South Pacific Regional Fisheries Management Organisation

**2nd Meeting of the Scientific Committee**

Honolulu, Hawaii, USA
1-7 October 2014

**SC-02-JM-01**

# Fishing vessels as Scientific Platforms: Indicators and Protocols for an Ecosystem Approach to Pelagic Fisheries

*IREA (Instituto de Rercursos Acuaticos)*

IREA

# International Wokshop

April 28th - May 2nd

Lima 2014

## REPORT



# REPORT ON THE WORKSHOP ON


Lima, 28 April – 2 May, 2014

The workshop was organized by IREA (Instituto de Recursos Acuaticos) in the facilities provided by the Universidad del Pacífico (Monday, 28th) and the UNDP offices (29 April – 2 May).

## Main objectives

A list of objectives was prepared and submitted to the participants of the workshop. Not all of them have been considered. Nevertheless we give here their list, as those that have not been analyzed should be considered in the future.

1. To inform the members of the fisheries acoustics community on the activities, projects, data and methods used by the Peruvian scientists to monitor the pelagic stocks, with particular attention to jack mackerel (*Trachurus murphyi*);
2. To produce a state-of-the-art on the use of acoustic data collected aboard fishing vessels for scientific research;
3. To evaluate the scientific pertinence of the works performed during the SNP workshops on jack mackerel;
4. To consider the consistency of the indicators defined during these workshops using a series of informations (acoustic, fishery, environment, behaviour, etc.)
5. To produce a series of recommendation for the improvement of the data collection techniques and methods, of the processing and analysis of the data, on the structure of the data base, etc.
6. To consider the possibility of designing a common format for fishers' acoustic data between the major countries exploiting the jack mackerel
7. To consider the possibility of publication of a series of papers on the methodology and major interactions between the jack mackerel population and environmental, fishery and abundance characteristics of the distribution area;

## Activity report

The list of participants to the different parts of the workshop is given in annex 1 with the detailed program of activities.

**28 April. State of the art**. This day was devoted to presentations of works made in the world taking advantage of the use of acoustic data from fishing vessels. The list of speakers and presentations is given in annex 1. The presentations were transmitted directly to social networks in order to make them easily visible by the whole scientific community[1]. After the series of presentations, a round table was organized between the speakers and the audience.

**29-30 April. Workshop**. Due to the number of participants and the question of languages, the structure of the workshop was adapted from the original proposal and the sessions were as follows:

- Session on calibration: evaluation of the calibration procedures and results for the fishing ships already calibrated; design of procedures for calibration (annex 3-A).
- Session on Managing Jack Mackerel: problem, solutions and the role of fishing vessels (Annex 3-B).

[1] See http://www.ustream.tv/recorded/46805477

- Session on VMS data (annex 3-C).
- Session on measurement of the Gravity Center of the distributions.
- Two sessions (one in English and one in Spanish) on the evaluation of techniques, methods and protocol for calculating indicators (see chapter Recommendations).

**2 May. General analysis of results and discussion.** The different sessions presented their results. Reports of these sessions are presented in the annex 3. Then a general discussion was organized in order to list the main conclusions and recommendations of the workshop. The workshop was closed by Pedro Trillo, President of IREA, at 4:00 pm.

## Description of fishers' echograms.

Before the sessions, a general presentation of the works performed during the 4 SNP workshops and a detailed description of the different data bases were given (F. Gerlotto and N. Herrera). Then an analysis of the characteristics of the acoustic data obtained from fishing vessels was performed by G. Melvin from the observation of some echograms extracted from the raw data base of TASA. We cite below his analysis and conclusions.

*For more than a decade commercial fishing vessels have been collecting acoustic, environmental and catch data during fishing operations off the coast of Peru. These data have been obtained through the extensive efforts and expense of the pelagic fishing industry. Over the years large volumes of interrelated ecosystem data have been achieved and analyzed by the industry (SNP) and several scientific organizations (IMARPE, IRD, University Federico Villareal). These data were reviewed at the "International Workshop on Fishing vessels as scientific platforms: Indicators and protocols for an ecosystem approach to pelagic fisheries" to evaluate the progress to date, establish protocols for analysis and data collections, and to make recommendation for future practices and procedures. The scientific data collected by commercial fishing vessels in Peru have made, and will make, a significant contribution to understanding of the biology, distribution, movement and abundance of anchovy and Jack mackerel relative to changing environmental parameters.*

*Calibrations of the acoustic technology aboard scientific and commercial fishing vessels form the foundation of quantitative acoustic backscatter estimates and enable the comparison of multiple systems (echo-sounders) from one vessel to another. Standard factory settings establish a starting point for each vessel and make the general comparison of vessel data in a relative sense, however, for quantitative comparison and biomass estimates each vessel must be calibrated (several methods). Currently, most of the echo-sounders have not been calibrated, consequently the data should only be used in a relative sense and not compared directly between vessels. Past data can be adjusted (corrected) to provide direct comparison from vessel to vessel and year to year.*

*Output tables from acoustic systems and data analysis need to be standardized so the information is available for storage in a consistent manner and adaptable to input into a master rational database. For example it was noted (file: bitacora Acoustica 2011-2012) that*

*the cell range for one vessel was from 0-500m, while the next vessel had the data for each 0.5nm interval broken down into 50m layers. This is not a problem, as the backscatter for each layer can be added to produce an average backscatter for the overall interval, but if the breakdown into layer is different between vessels misinterpretations of the data can occur. The simple solution is to standardize the output formats.*

*Calculation of biomass from distribution and catch. During the meeting it was explained that a biomass estimate was made by multiplying the area of distribution by catch. In this case a numeric value is multiplied by an area estimate (m2) to estimated biomass. This approach can be misleading in that the size of the seine should be incorporated to balance the units. Dividing the catch by the size of the seine in the same units (m2) as the distributional area will provide a better estimate of the biomass. The problem is mainly due to the use of biomass. Many managers will interpret this number in absolute terms rather than the relative form which is intended. So far there is no correction factor due to the dimension of the seines, as they are usually of the same dimension; nevertheless this point (and other similar that can be found in the protocol) must be considered when a general data base will be organized.*

A good example of echograms available from fishing vessels was presented by G. Melvin and is given below. This echogram for in transit, searching and fishing operations trip was analyzed in order to show precisely how the data are/should be extracted.

The first conclusion is that the quality of the acoustic data extracted from the echosounder ES60 of a fishing vessel can be demonstrated from this example taken at random. It is interesting to note that the observation of the echograms joined with the analysis of the trajectories allows a rather easy discrimination between the main activities of a trip: route (to/from the fishing grounds), exploration, fishing.

The second conclusion is that the processing of the acoustic data may lead to several errors and biases. For instance, when fishing vessels loop through fish to have a look they have the potential introduce multiple intervals with increased backscatter. This may bias the data. In this example there are 3 intervals with increased backscatter when during transit on one inter would occur. The extent of the bias will depend upon the intensity of the backscatter (figure 1).

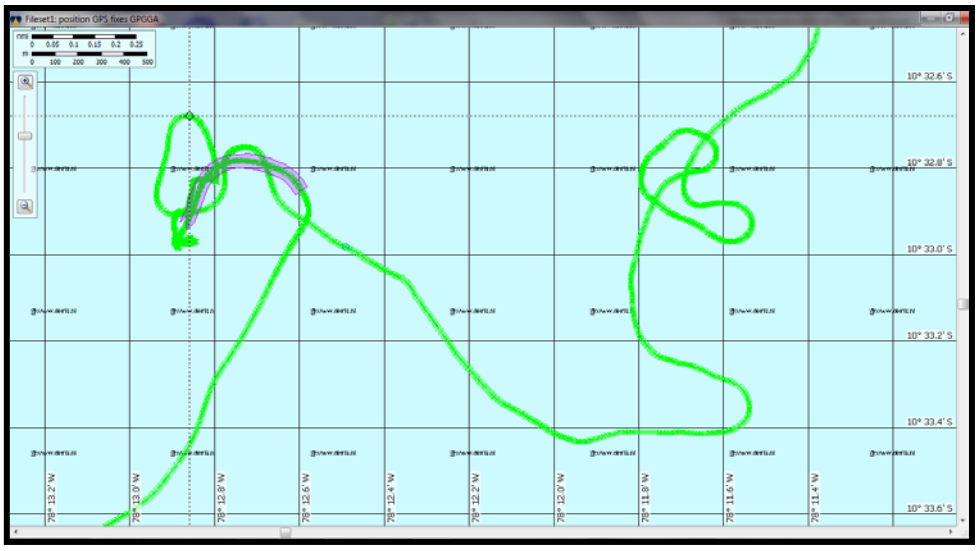


Figure 1. Example of the route of a single trip. Routes from-to the fishing grounds are not displayed.

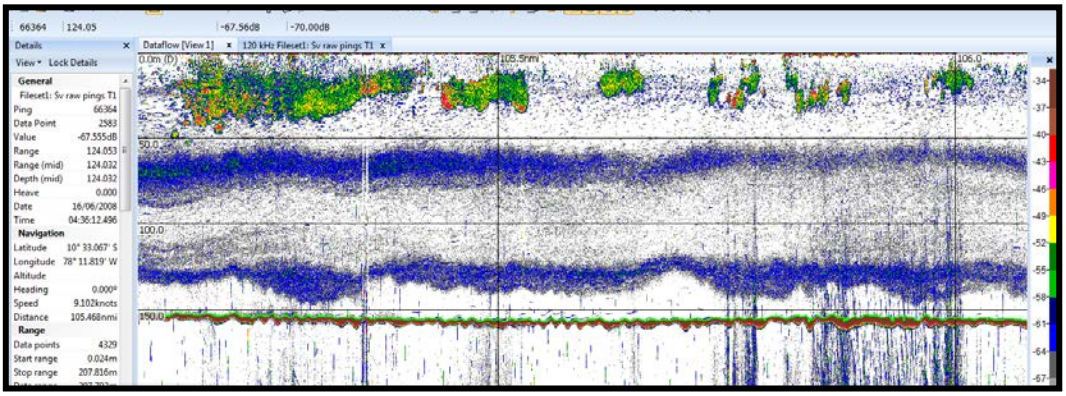


Figure 2. Echogram from search loop, but no fishing occurred. The location of this portion of echogram is displayed in figure 1.

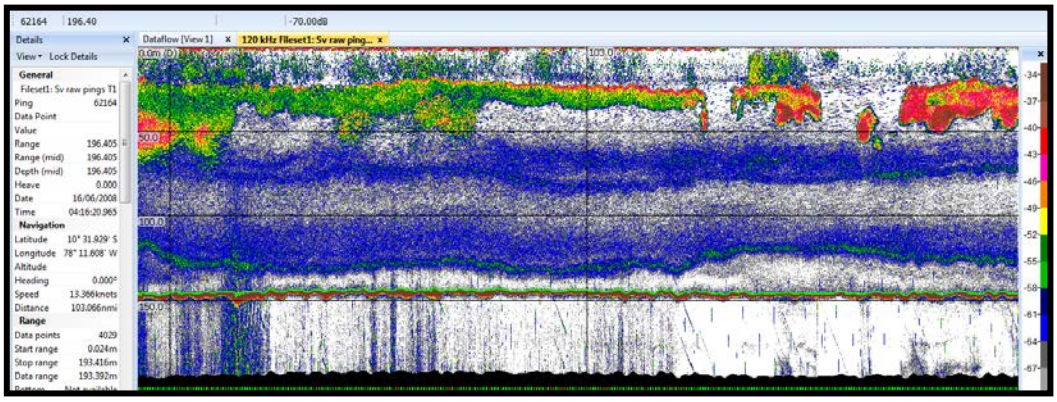


Figure 3. Echogram from in transit location.

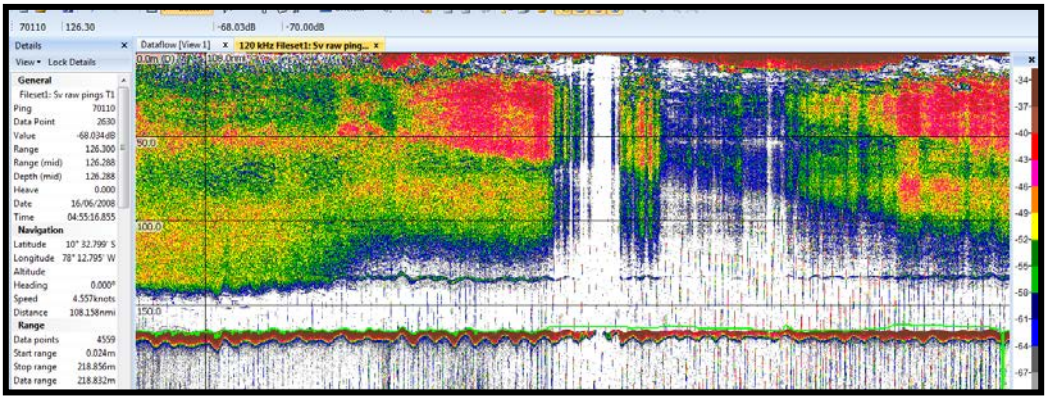


Figure 4. Echogram from area where set was taken. This portion of data must not be used in estimates of mean backscatter.

## General conclusions and recommendations.

The results of discussions, conclusions and recommendations are given following the main questions listed in the objectives of the workshop.

1. **To produce a state-of-the-art on the use of acoustic data collected aboard fishing vessels for scientific research**

   The first general conclusion, shared by all the participants, is that the technical characteristics of acoustic devices allow considering that acoustic data from fishing vessels can be used for scientific purposes. The particular case of the SNP data base was studied and the major general conclusion was that although the system developed in Peru and presented during the workshop is not yet completely optimal, it is already in condition to produce a remarkable set of information on the ecosystem. There is few (or no) equivalent data base of this magnitude elsewhere in the world; this importance makes it possible to discard doubtful or imprecise data without weakening the results. Nevertheless a series of comments and recommendations were presented during the workshop. They are listed below.

   - There is still need for designing a simple and efficient calibration procedure adapted to the fishing vessels and the use of the data. This will be detailed below.
   - Need to understand clearly the significance of fisher “sampling strategies” and to design adapted statistical methods.
   - Although this is already largely applied, it is of first importance that communication between the fishing fleets (fishers, managers, fishing companies) and the scientists is maintained permanently and especially prior to any work on the data (e.g. bycatch, experimentations, evaluations and mitigations).
   - A complete protocol must be created where the main sources of data are considered (e.g. acoustics, observers, landings and environment). This includes

comparison between the fishing vessels and research vessels acoustic data (trips and surveys)

- The development of new instruments and techniques interesting for both the fishers and the scientists must be encouraged. Indeed the instruments of the future already exist and require adaptation for obtaining more scientific information from fishing vessels. The two major developments are the multibeam systems and the broadband vertical echosounders.

**2. To evaluate the scientific pertinence of the works performed during the SNP workshops on jack mackerel;**

Quantitatively and qualitatively the data base was considered as good enough to allow the extraction of useful indicators for monitoring the jack mackerel population. No detailed analysis on the SNP workshop results was done but it has been agreed that major error in the analysis are unlikely (due to the magnitude of the data base and as long as the results are provided in relative values). Once this said the participants pointed out the fact that some elements of the database were not yet fully documented; for instance, settings of acoustic devices and characteristics of fishing vessels should be detailed and included in order to allow precise evaluation of the results. Besides, some sources of bias have been encountered and have to be corrected. In conclusion the system should be improved. More detailed comments and recommendations are listed below.

- There is a need for a detailed documentation on the data base and protocols; a quality control of the data should be designed (consistency of the results between years; between ships; between skippers; comparison between scientific and fishery results; etc.)
- It is essential that the cooperation between scientists and the fleet be permanent and fully accepted by both sides; communication between the scientists and the whole fleet should become routinely developed: the fleet should receive and exploit in real time the information (indicators) calculated by the scientists. Otherwise some questions e.g. bycatches and selectivity problems would never be answered.
- It is recommended to increase the effort in comparison between acoustic vs. catch selectivity

**3. To consider the consistency of the indicators defined during these workshops using a series of informations (acoustic, fishery, environment, behaviour, etc.)**

Again the magnitude of the data collected was pointed out, and generally speaking this represents a unique base of information from which can be demonstrated all that could be obtained by the use of fishers' data for stock/environment monitoring and assessment. Another important point is that the work focuses mostly on small environmental scales (in space and time) even though the results are observed in large areas. This scale of research cannot be observed in details by the scientific surveys. Still there are points to improve

before to consider the data base to be completely free of biases and particularly the need for a procedure for systematic quality control prior to analyses.

- It is essential to interconnect the different sources of data (e.g. acoustics with environment). This requires that a common variable is included in all the bases. One usual candidate is the time, and especially the GPS time (common to all the ships). It is important to check whether the computer time is not recorded instead of GPS time, and to correct this point if needed. This requires a protocol checking, and common linkages should be defined and tested.
- Some settings of the vessels are likely to change the value of the data and prevent any use beyond qualitative observation and results if not corrected. The case of the usual choice of the maximum power (1000 W) for the echo sounders is an example of such unwelcome settings (producing non linear results). In this same field the skippers' abilities should be compared: are there comparable or significantly different? This could be done by comparing their respective production levels and comparing the ranks between years. Other more sophisticated methods exist, e.g. by pairing the skippers, etc. Same question for the characteristics of vessels and gears. It is suggested to perform a first trial on the TASA data base in order to define consistent indicators in this area.
- A few more indicators could be easily obtained and would dramatically enrich the data base. For instance the oxycline could be routinely extracted from the echograms; school size and metrics are other sources of indicators; etc.
- The case of the gravity centre has been studied in details because its value is at the base of a series of calculations and particularly the abundance. GC is a synthesizing indicator, and simple approaches are not free of biases. New more optimal methods were described (annex 3-D).

4. **To produce a series of recommendation for the improvement of the data collection techniques and methods, of the processing and analysis of the data, for the structure of the data base, etc. in order to produce correct recommendations for an EAF.**

- **Acoustics**: the major recommendations about the acoustic data are the following:
  - Need for comparison, intercalibrations, etc. of scientific surveys and fishers data base;
  - Optimal settings of acoustic devices e.g. standardization of the data output, compatibility of data bases developed under different situations (countries, fleets, fishing methods…);
  - Need for considering the development of easy common tools for allowing all the companies to reach the level of the strongest ones. This means encouraging the development of independent free softwares and tools in open access. The question of ECHOPESCA was considered and it was agreed that a solution should be found to maintain this tool in open access (open sources, free and usable by anybody) and in development. No precise suggestion has been made during the workshop. IREA was encouraged to find and apply solutions in this field.

- Not all the fishing companies can/want to process themselves their data. Besides, not all the vessels are equipped with “standard” devices (e.g. echosounders from other manufacturers than SIMRAD, etc.). There is need for an independent structure that could process the data from any origin and input them in the common data base. The workshop suggested that IREA could consider taking this activity in charge if needed.
- Define calibration procedures. A general agreement is that calibration must be performed for all the vessels which data are integrated in the data base. This calibration can take 3 different levels: (a) standard calibration (using reference spheres etc. as for calibration of scientific devices) should be performed regularly, ideally on an annual basis; (b) during each trip some checking of the internal characteristics of the echosounder should be performed, e.g. by measuring the noise level (passive acoustics). in order to know whether some strong change has appeared in the echosounder characteristics; (c) at beginning or end of each trip some evaluation of bottom integration should be made at a place close to the harbor that all the fishing vessels cross when leaving and/or arriving. This only requires that the data are recorded (can be performed in the lab.). The calibration procedure for the walleye Pollock developed by NOAA could be taken as an example and adapted.
- A new document on calibration will be delivered soon by ICES and should be considered.

- **Processing/analysis of the data collection methods**.
  - Data base. Conceiving a final format for the data base appears to be a priority. Some works on this field already exist, and the ICES work on metadata base could be adapted and used when possible (ICES. 2013. A metadata convention for processed acoustic data from active acoustic systems, SISP 3 TG-AcMeta, ICES WGFAST Topic Group, TG-AcMeta. 35 pp.). Proposal for beginning this task are given below.
  - There is a practical need for precise analysis of data compatibility (e.g. time as common information). In any case (even the worst, i.e. time is wrong and obtained from non specified source), VMS data are given using the same GPS time values, making correction of the vessel recorded time possible.
  - Additional data could be collected for improvement of the data base, and particularly environmental information, such as oxycline, pH of the ocean, zooplankton densities and abundance, species ID and classification, etc.

- **Managing Jack Mackerel: problem, solutions and role of fishing vessels**
  During the workshop a work session leaded by Niels Hintzen was held to discuss current problems in Jack Mackerel management and to find and recommend potential solutions. Indeed the major role of the data collected from the different sources (scientific surveys, catch data, acoustics from fishers, satellites etc.) is to allow a good understanding of the interactions between the stocks and the environment and eventually to produce sound recommendations for a correct management. Participants from five different countries (Chile, Colombia, Holland, France and Peru) joined the discussions. Among them were scientists and industry members (7 and 3 respectively). The results of the session are given in annex 3-B. Among the conclusion the following were highlighted:

  - Acoustic survey: run a pilot survey before the acoustic survey starts to define the area that needs to be covered; define the area that the acoustic survey should cover which is in agreement with the area where Jack Mackerel is supposed to be present
  - Recruitment: the bycatch of juveniles should be reported to inform on young incoming fish. The fine associated with the catch of juveniles should be suspended; include adaptive management according to biological / hydrographical conditions

5. **To consider the possibility of designing a common format for fishers' acoustic data between the major countries exploiting the jack mackerel.**

This point has not be considered and studied yet, as the Peruvian fishery alone was taken as a case study. But as soon as a common and complete database is to be built, particularly with Institutes and countries that share the jack mackerel stock of the SE Pacific Ocean, it will become a priority. It should be performed under the sponsorship of SPRFMO in order to involve all the fisheries and countries and obtain agreement from them. Some additional activities and tools can help to standardize the data collection among countries.

- Information was given on the existence of the Electronic Reporting System built for EU by different manufacturers that could help to define common standards.

- In order to follow these points and the evolution of techniques and methods, the Working group supports the IREA suggestion for the creation of a network to deal with these future activities (annex 4). The proposal is to commit IREA to develop some exploratory analyses to define the best architecture, objectives and projects to reach this general goal.

- To design the architecture of the complete common data base. The design of fully operative data base that could be easily used by any user is among the most important conclusions and recommendations given by the workshop. Indeed there is now sufficient information to make it possible to design this data base,

keeping in mind that some adjustments would be necessary in the future for 3 purposes: (a) to transform some of the data that must be corrected and possibly get a different format; (b) to add new variables and metrics when they become available (e.g. oxycline); (c) to be compatible (or common) with equivalent data bases developed in other countries and fisheries. The different institutions that are involved in the acoustic data bases in Peru are not in condition to develop this research, for several reasons that it would be too long to develop here. It is obvious that they must be involved in this activity as they are on the one hand the producer of the data (SNP) and on the other hand the future user (IMARPE); but there is need of another independent structure to develop, maintain and manage this data base for them. The workshop recommends that IREA gathers as soon as possible a group of experts for studying this point, designing an adapted architecture taking as example the case of the Peruvian purse seine fishery. This should begin with a demonstration database in order to submit it to the scientific community of users (ideally within the SPRFMO) and get agreement for a final version. Such group should gather (a) users of the data base from Peru and Chile; (b) experts in the use of acoustic data from fishing vessels; (c) scientists who collect the data and feed the data base; (d) expert(s) in data base design. It is recommended that IREA begins immediately to evaluate the possibility and cost of organizing such working group of experts and submit a proposal.

6. **To consider the possibility of publication of a series of papers on the methodology and major interactions between the jack mackerel population and environmental, fishery and abundance characteristics of the distribution area.**

It was observed that although the consistency of quality, cost, scientific validity of the acoustic data extracted from fishing vessel instruments is no longer an issue and that a general scientific agreement exists on the interest to use this source of information for EAF (see state of the art), it is still difficult to convince the scientific community that they would bring valuable information for fish stock assessment. The unanimous conclusion of the workshop was that there is need to publish scientific papers in peer reviewed journals to describe the data, the techniques and methods, the results already obtained, the different areas where the data could improve the research, and more generally to provide thoughts on what they are, what they can (and cannot) do, etc.

The workshop recommends two actions to be taken in this area.

a. Write a high level theoretical review paper to describe this source of information, the best alternative being to submit a paper to Fish and Fisheries in its rubrique GHOTI. Rudy Kloser agreed to take this activity in charge, helped with the co-authors of his choice.
b. Submit the proposal of a special issue on this theme to a journal (e.g. Fisheries Research, CJFAS, ICES JMS, ALR, etc. François Gerlotto accepted to take this task in charge. So far a preliminary list of possible papers was defined:

- The role of the Fisheries National Society (SNP, Peru) for an Integration of the fishers' data analyses and results in a general project of monitoring of jack mackerel in Peru since 2011 (1st author: Mariano Gutierrez)
- Analysis of the evolution of indicators from 2011 to 2014 in the Peruvian fishery (1st author: Salvador Peraltilla)
- Population behaviour and environmental variables in Chile (1st author: Carolina Lang)
- Comparison between fishery vs. scientific surveys, with special attention to VMS in Peru (1st author: Rocio Joo)
- Definition and application of specific tools for fishing vessels data extraction, processing and management (1st author: Jérémie Habasque)
- Variation of abundance and spatial distribution of jack mackerel in centre-south Chile (1st author: Sergio Lillo)
- Methodology of surveys, processing, analysis and use of acoustic data from fishers in different fisheries in the world (1st author: Gary Melvin)
- Spatial patterns of jack mackerel population related to longitude and latitude (1st author: Jorge Páramo)
- Reproductive patterns of jack mackerel and environmental conditions as observed by fishing vessel data (1st author: Jorge Oliva)
- Study of the indicators on recruitment of jack mackerel (1st author: Alfredo Rodriguez)
- Advantages and drawbacks of fishers acoustic data (1st author: François Gerlotto)
- Future Techniques and methods to be deployed fy fishers and their use for research (1st author: Christophe Corbières)

## General conclusion

1. The first general conclusion, shared by all the participants, is that the technical characteristics of acoustic devices allow considering that acoustic data from fishing vessels represent a unique source of extremely important informations and that they can already be used for scientific purposes.
2. There is still some work to do before to obtain a completely bias-free data base and a list of actions to be taken was proposed. They must be performed as soon as possible, because as long as these corrections are not applied, some of the data would not be usable for absolute measurements. Some other metrics should be added to the present list, especially environmental data.
3. No consistent work will be possible without good interactions between the scientists, the professionals and the fishers. These interactions must be continuous, and based on a good understanding of the advantages of such work for all the groups.
4. It is prioritary to elaborate a final usable data base, with the help of all the people involved in this activity (users, data producers, database experts, countries, fisheries,

etc.). It is recommended that IREA should begin as soon as possible to explore the way to produce this data base.

5. The elaboration of an international network focused on the use of fishers' acoustic data could help to convince the international community on the interest of this source of information. Such network should maintain the communications between the different partners, help to transmit information on the field of interest, organize meetings and workshops at a rhythm to define, etc. It is recommended that IREA explores the possibility of such structure and submits some proposal on its organization, objectives, activities, etc.
6. A series of scientific papers should be written and published in peer reviewed journals.


**Annex 1**
List of Presentations

**Annex 2**
List of participants

**Annex 3-A**
Calibration procedure and processing-analysis of acoustic data: Recommendations for collection of high quality acoustic data on fishing vessels (Taina Honkalehto)

**Annex 3-B**
Managing Jack Mackerel: problem, solutions and the role of fishing vessels (Niels Hintzen)

**Annex 3-C**
Standardization of VMS information

**Annex 3-D**
Methods for calculating the gravity centre of the fish spatial distribution

**Annex 4**
Proposal for the creation of a Network on Environmental and Fisheries Acoustics (François Gerlotto)

**Annex 1. List of Presentations**

**Andrés Chipollini** (*Instituto del Mar del Peru-IMARPE, Lima, Peru*).
Monitoring System and observation platforms as tools for the ecosystem approach to management in Peruvian waters

**Jorge Castillo, Sergio Lillo and Carolina Lang** (*Instituto de Fomento Pesquero-IFOP, Valparaiso, Chile*).
Use of fishing vessels for supporting and research for management of fisheries in Chile

**Mariano Gutierrez** (*UNOPS, Lima, Peru*).
50 years using fishing fleets as opportunity ecosystem observers in Peru (1964-2014).

**Rudy Kloser** (*CSIRO, Hobart, Tasmania, Australia*).
Experiences using fishing vessels as acoustic observing platforms at regional to basin scales

**Taina Honkalehto** (*NOAA, Alaska Research Center,Seattle WA, USA*).
Delivering fishing vessel acoustics to fisheries managers: a case study with Bering Sea pollock

**Gary Melvin** (*Department Fisheries and Oceans, Saint Andrews, New Brunswick,Canada*).
Industry based acoustic surveys in Canada: An overview of their history, current approaches, and their future in an ecosystem approach to fisheries
.

**Rocío Joo** (*IMARPE, Lima, Peru*)
Fishermen behavior and its drivers: hidden stories from VMS, acoustics and satellite data in an ecosystem approach to fisheries

**Martin Hall** (*Scripps Institute of Oceanography, La Jolla, Cal., USA*)
Fishing vessels as scientific platforms to reduce bycatch and protect endangered species: the experience in the tuna purse seine fleet over the last 30 years.

**Niels Hintzen** (*IMARES, Ijmuiden, Holland / SPRFMO*)
From fishing vessel information towards management implementation.

**Jérémie Habasque** (*IRD, Brest, France*)
Echopesca, a processing tool for monofrequency fisheries acoustics data

**Christophe Corbiéres & Frédéric Mosca** (*SEAPIX, IXBlue, La Ciotat, France*).
Fishery 3D sonar technology for Ecosystem assessment

**Salvador Peraltilla** (*TASA, Callao, Peru*)
Use of information for management of the TASA fishing fleet

**Martin P. Oviedo** (*Orellana SIMRAD, Lima, Peru*).
New standards for observing water column scatterers using SIMRAD EK80 and ME70 echosounders

**François Gerlotto** (*IREA, Lima, Peru*).
Fishers and the fishing fleet: what do they tell us that research cannot know?

**Annex 2. List of participants**
**(participants to the workshop activities are highlighted)**

**AUSTRALIA**
RUDY KLOSER
Commowealth Scientific and Industrial Research Organisation - CSIRO
www.csiro.au
rudy.kloser@csiro.au

**CANADA**
GARY MELVIN
Peches et Oceans
www.dfo-mpo.gc.ca
Gary.Melvin@dfo-mpo.gc.ca

**CHILE**
JORGE CASTILLO
Instituto de Fomento Pesquero - IFOP
www.ifop.cl
jorge.castillo@ifop.cl

**CHILE**
SERGIO LILLO
Instituto de Fomento Pesquero - IFOP
www.ifop.cl
sergio.lillo@ifop.cl

**CHILE**
CAROLINA LANG ABARZÚA
Instituto de Fomento Pesquero - IFOP
www.ifop.cl
carolina.lang@ifop.cl

**CHILE**
ALEX MUÑOZ
OCEANA
www.oceana.org
munoz@oceana.org

**CHILE**
LIESBETH VAN DER MOOR
OCEANA
www.oceana.org
lvandermeer@oceana.org

**CHILE**
CARLOS MERINO
Instituto de Investigaciones Pesqueras del Norte - INPESNOR
cmerino@unap.cl

**CHILE**

MIGUEL ANGEL ESCOBAR
CORPESCA
www.corpesca.cl
mescobar@corpesca.cl

**CHILE**

JORGE OLIVA
CORPESCA
www.corpesca.cl
joliva@corpesca.cl

**COLOMBIA**

ALFREDO RODRÍGUEZ
Instituto de Investigaciones Marinas y Costeras
INVEMAR
www.invemar.org.co
alfredo.rodriguez@invemar.org.co

**COLOMBIA**

DR. JORGE PÁRAMO
Universidad de Magdalena
Santa Marta, Colombia
jparamog@yahoo.com

**FRANCE**

CHRISTOPHE CORBIÈRES
SEAPIX/IX BLUE
www.seapix.ixblue.com
christophe.corbieres@ixblue.com

**FRANCE**

FRANÇOIS GERLOTTO
Instituto de Recursos Acuáticos - IREA
www.irea.org.pe
fgerlotto@irea.org.pe
francois.gerlotto@ird.fr

**FRANCE**

FRÉDERIC MOSCA
SEAPIX/IX BLUE
www.seapix.ixblue.com
frederic.mosca@ixblue.com

**FRANCE**

JEREMIE HABASQUE
Institut de Recherche pour le Développement - IRD
http://es.ird.fr
jeremie.habasque@ird.fr

**HOLLAND**

NIELS HINTZEN
Institute for Marine Resources and Ecosystem Studies - IMARES
www.imares.wur.nl
niels.hintzen@wur.nl

**PANAMA**
ANNA NUÑEZ PERELIGINA
Autoridad de los Recursos Acuáticos de Panamá - ARAP
www.arap.gob.pa
annanu1011@yahoo.com

**PANAMA**
LILIANA GUERRA BATISTA
Autoridad de los Recursos Acuáticos de Panamá - ARAP
www.arap.gob.pa
liliana_1384@hotmail.com

**PERU**
ALEX ESPINOZA
UNOPS
espinozacarlosalex@gmail.com

**PERU**
ALEX ZUZUNAGA
Corporación Pesquera Inca - COPEINCA
www.copeinca.com
azuzunaga@copeinca.com.pe

**PERU**
ANDRÉS CHIPOLLINI MONTENEGRO
Instituto del Mar del Perú - IMARPE
www.imarpe.gob.pe
achipol@imarpe.gob.pe
dejecutivo@imarpe.gob.pe

**PERU**
ANIBAL ALIAGA
PESQUERA DIAMANTE
www.diamante.com.pe
aaliaga@diamante.com.pe

**PERU**
ARTURO ARANDA
Corporación Pesquera Inca - COPEINCA
www.copeinca.com
aranda@copeinca.com.pe

**PERU**

BETSY BUITRON
Instituto del Mar del Perú - IMARPE
www.imarpe.gob.pe
bbuitron@imarpe.gob.pe

**PERU**
CARMEN YAMASHIRO GUINOZA
Universidad Nacional Mayor de San Marcos
UNMSM
www.unmsm.edu.pe
cyamashirog@unmsm.edu.pe

**PERU**
CECILIA PEÑA
Instituto del Mar del Perú – IMARPE PERÚ
www.imarpe.gob.pe
cpena@imarpe.gob.pe

**PERU**
DAVID LÓPEZ
PESQUERA HAYDUK
www.hayduk.com.pe
dlopez@hayduk.com.pe

**PERU**
DIMITRI GUTIERREZ
Instituto del Mar del Perú - IMARPE
www.imarpe.gob.pe
dgutierrez@imarpe.gob.pe

**PERU**
EMILIO MENDEZ LAZARTE
AUSTRAL GROUP
www.austral.com.pe
emendez@austral.com.pe

**PERU**
ERICH DIAZ
Instituto del Mar del Perú - IMARPE
www.imarpe.gob.pe
ediaz@imarpe.gob.pe

**PERU**
FERNANDO DÁVILA
PESQUERA HAYDUK
www.hayduk.com.pe
fdavila@hayduk.com.pe

**PERU**

IVÁN PERALTA RUIZ
Tecnológia de Alimentos - TASA
www.tasa.com.pe
iperalta@tasa.com.pe

**PERU**
JORGE CASAS
CFG INVESTMENT
jorge.casas@cfgperu.com

**PERU**
JOSÉ LUIS ROJAS
AUSTRAL GROUP
www.austral.com.pe
jrojas@austral.com.pe

**PERU**
JORGE VIGIL MATOS
Sociedad Nacional de Pesquería - SNP
http://snp.org.pe/wp
jvigil@snp.org.pe

**PERU**
JUAN ARGUELLES TORRES
Universidad Cientifica del Sur - UCSUR
www.ucsur.edu.pe
jparguelles@hotmail.com

**PERU**
LEONARD CALDERÓN RABILLA
CFG INVESTMENT
leonard.calderon@cfgperu.com

**PERU**
MARCO ANTONIO ESPINO SÁNCHEZ
Universidad Nacional Mayor de San Marcos
UNMSM
www.unmsm.edu.pe
marcoespinosanchez@hotmail.com

**PERU**
MARIANO GUTIERREZ
Programa de las Naciones Unidas para el Desarrollo - PNUD
www.unops.org
marianog@unops.org

**PERU**
NALDI HERRERA
IREA

**PERU**
MARILYN MONTESINOS

CEDEPESCA
marilyn.montesinos@cedepesca.net

**PERU**
MARTÍN OVIEDO
SIMRAD/ Robinson Marine Electronics
www.simrad.com
www.robinsonme.cl
martin.oviedo@robinsonme.com
robinsonperu@robinsonme.com

**PERU**
MIGUEL ANGEL PEREA
Instituto del Mar del Perú - IMARPE
www.imarpe.gob.pe
apere@imarpe.gob.pe

**PERU**
NATHALY VARGAS LÓPEZ
Universidad Cientifica del Sur - UCSUR
www.ucsur.edu.pe
vnathy@gmail.com

**PERU**
RICARDO BERNALES
PESQUERA DIAMANTE
www.diamante.com.pe
rbernales@diamante.com.pe

**PERU**
SALVADOR PERALTILLA NEYRA
Tecnológia de Alimentos - TASA
www.tasa.com.pe
speraltilla@tasa.com.pe

**PERU**
ROCIO JOO
Instituto del Mar del Perú - IMARPE
www.imarpe.pe
kaoridrummer@gmail.com

**PERU**
RODOLFO CORNEJO URBINA
Universidad Cientifica del Sur - UCSUR
www.ucsur.edu.pe
recpesq@gmail.com

**PERU**
ROSA VINATEA CHÁVEZ
Tecnológia de Alimentos - TASA
www.tasa.com.pe
rvinatea@tasa.com.pe

**PERÚ**
SILVIA AGUILAR LUNA
Universidad Nacional Mayor de San Marcos UNMSM
www.unmsm.edu.pe
saguilarluna@gmail.com

**PERU**
ULISES MUNAYLLA
Sociedad Nacional de Pesquería - SNP
http://snp.org.pe/wp
umunaylla@snp.org.pe

**USA**
MARTÍN HALL
SCRIPPS Institution of Oceanography,
UC San Diego
https://scripps.ucsd.edu
mhall@iattc.org

**USA**
TAINA HONKALEHTO
National Oceanic and Atmospheric Administration - NOAA
www.noaa.gov
taina.honkalehto@noaa.gov

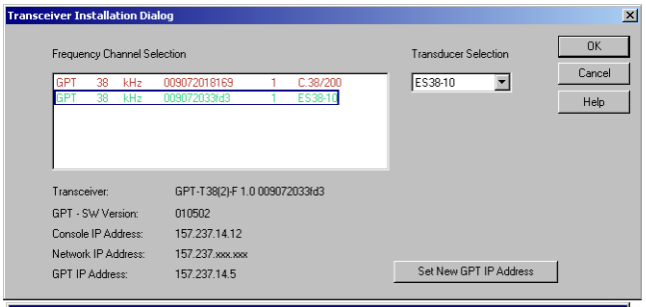
## Annex 3-A

**Calibration procedure and processing-analysis of acoustic data: Recommendations for collection of high quality acoustic data on fishing vessels** (Taina Honkalehto)

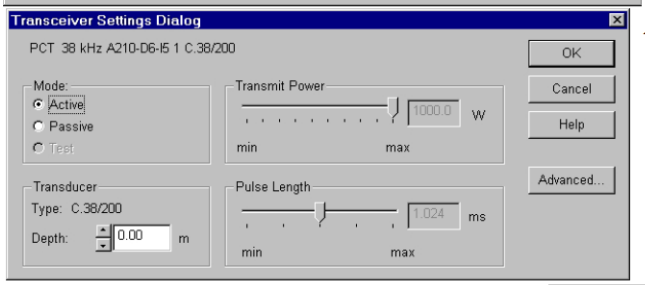
1) Develop a clear protocols document for vessel captain/crew and provide for each vessel. (Detailed protocols doc e.g. from Alaska Science Center fishing vessel acoustics is used in this analysis for reference starting point.)

A correct protocol should probably include the following tasks:

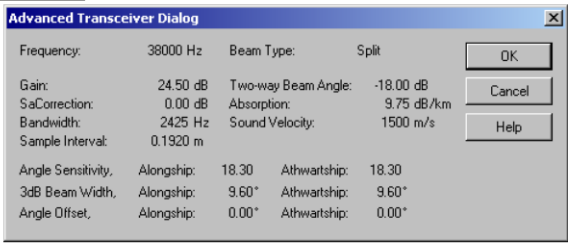
2) Check echosounder settings against protocol before each fishing trip. Make sure they are all the same and correct, including transceiver settings.




a.




b.




c.

Fig. 2 ES60 software windows a) Install-→ Transceiver window showing GPT type and transducer types. Click on "38 kHz" in upper left corner of screen to obtain b) Transceiver settings menu and c) Advanced transceiver menu.

3) Power setting for 120 kHz is currently 1000 W. Acoustics scientific research community recommends reducing power to 500 W due to instrument instability at higher power. Such lower power setting should not affect performance or screen picture at all. Ideally all vessels should do the same.

4) Calibrate all vessels at least once per year. ES60 error wave (triangle wave) needs to be removed before performing calibration. Results in Echoview in post processing can be applied.

5) Synchronize times within vessel between instruments, and between vessels with acoustic data by making sure the computer clocks are set to the correct time zone and time (local or GMT). ES60 file time-date stamps use the computer date-time, whereas inside the raw files the software uses GMT (based off the computer times). One possible correction method could be to compare the dates on the routes with the VMS values (all the VMS values come from the GPS date)

6) At other times, for a rapid evaluation of how the echosounder performances evolve, bottom echo can be used. When leaving and returning to port, define a "standard transect" , a short ideally flat bottom line between 2 waypoints that vessels can steam over and then check the strength of the bottom signal. That is a reasonable proxy for calibration both within and between vessels.

7) A spreadsheet of metadata about for vessels should be achieved and routinely fed.

8) The session rapidly analysed a processed Echoview EV file from TASA to see how they drew regions around schools for export, and if the regions were/were not drawn in areas when the vessels were fishing. Indeed it is essential to exclude bad data or vessel speed data while fishing.

9) Compare fishing vessel acoustic data to representative jack mackerel acoustic survey data at each time such data are available, which would allow to understand similarities, differences.

10) Sample calibration files in Echoview when this software is available.

# Annex 3-B

## Managing Jack Mackerel: problem, solutions and the role of fishing vessels (Niels Hintzen)

During the international workshop on 'Fishing vessels as scientific platforms: indicators and protocols for an Ecosystem Approach to Pelagic Fisheries', a work session was held to discuss current problems in Jack Mackerel management and potential solutions were given. Participants from five different countries (Chile, Colombia, Holland, France and Peru) joined the discussions. Among them were scientists and industry members (7 and 3 respectively).

The workshop was structured such that local and international regulations related to management were listed, followed by two sub-group discussions to detail problems related to management and solutions to these problems. In between the two sub-group discussions, a priority list of the problems were made. This enable the second round of sub-group discussions to focus on solutions tailored specifically towards the top two problems.

### Current management regulations in place

The Jack Mackerel fishery is partially regulated through the SPRFMO convention. Advice on Jack Mackerel catches is yearly prepared by the scientific committee of the SPRFMO and follows the MSY approach to setting Total Allowable Catches. Outside the SPRFMO area and inside territorial waters of Chile and Peru, additional regulations are in place.
For example, in Peru, the Minimum Landing Size (total length) is set at 31cm, there are regulations towards mesh size and the percentage of juvenile catches is limited to a max of 30%. The catches of Jack Mackerel may only be used for human consumption. Advice on catches inside Peruvian waters is prepared by the national fisheries institute IMARPE and follows from a stock assessment taking a summer-acoustic survey into account.
In Chile, the regulations adopted by the SPRFMO are enforced in territorial waters of Chile as well. Minimum Landing Size is set at 26cm (fork length) and allowed mesh sizes to be used vary from 12mm in the North (where Jack Mackerel is considered a bycatch species in the anchovy fishery) to 50mm in the South where it is targeted predominantly for human consumption.

### Defining the problems with management

During the first sub-group meetings (consisting of two subgroups) the following problems with Jack Mackerel management were noted.
Group 1:

- Recruitment is not well defined
- Minimum landing size might not be relevant for management (protect older fish)
- The spatial distribution of Jack Mackerel is not well defined and the possible existence of sub-populations needs better understanding.
- The influence of environmental conditions on Jack Mackerel are not well understood
- In the North of Chile, the fishery does not target Jack Mackerel but rather bycatch it in the Anchovy fishery, hence management in place might not be fit for this area

- Having similar management regimes in place for Jack Mackerel in Peru and Chile might be counter intuitive as fish in either region grow and mature differently
- The migration patterns of Jack Mackerel are not well understood

Group 2:

- Underestimation of the Jack Mackerel stock due to problems in the design of the acoustic survey
- Recruitment is not well defined
- Artisanal landings are not well documented and make up for approximately 10% of the catch
- Environmental conditions are not taken into account in the advisory process
- Management measures such as maximum allowed percentage of juvenile bycatch are not justified
- The artisanal fishery is not regulated
- Data collection program in place in Peru is not aimed at Jack Mackerel

From these list, the following six generic problems were identified

1. Understanding recruitment process
2. Call for management measures that are relevant for Jack Mackerel
3. Distinction between management targets when biology of fish is different
4. Data collection targeted on all Jack Mackerel fisheries
5. Understanding of ecological processes that determine distribution of Jack Mackerel are necessary
6. Underestimation of biomass by acoustic survey is problematic

## Solutions for identified problems

From the top 6 list, number 1 and 6 were identified as the most important concerns. Another round of sub-group meetings were held, each group consisting of a different set of people, to discuss 1) what potential solutions are and 2) how management could be helped by the suggested solution.

The solutions given by group 1 were:

- Acoustic survey: run a pilot survey before the acoustic survey starts to define the area that needs to be covered
- Recruitment: the bycatch of juveniles should be reported to inform on young incoming fish. The fine associated with the catch of juveniles should be suspended

The solutions given by group 2 were:

- Define the area that the acoustic survey should cover which is in agreement with the area where Jack Mackerel is supposed to be present
- Include adaptive management according to biological / hydrographical conditions

## Implementation of these solutions in management

The problems identified and solutions suggested will be communicated to the SPRFMO Scientific Committee. In addition, simulation modelling, based on Management Strategy Evaluation, will be applied to evaluate a number of the problems identified above. This should result in recommendations made to the Scientific Committee on what potential management plan designs might encompass, illustrated with performance indicators related to catches, stock recovery and stability.

# Annex 3-C.

**Standardization of VMS information.**

VMS and GPS values in the data base should be expressed in the same dimensions. Here are the proposals for the simplest standardized formats of the data.

date-time in format: dd/mm/yyyy HH:MM:SS
Example: 01/06/2011 23:00:00

longitude in decimal degrees.
Example: -77.15
latitude in decimal degrees
Example: -13.788

Annex 3-D.

**Methods for calculating the gravity centre of the fish spatial distribution**

The common way to calculate a gravity center (GC) for the abundance distribution is through a calculation of the mean of longitude and latitude of the densities. Nevertheless this method is highly sensitive to outliers (high unweighted densities at large distance from the average of the distribution). The way to reduce this source of bias is either to use the median instead of the mean, or to apply geostatistical methods that take this point into account. This last method is usually applied in Peru (Gutierrez, 2014).

Another way to calculate an unbiased GC is through the calculation of curves of cumulated biomass by latitude and by longitude. The 50% point of these two curves gives the gravity center. It is recommended by the group to pay attention on the risk of such biases and to compare the GC obtained by these different methods in order to evaluate the magnitude of the biases and to provide correct indicators. A way to compare the results is to allocate to each of the point locations a fixed arbitrary value, to recalculate the GC and to compare with the former value.

**Methods for comparing the fishing power of the ships and skippers.**

If skippers or ships (or both) do not present exactly the same abilities to catch fish, then the simple unweighted addition of their fishing effort would lead to biases in the average (and total) CPUE, abundance, and in most of the indicators extracted from the fishing activity metrics. Although the jack mackerel fishery in Peru is probably quite homogeneous (same kind of vessels, of gears and of skipper skills), it is indispensable to list the ships and gears characteristics and to produce a comparative analysis of the skippers' fishing power. The first method is to evaluate the rank of each ship (skipper) for the different years and to compare the significance of differences in rank between the different individuals. Another method is through comparisons by pairs of skippers.

Annex 4.

## Proposal for the creation of a Network on Environmental and Fisheries Acoustics

François Gerlotto

Lima, 27 April, 2014

Ecosystem Approach to Fisheries is now completely integrated in fisheries research as a methodology. Nevertheless in many cases it is not really applied, because of the difficulty to fulfill its requirements. Indeed the EAF needs ideally that environmental and fishery information be collected simultaneously in the same areas, in the 4 dimensions (3D plus time) and permanently.

This is almost never the case: the environmental data are collected by the research institutes independently from the fishery, and the fishing data come from the fishing fleet, with very few information on the environment where the catches were performed. The only links come from the satellite data and the oceanographic models (e.g. ROMs). Moreover the research Institutes are usually limited by staff and funding limitations and can only provide one or two snapshots of the environment in a year.

The stock assessment of the Chilean Jack Mackerel fisheries of the Southeast Pacific Ocean is a good example of such limitations. While it is known that the recruitment is the key variable explaining the changes in abundance, and that this recruitment is much more depending on environmental signals than on the spawning stock biomass, as we have no real information on these environmental signals, we continue with the (science-) fiction of the exclusive role of the fishing mortality and spawning stock biomass for calculating a meaningless MSY for elaborating regulation rules.

**What is lacking?**

- Coupled environment-fishery data in situ and in 3D + time
- A permanent monitoring of the ecosystem
- Definition of a list of indicators that can synthesize the ecosystem characteristics and dynamics
- A methodology

**What is usually and commonly done?**

- Use of fishing vessels hired by scientists (but acting as research vessels), to provide environmental observations over large areas and during long periods (in order to add to the information acquired by the research vessels);
- Use of fishing vessels by the fishing companies, to provide environmental information to the fishery in order to optimize the search and fishing time (e.g., find the proper water masses, or SST, Chl, etc. where the probability to find the exploited species is higher);

- Use of research vessels, to provide a general view of the ecosystem in a large area during a short period, where all the data (environment and stock) are collected simultaneously following a defined protocol.

**What has (almost) never been done?** Gathering all these sources of information in a single data base and use them in a single model. Why?

- Technical and methodological reasons:
    - The data are present in different and incompatible formats (e.g. the fishermen's trajectories, not planned and designed for current statistical analysis);
    - There is no methodology and models already developed for defining, integrating and weighting the indicators that are needed and (often already) collected by the different platforms.
- The Institutes are usually unable to take the initiative of such non-standard research: they are committed by their governments or administration to run standard observations in order to feed the classical models, which is extremely time consuming; besides, their funding is dedicated to specific research and their independence and ability to take scientific initiative has dramatically decreased these last decades. Most of the money comes from external funding agencies (national or international) for very specific researches previously defined by these agencies.
- The international organizations (e.g. RFMOs) have not the expertise and capacities (funding and personal) for taking such initiatives. Their only role is to gather the information, run standard models, point out the lacks of knowledge and list a series of non-mandatory recommendations. This role makes them usually rather conservative as far as scientific methodology is concerned.
- Individuals (scientists) are those who can develop these new or different methods, but they are unable to really develop research on their own (lack of personal funding and dependence on their respective Institutes).

To give an example of the effect of such limitations, all the fisheries scientists have agreed since the 70s that the MSY was not a good instrument for managing a fish population, but due to the limitations listed above, this indicator is still the (almost) only one currently used for stock assessment…

There is need for a structure that could "fill the gap". One essential source of data that presents the characteristics of observing simultaneously fishery and environmental informations in 3D and in time is the fisheries acoustics data (see the annual reports of the ICES WG FAST -since 1985- for more information). Indeed since the late 90s the acoustic instruments of industrial fishing vessels are similar in quality to those of research vessels and the acoustic data that they collect routinely is potentially able to provide the same kind of information as obtained during acoustic surveys, although with specific characteristics that should be considered before to use them. Acoustics is likely the best source of integrated data on the environment and the fishery.

The workshop on the use of fishers data that will be held in Lima (28 April – 2 May, 2014) will be a good opportunity to evaluate the impact and importance of the use by scientists of the acoustic data collected in routine by the fishers. Indeed as recommended by the SPRFMO (La Jolla, October, 2013: see www.southpacificrfmo.org ) in its Research Program:

**Scientific comment:**
*The continuous observation in situ of [biological and ecological] interactions is also necessary. The simplest method is to define a series of indicators that are likely to describe in time and space the effects of these interactions. They may come from research institutes, from international databases and from the fishery itself. There is a preliminary need to define the list of relevant indicators and the collection/processing protocol*.
**Recommendation:**
*Acoustic and environmental data from fishing vessels should be routinely collected and reported*.

**What should be done?**

- Building an ad-hoc small structure that would be:
  - Autonomous, independent from both governments and agencies
  - Administratively formalized (must have an administrative existence, e.g. NGO, etc.)
  - Able to gather the individual initiatives and propose projects and activities
  - Not competing with any other already existing structure, either governmental (Research institutes) or private (labs and structures organized by the fishery itself). This means that its major if not only role should be to gather the ideas of the scientists, produce meetings and workshops to highlight these ideas and evaluate their future, and propose the development of these fields of research defined by the scientific community. Anticipating this request, we created in Lima the IREA (Instituto de Recursos Acuaticos) as a fully independent structure: a first trial of such activity and structure is represented by the organization of the workshop in Lima.
- Elaborate (with the help of the scientific community) a list of objectives and priorities: what are the gaps in the fisheries research, why, what are the existing new methods and proposals for fulfilling these gaps, what new tools should be developed, how, etc.

**Proposal.**

We propose to create an international network on what we consider the most important points, i.e. the use of acoustic data from different sources and opportunity platforms to describe the environment and the fishery in this environment, the elaboration of a list of indicators, their testing and analysis, the development of new models taking these

indicators into consideration, etc. This independent network on “Acoustic data from fshing vessels” would be organized to work on these points and produce recommendations and suggestions for integrating ecosystem indicators and fisheries information in order to understand how and in which magnitude a stock depends on these two constraints. It would be managed by the IREA (Instituto de Recursos Acuaticos) which has been created precisely to fulfill the need presented above for an independent small free structure. IREA could take in charge the network activities during the year (contacts, state-of the-art, distribution of information and results, etc.) and organize each other year a meeting on a topic related to the network activities, in a place to define according to the Institutes interested by the works of the network, which would invite the network to have its meeting in its laboratories.

This network would limit its field of interest to all that the acoustic information collected aboard fishing vessels could provide. It would gather:

- Scientists interested in the Ecosystem Approach to Fisheries and the use of indicators extracted from direct observation data obtained aboard fishing vessels, namely acoustic data and ancillary environmental information;
- Acousticians and statisticians interested in the technical and methodological challenges such source of data brings;
- Professionals (fishers, managers, etc.)who would be interested by the feed-back between direct observations done by the fishing vessels and the results produced by the scientists on this field;
- Institutes and other organisms dealing with fish population management.


INSTITUTO DE RECURSOS ACUÁTICOS

www.irea.org.pe