	Fishing nets - hanging of netting - basic terms of definitions. Standard No. 1531.
ISO	1973d	Fishing nets - cutting knotted netting to shape ("tapering"). Standard No. 1532.
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ISO	1973f	Fishing nets - determination of mesh breaking load of netting. Standard No. 1806.
ISO	1974	Fishing nets - netting - basic terms and definitions. Standard No. 1107.
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<u>In press</u>		
FAO	1981	Calculations for fishing gear design. FAO Fishing Manual, FAO, Rome.
FAO	1981	Fisherman's pocket handbook. FAO, Rome.

TABLE 1

Participants at the principal ICES meetings concerned with the production of this report

HAMBURG, 1977

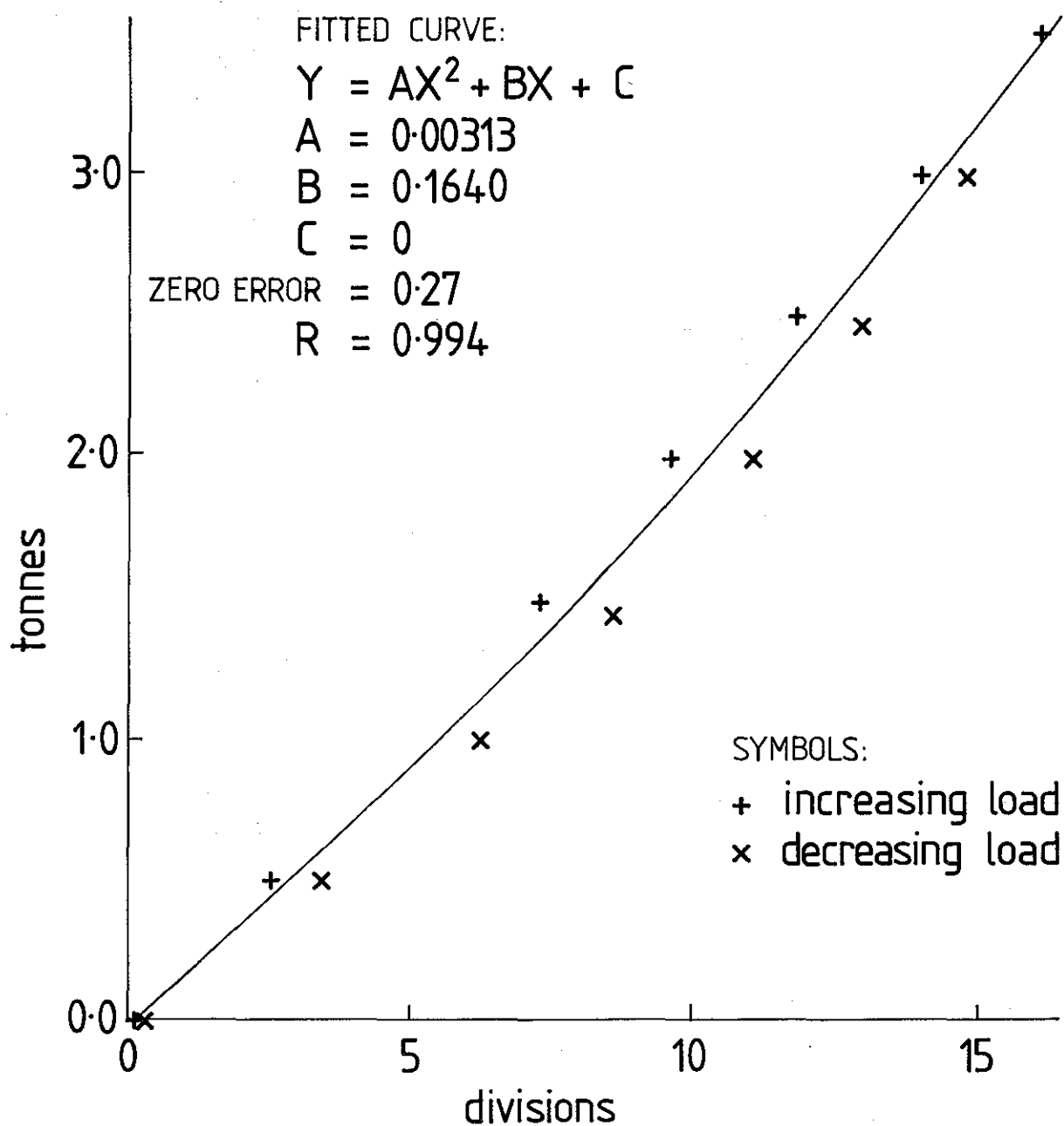
Convenor	J J Foster	UK
Rapporteur	H von Seydlitz	Federal Republic of Germany
	J Carrothers	Canada
	D N MacLennan	UK
	B van Marlen	Netherlands
	C Nedelec	FAO
	J Prado	France

GOTHENBURG, 1979

Convenor	D N MacLennan	UK
Rapporteur	B van Marlen	Netherlands
	J Brabant	France
	H B Becker	Netherlands
	J Carrothers	Canada
	A L Fridman	USSR
	C Nedelec	FAO
	J Prado	France
	H von Seydlitz	FRG

ABERDEEN, 1980

Convenor	D N MacLennan	UK
Rapporteur	-	-
	R Ferro	UK
	G V Goosev	USSR
	B van Marlen	Netherlands
	C Nedelec	FAO
	E M Postnikov	USSR
	J Prado	France
	H von Seydlitz	Federal Republic of Germany



LOAD CELL No. 32

CALIBRATION OF 2. 10. 79.

Figure 1. Example of calibration measurements fitted by a quadratic curve.

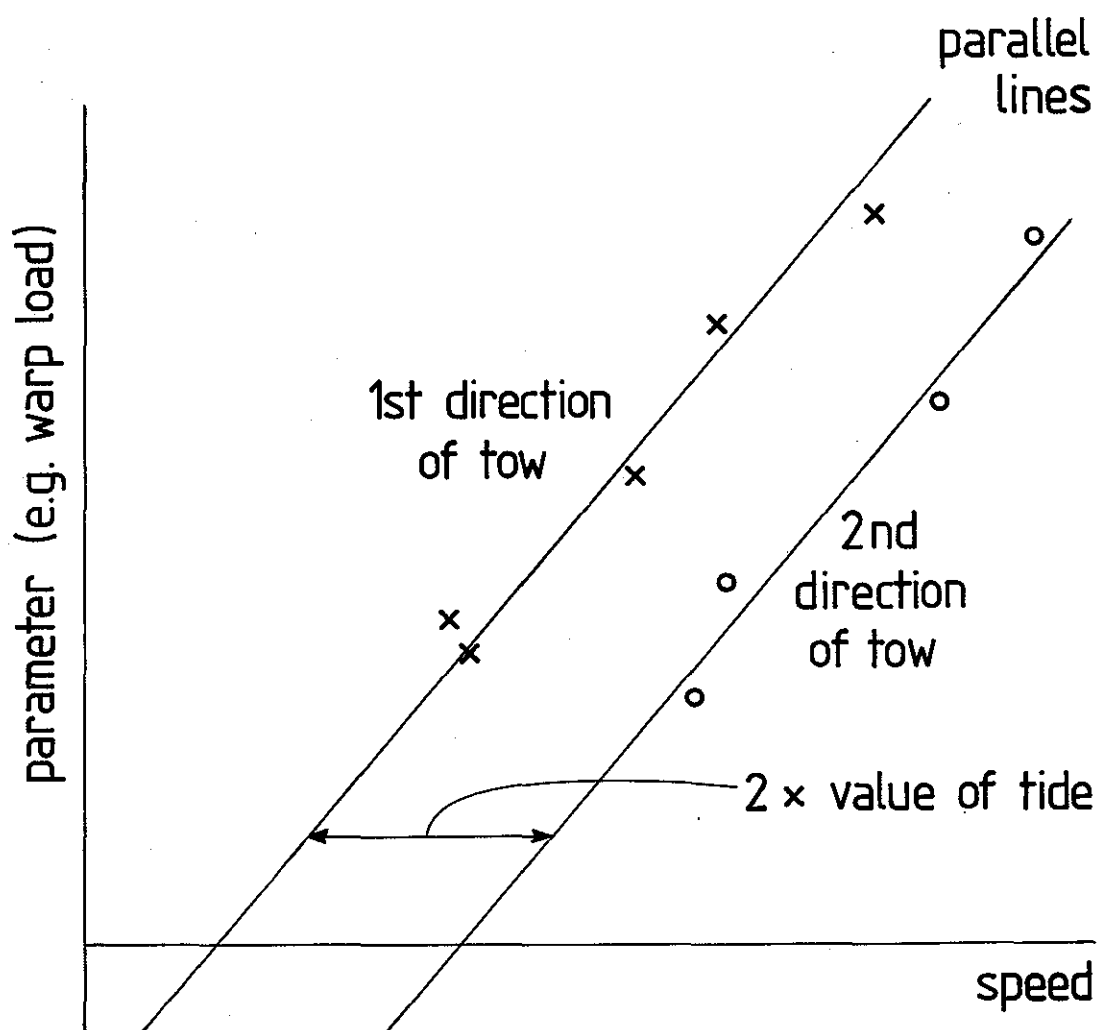


Figure 2. Calculation of the tide correction using the reciprocal tow method.

DATA REQUIRED:

FOR THE CALCULATION OF:

(1) TRAWL GEAR

WARP DIVERGENCE OR DOOR SPREAD AND)	GEAR DRAW, GEAR TOWING POWER, WARP
WARP TENSION AT SHIP OR DOOR AND)	SHAPE, DOOR POSITION OR WARP LIFT
DOOR DEPTH OR WARP DECLINATION AND)	FORCE
TOWING SPEED)	

DOOR SPREAD AND NET SPREAD)	BRIDLE ATTACK ANGLE
------------------------------	---------------------

DOOR DEPTH AND WINGEND DEPTH AND)	BRIDLE INCLINATION ANGLE
HEADLINE HEIGHT (*))	

BRIDLE TENSIONS AND ANGLES)	NET DRAG AND SPREADING FORCE
------------------------------	------------------------------

WARP TENSIONS AND ANGLES AT THE)	DOOR DRAG AND SPREADING FORCE
DOOR)	

(2) DANISH SEINE NET

TOWING SPEED AND ROPE SPEED AND)	ROPE SHAPE, GEAR DRAG, GEAR
ROPE TENSION AT SHIP OR NET AND)	TOWING POWER, NET POSITION,
NET SPREAD OR ROPE DIVERGENCE)	SWEPT AREA, NET DRAG OR
AND ROPE DECLINATION AT SHIP)	NET SPREADING FORCE

* INSUFFICIENT FOR RIGS WITH A LOWER BRIDLE WEIGHT FORWARD OF THE WINGEND. IN THAT CASE A TENSION MEASUREMENT, FORE OR AFT OF THE WEIGHT, IS REQUIRED IN ADDITION.

Figure 3. Data required to calculate certain features of trawl gears and seine nets.

Figure 4. Example of the output produced by an analysis program

HAUL NUMBER : 579.67

RUN ON 25-Sep-79

GEOMETRY

BLOCK NO.	SHIP SPEED (KN)	WARP LENGTH (M)	WARP ANGLES			WATER DEPTH (M)	DOOR SPREAD (M)	WINGEND SPREAD (M)	BRIDLE ANGLE (DEG)	HEADLINE HEIGHT (M)
			DIV (DEG)	DEC(S) (DEG)	DEC(P) (DEG)					
1	3.49	366	6.99	21.70	22.60	98.0	58.8	24.8	11.3	5.88
2	3.94	366	6.74	20.40	21.50	96.0	57.4	25.1	10.7	5.55
3	3.81	366	6.84	23.10	24.10	98.0	57.3	25.7	10.5	6.31
4	3.41	366	5.86	21.80	23.20	98.0	50.9	23.4	9.1	6.49
5	3.20	366	7.37	22.00	22.20	96.0	60.3	25.7	11.5	5.55
6	3.37	366	6.99	22.00	22.70	101.0	57.9	25.1	10.9	5.79

FORCES

BLOCK NO.	SHIP SPEED (KN)	RPM	STBD WARP LOAD (TNNE)	PORT WARP LOAD (TNNE)	GEAR DRAG (TNNE)	STBD DOOR DRAG (TNNE)	PORT DOOR DRAG (TNNE)	DOOR SPREAD FORCES		NET DRAG (TNNE)	SWEEP SPREAD FORCES	
								STBD (TNNE)	PORT (TNNE)		STBD (TNNE)	PORT (TNNE)
1	3.49	129	3.87	3.20	6.54	0.68	0.83	0.82	0.62	4.76	0.55	0.40
2	3.94	139	4.45	3.45	7.37	0.67	0.88	0.94	0.65	5.51	0.63	0.41
3	3.81	121	3.23	2.80	5.52	0.52	0.99	0.65	0.45	3.77	0.43	0.27
4	3.41	130	3.80	2.95	6.23	0.46	0.76	0.69	0.46	4.74	0.47	0.29
5	3.20	130	3.65	3.55	6.66	0.65	1.21	0.79	0.65	4.56	0.53	0.40
6	3.37	139	4.00	3.50	6.92	0.69	0.91	0.83	0.66	5.06	0.56	0.42

APPENDIX A

The following is a hypothetical example of the standard form of programme used by the Marine Laboratory, Aberdeen, for experiments on research vessels.

- - - - -

In Confidence

Cruise 6/80

FRV EXPLORER

PROGRAMME

3-21 June 1980

<u>Personnel</u>	I Newton (in charge)
	B Smith
	C Jones
	D Baird (14-22 June only)

Objectives

1. To measure the towing loads and geometry of three high opening trawls - BT 500, BT 501 and BT 502.
2. To observe the gears using underwater television equipment, particularly to detect areas of slackness or excessive strain in the netting.

Procedure

Gear and equipment will be loaded at Aberdeen on 2 June. On departing from port, the ship's log will be calibrated by making several runs over the measured mile in Aberdeen Bay.

The instrumentation work will be done mainly during the first half of the cruise, on selected tows East of the Shetland Islands. The tests will include deep water fishing North of Shetland. On all instrumented hauls, the gear will be towed for about one hour on a straight course, then for another hour on the reciprocal course to allow tide corrections to be made.

EXPLORER will berth at Lerwick on 13 June when Mr Baird will join the ship. Thereafter, trawling will be done on tows near the Orkneys, in the shallower water depths required for television observations.

B B Parrish
9 May 1980

APPENDIX B

Extract from a log (rig book) which describes one haul with bottom trawl gear.

Haul Date Location	S79/67 11 June 1979 Baltic Trench (60°45'N, 0°40'W)																												
Water depth Wind Sea State	93 - 103m Force 1 Calm																												
Objectives	Measurement of gear geometry and towing loads																												
Net	1400 HP White Sea trawl																												
Headline	42.6m long 100 x 20cm floats in fives																												
Groundgear	30.5m heavy bobbin groundrope (8 + 4.25 + 6 + 4.25 + 8) sections 53cm rubber bobbins (2 x 3m) 46cm rubber bobbins (2 x 4.25m) 15cm rubber discs (2 x 8m) ground chain (2 x 12m)																												
Rig	73m twin sweeps 4.6m backstrops																												
Doors	3.3m rectangular flat (F25, F26)																												
Warp aft	366m																												
Wire diameter	warp - 26mm upper sweep - 18mm lower sweep - 26mm																												
Instrumentation																													
(a) logged on-line (905 computer)	Time, DECCA position, depth, Doppler ground speed, engine RPM																												
(b) self recording instruments	Tension meters on port and starboard warps Headline height from Simrad netsonde at the headline centre, acoustic link																												
	<table><tr><td>Item</td><td>Position</td><td>Time on</td><td>Time off</td></tr><tr><td>LC28</td><td>T5S</td><td>1434</td><td>1820</td></tr><tr><td>LC20</td><td>T5P</td><td>1434</td><td>1822</td></tr><tr><td>LC32</td><td>T6S</td><td>1444</td><td>1816</td></tr><tr><td>LC31</td><td>T6P</td><td>1444</td><td>1816</td></tr><tr><td>Spread meter</td><td>1.8m up sweep from wingend</td><td>1448</td><td>1744</td></tr><tr><td>Spread meter</td><td>46m up warp from door</td><td>1500</td><td>1737</td></tr></table>	Item	Position	Time on	Time off	LC28	T5S	1434	1820	LC20	T5P	1434	1822	LC32	T6S	1444	1816	LC31	T6P	1444	1816	Spread meter	1.8m up sweep from wingend	1448	1744	Spread meter	46m up warp from door	1500	1737
Item	Position	Time on	Time off																										
LC28	T5S	1434	1820																										
LC20	T5P	1434	1822																										
LC32	T6S	1444	1816																										
LC31	T6P	1444	1816																										
Spread meter	1.8m up sweep from wingend	1448	1744																										
Spread meter	46m up warp from door	1500	1737																										

ctd.

Rig book extract (continued):

Times	Shot 1506, knocked out 1731																																			
	<table><tr><td><u>Block</u></td><td><u>Start</u></td><td><u>End</u></td><td><u>RPM</u></td><td><u>Course</u></td></tr><tr><td>1</td><td>1525</td><td>1540</td><td>139</td><td>192</td></tr><tr><td>2</td><td>1540</td><td>1555</td><td>121</td><td>192</td></tr><tr><td>3</td><td>1555</td><td>1610</td><td>130</td><td>191</td></tr><tr><td>4</td><td>1638</td><td>1652</td><td>130</td><td>040</td></tr><tr><td>5</td><td>1704</td><td>1718</td><td>139</td><td>049</td></tr><tr><td>6</td><td>1718</td><td>1728</td><td>121</td><td>046</td></tr></table>	<u>Block</u>	<u>Start</u>	<u>End</u>	<u>RPM</u>	<u>Course</u>	1	1525	1540	139	192	2	1540	1555	121	192	3	1555	1610	130	191	4	1638	1652	130	040	5	1704	1718	139	049	6	1718	1728	121	046
<u>Block</u>	<u>Start</u>	<u>End</u>	<u>RPM</u>	<u>Course</u>																																
1	1525	1540	139	192																																
2	1540	1555	121	192																																
3	1555	1610	130	191																																
4	1638	1652	130	040																																
5	1704	1718	139	049																																
6	1718	1728	121	046																																
Catch	25 baskets, mainly saithe																																			
Damage	None																																			

APPENDIX C

Tabulation sheets

Tabulation sheets are forms in which data are recorded during an experiment or in the course of the subsequent analysis.

Some examples are given in the following pages. The 'form' reference in each sheet has been included to relate to the notes below, otherwise the sheets are as used in fishing gear experiments.

Form A

Used for trawling work (mainly pelagic) by RIVO, IJmuiden. Includes information from a multi-netsonde system and shipboard tension meters.

Form B

Used for trawling work by the Marine Laboratory, Aberdeen. Includes information from self recording instruments on the gear.

Form C

Used in purse seining by ISTPM, Lorient. Includes records of visual observation of the net shape at different stages.

Form D

The above examples are for recording data during an experiment. This form is used later for the purpose of storing data on the Marine Laboratory data bank. Sum checks are included for the detection of errors.

[illegible]

FORM B (1 page)

VESSEL	_____	AREA	_____
HAUL NO.	_____	WARP AFT	_____
DATE	_____	COURSE TOWED	_____
TRAWL TYPE	_____	WIND DIRECTION	_____
TRAWL BOARDS	_____	WIND FORCE	_____

Block No.								
Time								
Revs								
Speed (Crude Log)								
Speed (Tide corrected)								
T ₁ F (tonnes)								
T ₁ A (tonnes)								
T ₂ F (tonnes)								
T ₂ A (tonnes)								
T ₃ F (tonnes)								
T ₃ A (tonnes)								
T ₅ F (tonnes)								
T ₅ A (tonnes)								
T ₆ F (tonnes)								
T ₆ A (tonnes)								
Water depth (m)								
Headline Height (m)								
Net Spread (m)								
Board Spread (m)								
Divergence Meter (degrees)								
Divergence (m)								
Declination (degrees)								

Gear Rigging and/or Remarks

FORM C (1 page)

SENNE / SENNEUR

coup	jour	mois	année	bateau	station			

Heure:

OBSERVATIONS GÉNÉRALES. ENVIRONNEMENT

- repérage du poisson, position du poisson par rapport à la surface
- position du bateau présence éventuelle de bateaux aux environs
- météo, vent : force et direction
- thermocline
- houle
- courants
- couleur de l'eau et transparence

DÉROULEMENT DE LA MANOEUVRE

- vitesse de filage (valeur moyenne)
- longueur de remorque filée
- pression d'huile au treuil
- position des appareils de mesure, bathykymographes ou autres

(No. de l'anneau) :

(de l'aile avant à l'aile arrière) (No. du bathykymographe):

CHRONOLOGIE DES OPÉRATIONS

			temps
+ Filage	Filet	début	.....
	(filage des divers appareils de mesure)		.....
		fin	.....
	Remorque	début	.....
		fin	.....
+ Boursage		début	.....
		fin	.....
+ Virage au poxer-block		début	.....
+ Salabardage		début	.....
		fin	.....
+ Fin des opérations			.....

CONSTANT DATA RECORD

Number of blocks (max. 20)

Type of trawling

Net reference number

Board reference number

Sweep system

Rig reference number

Comments and further information (last character of string should be \ (backslash) to indicate end of comments).

Lat. and long. at start of haul

Lat. and long. at end of haul

Wind speed (knots)

Wind direction (degrees from north)

DEG MIN N or S DEG MIN E or W

If data unavailable for any channel then enter -1, in first two spaces, for that channel.

METRIC CODING FORM FOR GEAR TRIALS DATA BANKRIG DATA

(Haul No.)

DEMERSAL TWIN SWEEP RIG

1. Distance between warp upper ends (m)
2. Warp diameter (mm)
3. Warp weight in water (kg/m)
4. Board weight in water (kg)
5. Board area (m²)
6. Distance between backstop
fixings (m)
7. Length of upper backstop (m)
8. Length of lower backstop (m)
9. Length of stem of Y-backstop (m)
10. Length of upper sweep (m)
11. Length of lower sweep (m)
12. Headline length (m)
13. Groundrope length (m)
14. Sideline length (m)

Enter 9999 if a particular parameter was not included in the rig used. Enter -1 if a parameter was present but its value was not recorded.

CODE*

(Haul No.

•

1. Block number
2. Start time of block
3. Propeller RPM
4. Propeller pitch
5. Propeller shaft thrust (tonnes).....
6. Shaft horse power (1HP = 764W).....
7. Ship speed relative to water (knots).
8. Tide corrected ship speed (knots) ...
9. Course (degrees from north)
10. Warp aft (m)
11. TOS (tonnes)
12. TOP (tonnes)
13. T1S (tonnes)
14. T1P (tonnes)
15. T2S (tonnes)
16. T2P (tonnes)
17. T3S (tonnes)
18. T3P (tonnes)
19. T3S lower (tonnes)
20. T3P lower (tonnes)
21. T4S (tonnes)
22. T4P (tonnes)
23. T5S (tonnes)
24. T5P (tonnes)
25. T5S upper (tonnes)
26. T5P upper (tonnes)
27. T5S lower (tonnes)
28. T5P lower (tonnes)

[illegible]

(Haul No. _____)

CODE

29. T6S (tonnes)
30. T6P (tonnes)
31. T6S upper (tonnes)
32. T6P upper (tonnes)
33. T6S lower (tonnes)
34. T6P lower (tonnes)
35. Divergence
36. Declination starboard (degrees)
37. Declination port (degrees)
38. Warp roll angle (degrees)
39. Warp or board spread (m)
40. Dist. from board to spreadmeter (m) ..
41. Net spread (m)
42. Dist. from wingend to spreadmeter (m)
43. Water depth at ship (m)
44. Warp or board depth starboard (m) ...
45. Dist. from board to depthmeter (m)...
46. Warp or board depth port (m)
47. Dist. from board to depthmeter (m)...
48. Headline depth (m)
49. Headline height (m)
50. Height of footrope above seabed (m) ..
51. Wingend height (m)
52. Dist. wingend to mano. head (m)
53. Warp or board angle (degrees)
54. Board attack angle (degrees)
55. Board heel angle (degrees)
56. Board tilt angle (degrees)
57. Net speed (knots)

35

METRIC CODING FORM FOR GEAR TRIALS DATA BANK

(Haul No.)

SUMCHECK DATA

For each of the 57 parameters on pages 3 and 4 add up all the numbers in each row (including Code No.) and record the total on this form.

Row number	Sum
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	

Row number	Sum
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
30	
31	
32	
33	
34	
35	
36	
37	
38	

Row number	Sum
39	
40	
41	
42	
43	
44	
45	
46	
47	
48	
49	
50	
51	
52	
53	
54	
55	
56	
57	

Now add together the 57 row sums and record the total sum

Punch down the three 'Sum' columns - each entry on a new line

METRIC CODING FORM FOR GEAR TRIALS DATA BANKNotes

(a) Block numbers should be separated by a comma (eg 3, 4, 6, 7, 8 etc.)

(b) Start times of blocks should be integers separated by commas
(eg 0845, 1220, 1510 etc.)

(c) Tension measurements are as follows:

T0	Warp tension measured on deck
T1	Warp tension at top of warp
T2	Warp tension at bottom of warp
T3	Tension in upper backstrop
T3 lower	Tension in lower backstrop
T4	Tension in cable immediately forward of danleno bobbin or spreading wire junction
T5	Tension in upper sweep or spreading wire at its aft end
T5 upper	Tension in upper bridle at headline
T5 lower	Tension in lower bridle at headline
T6	Tension in lower sweep or spreading wire at its aft end
T6 upper	Tension in upper bridle at footrope
T6 lower	Tension in lower bridle at footrope

(d) Codes:-

0	No data - leave remainder of row blank
1	Acceptable data averaged from continuously recording instruments
2	Acceptable data averaged from visual readings (eg from a dial)
3	Data from divers measurements
4	Corrected or calculated data
5	Suspect data
6	Uncalibrated data or non standard units

(e) If some, but not all, values of a parameter are available enter = for those
values which are missing

APPENDIX D

Gear drawing rules as adopted by the FAO

So far as is possible, the main design drawings are prepared to scale. The scale is indicated by unit length equivalent in the metric system. Of course, the one scale cannot refer to netting and framing lines at the same time, and the following basic rules, in accordance with the mode of presentation in the FAO Gear Catalogues, are recommended.

- Surrounding nets (purse seines, lamparas, etc.): the length of the net is drawn according to the length of the floatline, and its depth according to that of the stretched netting.
- Trawls: the width of netting panels or sections is drawn according to half the width of the stretched netting, and the depth or length according to that of the stretched netting.
- Gillnets, tangle nets: the drawn length is proportional to the length of the floatline. When the net has side lines, the depth is drawn according to their length, and in the absence of side lines according to the stretched netting.
- Other gears (dredges, pots, lines, etc.): in view of the great variety in construction, a standard presentation would be impractical. Schematic or perspective sketches, complemented by detail drawings as required, should be given with dimensions and scales where applicable.

The specification of netting should be given in accordance with the international standards set by the ISO (International Standardisation Organisation). Thus the yarn size is in the tex system (R tex), the mesh size is the stretched length of a mesh, the cutting rates are defined by symbols (N, T, B, AB), and the size of the netting by the number of meshes in both the N (normal) and T (transverse) directions, or by the stretched netting length in the case of the N-direction. The ropes are specified by their material, diameter, length and when necessary, by their construction. The hanging ratio (E) is the ratio of rope length to the stretched netting length hung on the rope. E is expressed as a decimal fraction.

The materials used in gear construction are indicated by abbreviations based on terms in common international use, such as PA (polyamide), PE (polyethylene) and PP (polypropylene).

To complement a gear design drawing, sketches of the complete rig must also be prepared together with detailed drawings of important components such as otterboards.

Indication of spine colours

Reports of the Advisory Committee on Fishery Management	Red
Reports of the Advisory Committee on Marine Pollution	Yellow
Fish Assessment Reports	Grey
Pollution Studies	Green
Others	Black

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