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Draft of abstracts

Fishing vessels as scientific platform: An introduction.

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The results of more than 50 years of fisheries management show that stock management has not succeeded in preventing stocks from over-exploitation[1]. Fisheries science has faced great successes in understanding the dynamics of fish populations and managing fisheries, but also a long series of failures in the predictive capacities of mathematical models. This has been studied by many groups and Institutions (e.g. FAO, ICES, etc.) and the reasons of this relatively low capacity of fisheries biology to develop good predictive models have been explored. They are due to two major causes.

(A) A too narrow vision of the biology of fish populations.

Fish populations have been considered independently from their environment for decades. Traditionally indeed, the implicit hypotheses were that environment could be considered as a white noise included in the observation variance and that fishing activity was the main (if not only) forcing variable. Such hypotheses were induced by the fact that the only consistent data bases for fisheries research were commercial fishing data, which were used as indicators of the status of an exploited population. This weakness has been recognised since the mid 80s, but the lack of consistent information from the environment did not allow more than limited introduction of a few environmental variables.

This led to the concept of "Ecosystem Approach to fisheries" linked with the operational "ecosystem-based fisheries management" (see www.fao.org and www.ices.dk)[2]. In this integrative vision, it is assumed that all the environmental and ecological parameters must be considered when analysing the dynamics of a population. This includes their interactions, and it is admitted nowadays that both the effect of the environment on the fish population and the impact of fish populations and fishing activities on the ecosystem must be considered together. There was also a concern on the small quantity of data collected on a relatively few variables on the environment, which prevented to expect a better efficiency of models. Due to the lack of other source of data, it was impossible to correct satisfactorily theses biases. Direct methods of observation and

[1] Botsford, L. W., Castilla, J. C., and Peterson, C. H., 1997. The Management of Fisheries and Marine Ecosystems. *Science* 277: 509-515.

Hutchings, J. A., 2000. Collapse and recovery of marine fishes. *Nature* 406: 882-885.

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[2] Garcia, S. M., and Cochrane, K. L., 2005. Ecosystem approach to fisheries: a review of implementation guidelines. ICES Journal of Marine Science 62: 311-318.

monitoring of the exploited ecosystem were indispensable. Meanwhile, in order to take these drawbacks into consideration, the concept of precautionary approach was applied to fisheries management, and an important effort was put on the development of methods and tools allowing a better knowledge of the dynamics of the main variables driving an ecosystem. From them arose a series of concepts and hypotheses in the way a population evolves inside an ecosystem and how –and with which tools and methods- it should be studied.

(B) Limited forecasting capacities on populations dynamics.

The "strictly deterministic" vision of ecological patterns has been seriously discussed these last decades. The pioneer works by Lorenz[3] and May[4] allowed the assumption that populations could have non linear and chaotic response to physical forcing. Hsieh *et al* (2005)[5], stated that « *the biological populations are not simply tracking the environment. Rather, our results support the hypothesis that ecological dynamics in the oceans can be characterized by nonlinear amplification of stochastic physical forcing by biological processes. (…) The result (…) should call into question static conceptions of maximum sustainable yield and the use of fixed exploitation quotas for managing commercial fisheries. The potential for rapid and unpredictable shifts in response to environmental stochasticity and human impact supports a precautionary management approach for marine ecosystems*".

Regime shift constitute key moment in ecosystem history and are now intensively studied (see the works published in the special issue of Progress in Oceanography, 60, 2004). Following a definition given by Collie et al (2004)[6] for instance, "*regime shifts are considered to be low-frequency, high-amplitude changes in oceanic conditions that may be especially pronounced in biological variables and propagate through several trophic levels. Three different types of regime shifts (smooth, abrupt and discontinuous) are identified on the basis of different patterns in the relationships between the response of an ecosystem variable (usually biotic) and some external forcing or condition (control variable)*".

This definition explains why direct relationships between a control variable and the depending biotic pattern are not always linear and sometimes even more complex, when hysteresis for instance makes that for a same level of external forcing, several pseudo-stable states are possible for the response variable

Such results and concepts show the extreme difficulty for an ecosystem approach to fisheries to reach an operational level: fish and other components of the ecosystem may react or interact in a non linear way to a given variable; such interaction should impose to measure all the variables, which is conceptually impossible.

[3] Lorenz, 1963. Deterministic nonperiodic flow. Journal of the atmospheric science, 20 :448-464

[4] May, 1976. Simple mathematical models with very complicated dynamics. Nature, 1976, vol. 261 :459-467

[5] Chih-hao Hsieh, Sarah M. Glaser, Andrew J. Lucas & George Sugihara, 2005. Distinguishing random environmental fluctuations from ecological catastrophes for the North Pacific Ocean. Nature, 435, May 2005: 336-340

[6] Collie, J.S., Richardson, K., Steele, J.H., 2004. Regime shifts: can ecological theory illuminate the mechanisms? Progress in Oceanography, 60, 2004: 281-302

As we can see, the important question on the predictive capacity of fisheries biology models remains unanswered in a large part. Such uncertainty in the effectiveness of predictive models, which is acceptable in fundamental research, presents a serious problem for fisheries managers who have the obligation to monitor permanently on a real-time basis (or as real-time as possible) the human activity in fisheries and especially the fishing effort, in order to guarantee sound reactions to environmental changes and variations in stock abundance. As far as marine environment is concerned, experience demonstrated that this "unpredictability" increases with the trophic position of the ecological compartment considered: it becomes more and more complex when going from physical oceanography to fishery activities, through geochemistry, primary and secondary productivity, forage species, predators and apex predators, among which, fishers.

One answer to this question was to introduce non trophic and behavioural indicators. Indeed, behavioural patterns allowing the adaptation to the environment, like species interactions or space occupancy, play a consistent role in populations dynamics: density dependence effects may have a determinant importance, independent of environmental conditions; trophic –production- data such as fish catches or abundance are insufficient if considered alone to describe the interactions between the exploited population and the ecosystem; many of the sudden and huge explosions of populations that occurred in the last 30 years in the tropical and subtropical Oceans (e.g. *Balistes capriscus, Macroramphosus scolopax, Capros aper, Boops boops*, to give a few examples from the Eastern Atlantic Ocean) were often due to particular (undocumented: ecological, anthropic, biological, etc.) local conditions favouring extremely successful recruitments and triggering a particular development of the population biology.

In this domain, it is also important to keep in mind that forecasting capabilities are not the privilege of humans: «*Life is everywhere. And because the* [Darwinian evolutionary] *trial-and-error procedure has gone for billions of years, the organisms are splendidly adapted to their context, and very complex even in the most elementary form (…). Every living thing has or is a machinery for learning, remembering, and forecasting. The objective is to provide anticipatory reactions to the interactions with the external world* [7]". In clear, this means that animals are able to react to changes in the environment at thresholds below the measuring capacity of human sensors or to conditions that are not taken into consideration by the models. The reactions can be either quantitative by changing the dimension of a given behavioural characteristics (e.g. school dimension) or qualitative by selecting a new behavioural pattern (e.g. change in migration route or alimentary regime). If behavioural patterns are the adaptive answer to variations of several variables which are not necessarily registered by the scientist, then they are integrative and may display easy-to-measure characteristics synthesizing reactions to a number of non measured or non measurable environmental variables.

The study of these indicators can serve different specific objectives:

- Definition of descriptive indicators of the status of a population. Important works have been achieved on this field but more work is needed in the case of behavioural indicators. The

[7] Marchetti, C., 1998. Notes on the limits to knowledge explored with Darwinian logic. Complexity, Vol. 3, N° 3:22-35

effect of such change in school sizes implies changes in fishery management, with adaptations of fishing gears to the new dimension of the target.

- Determination of "warning indicators", showing that something is happening in the stock. In this case, the result is to produce a warning in real time for the fishery managers.

- Determination of "anticipatory indicators", if the changes appear before the related environmental/ecological changes are observed by scientists from conventional sources of data. In this case the reaction can be used as an environmental indicator showing that a change will appear in the ecosystem. It has predictive capacities. In some cases a general trend in the environmental conditions (e.g. shift from a cold decadal period to a warm one) can be measured, and can also allow some longer term (several years) anticipation based on probabilistic modelling.

The question then is to get metrics from which these different kinds of indicators can be extracted. Conventionally, fisheries research is performed using data from two sources.

- Indirect data, i.e. those extracted from the fishing activity and catch statistics. Mostly these data are the catch, the fishing effort, the catch-per-unit effort (CPUE). They are called “indirect” because they do not represent direct observation on the fish population. Historically, this set of information represents the first source of information that was available to fishery biologists; it allowed building mathematic models of dynamics of fish populations, after the pioneer and seminal works of Beverton & Holt[8]. Among the advantage of this group of data, the most obvious is the rather low cost of the data which are a by-product of the fishing activity. It does not require any expensive effort with research vessels and any other equipment; it is linked with the fishing activity that it describes quite accurately. Among the drawbacks: catch data, which were practically the only biological data on the population studied, implies a very strong assumption, that the catch per unit effort (CPUE) represents correctly the density of fish present and their variations. We know that this is not always the case, and Freon and Misund[9] (1999) showed that and density could evolve even in opposite ways[10]. Other drawbacks are: no reference with space as fishing data were not spatially located until the development of

[8] Beverton, R.J.H. & Holt, S.J., 1957. On the dynamics of exploited fish populations. Fisheries Investigations, 2(19):533 pages.

[9] Fréon, P., Misund, O.A., 1999. Dynamics of Pelagic Fish Distribution and Behaviour: Effects on Fisheries and Stock Assessment. Blackwell Science, Oxford, UK.

[10] Branch,T.A., Jensen O.P., Ricard Daniel, Ye Yimin and Ray Hilborn R., 2011. Contrasting Global Trends in Marine Fishery Status Obtained from Catches and from Stock Assessments. Conservation Biology, London, U.K.

Vert-pre Katiana A., Amoroso Ricardo O., Jensen Olaf P. and Ray Hilborn, 2013. Frequency and intensity of productivity regime shifts in marine fish stocks, PNAS, USA.

Vessel Monitoring Systems (VMS) recently; bad representation of the ecosystem and the interactions between the fish population, the fishery and the environment[11].

- Direct data, i.e. those that are collected independently from the fishery, aboard research vessels or other scientific platforms. This source gathers roughly four types of information:
  - Acoustic observations. They were collected practically since the invention of the vertical echo sounder. Fernandez et al. (2002)[12] note that "*In the early 1920s, reference had already been made to the possibility of detecting echoes from sardine and herring schools*". The invention of echo integration in the late 60s[13] allowed to produce absolute abundance estimates that could be introduced in mathematic models (and specifically Virtual Population Analyses, VPA); but acoustics gives also maps of fish distribution and data for studying fish behaviour (e.g. schooling, migrations, predation, communication, etc.), which are not used in models. Acoustic surveys are performed aboard research vessels, with scientific echo sounders, following adapted sampling strategies. Acoustic data are spatially referenced, allowing the use of spatial statistics (e.g. geostatistics).
  - Egg and larvae evaluations. Evaluating the number of eggs spawned during a spawning season gives a proxy for measuring the fish biomass (knowing the average number of eggs spawned by a female during this season and the sex-ratio). This method has been improved by the development of "CUFES" (Continuous Underwater Fish Egg Sampler), a device that collects eggs along a dedicated transect during the route of the research vessel. Here too, beside the actual abundance of adults, the method allows the drawing of egg spatial distribution, i.e. the definition of the spawning area and its links with the environment.
  - Observers aboard fishing vessels. Differently from the other methods, this one is developed aboard fishing vessels. It consists in embarking scientific observers who collect biological, environmental and fishery information during the fishing activity.
  - Ecological data. Most of the data describing the environment are useful for the correct understanding of the interactions between the fish population and the environment. These data come from two main sources: scientific surveys aboard research vessels and satellite measurements.

[11] Garcia, S. M. (Ed.), 2012. Selective Fishing and Balanced Harvest in Relation to Fisheries and Ecosystem Sustainability. IUCN, 2012: Report of a scientific workshop organized by the IUCN-CEM Fisheries Expert Group (FEG) and the European Bureau for Conservation and Development (EBCD) in Nagoya (Japan), 14–16 October 2010

[12] Fernandes, P. G., Gerlotto, F., Holliday, D. V., Nakken, O., and Simmonds, E. J. 2002. Acoustic applications in fisheries science: the ICES contribution. – ICES Marine Science Symposia, 215: 483–492.

[13] Scherbino, M., and Truskanov, M. D. 1966. Determination of fish concentration by means of hydroacoustic apparatus. ICES CM 1966/F:3. 6 pp.

The advantages of direct data are that they extract complete synchronous information from the different compartments of the ecosystem, without the bias introduced by the fishery activity which is only interested in the high abundance areas. They are spatially referenced and obey by construction the statistical rules. As the scientist is defining the survey, any kind of particular experiment can be performed[14]. It has two drawbacks as far as exploited stocks are concerned: the cost of oceanographic surveys is high; it requires the use of a research vessel that is not always available at the good moment (anticipated bureaucratic decisions on vessel agendas and ecological events are not really compatible).

Recently a new source of data was considered: the direct observations performed aboard fishing vessels. This has been made possible thanks to three new developments:

- The installation of Vessel Monitoring Systems (VMS) and more generally the recording of GPS positions that allows to include the spatial dimension in the data bases extracted from the fishers' activities.
- The improvements of in-board sensors (acoustics, hydrology, etc.) which quality is now almost identical to that of scientific instruments. This is particularly the case for acoustic instruments (vertical echo sounders, omnidirectional sonars, and other acoustic sensors) which are derived from scientific devices (e.g. the vertical echo sounder commercial series which is a particular version of the EK scientific equipments).
- The digital technology. Nowadays all the equipments aboard industrial fishing vessels are monitored by computing systems, and it becomes possible to record all the digital data on external hard disk drives of very low cost and without any interference with the fishers' activities. This allows a good cooperation between scientists and fishers, as long as the direct information collected has no impact on the fishing and commercial activity of the fishing vessel.

This new source of data presents a huge potential use, and it became important to evaluate whether these data could be used for scientific research, and which. This means measuring the scientific value of the information, which requires analyses at different levels: feasibility of data collection, calibration of the instruments, precision-accuracy of the data, scientific quality of the information, statistical constraints due to the "sampling strategy" of the fishing vessels, comparison with the similar data collected aboard

[14] See for instance: Bertrand, A., F. Gerlotto, S. Bertrand, M. Gutiérrez, L. Alza, A. Chipollini, E. Díaz, P. Espinoza, J. Ledesma, R. Quesquén, S. Peraltilla, F. Chavez, 2008. Schooling behaviour and environmental forcing in relation to anchoveta distribution: An analysis across multiple spatial scales. Progress in Oceanography 79 (2008) 264–277

research vessels, cost of collection, processing, equipment, calibration etc. Finally the possibility to extract consistent indicators from these data has to be considered.

In order to study all these points, the IREA (Instituto de Recursos Acuaticos, Lima, Peru) organized a workshop in April-May, 2014, on the theme of “Fishing Vessels as Scientific Platforms”, and one of the conclusions of the workshop was to publish a special issue in Fisheries Research on this theme, inviting scientists from all the world to contribute to this volume. The call was successful, showing that this new source of information is considered very seriously by the fishery scientists all over the world and for many fisheries, and over 30 contributions were submitted. They will follow a standard selection and editorial process by the journal, with the objective to have this special issue published in the mid-2015. We present here in annex the list of abstracts of all these contributions. They show the potential importance and use of the fishers’ scientific information.

List of contributions.

1. **Richard L. O'Driscoll, Adam J. Dunford, Alistair Dunn**. Industry acoustic surveys of spawning southern blue whiting on the Bounty Platform, New Zealand.

2. **Cleridy E. Lennert-Cody, Mark N. Maunder, Paul C. Fiedler, Mihoko Minami, Tim Gerrodette, Jeremy Rusin, Carolina Minte-Vera, Michael Scott.** Advantages and Disadvantages of Using Purse-Seine Vessels and Data Collected by Onboard Observers for Monitoring the Population Status of Dolphin Species in the Eastern Tropical Pacific Ocean.

3. **F. Gerlotto, S. Bertrand, N. Bez, M.-G Pennino, Mariano Gutierrez**. Advantages and Drawbacks of Acoustic Data from Fisher surveys for Fish Stock Assessment Purposes.

4. **Gang Li, Jie Cao, Xiaorong Zou, Xinjun Chen**. Modeling habitat suitability index for Chilean jack mackerel (*Trachurus murphyi*) in the South East Pacific.

5. **Sascha M.M. Fässler, Thomas Brunel, Sven Gastauer, Dirk Burggraaf**. Interpretation of acoustic data collected on pelagic fishing vessels throughout an annual cycle.

6. **J. Massé, F. Sanchez , J.M. Robert, D. Delaunay, P. Petitgas**. A partnership between science and industry for a monitoring of anchovy and sardine in the Bay of Biscay: When fishermen are actors of science.

7. **J. Habasque, F. Gerlotto, E. Josse, S. Peraltilla, M. Gutierrez, L. Berger, N. Le Bouffant**. Definition and application of a specific processing tool for monofrequency acoustic data collected on fishing vessels.

8. **Gary D. Melvin, Rudy Kloser**. Survey methodology, data processing, analytical procedures and the application of acoustic data from commercial fishers in resource assessment and ecosystem monitoring.

9. **C. Lang, A. Barraza, M. Bevilacqua.** Bivariate Spatial Analysis between Distribution of Anchovy (*Engraulis ringens*) Aggregations and Environmental Factors.

10. **Sergio Lillo, Carolina Lang, Javier Legua.** Variation of Relative Abundance and Spatial Distribution of Jack Mackerel (Trachurus murphyi) offshore in the South Central Region of Chile.

11. **G. Moreno, L. Dagorn, K. Holland, J. Lopez, M Capello, F. Forget, J.D. Filmalter**. FADs as Scientific Platforms.

12. **Frédéric Mosca, Christophe Corbières**. Fishery 3D Multibeam Echosounder for Ecosystem Assessment.

13. **N. Behagle, O. Gauthier, C. Cotte, G. Roudaut, P. Brehmer, E. Josse, Y. Cherel**. Acoustic structure and distribution of micronekton along a latitudinal oceanographic gradient from the tropics to the Polar Front in the southwestern Indian Ocean.

14. **Salvador Peraltilla, Aníbal Aliaga, Alex Zuzunaga, Emilio Méndez, David López, Rosa Vinatea, Mariano Gutiérrez, F. Gerlotto**. Analysis of the evolution of indicators from 2011 to 2014 in the Peruvian fishery.

15. **Pablo Pita, Duarte Fernández-Vidal, Javier García-Galdo, and Ramón Muíño**. An evaluation of the integration of a voluntary fisheries monitoring and the traditional ecological knowledge of the fishers in the management of the common octopus in Galicia (NW Spain).

16. **Egil Ona**. Experience with multi-frequency echosounder noise assessment of fishing vessels.

17. **Egil Ona**. Simple calibration of scientific multifrequency systems using echoes of a fixed bottom stretch

18. **A. Barraza, C. Lang, M. Bevilacqua**. Space-Time Characterization of the distribution of Southern blue whiting (*Micromesistius australis*) in South-Austral region of Chile.

19. **S. Lillo, J. Legua.** Humboldt squid (*Dosidicus gigas*) Target Strength Measurements Off Chile.

20. **Jorge Paramo, Carolina Lang, Sergio Lillo**. Modelled day-night biases in spatial structure of Jack mackerel (Trachurus murphyi) in Chile.

21. **Yann Tremblay**. Radar technology and seabirds ecology.

22. **JL Watkins, K Reid, D Ramm, XY Zhao, M Cox, G Skaret, S Fielding, XL Wang, E. Nicklitschek**. The use of commercial fishing vessels to provide acoustic data on the distribution and abundance of Antarctic krill.

23. **Jorge Oliva L., Luis Bustos R**. Reproductive dynamics of Jack mackerel (*Trachurus murphyi*) and associated environmental conditions.

24. **Jorge Oliva L, Carlos Merino P**. Proposition of a conceptual model for fisheries management of Jack mackerel (*Trachurus murphy*) as by-catch of anchovy (*Engraulis ringens*) in northern Chile.

25. **Marco Espino, Rosa Vinatea, Marilyn Montesinos**. Distributions patterns and relative abundance (CPUE) of Jack mackerel (Trachurus murphyi) and environmental variables from 2011 to 2013.

26. **Edwin J. Niklitschek, Jorge Cornejo-Donoso, Eduardo Hernández, Pamela Toledo, Rubén Roa-Ureta**. Parallell transects and design-free searching tracks from commercial vessels yielded similar hydroacoustic biomass estimates for Patagonian grenadier spawning aggregations.

27. **Héctor Peña, Espen Johnsen**. Comparison of scientific echo sounder data from commercial vessels in the Norwegian Sea.

28. **Saša Raicevich, Mion Monica, Celić Igor, Fortibuoni Tomaso, Franceschini Gianluca, Piras Camilla, Giovanardi Otello, Martinelli Michela**. Self sampling in the Northern Adriatic sea: Collection and validation of electronic logbooks Fishery Data.

29. **Saša Raicevich, Camilla Piras, Monica Mion, Tomaso Fortibuoni, Gianluca Franceschini, Giuseppe Scarcella, Elisa Punzo**. A photographic method to identify benthic assemblages based on demersal trawlers discard

30. **J. Córdova**. Technical Note: Fishing Vessels as Research Platform

Industry acoustic surveys of spawning southern blue whiting on the Bounty Platform, New Zealand

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Annual acoustic surveys of spawning southern blue whiting (*Micromesistius australis*) on the Bounty Platform, southeast of New Zealand, have been carried out using industry vessels since 2004. In most years, surveys were carried out from a single vessel, while in 2009, acoustic data were collected from three vessels. The survey approach in all years was the same – vessels with calibrated Simrad ES60/ES70 echosounders and hull-mounted 38 kHz transducers conducted aggregation-based surveys using an adaptive design. Surveys attempted to cover all areas of high southern blue whiting density. In most years there were multiple snapshots of the same aggregation. The resulting biomass was used as a relative estimate of spawning southern blue whiting abundance. There was a very large (seven-fold) increase in estimated biomass of SBW at the Bounty Platform from 2006 to 2007, which was due to the recruitment of one very strong year class (2002) into the spawning population. The estimated SBW biomass from 2008 was also high, but biomass declined by a factor of four in 2009. The observed decline in acoustic estimates between 2008 and 2009 was too great to be explained solely by fishing and average levels of natural mortality. The very large changes in estimated abundance between years, and also between snapshots within a year, are related mainly to changes in survey temporal and spatial coverage, and illustrate an important limitation on interpretation of aggregation-based acoustic abundance estimates. In each snapshot an unknown proportion of the spawning aggregation is surveyed, and almost certainly not the entire spawning stock. Survey coverage depended on both the amount of survey time available (which is often limited by commercial constraints) and the behaviour of the fish (e.g., the extent and density of the aggregation, and the timing of spawning). It is therefore difficult to incorporate the resulting series of abundance estimates into a formal stock assessment model as a time series. Despite this, industry acoustic surveys of the Bounty Platform have led directly to management decisions and changes in catch limits.

Keywords: Fishing vessel, acoustics, blue whiting, survey design, stock assessment

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Advantages and Disadvantages of Using Purse-Seine Vessels and Data Collected by Onboard Observers for Monitoring the Population Status of Dolphin Species in the Eastern Tropical Pacific Ocean.

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In the eastern tropical Pacific Ocean (EPO), yellowfin tuna (*Thunnus albacares*) are often found in association with spotted (*Stenella attenuata*) and spinner (*S. longirostris*) dolphins. Purse-seine vessels use this co-occurrence to locate the tuna by searching for dolphins and associated birds. Onboard observer sampling coverage of large purse-seine vessels in the EPO began in the late 1970s and has been nearly 100% since 1992. Using these observer data, indices of relative abundance for dolphins were originally developed in the late 1980s based on line transect methodology when the primary method of detection was binoculars. Trend estimation was subsequently discontinued in 2000 due to concerns about changes in reporting rates of dolphin school detections with increased use of helicopter and radar search. However, at present, as a result of a hiatus in fishery-independent surveys since 2006, fisheries observer data are the only source of information with which to monitor dolphin population status. Analysis of fisheries observer data for 1990-2012 shows that non-random search, as well as selective reporting of dolphin sightings by helicopters and radar, poses serious challenges for trend estimation with these data. Using data for the spotted dolphin, we review possible methods to deal with these data challenge sand discuss the reliability of the results. We also present a discussion of alternatives for dolphin abundance estimation, including the use of purse-seine vessels during fishery closures for dedicated line-transect surveys for dolphins, and the use of purse-seiners as platforms for tagging (using visual tags, radio tags and PIT tags) and genetics sampling, for mark-recapture modelling. We present cost-sample size matrices for these alternative uses of purse-seine vessels, using the precision of the fishery-independent survey abundance estimates as a guide.

Keywords: tuna-dolphin, ETP, abundance, trend estimation, CPUE.

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Advantages and Drawbacks of Acoustic Data from Fisher surveys for Fish Stock Assessment Purposes

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Since the late 90s, fishing vessels are equipped with digital echo sounders which capacities are almost identical to those of scientific instruments. As fishers use permanently these devices and are at sea during at least all the fishing season, this source of data was considered as potentially important for research, for several obvious reasons of cost and number of data. Nevertheless it is difficult to input these data in acoustic stock assessment due to their intrinsic characteristics. Indeed the fishers' data must fulfill in priority the requirements of fishing companies, and collection, processing and analysis are adapted to these objectives: how compatible are they with the scientific requirements?

The paper considers two major sources of difficulties: (i) technical, i.e. the impact of fishers acoustic data collection methods such as calibration procedure, choice of settings, acoustic characteristics of the vessels, etc. on the data quality; (ii) methodological, i.e. the sampling strategy and "survey design" which is strictly adaptive and in hands of the fishers: how can the "predator strategy" be made compatible with the objectives of a scientific surveys (exploration of "density hotspots" vs. general mapping, etc.). The possibility of applying specific statistical methods to such adaptive samplings are considered.

The paper presents a list of the main characteristics in these two fields and evaluates how the fishers' data can be used for scientific purposes – and to which. Some examples are given from works done on the Peruvian fishery of Chilean Jack mackerel. The discussion deals with comparisons between the strategies of scientific surveys vs. fishers' surveys. It analyses how complementary both methods are, the possibility to input fishers' data to stock mapping and abundance estimates, the new information provided by fishers, the sampling validity of "predators' survey". Some recommendations on development of adapted statistical methods are given.

Keywords: fisheries acoustics, fishing vessels, sampling, survey design, *Trachurus murphyi*

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Modeling habitat suitability index for Chilean Jack mackerel (*Trachurus murphyi*) in the South East Pacific

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Fish habitat is an essential ingredient for the ecosystem-based fishery management. Habitat suitability index (HSI) models have been extensively used to describe the relationship between fish species and their habitat and to estimate the spatial distribution of fish species. In this study we used fishery data of *Trachurus murphyi* collected from Chinese trawl fishery during 2001-2013 in the South East Pacific Ocean and remote sending data including sea surface temperature (SST), sea surface height (SSH) and sea surface chlorophyll-*a* concentration (Chl- *a*) to establish suitability index (SI) models of the three environmental variables for *Trachurus murphyi*. Observed SI values were calculated based on the frequency distribution of fishing effort on each environmental variable, and parameters of SI models were estimated by nonlinear regression. SI models for SST, SSH and SSC were combined into two empirical HSI models respectively: the arithmetic mean model (AMM) and the geometric mean model (GMM). Comparison results indicate that AMM perform better than GMM model to define the optimal habitat for *Trachurus murphyi*. Spatial distribution of catch and fishing effort corresponded with it of suitable habitat, but there were still some fishing operation occurred in the non-suitable habitat in 2013. The seasonal latitudinal variation trend of suitable habitat is consistent with that of the gravity centers of fishing effort. There is strong agreement between annual total catch of the international trawl fishery and annual mean suitable habitat area during 2001 to 2010, but they show an opposite tendency from 2011 to 2013 which might relate to the lowest level of stock biomass over the history of *Trachurus murphyi* fishery and catch quota introduced by South Pacific Regional Fisheries Organization in 2011.

Keywords: habitat suitability index; satellite remote sensing; *Trachurus murphyi*; South East Pacific

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Interpretation of acoustic data collected on pelagic fishing vessels throughout an annual cycle

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Pelagic trawlers make extensive use of acoustic equipment during their fishing operations. Data from these could potentially be recorded to provide useful information such as high-resolution fleet behaviour, estimates of fish density detected on the fishing grounds, extent of stock distribution, or stock migration. Acoustic data collection trials were realized in 2012 during several fishing trips of Dutch pelagic freezer-trawlers. Fishing trips targeted blue whiting west of the British Isles in spring, North Sea herring in summer, and horse mackerel in the English Channel and Celtic Sea in autumn. Echosounders were calibrated and time- and position-stamped data logged along the path covered by the vessels.

Keywords: Acoustic data, echosounder, freezer-trawler, fish abundance, fishing behavior.

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A partnership between science and industry for a monitoring of anchovy and sardine in the Bay of Biscay: When fishermen are actors of science.

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Anchovy and sardine are small pelagic species occupying partially the same geographic areas in the Bay of Biscay (North-East Atlantic). The level of biomass is strongly dependent on the recruitment making an annual TAC management little adapted to the management of this resource. Currently, the management is based on annual spawning stock abundance indices available in spring each year, through acoustics and egg production research surveys.
The monitoring of the resource more finely in time and along the life cycle would allow to adjust quickly management measures as soon as good/bad recruitment signals are detected. For that, an innovative data collection strategy for additional information through a partnership between fishermen and scientists has been developed in 2009 and 2010 called "pilot sentinel surveys". The method was based on short commercial vessels surveys, several times along the year, in two restricted "key areas" known as potential recruitment one. The objective was to combine acoustic recordings and fishing operations for biological sampling in order to provide indicators in each key area. Only one scientist was on board and an ad hoc sampling strategy was adopted at each survey by the team "Captain/Scientist" according to the situation. This partnership allowed to benefit of fishermen experience through a rigorous scientific approach in order to optimise sampling in time and space. The sentinel data series was complemented with some parameters collected during the annual spring acoustic surveys carried out by the R/V Thalassa, itself assisted by commercial vessels for additional fishing operations and echoes interpretations. This experiment showed that the "sentinel" observations in restrictive areas cannot give any abundance indices, but are adequate to provide significant biological indicators on the progress of the life cycle of each species within the year. In addition, these pilot sentinel surveys significantly improved the understanding between fishermen and scientists and the benefits of alternative adaptive management strategies.

Keywords: anchovy, sardine, acoustic, monitoring, fishing vessel, consort survey
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Definition and application of a specific processing tool for monofrequency acoustic data collected on fishing vessels

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The use of acoustic data collected on fishing vessels for scientific purpose is an ongoing field. Processing and analyzing the vast amount of acoustic data opportunistically collected by fishing vessels would benefit from automation. Although the automation of acoustic data and signal processing for fishery and environmental application is developing rapidly, it is still in its infancy for the data collected by fishing vessels (ICES, 2007).

We present a methodology developed to process monofrequency acoustic data. The method has been applied to fishing trips realized by a pool of Peruvian industrial purse seiners targeting pelagic species of the Peruvian coast. This tool includes methods developed for classic scientific data allowing the extraction of information on: (i) the depth of the lower oxycline (or upper oxygen minimum zone), (ii) the characteristics of the fish schools, (iii) the fish acoustic density, and (iv) a proxy of prey density.

Key words: Peru Humboldt Current System, acoustics, fishing vessels, oxygen minimum zone, shoals characteristics.

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Survey methodology, data processing, analytical procedures and the application of acoustic data from commercial fishers in resource assessment and ecosystem monitoring.

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The collection of scientific data from commercial fishing vessels will play an important role in the future assessment of fish stocks and ecosystem monitoring. Currently acoustic data collections range from fully structured random/systematic surveys to the ad hoc search patterns of pelagic fishing vessels during standard fishing operations and are used primarily in single species stock assessment. The critical component to using these data is the understanding the requirements for data collection, the method of collection, analytical procedures and the limitations of the data depending upon the previous considerations; The limitations and the interpretations of the data being a major factor in the validity of the outputs and the acceptance of the results by the scientific community. In this paper we discuss these factors and provide real examples of how acoustic data from commercial fishing vessels are being used to provide information on fish resources and advice to management. Furthermore we explore opportunities for acoustics to support broad scale ecosystems monitoring, as well as the potential to deploy other autonomous monitoring/collection technologies without interfering with the day to day operations of the vessels.

Key words: fisheries acoustic, acoustic data, fishing vessels, data collection, environmental indicators.

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Bivariate Spatial Analysis between Distribution of Anchovy (*Engraulis ringens*) Aggregations and Environmental Factors.

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The environment effect on anchovy (*Engraulis ringens*) distribution in the South of Chile has been extensively characterized and studied through statistical methodologies, which are based on the assumption of independence between samples. It has been shown that a relationship exists between the resource and some environmental components.

However, research has been conducted concluding that these aggregations have a spatial correlation structure. On this background, it is proposed to study the joint behavior between anchovy aggregations, oceanographic variables (temperature, salinity and oxygen) and food supply as plankton (abundance fito and zoo plankton) collected on Hydroacoustic Surveys through bivariate geostatistical analysis.

Specifically it is proposed the use of a bivariate Gaussian Random Field with cross-covariance model of the Matern type. The main advantage of this model is that it is possible to model distinct variances, smoothness and scale parameters and at the same time the correlation between two variables. Then the estimation is performed using maximum likelihood technique while prediction is performed using standard cokriging predictor.

Key words: Bivariate spatial analysis, anchovy, environmental variables.

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Variation of Relative Abundance and Spatial Distribution of Jack Mackerel (Trachurus murphyi) offshore in the South Central Region of Chile.

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Until 2013 in the south central region of Chile 12 echo-surveys with fishing vessels of the purse seine fleet have been carried out, for the study of the spatial distribution during the reproductive period of jack mackerel *Trachurus murphyi* offshore over an area of $230*10^3$ square nautical miles.

These echo-surveys provided information from egg abundance and density and jack mackerel aggregations. Since most fishing vessels are not equipped with scientific acoustic systems allowing calibrated and store information during the surveys, a handwriting form was made to register aggregations detected by the echo sounder and sonar, relative to its geographic and bathymetric position, aggregation type and expected catch, the latter according to the expert judgment of the skipper.

The data collected were characterized and studied as spatial indicators. The results have shown since the middle of last decade, a persistent decline in the indicators of the presence of the resource, from a maximum of 1,680 records identified in 2004 to less than 100 in the years 2008, 2012 and 2013, which leads to a drastic reduction in these indicators.

This trend is consistent with the status of the stock of jack mackerel in the southeastern Pacific and allows complementing the information about the fishery.

Key words: Jack mackerel, spatial indicators, purse seine fleet, echosounder, reproductive period.

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FADs as Scientific Platforms

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Fish aggregating devices (FADs) are floating objects used by fishers to aggregate pelagic fish such as tunas, and enhance the catch of these species. Because this is so important for tuna fisheries, nearly 100,000 FADs are deployed every year in the world's tropical oceans by fishers. Fishers use geolocating buoys to track and maintain these FADs by visiting them regularly, reinforcing them if they are weak or replacing them. Many of these buoys are now equipped with echosounders in order to provide remote information on the aggregated biomass. FADs are currently only used for fishing purposes but they can also serve scientific objectives. In this paper, we investigate the potential of these data to improve our knowledge on the ecology of tunas and other pelagic animals and to get fishery independent indices of abundance. These FADs also represent ideal platforms for scientists to deploy scientific instruments, such as tag receivers, cameras, hydrophones to collect new data on the pelagic biodiversity, using the fact that FADs naturally aggregate several pelagic species. FADs provide a unique window of observation onto pelagic ecosystems not open from conventional research vessels. The amount of data that they can provide in a cost-effective way can make a big difference in the scientific understanding of pelagic ecosystems. This is key to improve the conservation of pelagic fishes and management of fisheries.

Key words: Fish Aggregating Devices, tuna, instrumented buoys, fisheries acosutics.

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Fishery 3D Multibeam Echosounder for Ecosystem Assessment.

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SEAPIX is a new 3D multibeam echosounder with an original architecture in double Mills Cross. This configuration allows to image water column and bottom in both athwartship and fore-and-aft direction. Furthermore, steering capability in transmit and receive allows a volume coverage of 120°x120° under ship with 1.6°x1.6° beam aperture. 64 beams are acquired per ping in the frequency range of 145-155 kHz using continuous wave or frequency modulation. All beams are stabilized in roll, pitch and yaw using an embedded inertial motion unit. First part of this paper describes main capabilities and technical limitations of the SEAPIX. We then suggest some research areas where SEAPIX could provide new types of information, especially in the field of Ecosystem Mapping and Assessment. Finally, we illustrate those potential contributions with early results obtained on both scientific and fishing boat.

Key words: fisheries acoustics, three dimension acoustics, multibeam sonar, acoustic assessment, technology.

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Acoustic structure and distribution of micronekton along a latitudinal oceanographic gradient from the tropics to the Polar Front in the southwestern Indian Ocean.

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Little is known about the distribution patterns of mid-trophic level organisms in the deep-sea, while oceanic waters constitute the largest habitat on the planet. Micronekton constitutes a critical intermediate trophic link between primary producers, first-order consumers and higher trophic level predators, including heavily exploited- (e.g. tunas) or protected species. In this study, hydroacoustics were used to investigate the vertical distribution of micronekton according to a horizontal latitudinal gradient (i.e. water masses delineated by fronts) observed from satellite data. Acoustic data were collected continuously with a Simrad EK60 38 kHz split-beam echosounder during seven surveys carried out in the southwestern Indian Ocean (20-60°S, 50-90°E) within the framework of the ANR MyctO-3D-MAP program (scientific data) and IMOS project (opportunity data from fisheries).

Firstly, there was evidence of a changing vertical structure of micronektonic organisms, in terms of thickness and density, along the latitudinal gradient. An organization in three main depth layers (surface, intermediate and deep) has been studied along the latitudinal gradient 20-60°S. All seasons and years considered, the surface layer acoustic density and thickness decrease southward. The intermediate layer looks almost empty most of the time but is well-defined between 30 and 40°S. Moreover, the deep layer acoustic density increases from north to south but its thickness does not change significantly.

Secondly, a combination of a spatially constrained clustering and a multiscale analysis based on Moran's eigenvector maps was applied on acoustic data to assess the importance of changes in vertical acoustic structure along this latitudinal gradient. For all seven surveys, similar horizontal groups were observed with clear latitudinal limits along seasons and years and clear vertical type profiles. To explain these stable latitudinal observations from acoustic data, a redundancy analysis between these results and hydrological properties of water masses was performed. In 85% of cases, a link could be established between vertical acoustic organization and horizontal hydrological parameters considered (surface temperature, a-chlorophyll and oceanographic front positions from altimetry data). The study highlights the usefulness of collecting opportunistically acoustic data from fishery ships to complete scientific data that are often restricted in time and space.

Key words:. Acoustic, distribution of micronekton, oceanographic gradient, Polar Front, Indian Ocean.
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Analysis of the evolution of indicators from 2011 to 2014 in the Peruvian fishery

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The jack mackerel (*Trachurus murphyi*) and horse mackerel (*Scomber japonicus*) species hold important fisheries in Peru. They share a similar habitat. The environmental conditions such as temperature and oxygen are the key variables for the presence of these resources.

During the fishing period from 2011 to 2014, through digital fishfinders of the fishing fleet, trials for identifying the habitat of these species was performed, using variables such as. geographic distribution and location in the horizontal and vertical plane, the number of schools, morphology, e.g. pod size, height, length; acoustic density; the relationship of schools with oceanographic variables of temperature, salinity, oxygen and chlorophyll; acoustic presence of zooplankton, etc. which has been considered as indicators of the Peruvian fishery.

However during this period of study, it has been observed that oxygen has a strong relationship in the horizontal and vertical plane with the presence of horse mackerel and mackerel as well as the edges of high phytoplankton productivity characterized by boundaries of warm and cold temperatures; also the characteristics of the morphology of the schools are depending on the conditions of the environment, noting that warm environments are favorable for the presence of jack mackerel and horse mackerel.

We show that recording indicators of the environment and populations and their evolution through a permanent monitoring of the Peruvian fishery depends understanding of the interactions between the environment and the abundance or accessibility of horse mackerel and jack mackerel resources and thus allows better management of their fisheries.

Key words: fisheries acoustics, acoustic indicators, fishing fleet, fisheries monitoring, *Trachurus murphyi, Scomber japonicas*, Peruvian fishery

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An evaluation of the integration of a voluntary fisheries monitoring and the traditional ecological knowledge of the fishers in the management of the common octopus in Galicia (NW Spain)

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The octopus fishery of Galicia (NW Spain) is a paradigmatic example of top-down management that generates conflicts between fishers and policy makers. This confrontation is putting at risk one of the most traditional and economically relevant fisheries of Galicia. In order to contextualize and update the current socio-economic dimension of the coastal octopus fishery, an analyses of media news about octopus and of the annual activities of the Galician octopus fleet were performed. Furthermore, key experts were consulted to identify the major management requirements to achieve a sustainable octopus fishery in the long-term. Secondly, in the absence of conventional sources of scientific information in the context of this small scale, data-poor fishery, the performance of a participatory model based in new techniques and tools was evaluated to obtain cost-effective information relevant to support future management measures. For this, a 1-year voluntary fishery monitoring was accomplished by using low-cost GPS data-loggers and fishing log-books to allocate the intensity of effort and CPUE of a selection of the octopus fishers of the Ría of Arousa, along the Galician coast. Additionally, the Traditional Ecological Knowledge (TEK) of the fishers was used to map the distribution of the octopus fishing grounds in the same area. The results showed that in Galicia, approximately 700 vessels use traps to catch annually 2000 t of octopus, with a market value of 13 M €. In the study area, the fishers identified 174 km^2 of octopus fishing grounds, mainly distributed in the mid and outer parts of the area. The creation of a long term co-management plan in the near future to ensure the sustainability of the octopus stocks and the profitability of this artisanal fleet was recommended. The use of participatory models based on cost-effective GPS data-loggers and log-books, like the ones used in this study, jointly with the use of TEK is encouraged to achieve this objective.

Keywords: artisanal fisheries, fisheries conflicts, common octopus, TEK mapping, GPS data-loggers.

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Experience with multi-frequency echosounder noise assessment of fishing vessels

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This article summarizes our experience from up to10 vessels regularly used in Norway for surveying pelagic stocks, with examples of what can be found in the echosounder noise ranging in deep water with the sounders in passive mode, 0 – 12 knots. The main sources of interferences are listed. They come from interferences with the instruments aboard, noise from pumps and machinery, e.g. different propulsion tools, as AC machinery and supply, DC, standard diesel and several different propellers.

This noise source is different from the external, low frequency noise usually measured at a noise ranging, but the noise limiting the acoustic instruments and the post processing of the data. Some evaluations of the absolute limitations for using fishing vessels are given, and a discussion on the protocol for defining a "correct" fishing vessel to be used in acoustic research is given.

Keywords: fisheries acoustics, multifrequency, acoustic noise, calibration, fishing vessels

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Simple calibration of scientific multifrequency systems using echoes of a fixed bottom stretch

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Calibration accuracy for scientific vessels are usually better than 1% (0.1 dB). If this demand can be relaxed to 2-3%, then a much simpler calibration procedure have been tried out, where the fishing vessels with up to 6 frequencies are sent to a "calibration fjord" south of Bergen, with a fairly flat bottom. The recording of the bottom echo are compared with previous runs by research vessels carrying the same frequencies.

G(f) for the different frequencies for the fishing vessel are estimated directly from the ratio, and repeated once.

Keywords: fisheries acoustics, fishing vessels, vertical echo sounders, calibration methods

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Space-Time Characterization of the distribution of Southern blue whiting (*Micromesistius australis*) in South-Austral region of Chile.

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Acoustic surveys conducted aboard fishing vessels in the South-Austral of Chile between 2003-2013, whose objective was to estimate the abundance of blue whiting (*Micromesistius australis*) in the area circumscribed by the latitudes 47º and 51º S. The acoustic data collected on these cruises typically has a high proportion of null values, this is one of the main limitations of direct application on Classical Geostatistical methods, it proposed the use of an alternative methodology as Lorelogram (Heagerty and Zeger, 1998), a tool that considers the modeling of the correlation structure in both space and time, allowing to quantify the spatio-temporal interaction, also has the advantage of binary treatment variables as absence-presence. In the past two decades, the space-time models have been widely studied and applied in different areas, but not in the fisheries sector becoming a convenient tool for characterizing spatio-temporal components.

Keywords: acoustic surveys, lorelogram, spatial analysis, blue whiting

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Humboldt squid (*Dosidicus gigas*) Target Strength Measurements Off Chile.

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The Humboldt squid (*Dosidicus gigas*) has increased its importance as fishing resource as its biomass increased sharply after 2002. Its stock has remained at high levels and allowed the development of a large fishery with landing over 150 000 t year^{-1}. During acoustic survey carried out off Chile, digital echograms were recorded in fishing areas using an EK60 echo sounder with split beam transducers operating at the 38, 120 and 200 KHz. Jumbo squid was fished with jigs, weighted and dorsal mantle length measured. The acoustic data was processed using TS analysis function in Echoview software in order to establish relationships between squid size and acoustic target strength (TS).

Keywords: Humboldt squid, echosounder, TS analysis, target strength.

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Modelled day-night biases in spatial structure of Jack mackerel (Trachurus murphyi) in Chile

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The jack mackerel population has been assessed directly by fisheries acoustics without consider the day-night fish school behavior. In this paper the day-night effect on spatial structure of jack mackerel is analyzed from fisheries acoustics surveys. The diel behavior of fish schools were assessed by variograms in order to characterize the spatial structure of fish density. In general, variograms showed differences in the day-night spatial structure. The day variograms showed a higher nugget effect than night. The percentage of variance explained by the sampling design (sill/nugget) varies between 60.87 and 78.37% in the day variograms and only between 0.16 and 16.77% at night variograms. An intense schooling behavior during the day is likely to be responsible for this increased small-scale variability. The night variograms were characterized by a smaller range of autocorrelation than day variograms. These features may be caused by differences in schooling behavior which exists in jack mackerel with respect to day and night. On the day, schools of jack mackerel were formed in compact higher densities that were distributed in a more extensive area (variogram range between 18.8 and 28.8 nmi). While at night, these schools were joined to form large aggregations in extensive layers, but occupying minor area of spatial distribution (variogram range between 3.5 and 12,7 nmi). These differences in the form of school aggregation has strong implications for the estimation of biomass in the interpolation process by kriging.

Keywords: Jack mackerel, diel, fish school behavior, spatial.

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Radar technology and seabirds ecology.

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The use of seabirds to gain insight about fish location is ancient, but the use of radar to detect seabirds takes it to another level, and gives us the opportunity to study seabirds ecology. In this respect, fishing vessels form a great opportunity for the study of seabirds at sea. The radar can provide direct visual observations in real time that are useful for fishing, but science needs recording, counting, and measuring. I present here some technical considerations aiming at helping the development of such research activities in fishing vessels. I show that the recording is easy and cheap, but that proper settings of the radars are required to collect useful information. Analysis of the data is however more challenging, but can be partially automatized. The information provided by such systems is unique and extremely useful in seabirds ecology.

Keywords: Seabirds, Radar, Movement, Ecology, Spatial dynamics, Foraging, Fishing, Interactions.

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The use of commercial fishing vessels to provide acoustic data on the distribution and abundance of Antarctic krill.

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A commercial fishery for Antarctic krill (Euphausia superba) has existed for over 3 decades and the Commission for Conservation of Antarctic Marine Living Resources (CCAMLR) manages this fishery using precautionary catch limits, fishery data collection and a scientific observer programme operating on the fishing vessels. A recent increase in the number of vessels fishing and the increased costs of undertaking scientific research cruises has focussed attention on being able to use fishing vessels to collect more extensive scientific data sets. In 2012, CCAMLR's Subgroup on Acoustic Survey and Analysis Methods (SG-ASAM) was tasked with assessing the use of acoustic data collected from fishing vessels to provide qualitative and quantitative information on the distribution and relative abundance of Antarctic krill and other pelagic species. SG-ASAM conceived a proof of concept programme and implemented stage 1 in 2013 to determine the current setup of acoustic equipment on participating fishing vessels and to establish whether these vessels could collect position and time-referenced acoustic data. To date stage 1 data have been received from 7 krill fishing vessels and SG-ASAM has most recently focussed on the development of data collection protocols to enable fishing vessels to collect quantitative acoustic data along prescribed transects. While this development work continues, the willingness of fishing companies to participate in such studies has already been demonstrated by Norwegian- and Chinese-flagged fishing vessels undertaking krill biomass surveys in two key fishery areas in the South Atlantic sector of the Southern Ocean.

Keywords: Acoustic methods, Euphausia superba, fishing vessel acoustics, CCAMLR

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Reproductive dynamics of Jack mackerel (*Trachurus murphyi*) and associated environmental conditions

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The jack mackerel is widely distributed, showing spawning areas, both north and south of the southeastern Pacific, and in coastal and oceanic areas, whose gaps are related with the physiological proper of the species and the environmental conditions.

In most fish exits a genetically determined reproductive behavior through multiple generations and it is related to spawning best conditions, allowing each population to maintain over time. Thus, some pelagic fish prefer to spawn in coastal areas associated with certain bays rich in nutrients and others who seek areas in oceanic water with optimal environmental characteristics for spawning of certain size groups. Knowledge of the specific behavior of each stock, is relevant for fishery evaluation and indispensable to estimate the parameters used in assessment models.

Reproductive aspects of jack mackerel are analyzed, based on information obtained from industrial purse seiners in the north of Chile, through the analysis of reproductive indicators, maturity ogive, fecundity and schools distribution associated to environmental conditions.

Keywords: spawning behaviour, fisheries, *Trachurus murphyi*, South Pacific Ocean

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Proposition of a conceptual model for fisheries management of Jack mackerel (*Trachurus murphy*) as by-catch of anchovy (*Engraulis ringens*) in northern Chile

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A conceptual management model is proposed for the purse seine fishery in the northern area of Chile, when the jack mackerel appears as unavoidable by-catch anchovy. The model considers the historical behavior landings of industrial fleet, before and during the application of the maximum catch limit per owner (LMCA), associated with both fishing quota resources. The estimate quota of jack mackerel depends of anchovy biomass in a manner that ensures that jack mackerel is not limiting to achieve compliance with the anchovy fishing quota allocated to the fishery unit of Regions XV-II.

The estimate of this quota has great relevance for northern Chile because both resources coexist over a large extension in fishing areas and virtually occurs during all the year.

Keywords: purse seine fishery, *Trachurus murphyi*, abundance estimate, anchovy, assessment model

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Distributions patterns and relative abundance (CPUE) of Jack mackerel and environmental variables from 2011 to 2013

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How works the CPUE dynamics of jack mackerel (*Trachurus murphyi*) depending on environmental conditions expressed in the sea surface temperature? Catches by appropriately georeferenced coves corresponded to 1662 fishing trips from the main Peruvian industrial fleet dedicated to fishing for human consumption. Fishing seasons analyzed were: January-December 2011, January-April 2012 and January-May 2013.

Fishing effort corresponded to the duration in hours of each fishing trip and, discharges in tonnes was took it every fortnight; with both data was generated the CPUE series for the analysis

The highest abundances and wider distributions corresponded to the fishery in 2011, declining in 2013 to a minimum due to cold conditions favored by the predominance of Cold Coastal Waters (ACF) keeping away the Subtropical Surface Water (SSW), which are more favorable to the availability and abundance of the *Trachurus murphyi*.

Keywords: Distribution patterns, *Trachurus murphyi*, CPUE, habitat, South-East Pacific Ocean

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Parallell transects and design-free searching tracks from commercial vessels yielded similar hydroacoustic biomass estimates for Patagonian grenadier spawning aggregations.

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Hydroacoustic biomass surveys are fundamental sources of information for stock assessment and fisheries management. As conventional surveys demand large allocations of funding and research vessel time, obtaining hydroacoustic data from commercial fishing vessels represents an attractive alternative to reduce costs and enhance coverage of scientific surveys. Commercial fishing operations, however, do not follow a sampling design and tend to concentrate their sampling effort in higher density areas, being expected to produce biased biomass estimates. We measured such bias by comparing Patagonian grenadier biomass estimates obtained under two sampling scenarios: (1) a semi-random stratified transects design, and (2) normal design-free commercial searching. This sampling experiment was conducted between August and September 2005, in the Guamblin Canyon, off Southern Chile. Following a semi-randomized hourly schedule, three fishing vessels alternated design-based hydroacoustic sampling with design-free searching and fishing. Biomass estimations were obtained using maximum likelihood geostatistics, treating date and vessel as random effects. We found a rather small difference in mean biomass between sampling methods, being just 7% higher for the design-free approach. A much larger coefficient of variation (CV) was found, instead, for the parallel transects design, likely related to both a smaller sample size and a larger survey area, where the stock was absent in a larger proportion of the sampling units. Our results suggest biomass estimates obtained from design-free commercial fishing activities, may be equivalent to those obtained from design-based sampling approaches, when the commercial fleet searching effort is high relative to the surface area occupied by the stock.

Keywords: fisheries acoustics, maximum likelihood, geostatistics, spatial correlation, hoki, macriuronus

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Comparison of scientific echo sounder data from commercial vessels in the Norwegian Sea

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The comparison and inter-calibration of echo sounders of research vessels has been common practice for many years when two or more vessels cooperate in an acoustic fish abundance survey. Recently, and with the increasing use of commercial vessels in research surveys, the comparison between the performance of echo sounders has became an important issue that needs to be studied in these surveys as well. In 2005 three and in 2006 2 survey vessels were compared. Comparability between years was secured by reusing one of the vessels both years. This vessel had transducers mounted in a protruding keel. The weather conditions during the 2005 comparison were conducted in fairly rough weather, characterized by wind force Beaufort 6 and high waves, while in 2006 the conditions were good, with wind force Beaufort 1. The results from 2005 showed significant differences between the three vessels at a survey speed of 3.5 ms-1, with higher estimates of blue whiting from the system of the vessel with the protruding keel. The two other vessels with identical design also showed some differences related to propeller cavitation and air bubble attenuation, affected by different amounts of ballast water. In 2006, both vessels showed a very good agreement (mean differences below 2 %) between the biomass estimates of blue whiting, at 6 and 3.5 ms-1 vessel speeds.

Keywords: acoustic abundance, air bubble attenuation, echo sounder, propeller cavitation, commercial vessels.

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Self sampling in the Northern Adriatic sea: Collection and validation of electronic logbooks Fishery Data.

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In the last years large emphasis has been given to participatory research, in order to enhance knowledge co-production among stakeholders. Currently there is much effort worldwide to develop programmes to involve fishers in the sampling of their catches. Indeed, trawl survey and onboard observers data collection is usually not cost effective and difficultly provide a high spatio-temporal coverage. Within the EU participatory research project GAP2, electronic logbooks were installed onboard beam trawlers to collect for each haul geo-referenced catch data in the Northern Adriatic Sea. Since April 2012 catches of some of the most important local demersal species (8 species, including Teleosts, Cephalopods and Crustaceans) were recorded in 3,145 self sampled hauls. Since a major difficulty with this kind of study is to provide scientifically valid information, self-sampling run concurrently with an observer programme, with 177 hauls monitored also by scientific observers. The latter dataset was used to test the accuracy of self-sampled data. For almost all species a good agreement between these two datasets was observed, allowing to describe with a high temporal resolution seasonal changes of their main fishing grounds. Moreover, fishermen were involved in data interpretation in order to incorporate their knowledge in the scientific process. Future improvements in the logbook system (e.g., increasing the number of fishing vessels involved) will allow better describing fishing effort and species spatio-temporal distribution, where the collaboration among scientists and fishers represent a fundamental tool to generate quality data and efficient management.

Keywords: self-sampling, electronic log-book, fishery-dependent data, spatial distribution, Adriatic Sea.

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A photographic method to identify benthic assemblages based on demersal trawlers discard

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Knowledge on the distribution of benthic assemblages is important to understand the spatial pattern of demersal fish species, their essential habitats and fishing activities, allowing enforcing spatio-temporal explicit management schemes. However, benthic fauna sampling is time consuming and, when wide areas need to be covered, it needs the use of expensive sampling platforms such as research vessels. We developed a photographic geo-referenced method based on mega-epifauna identification through pictures of discard collected from demersal trawlers during commercial fishing activity (otter-trawls and rapido-trawls), with the aim of implementing a practical and proficient approach for the description of benthic assemblages distribution both in spatial and temporal terms. The method was developed using samples collected in the Northern Adriatic Sea (Mediterranean) by taking discard pictures of a definite surface (quadrants of 0.5 x 0.5 m size) and simultaneously getting samples of discards that were analysed in the laboratory at the highest taxonomic resolution. An overall agreement between assemblages composition and classification obtained with both methods was observed, even if the photographic analysis did not allow to describe rare, small-sized species. A similar assemblage classification was obtained when the spatial distribution of exclusive and characteristic species recorded with both methods was considered. These results suggest that fishery dependent information related to demersal discard composition could be successfully used to define benthic assemblages distribution. Thus, this method could allow describing benthic assemblages at a high spatial resolution and on a wide scale by involving fishermen in the collection of pictures during commercial trips in the framework of participatory research activities.

Keywords: benthic assemblage, photographic method, discard, fishery-dependent data, Adriatic Sea

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Technical Note: Fishing Vessels as Research Platform

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In Chile, the Pacific Ocean covers a coastline of over 3,500 mn where a variety of marine resources, so that, through the years of marine research requirements have increased, which in recent years, it has not been possible to meet the current research ship has (V/R Abate Molina), it has been necessary to adapt commercial fishing vessels as research platform, both to support research vessel or conducting research studies. In this document the experience of Instituto de Fomento Pesquero (IFOP) is presented, in enabling commercial ships and characteristics of crew to collect data to ensure the provision of reliable information, analyzing advantage and limitations of commercial fishing vessels as research platform, addition to presenting estimates of relative abundance considering commercial detection equipment and the experience of skippers.

Keywords: Fishing Vessels, collect data, relative abundance of marine resource.

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