ICES WGFAST REPORT 2011

SCICOM Steering Group on Ecosystem Surveys Science and Technology

ICES CM 2011/SSGESST:12

Ref. SCICOM, ACOM

Report of the Working Group on Fisheries Acoustics Science and Technology (WGFAST)

10–13 May 2011

Reykjavík, Iceland

ICES International Council for the Exploration of the Sea

CIEM Conseil International pour l'Exploration de la Mer

International Council for the Exploration of the Sea
Conseil International pour l'Exploration de la Mer

H. C. Andersens Boulevard 44–46
DK-1553 Copenhagen V
Denmark
Telephone (+45) 33 38 67 00
Telefax (+45) 33 93 42 15
www.ices.dk
info@ices.dk

Recommended format for purposes of citation:

ICES. 2011. Report of the Working Group on Fisheries Acoustics Science and Technology (WGFAST), 10–13 May 2011, Reykjavík, Iceland. ICES CM 2011/SSGESST:12. 37 pp.

Contents

Executive summary

The Working Group on Fisheries Acoustic Science and Technology (WGFAST) met at the Grand Hotel, Reykjavik, Iceland, from the 10–13 May 2011. Nils Olav Handegard, Norway, served as Chair and Alex De Robertis, USA, served as Rapporteur. There were 68 participants from 18 countries who contributed to the six Terms of Reference with 39 presentations (excluding the joint session) of new and exciting research in subjects related to fisheries acoustics. The planned session on fish behaviour was re-routed to the joint WGFTFB/WGFAST session, as this work is of interest to both working groups.

Highlights:

The major themes addressed during the meeting included:

- Ecosystem approach to fisheries management: metrics, indices and indicators
- Design, implementation and review of observing systems integrating acoustic and complementary technologies
- Special call for review of use of ADCP technologies for fisheries acoustics applications
- Update on models and measures of target strength for classifying and enumerating living marine resource
- Emerging technologies, methodologies and protocols for single and multispecies surveys

A session on development of metrics and indicators from acoustic measurements was held. The primary themes covered in the session included indicators/metrics for ecosystem-based management, the use of acoustics in monitoring of Marine Protected areas, re-analysis of existing time-series for non-target species/groups and the need to incorporate uncertainty in the metrics. There was substantial discussion on how to strike the correct balance between the need for cautious interpretation of acoustic measurements and becoming overly fixated on measurement problems. Several of the contributions were highly relevant to the descriptors of Good Environmental Status that will be implemented by the European Union.

Ocean observatories are an emerging field relevant to WGFAST, and a session was held on the use of acoustics in the context of observatories covering development of long-term moored and ship-based time-series of acoustic measurements, advances in visualization of complex datasets, and calibration, processing, quality control, and archiving of acoustic data in the context of ocean observatories. There was consensus that the broader ocean community should be better informed of the potential contribution of acoustic methods in ocean observing systems, and the annual science conference was identified as one vehicle to provide exposure to the broader community.

A special session on the use of Acoustic Doppler Current Profilers (ADCP's) reviewed the advantages and technical limitations of ADCP's. The primary limitations discussed include lack of calibration methodology, linearity of the ADCP's response, blind zones, non-vertical beam pointing angles, and the primary advantages identified included the existence of large existing datasets, the ability to concurrently measure animal movement speeds, current velocities, and backscattering strength.

Target Strength (TS) and species identification remains core areas of research for WGFAST, and the working group recognized that continued progress in understanding the acoustic properties of marine organisms, in terms of frequency and observation angles, and covariates such as geographic location, size, depth, age, physiological state, and behaviour is required for continued progress. The presentations and ensuing discussion indicated that progress in this important area will be made by a combination of approaches, including *in situ* measurement, measurements of morphology, modelling, and laboratory observations, and it is clear that a deterministic view of TS as simply size-dependent is insufficient.

The membership continues to incorporate technological advances it it's work, and many new advances in instrumentation, data processing and analysis techniques were presented. In particular, major progress in the design, calibration, verification and application of broadband echosounder systems was reported. These broadband systems hold great promise as they allow will allow improved estimates of range and target position and will allow target-strength measurements at high animal densities, and have the potential to greatly improve acoustic species identifications. One physical limitation of use of high frequencies in these systems is that high absorption will limit the depths to which the systems will be useful, which will necessitate the more widespread use of profiling systems.

1 Opening the meeting

1.1 Opening and welcome to FAST

Nils Olav Handegard, the new WGFAST chair opened the meeting, welcomed the participants to the WGFAST meeting and thanked our host Sigurður Þór Jónsson of the Marine Research Institute, Iceland for the work in organizing the meeting and for kindly providing the facility for the WGFAST and study group meetings. The chair emphasized that WGFAST is a unique and vital group with many strengths. He highlighted the technological advances in fisheries acoustics that have in a large part been developed in this community over the last decade. He highlighted that WGFAST is a small and tight-knit community, and expressed that WGFAST has a lot to offer to the broader scientific community. He challenged the membership to expand the use of acoustic methods, links to the rest of the scientific community. He expressed that WGFAST is a working group, not a conference, and encouraged the presentation and discussion of work in progress during the WGFAST meeting.

Mike Jech (USA) gave a heartfelt and moving tribute to the life and science of Dr Clarence Clay (USA) who passed away at the age of 87 just prior to this meeting. He was a dedicated teacher and mentor, who had a profound impact on his many students, many of who are active in WGFAST and Fisheries Oceanography. Mike emphasized Clay's wisdom, curiosity, collegiality, scholarship, and his many significant contributions to a broad range fields in underwater acoustics, including but not limited to fisheries acoustics.

1.2 Participants and agenda

A list of the 68 participants from 18 countries appears in Annex 1, the agenda appears in Annex 2, and a group photograph can be found in Annex 3.

2 Terms of Reference

In response to the ICES Resolution as approved by SCICOM in October, 2010/2/SSGESST12, The Working Group on Fisheries Acoustics, Science and Technology (WGFAST) chaired by Nils Olav Handegard, Norway and Rapporteur Alex De Robertis, USA, met in Reykjavík, Iceland from the 10–13 May 2011 with the following ToRs:

a) In response to the ICES strategic plan 2009–2013, WGFAST will document how acoustic and complementary methods will contribute to the goals of an ecosystem approach with benthic and pelagic observations to improve assessment and management of living marine resources, understanding mechanisms and processes of change and stability, and parameterize and evaluate models of ecosystem structure and function.

1) Ecosystem approach to fisheries management: metrics, indices and indicators.

a. Provide methods and standards for creating and validating indicators and metrics derived from acoustic and complementary methods. Evaluate and compare a range of suitable metrics in empirical situations and by simulation. (presentation session Verena M. Trenkel)

2) Design, implementation and review of observing systems integrating acoustic and complementary technologies to meet national and international goals for ecosystem based marine management. (presentation session Rudy Kloser)

3) Special call for review of use of ADCP technologies (presentation session Anne Lebourges-Dhaussy)

4) Update on models and measures of target strength for classifying and enumerating living marine resources and associated variability of validating results (Presentation session - To be determined).

5) Behavioural metrics, indices and indicators of the status of fish populations from acoustic information collected by research and fishing vessel and other stationary and mobile platforms.

a. Characterization of animal behaviour in order to characterize ecosystem processes and/or describe measurement uncertainty when using acoustic and complementary survey technologies. (Presentation session, Alex De Robertis)

6) Emerging technologies, methodologies and protocols for single and multispecies surveys. (presentation session)

b) Based on our use of active sound in the ocean there is a need to review and document its footprint and place this in context with other natural and anthropogenic sources and the relative impact on marine biota. Review progress to document footprint of fisheries acoustic devices and characteristics and recent symposia (Rudy Kloser, Nils Olav Handegard).

c) Review the reports and receive updates from:

7) Study Group on Calibration of Acoustic Instruments in Fisheries Science (SGCal; David Demer).

8) Final report of Study Group on Fish Avoidance of Research Vessels (SGFARV; Francois Gerlotto).

9) Final report of Study Group on Fisheries Optical Technologies (SGFOT; Eirik Tenningen).

10) Protocols of biological data from trawling for acoustic surveys (Dezang Chu).

11) Workshop on the Determination of Acoustic Target Strength of Redfish (WKTAR), (Mike Jech).

12) The IMBER MAAS program (Nils Olav Handegard)

13) Engagement with SPRFMO (Francois Gerlotto).

14) Observatories publication topic group (John Horne)

15) Development of a wiki page and acoustic forum

3 Updates

3.1 Study Group updates

Francois Gerlotto, Update on SGFARV – Study Group on Fish Avoidance of Research Vessels

Francois Gerlotto, SGFARV chair reported that although at the 2010 meeting in San Diego in 2010 plans were underway to submit a CRR after the meeting, the final draft has not been completed and submitted for peer review. He committed to complete the draft by 30 June 2011. The document, which is intended for publication as a cooperative research report will then be peer-reviewed by Bill Karp and Rudy Kloser. It was agreed that the report will not be published if the publication fails to meet the deadline or does not pass review.

3.1.1 David Demer: Update on SGCal, Study Group on Calibration of Acoustic Instruments in Fisheries Science

The Study Group met in Reykjavik, Iceland, 7–8 May 2011.

The ICES Study Group on Calibration of Acoustic Instruments in Fisheries Science (SGCal) convened its second meeting, in room Háteigur B of the Grand Hotel Reykjavik, Reykjavík, on 26 and 27 April, 2010. David Demer (USA) was Chair, and Tim Ryan (AUS), was Rapporteur. Twenty-five scientists from fifteen nations participated. The agenda spanned two days, and, according to the terms of reference, included presentations on calibration-related developments and was focused on reviewing draft chapters of a new Cooperative Research Report on the calibrations of acoustic instruments.

David MacLennan (UK) presented "Forward-scatter distortions in real-time sphere calibrations"; Pall Reynisson (Iceland) presented the results of his measurements of copper sphere target strengths; Gavin Macaulay (Norway) demonstrated his Matlab application for calibrating EK60 and ES60 echosounders; Dezhang Chu (USA) demonstrated his Matlab application for calculating sphere target strength (TS); David Demer demonstrated a web application to calculate sphere TS; Naig Le Bouffant (France) presented a technique for calibrating one ME70 configuration from another; Eckhard Bethke (Germany) discussed details of calibrating an EK60; and Matteo Bernasconi (Italy) presented a new method for calibrating omnidirectional sonars.

Chapter reviews were presented by David Demer (CRR summary; Terms, Symbols, and Units; and Theory); Mike Jech (USA; Introduction); Gavin Macaulay (Standard sphere calibration); Tim Ryan (Calibration protocols); and Dezhang Chu (Calibration Uncertainty and Future work). The group discussed each draft chapter and provided guidance to the authors for additions and refinements. Over the next year, draft chapters will again be available to co-authors via the SharePoint site; Claire Welling (ICES) is thanked for supporting the SGCal with this utility and her other administrative tasks.

The following timeline was adopted: 31 August 2011, authors update draft chapters; 31 October 2011, Chair merges chapters, reduces redundancy, and adds cross-references; 31 January 2012, refinements are made to draft cooperative research report (CRR; 31 March 2012, Chair edits refined draft CRR; May 2012, review draft CRR at SGCal 2012; September 2012, submit final SGCal report and CRR. The next meeting will again be held in conjunction with WGFAST in Brest, France, from 7–10 May 2012.

3.1.2 Jim Churnside: Update on SGFOT, Study Group on Fisheries Optical Technologies

Jim Churnside (USA) provided an update on the activities of SGFOT on behalf of SGFOT chair Eirik Tenningen. There was commitment for a draft final report to be delivered to the WGFAST chair by the 15 July. There was some discussion about how up-to date the current report is, and the possibility for not publishing a cooperative research report was raised. It was agreed that the report will not be published if the publication fails to meet the deadline or does not pass review.

3.2 Other updates

3.2.1 The IMBER MAAS program (Nils Olav Handegard)

Nils Olav Handegard reported from on a EurOcean Foresight workshop held in Bergen 3–6 May addressing the combination of acoustics with regional and basin scale ecosystem models, addressing major challenges in the IMBER MAAS program. Two main conclusions were reached: 1) existing data should be made available to the community through the Global Ocean Observing System (GOOS) or any equivalent data access options, and the focal areas should be intensively studied to provide means of validation of the data-model interface.

3.2.2 Effects of aquatic noise meeting and WGFAST activities on noise emission (Alex De Robertis and Rudy Kloser)

Alex De Robertis presented an update on the Effects of Aquatic Noise meeting in held on 15–20 August, 2010 in Cork, Ireland. This meeting focused on the effects of underwater noise on marine animals. Major sources considered included 1) military sonar 2) pile driving noise 3) seismic surveys. In discussion, it was clear that underwater noise is an emerging issue for WGFAST, and that the working group should address these issues in future, particularly for the instruments used by WGFAST. Rudy Kloser gave an update on ongoing plans to quantify noise emission by the instruments used in fisheries acoustics instruments.

3.2.3 Engagement with SPRFMO (Francois Gerlotto)

Francois Gerlotto updated the working group regarding engagement with the South Pacific Regional Fisheries Management Organization (SPRFMO). This is a multinational organization that is active in the jack mackerel fisheries. SPRFMO conducted a workshop to initiate a pilot program to explore the use of acoustics from fishing vessels. A meeting will of SPRFMO is planned in 2011, where the activities of WGFAST will be related to SPRFMO. Francois pointed out that SPRFMO is interested maintaining contact with WGFAST.

3.2.4 Observatories publication group (John Horne)

John Horne updated the WGFAST on the progress of the observatories publication group. The group is preparing a series of papers describing the merits of adding active acoustics on marine observatories for possible submission to ICES journal of marine science as a collection of papers. Two papers are now complete, and a review is underway. It was agreed that John will poll the authors as to when papers will be ready, and will then set date for when the publications will be ready.

3.3 SCICOM Update (Bill Karp)

Bill Karp addressed the meeting about SCICOM (Science Committee) related matters, presenting a report on SCICOM's activities. He discussed the new ICES Science Plan

and highlighted where the WGFAST group fits within that structure. He focused on the new, broader focus on ecosystems and marine ecosystems. He made it clear that the value of ICES advice is based largely on the quality of the science that underlies it. He reviewed SCICOM's mandate and responsibilities, and described changes to the membership of SCICOM. Manuel Barange (UK) is the new chair of SCICOM, and membership has been expanded to one member per country. He reviewed the European Union's Marine Strategy Framework Directive and described the 11 descriptors for good environmental status, to be met by 2020. He sought feedback on how WGFAST can contribute to identifying the status of these descriptors and how to set reference points for good environmental status for these descriptors. Bill made it clear that the activities of WGFAST are relevant to the ICES science plan, and challenged the group to continue efforts to communicate with other groups in ICES and facilitate implementation of the ICES science plan.

3.4 Redfish Target Strength Update (Mike Jech)

The first workshop on redfish target strength (WKTAR-I) conducted a meta-analysis of historical acoustic target strength (TS) data and derived a TS-to-length equation to be applied to the data collected during acoustic surveys for redfish in the Irminger and Norwegian Seas. Two recommendations were made: 1) continued data analysis in a second workshop (WKTAR-II); and 2) recommend collecting EK500 and EK60 data during surveys to compare the echosounders. These recommendations were proposed to the Working Group on Redfish Surveys (WGRS).

Response from WGRS

1) Recommendation on continuing TS analysis during a new workshop WKTAR-II

At the last WGRS meeting these data analysis and relationship was discussed and we faced critical difficulties to organize the redfish surveys and ensure hydroacoustic data collection suited for target-strength measurements. In fact, only the survey in the Irminger Sea will be conducted, and not in the Norwegian Sea, during 2011. The comparative work between EK60 and EK500 might be carried out but this is still uncertain. For those reasons, WGRS decided to postpone any recommendation for a WKTAR-II until we know that more data of good quality will be available. The WGRS is still interested in running WKTAR-II but we want to do it with the appropriate data at hand to make a significant advance from WKTAR-I.

2) Simultaneous comparative measurements between EK500 and EK60 for Target Strength determination.

The WGRS will coordinate with Eckhard Bethke to determine whether simultaneous EK500 and EK60 data will be collected during the survey in the Irminger Sea.

Response from FAST:

Depending on the outcome of the survey conducted this summer (2011), the WGFAST will coordinate with WGRS to set up WKTAR-II to address further data analysis. Mike Jech will coordinate this with the red fish working group, and take further action.

4 Topic A: Ecosystem approach to fisheries management: metrics, indices and indicators

4.1 Rolf Korneliussen[1]: Correction of historical multifrequency data for non-linear loss

[1]*Institute of Marine Research, Norway (rolf.korneliussen@imr.no)*

Acoustic multifrequency backscatter is used to identify several species of fish and zooplankton, and also to estimate size of zooplankton specimens. Recent work show that some commonly used scientific echosounders lost energy into higher harmonic frequencies, which in turn resulted in wrong measurements at the fundamental frequency. The non-linear loss increased with increasing sound pressure and increasing frequency, so that the main lobe is flattened and the accumulated loss increases with range. Most of this loss is compensated for due to the common calibration method of using a standard target at a reference depth, which in turn results in the peculiar effect that some of the measured sv-values would be too weak while some would be too strong. However, the recent work gives a method of range-dependent correction of historical multifrequency data, provided the input-power, transducer efficiency and range from transducer to calibration sphere is known. These methods are applied to collected data, and show that established acoustic properties of some species based partly on historical data should be corrected. The correction method is applied on acoustic data from Atlantic mackerel, and explains previously unexplained differences in oceanic measurements and measurements made at shorter distance on captured mackerel.

4.2 Valerie Samedy[1], Erwan Josse, Jean Guillard and Philippe Boët: Hydroacoustic methods to monitor spatio-temporal distribution of fish population in the Gironde estuary (France)

[1]*Cemagref (valerie.samedy@cemagref.fr)*

Nowadays, European Directives ask to develop reliable methods to improve the assessments of fish stocks in inland ecosystems and coastal areas. Hydroacoustic technologies are used extensively throughout the world to study the fish distribution in various ecosystems. This is much more rarely the case in estuaries which are influenced by a highly variable environment (e.g. turbidity, oxygen, temperature, flow). Our study was prompted by the need to deepen the knowledge of estuarine ecology with quick and non destructive tools to supplement conventional sampling gears. The use of a multifrequency approach allows to either discriminate faunistic compartments or environmental perturbations. The aim of our study is to assess the potential and constraints of acoustic in such estuarine ecosystem. In the Gironde estuary, echo-surveys were carried out in 2009 and 2010, at different hydrological seasons, and we test two sampling efforts based on moored stations and mobile strategies. This second method consists in covering an area by repeated zigzags or transects when environmental conditions are similar. The two kinds of surveys are compared and an optimal design to monitor fish population in an estuary is proposed.

4.3 Verena Trenkel[1], Patrick Ressler, Mike Jech, Marianna Giannoulaki, Chris Taylor: Under-water acoustics for ecosystem-based management: a review and proposals for ecosystem indicators

[1]*Institut français de recherche pour l'exploitation de la mer, rue de l'Ile d'Yeu, B.P. 21105, 44311 Nantes Cedex 03, (verena.trenkel@ifremer.fr).*

Ecosystem-based management requires more extensive information than single-species stock assessment. Active under-water acoustic methods provide a means of collecting a wealth of ecosystem information with high space-time resolution. Worldwide fisheries institutes and agencies are carrying out regular acoustic surveys covering many marine shelf ecosystems but these data are seriously under used. In addition, more and more acoustics data collected by vessels of opportunity are becoming available. To encourage their use for ecosystem-based management, we provide a brief introduction to acoustics and complementary data collection methods and review the current and potential contributions to monitoring population abundance and biomass, spatial distributions and predator–prey relationships. Acoustic derived indicators are another neglected field. We review and propose indicators for assessing and monitoring zooplankton, fish and other nekton population dynamics and changes in foodweb functioning. Acoustics have the potential to make a strong contribution to ecosystem-based management, but only if a clear understanding of the targets of acoustic measurements can be achieved. This and the development, testing and cross ecosystem comparison of new indicators and suitable reference points is the current challenge.

4.4 Laurent Berger[1], and Verena Trenkel[2]: Development and application of a multifrequency diversity index for monitoring major scatter groups in the Bay of Biscay

1 Institut français de recherche pour l'exploitation de la mer Z.I. Pointe du Diable B.P.70, 29280 Plouzane, France, laurent.berger@ifremer.fr
2 Institut français de recherche pour l'exploitation de la mer, rue de l'Ile d'Yeu, B.P. 21105, 44311 Nantes Cedex 03, verena.trenkel@ifremer.fr .

Scattering properties of marine organisms depend on echosounder frequency and a discrete frequency response is commonly used for identifying major acoustic scatter groups in ecosystems. In order to summarize the frequency response in a directly usable metric we developed a multifrequency diversity index. We demonstrate its information content using simulations of different scatter groups and evaluate its performance for monitoring the Bay of Biscay ecosystem using five years of data from the large-scale PELGAS survey. Filtering for noise and wind induced attenuation through bubbles in surface layers is performed as it strongly affects the index. The average features of the distribution over time of the main scattering groups are compared to those of environmental data and abundance estimates for swimbladder fish.

4.5 Alex De Robertis[1], Thomas C. Weber, Larry Mayer, Christopher D. Wilson: Acoustic observations of the deep scattering layer during the Deep water Horizon oil spill

[1] *Alaska Fisheries Science Center (alex.derobertis@noaa.gov)*

The explosion of the Deep water Horizon drilling rig on April 20, 2010 resulted in the release of large quantities of oil and gas from the damaged wellhead into the deep waters of the Gulf of Mexico. During the monitoring effort that ensued, a large body of acoustic measurements with scientific echosounders was collected from May to October with the goal of mapping subsurface oil and gas and monitoring the integrity of the well head. These measurements will be used to observe the deep scattering layer (DSL), a ubiquitous community of sound-scattering mesopelagic organisms in the vicinity of the spill site. Preliminary observations of reduced backscatter in the near field of the rising oil indicate that the DSL is perturbed by the rising oil close to the well head. It is unclear whether this is highly localized effect occurring only near the well, or whether the DSL was also perturbed by a deep oil plume that spread

from the well site. The acoustic measurements of the DSL will be related to fluorometric indices of hydrocarbons from CTD profiles to gauge if the there was a larger-scale perturbation on the abundance, behaviour, and distribution of the midwater community.

4.6 Nolwenn Behagle[1], I. Sow, J. Guillard, A. Lebourges-Dhaussy: Acoustic monitoring of a Senegalese Marine Protected Area and of its close vicinity

[1]*nolwenn.behagle@ird.fr> (IRD (Institut of Research for the Development))*

For a better management of fish stocks, decreasing at global scales, the implementation of Marine Protected Areas (MPAs) has been envisaged as a tool to ensure the durability of renewable marine resources. The implementation of MPAs implies to set up also monitoring protocols from an initial state to study and measure trends and estimate the efficiency of these protected zones. The Bamboung Marine Protected Area created in 2003 in the Sine-Saloum estuary, Senegal, has been monitored for eight years using the same protocol combining experimental fishing operations and acoustic data observations. Twenty acoustic surveys were carried out from 2003 to 2010 in the Bamboung tributary. Since October 2007 these acoustic surveys included two additional tributaries in close vicinity to the Bamboung tributary: the Sangako (rather similar to the Bamboung) and the Diomboss tributaries. The data were processed in order to get time-series of the bio-acoustic metrics of densities (sA) and of relative sizes (TS) inside the Bamboung, and for the years sampled, outside the MPA but in its neighbourhood for comparison. According to the preliminary results the following questions will be addressed: 1) Is there an evolution in the composition of the fish population (density, size distribution) inside the Bamboung because the implementation of the MPA? 2) Is there an impact of the MPA existence onto the fish composition outside the MPA, in its close vicinity, and thus a positive effect for the local artisanal fishery?

4.7 Christopher J. Taylor[1], John S. Burke, Erik Ebert: Acoustic-derived metrics and indicators for marine reserve assessments and monitoring in coral reef ecosystems

[1]*NOAA Ocean Service (chris.taylor@noaa.gov)*

The Tortugas Ecological Reserve (TER) was established in 2001 as a no-take research reserve extending the area of the Florida Keys National Marine Sanctuary, USA. The Sanctuary is evaluating the effects of management areas, including the TER. In 2008 we initiated a fisheries hydroacoustic survey to compliment the visual census for reef fish and coral communities that was initiated in 2000. The hydroacoustic survey was specifically designed to map the distribution and abundance of reef fish in relation to the reserve boundary, and over a broader spatial extent than is possible using scuba divers. Biomass of large, exploited species observed by divers was significantly higher within the Reserve, and biomass increased with proximity to the boundary. Fish densities assessed using hydroacoustics showed a similar pattern. We developed an indicator from the acoustic data analogous to the biomass size spectrum and found that biomass of larger size classes was higher within the reserve. Indicators produced from fisheries hydroacoustic surveys can not only inform marine reserve design and monitoring, but can also enhance the interpretation of smaller-scale visual surveys by providing landscape-scale maps of fish densities at high spatial resolution.

4.8 Vidar G.Wespestad[1], Suzanne Romain[2], and Martin Dorn[3]: Pollock, forage, and whales: an attempt to measure trophic interaction and change in the western Gulf of Alaska

[1]Aleutians East Borough, Science Coordinator, 21231 8th Pl, W., Lynnwood, WA 98036 USA; [2]Romain Consulting Service, 1122 East Pike St #718 Seattle WA 98122; [3]NOAA/NMFS, Alaska Fisheries Science Center, 7200 Sandpoint WY NE, Seattle, WA 98115.

This project developed to conduct small-scale exploratory surveys to augment NMFS annual pollock surveys in the Western Gulf of Alaska. The region is one of submerged glacial fjords with complex bathymetry that are utilized by pollock for spawning and feeding. Pollock distribution is variable in the annual survey and this project was designed to compare distribution in temporally offset surveys and summer-winter distribution within the area. Part of the project was a demonstration that a small (18 m) trawler could effectively survey the region. Initially data were collected on 38 KHz using an ES60 echosounder. Calibrations were performed in the field and processed after the survey. As we sampled the area it became apparent that the fjords concentrated large volumes of zooplankton and Euphausids that serves as food for pollock, salmon, and other pelagic fish, as well as large numbers of whales drawn to the same feeding grounds. A 120 KHz transducer was added and the echosounder upgraded to an ES70. We were able to identify sign and group into age classes based on net samples. In September 2010 over 75 whales were surveyed over a 100 nm 2 area of Nagai Strait and were strongly associated with krill and pollock sign. The whales observed in 2010 were primarily humpback whales, but fin whales are also observed in the area. 30–40 years ago whales were almost nonexistent in the area, but today are common throughout the Gulf of Alaska. It is believed that this study can be developed into a flexible ecosystem monitoring tool to attempt to quantify relationships between cetacean consumption and the abundance of pollock and other pelagic fish.

4.9 Guillermo Boyra[1], A. Urkullu, H. Arrizabalaga, Y. Yurramendi, J. Fernandes, I. Arregi and N. Goñi: Exploring two acoustic based methodologies to estimate abundance of juvenile Albacore (*Thunnus alalunga*) and Bluefin (*Thunnus thynnus*) tuna in the Bay of Biscay

[1] AZTI Tecnalia (gboyra@azti.es)

Tunas are highly migratory fish species that occupy extensive oceanic areas. This makes difficult to estimate their abundance based on direct surveys. The management of the fishery is thus generally based on indirect abundance indices using information from the captures of the commercial fleet. This work attempts to apply two different acoustic-based methodologies to advance in the knowledge and scientific advice about albacore and bluefin tuna. (i) The first line explores the viability of developing systematic acoustic surveys of juvenile tuna in their feeding area (the Bay of Biscay) using scientific split-beam echosounders. As a pilot experience, scientific acoustic equipment was placed continuously for one month on a fishing vessel while conducting commercial fishery in summer 2009. Two echosounders (of 38 and 120 kHz) were pointed vertically downwards and a 200 kHz one was pointed horizontally to the side of the boat. As the vessel was performing commercial fishing activities, most acoustic data were recorded at low (2–3 knot) vessel speed. A special case of school mapping methodology was developed to process this set of semi stationary acoustic records. (ii) The second line attempts to use sonar screenshots on-board commercial fishing vessels to count and characterize tuna schools using image analysis with the idea of producing a cpue-like index based on the acoustic records. This index would be independent of the catchability of tuna by baitboats and thus, poten-

tially less biased than the baitboat cpue. Preliminary results of the ongoing work are presented for discussion.

4.10 Svetlana Kasatkina[1] and P. Gasyukov: Improvement in data processing of the Baltic international acoustic surveys for management application

[1] *AtlantNIRO, Russia, (ks@atlant.baltnet.ru)*

Abundance indices obtained in the acoustic surveys are the most important information for stock assessment models. The assessment of many fish stocks in ICES Subdivisions is fulfilled using the Extended Survival Analysis Method (XSA). The authors are discussing the ways of the acoustic surveys improvement for required parameterization of XSA method by the example of pelagic fish stocks assessment in the Baltic Sea. Traditionally, the XSA in the ICES program is based on the hypothesis that the abundance indices variance is constant by years for each age-group. To verify this hypothesis the statistical characteristics of fish abundance were obtained by processing the Baltic International Acoustic Surveys data using the simulation method. The relationships between the abundance indices variance and indices value for all age-groups of herring and sprat were revealed. The XSA software used by ICES WGs was modified by replacement of the traditional linear regression to the regression with the known accuracy of predictors-abundance indices. The authors compare the results of stock assessment for 2004–2008 obtained by means of the traditional XSA and the new XSA version. Application of the new XSA version results in new estimates of stock and population parameters (recruitment, spawning biomass, mean fishing mortality rate), as well as in changes of the temporal trends in these fish stocks dynamics. It is demonstrated, that evaluating acoustic survey methods to improve parameterization needs for stock assessment models is very important in view of ICES initiative to revise stocks assessment methods. Keywords: acoustic survey, stock assessment model, Baltic herring and sprat.

4.11 Summary of session

Discussion

The primary themes covered in the session included the following:

- Indicators/Metrics for ecosystem-based management
- Use of acoustics in monitoring of marine protected areas
- Re-analysis of existing time-series for non-target species/groups.
- The need to incorporate uncertainty when we think about the ecosystem approach

There was substantial discussion of the reliance on species composition information and target strength when making acoustic measurements. Often, TS and species composition are unknown. The discussion focused on how to strike the correct balance between the need for cautious interpretation of acoustic measurements and becoming overly fixated on measurement problems. A diversity of opinions was expressed, but it was generally recognized that a balance between being overly cautious and coming to erroneous conclusions must be struck, as that further progress may be limited if requirements for TS and species composition used in indicators/metrics are held to same standard as those for single-species acoustic-trawl surveys. It was suggested that we may be able to do a lot with partial information as long as we understand that the important caveats. However, this does not mean that we should ignore our basic research in supporting acoustic measurements.

It was recognized that when designing indicators one should think about what the user's information requirements are, as well as the requirements for precision and uncertainty. It was suggested that large changes may be easy to detect with acoustics, but as it stands, this may not make it through to official advice. To demonstrate the utility of an indicator, one must test the efficacy of the method, and it was suggested that simulation models and correlations with independent information would be valuable first step. In discussion it became clear that there was substantial information in existing data that has not fully been taken advantage of.

5 Topic B: Design, implementation and review of observing systems integrating acoustic and complementary technologies

5.1 Veronica Solteszova, Ruben Patel[1] and Ivan Viola: Real-time 3D visualisation of sonar data for overview and school inspection

[1]*Institute of Marine Research, Bergen, Norway (ruben@imr.no)*

The Simrad multibeam echosounder and sonar ME70 and MS70 both deliver high volume scientific acoustic data, but the front end visualization is at present still 2D. For fishing skippers and scientists it is frequently valuable to see the full 3D representation of the water column during data collection for fishing decisions or survey decisions. The main problems for using standard 3D visualization tools is that the coordinate systems are different and that and streaming volume rendering is a demanding computer task, if real-time visualization is required. The presentation will show some examples of real-time visualization of ME70 data recorded on the North Sea sandeel ground. The methods used for stopping the 3D display for inspecting school detections while simultaneously continuing recoding 3D scenes will also be briefly presented.

5.2 Gavin Macaulay[1], Terje Torkelsen, Frank Reier Knudsen and Olav Rune Godø: Testing of a small autonomous moored and profiling echosounder

[1]*Institute of Marine Research, Bergen, Norway (gavin.macaulay@imr.no*
A prototype scientific echosounder (Simrad EK15, single-beam, 200 kHz, internally or externally logging, low power consumption) installed in an underwater cylinder with associated control computer and batteries has been tested both as a long-term moored echosounder with transponder for localization and release and as a profiling instrument attached to a conventional CTD. Results from these tests are presented as well as details of the performance and capability of the system. The experience and results are discussed with respect to further development and the use as part of observing systems. A Norwegian Research Council funded project is currently underway to develop this system into a commercial product.

5.3 Rudy J. Kloser[1] and R. McCauley: Sustained ecosystem monitoring using passive and active acoustics

[1]*CSIRO (rudy.kloser@csiro.au)*

Passive and active acoustic methods provide a means to systematically observe marine biota from krill to whales at local and ocean basin scales. These acoustic methods are an important part of the Australian integrated marine observing system (IMOS) providing a link between ocean physics and the structure and function of ecosystems. These methods complement primary production measurements using ocean colour, continuous plankton recorders and fish tracking. Within IMOS passive acoustic devices detect and track a range of fauna from fish to whales. The vocalizations of several great whale species allow long-term tracking of trends in their numbers and their seasonal presence. Many fish vocalize routinely and regularly, producing choruses which are monitored. In oceanic, near shelf waters these fish choruses reflect movements, the spatial distribution and density of large numbers of fish which appear affiliated with the deep scattering layer. Seasonal and spatial variations in these fish choruses may link directly to secondary productivity. Active acoustics is being used to monitor ocean basin scale secondary productivity. These basin scale measurements are being used to initialize and assimilate with ecosystem models to map the biomass and distribution of organisms from krill to small fish. Both single and multifrequency acoustic methods are being used to determine acoustic species groups and biomass. In the context of climate change and variability this monitoring is being designed to

detect decadal signals at basin scales. Current methods are using well established technologies and methods but several new developments may be part of future observing systems.

5.4 Tim Ryan[1], Ryan Downie and Rudy Kloser: Processing of acoustic data for ship of opportunity observing system - Techniques to remove intermittent noise and attenuated ping

[1]*CSIRO (tim.ryan@csiro.au)*

Bio-Acoustic data from ships of opportunity are being incorporated into Australia's Integrated Marine Observing System. The data quality of these water column acoustic backscatter measurements will vary greatly according to the characteristics of the vessel, its echosounder system and in particular the transducer placement and the sea conditions encountered. These measurements can be biased high by signal from non-biological sources (i.e. noise). In bad weather attenuation of the received signal due to the presence of near-surface micro-bubbles will bias measurements low. Post-processing to minimize these biases is therefore a critical step. This presentation will describe how methods from journal and grey literature have been used in combination with newly developed techniques to filter for commonly encountered characteristic noise types and for weather-induced attenuated signal. The effectiveness of the techniques will be demonstrated with examples from ocean basin-scale acoustic transects. Metrics sourced from pre and post-processing results as indicators of data quality will be discussed.

5.5 James Churnside[1], Doyle Hanan, Zachary Hanan, David Demer: Comparing and combining lidar, photographs, and acoustics

[1]*NOAA ESRL (james.h.churnside@noaa.gov)*

In autumn 2010, we operated an airborne lidar and camera off the coast of Southern California. Some of these flights were made in coordination with acoustic measurements from a ship. The objective was the design of an observing system integrating acoustic and complementary technologies that could be used for Pacific sardine (*Sardinops sagax caerulea*). Each of these techniques has its own unique strengths and weaknesses. Photography can cover a very wide area quickly, but detection of schools more than a few m below the surface is difficult, especially when conditions are not ideal. Lidar has a narrower swathe width than photography, but can penetrate to greater depths and is less affected by conditions. Acoustics are much more sensitive and have greater depth coverage, but are limited to ship speeds and may have difficulties detecting schools right at the surface. We will present preliminary results from the California measurements and discuss some of the problems encountered in designing an integrated observing system.

5.6 Nolwenn Behagle[1], E. Josse, F. Ménard, A. Lebourges-Dhaussy, G. Roudaut, P. Brehmer, D. Dagorne, L. Dubuisson: Effect of mesoscale eddies on local micronektonic biomass: the case of the Mozambique Channel

[1]*Institut of Research for the Development (IRD; nolwenn.behagle@ird.fr)*

Our study area, the Mozambique Channel, is characterized by an important mesoscale activity with cyclonic and anticyclonic eddies that propagate southwards along the western edge of the channel. Eddies are known to play a key role in biological processes of usually less productive deep-sea ecosystems by converting physical energy into trophic energy. This study focuses on data collected during three acoustic surveys (2008, 2009, 2010) carried out within the framework of the MESOBIO project.

Acoustic 38 kHz data were used to study the spatial organization of micronektonic organisms and to highlight the impact of eddies on their abundance. Satellite data (SLA, Sea Level Anomalies) were used to define the nature of eddy i.e. cyclonic, anticyclonic or edge. A two steps processing was performed: first the vertical distribution of micronekton according to diel variation has been explored; second the effect of eddy nature on micronekton abundance was analysed. Results show both dependencies of the spatial organization of micronekton on the circadian rhythm and mesoscale dynamics. For all surveys, more than 70% of the micronekton abundance was detected in the 400–740 m layer during the day, while during the night it was observed in the 10–200 m layer. The greatest abundances of micronekton were detected in cyclonic eddies in 2008 and 2009, and in anticylconic eddies in 2010. This difference is explored through hypotheses on the influence of mesoscale structures on the local organic production, and on the effect of the tropical seasonality (monsoons) in the Mozambique Channel.

5.7 Horne, John K[1], S.S. Urmy, and D.H. Barbee: Calibrating an Ocean Observatory Echosounder at Depth

[1]*University of Washington (jhorne@u.washington.edu)*

Active acoustics is a common component of ocean observatory instrumentation. Echosounders can be calibrated at the factory, prior to deployment, or after retrieval. But performance of deep transducers may differ from those operating or being calibrated near-surface. Additional logistic challenges are encountered when calibrating a bottom-mounted, upward looking system. We calibrated a Simrad EK-60 split-beam echosounder paired with an ES-38DD transducer that was connected to the MARS observatory node at 875 m. An ROV was used to deploy two anchors and a calibration ball suspended above the transducer by a syntactic float. Over a two month period, nine sets of data were collected for calibrations. On average, it took 5.11 days of data to provide 450.75 accepted single target detections for beam pattern mapping in the LOBES program. Distributions and periodicities of single target detections emulated current and tidal flows at the site. RMS LOBES model fit values, updated from factory default settings using an initial field calibration, averaged 0.29 for the remaining calibrations. Real-time data delivery and observatory infrastructure enabled parameter estimation and updating of new calibration values at any time. Calibration of echosounders with long-term deployments at ocean observatories is an issue that should be incorporated in infrastructure design and maintenance schedules.

5.8 Reka Domokos[1]: Development of a fisheries independent method of bottom fish biomass estimation using active acoustics

[1]*PIFSC, NOAA (reka.domokos@noaa.gov)*

Local commercial fishers heavily target six species of snappers and one grouper that occupy areas with 100–400 m deep slopes in the Hawaiian archipelago. To date, fisheries dependent methods are being used for stock assessment and management purposes of these bottomfish. This project is designed to develop a fisheries-independent method to estimate biomass of these economically important species using multifrequency acoustics methods. Acoustics will also be utilized to study the spatio-temporal distribution and movement patterns of these fish. To be able to acoustically identify the targeted species, acoustic descriptors are being defined with the help of simultaneous baited stereo-video camera recordings and experimental fishing operations. Although the use of acoustics to study these fish is challenging

due to their preference to occupy steep slopes with high rugosity and to form multispecies aggregations that include fish not targeted by fishers, preliminary results are promising. These results indicate that the 7 economically important bottomfish species typically form relatively loose aggregations during daytime that are about 40–50 m tall and 40–100 m long, tapering off upward and resulting in a "cone-shape" appearance on the echograms. These aggregations sometimes occupy depths well above the seabed, such as 100–150 m up in the water column. At the evenings aggregations become denser; more elongated horizontally, and occupy depths nearer to the bottom. Later the night they form cone-shaped aggregations that are typically denser than during the day. Fisheries-targeted fish tend to form 1–3 species aggregations that can mix with non-targeted species from time to time.

5.9 Samuel S. Urmy[1], John K. Horne, David H. Barbee: Pelagic biophysical coupling in Monterey Bay

[1] *University of Washington (urmy@uw.edu)*

A bottom-mounted echosounder was used to investigate the coupling of nekton and macrozooplankton to physical processes in Monterey Bay, California. The Deep Echo Integrating Marine Observatory System (DEIMOS), an acoustic package built around a Simrad EK-60 scientific echosounder, was deployed at the MARS ocean observatory for 18 months. A suite of metrics was developed to summarize the distribution of pelagic fauna in the water column. These time-series were compared to oceanographic variables, measured in situ at the Monterey Bay Aquarium Research Institute's M1 buoy, 15 km to the east-northeast of DEIMOS. Cross-wavelet spectra were used to quantify coherence between variables through time across temporal scales from 6 hours to 256 days. At the seasonal time-scale, total backscatter (Sa) and sea surface temperature (SST) were positively correlated, reaching their lowest points during spring upwelling season, when surface fluorescence, a proxy of phytoplankton concentration, was highest. During these times, backscatter was concentrated near the surface. A subsequent increase in Sa lagged the peak in fluorescence by 2–3 months. During spring and summer, Sa was also linked to fluorescence at scales between 8 and 20 days, possibly representing the growth of zooplankton responding to episodic upwelling. When these links were examined in discrete depth strata, we found evidence of depth-dependent biophysical coupling.

5.10 Summary of session

Discussion

The primary themes covered in the presentation session included the following:

- Development of long-term moored and ship-based time-series of acoustic measurements
- Calibration, processing, quality control, and archiving of data for observatories
- Increasing application of acoustics to study micronekton
- Advances in visualization of complex datasets from multibeam systems
- Validation of measurements/model predictions
- Comparison with other methods e.g. optics/trawls/lidar/acoustics/fishing).
- Once acoustics is incorporated in observatories, it can be difficult to fund the necessary validation.

There was consensus that the broader ocean community should be better informed of the potential of acoustic methods. There is a need to identify and engage with potential users of acoustic data. There is a need to 1) establish what the most appropriate data products from acoustics and 2) provide guidance for correct interpretation. It was recognized that what can be provided sometimes falls short of what is needed. There is general consensus on the methodology to process the data to the level of backscattering strength, but biological interpretation of the data are more difficult and the required methods are often situation-dependent. The annual science conference was identified as one vehicle to provide exposure to the broader community. There should also be outreach to specific parts of ICES, including the recently formed working group on ecosystem surveys.

Implementing the ecosystem approach to management is an ongoing challenge. Models are still under development, and what is needed as inputs has not been clearly defined. We need to have outreach as to the potential of acoustics and complementary technologies, but we need to be able to validate the methods and demonstrate the utility of the measurements. It was pointed out that this was in part an opportunity to make progress: one should consider the historical precedent: great progress has been made by WGFAST on single-species stock assessment issues that were challenging in the past.

The link between acoustic data and models was discussed. Models operate on different currencies, and it is an open question whether acoustics can represent these quantities. Traditionally acoustics is validated to biomass. It was emphasized that there is a need to identify and interact with ecosystem modelers (in addition to the single-species assessment scientists with whom we have traditionally engaged). It was recognized that WGFAST will continue to support single-species stock assessments as it broadens its focus.

Several areas for future work were identified over the course of discussion:

1) Historical analysis and regional comparisons based on existing data. This may help in the design and implementation of observing systems.

2) There is a need for focused studies in which acoustic measurements are validated. The consensus was that improvement in sampling gears is the key for reduction of uncertainty in acoustic estimates, and this may be an appropriate area for future collaboration with FTFB. In particular, sampling of the deep scattering layer was discussed.

3) It was recognized that existing data from single-species surveys can be used in a broader range of applications than initially intended: useful new information can likely be extracted from existing datasets.

6 Topic C: Special call for review of use of ADCP technologies

6.1 A. Lebourges-Dhaussy[1]: Literature review over the 15 last years' about ADCP backscatter information use for living organisms' description

[1]*IRD (anne.lebourges.dhaussy@ird.fr)*

6.2 Kyounghoon LEE[1], Yong-Su YANG, Seong-Wook PARK, Kangseok HWANG: Classification of Sound-scattering Layer using swimming speed estimated by acoustic Doppler current profiler

[1] *National Fisheries Research & Development Institute (khlee71@nfrdi.go.kr)*

There are such various techniques as a multi frequency method, in situ TS characteristics, and digital imaging processing methods for fish's species identification technology. The acoustic Doppler current profiler for determining simultaneous current fields has been used to observe the swimming speed and behaviour patterns of pelagic fish's shoal in natural conditions. This study was aimed to examine the classification method by estimating the swimming velocity of sound-scattering layer as well as the pelagic fish shoals with ADCP (153.6kHz) and scientific echosounder (38, 120kHz). In order to calculate their actual swimming speed, each stratified bins must be considered between the mean surrounding current velocity 3-D swimming vectors and their mean swimming velocity vectors. Results showed that the averaged 3-D swimming velocity of sound-scattering layer was estimated by the deviation of 5.3cm/s differed from the surrounding current field, and the averaged 3-D swimming velocity of Pacific saury (Coloabis saira) was calculated to be 91.3cm/s, while that of lanternfish (Diaphus theta) was 28.1cm/s. In addition, they were estimated to be 4.19 times and 4.26 times relative to body length (BL/s), respectively. So it was expected that this swimming velocity information would be one of useful fish species identification methods for various fish distributed in the survey area.

6.3 Y. Simard1 and N. Roy2: Multi-scale ecosystem processes tracked with ADCP current and acoustic backscatter time-series: applications, possibilities and limitations from several environments in Canadian waters

[1]*Marine Science Institute, University of Québec at Rimouski, 310 Allée des Ursulines, PO Box 3300, Rimouski, Québec G5L 3A1, Canada (yvan_simard@uqar.qc.ca).*[2] *Maurice Lamontagne Institute, Fisheries and Oceans Canada, 850 Route de la Mer, PO Box 1000, Mont-Joli, Québec G5H 3Z4, Canada,*

Acoustic Doppler Current Profilers (ADCPs) are routinely used in ocean sciences since several decades to measure the 3D flow structure with high-resolution in space and time over long periods from various deployment platforms. The instruments usually track both the frequency and the energy backscattered by fields of particles insonified along the paths of the acoustic emission propagating through the water column. Dopper shift is used to automatically estimate current velocities. The backscattered energy, stored in raw format, can be post-processed to estimate the volume backscattering strength (Sv in dB re 1 m-1) corresponding to current measurements. Diverse temporal or spatio-temporal applications to assess the concentration of inorganic or biological particles from ADCP backscatter in several environments were realized because of the appearance of the instrument in oceanography. In the context of the emerging need for ecosystem monitoring, there is a renewal of interest for long time recordings of Sv and current series from simple autonomous ADCP deployments on ocean observatories. This paper presents examples of such applications for the tracking of biophysical processes involved in the dynamics of a large-scale baleen whale feeding habitat in Gulf of St-Lawrence and for studying light-driven biological

rhythms over the large latitudinal gradient in Canadian waters. The advantages and limitations of the approach are discussed and ways to circumvent some weaknesses are presented.

6.4 Discussion

Major themes of the presentations included the following subjects:

- Calibration limitations and validation of ADCP data
- Observations of swimming speed and swimming patterns
- Utility of swimming speed to assist in species identification
- Utility of concurrent measurements of animal abundance, swimming speed, and current velocity
- How to assimilate time-series of backscatter in ways that useful to managers

The working group reviewed the unity of Acoustic Doppler Current Profilers (ADCP's) in a special session. Although ADCP's are traditionally not widely used by members of WGFAST, these instruments have become an integral component of physical oceanographic studies, and shipboard and self-contained instruments have been used widely in recent last decades. There was a review of advantages and technical limitations of ADCP's. The primary limitations discussed include lack of calibration methodology, linearity of the ADCP's response, blind zones, and non-vertical beam pointing angles. However, a method to inter-calibrate an ADCP and an echosounder has been presented. The primary advantages identified included the existence of large existing datasets, the ability to concurrently measure animal movement speeds, current velocities, and backscattering strength. Several examples of studies employing ADCP's were presented. The ability to concurrently measure Doppler shift and backscatter strength allows simultaneous measurements of vertical distribution of animals, and current velocities which can be used to measure transport of planktonic animals. It was noted that the non-vertical pointing angles of the beams may make the measurements less sensitive to uncertainties in animal orientation compared to a vertical pointing angle. It was suggested that it may be possible to infer the identity of acoustic scatterers by measuring swimming speed. ADCP's have been applied in several applications, including estimates of swimming speed of fish aggregations, studies of vertical migration behaviour, relationships with physical conditions, and predator–prey studies.

7 Topic D: Update on models and measures of target strength for classifying and enumerating living marine resources and topic E Emerging technologies, methodologies and protocols for single and multispecies surveys:

These presentation topics were merged for logistical reasons.

7.1 Ian H. McQuinn[1], Maxime Dion, Jean-François St. Pierre and Sylvain Chartrand:The multifrequency acoustic classification of two sympatric krill species (*Thysanoessa raschii* and *Meganyctiphanes norvegica*)

[1]*Maurice Lamontagne Insttute (ian.mcquinn@dfo-mpo.gc.ca)*

The ecosystem approach to fisheries management requires monitoring capabilities at all trophic levels, including long-neglected pelagic organisms. Although active acoustic techniques continuously sample the quasi-totality of the water column, their usefulness for ecosystem monitoring has been limited by ambiguities in the identification of scattering layers. The increasing use of multifrequency acoustic methods for the classification of scattering layers into species and species groups has opened up a vast range of potential applications for quantifying organisms in the pelagic zone. We describe a method for distinguishing between sympatric northern and Arctic krill (*Meganyctiphanes norvegica* and *Thysanoessa raschii*) using Sv amplitude ratios from 38, 120 and 200 kHz data. Data were preprocessed through a background-noise removal algorithm and the manual edition of logging artefacts. Frequency responses of both euphausiid species were predicted from a SDWBA physical model using characteristic body forms (length and fatness) for Arctic and northern krill. Classification and model validation was achieved using macrozooplankton samples collected from multiple-sampler (BIONESS) and ringnet (JackNet) hauls. Both samplers were equipped with a stroboscope to reduce avoidance by euphausiids. Modelled SDWBA frequency responses were calculated with a range of orientations and compared to empirical measurements.

7.2 Geir Pedersen1,2, Olav Rune Godø1, Egil Ona1, and Gavin J. Macaulay[1]: A revised length to TS estimate for blue whiting (Micromesistius poutassou) and implications for biomass estimates

[1] *Institute of Marine Research, PO Box 1870, 5817 Bergen, Norway; tel: +47 55 23 85 00; fax: +47 55 23 85 84;* [2] *Christian Michelsen Research, PO Box 6031, 5892, Bergen, Norway. (geir.pedersen@cmr.no)*

Acoustic abundance estimates of blue whiting stocks have generally been higher than estimates based on catch data. One explanation has been that the acoustic target strength (TS) to length relationship is too low and hence overestimates the number of fish. TS measurements were conducted during blue whiting surveys in March-April 2003–2007 to the west of the British Isles from several different measurement platforms, and also during August 2005 in the Norwegian Sea. Results from these experiments confirm the view that the existing TS to length relationship are too low. A new TS-length relationship is proposed that is approximately 5 dB higher. Blue whiting TS is considerably higher than what has been observed and modelled for a similar species, southern blue whiting (*Micromesistius australis*).

7.3 R.J. Kloser[1], G. Macaulay, T.E. Ryan and M. Lewis: New interpretations of orange roughy target strength using multifrequency visually verified in situ target strength, school scattering, and a scattering model

[1]*CSIRO (Rudy.kloser@csiro.au)*

It is often assumed that in situ target strength (TS) measurements from dispersed fish are representative of the surveyed schooling fish population. For deep water in situ TS measurements of orange roughy it has been difficult to validate the target species, their length and inclination and how representative these are of schooling fish. In situ TS measurements have been obtained with a net attached dual frequency (38 and 120 kHz) split-beam acoustic system with a stereo optical system. These in situ TS measurements have verified optical species identification and measurements of orientation and species length. Interpretation of these in situ measurements and how representative they are of the survey population is evaluated using frequency difference scattering from schools and individual fish and a finite-difference time-domain scattering model. Based on a mean school frequency difference dSv38-120 of -3.3 dB the TS of the population using frequency difference in situ measurements was -52 dB at 38 kHz for a mean standard length of 34 cm. The anatomically detailed scattering model has been applied to orange roughy at 38 and 120 kHz at a range of tilt angles and verifies the frequency difference observed.

7.4 Egil Ona[1] and Ingvald Svellingen[1]: Pressure dependent target strength in capelin (Mallotus Villosus)

[1]*Institute of Marine Research, PO Box 1870, Bergen Norway (egil.ona@imr.no)*

The Barents Sea capelin stock has been assessed with data from acoustic surveys as the main data source since 1970. The target strength used to convert echo energy to biomass is based upon early combined in situ counting and echo integration close to the transducer. Because capelin has an physostome swimbladder with no gas producing capacity, it must fill its bladder at surface like its relatives, the salmonids. Detailed in situ target-strength measurements at several depths using a simple TS probe was conducted from a fishing vessel in winter 2008 and 2009. As expected, the target strength was strongly pressure dependent, like in herring, but indicating a much closer bubble performance during increased pressure when compared with the herring swimbladder. Measurement methods, calibration procedure, fish sampling and new target strength relationships will be demonstrated.

7.5 Jakub Idczak, Natalia Gorska[1], Bartłomiej Arciszewski: Scattering properties of southern Baltic herring

[1]*University of Gdańsk, Institute of Oceanography (oceng@ug.edu.pl)*

Reliable TS – length relationship is required to improve acoustic algorithms of abundance estimation of Baltic herring. The relationships, empirically obtained in the different parts of the Baltic Sea, produce up to 8 dB – difference in the herring TS. To have accurate TS – length relationship, the factors controlling the TS variability were analysed. The possible impact of the regional difference in the swimbladder morphometry, critical in the backscattering by fish, was not considered yet because the morphometry was analysed only for herring and sprat, caught in the Swedish coastal zone (ICES Subdivisions 25, 27, 29) in October 2002, using the X-ray images. It motivated our study. The paper is addressed to the numerical analysis of the backscattering properties of the Southern Baltic herring. The input morphometric data for the modelling were obtained basing on the X-ray image collection of the herring caught in the Polish coastal zone (ICES Subdivision 26) in October 2010. The optimal methodology of the morphometry study, including the fish catch, transport, storage and the X-ray analysis has been developed. The difference in the swimbladder morphometry for herring from the two different Baltic Sea areas is demonstrated and its impact on the herring backscattering properties is analysed.

7.6 Tonje Nesse Forland[1], Rolf Korneliussen, Halvor Hobæk: Experimental investigation of scattering properties of Atlantic mackerel

[1] *University of Bergen, Department of Physics and Technology (tonje@ift.uib.no)*

Schools of Atlantic mackerel (Scomber scombrus) are identified acoustically with multi frequency echosounders by utilizing the increase in the backscattered signal between 70 and 200 kHz, which is the distinguishing mark of mackerel. However, scattering from mackerel is not used to determine abundance due to variations between the abundance estimates from repeated annual surveys. A better understanding of mackerel backscattering is needed to be able to extract more information from echosounder measurements on schools of mackerel. A starting point could be to explain the cause of the distinguishing increase in the mackerel backscatter. Because mackerel does not have a swimbladder, it has been suggested that the increase could be due to the back bone. In this work, measurements on acoustic backscattering from individual dead mackerel and segments of mackerel is presented. Most measurements are done on 10 cm segments of the backbone where the frequency response is measured at several tilt angles. All measurements are done in a laboratory tank filled with freshwater or with physiological salt water. Results show that both the flesh and the bone contributes significantly to the scattered signal, but do not show any systematic increase between 70 and 200 kHz, neither from single fish or attempts to simulate schools.

7.7 Fassler, S. M. M., and J. M. Jech[1]: Pressure effects on the KRM-predicted frequency response of an individual Atlantic herring

[1]*NOAA/NMFS/NEFSC (michael.jech@noaa.gov)*

Images of an individual Atlantic herring's (Clupea harengus) body and swimbladder were obtained in vitro at six water pressure levels using magnetic resonance imaging (MRI; Fassler *et al*., 2009. J. Fish. Biol. 74: 296-303). The pressure levels of 0, 1, 2, 4, and 6 bars simulated the fish being at 0, 10, 20, 40, and 60 m depth. The swimbladder and body images were transformed to digital files, which were used to predict the target strength (TS; dB re 1 m2) of the body, swimbladder and of the combined anatomy with the Kirchhoff ray-mode (KRM) analytical approximation. The TS was predicted at 18, 38, 70, 120, and 200 kHz at dorsal incidence and for angles within ±40o of dorsal. The 250-mm herring was scaled to predict TS from 100 to 300 mm length. As expected, the overall magnitude in predicted TS decreased with increasing pressure and the frequency response changed due to the "squeezing" of the swimbladder with pressure. However, these trends were not necessarily consistent among pressures. For example, the frequency-dependent maximal TS occurred at different pressures - not necessarily at the "surface", and the ΔTS was not consistent among pressures. Findings were compared with volume backscatter (Sv; dB re m-1) values of herring schools at various depths observed during surveys. The implications of these pressure effects on frequency-dependent TS and on classification and identification of marine fish are discussed.

7.8 Peña, Marian[1], Iglesias, M., Miquel, J., Olivar, P.: Evaluation of the forward models available for the species sampled during the IDEADOS surveys

[1]*IEO (marian.pena@ba.ieo.es)*

Seasonal differences between the acoustic echograms of zooplankton and micronekton species recorded during winter and summer surveys on the shelf and slope in the Balearic waters are evaluated. Several forward models for the species sampled with

pelagic trawling and plankton nets are examined for the frequencies available (18, 38, 70, 120 and 200 Khz), particularly for the first three, where deeper layers can be considered. We present an experimental mask to help the comparison between those models and the echograms. Changes of the acoustic response with depth, size and frequency are evaluated. Main organisms found along the water column were species of mictofiforms and stomiforms (mainly Cyclothone braueri), northern krill, tunicates and jellyfish, and to a lesser extent some siphonophores and cephalopods.

7.9 Chu,Dezhang[1], Mike Jech, Stan Tomich, and Larry Hufnagle: Three-dimensional Acoustic Imaging of Fish Swimbladder

[1]*NOAA/NMFS/NWFSC (dezhang.chu@noaa.gov)*

A prototype of a high-frequency underwater Acoustic Imaging Microtome System (AIMS) has been developed to image the swimbladder shape and volume. By using a group of vertical and horizontal high-frequency acoustic line arrays, the AMIS can provide a 3D acoustic intensity image- a shadow-gram similar to an X-ray image- of the fish swimbladder due to its larger acoustic attenuation. In addition, the AIMS can provide the relative acoustic attenuation by fish bones and other anatomical structures. Using image processing techniques, we should be able to reconstruct a 2D/3D digital image of the fish swimbladder and the inhomogeneous structures of the fish body. It will significantly enhance our capability of modelling the target strength of swimbladder-bearing fish and consequently improve the accuracy of fish abundance estimates.

7.10 Jarvis[1], Toby, Ian Higginbottom: Hydroacoustic data-processing algorithms: from a broad-level roadmap to specific examples available to all

[1]*Echoview (toby.jarvis@echoview.com)*

Amid the diversity of hydroacoustic applications we have identified a universal framework for data processing (UFDP). The UFDP is useful as a roadmap to guide the data analyst through the sequence of events required to go from raw data to usable information. At a broad level this roadmap includes six key steps: loading and viewing; calibration; background-noise removal; detection and filtering; classification; characterization. At ground level, it is clear that specifics are required to enable navigation through varying terrain. For example: best practice for different instruments and platforms; mitigation of different noise phenomena; identification and characterization of different types of acoustic scatterer under a variety of conditions, etc.. In response to a growing call from the hydroacoustics community, this talk presents a number of specific examples within the UFDP and discusses initiatives for making these available to all.

7.11 Jeong-Hwa CHOI, Kyounghoon LEE[1], Seong-Wook PARK, Dong-Woo LEE: Acoustical backscattering strength characteristics and density estimates of Japanese common squid distributed in Yellow Sea

[1]*National Fisheries Research & Development Institute (hlee71@nfrdi.go.kr)*

Due to change of various marine environments according to seawater temperature rising, Japanese common squid (*Todarodes pacificus*), which was distributed in East Sea, was recently caught in Yellow Sea during a summer season from 2006. The fishery resources density research was carried out in Korea-China Provisional Water Zone using trawl fishing gear and acoustics in National Fisheries Research & Development Institute in Korea. This paper showed the analysis on the acoustical backscattering strength by two frequencies(38kHz, 120kHz) for Japanese common squid by

acoustical scattering theoretical model based on size distribution for survey period, and estimate the density distribution for squid's integrated layer which was extracted from any scatterers distributed in water column using two frequency difference method which has been used to distinguish fish shoals or specific target scatterers from sound-scattering layer which is composed of various zooplankton. Furthermore, the entire range of their density estimation was suggested using by Monte Carlo simulation under considering each uncertainty such as size distributions or swimming angle and so on in the survey area.

7.12 Rokas Kubilius, Egil Ona[1] and Georg Skaret: Orientation of krill and fish in situ as determined by stereogrammetry

[1]*Institute of Marine Research, PO Box 1870, 5817 Bergen, Norway (egil.ona@imr.no)*

Most marine animals are directive acoustic scatterers, and animal orientation may therefore be important when interpreting acoustic observations. Free swimming, single individuals of Northern krill (*Meganyctiphanes norvegica*) and fish were monitored with a stereo photo camera system during acoustic target strength experiments. Details of the camera calibration procedures, calibration data and resulting measurement accuracies will be presented. A standard post-processing system for stereogrammetry was used both in the calibration and measurement process. Initial results of animal orientation and computed animal volume density, as determined from the photographic material will be demonstrated. Critical elements of the method used will also be discussed.

7.13 Egil Ona[1], Lars Nonboe Andersen[2], Lucio Calise[1], Gavin Macaulay[1], Rolf Korneliussen[1], Tor Knutsen[1], Dezhang Chu[3], Anne Lebourges Dhaussy[4]: Exploiting broadband split-beam echosounders for zooplankton; some preliminary results from the WESTZOO project

[1]*Institute of Marine Research, PO Box 1870, Bergen Norway (egil.ona@imr.no);* [2] *Kongsberg Maritime AS - Simrad, P.O Box 111, 3191 Horten, Norway;* [3] *NOAA/NMFS/NWFSC/FRAM; 2725 Montlake Blvd. E., Seattle, WA 98112, USA;* [4] *IRD, Site de la Pointe du Diable, BP70, 29280 Plouzané, France*

Prototype broadband split-beam echosounders from Simrad with split-beam transducers have been used for about 2 years in an exploratory technology project, (WESTZOO = Exploiting new wide band echosounder technology for zooplankton characterization, sizing and abundance estimation). Using four channels in each echosounder, chirp signals of different bandwidth and shape have been transmitted and received on standard split-beam transducers. The available composite element transducers from 70 – 333 kHz have been used to exploit frequencies from about 50 to 450 kHz, suitable for covering the most interesting backscattering spectra of euphausiids. The prototype transceivers were installed in a profiling acoustic probe with motorized transducer platform in order to facilitate full split-beam calibrations and single target measurements at depth. Examples from the calibration exercises on large and small standard targets and measurements on animals including euphausiids, mesopelagic fish, blue whiting, herring and saithe will be demonstrated.

7.14 Gavin Macaulay[1], Lars Nonboe Anderson, and Egil Ona: Estimation of target position using a split-beam broadband echosounder

[1]*IMR (gavin.macaulay@imr.no)*

Data from prototype broadband split-beam echosounders (50 to 450 kHz) have been used to investigate the performance and accuracy of four methods for determining target position from shaded chirp pulses; phase comparison on pulse-compressed

quadrant data (method A), frequency-specific (method C1) and weighted-mean (method C2) phase comparison from the FFT of the pulse-compressed quadrant data, and direct time-of-arrival delay estimation using between quadrant cross-correlation in the time domain (method B). Estimates of true target position were obtained by placing various calibration spheres below the transducers then rotating the transducers while simultaneously measuring their pitch and roll. Position estimates from method A were robust and accurate, but the accuracy is expected to degrade depending on the frequency spectra of the target. Method B was also robust but slightly less accurate than method A. Method C1 was good except at frequencies close to nulls in the sphere frequency spectra. Method C2 was potentially as good as method A, but required appropriate down-weighting of the positions obtained from frequencies close to sphere nulls. Estimates of angle sensitivity, beam width, and equivalent beam angle as a function of frequency have also been derived for the transducers used in the test.

7.15 Lucio Calise, Egil Ona, Tor Knutsen, Gavin Macaulay, Ruben Patel, Lars Nonboe Andersen, Rokas Kubiliu: Ex situ target-strength measurements of Northern krill (*Meganyctiphanes norvegica*) with a broadband split-beam echosounder prototype

[1]*Institute of Marine Research, Bergen, Norway (lucio@imr.no)*

Free swimming, single individuals of Northern krill (*Meganyctiphanes norvegica*) were monitored with a prototype broadband split-beam echosounder in a large enclosure at the aquaculture facility of the Institute of Marine Research in Austevoll. Four broadband echosounders were operated sequentially transmitting linear-up sweep signals covering the approximate bands 50-90, 90-170, 170-270 and 270-370 kHz with the Simrad ES70-7C, ES120-7CD, ES200-7CD and ES333-7CD split-beam transducers respectively. Simultaneous observations with a stereo camera system enabled also measurements of animal orientation and animal size for some of the recorded tracks. Examples of krill backscattering spectra together with details of the measurement setup, krill catch and handling methods as well as sphere calibration procedures will be demonstrated.

7.16 Lebourges-Dhaussy[1], A., D. Chu, R. Korneliussen, I. Leblond: Investigations on inversion methods and data resolution for determining zooplankton organism size distributions, in the framework of the WESTZOO project

[1]*IRD (anne.lebourges.dhaussy@ird.fr)*

In the framework of the WESTZOO project, multifrequency data on sampled krill have been acquired and broadband data on known populations will soon be available. A high spatial resolution will be reached and therefore the possibility for resolving small, individual targets. This presentation includes two aspects when exploring the inversion methods. On the one hand, simulations have also been made on broadband signals in order to elucidate the minimum number of necessary frequencies needed for stabilizing the results according to variable noise level and different size classes thus involving different "ka" ranges. On the other hand, inversions have been implemented on multifrequency data on sampled krill.

7.17 Sigurður Þór Jónsson[1] Bootstrapping the uncertainty of winter survey echo abundance estimates of Icelandic-Greenland-Jan Mayen capelin

[1]*Marine Research Institute, Iceland (sigurdur.thor.jonsson@hafro.is)*

A framework for accounting for uncertainty in winter acoustic estimates of Icelandic-Greenland-Jan Mayen capelin SSB is under development. The following is intended to give an indication of the status of the work as regards the treatment of the acoustic estimates. It is planned to couple the uncertainty in the acoustic estimates with predator stock size, with the aim of establishing a stochastic framework for the fisheries management of the stock.

7.18 Discussion

Major themes:

- New measurements of Target Strength (TS) of marine animals
- Technological developments in broadband acoustics, multifrequency, lowered transducers, and optical systems
- Advances in use of frequency response for species classification
- Laboratory measurements of fish anatomy and acoustic backscatter
- Use of lowered transducers for TS estimation and measurement of frequency response
- Acoustic methods have traditionally provided relative indices, but there are some recent developments towards absolute abundance

Target Strength (TS) and species identification remain core areas of research for WGFAST. The consensus is that continued progress in understanding of these issues is required for continued progress in our ability to convert measurements of backscatter strength to 1) animal identity and 2) animal abundance. It is important to recognize that TS and frequency response are inherently linked, as the frequency response is simply the frequency-dependence of TS of targets in the volume. Acoustic methods in fisheries applications have often been used to generate abundance indices for use in assessment models, but there were several reports for requirements for absolute abundance, which places higher demands on knowledge of TS as measures of absolute abundance are highly sensitive to biases in TS than indices. The presentations and ensuing discussion indicated that progress in this important area will be made by a combination of approaches: in situ measurement, measurements of morphology, modelling, and laboratory observations.

It is clear that a deterministic view of TS as a size-dependent is insufficient. In discussion, it was emphasized that TS is situation-dependent: for a given species, covariates such as geographic location, depth, age, physiological state, and behaviour must be considered. Substantial differences in herring swimbladder anatomy from different regions were reported, and models suggest that this will lead to substantial regional differences in TS. Additionally, several examples of pressure dependence in fish TS and frequency responses were discussed. Discussion on models centred on variability of the anatomy of individual fish, and how many fish must be measured to arrive at reliable TS estimates. It was suggested that we should move from deterministic to probabilistic scattering models. This will reduce the effect of destructive interference which can average out nulls in the backscattering cross section

Several important advances were reported. One area was improvements in the ability to distinguish among acoustic backscatter from related biological species rather than acoustic scattering groups based on frequency response. The study of frequency response is progressing from analysis of large differences in frequency response to discriminate among very different scatters such as fish and zooplankton to attempts to understand the factors causing relatively small differences (i.e. < 2 dB) arising from

small changes in size or orientation in a single species. A new classification technique was developed to distinguish among two dominant species of euphausiids. Advances were reported in lowered acoustics systems, as well as on stereo-camera verification of TS measurements made with instrumented trawls. In addition, significant advances in the design, calibration, verification and application prototype broadband echosounder systems were reported. One possibility is to use the nulls in the broadband spectrum to provide information to help identify targets. These systems hold great promise as they allow will allow improved estimates of range and target position and will allow target-strength measurements at high animal densities and/or longer ranges and broadband measurements of frequency response that may improve species identification. From discussion, it was clear that these methods offer significant potential for improvement and that a significant amount of development in this area will be required for routine application. One physical limitation of use of high frequencies in these systems is that high absorption will limit the depths to which the systems will be useful, which will necessitate the more widespread use of profiling systems.

8 WGFAST meeting business and planning

8.1 Requests

8.1.1 WGACEGG – SSGESST request

It was suggested that WGFAST maintain and enrich a Target Strength to length equation database, in an open-access framework.

It was suggested that this would be better included in an existing database FishBase (www.fishbase.org) which is widely used in fisheries science. Chris Taylor, USA, will contact Dr Villy Christensen at the Fisheries Centre at the University of British Columbia, and explore the possibility of including relevant citations for Target Strength observations for different species in Fishbase.

8.1.2 Strategic Initiative on Area Based Science and Management (SIASM)

The main objective of the Strategic Initiative on Area Based Science and Management (SIASM) is to demonstrate to ICES clients, Member Countries and stakeholders that ICES has the expertise and facilities to deliver solid, robust and independent science and advice on marine area based management and spatial planning. Acoustics is particularly suited to do non intrusive sampling, and the WGFAST had several contributions on using acoustics to address the effect of marine protected areas and the effect of hydro kinetic power plants (cf. above). WGFAST added explicitly the need for contributions to further address this topic in the 2012 ToR.

The WGFAST is also suggesting a training course in geostatistics that is a powerful technique for analysing spatial data.

8.1.3 Marine Strategy Directive Framework Steering Group (MSFDSG)

The Marine Strategy Directive Framework Steering Group (MSFDSG) has asked the EG to identify elements of the EGs work that may help determine Good Environmental Status (GES), with particular emphasis on linkages that could be made between fish stock and ecosystems. The EG responded by adjusting the ToR for the indicator session to accommodate and address Good Environmental Status, and in particular to ask for contributions of similar initiatives globally. The EG is also proposing an ICES ASC session on acoustical derived indicators (2012, responsible Verena Trenkel), with the intention of bringing in a chair from another expert group to broaden the perspective and facilitate cross fertilization.

8.2 2012 and 2013 meeting plans

WGFAST received an invitation from A Lebourges-Dhaussy and L Berger (France) to hold the 2012 meeting in Brest on 7–11 May 2012.

G. Boyra, AZTI, expressed interest in hosting a meeting in 2013 in Pasaia, Spain.

8.3 Acoustic Symposium (2014)

The working group discussed provisional planning for the ICES sponsored Acoustic Symposium. We will need someone to step forward to lead the process. Important that there is a principal chair and host as this requires funding. There are documents from the last 3 symposiums that give budget and logistic details. It was emphasized that the next symposium needs to have a new focus to distinguish it from previous symposia. No candidates were identified at the meeting.

8.4 Meeting Recommendations

The meeting discussion on the terms of reference for the next WGFAST meeting resulted in the following recommendations:

8.4.1 Terms of Reference for the 2012 WGFAST meeting

See annex 3.

8.4.2 Study, Planning and Topic Groups

Recommendation: WGFAST recommends that SGCal, David Demer (USA), Chair, work towards an ICES Cooperative Research Report and meet in Brest, France Monday 7 May 2012. The result of their meeting is to be reported to the WGFAST 2012.

Recommendation: WGFAST recommends that the topic group on metadata standards, Tim Ryan (AUS), Chair will work towards a first version of a standardized metadata standard for acoustic data from ships of opportunity to suit ocean observing system requirements for data acquisition, processing, quality control and data dissemination. They should indicate the most appropriate way forward for this initiative, including the relation with GOOS and other similar organizations. The result of their 2011 meeting conducted immediately after the WGFAST meeting will be reported to the WGFAST 2012.

The WGFAST discussed the issues with the overdue cooperative research report (CRR) drafts, and the chairs agreed on the following: The SGFOT draft CRR should be sent for review no later than 15 July 2011, and the SGFARV draft CRR should be sent for review no later than 30 June 2011. If the reports are not received or if a major revision is required, the process must be re-initiated for the draft to be considered becoming a CRR. This means a new study group must be formed.

8.4.3 Theme Sessions for the ICES 2012 Annual Science Conference

Recommendation: In a continuing effort to contribute to the ICES Annual Science Conference, WGFAST proposes the following Theme Session for the 2012 Annual Science Conference:

WGFAST in collaboration with other assessment and survey-based expert groups recommend a theme session in 2012 on the ecosystem-based fisheries management information needs from surveys: metrics, indices, models and indicators. The effort will be co-chaired by Verena Trenkel, who will explore potential for coordination with other groups through SSGESST. The theme session should address how acoustics can address some of the Good Environmental Status (GES) descriptors in the EU, and similar efforts elsewhere.

8.4.4 ICES courses?

WGFAST feels that ICES facilitation of a training course on the use and application of Geostatistics would be well supported by its members and represents a cross cutting methodology that may appeal to a range of ICES working groups and members.

The broader community supported the idea, but suggested that the title should be more specific and tailored to the specific user group in mind. It was also enquired if such a course could be hosted in conjunction with a future ICES WGFAST meeting rather than in Copenhagen.

A proposal will be prepared by Tim Ryan.

8.4.5 Future meetings of the WGFAST/WGFTFB joint session

The joint session (see separate joint session report) was held prior to the FAST meeting, and although some concern about the content and role of the session was expressed prior to the session, the consensus was that the joint meeting with FTFB was valuable and should be continued in future. Some talks from were re-routed to the joint session from the WGFAST and WGFTFB submissions, which was considered to be a useful way to supplement the contributions to the joint session. A general feedback from WGFAST was that themes for future joint sessions should focus on themes that engage both groups. One such item is the need for improved sampling for species identification and size estimation, including micro nekton communities. Methods to evaluate the efficiency of the different gears are instrumental to make further progress, and it was believed that this could be a topic that could be of common interest between the FAST and FTFB. FTFB will have a triennial meeting in Rome, and we propose to hold the next session in 2014. Chris Wilson volunteered to act as a joint session chair from WGFAST, and will take further steps to plan and arrange this session in collaboration with FTFB.

8.4.6 HAC

It was recommended that Laurent Berger should handle requests for the HAC format on behalf of the WGFAST.

WGFAST encourages the industry to facilitate data access through standard or open data formats (i.e. HAC). A lot of unnecessary effort is used to link the output from hardware to available post-processing software. Adhering to standards makes the products more easily usable, and is strongly encouraged.

8.5 Closure of meeting

At the end, the structure of the meeting was discussed. It was commented that the participants provided good feedback to the speakers, and it was recommended that more time for questions be allotted in the talks. Speakers could also provide a discussion topic to further facilitate comments and feedback in response to talks provided during the group discussions

Nils Olav Handegard closed the meeting at 15:00 on Friday, the 13 May and thanked the participants for their active discussions and science presentations and Alex De Robertis for his service as rapporteur. In particular Nils Olav thanked our host Sigurður Þór Jónsson and his team at the Icelandic Marine Research Institute for ably hosting the meeting and for ensuring that the meeting and social events ran smoothly.

Annex 1: List of participants

Last name	First name	Email	Institute	Country
Algrøy	Tonny	tonny.algroy@simrad.com	Simrad	Norway
Andersen	Lars Nonboe	lars.nonboe.andersen@simrad.com	Simrad	Norway
Axenrot	Thomas	thomas.axenrot@fiskeriverket.se	Institute of Freshwater Research, Swedish Board of Fisheries	Sweden
Bardarson	Birkir	birkir@hafro.is	Marine Research Institute Iceland	Iceland
Behagle	Nolwenn	nolwenn.behagle@ird.fr	IRD (Institut of Research for the Development)	France
BERGER	Laurent	laurent.berger@ifremer.fr	IFREMER	France
Bethke	Eckhard	eckhard.bethke@vti.bund.de	Institute of Sea Fisheries	Germany
Björnsson	Höskuldur	hoski@hafro.is	MRI Reykjavík	Iceland
Boyra	Guillermo	gboyra@azti.es	AZTI Tecnalia	Spain
Calise	Lucio	lucio@imr.no	Institute of Marine Research	Norway
Chu	Dezhang	dezhang.chu@noaa.gov	NOAA/NMFS/NWFSC	United States
Churnside	James	james.h.churnside@noaa.gov	NOAA ESRL	United States
Condiotty	Jeff	jeff.condiotty@simrad.com	Kongsberg	United States
Copland	Phil	coplandp@marlab.ac.uk	Marine Laboratory, Aberdeen	United Kingdom
Cutter	George	george.cutter@noaa.gov	Southwest Fisheries Science Center	United States
De Robertis	Alex	alex.derobertis@noaa.gov	Alaska Fisheries Science Center	United States
Demer	David	david.demer@noaa.gov	Southwest Fisheries Science Center	United States
Domokos	Réka	reka.domokos@noaa.gov	PIFSC, NOAA	United States
Fässler	Sascha	sascha.fassler@wur.nl	IMARES	The Netherlands
Forland	Tonje Nesse	tonje@ift.uib.no	University of Bergen, Department of Physics and Technology	Norway
Gerlotto	Francois	francois.gerlotto@ird.fr	IRD	France
Giannoulaki	Marianna	marianna@her.hcmr.gr	HCMR	Greece
Goncharov	Sergey	sgonch@vniro.ru	Russian federal research institute of fisheries and oceanogr	Russia
Gorska	Natalia	oceng@ug.edu.pl	University of Gdańsk, Institute of Oceanography	Poland
Handegard	Nils Olav	nilsolav@imr.no	Institute of Marine Research	Norway
Higginbottom	Ian	ian@myriax.com	Myriax Pty Ltd	Australia
Horne	John	jhorne@u.washington.edu	University of Washington	United States
Hreinsson	Einar	eihreins@hafro.is	UNAK/MRI Iceland	Iceland
Idczak	Jakub	kubid@wp.pl	University of Gdańsk, Institute of Oceanography	Poland
Jarvis	Toby	toby.jarvis@echoview.com	Echoview	Australia
Jech	Mike	michael.jech@noaa.gov	NOAA/NMFS/NEFSC	United States
Jonsson	Sigurdur Thor	sigurdur@hafro.is	Marine Research Institute	Iceland
Josse	Erwan	erwan.josse@ird.fr	IRD	France
Karp	Bill	bill.karp@noaa.gov	NOAA - AFSC	United States
Kasatkina	Svetlana	ks@atlant.baltnet.ru	AtlantNIRO	Russia
Kloser	Rudy	rudy.kloser@csiro.au	CSIRO	Australia
Korneliussen	Rolf	rolf.korneliussen@imr.no	Institute of Marine Research	Norway
Kracker	Laura	laura.kracker@noaa.gov	NOAA	United States
Laczkowski	Tomasz	tomlacz@mir.gdynia.pl	Sea Fisheries Institute in Gdynia	Poland
Le Bouffant	Naig	naig.le.bouffant@ifremer.fr	IFREMER	France
Lebourges-Dhaussy	Anne	anne.lebourges.dhaussy@ird.fr	IRD	France
LEE	Kyounghoon	khlee71@nfrdi.go.kr	National Fisheries Research & Development Institute	Korea
Lilja	Juha	juha.lilja@rktl.fi	Finnish Game and Fisheries Research Institute	Finland
Macaulay	Gavin	gavin.macaulay@imr.no	IMR	Norway
MacLennan	David	maclennan22@aol.com	Marine Science Scotland	United Kingdom
McQuinn	Ian	ian.mcquinn@dfo-mpo.gc.ca	Maurice Lamontagne Insttute	Canada
Melvin	Gary	gary.melvin@dfo-mpo.gc.ca	Fisheries and Oceans	Canada
O'Driscoll	Richard	r.odriscoll@niwa.co.nz	NIWA	New Zealand
Ona	Egil	egil.ona@imr.no	Institute of Marine Research	Norway
Patel	Ruben	ruben@imr.no	imr	Norway
Pedersen	Geir	geir.pedersen@cmr.no	Christian Michelsen Research AS	Norway
Pena	Hector	hector.pena@imr.no	IMR	Norway
Peña	Marian	marian.pena@ba.ieo.es	IEO	Spain
Reynisson	Páll	pall@hafro.is	IMR	Iceland
Romain	Suzanne		Romain consulting	United States
Ryan	Tim	tim.ryan@csiro.au	CSIRO	Australia
Samedy	Valérie	valerie.samedy@cemagref.fr	Cemagref	France
Schmidt	Beata	bschmidt@mir.gdynia.pl	Sea Fisheries Institute in Gdynia	Poland
Simard	Yvan	yvan_simard@uqar.qc.ca	ISMER-UQAR	Canada
Taylor	J. Christopher	chris.taylor@noaa.gov	NOAA Ocean Service	United States
Thomas	Rebecca	rebecca.thomas@noaa.gov	Northwest Fisheries Science Center	United States
Toliusis	Sarunas	sarunast@gmail.com	fishery research and science department	Lithuania
Trenkel	Verena	vtrenkel@ifremer.fr	IFREMER	France
Urmy	Samuel	urmy@uw.edu	University of Washington	United States
Warren	Joseph	joe.warren@stonybrook.edu	Stony Brook University	United States
Weber	Thomas C.	weber@ccom.unh.edu	University of New Hamphsire	United States
Wespestad	Vidar	vidarw@frontier.com	Aleutian East Borough	United States
Wilson	Christopher	chris.wilson@noaa.gov	NOAA Fisheries, Alaska Fisheries Science Center	United States

Annex 2: Agenda

	Tuesday	Wednesday	Thursday	Friday
8:45	*Housekeeping*	*Housekeeping*	*Housekeeping*	*Housekeeping*
9:00	FAST opening	Kloser - Introduction	Lebourges-Dhaussy - Introductio	Ona
	FAST opening	Patel	Simard	Macaulay
9:30	Tribute to Clay	Macaulay	Lee	Calise
	FAST program	Kloser	Discussion	Lebourges-Dhaussy
10:00	Trenkel - introduction	Ryan	Discussion	Discussion
	Korneliussen	Churnside	Discussion	Discussion
10:30	*Coffee*	*Coffee*	*Coffee*	*Coffee*
	Coffee	*Coffee*	*Coffee*	*Coffee*
11:00	Samedy	Behagle	Egil Ona - Introduction	Observatories (John Horne)
	Trenkel	Horne	McQuinn	WKTAR (Mike Jech)
11:30	Berger	Urmy	Pedersen	IMBER MAAS/Wiki (Nils Olav Handegar
	DeRobertis	Domokos	Kloser	SPRMFO (Francois Gerlotto)
12:00	*Lunch*	*Lunch*	*Lunch*	*Lunch*
	Lunch	*Lunch*	*Lunch*	*Lunch*
12:30	*Lunch*	*Lunch*	*Lunch*	*Lunch*
	Lunch	*Lunch*	*Lunch*	*Lunch*
13:00	*Lunch*	*Lunch*	*Lunch*	*Lunch*
	Lunch	*Lunch*	*Lunch*	*Lunch*
13:30	Behagle	Discussion	Ona - Caprein	
	Taylor	Discussion	Idczak	
14:00	Wespestad	Discussion	Nesse Forland	Present ToR 2012
	Boyra	SCICOM update (Bill Karp)	Fassler	Plan next meeting
14:30	Kasatkina	SCICOM update (Bill Karp)	Peña	FAST report
	Discussion	SCICOM update (Bill Karp)	Chu	Other business
15:00	Discussion	*Coffee*	*Coffee*	*Coffee*
	Coffee	*Coffee*	*Coffee*	*Coffee*
15:30	*Coffee*	*Excursion*	Jarvis	Plan next meeting
	Input for ToR 2012	*Excursion*	Choi	FAST report
16:00	Input for ToR 2012	*Departure from Grand Hôtel R*	Kubilius (Ona)	Other business
	SGCAI (Dave Demer)	*Excursion*	Sigurdur	
	SGFARV (Francois Gerlotto)	*Excursion*	Discussion	
- 17:00	SGFOT (James Churnside)	*Arrival at the Blue Lagoon*	Discussion	

Annex 3: Group photograph

Annex 4: WGFAST meeting resolution

The **Working Group on Fisheries Acoustics, Science and Technology** (WGFAST) chaired by Nils Olav Handegard, Norway, will meet in Brest, France from 8–11 May 2012:

a) In response to the ICES strategic plan 200–2013, WGFAST will document how acoustic and complementary methods will contribute to the goals of an ecosystem approach with benthic and pelagic observations to improve assessment and management of living marine resources, understanding mechanisms and processes of change and stability, and parameterize and evaluate models of ecosystem structure and function.

i) Ecosystem approach to fisheries management: metrics, indices and indicators. Provide methods and standards for creating and validating indicators and metrics derived from acoustic and complementary methods. Contributions addressing how acoustic metrics can be used to inform models and metrics addressing the effects of marine spatial planning, including marine protected areas are encouraged. Evaluate and compare a range of suitable metrics in empirical situations and by simulation, and data archaeology establishing long time-series of acoustic data are believed to be a key to make progress. (presentation session, Verena M. Trenkel)

ii) Design, implementation and review of observing systems. Integrating acoustic and complementary technologies to meet national and international goals for ecosystem based marine management. (presentation session, Yvan Simard/John Horne)

iii) Acoustic properties of marine organisms. Update on models and measures of target strength for classifying and enumerating living marine resources and associated variability of validating results. The use of multibeam sonars emphasize the need for addressing the dependence of beam inclinations from several inclinations as opposed to the traditional vertical approach and needs to be addressed (Presentation session, Egil Ona).

iv) Behaviour. Characterization of animal behaviour in order to 1) describe measurement uncertainty when using acoustic and complementary survey technologies and 2) measure the behaviour or marine organisms for ecological studies. There is a particular need to quantify behavioural disturbance in response to acute and chronic stimuli, including anthropogenic noise effects on marine animals (addressing GES descriptor 11) in order to characterize impact on ecosystem processes. (Presentation session, Alex De Robertis)

v) Emerging technologies, methodologies, and protocols in single and multispecies surveys and end-to-end ecosystem models, including error structures and error budget modelling. (Presentation session, Richard O'Driscoll)

b) Based on our use of active sound in the ocean there is a need to review and document its footprint and place this in context with other natural and anthropogenic sources and the relative impact on marine biota. We will present a paper in the "Behaviour" session where the time, volume and levels will be addressed (Rudy Kloser).

c) Review the reports and receive updates from:

i) Study Group on Calibration of Acoustic Equipment (SGCal; David Demer).

ii) Topic Group on metadata standards (Tim Ryan).

iii) Engagement with SPRFMO (Francois Gerlotto).

iv) Observatories publication topic group (John Horne)

WGFAST will report by 30 June 2012 (via SSGESST) for the attention of SCICOM.

Supporting Information

Priority	Fisheries acoustics and complementary technologies provide the necessary tools and methods to implement the ecosystem approach to fisheries management within ICES and research into their application and further development is vital.
Scientific justification and relation to action plan	In response to the ICES strategic plan 2009–2013, WGFAST will document how acoustic and complementary methods will contribute to the goals of an ecosystem approach with benthic and pelagic observations to improve assessment and management of living marine resources, understanding mechanisms and processes of change and stability, and parameterize and evaluate models of ecosystem structure and function. WGFAST will report by 31 July 2012 for the attention of the SCICOM steering Group on Ecosystem Surveys Science and Technology.
Resource requirements	No new resources will be required for consideration of this topic at WGFAST annual meeting. Having overlaps with the other meetings of the Working, Planning, Study and Topic Groups increases efficiency and reduces travel costs; undertake additional activities in the framework of this group is negligible.
Participants	The Group is normally attended by some 60–70 members and guests.
Secretariat facilities	None.
Financial	No financial implications.
Linkages to advisory committees	
Linkages to other committees or groups	The work in this group is closely aligned with complementary work in the WGFTFB group. The work is of direct relevance to WGNAPES, WGRS, WGIPS, and WGBIFS.
Linkages to other organizations	IMBER, SPRMFO
Secretariat marginal cost share	ICES: 100%

Annex 5: Recommendations

No recommendations to other expert groups were identified at the meeting.