REPORT OF THE

WORKING GROUP ON FISHERIES ACOUSTICS SCIENCE AND TECHNOLOGY (FAST)

Woods Hole, Massachusetts, USA

17–19 April 1996

International Council for the Exploration of the Sea

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Contents

1. TERMS OF REFERENCE

In accordance with C. Res. 1995/2:15 the Working Group on Fisheries Acoustics Science and Technology (Chairman: Mr. E. J. Simmonds, UK) met in Woods Hole, Massachusetts, U.S.A., 17-19 April 1996 to:

a) discuss echo classification methods and results including shoal parameters, evaluation and definitions, methods and problems, behavioural parameters, standardisation, signal classification, and interpretation of echograms;

b) define fish behavioural aspects that affect acoustic surveys with the aim of identifying the most tractable problems.

2. MEETING AGENDA AND APPOINTMENT OF RAPPORTEUR

The chairman opened the meeting and Dr. P. Fernandes of the SOAEFD Marine Laboratory, Aberdeen, UK, was appointed as rapporteur. The following agenda was adopted:

1. Plenary session on behaviour and acoustic surveys;

2. Plenary session on echo classification and shoaling parameters;

3. Parallel discussion and drafting sessions:
   i. Echo classification, chaired by Gordon Swartzman and David Reid;
   ii. Fish behaviour and acoustic surveys, chaired by Pierre Freon and Geoff Arnold;

4. Plenary session on general topics;

5. Plenary session discussing the report from the parallel session on echo classification and shoaling parameters;

6. Plenary session discussing the report from the parallel session on behaviour and acoustic surveys;

7. Plenary session on poster presentations;

8. Recommendations.

3. SESSION ON BEHAVIOURAL ASPECTS THAT AFFECT ACOUSTIC SURVEYS

3.1 Arnold, G. Fish behaviour as a source of error in acoustic survey: evidence for systematic patterns of vertical and horizontal movement

Fish behaviour can affect sampling gear efficiency through availability, accessibility and vulnerability. Seasonal migration influences availability by changing the geographical distribution of fish stocks and this point is illustrated by recent work with plaice. Comparative fishing experiments in the Dover Strait show that annual spawning migrations may well be structured with clearly defined differences in behaviour between fish of different ages, sexes and maturity stages. Catch rates varied significantly according to the state of the tide. Tracking and archival tag studies in the southern North Sea indicate systematic patterns of vertical migration that affect the accessibility of a number of species of demersal fish to sampling gear. The commonest patterns of vertical movement have diel (24 h) and tidal (12.5 h) periodicities, but other patterns are also evident. For flatfish, the effects on sampling will be confined to fishing gear, but for fish with swimbladders there are implications for acoustic surveys. Vertical movements will have a significant effect on the TS of roundfish, such as cod, which have a closed swimbladder and which maintain neutral buoyancy only at the top of their vertical range (50 % pressure reduction from the depth of neutral buoyancy). The reduction in TS is likely to be in the order of 2 - 5 dB and further reductions in TS are likely as the fish compensates for negative buoyancy by adopting a head-up posture. Little is, however, known about the swimming behaviour of free swimming gadoids and this could be a productive area for future research particularly if measurements of the attitude of the fish could be correlated with simultaneous measurements of their depth, TS and pattern of vertical migration.

Discussion: In the studies of migration using tracking techniques, it is thought that 12 - 20 observations might yield sufficient information to obtain an idea of general trends.

3.2 Olsen, K. and Ahlquist, I. Target strength of herring when descended.

Diurnal migrations in fish are likely to induce changes in swimbladder volumes and tilt angles. These in turn might be expected to result in complementary changes in target strength. The study here looks at the acoustic backscattering of large herring after a forced descent. Herring were caught by purse seine and transferred into a special rig where they were insonified with a 38 kHz transducer mounted on a curved track covering a 53° sector. The whole rig was moved to enable the fish to take up a swimming position. The net containing the fish was lowered to 5, 20 and 50 m, and tilt angle was observed with the aid of low light UTV. At 5 m the herring was observed to swim horizontally. At 20 m the fish was at 11° "head up" and the mean reduction in acoustic backscattering was 0.6 dB. At 50 m the tilt had increased to 18° "head up" and a further reduction in mean acoustic backscattering of 0.9 dB was observed. Changes in directivity patterns were moderate. The changes in depth are

not as important as those of tilt which may cause a change in backscattering of as much as - 9 dB (tilt angle of -20° ± 5° at 50 m). It may, therefore, be important to investigate the true tilt orientations of fish during echo-surveys.

Discussion: In answer to the possibility of fish adaptation and anticipation of their own behaviour, it is thought that the maximum physiological adaptation that could take place would be of the order of 10 % even if they could anticipate any movement.

3.3 Mitson, R.B. That awkward angle: fish tilt angle revisited

The frequencies commonly used in acoustic surveys result in the formation of relatively narrow directivity patterns, which are subsequently very sensitive to tilt angle. Changes in tilt induced by avoidance of a survey vessel have been estimated to result in errors in abundance estimates of up to 60 %. There are two possible solutions to this problem: i) reduction in directivity; ii) making measurements to assess the tilt angle.

is possible through the adoption of lower frequencies; e.g. for an ideal 30 cm fish at a tilt of 20°, the directivity pattern would be -19 dB at 38 kHz and -1.7 dB at 5 kHz. However, vessel noise increases by similar magnitudes at lower frequencies (noise at 5 kHz is likely to be > 20 dB higher than at 38 kHz). The additional impracticality of switching to lower frequencies renders this option unattractive.

Alternatively, the tilt angle may be assessed and then accounted for. Tilt angle can be measured using a simple sensor. A unit 20 mm long and 5 mm in diameter can measure the angle to an accuracy of ±1° over a range of ±50°. An acoustic tilt angle transponder (ATAT) tag enables almost instantaneous readings to be taken from a free swimming fish via the vessels sonar. Results using this tag on a 47 cm cod are presented. Another type of tag is the data storage tilt angle tag (DSTAT) which gives a long term record of tilt angle variations, in addition to other (environmental) parameters. The technology is, therefore, available to study tilt angle and it is hoped that more studies on fish orientation will follow.

Discussion: With regard to the use of lower frequencies, the point was made that in addition to the technical difficulties involved, additional problems may occur due to the use of frequencies closer to resonant scattering.

3.4 Masse, J. Catchability of different species aggregations by midwater trawl during acoustic surveys

The pelagic trawl is currently the most common means of qualifying acoustic data. It provides the length and species composition information that is used to set target strength (TS) values according to published TS/length relationships. This presentation was aimed at stimulating discussion on the ability of trawls to assess the true species proportions, by examining measures of the catchability of different

species. Data was examined from 150 trawl hauls taken in the Bay of Biscay from 1991-1994. Theoretical catches based on estimates from the echosounder output were compared with actual catches assuming that the fish had not moved and also when the school depth had changed.

3.5 Godo, O.R. and Totland, A. A stationary acoustic system for monitoring undisturbed and vessel affected fish behaviour.

Thorough knowledge of the dynamics of natural fish behaviour and distribution within a survey and among surveys is fundamental for the reliability of time series and abundance indices. Furthermore, vessel / trawl affected avoidance may greatly affect density estimates from trawl and acoustic surveys. Means for monitoring behaviour of fish during surveys or in special experiments have been limited, time consuming and expensive.

This paper describes an acoustic buoy system for monitoring undisturbed distribution and behaviour of fish as well as avoidance reactions of fish in relation to a passing vessel. The system was designed to meet five main requirements: i) Small in size, portable, and simple to operate - The design was based on the ARGOS satellite buoys, therefore, the technology and problems associated with deployment and handling are well known. Easy operation is acquired through direct access via conveniently located connections; ii) Rough weather operation - As for (i) above, the ARGOS system incorporates a variety of appropriate features; iii) Remote control - The unit can be controlled via a PC to PC modem through UHF communication; iv) Large data storage - Currently 1 Gigabyte, which will store approximately 24 hours of data; and v) Compatibility with survey acoustic data - The system utilises the EY500 which produces the same type of data as the EK500. In addition, the rig is equipped with a compass to detect and, therefore, compensate for the motion of the transducer in trace tracking.

Field trials are expected in May 1996 and the buoy is planned to be used during a routine survey on cod and haddock in August 1996.

3.6 Guillard, J. and Lebourges, A. Spatial structures and behaviour of fish populations in a Senegalese coastal area.

During an annual cycle, acoustic surveys were carried out in an inshore coastal area of Senegal, in depths of less than 15 m. Previously these areas had not been studied by acoustic methods. A Simrad EY500 echosounder and RESON SEABAT 6012 multibeam sonar were deployed from a small sports fishing boat. Very few aggregations were detected, and most of the concentrated structures were observed in February. Fish counts nearest the surface or the bottom remained the same regardless of seasons, moon cycle or tides. Sonar observations at 5 m from the boat were almost 50 % of those further away indicating the possibility of marked avoidance, particularly for larger schools.

4. REPORT FROM THE DISCUSSION GROUP ON BEHAVIOURAL ASPECTS THAT AFFECT ACOUSTIC SURVEYS (FREON, P. AND ARNOLD, G.)

4.1 Classification of behaviour

The various aspects of fish behaviour that might be expected to affect acoustic surveys were discussed and the following classification produced. This classification distinguishes between natural behaviour and behaviour induced by the survey vessel (Table 1); both are thought to be important.

4.2 Echo identification

The group also recognised the continuing importance of independently identifying echo traces by biological sampling until automatic recognition becomes more reliable. Biological sampling entails the use of several different sampling gears (possibly including purse seines), which may have different selectivities in terms of the species and sizes of fish that are caught. The group concluded that this was an area for co-operation between the FAST and FTFB working groups.

4.3 Sources of variation

The various types of behaviour affecting acoustic surveys are thought to vary with a number of factors, including: the position of the fish in the water column; the biology and physiology of the fish; the characteristics and mode of operation of the survey vessel; and various features of the biological and physical environment (Table 2).

4.4 Prioritisation and tractability

Although some general patterns of natural and induced behaviour have been identified, the group concluded that, because of the large degree of variability expected between different environments as well as diel, seasonal and interannual effects, it would not be possible to derive correction factors for use with all acoustic surveys. Instead it would be necessary to compute behavioural indices from quantitative observations made routinely during the course of each individual survey. In addition, it would be appropriate to carry out specific experiments to validate these indices independently of the surveys (e.g. acoustic tags, instrumented buoys, bottom-mounted acoustic devices etc.).

The group concluded that, although they did not occur in all survey situations, avoidance and tilt angle were high priority topics. Three communications emphasised the importance of natural variability in tilt angle, as well as systematic departure from the horizontal attitude as a result of positive or negative buoyancy Avoidance was probably the more tractable problem as continuous sonar observations could be used to complement conventional echosounders during routine surveys. The measurement of tilt angle was, however, more difficult at present and new techniques were needed. These might include tracking individual targets with split-beam sounders at high ping

rates, following movements of homogeneous layers of fish with Doppler profilers (ADCP) whenever possible during routine surveys, or comparing signals at two frequencies. In addition acoustic tags with tilt sensors and other techniques could be used during specific experiments. Alternatively, the possibility of reducing the tilt angle influence by using lower frequencies (e.g. 18 kHz) should be investigated. Finally, steps should be taken to design ways of screening deck lights to minimise visual avoidance stimuli during trawling and acoustic survey (also needed for commercial vessels).

Among the other behavioural factors, special attention should be paid to the biases related to horizontal migration. These could occur on a daily basis as result of the relative movement of the fish and the survey vessel or on a seasonal basis as a result of the relative movement of the fish population and the track of the acoustic survey. Advantage should also be taken of school cluster studies to determine whether inter or intra-cluster sampling intensity is responsible for the higher source of variability.

4.5 Recommendations

The group recommends that:

1. In the short term the investigation of vessel avoidance and fish tilt angle (natural and vessel induced) should have high priority and new techniques should be developed for this work. The aim is that these aspects of behaviour should be observed routinely during surveys but special experiments should also be carried out to obtain independent validation.

Additionally:

2. In the medium term, avoidance stimuli should be reduced by improvements to conventional research vessels (e.g. by noise reduction and light limitation) and in the longer term by adoption of less intrusive platforms (e.g. SWATH vessels and Autosubs). Recommendations for noise reduction are available in the recent ICES Co-operative Research Report (No. 209) on RV Noise (Mitson, 1995).

Table 1 Influence of fish behaviour on acoustic survey

CATEGORY	BEHAVIOUR	INFLUENCE	SIGN	MAIN PERIOD
Induced behaviour	Avoidance	Biomass estimate Vertical. distribution	-	Day (Night)
	Tilt angle	Biomass TS	- -	Day (Night)
Natural behaviour	Tilt angle	Biomass TS	- -	Day/night
	Aggregation	Biomass (shadowing) TS (multi-target)	- +	Day Night
	School clustering	Biomass	- or +	Day
	Horizontal migration (seasonal, daily)	Biomass (bias) Distribution	- or +	Day and Night
	Vertical migration	TS (swimbladder vol.) Blind areas	- or + - or +	Twilight Day/night

Table 2. Sources of variation in fish behaviour

FISH

-Species (prey, predator, etc.)
-Physiological stage (reproduction, hibernation, rhythms, etc.)
-Learning (vessel, gear)
-Hunger
-Fish depth
-Fish altitude

VESSEL

-Noise intensity
-Noise frequencies
-Speed
-Size
-Light (night)

BIOLOGICAL ENVIRONMENT

-Predators (natural and fishing pressure)
-Preys
-Bioluminescence
-Conspecifics
-Competitors

PHYSICAL ENVIRONMENT

-Light intensity (sun, moon, stars, clouds influence)
-Turbidity
-Light orientation relative to the vessel
-Bottom depth
-Temperature
-Sound propagation
-Background noise

5. SESSION ON ECHO CLASSIFICATION AND SHOALING PARAMETERS

5.1 Pedersen, J. and Holst, R. Description of fish layers using the three-dimensional information obtained by a split-beam echosounder.

The work described here aims to identify the spatial distribution of single targets within pelagic and benthic layers of fish by statistical analysis of the three-dimensional information obtained by a split-beam echosounder. In the pelagic layer, mainly composed of herring and sandeel, the fish were randomly distributed and for the vertical distribution a good fit to a normal distribution was obtained. In the benthic layer, mainly composed of whiting, haddock and Norway pout, the fish were aggregated. The distribution could therefore not be fitted to a normal distribution. However, within the aggregations the fish seem to be normally distributed.

5.2 Masse, J. Time variability of school structures

A small rectangular area in the Bay of Biscay was surveyed 19 times over the course of eight days to look at the variability in aggregation patterns of anchovy schools during their spawning season. The geographic distribution of total acoustic energy was more variable than that of school number, although both showed changes in location with time.

The features of the latest upgrade to the hydroacoustic data analysis package "Movies" were also described. The package is now Windows compatible, can take data from Biosonics and Simrad EK500, as well OSSIAN sounders, and has a variety of new features (see Appendix B.1 for details).

5.3 Freon, P. Three-dimensional analysis and visualisation of the spatial structure of fish schools using multi-beam sonar image processing

This paper introduces the scope of an EC funded project involving four laboratories, which aims to adapt a multibeam sonar system specifically as a tool for fisheries research. Compared to a vertical sounder, a multibeam sonar system has the following advantages: it can sample in two dimensions for each transmission; it has a larger sampling volume (90 °); and it is able to scan beyond the vessel track enabling avoidance behaviour to be studied. The project has three main objectives: technical research, involving higher data rate acquisition and the design of image analysis software; methodological research, to improve calibration and comparison with a vertical sounder; and biological research, looking at various fish species with the aim of classifying schools. Ultimately the system should provide three dimensional images and numerical data on pelagic fish school structures from a multibeam sonar system.

Discussion: The sonar, a SEABAT 6012, operates at a frequency of 455 kHz. This was decided as the best compromise between definition and range. If fully calibrated, quantitative

data may be obtained, but initially a vertical sounder will provide density estimates and the sonar will be used to calculate school volumes.

Features of the new ORSTOM research vessel "Antea" were also described. The vessel is very silent and operates extremely well when cruising with the wind, stability is not as good when the wind is from the side or ahead.

5.4 LeFeuvre, P., Rose, G., Gosine, R., Khan, R. and Pike, C. Fish species identification using image analysis of acoustic data.

This paper describes a project which has been undertaken to develop analytical techniques and a software toolkit for the taxonomic identification of fish from high resolution acoustic data. This will enable accurate and time efficient measurements of fish distribution and density by post processing acoustic survey data. The initial species to be identified are Atlantic cod (*Gadus morhua*), capelin (*Mallotus villosus*) and herring (*Clupea harengus*). The general approach has been to incorporate signal processing of individual acoustic traces, digital image processing of echogram images and semi-automated interactive classification. The paper introduces the overall project and discusses the ongoing work on the image processing component for the classification software.

6. REPORT FROM THE DISCUSSION GROUP ON ECHO CLASSIFICATION (SWARTZMAN, G. AND REID, D.G.)

The group discussed a wide variety of agenda topics including:

- The need for data standards
- Methods and definitions for school/shoal localisation
- Aggregation parameters and clues
- Classification methods and questions
- Challenges and opportunities in classification
- Communication of results

Because of the broad nature of the topic and the limited time for discussion most time was spent on discussing data standards and a recommendation for the formation of a FAST study group on classification.

6.1 Data standards

6.1.1 Discussion

There was a clear consensus for the need for data standards at several levels of processing. The most important of these were for the raw acoustic data from the echosounder and for data after corrections e.g. for beam pattern, ping rate, sample volume and

echo-integration. A requirement was also identified for a common protocol for the transfer of processed echogram data for the cross validation of classification techniques and comparative studies. The need for data standards transcends classification, however, the group believed that a concerted approach to classification was impossible without first setting data standards to allow sensible comparison of acoustic data collected with different equipment, stock situations and analysis approaches.

Several projects were reported, as underway or in the proposal stages, on developing and evaluating classification methods. These included projects led by G. Rose (U. Of Newfoundland, Canada); G. Swartzman (U. Of Washington, USA); P. Petitgas (ORSTOM, Montpellier, France) and J. Masse (IFREMER, Nantes, France). These, and additional planned projects will depend on having data standards both for data transfer and inter-comparison of results.

A data standard model, developed as part of the Canadian National Hydroacoustics Programme (NHP), was presented by Y. Simard. This model relies heavily on the use of tuples and tags to identify formats and data specifications, and seems promising as the basis for an international standard for acoustic data. Such a standard must be flexible, to incorporate data at several levels of resolution and detail, and general, to include all current and future developed systems. Because of the complexity of the object-oriented model presented, there was an expressed need for further study of the document and a request by Y. Simard for comments by those present on the proposed format. The group felt that the NHP format was a good basis for the development of appropriate international standards, and recommended that all interested parties transmit their comments on the draft proposals to Y. Simard before the 1st June 1996. The discussion resulted in a recommendation by FAST for the need for data standards (see below).

6.1.2 Recommendation

Data standards for acoustic data are needed at several levels: particularly raw data format & data transfer format for classification methods comparison / evaluation We recommend such data standards be developed by the ICES user community in collaboration with acoustic system developers and that it be flexible enough to incorporate future technologies. As a working assumption this should initially be based on the NHP proposals.

6.2 Classification

6.2.1 Discussion

Several topics on classification from the agenda were discussed, including

1. There is a general lack of clarity in the terminology in this area of study. For some workers classification is taken to mean species identification, for others it means

classifying aggregations according to similar structure or shapes or clustering properties, to others it means grouping the aggregations into associations or groups that are representative of given habitats. We suggested all the above definitions are consonant with similar methods and should be considered as part of "classification" studies. The term localisation was suggested for the process of locating aggregations from acoustic survey data.

2. Producing an image library of schools for training in classification and the need to include the non-typical cases (i.e. those schools where identification by trawl disagreed with initial visual echogram identification), as well as best cases for the library. This is made more important by a common desire to work with and communicate the best cases.

3. How large a training data set is needed for reliable classification. This would be dependent on the specific questions being asked and the nature of the studied stock, mono- or multi-specific.

4. What is the influence of fish behaviour, e.g. vessel avoidance and multi-species associations, on classification and what information can classification approaches provide to enhance understanding of fish behaviour on acoustic (and other) survey estimates.

5. The current emphasis is on morphological, image analysis (IA) methods for aggregation localisation and the possibility of other methods being introduced in the future, based on new technologies, was discussed. For example, frequency domain analysis may help in classification when multifrequency, or wide band sonar data are available.

6. There is uncertainty about the generality of school behaviour and its relevance to classification. For example, is the clustering of schools general to all pelagic schooling fish, or is each species/system different? Are there general patterns which control schooling fish behaviour in most situations, or does each species respond differently to the same situations?

8. It was recognised that distinguishing fish from plankton aggregations is part of the classification process, and that in some situations the analysis was targeted on other organisms e.g. krill or zooplankton aggregations. Classification analysis of acoustic data should not be considered as a tool solely for the study of FISH aggregations.

9. To date, multifrequency data has not often been used in classification, but can provide information that can help with classification not only at the species but also the size structure level.

10. Because data are collected by a wide range of systems, further study on inter-system comparison must be made. How does an aggregation localised from one system

appear to another system? Both simulation and experimental approaches are encouraged.

11. Besides providing a classification there is a need for a measure of success of the classification, this can be a probability measure.

12. Currently, the main aim of classification studies has been towards species identification and the study of aggregation behaviour *per se*. The group emphasised that classification techniques can also produce highly important data on aggregation patterns in relation to a variety of stock parameters e.g. biomass, age structure, reproductive state, hydrography, topography, intra- and inter-specific interactions and exploitation patterns. This type of data is of considerable use in improving our understanding of the fisheries ecology of the stocks under study, and can provide assistance to fisheries managers. Classification studies should also yield considerable information on variability in fish behaviour in relation to stock assessment from acoustic surveys (ref: Behaviour discussion group).

13. Classification is a broad topic, and the time allotted for this session was adequate only for the preparation of an overview of the problems and the potential of this field. The group therefore recommended that, future study and discussion should be conducted by a FAST study group.

Topics addressed by classification discussion group and recommended for further study by a FAST study group on aggregation classification:

1. The need for Data Standards, At what level - raw acoustic data? processed data (e.g. echogram images)? Who defines standards? How?

2. School / shoal localisation / characterisation

a. definitions - echo vs. pixel (image) based analyses - are they comparable?

b. Methods:-

- Are there standard tools?
- Should there be standard software or (more likely) a consensus on algorithms.
- There is a need for inter-system comparison. Given the same data, do different approaches produce the same output?

c. Tools:-

- morphological (IA) techniques
- image filtering
- signal processing (frequency domain)

d. Automatic, semi-automatic with user decisions or fully interactive/manual approaches.

e. Multifrequency data - can it help in localisation, identification & classification?

f. Other data sources - how can they be integrated?:-

- doppler systems
- wide band systems
- 3-D multibeam systems.

3. Aggregation parameters and clues for classification analyses:-

a. location
b. size
c. shape
d. acoustic - doppler, swimbladder (resonance)
e. spatial (nearest neighbour, cluster parameters)
f. individual fish TS, shape
g. other information e.g. biology, hydrology, location

4. Classification

a. Need for training sets - including the best & worst images, how large should a training set be?
b. General vs. system specific. Are there general rules for pelagic fish aggregative behaviour or is every situation different?
c. Species assemblages. How does the presence of more than one species affect aggregative behaviour e.g.

- Competitors
- Predators
- Others

d. Tools:-

- Hierarchical tree (CART)
- Linear discriminant analysis
- Principal component analysis
- k-neighbour clustering
- Neural networks

e. Multifrequency information - how to use it?

5. Challenges and opportunities:-

- School behaviour - general or system specific?
- Inter-system calibration/ comparison needed
- Depth distortion
- Response to vessel
- Multi-species associations.

6. Communication of results:-

- e-mail news group
- WWW - for report and theme page
- ICES study group leading to co-operative research report.

6.2.2 Recommendation

We recommend a study group be constituted to address and document issues of aggregation, localisation and classification including:

a. tools, parameters and clues for acoustic classification
b. classification methods evaluation
c. behaviour information - its effect on and input to classification
d. communication and collaboration between existing research programs.

6.2.3 Justification

Classification can provide a wider range of information about the distribution and structure of fish than biomass and this is potentially useful for management. Furthermore, the effect of aggregation on acoustic survey design and analysis must be considered. There are a growing number of researchers in the area and a growing interest within ICES in the use of classification techniques. There is, therefore, a need to evaluate and compare current methods to avoid wasteful duplication of effort. Future technologies (e.g. wide band sonar) represent an opportunity that needs to be considered both for data standards and classification methods. It would be prudent to incorporate fish behaviour information into improving classification reliability, and similarly, classification may provide useful information about fish behaviour.

7. GENERAL PAPERS

7.1 Nakken, O. and Michalsen, K. Year to year variations in horizontal and vertcial distribution of North east Arctic cod - influence on survey estimates of abundance.

Combined bottom trawl and acoustic surveys have been carried out in the Barents Sea each winter since 1981. An important source of error in both estimates is related to the spatial distribution. Temperature related changes in horizontal distribution are described, as well as observed changes in vertical distribution. In the eastern Barents Sea, the period in 1993-1995 was warmer than that in 1988-1989; this coincided with an eastward shift in the distribution of fish (echo) densities. The higher the temperature in the eastern area, the larger are the expected amounts of fish situated to the north and east of the old survey area. Therefore, the temperature in the eastern section has been used as a measure of decreasing availability i.e. increasing underestimation.

The relative changes in the acoustic and bottom trawl swept-area estimates were in accordance with observed changes in the vertical distribution of cod: when fish were closer to the bottom, the swept area estimates were significantly higher than the acoustic estimates

due to acoustic dead-zone losses. Two measures of vertical availability were calculated: a ratio between swept area estimates and acoustic estimates for 2-4 year old cod, the higher this ratio the more fish are present in the dead zone; and a ratio between total acoustic recordings (all depths) and those in the bottom channel (10 m from the bottom). These ratios and the measure of horizontal availability were compared and ultimately the objective is to correct the longer time series for the observed changes.

Discussion: It was noted that age distribution data relied on information from the trawl which may have a temperature related catchability component.

7.2 Soule, M., Barange, M., Solli, H. and Hampton, I. Performance of a new phase algorithm for discriminating between single and overlapping echoes in a split beam echo-sounder.

The performance of a new single target detection algorithm (version 5.0) in the EK500 split beam echo-sounder, which uses the standard deviation in the sample phase of received echoes as a detection criteria, was tested under controlled conditions using spheres as targets. Although not infallible, the new algorithm enables the user to achieve improved rejection performance, at settings which do not produce marked bias against weaker single targets, when operating at pulse durations of 1.0 ms at 38 kHz. At the 0.3 ms pulse duration the discrimination offered by both the phase and duration criteria was unreliable due to the reduced number of samples falling within the -6 dB limits of the echo peak. This will introduce uncertainty in any TS estimate obtained in the field.

7.3 Soule, M. Preliminary results from a new split beam receiver using individual quadrant amplitudes for improved single target recognition.

Preliminary performance results from a newly developed 38 kHz split beam receiver employing digital basebanding techniques were presented. The system produces complex channel samples which allow examination of both amplitude and phase of the individual channels as an aid to discriminating between single and overlapping echoes. It was shown that in a number of cases where overlapping echoes occur, a comparison of the individual channel amplitudes indicated the presence of multiples which traditional phase techniques failed to do.

7.4 Lebourges, A., Holliday, V. and Dhaussy, P. Improvements in the selection of the size vector for the inverse problem: An example from the shelf-slope break near Los Angeles, CA.

Previous approaches to the transformation of multifrequency acoustical data to estimates of size and abundance in zooplankton have been constrained by selection of a single set of sizes that were common to all depths in a vertical profile. Three methods by which this

restriction can be removed are discussed in the context of data collected during a winter cruise at the shelf-slope break in the Pacific Ocean off Los Angeles, CA. The results indicate that the methods can achieve an improved measure of the difference between calculations of the size spectra based on the inverse method, and the original measurements of volume scattering strength. The estimated sizes and abundances obtained for the three methods were comparable and no statistically significant differences in error were found between them. Therefore, it is concluded that the simpler, faster "zoom" method was the most favourable.

7.5 Holliday, D.V. Mulit-model multifrequency inverse methods

The inverse problem has traditionally used a single scattering model to predict size distributions and abundances from acoustic scattering. The work described here attempts to employ two scattering models in the inverse procedure: a truncated fluid sphere model for zooplankton and an elastic sphere type model for sand or shelled organisms. The success of the procedure relies on the deployment of many frequencies to separate the two model components. Initial results using the Tracor Acoustic Profiling System (TAPS) off the coast of California at a single depth range compared quite well with samples obtained from a MOCNESS net sampler. A number of ground truthing exercises are required to improve the method, in particular to deal with the problems encountered with major contributors such as pteropods (shelled organisms), sand and air bubbles.

There is no reason why the principles described could not be translated in order to be useful for fish discrimination, although lower frequencies would have to be employed.

7.6 Simard, Y. Draft proposal for a standard hydroacoustic data format

The Department of Fisheries and Oceans (DFO) Canada proposes that a standard data format be implemented for hydroacoustic data. As a result of a dedicated workshop, the DFO has proposed a "tuple file" format and would appreciate any comments before **1 June 1996**, when final implementation will take place. The "tuple file" format has been chosen in order to optimise the following criteria: efficiency in storage and access; forward and backward compatibility; forward and backward scrolling; compatibility with most echo-sounders (single to multiple channels); future development; self-contained files; high data resolution; computer platform independence; and the accommodation of as many data analysis steps as possible.

A tuple file (*.HAC) is a series of tuples; a tuple is a structured group of bytes and each tuple holds particular information in a variety of fields according to its type. All tuple types have at least three common fields: tuple size, tuple type and tuple backlink. The proposed standard would contain four principal tuple types and a variety of satellite tuple types: (1) the **document tuple** is machine specific, and contains information common to all echograms; each document tuple is associated with a number of **channel descriptor tuples** (2) which contain information common to all channels (frequency, pulse width, beam width, calibration

parameters etc.); each channel descriptor tuple is in turn associated with a number of **ping tuples** (3) which contain the raw sample data; a position tuple (4) stores latitude, longitude, GPS time and CPU time.

Other proposed tuples include an event marker tuple, environmental tuples, navigation string tuples, platform attitude tuples, and cruise and project tuples.

Please direct any further enquiries to Dr. Y. Simard (see Appendix C).

7.7 Brede, R. EK500 software version 5.2

A summary of new features and improvements in the latest version of software for the Simrad EK500 scientific echo-sounder was presented. This new version allows for a complete replay of EK500 sample data using the EY500 software from a common data format (EP500 or BI500). It also has new algorithms for single fish detection, improved calibration accuracy, new ranges (15 and 150 m), better Sa resolution, and many other features. This software should be available within one month. Details are given in Appendix B.2

7.8 Rose, G. The National Hydroacoustic Program (video)

A video was presented describing the essential elements of the National Hydroacoustic Program (NHP) of the Department of Fisheries and Oceans (DFO), Canada. This initiative has been set up to improve fish stock estimation. The NHP is focused on seven major projects taking place throughout the DFO: 1) acoustic and trawl survey design, looking at the best ways to combine information for stock assessment purposes; 2) standardising data formats and data analysis techniques; 3) species identification; 4) the application of new technologies; 5) collaboration with the fishing industry; 6) training and communication, through new education programmes; and 7) international collaboration and the advent of a "cyber-class" for improved communication.

8. POSTER SESSION

8.1 Berman, M., Green, J. and Holliday, D.V. The effect of non-biological particles on the acoustic assessment of plankton distributions.

The Tracor Acoustic Profiling System (TAPS) operating at 265, 420 1100, and 3000 kHz was used to study plankton distributions on Georges Bank. In stratified areas copepods were found in association with the thermocline. However, in some mixed profiles, very high biomasses were encountered. A large component of this was found to be sand particles (about 0.3 mm in diameter). Assuming the sand to reflect as an elastic scatterer, a two model inverse technique was applied aiming at separating the plankton from the sand. Initial results did make some distinctions, but a rather large patch of plankton remained close to the bottom which was probably representative of sand particles. Microsopic examination of the sand

particles from pump samples have revealed an irregular form which implies that their scattering may best be predicted by a truncated elastic sphere model.

8.2 Brierley, A.S., Watkins, J.L. and Goss, C. Does echo-sounder calibration change with temperature ?

The possible effect of water temperature on echo-sounder performance is of particular concern to those working in areas where the temperature may change rapidly and significantly over short distances such as in the Antarctic Polar Frontal zone. To illustrate this point, data was presented from a series of calibrations carried out alternately in polar (Antarctic Ocean, 2° C) and temperate waters (Norwegian fjord, 7° C). Repeat calibrations carried out within each region were similar, however, calibrations performed in different water masses yielded consistently different results despite taking into account the appropriate environmental variables (and therefore sound speed). The beam patterns of the transducers were determined using Simrad's "lobe" programme. At 38 kHz, transducer gains were typically 0.8 dB higher in temperate waters than in polar waters. At 120 kHz, gains were 1.5 dB higher in temperate waters.

Discussion: A significant amount of discussion was concluded with the recommendation that calibration should take place within the environment of the survey; if this environment varies in temperature then appropriate calibrations should take place in each region to account for the variation.

Some concern was expressed as to the status of current calibration documentation and the need for keeping this up to date. As a result of discussion a recommendation was made that David Demer collate new information relating to echo-sounder performance (see recommendations, section 10).

8.3 Fernandes, P.G. Using the simulated log option of the Simrad EK500: Warning.

When the EK500 Simulated Log option is used to control log interval length, large discrepancies can appear between the S_A values obtained from inspection of the EK500 paper trace and the values calculated from the same data by the BI500 / EP500 echo-integration software. The BI500 / EP500 both use a ping based method to calculate S_A values and, therefore, are most likely to provide the true S_A value. The observed discrepancies appear to be due to an as yet unknown problem in the EK500's Simulated Log option. These discrepancies do not constitute a bias; they are errors, the magnitude of which cannot be pre-estimated, which can be over- or under- estimates of the true S_A value. In one case this could have led to an underestimate of stock size which was almost twice that of the TAC.

It is suggested that the EK500's simulated log should not be relied upon, particularly when dealing with a patchy, high density, schooling species, where large schools should be

evaluated with a ping-based integrator. Ideally, the ping-based log interval, available in EK versions 4.0 and above, should be used; the problem does not occur with this option.

Discussion: The problem apparently occurs due to the mismatch between the sampling rate and ping rate. These also need to be synchronised, which can be achieved by using the trigger pulse as an external log input.

8.4 Fernandes, P.G. and Simmonds, E.J. Accounting for the TVG delay: a practical approach to calibration in the EK500.

Despite previous reference to the problem, some manufacturers of scientific echosounders seem to have ignored the need for the start time of the TVG to be delayed for an interval after the beginning of the transmitter pulse. This delay depends upon the pulse duration and the bandwidth of the receiver; it is always more than half the pulse duration. The effect of omitting the delay can have serious consequences if, as in most cases, calibration is performed using a standard target at one depth, and subsequent echo integration takes place at significantly greater depths. e.g. Calibrating at 10 m range and integrating at 100 m, would result in an underestimate of biomass by 11 % if no account is made for the delay.

The aim of this presentation is to demonstrate that the delay has not been taken into account in the Simrad EK500. Furthermore, no mention is made in the operator manual of the need for a delay nor, therefore, of how it should be taken into account. Therefore, a simple method is presented, consistent with the calibration procedure in the manual, which provides a calibration factor specific to the depth of the fish.

Discussion: The new version of EK500 software (5.2) aims to account for this problem (Appendix B.2).

8.5 Goss, C., Brierley, A.S. and Watkins, J.L. Identification of squid echoes in the South Atlantic.

The red squid, *Martialia hyadesi*, is the squid species most often taken by albatrosses. Little is known about the behaviour and acoustic characteristics of this squid because it is caught only as a bycatch in commercial fisheries. During a recent survey in the vicinity of the Antarctic Polar Frontal Zone in the South Atlantic Ocean, *M. hyadesi* was observed on a Simrad EK500 echo-sounder and sampled with a pelagic trawl. At night the squid formed a strongly speckled layer between the surface and 50 m. After dawn the speckles cleared away and no more targets were seen. By day it is thought that the speckles form part of a more compact mixed layer deeper down the water column. Values of TS in the speckled layer were between -55 and -56 dB, which are somewhat lower than those published for other species of squid of similar size.

8.6 Watkins, J.L., Goss, C. and Brierley, A.S. 38 kHz: an appropriate frequency for zooplankton studies ?

Traditionally 38 kHz has been considered an ideal frequency for fisheries acoustics, but not ideal for Antarctic krill. During a recent cruise to South Georgia, a Longhurst-Hardy Plankton Recorder and a Simrad EK500 echo-sounder operating at 38, 120 and 200 kHz was used to study fine-scale heterogeneity in zooplankton species. At 38 kHz, when set to the lowest available threshold setting (-100 dB), a large amount of backscatter was visible which was not apparent on the other higher frequencies or with the 38 kHz set to a threshold of -75 dB. This scattering came from layers which were composed of amphipods and small krill. Given the extensive operating range of 38 kHz systems and the associated lower noise levels, this frequency has proved most useful in providing a good representation of the presence and relative abundance of scattering layers which can then be targeted for sampling.

9. SPECIAL ANNOUNCEMENT BY THE CHAIRMAN

The Chairman of the FAST WG, John Simmonds, announced his retirement as chairman of the WG after four years in post. Following consultation it was proposed that Francois Gerlotto be nominated as a suitable successor. The new chairman will be chosen at the ICES Statutory Meeting in September.

The chairman, as convenor of last years' Fisheries and Plankton Acoustics Symposium, also announced that the proceedings are to be published imminently, in a special issue of the ICES Journal of Marine Science; he displayed a proof copy of the journal.

10. MISCELLANEOUS ANNOUNCEMENTS

1. Jacques Masse (IFREMER, France) announced the arrival of the new research vessel "Thalassa". Details of this are available on a web site on which he also hopes to collate information on data standards. Any interested parties can access the site at:

   http://www.ifremer.fr/ditidsiw3/navires/thalassa

2. Mike Soule (Sea Fisheries Research Institute, South Africa) announced the availability of a large tank facility (20 × 10 ×10 m) run by the Institute of Maritime Technology in Simonstown (near Cape Town). Interested parties should contact him (see Appendix C).

3. Gordon Swartzman (University of Washington, USA) announced the setting up of a web site for those wishing to seek information about his data analysis software:

http://www.cqs.washington.edu/~gordie/help.intro.html

11. WORKING GROUP RECOMMENDATIONS

The Working Group made the following recommendations:

1. The FAST WG should meet in Hamburg, Germany on Monday 21 - Wednesday 23 April 1997 to:

   a) Review the progress of the classification study group;

   b) Discuss and assess the impact of acoustical scattering from plankton on acoustical fisheries survey methods;

   c) Describe and evaluate methods for acoustically separating the plankton and fish components of the ecosystem;

   d) Discuss any problems and uncertainties in vertical sounder performance.

2. The FAST WG recommends that a study group be constituted to address and document issues of aggregation, localisation and classification including:

   a) tools, parameters and clues for acoustic classification
   b) classification methods evaluation
   c) behaviour information - its effect on and input to classification
   d) communication and collaboration between existing research programs.

3. The FAST WG recommends that F. Gerlotto should be appointed chairman of the FAST WG.

4. The FTFB and FAST WG should have a joint session (chairman to be arranged) to discuss and define the problems in determining catchability of sampling gears of size and species used to ground truth acoustic signals in pelagic and demersal hydroacoustic surveys.

5. The FAST WG recommends that details of the problems and uncertainties in vertical sounder performance be collated by Dr. David Demer. Any parties with relevent information should contact Dr. Demer at National Marine Fisheries Service, Southwest Fisheries Science Center, 8604 La Jolla Shores Drive, La Jolla, California 92037, U.S.A. or on e-mail: ddemer@ucsd.edu

12. CLOSURE

The chairman thanked the staff of the National Marine Fisheries Service, Woods Hole for their hospitality and members of the Working Group and Study Groups for their efforts and contributions.

13. NATIONAL PROGRESS REPORTS

Appendix A

14. SYSTEM UPGRADE INFORMATION

Appendix B

15. PARTICIPANT LIST

Appendix C

APPENDIX A: National progress reports

A.1 FRANCE

I. AMELIORATION DES MOYENS D'ETUDE

1.1 Navires de recherche halieutique

Le programme d'achèvement du N/O THALASSA a pris quelques retard, et les premiers essais à la mer de ce navire auront lieu en mars 1996.

1.2 Bassin d'essais

Le bassin d'essais de Boulogne-sur-mer est maintenant équieè d'un vélocimètre laser à une composante.

1.3 Instrumentation à la mer

Le système télécommandé acoustiquement de fermeture et de fractionnement du cul de chalut a connu des dysfonctionnements; ceux-ci ont été observés in situ, et quelques modifications de la géométrie de certains éléments (boîtier et largueur) ont permis d'y remédier. L'appareil est maintenant utilisé sans problème par les halieutes d'IFREMER.

II. ACOUSTIQUE SOUS-MARINE APPLIQUEE A LA PECHE

Alors que les travaux ci-dessus sont menés oar des équipes appartenant au même organisme, même si elles sont dispersée - sur le terrotoire français, les travaux menés en acoustique sous-marine appliquée a la pêche sont réalisése pour partie par l'IFREMER et pour partie par l'OSTROM.

2.1 Travaux réalisés par l'ORSTOM

Les activités de l'ORSTOM ont été assurées par une équipe de huit chercheurs et trois ingénieurs travaillant en coopération avec les chercheurs et ingénieurs des pays de la zone tropicale et d'Espagne. Le nombre total de campagnes a été limité en 1995 du fait de la priorité donnée au traitement de données au Sénégal et en Indonésie.

En Méditerranée, deux campagnes ont été réalisées dans le cadre du programme européen T-ECHO (projet AIR1 CT92 0314 de l'Union Européenne) concernant l'influence de l'environnement sur la distribution et la structuration des biomasses pélagiques. La première campagne a eu lieu en Espagne en mai et la deuxième en Adriatique en septembre, toujours à l'aide du sonar Reson multifaisceaux et de l'intégrateur de banc Ines Movies. Il s'agit des dernières campagnes du projet.

En Atlantique

Dans le cadre le l'étude du déterminisme des concentrations saisonnières de thons dans la zone équatoriale centrée sur 3°N et 15°W, une étude intégrée a été entreprise. Les premiers résultats indiquent une concentration d'un poisson mésopélagique Viinciguerria nimbaria, qui présente un schéma de migration nycthémérale inversé dans cette zone. L'étude englobe les aspects physiques (structure des masses d'eau), biologique (croissance, reproduction et alimentation) et comportemental (étude par hydro-acoustique). En 1995 cinq campagnes ont été réalisées (Microthon et Picolo) dans cette zone. Une communication des résultats a eu lieu lors du Symposium d'Aberdeen (juin 1995) et lors d'une table ronde du PNDR (Programme National sur le Déterminisme du Recrutement) en décembre.

Une campagne d#évaluation des stocks de poissons pélagiques du plateau continental de Guinée a été réalisée en début d'année.

En mer de Java

Dans le cadre du projet européen PELFISH conduit en coopération avec le BPPL indonésien, deux campagnes ont eu lieu, l'une couvrant le plateau continental du détroit de Makassar l'autre les tombants orientaux de la mer de Java et le nord de l'île d Java. L'objectif îtait l'îtude des stocks pîlagiques et leur relation avec la pêcherie de senneurs (évaluation du stock, comportements nycthéméraux et agrégatifs, structures spatiales). Cinq communications ont été présentées au quatrième Forum des Pêcheries Asiatiques (Beijing, octobre 1995) et portaient sur:

- les mesures de TS sur les espèces javanaises,
- une tentative de stratification des données acoustiques,
- la saisonnalité des distribution verticales des populations acoustiques,
- la saisonnalité de l'agrégation,
- la stratégie des flottilles et les structures de distribution de la densité sur les lieux de pêches.

Pacifique

En Polynésie les travaux sur le comportement agrégatif des thons sous des radeaux (DCP) se poursuit. Des campagnes de marquage acoustique ont eu lieu (marques émettrices et suivi du poisson) ainsi que des échoprospections autour des DCP.

Dans le cadre de la discrimination entre les échos du au plancton et ceux dus au poisson, une coopération s'est établie avec le laboratoire Tracor Applied Sciences de San Diego où un ingénieur ORSTOM passe une année sabbatique.

Dans la région Caraïbe

L'ORSTOM continue de s'impliquer dans les activités du Réseau Acoustique Caraïbes (RAC) par l'organisation de la cinquième réunion annuelle qui a eu lieu à Margarita (Vénézuéla) en février 95. John Simmonds était invité et a exposé les stratégies d'échantillonnage en acoustique. Au cours de cette année les membres du réseau, soit 19 personnes appartenant à 7 pays (Costa Rica, Cuba, Espagne, France, Mexique, USA et Vénézuéla), ont réalisé 7 campagnes dans la zone caraïbe et deux campagnes méthodologiques en Europe. La problématique dominante est celle de l'étude du comportement et l'évaluation des stocks dans les petits fonds.

Echospace

Le groupe Echospace s'est réuni à Aberdeenen juin dernier, à la fin du Symposium. Ce groupe a maintenant le statut d'association loi 1901 et son siège est à Nantes. Un projet d'ouvrage commun a été lancé sur le thème du comportement grégaire étudié par acoustique. Il s'agira sans doute d'un ouvrange collectif.

2.2 Travaux réalisés par l'IFREMER

Projet BIOMASS

Le rapport final du projet BIOMASS (FAR TE MA 2-542) a été terminé et expédié à la CEE/DGXIV. Rappelons que ce projet avait pour objectif essentiel la classification automatisée des détections de poissons en banc par les techniques bande étroite mais aussi large bande de fréquence. L'IFREMER n'a traité que des données en bande étroite grâce au logiciel MOVIES-B. Les principales conclusions sont la possibilité d'une classification automatisée, atteignant des degrés de précision compatibles avec les évaluations de stocks, à condition de traiter des données issues d'une aire géographique (ex la moitié sud du golfe de Gascogne) et une durée temporelle limitée (de l'ordre de 2 mois).

Logiciel MOVIES-B

Une nouvelle version de ce logiciel de stockage traitement des données acoustiques est en cours de mise au point. Elle permettra en particulier une acquisition plus poussée des données de navigation (GPS) et un traitement réactualisé (après le projet BIOMASS) des échos des bancs de poissons.

NO THALASSA

L'essentiel de l'activité en matière de technologie a essetiellement porté en 1995 sur l'équipement du nouveau de navire de recherche THALASSA (75 m de long) qui doit être opérationnel en juin 1996. Une attention spéciale a été portee sur la réduction du bruit rayonnéavec en particulier le choix d'une hélice adaptée (6 oales). Un dispositif spécial est prévu à bord pour la surveillance continue du niveau ce bruit rayonné; ce systéme devrait

également permettre la suirveillance du bon fonctionnement des équipements de détection acoustique implantés à bord.

Avant leur installation à bord du navire, l'ensemble des sondeurs verticaux et transducteurs a également été étalonné soigneusement en bassin à IFREMER Brest.

Enfin ce navire comportera un réseau informatique performant sur lequel transiteront également les données acoustiques ce qui en permettra un archivage centralisé. Un nouvel outil de visualisation intégrée des données halieutiques est en cours de mise au point. Il est prévu de prendre en compte les données acoustiques pour offrir aux scientifiques une aide à la prise de décision. On pourra en particulier représenter en plan horizontal mais aussi vertical la sonde, la nature du fond, la présence et le type de détection en même temps que les données géographiques, de navigation, océanographiques ou encore de pêche.

Evaluation acoustique des stocks

Deux campagnes à la mer ont été consacrées à la surveillance acoustique des stocks, mais uniquement en Méditerranée dans le golfe du Lion à bord du nouveau catamaran de recherche l'EUROPE. Il s'agit de PELMED 95 avec pour objectif essentiel la production par acoustique d'un indice d'abondance de l'anchois. Cette campagne a été suivie par ECOPEL orientée sur la de l'écologie des poissons pélagiques et plus spécialement l'anchois

A.2 GERMANY

Federal Research Centre for Fisheries, Institute for Fisheries Techniques, Hamburg

FRV *Walther Herwig III* took part in the ICES co-ordinated herring survey in the North Sea, July 1995 and covered the eastern part of Division IVb between the Doggerbank and the Danish coast. Acoustic data were collected using the EK500 echosounder with a hull-mounted transducer ES38 and stored on the Bergen-integrator BI500.

A hydroacoustic survey of herring and sprat stocks in the western Baltic was carried out in co-operation with Denmark in October 1995. The measurements onboard FRV *Solea* were performed with an EK500 echosounder connected to the BI500. The transducer 38-26 was installed in a towed body.

Trials were started to examine the echostructure with the signal and image processing software system "Khoros" running on a SUN workstation. The experiments are aimed to the classification of fish concentrations.

Fish reactions to vessel noise were investigated by means of a towed transducer in different lateral distances to the ship. A maximum of Sa was measured at a distance of 20 to 30 m to the vessel. Because of the high variance of the Sa values the experiment must be repeated in the next time.

A.3 REPUBLIC OF SOUTH AFRICA

Sea Fisheries Research Institute, Cape Town.

Surveys

Echo integration surveys of anchovy (*Engraulis capensis*) and pilchard (*Sardinops sagax*) spawner biomass and recruitment are undertaken each year in November and in May/June respectively. The estimates are used directly in recommending TACs for the South African anchovy and pilchard fisheries. Acoustic surveys have also been conducted of round herring (*Etrumeus whiteheadi*) and horse mackerel (*Trachurus trachurus*) biomass, for possible use in the management of these resources.

Acoustic Methodology

Effort has been concentrated on the improvement of single-target recognition methods for use in *in situ* target strength estimation with split-beam echo sounders. Commercial (Simrad EK500) single-target recognition systems have been tested on closely-spaced model targets in a large test tank at the Institute for Maritime Technology (IMT) in Simonstown. A number of new recognition techniques based on amplitude as well as phase variations in the split-beam elements have been developed and are now being tank-tested. These techniques are to be coupled with empirical methods to reduce the effect of overlapping echoes on *in situ* estimates of pelagic fish target strength.

A multi-beam 420 kHz high-resolution counting system (ABACUS) is being developed as a means of estimating density (and indirectly, target strength) in aggregations of pelagic fish which are too dense for the reliable estimation of target strength *in situ* by conventional split-beam technology. The receiver is now complete, and tank-testing of its performance has commenced.

In addition to the above, work is continuing on the improvement of sphere calibration techniques, using the tank facilities at IMT. Aspects under investigation are the verification of absolute back-scattering cross-sections of various standard spheres, and the effect of target movement on sphere calibration results obtained with split-beam echo sounders.

Behaviour

Acoustic investigations have been undertaken on the schooling and vertical migration patterns of pilchard, both of which can have a significant effect on acoustic survey results. The work has been done using a locally-developed program (SHAPES) to recognise schools and estimate their physical characteristics from echo sounder recordings. In addition, a sonar study of

pilchard avoidance reactions and schooling dynamics has recently been conducted from the Norwegian vessel *Dr Fridtjof Nansen*, using the vessel's Simrad SA950 true-motion sector-scanning sonar and data capture software.

Other aspects of fish behaviour being investigated acoustically include vertical migratory behaviour of horse mackerel and hake (*Merluccius capensis*), and the dynamics of chokka squid (*Loligo vulgaris*) aggregations.

Survey Design and Analysis

Research has been undertaken in the use of geostatistics to characterise differences in spatial distribution between pilchard and anchovy, for possible use in the design of joint acoustic surveys for these two species.

A.4 SPAIN

Atlantic Waters

The ACFM meeting in October 1994 considered that an analytical assessment of Atlantic-Iberian sardine stock was not reliable due to the absence of an acoustic survey covering the whole distribution area. In order to solve this problem, Portugal and Spain agreed to undertake a joint acoustic survey as soon as possible. This was finally achieved with the Portuguese research vessel *Noruega* from 5 May to 4 June 1995. This survey, *Ibersar-95*, covered the whole Atlantic-Iberian sardine distribution area between Cape Higuera (Spanish-French border) and Cape Trafalgar. Whereas in the Spanish waters sardine was found in small, isolated patches, close to the coast, in Portugal it was distributed further offshore and more concentrated. Total biomass estimated in Spain was the lowest since 1983.

Also results on Spanish blue whiting acoustic survey carried out in 1994 around the Bay of Biscay were presented at the Acoustic Symposium held in Aberdeen.

Contact person: Pablo Carrera, IEO A Coruña (IEO, Apdo 130, 15080 A Coruña, Spain)

Mediterranean Waters

From 1 to 12 November 1995, the acoustic survey Ecomed 95 was carried out on board RV *Cornide de Saavedra* and its main goal was the assessment of the sardine and anchovy. The area covered was the Catalan Sea (NE Spain) from 30 to 200 m isobath. Pelagic trawl were performed at night for species identification; catch in number of these fishing stations were used in order to allocate total echo integrated values by nautical mile.

Contact persons: Rogelio Abad, IEO Málaga (IEO, Apdo 285, 29680 Fuengerila, Spain); Magdalena Iglesias, IEO Baleares (IEO, Apdo 291, 07080 Palma de Mallorca)

A.5 UNITED KINGDOM

SOAEFD Marine Laboratory, Aberdeen

Surveys

Surveys of herring were carried out in July 1995 in the following ICES areas: VIa north; IVa (eastern section in the Shetland, Orkney areas); VIa south and VIIb. The latter survey was carried out on contract to the Irish government. The surveys encompass a large area in collaboration with the Norwegian, Danish and Dutch fisheries research laboratories co-ordinated by the Marine Laboratory. Survey data were collected using the Simrad EK500 and recorded using the BI500 at frequencies of 38, 120 and 200 kHz. Environmental data was collected during the survey. Relationships between stock and water depth, temperature, salinity, seabed type (from ROXANNE) and plankton distributions are being investigated from this data.

Surveys of spawning herring in the Celtic Sea were carried out in November 1995 and January 1996 on contract to the Irish government. Data were collected using an EK500 at 38 kHz and recorded using the EP500 software. Significantly larger quantities of herring were observed in January 1996 compared to previous years.

Acoustic data was also collected during the International Young fish Surveys in the North Sea and off the west coast of Scotland. These were collected using an EK500 at 38 and 200 kHz, and recoreded on the BI500. The survey mainly targets demersal fish, but it is hoped that the analysis of acoustic data might help to improve swept-area estimates in some way.

Data analysis

Work on survey analysis through the use of geostatistics has been carried out through an EC funded project in collaboration with the School of Mines at Fontainebleau, France and the Institute of Marine Research in Bergen, Norway. A variety of datasets have been prepared and analysed. Raw experimental variograms showed no structure in the datasets with highly skewed distributions. However, a log transformation followed by a backtransform has produced robust estimates of the variogram. These have been used to assess how best to utilise the available data and to produce estimates of variance and abundance that account for the autocorrelation. The validity of the backtransform has been investigated using simulation techniques. A geostatistical analysis of length groups has also been performed to improve the stratification criteria in TS allocation to the echo integral.

(Contact persons: John Simmonds, David Reid and Paul Fernandes)

British Antarctic Survey

Acoustic studies were carried out in the South Atlantic from RRS James Clark Ross during a two-legged cruise in January, February and March 1996. We used a Simrad EK500 sounder with hull-mounted 120 kHz and 38 kHz split beam and 200 kHz single beam transducers. Integrated and raw data were logged over a LAN to a Sun workstation. A PC was additionally used to provide a backup logging system for the EK500, and also to send set-up files of sounder settings. Integrated data were processed on the ship using Unix shell scripts, the statistical package Genstat and the visualisation system AVS, and a krill biomass estimate was derived. For the first time on this ship a towed-body containing a similar set of transducers to those mounted in the hull was deployed. The sounder was calibrated on two occasions at South Georgia using the standard sphere method.

Studies began and ended with large scale acoustic and oceanographic transects between Stanley, Falkland Islands, and the South Georgia shelf. These provided information on the current location of the Antarctic Polar Frontal Zone (APFZ). To the north of South Georgia two rectangular boxes were surveyed using acoustics and nets, and accompanying oceanographic measurements were taken using CTD, ADCP and undulator. These box surveys were the first of a series that will be repeated each year for at least the next five years in order to study inter-annual variation in krill and other zooplankton in relation to oceanography. Comparative zooplankton studies at sites on and off the shelf were supported by acoustic surveys carried out at the fine scale appropriate to the zooplankton net sampling.

In February, a study north of South Georgia and north of the APFZ, looked at squid and associated fish populations. The site was selected by tagging albatrosses known to prey on squid and observing their foraging trips, and by considering the current location of the APFZ. Considerable numbers of squid were caught, and it has been possible to attribute specific acoustic signatures to them.

In addition to the above surveys, all carried out at pre-selected locations, time was allocated during this cruise for fishing on targets found as a result of acoustic searches. This targeted fishing, using both a RMT8 and an LHPR, was in support of our continuing investigations into the identification and classification of acoustic targets in this region.

(Contact persons: Inigo Everson, John Watkins, Catherine Goss and Andrew Brierley).

Fisheries laboratory, Lowestoft, UK

DFR Lowestoft currently has a five year programme of research to investigate the movements and migrations of plaice and cod in the southern North Sea. The programme, which lasts until 1999, involves tracking individual acoustically-tagged fish, as well as deploying several hundred fish tagged with data storage (archival) tags. A parallel programme continues the

development of the Lowestoft data storage tag with the aim of making the tag significantly smaller, as well as adding additional sensors.

The aim of the archival tagging programme is to describe patterns of behaviour over the time scales of seasonal migrations. To date the work has been restricted to plaice and 140 tags have been released in three batches between December 1993 and March 1995. Different return rates have been recorded between the three batches of tags, but in each case the return rate of fish marked with data storage tags has matched that of control fish marked with Petersen disc tags. Overall, 20 tags have been returned. Two tags failed prematurely but the remaining 18 have yielded 1500 days of pressure and temperature data recorded at 10 minute and 24 hour intervals, respectively. Three tags have been returned with full memories (225 days) after approximately a year at liberty. The pressure data have been used in conjunction with the Lowestoft tidal stream simulation model to successfully reconstruct the ground tracks of the fish. Independent checks of the veracity of these reconstructions have been obtained from the pressure and temperature data recorded by the tags, using a different tidal (hydrostatic) model and satellite measurements of sea surface temperature.

The aim of the complementary fish tracking programme is to obtain a direct estimate of the downtide swimming speed of fish migrating by selective tidal stream transport. The work is being undertaken by RV 'Corystes', using sector scanning sonar and high-frequency transponding acoustic tags. Continuous measurements of tidal stream speed and direction are made with an Acoustic Doppler Current profiler during tracking.

Engineering developments have included the construction of a batch of 20 archival tags for Norway designed to work at depths down to 1000 m. The titanium cases of these tags proved to be too large for practical application and further development of deep water tags has been postponed until completion of the Mk 3 Lowestoft data storage tag, which is scheduled for the summer of 1996. This new tag will be only half the size of the existing tag. But it will have four times as much memory and will only cost half as much a the Mk 1 hemispherical tag currently being used with large plaice. Development work on a high-resolution solid state miniature compass is also well advanced.

(Contact person: Geoff Arnold).

A.6 UNITED STATES

National Marine Fisheries Service, Alaska Fisheries Science Centre

The Alaska Fisheries Science Centre (AFSC) has continued research on walleye pollock (*Theragra chalcogramma*) and Pacific whiting (*Merluccius productus*) in the northeast Pacific Ocean. Annual spawning stock surveys of pollock in the Gulf of Alaska (Shelikof Strait) and Bering Sea (Bogoslof Island) continue as do summer triennial surveys of pollock in the Bering Sea and Pacific whiting off the west coast of the US. Co-operative surveys of pollock in the Bering Sea with Japan, Russia, Korea and China are ongoing.

Research activities include: 1) continued target strength measurements for pollock and whiting, using both the centreboard-mounted system as well as a lowered-transducer assembly; 2) the development of an acoustic buoy system (in collaboration with scientists at the Institute of Marine Research, Bergen, Norway) to investigate fish behaviour in the vicinity of research vessels either trawling or conducting acoustic transects. First field tests of the system are expected in early 1997; 3) evaluation of geostatistical techniques to variance estimation of stocks surveyed acoustically. A special study was conducted on a spawning group of pollock near the Shumagin Islands in the Gulf of Alaska. Replicate surveys were completed and the application of geostatistical techniques will be investigated. Selected transects were repeated to observe temporal changes and transects orthogonal to the original survey track were also completed. Analysis of this data set is expected to be undertaken this fall; 4) comparison of the acoustic scattering by macro-zooplankton collected during the 1995 Pacific whiting survey. By observing the difference in scatter at 38 and 120 kHz, information about the size of the scatterers may be obtained using the technique described by Mitson *et al.* (1995).

(Contact persons: Jim Traynor, Neal Williamson or Chris Wilson)

National Marine Fisheries Service, Southeast Fisheries Science Centre

The Southeast Fisheries Science Centre (SEFSC) is currently conduct three annual surveys that employ acoustics: small pelagics, reef fish and a survey of the Experimental Oculina Reef Reserve. They are using a Simrad EK500/BI500, with the transducers mounted in an Endeco V-fin. Three Simrad transducers were just hull-mounted on the NOAA ship Oregon II; 38 kHz and 120 kHz split beam and a 200 kHz single beam.

The small pelagics survey (sardines, herrings, scads, chub mackerel, gulf butterfish) is conducted in October-November. Transects are selected systematically. Trawl tows to identify targets are conducted purposefully. Acoustic transects are run at night only when target species form a scattering layer near the thermocline. Targets species comprise 100% to 80% of the total catch from trawl tows within this layer. A bottom trawl survey is conducted during daylight hours. These stations are selected using a stratified-random procedure.

Acoustic data are also collected during a summer reef fish survey. Reef sites are selected in two stages with first stage units selected by a stratified-random procedure, and sample sites selected randomly. Fish abundance is estimated using video cameras. Systematic transects over each reef site are run to collect acoustic data. Acoustic estimates of total fish abundance provide auxiliary information.

In 1993, the South Atlantic Fisheries Management Council set aside an experimental area close to reef-fish fishing that is located off of Ft Pierce, Florida. This area was named the Experimental Oculina Reef Reserve, and will be closed for a 10 year period that started on 27 June 1994. The EORR is a 96 km^2 area with beds of fragile Oculina corals. The goal of the closure is the re-establishment of reef fish, especially groupers. Groupers form spawning aggregations over these reefs in January-April. Videos made during manned-submersible

surveys in the 1970s show large concentrations of groupers, snappers and amberjacks. These aggregations extended well above the bottom. Any changes in the abundance of fishes near the bottom during the closure period will be monitored using acoustic surveys and an ROV. The first survey was completed in January 1995. The overall acoustic estimate of fish within 7 m of the bottom was 17 m^2 per nautical square mile. Video data collected with an ROV, and with a manned submersible confirmed few fish over Oculina beds. The 1996 survey is scheduled for April.

(Contact person: Chris Gledhill).

National Marine Fisheries Service, Southwest Fisheries Science Centre

Hydroacoustic methods have been used to study predator-prey relationships in a variety of marine ecosystems. In general, a Simrad EK500 was used, configured for 38 and 120 kHz split-beam and 200 kHz single-beam operation. Remote species delineation was performed with a variety of multifrequency methods, *in situ* individuals target strength measurements, morphological differences in the echograms and directed high-resolution net sampling.

In collaboration with the Fisheries Oceanography Co-ordinated Investigations (FOCI), the distribution of juvenile pollock prey and predators were studied in relation to bathymetric features. Near the Pribil of Islands, hydroacoustic transects were conducted with the R/V *Surveyor* across the inner, middle and outer shelf domains. The aim is to understand the biological and physical processes that cause variability of recruitment to commercially valuable fish and shellfish stocks in Alaskan waters.

Off the northern tip of the Antarctic Peninsula, near Elephant Island, the distribution and abundance of Antarctic krill (*Euphausia superba*) were acoustically surveyed each austral summer since 1988/89. These data are used to relate prey availability to the success rates of land breeding predators (chinstrap penguins and southern fur seals). The eight year time series is used to describe within and between season variations in the distributions of krill and other zooplankton, penguins, seals, phytoplankton, ice and water types.

In conjunction with a research team from UCSC, the role of sound in the predator-prey relationships of whales and krill was investigated in both the Bay of La Paz, Mexico, and in the relatively noisy Monterey Bay, California. Large and small area acoustic surveys were conducted in both areas. Concurrently, blue and fine whales were tagged with time-depth-recorders and both vocalisations and ambient noise were recorded.

In support of the NOAA Coastal Ocean Program (COP) Georges Bank predator-prey study, a two frequency EK500 system was tested and calibrated off Georges Bank, aboard the chartered vessel *Katahdin*.

Off southern California, the distribution and feeding behaviour of baleen whales were studied relative to prey distribution and abundance, and oceanographic factors. Large and small area acoustic surveys were conducted near the Channel Islands from the R/V *McArthur*.

Simultaneous studies included visual whale surveys, net sampling of krill, oceanographic sampling, photo identification, satellite tagging and biopsy sampling.

Additionally, research and development of acoustic technologies have been conducted in Capetown, South Africa and the surrounding waters. Investigations relating to acoustic doppler methods for determining fish school velocities, multi-beam methods for single-target delineation and system calibration uncertainty, were conducted through international co-operation with the Sea Fisheries Research Institute.

(Contact persons: Roger P Hewitt and David A Demer)

National Marine Fisheries Service, Northeast Fisheries Science Centre

For more than two decades, the Northeast Fisheries Science Centre (NEFSC) has not been involved in fisheries acoustics research. However, the NEFSC has recently purchased a Simrad EK500 scientific sounder (with 38 and 120 kHz split-beam transducers) and Simrad BI500 post-processing software. The first attempt at using the EK500 was made during a 1995 May cruise sponsored by the NEFSC and the NOAA Coastal Ocean Program's (COP) Georges Bank predation study.

The 1995 COP cruise used the EK500 from an electronics van mounted on a chartered 32 m commercial vessel. A 160 kg Simrad flooded dead-weight towed-body housed a single (38 kHz) transducer. The towed body-body was towed mid-ship via double armoured multi-conductor cable from a portable A frame and winch system. Optimal towing speed of the towed body, based o the passive test of ambient noise, ranged between 4.5 and 6.5 knots. Calibrations of the 38 and 120 kHz were done dock-side (e.g. at the WHOI dock having 20 m bottom depth), while calibrations at sea were unsuccessfull due to strong tides. The EK500 operations went well with the exception of some minor cable problems.

A systematic grid survey of acoustical transects along with midwater trawling and plankton sampling were completed across Georges Bank during the 1996 COP predation study during May. The purpose of the COP field study was to estimate predation mortality of larval cod and haddock by pelagic fish (e.g. mackerel and herring). This field study was in co-ordination with other field studies simultaneously conducted by the US GLOBEC program.

The EK500 will be used on a second cruise this May aboard the NOAA R/V *Albatross IV* during the 1996 COP Georges Bank predation study. The EK500 (with hull-mounted 38 and 120 kHz transducers) has been installed recently on the NOAA R/V *Albatross IV*. Sampling operations will involve systematic acoustical survey of the density distribution of pelagic fish with trawling and ichthyoplankton sampling.

The NEFSC has recently initiated fisheries acoustics in its field research and anticipates further development in its acoustical program in the future. The NOAA R/V *Delaware* is expected to be out of the shipyard next spring with a second EK500, and plans are underway to train NEFSC staff with the EK500 operations.

(Contact person: William Michaels)

Tracor Applied Sciences, San Diego, USA

Research in zooplankton continues at Tracor and at the University of Southern California, where data from a BITS mooring off the southern California coast continues to add to measurements of abundance and variations in the biomass of small zooplankton, micronekton and juvenile fishes. The mooring was initially deployed in 1992. The most recent upgrade has been the addition of an eight frequency acoustical sensor at one depth. This will allow measurement of the zooplankton size spectrum at that depth every half hour as currently configured. A similar system, which included two eight-frequency sensors with internal recording, was placed on Georges Bank last fall, but along with two other co-located moorings, broke loose in a March storm and is currently the subject of a search. Anne Lebourges (ORSTOM) and C Uzes (U of Georgia) are working with Tracor on advanced methods for transforming multifrequency TAPS data to distributions of plankton abundance. M Berman and J Green (NOAA/NMFS Narragansett), Steve Ignell (NOAA/NMFS Auke Bay, AK), J Napp (NOAA/NMFS/AFSC/RACE Seattle) and C Barans (State Wildlife and Fisheries Department, South Carolina) are currently working up multifrequency TAPS data sets collected on Georges Bank, off southeastern Alaska, in the Bering Sea, off southeastern Alaska and in an estuary on the east coast of the US. Data from the BITS mooring off southern California and TAPS data from the same location are also being analysed. A special, deep submergence TAPS was used during the JGOFS program of research in the Arabian Sea over the last year. The system was employed to collect data during both CTD casts and from a SeaSoar towed body. These data include over one million independent measurements of volume scattering strength, with depth and temperature, along the JGOFS lines in the Arabian Sea during different seasons. We are preparing to deal with this (major) data processing task.

Tracor scientists are also working with scientists at the University of Rhode Island and Oregon State University to develop technology to examine the distribution of small zooplankton in relation to very thin layers (*ca* 10 cm) of phytoplankton which have been observed in the sea. The abundance of phytoplankton in these layers has been shown to be exceptionally large and mechanisms regarding their formation and persistence are also the subject of study. In a new effort, Tracor has initiated a project with researchers at the University of Washington (UW) to develop methods for examining benthic organisms in and on the bottom with very high resolution, high frequency acoustics. We are examining the applicability of multifrequency acoustical methods to problems in measuring the abundance, distribution, movements and migration of benthic animals, e.g., brisaster urchins, burrowing shrimps and crabs. The first field program for this work was carried out on a mud bottom in a fjord environment in the San Juan Islands of northern Washington State.

(Contact persons: D V Holliday or Charles Greenlaw at Tracor; R E Pieper and J Dawson at USC; D Jackson and P Jumars at UW; P Donaghay at URI; T Cowles and R Zanefeld at OSU).

Great Lakes Centre for Education and Environmental Research SUNY at Buffalo State College

Acoustic research at the Great Lakes Centre is focused on three primary themes: energy transfer among nekton in the Great Lakes and large estuaries, theoretical modelling and empirical measurement of frequency and aspect-dependent backscatter by aquatic organisms, and continued refinement of spatially-explicit bioenergetic models of predator-prey interactions.

The trophic transfer studies examine the spatial distributions and interactions of piscivorous fish and their prey. Acoustic (38 kHz, 120 kHz dual and split beam) and trawl (bottom, midwater) data are collected seasonally in Lakes Erie and Ontario in conjunction with Canadian colleagues (CCIW, University of Toronto). In Chesapeake Bay, we are participating in the Trophic Interactions of Estuarine Systems (TIES: under LMER-NSF) project to model seasonal energy transfer across trophic levels over a range of spatial scales. A project with the Maryland Environmental Service is in its 4th year of seasonal sampling to describe the impact of dredge spoil placement on fish communities at dredge and control sites is in the upper Chesapeake Bay. A project has been initiated in the Hudson River Estuary to examine distributions and interactions of striped bass (*Morone saxatilis*) and bay anchovy (*Anchoa mitchilli*).

Collaborations continue with C Clay (University of Wisconsin-Madison) to model and measure the backscattering of swimbladdered and non-swimbladdered aquatic organisms. A general acoustic model has been completed for swimbladdered fish. This model has been used to predict frequency and aspect-dependent scattering by individual organisms and probability density functions (PDF's) of aggregations. A four frequency, digital sounder, designed and built by the University of Wisconsin-Madison, will be used to empirically measure scattering by fish species in laboratory, in fresh water and in marine environments.

Efforts to refine spatially-explicit bioenergetic models of predator-prey interactions include modelling and parameterisation projects. Three-dimensional visualisation models are used to examine encounter rates of predators in Chesapeake Bay and interpolation distances of fish densities in Lake Ontario. Individual based models (IBM's) are being developed to enable comparison of potential growth of static predators to dynamic individuals. To increase precision of foraging models, anchovy data from Chesapeake Bay are being used to quantify inter-fish distances and swimming speeds through a diel cycle. To examine the scale-dependence of nekton temporal distributions, a 120 kHz split beam sonar will be installed on a large meteorological buoy in Lake Ontario during spring 1996.

(Contact person: Stephen Brandt, John Horne, J Michael Jech)

Woods Hole Oceanographic Institution

Scientists at the Woods Hole Oceanographic Institution have been developing acoustic scattering models of various types of zooplankton and applying the results to their surveys over Georges Bank. Model development: Laboratory-style acoustic backscattering measurements have been made with live individual zooplankton both in land-based and shipboard

measurements with freshly caught animals. Data have been collected over the range 50 kHz to 1 MHz. In one series of measurements, backscatter versus angle has been collected for decapod shrimp over than range of frequencies. Using the laboratory data, scattering models have been developed for fluid-like scatterers (euphausiids, decapod shrimp), elastic shelled scatterers (gastropods) and gas-bearing scatterers (siphonophores). Surveys: Along with colleagues (including Dr Chuck Greene from Cornell University) we have conducted acoustic backscattering surveys of the entire water column at 120 kHz and 420 kHz over Georges Bank. Distributions of copepods and gastropods have been characterised in terms of their horizontal and vertical variability. The mixing processes over the bank have played a key role in the distribution of the animals. Because of the diversity of the animal populations, the echo energy was not related in a simple way with respect to total biomass (i.e., the data did not follow a simple regression of echo energy versus biomass). The use of our above-mentioned scattering models for the different animal types has helped us interpret the data. In fact, we have shown that when using the models, we have been able to predict the trend of acoustic scattering levels for the different stations.

We are currently constructing a five frequency echosounder covering the frequencies 38 kHz to 1 MHz. Early tests begin in the fall of 1996.

(Contact persons: Tim Stanton and Peter Wiebe)

APPENDIX B: System upgrades.

B.1 New "MOVIES".

a) Movies "C": MOVIES actuel revu, en perticulier
- copatibilité avec tous types de sondeurs numériques
- calcul de nouveaux paramètres descripteurs des échos
- traitement bifrequence
- possibilite de classification automatisée des échos
- prise en compte de la nature du fond

b) Etalon: module regroupant:
- les fonctionnalités étalonnage de MOVIES
- le logiciel "BILLE"de mise en place de la cible
- l'étalonnage in-situ sur échos simples de poissons

c) IMAGE:
- production de documents synthétiques
- cartographie

d) STOCK: reprise du logiciel OEDIPE pour le calcul des stocks de poisssons avec en particulier la possibilité de prendre en compte:
- les TS in-situ
- les résultats de l'écho-intégration par banc
- la classification

e) SIMULATION: intégration du logiciel de simulation des échos de sondeur avec calcul des paramétres "MOVIES" sur banc réels at images

MOVIES-B: FONCTIONS ACTUELLES

Toutes fonctions par menu déroulant

VISUALISATION:
- données sondeur at navigation

ARCHIVAGE:
- données acousticques brutes (*.MOV)
- données traitées (*.MEI ou *.MBC)
- cahier de quart (*.LOG)
- différents réglages at configurations

IMPRESSION:
- échogrammes couleur sur imprimante graphique

- données traitées (*.MEI ou *.MBC, résultats de l'étalonnage) sur imprimante texte

TRAITMENT:
- en temps réel ou en rejeu: écho-intégration par couche ou par banc
- en rejeu seulement: tomographie

ETALONNAGE du système:
- étalonnage acoustique sur bille avec calcul des paramètres pertinents
- control de l'amplification TVG
- control de l'interface INES

CONFIGURATION du système:
- espaces disque d'archivage
- choix des sorties imprimante
- définition des périphériques de navigation
- langue

B.2 EK 500 SOFTWARE VERSION 5.20; Summary of New Features and Improvements

Replay of Survey

By means of EP500 or BI500, raw sample data from EK500 can be recorded on tape or hard disk for later replay using the EY500 software.

This unique feature allows scientists to actually repeat the survey and study the exact same fish at the exact same locations, with new echo sounder parameter settings. Examples of settings that can be of interest to vary are integration and TS-detection parameters. In fact all echo sounder parameters except transmitted power, pulse duration, bandwidth and ping interval can be changed. (The ping interval can be changed during replay, but it will only effect the speed of replay, not the echogram itself).

Essential transceiver and transducer data will be stored at recording time, and restored when replaying.

In addition, the replay function is sensitive for time, position, vessel log, heave and annotation data. So, when replaying, these data will show up as during the survey.

New Algorithms for Single Fish Detection

Earlier versions operated with only one threshold for single fish detection. Version 5.2 operates with multiple thresholds, thus allowing for detection of single fish echoes closer to the noise level.

In order to reduce the possibility for several fish in the pulse volume being detected as one single fish, the standard deviation in phase measurements in the returned echo is now used as one of the discriminators. Earlier versions used the average phase difference as a discriminator criterion.

In addition to the threshold, pulse duration and phase deviation criteria, a multiple echo amplitude peak detector is incorporated for the best possible single fish detection.

Improved Calibration Accuracy

For sample distance clock, a constant low sound velocity is used. The sound velocity/depth profile is corrected for by inserting extra samples in software. This method could, at certain calibration sphere depths, cause a small error when calibrating Sv transducer gain. Version 5.20 eliminates this risk by starting the sound velocity profile at different onsets.

Version 5.20 subtracts three sample distances from the detected target depth in order to compensate for echo pulse rise time.

Furthermore, the depth to the target is interpolated between sample intervals to increase accuracy in transmission loss compensation.

Vessel Speed Input from Navigation Instruments

In addition to position, EK 500 can now read vessel speed information from navigation instruments supplying these data in NMEA 0183 format. The data can be received on the navigation serial line or ethernet port.

HP Deskjet Printer Support

The HP Paintjet printer is discontinued and a new printer driver is included in the EK500 software to support the HP Deskjet series of printers. The printer we recommended is the HP Deskjet 850C. Since the new printers do not have continuous paper, the echogram sheets are stamped with page numbers.

New Ranges

Many customers have asked for 15 m and 150 m ranges in addition to the existing basic echogram ranges. Version 5.20 includes these ranges.

Improved Scope Function

The oscilloscope function is improved by allowing the operator to select the maximum and minimum received power levels to be displayed.

Better Resolution in Sa Values

The Sa values routed to the printer and serial line output now include one decimal. Example: An Sa value of 5.45 m^2/nm^2 would with earlier versions be truncated to 5 m^2/nm^2.

Number of Sample Data Increased from 5,000 to 10,000

This effects logging to hard disk of all sample data (Power-, Phase-, TS- and Sv-samples). At 38 kHz operating frequency you can now log (and replay) sample data to a range of 1,000 metres.

More Flexible Sequencing of Transducers

Up to 32 transducers can be multiplexed and the number of soundings on each of these transducers can be set individually. (Optional multiplex unit required).

Menu Texts now in French and German

In addition to Norwegian and English, the operator can now select French and German in the menu texts.

Avoids Multiples of Ethernet Datagrams

When operating two or more transceivers simultaneously and logging data from these over ethernet, telegrams were sent twice for each frequency. This bug is now removed.

Double Log Based Table Printouts Prevented

At high readings of log distances (>3,000), a double set of TS/integration tables were sometimes printed. This effect has been removed.

Improved Handling of Log Interval at Low Vessel Speeds

Changes in velocity are now being monitored more often to prevent no reaction for vessel speed close to zero.

APPENDIX C: Participant list

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