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Report of the Study Group on Collection of Acoustic Data from Fishing Vessels (SGAFV)

17–18 April 2005

Rome, Italy

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

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Executive summary

The Study Group on Collection of Acoustic Data from Fishing Vessels (SGAFV) held its second annual meeting at the United Nations Food and Agriculture Organization (FAO) Headquarters in Rome, Italy, prior to the 2005 meetings of ICES FTC working groups, WGFAST and WGFTFB. The meeting was Chaired by Bill Karp (USA). Guy Fleischer (USA acted as Rapporteur and Jessica Lipsky (USA) acted as Recorder. The Chair opened the meeting by thanking FAO and introducing those present. The Study Group then reviewed the agenda and discussed the goals of the meeting.

Summaries of recent work germane to the SGAFV terms of reference were presented by four attendees.

- *Richard O'Driscoll and Gavin Macaulay (New Zealand) - Using fish processing time to carry out acoustic surveys from commercial fishing vessels.* This is an important case study in efficient and effective use of commercial vessels as platforms for collecting acoustic data. The authors carried out scientific surveys during "down time" when factory trawlers were processing catches and not engaged in commercial fishing. Benefits and limitations of this approach were discussed during and following the presentation. Several important points were raised in discussion, including the need for a better understanding of operational and survey design limitations associated with this kind of work.
- *Hector Peña et al. (Norway) – Using commercial fishing vessels to conduct acoustic surveys of capelin in the Barents Sea*. Three systematic surveys were conducted in an attempt to describe distribution and abundance of spawning capelin in the Norwegian zone. Although fish were not encountered during the first two phases, it was possible to survey the stock and develop an abundance estimate during fishing operations in the third phase of the project. In addition to collecting data for abundance estimation, this study provided important information on migration and spawning stock dynamics. Following the presentation, the discussion focussed on concerns that sonar observations might influence behaviour by vessel operators, leading to possible upward bias in abundance estimates, questions regarding possible interference among acoustic instruments, and concerns about possible vessel avoidance by capelin (considered to be minimal based on the experience of Norwegian researchers).
- *Edwin Niklitschek (Chile) – Industry surveys of orange roughy off Chile*. The author described the development of the Chilean orange roughy fishery, the lack of government vessels for conducting surveys, and the role that industry has played in supporting in providing platforms for acoustic assessment. This collaborative work has been successful. The success is due, in part to the fact this is a rights based fishery and the industry has strong incentives to facilitate stock assessment research. Discussions following the presentation considered technical aspects of data collection, statistical criteria for determining survey success, goals and incentives for industry participation in this type of research, and the author's experience in developing an algorithm for remote species identification.
- *Arnaud Bertrand (France) – Qualitative use of echograms beyond target organisms as support to the ecosystem approach.* The author provided a brief overview of studies conducted off the coast of Chile. Research included studies of jack mackerel and bigeye tuna. Acoustic data were collected during broader studies of these species and the ecosystems they inhabit. Acoustic observations revealed diel migratory behaviour of jack mackerel and information on predator-prey relationships. He concluded that rough indices of plankton or micronekton abundance and qualitative classification of patterns of distribution can be very valuable during ecosystem studies. He encouraged researchers to collect and archive acoustic data, and not to discard data that is considered to be "noise" during biomass estimation of target species.

Lead authors of SGAFV final report chapters presented work that had been accomplished since the last SGAFV meeting and discussed plans for work to be accomplished before the 2006 meeting of the study group. These presentations summarized work that had been accomplished since the last SGAFV meeting. Subsequent discussions identified potential changes in report content and structure.

- Martin Dorn presented a summary of the chapter and led a discussion which focused on possible changes to be made in the next draft. The report provides an overview of the goals of SGAFV, and background information on relevant studies.
- The draft section on fishing vessels was reviewed by Ron Mitson and John Dalen. The section includes a detailed discussion on causes of radiated vessel noise, possible effects on surveyed species, and recommendations for mitigation.
- Richard O'Driscoll presented the draft chapter that had been prepared by Gavin Macauley, Atle Totland, and Olav Rune Godø. The discussion emphasized the range of applications that are currently being addressed through collection of acoustic data from commercial vessels, and the linkage between research goals and instrumentation requirements. Requirements and procedures for calibration were also discussed at length. Richard encouraged feedback from the study group so that a broader range of perspectives could be incorporated in the next draft.
- Bill Karp summarized the draft chapter on biological sampling. He suggested that the extent to which biological sampling can or cannot be conducted will limit the types of objectives that can be addressed by the research project or survey. He then proceeded to define several general cases for the purposes of discussion and concluded with a discussion of catch processing.
- Hector Peña presented the draft chapter on cooperative research. He identified several important considerations including limitations in agency research vessel fleets, ability to address a range of objectives, benefits and limitations of industry participation, and the importance of communication in all aspects of cooperative research
- Rudy Kloser reviewed the section on study requirements. This section will consider fisheries management objectives, ecosystem research objectives, and specific aspects of acoustic data collection from commercial vessels. Examples of sampling strategies will be provided. Emphasis will be placed on matching objectives with research tools. Rudy highlighted issues concerning management strategies and information needs, factors associated with quantitative data collection, bias associated with species identification and target strength estimation, and consideration of noise, interference, calibration, and instrument performance.
- Work on the analysis, processing, and data management chapter will be initiated following the 2005 meeting; lead author will be Gary Melvin.

Study Group members agreed on the following schedule for work to be completed before the 2006 annual meeting:

- Lead chapter authors will provide complete drafts to the SGAFV Chair by 1 August 2005,
- The Chair will collate and review all chapters for consistency and redistribute to SGAFV members by end of October 2005 for final review,
- Sections will be updated and returned to the Chair by 31 December 2005,
- The Chair will work with lead authors to develop a comprehensive near-final draft for distribution to SGAFV in February, 2006, and
- Outstanding issues will be resolved at the 2006 SGAFV meeting and the report will be finalized.

SGAFV will hold its next meeting in Hobart, Tasmania, 25-26 March 2006.

1 Agenda and appointment of rapporteur

1.1 Introductions

Dr Bill Karp opened the meeting and welcomed SGAFV members. Dr Wilfried Thiele, Senior Fishery Industry Officer, FAO, welcomed all participants on behalf of FAO and provided information on facilities and building access. Dr Karp indicated that Dr Guy Fleischer (USA) had agreed to act as Rapporteur and Ms. Jessica Lipsky (USA) had agreed to act as Recorder. SGAFV members agreed with this selection. The Chair then provided brief introductory comments regarding the work of the study group and the tasks to be accomplished during the meeting

1.2 Review of agenda

Following a brief discussion, SGAFV adopted the proposed agenda without change.

2 Terms of reference

The Chair reviewed the Terms of Reference (ToRS). The following text was provided to the Study Group by the ICES Secretariat:

The **Study Group on Collection of Acoustic Data from Fishing Vessels** [SGAFV] (Chair: Bill Karp, USA) will meet in Rome, Italy, from 17–18 April 2005 to:

a) update, summarize and report on information on research which involves collection of scientific acoustic data from commercial vessels;

b) develop recommendations for methods and guidelines for collection of acoustic data to address specific ecosystem monitoring, stock assessment and management objectives including: acoustic system calibration and performance monitoring, characterization of radiated vessel noise, comparability of results, survey design, biological sampling, data interpretation and analysis, and data storage and management; and

c) prepare background material, guidelines, methods and recommendations for possible publication in the ICES Cooperative Research Report series.

SGAFV will report by 21 May 2005 for the attention of the Fisheries Technology Committee and make its report available to WGFAST.

Term of reference a): Collection of acoustic data in support of ecosystem monitoring, stock assessment and other scientific objectives has traditionally been carried out with calibrated scientific instruments aboard research vessels. Demands for this type of information have continued to expand and, in many cases, now exceed the capacity of national research vessel fleets. At the same time, improvements in technology have made instruments capable of collecting scientific-quality acoustic data more widely available, and these types of instruments are being installed on many commercial fishing vessels. Scientists have taken advantage of this opportunity to collect data in support of a range of research and assessment objectives.

Term of reference b): Standardized methods and protocols have been developed for routine acoustic surveys aboard research vessels, and concerns regarding research vessel radiated noise impacts on fish behaviour have received significant attention by WGFAST and the broader scientific community. However, recommended methods and guidelines for collection of acoustic data from commercial vessels do not exist, and objective criteria for matching data collection procedures with research objectives or for evaluating data quality are lacking. While commercial vessels equipped with calibrated commercial sounders are suitable for col-

lecting data in support of some specific research and survey objectives, use of these platforms and instruments will not always be appropriate.

Term of reference c): There is a recognized need to develop methods and protocols and publish them in an easily accessible report.

3 Review of 2004 meeting

The Chair presented a brief overview of the proceedings of the 2004 SGAFV meeting, also making reference to a topic session on industry acoustics which took place during the 2003 WGFAST meeting in Bergen, Norway. During both of these meetings, discussions addressed a range of topics and several concerns were identified. Use of commercial vessels for collection of acoustic data is appropriate for addressing some objectives and these must be well defined. There is a need to consider costs and benefits relative to specific objectives. Concerns include equipment stability and performance, time series continuity, radiated noise, biological sampling, survey design, data interpretation and analysis, and data storage and management. During the 2003 and 2004 meetings, presentations were made by scientists involved in studies germane to the work of SGAFV. Titles and authors are listed below to summarize the range of work that has taken place, or is currently underway, and the broad interest in the activities of SGAFV.

- Deepwater assessment surveys off Australia (Rudy Kloser *et al.*),
- Qualitative industry surveys of herring in Eastern Canada with multiple vessels leading to adaptive sampling and calibration of systems. (Gary Melvin *et al.*,
- Multivessel jack mackerel surveys off Chile. (Angela Barbieri *et al.*),
- Multivessel anchoveta surveys off Peru (Mariano Gutierrez),
- Surveys of hoki during normal fishing operations with calibrated commercial sounder. (Richard O'Driscoll and Gavin Macauley, New Zealand),
- Reference fleet – assessment from chartered commercial trawlers in the Barents Sea. (Olav Rune Godø and Atle Totland, Norway),
- Use of chartered vessels for routine surveys (e.g., herring) off Scotland (Dave Reid and Paul Fernandes),
- Pilot surveys of hoki off Argentina – potential for calibration and "low resolution" surveys. (Adrian Madirolas),
- Analysis of opportunistic acoustic data collections in the assessment of Alaska pollock Martin Dorn *et al.*),
- Use of commercial vessel acoustic data for monitoring stocks (Svetlana Kasatkina and Ivanova, Russia),
- Acoustic surveying from commercial vessels – behaviour of Scottish herring fleet. (Dave Reid),
- Acoustic data collection from fishing vessels in the Gulf of Maine (Bill Michaels *et al.*, USA),
- Surveys with autonomous and remotely-controlled echosounders systems. (Dave Demer, USA),
- Performance of ES60 and EK60 systems (Rudy Kloser and Tim Ryan Australia),
- Specialized vessel construction (Atle Totland *et al.*, Norway),
- Technology for species identification (Atle Totland *et al.*, Norway), and
- Assessment of jack mackerel using EK60-equipped commercial vessels in Chile. (Hector Peña).

Following this discussion, the Chair again reviewed the goals of the 2005 meeting: discuss and update recent developments, review status of report, agree on content, authorship and

completion of final draft report, review ToRs, and recommend changes if appropriate, and report to WGFAST and FTC on progress and status.

Several SGAFV members emphasized the importance of maintaining a focus on the ecosystem approach. It was agreed that the goals of SGAFV are consistent with the ecosystem approach, and that there is great potential for addressing ecosystem monitoring goals through use of acoustic instruments aboard commercial vessels. It is also important to bear in mind that use of industry acoustics for ecosystem monitoring is just one aspect of a broader topic regarding use of vessels of opportunity for the collection of scientific data.

4 Recent work

4.1 Using fish processing time to carry out acoustic surveys from commercial vessels – Richard O'Driscoll and Gavin Macaulay, New Zealand

In some fisheries large factory freezer trawlers have periods of down time as the catch is processed. By utilising this time, scientific acoustic surveys can be carried out between commercial fishing operations without compromising fishing success. Examples are presented from recent acoustic surveys for hoki (*Macruronus novaezelandiae*) and southern blue whiting (*Micromesistius australis*) in New Zealand waters conducted from commercial vessels fitted with scientifically calibrated Simrad ES-60 echosounders. The approach described works well for small-scale acoustic surveys adjacent to areas of high catch rates (typically spawning aggregations) and is cost-effective because the vessel 'pays for itself' by fishing commercially. The major limitation is that the boundaries of the survey area are determined by the time available during processing, which is related to the size of the catch and the time required searching for a suitable location for the next commercial trawl. In the New Zealand surveys, processing time was typically 3–8 h, which was sufficient to carry out about 10–70 km of acoustic transects. Acoustic research was also limited by the use of a hull-mounted transducer to periods of relatively good weather. For further information, please consult the recent article by these authors (ICES Journal of Marine Science, 62: 295 – 305 (2005))

Discussion points:

- Benefits include low cost, increased research opportunities, and fisher participation,
- Not suitable for low fish density areas,
- Survey operations have to work around fishing operations,
- Sea state and noise problems with hull-mounted transducers,
- Less ability to sample for backscatter layer identification,
- Much analysis of echo data was done at sea; area identification and uncalibrated biomass densities. Acoustic data were available to captain, while researchers also looked at catches. Fishing strategy was changed according to acoustics but overall fishing area did not change,
- Information to date has been not fully used in stock assessment. However, since survey, additional spawning areas have been recognized in the assessment model. Results from industry vessel compare well with other survey results, and
- Involving more vessels may be advantageous or problematic. Concerns include selectivity of different fishing gears, radiated noise, and differences in the way transducers are mounted.

4.2 Using commercial fishing vessels to conduct acoustic surveys of capelin in the Barents – Hector Peña, Olav Rune Godø *et al.*, Norway

This study focused on a severely depleted stock of capelin (*Mallotus villosus*) in the Barents Sea which is co-managed by Norway and Russia. Scientific echosounders (Simrad EK60) and sonars installed on commercial vessels were used to describe geographical distribution and abundance of the spawning stock. Three systematic surveys were conducted; no fish were detected during the first two phases but fish were encountered during phase 3. Phase 3 surveying was conducted during commercial catch processing. Environmental monitoring was also conducted. This survey was considered successful because it was possible to complete the work within a relatively short (two week) time period. Survey results indicated that the capelin spawning abundance was slightly higher than expected from the stock assessment, but management advice was not adjusted. The absence of capelin during the first two survey phases could be due to an eastern migration of capelin through the Russian EEZ, as been observed occasionally in the past. Abnormally high surface temperatures to the west could have influenced this pattern of migration. Migration speed of the capelin is high when approaching the spawning grounds perhaps as high as 10 nautical miles per day (average swimming speed ~ 0.2m/s)..

Discussion points:

- Use of sonar may influence survey tracking by vessel (motivation to re-direct to greater aggregations); this could create upward bias in survey results,
- Possible sonar interference with vertical echo sounding systems was observed, and
- Concerns were expressed regarding possible vessel effects and the possibilities for conducting intervessel comparisons, but the point was made that Norwegian scientists have observed only weak reactions of capelin to vessels.

4.3 Industry surveys of orange roughy off Chile – Edwin Niklitschek

The Chilean orange roughy fishery began in 1999 and covers 6 fishing areas (sea mounts) 200–500 miles from the coast. Given the small scale of the fishery and the distance from the coast, the Chilean government was unable to fund regular acoustic surveys. Moreover, no national research vessels were capable of providing a stable platform with adequate fishing capabilities given the open ocean-deep distribution of this species. Therefore, only biological data were collected by at-sea observers from the beginning of the fishery. Consequently, orange roughy quota holding companies in Chile recommended that a research program based on industry acoustics be developed, and signed an agreement with the government (2002) which included:

- Logging ES/EK60 data during normal fishing operations on wet fish trawlers (delivering unprocessed catch) to obtain distribution information and, eventually, a relative abundance index alternative to CPUE (2003-current),
- A collaborative 2003 survey using a chartered 58 m purse-seiner for acoustic transects; biological sampling and echotrace identification (trawling) by industry vessels on a voluntary basis,
- A collaborative 2004 survey, where each of 5 fishing vessels provided 15–45 days of dedicated time to complete 9 valid snapshots per sea mount with a goal of <20% sampling CV. (Valid survey criteria: >25% spawning females, <25% missing pings, <25% signal attenuation due to vessel motion), and
- A collaborative 2005 survey, where a single factory vessel will conduct the whole survey, including 87 days of dedicated survey time.

All vessels have been calibrated annually and operated under speed conditions that assure the lowest possible environmental noise. Results from 2003 and 2004 surveys have been accepted as (minimum) biomass estimates and they are used today for tuning orange roughy stock assessment models. Analysis of the routine data logging program is a work in progress, and relative abundance indices based upon this logging have not yet been accepted for stock assessment purposes.

Some lessons learned:

- Companies holding property rights might have higher incentives than government agencies to initiate and fund expensive research programs in small and/or developing fisheries such as the Chilean orange roughy,
- Extensive temporal and spatial coverage of the grounds provided valuable information about distribution and school dynamic. This had been impossible to obtain by means of a traditional, single snapshot surveys, and
- Goals and incentives for industry managers and vessel officers/crew are clearly different in time and magnitude, especially with wet fish trawlers that have limited endurance at sea. A satisfactory process for engaging wet fish trawlers in this survey activity has not yet been developed.

Discussion points:

- An algorithm for species identification was developed by the author. He was asked to elaborate on this. He responded that depth was the most important factor, followed by maximum Sv (maximum energy within an echotrace), kurtosis, longitude, horizontal correlation, and amplitude,
- Concerns were expressed regarding use of hull-mounted transducers for assessment in deep waters,
- When asked to elaborate regarding the outcome of error analysis, the author indicated sampling error was about 11% (resulting from the high level of coverage) and that overall error was 25%, and
- Industry protocols provide for commercial vessels to be assigned to research activities when a threshold of 25% spawning females in the catch is reached.

4.4 Qualitative use of echograms beyond target organisms in support of the ecosystem approach – Arnaud Bertrand, France

The author provided a brief overview of studies conducted off the coast of Chile. Research included studies of jack mackerel and bigeye tuna. Acoustic data were collected during broader studies of these species and the ecosystems they inhabit. Acoustic observations revealed diel migratory behaviour of jack mackerel and information on predator-prey relationships. He concluded that rough indices of plankton or micronekton abundance and qualitative classification of patterns of distribution can be very valuable during ecosystem studies. He encouraged researchers to collect and archive acoustic data, and not to discard data that is considered to be “noise” during biomass estimation of target species.

Discussion points:

- We now have the ability to collect and archive vast amounts of data but we still have limited capabilities for processing and analyzing this data,
- Fisheries acoustics in general, and industry acoustics in particular offer substantial opportunities for obtaining information that may be very valuable for addressing ecosystem monitoring goals and studies consistent with the ecosystem approach to management, and
- There is a need for improved data processing tools.

5 Review draft report chapters

5.1 Introduction

Martin Dorn presented a summary of the chapter and led a discussion which focused on possible changes to be made in the next draft. The following points were raised during this discussion:

- The introduction can be expected to improve as the authors gain a perspective on topics covered in the other chapters,
- Vessel-generated noise and associated fish behaviour is considered particularly important. It will be dealt with at length in a dedicated section of the report but should receive some attention in the introduction,
- Study design and data use in stock assessments will also receive more attention in the next draft (see comments in later section),
- Uncertainty analysis as a common theme for the report was suggested and discussed at length; some changes may be made to recognize the importance of this approach,
- Consistency in terminology was also raised and will be addressed by the editor when he reviews the next set of draft chapters.

5.2 Use of fishing vessels

This draft section was reviewed by Ron Mitson and John Dalen. The section includes a detailed discussion on causes of radiated vessel noise, possible effects on surveyed species, and recommendations for mitigation. Points raised during the presentation and subsequent discussion included:

- Many vessels have the potential to cause fish avoidance behaviour. ICES recommended underwater radiated noise limits (ICES Cooperative Research Report (CRR) 209). This report considers reaction distances of key species under different noise conditions,
- Noisy research vessels are often based on commercial designs with insufficient machinery isolation from the hull and variable (controllable) pitch propellers,
- On noise-reduced vessels, fixed-pitch propellers are employed, and vessel speed is adjusted by adjusting shaft rpm. Propeller shafts are driven by electric motors and electricity is supplied by generator sets,
- Many research vessels have measured noise signatures; this is generally not the case for commercial vessels,
- Knowledge regarding fish hearing response is lacking for several species and information on vessel avoidance behaviour is scanty. Variability is an important consideration in this context,
- Recommendations provided in the current draft and suggestions for additional recommendations were discussed at some length. Specific points included:
    - Several study group members felt that some of recommendations in the draft report (such as those concerning use of controllable pitch propellers, propeller blade requirements, always selecting the quietest vessel available, etc) were appropriate under ideal circumstances, but that some degree of flexibility was essential because researchers generally work under less than ideal conditions. Some study group members felt that such recommendations should be carefully linked to study objectives and recommendations should be considered with respect to the risk associated with making certain decisions. Others were concerned that some types of research might be precluded if recommendations were followed strictly and this might not always be necessary. Others felt that there should be clear guidance for eliminating unsuit-

able vessels. Also suggested was development of a table linking research objectives to allowable noise tolerances,

- Since orientation affects target strength and may itself change as part of a behavioural response to noise, this factor should be considered by the authors of this chapter,
- Use of controllable pitch propellers should be avoided where possible to minimize vessel avoidance behaviour by fish - but, also to prevent restriction of fish detection capability by the echo sounders,
- The recommendation that commercial vessel owners should be requested to noise range vessels at survey speed when possible was considered important for many applications, but it was noted that not all research vessels have been noise-ranged but in most parts of the world facilities are available but expensive
- Transducer placement, and performance in good and bad weather should be taken into account during vessel selection, and
- The possibility of recommending propeller pitch settings to minimize propeller noise on commercial vessels depends on the design criteria used. This will be addressed in the next draft.

5.3 Instrumentation and remote operation

Richard O'Driscoll presented the draft chapter that had been prepared by Gavin Macauley, Atle Totland, and Olav Rune Godø. The discussion emphasized the range of applications that are currently being addressed through collection of acoustic data from commercial vessels, and the linkage between research goals and instrumentation requirements. Requirements and procedures for calibration were also discussed at length. Richard encouraged feedback from the study group so that a broader range of perspectives could be incorporated in the next draft.

Topics of discussion included:

- Equipment integration. Integration and ping synchronization among instruments produced by different manufacturers may be problematic, but synchronization may be critical to successful data collection. Time synchronization and event logging are also of fundamental importance,
- Calibration. The discussion should distinguish between needs for relative and absolute calibration. Beam patterns are required for absolute calibration,
- Identification of performance concerns from echograms. Alex DeRobertis has assembled echograms which illustrate a range of performance problems. He will make these available to the section authors,
- Transducer location:
  - Study group members emphasized the importance of knowing where transducers are located on commercial vessels, and the need to provide recommendations on locations which minimize potential for performance problems,
  - Some manufacturers recommend placing transducers approximately one third of the vessel length from the bow, but some researchers have observed better performance from transducers located further forward. Others have observed poor performance associated with recent installations in forward portions of hull; concerns about damage to forward-mounted transducers from pounding were also noted,
  - Weather-related factors and vessel trim were also noted as areas of concern, and
  - The discussion on towed vehicles should consider stern and side deployment,
- Other instrumentation concerns:

- Several suggestions were offered regarding improvement of tables in the draft section, and use of tables for linking objectives with instrument quality, and equipment type with installation considerations, and
- It is important to recognize that small vessels may be perfectly appropriate for certain types of research but may not be able to provide instrumentation comparable to larger vessels.

5.4 Biological sampling

Bill Karp summarized the draft chapter on biological sampling. He suggested that the extent to which biological sampling can or cannot be conducted will limit the types of objectives that can be addressed by the research project or survey. He then proceeded to define several general cases for the purposes of discussion:

- Biological sampling cannot be conducted (e.g., when the vessel is transiting to or from the fishing grounds or if the vessel's gear is unsuitable for sampling scatterers encountered during all or part of the deployment),
- Biological data is provided from commercial gear directed to sample only aggregations of commercial interest (normal commercial fishing),
- Only unmodified commercial gear is available, but vessel operators are willing to perform additional sets in accordance with agreed-upon protocols,
- Some modification of commercial gear is possible to reduce selectivity (e.g., a trawl net modified with a codend liner) and/or the vessel is willing to deploy sampling gear in accordance with agreed-upon protocols,
- Concurrently collected scientific sampling data is available (e.g., from research surveys conducted in the same location during the same time period), or echosign composition can be inferred from other research activities, and
- Alternative sampling approaches (e.g., AUVs, video, emerging potential for use of multifrequency systems).

Next, he discussed catch processing and considered the benefits and limitations of sampling at sea by observers, sampling by trained vessel personnel, and port sampling.

The following points were raised during the ensuing discussion:

- Selectivity may be of particular concern when evaluating results of fishing with commercial gear. Modification of commercial gear to reduce selectivity may be in conflict with regulatory requirements,
- Non-lethal methods (e.g., optical or acoustical) for identifying scatterers should be encouraged,
- Incentives to encourage industry participation - this was considered to be of general importance and should, be discussed under the "cooperative research" heading,
- The lack of gear standardization in commercial fisheries may be problematic, and
- Temporal and spatial matching of acoustic and biological data collection is important.

5.5 Issues regarding cooperative research with industry

Hector Peña presented the draft chapter on cooperative research. He identified several important considerations:

- Industry acoustic data may be collected to address stock assessment or broader ecosystem monitoring objectives,
- Industry acoustics may be particularly useful when the research goal requires obtaining the best possible coverage of stock distribution in the least possible time,

- Research vessel resources may not be sufficient to provide required levels of temporal and spatial coverage,
- Benefits of industry participation include cost, coverage, and political factors,
- Limitations of industry participation include: vessel and instrument characteristics (noise, calibration and intercalibration considerations, concerns regarding industry personnel changing critical instrument settings), vessel availability and factors which may influence vessel selection,
- Communication is critical. This includes: explanation of scientific objectives, encouraging participation from all interested parties, addressing concerns regarding data confidentiality, onboard communications between scientists and industry personnel, drafting of clear and unambiguous agreements and data collection protocols,
- Motivation and incentives for industry participants include: direct and indirect economic factors. Motivation for individual fishermen and vessel owners may be different from motivation for fishing companies, and
- Examples of successful cooperation include Rastrillo surveys off Chile, and Eureka surveys off Peru.

Points raised during the discussion include:

- The need for further discussion of motivational factors and differences between individual skippers and fishing companies,
- The importance of linking information collection to the stock assessment process (when appropriate), and
- The need for input and examples from areas outside South America (several Study Group members agreed to provide sections for this chapter).

5.6 Study requirements

Rudy Kloser reviewed the section on study requirements. This section will consider fisheries management objectives, ecosystem research objectives, and specific aspects of acoustic data collection from commercial vessels. Examples of sampling strategies will be provided. Emphasis will be placed on matching objectives with research tools. Rudy highlighted the following points:

- Management strategies should be evaluated at an early stage in the formulation of research projects. This should include consideration of: management objectives (performance measures, indicators, reference points and decision rules), harvest strategies (monitoring, assessment and decision rules) and monitoring strategies. Tradeoffs should be taken into account,
- Key management information needs should be defined clearly; for example, precise acoustic echo integration snapshot biomass estimate may not hold the greatest value,
- Quantitative acoustic data use concerns include:
  - Factors which may decrease estimates (vessel avoidance, vessel motion/signal attenuation, proportion of stock sampled),
  - Factors which may reduce precision of estimates (calibration and sound propagation compensation, sampling, species ID and TS), and
  - Factors which may increase estimates (noise and vessel attraction),
- Addressing bias associated with species identification and target strength is of particular concern,
- Potential bias and precision concerns should be addressed prior to study initiation. Effects of noise and vessel motion on acoustic data should be determined before accepting a vessel as a data collection platform,

- On-axis calibration should be conducted before and after each data collection period,
- Onboard system checking should occur at an early stage and at regular intervals thereafter. This should include transducer impedance, and transmitter and receiver performance, and
- Instrumentation to monitor vessel motion is recommended.

Points raised during the discussion include:

- Error analysis is important but consistent operations or protocols may not provide consistent results,
- Abundance indices and absolute measures of abundance. There was much discussion of this issue and Study Group members expressed different opinions regarding the value of abundance indices, and the distinction between absolute and relative measures. It was agreed, however, that this is an issue associated with fisheries acoustic assessment in general. This should be recognized in the final report, and
- It was agreed that the chapter on study requirements would follow immediately after the introduction because of the key importance of matching research tools with study objectives.

5.7 Analysis, processing, and data management

Work has not yet been initiated on this chapter. Gary Melvin agreed to act as lead author. He will be assisted by Tim Ryan, Eric Armstrong, and other possible volunteers.

6 Preparation of draft final report

6.1 Report content

Draft report chapters will be updated taking into account suggestions and discussion points raised during this meeting. Work on the analysis, processing and data management section will commence as soon as possible. The study requirements section will include a table linking study objectives with vessel and instrumentation requirements, following the example proposed by Ian McQuinn. The editor will draft an executive summary following completion of all other report sections. The editor will also address issues of consistency and redundancy following review of updated chapter drafts.

Bill Karp agreed to assemble an annex consisting of abstracts of presentations from the topic session at the 2003 WGFAST meeting and the 2004 and 2005 SGAFV meetings. He will ask authors to review and update abstracts before assembling the annex.

6.2 Schedule for completion of report

SGAFV members agreed to meet the requirements of the following schedule:

- Lead chapter authors will provide complete drafts to the SGAFV Chair by 1 August 2005,
- The Chair will collate and review all chapters for consistency and redistribute to SGAFV members by end of October 2005 for final review,
- Sections will be updated and returned to the Chair by 31 December 2005,
- The Chair will work with lead authors to develop a comprehensive near-final draft for distribution to SGAFV in February, 2006, and
- Outstanding issues will be resolved at the 2006 SGAFV meeting and the report will be finalized soon after that meeting.

7 Terms of Reference for 2006 Meeting

SGAFV recommended a minor change in ToR c for 2006. This ToR would be changed from:

Prepare background material, guidelines, methods and protocols for possible publication in the Cooperative Research Report series to:

Prepare background material, guidelines, methods and protocols for publication in the Cooperative Research Report series.

SGAFV will hold its next meeting in Hobart, Tasmania, from 25–26 March, 2006.

8 Agenda for 2006 meeting

SGAFV members agreed on the following major agenda items for the 2006 meeting of the study group:

- Discuss recent developments in the field,
- Review the draft final report and resolve any areas of concern, and
- Reach agreement on a schedule and responsibilities for completion of the final report and submission to the ICES Secretariat for publication as a Cooperative Research Report.

Annex 1: List of participants

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Annex 2: Conceptual framework for data processing

Chris Wilson (USA) made a brief presentation on the concept for a software product to process acoustic data collected during eastern Bering Sea groundfish trawl surveys. This data could then be used to augment data collected during targeted walleye pollock acoustic surveys.

This software is to be semi-autonomous, allowing deletion of bad data, to flagging of suspect data, and would be used only to process water column backscattering (e.g., no judging, no image analysis, and no multi-frequency comparisons).