Fisheries Technology Committee **ICES CM 2002/B:05**

Report of the

Working Group on Fisheries Acoustics Science and Technology

Montpellier, France
17 June 2002

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

Palægade 2–4 DK–1261 Copenhagen K Denmark

TABLE OF CONTENTS

EXECUTIVE SUMMARY

The Working Group on Fisheries Acoustics Science and Technology (WGFAST) met in Montpellier, France on 17 June 2002, following the Symposium on Acoustics in Fisheries and Aquatic Ecology. Fifty-one participants attended the meeting. The agenda included: a) a discussion on the results of the ICES Symposium on Acoustic in Fisheries and Aquatic Ecology held in Montpellier during the previous week; b) decisions on items discussed at the 2001 meeting; c) an initial discussion on the 2001 resolution concerning the evaluation of the possibilities and limitations of getting hydroacoustic data from commercial fishing vessels; d) a discussion on acoustic seabed classification; and e) the review of the work of the PGHAC planning group on the HAC standard data exchange format.

The 2002 WGFAST recommendations resulting from this meeting are that:

1) a Study Group on Acoustic Seabed Classification (SGASC) reporting to WGFAST be form to evaluate acoustic seabed classification technologies and applications, its underlying physics, theoretical basis, and empirical practices with reference to scales of observations, data quality and standards, classification methods and criteria, ground-truthing means, sampling design, and the combination of this ancillary information in studies on fish distribution, abundance and ecology. This Study Group should include members of other Committees or Working Groups interested in acoustic seabed classification.
2) a Study Group on Assessment of Possibilities of using Fishing Vessels for Acoustic data Collection (SGAPFVAC), chaired by William Karp, reporting to WGFAST be created to promptly evaluate the possibilities and limitations of using fishing vessels to collect acoustic data for fish stock assessments and recommend guidelines and standards.
3) the 2003 WGFAST meeting be organised in Bergen, Norway, on 19–21 June, to:

    - initiate work on acoustic seabed classification in co-ordination with the proposed Study Group to work on this subject (see below);
    - discuss developmental work and applications of echo trace spectral signatures;
    - discuss the combination of methods in acoustic applications and multi-species estimation in the context of an ecosystem approach;
    - discuss advanced technologies and platforms;
    - review the works of the:
    - Planning Group on the HAC (PGHAC) common data exchange format;
    - Study Group on Baltic Herring TS (SGTSEB);
    - Study Group on Assessment of Possibilities of using Fishing Vessels for Acoustic data Collection (SGAPFVAC);
    - recommend a new Chair for chairing the WGFAST for the next 3-year term.

1 TERMS OF REFERENCE

In accordance to the ICES Resolutions adopted at the 89th Statutory Meeting, the Working Group on Fisheries Acoustics Science and Technology (Chair: Yvan Simard, Canada) met in Montpellier, France, on 17 June 2002 to:

a) discuss the results of the ICES Symposium on "Acoustics in Fisheries and Aquatic Ecology";
b) discuss the possibility of preparing a special issue of a Journal on the contribution of acoustics to ecosystem study and a review article on use of acoustics for bottom classification;
c) initiate work to evaluate acoustic seabed classification technologies and applications with reference to scales of observation, data quality and management, theory of acoustic seabed classifications, classification methods and criteria, and ground-truthing standards;
d) initiate work on the development of recommendations for the collection and analysis of hydroacoustic and ancillary data aboard commercial fishing vessels and the review of the advantages and limitations of such data collection for preparing papers on this topic for the 2003 meeting;
e) review the work of the Planning Group on the HAC (PGHAC) common data exchange format.

WGFAST will report to the Fisheries Technology Committee at the 2002 Annual Science Conference.

2 MEETING AGENDA AND APPOINTMENT OF A RAPPORTEUR

The Chair opened the meeting and John Andserson from the Northwest Atlantic Fisheries Centre of Fisheries and Oceans Canada was appointed as Rapporteur.

The adopted agenda was:

Topic 1 "Discussion on the results of the Symposium"
Topic 2 "Postponed decisions from 2001 meeting"
Topic 3 "Hydroacoustic from commercial fishing vessels"
Topic 4 "Acoustic seabed classification"
Topic 5 "Review of PGHAC report"
Miscellaneous
Recommendations
Closure of the meeting

A list of participants appears in Appendix.

3 TOPIC 1. DISCUSSION ON THE RESULTS OF THE SYMPOSIUM

The following subjects were presented by the Chair as areas of research emerging from the presentations made at the Symposium.

3.1 Echo Trace Spectral Signatures:

Several papers presented at the Symposium explored multifrequency and wideband acoustics to infer characteristics of the insonified targets such as their taxa and/or their behaviour. From these new results and the previous knowledge on this approach, what are the possibilities, limitations and needs for future research in this area? The discussion wandered around the several important points that are summarised below.

- The challenge is using the frequency information that can mean several things such as the tilt angle of the fish relative to the beam or its biological (e.g., species) and physical properties (e.g., size). The echo trace spectral signature does not directly lead to echo trace classification, as commonly understood for species or taxa identification. Given the intra- and inter-specific fish inherent variability observed in the field, the challenge is big. Validation is required throughout the process, and adequate validation is difficult. Likely new technologies (e.g., acoustic camera presented at the Symposium) can help here.
- In the future, the definition of what we want for echo trace classification should be rethought.
- Broadband and multifrequency techniques should not be used as the same approach since they have distinct advantages and drawbacks. One advantage of broadband acoustics is its capacity for better range resolution.

- What is the advantage of such approaches for echo trace classification compared to the echo energy partitioning techniques at common single frequency we are all used to for fish stock estimation surveys? Handling more information requires more effort. Given the high variability context, does this worth the effort?
- Last decade zooplankton acoustic research have shown, both empirically and with scattering model, that their TS signature at several frequencies were species specific. This led towards trying broadband acoustics for this problem.
- Good sound scattering models from complex surfaces are now available. They can be used for determining the discriminant frequencies, the number of frequency required and the bandwidth. Wrong frequencies, wrong bandwidth, wrong results.
- Models can guide us to move forward but the ideas will evolve in time and the specific outcome is not clear.
- The possibility of adequately integrating model results in routine practice in the field was questioned.
- Models can be combined to field data to identify the source of variability (i.e., in TS) that can mask the information (i.e., total biomass) sought from acoustic surveys.
- The fish is no longer a point target relative to TS, the spectral signature is a breakthrough towards a fish "acoustic cast". Detailed experiments will be needed to determine where this approach will work.
- We need to open our minds to new approaches to move ahead. This cannot be done in traditional survey mode.
- The inherent variability in the field can be taken into account by new technologies such as expendable instruments.
- Echo trace identification is recognised as a big challenge to exploit all the information present on echograms to get an understanding of the communities at the ecosystem level. Looking with several acoustic frequencies surely brings more information to help to solve this problem.
- The combination of single target TS information at several frequencies as presented at the Symposium may help to better classify echo traces.
- The data collected at several frequencies should be properly stored for future uses. Large data sets from different areas will be needed to develop robust classification solutions.
- The several tools available to us to make use of more information are now different and here is where we must move forward.

Len Zedel, Van Holliday, John Simmonds, Tim Stanton, Gordie Swartzman, John Horne, Robert Kieser, Paul Fernandes, Dezhang Chu, Jacques Massé, Ian McQuinn, David MacLennan and Yvan Simard contributed to this discussion.

3.2 Habitat Acoustic Classification:

Diverse applications of acoustics for fish (benthic) habitat[1] description, namely the seabed substratum type and the flora and fauna growing in or on it, were presented at the Symposium. As discussed at previous WGFAST meetings, such applications of acoustics are getting more and more considerations from members of our community interested to link the fish with some habitat characteristics for various objectives including ecological considerations, ecosystem approach, stock estimation and survey design. The WGFAST will co-chair a special session on acoustic habitat classification at the 2002 annual science conference in Copenhagen. Work in this field is still very empirical. It has not reached the same level of standardization that the WGFAST implemented in fisheries acoustics in the last decades. This acoustic aspect of the question is a matter that belongs to the WGFAST and it is critical that the WGFAST actively contributes to the scientific development of this acoustic field. What type of action should the WGFAST undertake? Here are some comments and discussion points from the assembly.

- This is an area that is developing rapidly and which is interesting a lot of people. It is important to look at the underlying physics and theoretical basis of sound scattering from the seabed. Several scientists are working on these questions in other fields of acoustics. It is important to invite these peoples. Possible WGFAST actions are the organisations of special theme session at the annual science conferences and workshops.
- Support to the previous comment: Acousticians that are specialised in this field work in working in "biology free zone" and do not generally take into account the biology. They are a very sophisticated group of scientists and we are below the critical mass (driven by the navy).
- It is important to define the questions of interest. What tools are available? What spatial scale is relevant, for the observations and for the ecological interpretations?

1 Traditionally fish "habitat" is used as meaning "benthic habitat" only, the whole pelagic environment being ignored.

- There is expertise also in geo-acoustic groups, mostly from an empirical approach and not from scattering models. Integration of those peoples is important. There are review papers dealing with the theory and practice that are available.
- The technology is in advance compared to models in this field.
- This is an interesting field of scientific studies where the difference is primarily along the depth of the bottom, and the coastal area versus the open ocean.
- The WGFAST must have a comma between FA and ST. The WGFAST community must deal with other advanced technologies.

The Chair suggests that ICES create a Study Group on acoustic seabed classification in collaboration with other interested groups. This might be also a recommendation coming from the steering committee in charge of the special theme session on this issue at the 2002 annual science conference. The details of the Study Group would be decided then, after the 2002 annual meeting.

Van Holliday, Dezhang Chu, Len Zedel, Tim Stanton, Rudy Kloser, Jim Galloway, and Yvan Simard contributed to the comments.

3.3 Single Target Tracking and Target Strength Modelling

In situ TS estimation from the split-beam technique and single target tracking from several tracking algorithms appeared to have reached the level of routine application to study fish and plankton behaviour *in situ*. Though a different research area, TS modelling also appears to be more and more applied to extract characteristics from fish *in situ*. What are the expected further developments in these areas?

- We need to look in details at the distribution of TS and the spectral signature in the targets, not just the mean but higher moments too.
- Target tracking is used in rivers to measure fish flux. It is used in ocean now to measure TS but it will be useful to measure other fish characteristics such as behaviour. It can be used to deduce fish migration routes when fish flux is measured.
- From ship deployments, which behaviour to tackle with single target tracking must be carefully selected, especially considering the movements of the platform and the medium?
- Why don't we have low-cost self-contained split-beam mooring systems to study fish migrations over long periods in critical areas?
- Monitoring of fish can also be done from forward propagation of sound as it was presented at the Symposium from moorings of transmitters and receivers.
- Yes, but then the insonified volume is function of the sound propagation paths.
- Monitoring systems in oceans, with links to shore, are now in project in several environments.

Van Holliday, Dezhang Chu, Robert Kieser, Ian McQuinn, Bo Lungdren, Len Zedel, and Yvan Simard contributed to the short discussion.

3.4 Combination of Methods and Multi-species Biomass Estimation

Acoustic estimation has been traditionally targeting one or a few commercial species, often taking advantage of seasonal aggregation, but now the ecosystem approach to fisheries management requires a more complete view of the community, including notably the important forage species. This is a much larger task and the combination of several methods of observation with formal merging of the results appears to be required. What are the possible avenues? Comments and discussion were as follows.

- To study the whole community, the classification could be done by trophic links instead of by species.
- There must be a balance between single species (stock) and multi-species applications.
- Twenty fish stocks managed by ICES in Europe are assessed by acoustic, but some species like haddock and cod cannot be separated. As a result, there is a will to move towards multi-species estimation.
- The integration of data from commercial fishing fleet in scientific estimation surveys is an area for future.
- We should take advantage of imaging systems using optics, such as web cameras and image compression which are getting very cheap.

- The research on seafloor community is more advanced in using different observing methods, for example laser live scanner with detection ranges of about 30 m. These are current applications that can be affordable.
- Other potential complementary methods were invoked, such as the lidar for pelagic schools, as presented at the Symposium, and continuous egg samplers for pelagic fish spawning at the surface.
- The possibility of ground-truthing from an acoustic camera, such as the one presented at the Symposium, which can see over larger ranges than optical ones and which would have less avoidance and capturability problems than a trawl, was suggested as an area for further exploration.
- The behaviour (e.g., tilt angle) must be integrated in the combination of methods.
- Automated underwater vehicles (AUVs) are another observation mean that could be used more regularly.

Arnaud Bertrand, Tim Stanton, Paul Fernandes, Rudy Kloser, Van Holliday, Bill Overholtz, John Breslin, Jacques Massé, Jim Churnside, Dezhang Chu, and Yvan Simard contributed to the comments.

3.5 Conclusion on Topic 1

The four discussion subjects were prioritised as items to put on the agenda for the next meeting as follows: 1) acoustic classification of habitat, 2a) echo trace spectral signature, 2b) combination of methods. Another subject to add to the 2003 meeting agenda was: 3) advanced technologies and platforms. (c.f. recommendations below).

4 TOPIC 2. POSTPONED DECISIONS FROM 2001 MEETING

The decisions on the following two proposals had been postponed to the 2002 WGFAST meeting to take into account the developments on these subjects during the year.

4.1 Conclusion on Topic 2

The possibility of preparing a special issue of a Journal on acoustics applications to aquatic ecosystem studies was abandoned because of the bad timing with the special issues of Journals that will come out of the Symposium.

The possibility of preparing a review article on the use of acoustics for bottom classification was deferred to the proposed new Study Group to work on this issue.

5 TOPIC 3. HYDROACOUSTICS FROM COMMERCIAL FISHING VESSELS

This topic results from a recommendation proposed by the USA that WGFAST evaluates the advantages and limitations for the collection and analysis of hydroacoustic and ancillary data aboard commercial fishing vessels and develop recommendations.

The Chair mentions a letter from Ron Mitson pointing out the high levels of noise produced by fishing vessels relative to the standard established by the WGFAST and recommended by ICES for fisheries research vessels (ICES Coop. Res. Rep. no. 209. 1995.). The letter stresses, among other factors (e.g., calibration), the effects of such high and variable noise levels on the quality of acoustic data that could be collected and on fish avoidance or herding on the bottom.

Some participants favourably mentioned experiments done in Peru and Chile as well as others conducted elsewhere, especially to enhance the space-time coverage relative to assessment surveys from research vessels. Others stressed the difficulty of doing any assessment with such type of data, the absence of standard and survey designs and the importance of fishery-independent data for responsible management. The high requirement of resources for data handling and processing from a large fleet of vessels was also brought up. Specific tests and methods are sought to evaluate the potential of using fishing vessel information. The questions of the limitations of such platforms, the standards, the guidelines and advice are those that most frequently came out during the discussion. There was a consensus as to that question had to be dealt with rapidly. Several possibilities of format for diffusing the WGFAST recommendations were evoked, including the use of an appendix to the annual WGFAST report.

François Gerlotto, Gary Melvin, Gordie Swartzman, Ian McQuinn, Rudy Kloser, Paul Fernandes, Steve Walsh, Bill Overholtz, Van Holliday, John Simmonds, Vidar Wespestad, Jeff Condiotty participated in the debate.

5.1 Conclusion on Topic 3

The conclusion of the debate was that a Study Group, chaired by William Karp, reporting to WGFAST be created to promptly evaluate the possibilities and limitations of using fishing vessels to collect acoustic data for fish stock assessments and recommend guidelines and standards. Several participants volunteered to participate to this Study Group. (c.f. recommendations below).

6 TOPIC 4. ACOUSTIC SEABED CLASSIFICATION

The development on this subject over the last year was that the WGFAST Chair and Dave Reid met the Marine Habitat Committee at the 2001 statutory meeting in Oslo to co-chair a special session on acoustic seabed classification at the 2002 annual science conference in Copenhagen.

6.1 Conclusion on Topic 4

The conclusion of the discussion on this subject at topic 1 was that ICES forms a Study Group on acoustic seabed classification in collaboration with other interested groups. The details of the Study Group should be decided after the special theme session on this issue at the 2002 annual science conference. (c.f. recommendations below).

7 TOPIC 5. REVIEW OF THE PGHAC REPORT ON THE STANDARD DATA FORMAT

7.1 Report of the Planning Group on the HAC Standard Data Exchange Format (PGHAC)

WGFAST acknowledged the report of the planning group presented by Ian McQuinn. The PGHAC group met on 7–8 June in Sète. The 2002 PGHAC report will be presented in separate ICES document. All the information on the HAC standard data format, its original version (1997) and its updates, will now be entirely available through Internet addresses.

8 MISCELLANEOUS

8.1 Internet Forum

Harry Dooley from ICES secretariat suggested setting up a Yahoo group to respond to the request of having an exchange forum on Internet for WGFAST members. After discussion, this idea was abandoned because no one volunteered to take charge of the management of such a forum.

9 RECOMMENDATIONS

9.1 Next Meetings Time and Venue:

- The WGFAST recommends that:
- the Planning Group on the HAC standard data exchange format (PGHAC) (Chair: Dave Reid, Scotland) meet in Bergen, Norway, on 17 June 2003, to coordinate the development of the HAC standard data exchange format.
- The WGFAST recommends that:
- the Study Group on Baltic Herring TS (SGTSEB) on the HAC standard data exchange format [PGHAC] (Chair: Frederik Arrhenius, Sweden) meet in Bergen, Norway, on 17 June 2003, to pursue their work on this subject.
- The WGFAST recommends that:
    - the WGFAST meeting be organised in Bergen, Norway, on 19–21 June 2003, to:
    - initiate work on acoustic seabed classification in co-ordination with the proposed Study Group to work on this subject (see below);
    - discuss developmental work and applications of echo trace spectral signatures;
    - discuss the combination of methods in acoustic applications and multi-species estimation in the context of an ecosystem approach;
- discuss advanced technologies and platforms;
- review the works of the:
    - Planning Group on the HAC (PGHAC) common data exchange format;

    - Study Group on Baltic Herring TS (SGTSEB);
    - Study Group on Assessment of Possibilities of using Fishing Vessels for Acoustic data Collection (SGAPFVAC);
- recommend a new Chair for chairing the WGFAST for the next 3-year term.

There will be no Joint Session with the FTFB group in 2003.

9.2 Study Group on Assessment of Possibilities of Using Fishing Vessels for Acoustic Data Collection

- The WGFAST recommends that:
    - a Study Group on Assessment of Possibilities of using Fishing Vessels for Acoustic data Collection (SGAPFVAC), chaired by William Karp, reporting to WGFAST be created to promptly evaluate the possibilities and limitations of using fishing vessels to collect acoustic data for fish stock assessments and recommend guidelines and standards. Members of the Study Group should include Ron Mitson, Dave Reid, Paul Fernandes, Gary Melvin, François Gerlotto, Ian McQuinn, Rudy Kloser, John Breslin.
    - this Study Group meet in Bergen, Norway, on 18 June 2003, to initiate work on this subject for examination at the WGFAST meeting.

9.3 Study Group on Acoustic Seabed Classification

- The WGFAST recommends that:
    - a Study Group on Acoustic Seabed Classification (SGASC) reporting to WGFAST be form to evaluate acoustic seabed classification technologies and applications, its underlying physics, theoretical basis, and empirical practices with reference to scales of observations, data quality and standards, classification methods and criteria, ground-truthing means, sampling design, and the combination of this ancillary information in studies on fish distribution, abundance and ecology. This Study Group should include members of other Committees or Working Groups interested in acoustic seabed classification.

10 CLOSURE OF MEETING

FTC Chair presented a discussion document on the FTC contribution for the ICES Strategic Plan.

The Chair mentioned that 2003 is the end of his 3-year term and that a new Chair would have to be chosen at the next meeting.

The Chair thanked the local hosts at IRD in Montpellier, France, François Gerlotto and Laurence Vincens, for their hospitality, and closed the meeting.

APPENDIX 1: LIST OF PARTICIPANTS TO THE 2002 WGFAST MEETING IN MONTPELLIER

NAME	E-MAIL
Anderson, John	Andersonjt@dfo-mpo.gc.ca
Axelsen, Bjorne-Erik	Bjorna@imr.no
Bertrand, Arnaud	Arnaud.bertrand@ird.fr
Breslin, John	j.breslin@seabedsurveys.ie
Chu, Dezhang	Dchu@whoi.edu
Churnside, Jim	James.h.churnside@noaa.gov
Condiotty, Jeff	Jeff.conoiotty@simrad.com
Copland, Phil	Coplandp@marlab.ac.uk
Denny, Gerald	Scifish@seanet.com
Fernandes, Paul	Fernandespg@marlab.ac.uk
Fleischer, Guy	Guy.fleischer@noaa.gov
Galloway, Jim	Gallowayj@pac.dfo-mpo.gc.ca
Gerlotto, François	Fgerlotto@ifop.cl
Godin, André	Godina@dfo-mpo.gc.ca
Goss, Cathy	Cg@bas.ac.uk
Higginbottom, Ian	Ian@sonardata.com
Holliday, Van	van.holliday@baesystems.com
Horne, John	Jhorne@u.washington.edu
Hotaling, John	John.hotaling@noaa.gov
Jech, Mike	Michael.jech@noaa.gov
Kieser, Robert	Kieserr@pac.dfo-mpo.gc.ca
Kloser, Rudy	rudy.kloser@csiro.au
Lang, Chris	Langch@dfo-mpo.gc.ca
Linares, E. Omar	Ecomar@oceano.inf.cm
Liorzou, Benard	Bliorzou@ifremer.fr
Lundgren, Bo	Bl@dfu.min.dk
Massé, Jacques	Jacques.masse@ifremer.fr
McClure, Bob	Bmcclure@biosonicsinc.com
McQuinn, Ian	Mcquinni@dfo-mpo.gc.ca
Meehan, James M.	James.m.meehan@noaa.gov
Melvin, Gary	Melving@mar.dfo-mpo.gc.ca
Michaels, William L.	William.michaels@noaa.gov
Mitson, Ron	Acoustec@acoustec.co.uk
Neville, Suzanna	s.neville@cefas.co.uk
Oliva, Jorge	Jooliva@hotmail.com
Overholtz, Bill	William.overholtz@moaa.gov
Schneider, Patrick	Ocean@wol.es
Stanton, Tim	Tstanton@whoi.edu
Stenersen, Erik	Erik.stenersen@simrad.com

NAME	E-MAIL
Stensholt, Boonchai K.	Boonchai@imr.no
Swarteman, Gordie	Gordie@apl.washington.edu
Tollefsen, Cristina	Cristina@physics.mun.ca
Vladimir, Severin	Sever@gazinter.net
Walsh, Stephen	Walshs@dfo-mpo.gc.ca
Wespestad, Vidar	Vidar@att.net
Williamson, Ned	Neal.williamson@noaa.gov
Wilson, Chris	Chris.wilson@noaa.gov
Woodd-Walker, Rachel	Rsww@bas.ac.uk
Zedel, Len	Zedel@physics.mun.ca