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Proposal for a SPRFMO task group on Ecosystem and Habitat monitoring

IREA, Lima

PROPOSAL FOR CREATING A GROUP ON ECOSYSTEM AND HABITAT MONITORING INSIDE SPRFMO SCIENTIFIC COMMITTEE

IREA, Lima

INTRODUCTION

Modern research in fisheries ecology takes into consideration the environment in order to understand the variations of spatial distributions and changes in abundances of the populations This is clearly specified for instance in Article 3(1)(b) and (2) of the SPRFMO Convention calling on the Commission to apply the precautionary approach and the ecosystem based approach to fishery resources under the mandate of the Convention. Furthermore, the UE Common Fisheries Policy (which considers the Ecosystem Approach to Fisheries: Garcia, 1996) and the Marine Strategy Framework Directive within Descriptor 7 "Hydrographical Conditions", state that the monitoring of physical parameters is essential to determine the various habitats that provide the environmental conditions for marine life.

The major question could be formalized as such: the dynamics and behaviour of a species is driven by two types of factors, i.e. environmental characteristics and fishing pressure. Both affect the population in many different ways, but there is very few knowledge on the respective impacts of these forcing factors. Inside the SPRFMO area of study, the two major types of populations, namely the Chilean Jack Mackerel (CJM) and the deep-sea populations, are likely to react very differently to these factors: CJM, capable of high recruitments and huge abundances in a highly variable environment (Yañez et al., 1992; Silva et al., 2012), and the orange roughy, living in a much more stable environment, presenting a low growth, stable recruitment, long life, relatively reduced abundance and a population structure making it highly sensitive to fishery (Clark and O'Driscoll, 2003). Fisheries are usually well documented and can be reasonably controlled, however, the understanding of the effect of environmental condition is much less clear, and there is evidently no possible control on these factors.

Environment is described by a wide number of variables, each one with a different impact on fish. Measuring exhaustively these variables in large areas such as the South Pacific Ocean and continuously in time is completely impossible. There is a need to define a series of habitat indicators that could synthesize these various data. Gerlotto (2017) suggests "*The fundamental motivation of fish behaviour is to guarantee the survival of the species. This means maintaining the population in a favourable environment, i.e. a given suitable habitat (…).Then, habitat definition and 3-D dynamics could be one synthetic indicator for understanding, analysing, and predicting the dynamics of the population".* Habitat has been studied recently by most of the scientific teams involved in the SPRFMO Scientific Committee activities (Bertrand et al., 2016; Silva et al., 2016; Anderson et al., 2016; Gang Li et al., 2016; Vasquez et al., 2016; etc.). Although these studies were performed for different purposes and using different metrics, they both present the same objective: understanding the variation of the dynamics of the exploited stocks.

The major limitation so far in the use of indicators was the lack of data covering satisfactorily 3-D spahabitat ce and time. Satellite data fulfil most of these requirements, being both exhaustive and collected daily; but they are mostly superficial (although some proxies and extrapolation can bring information on the global water mass). Fishing data are important and give an essential series of information, including VMS movements of the fleet, data from observers, etc. But they are often biased by the specific selectivity of gears and fishers' fishing strategies. The other biological and hydrological

information depend mostly on the use of scientific surveys, e.g. acoustic surveys as performed yearly by Peru and Chile. These surveys give precise and detailed information on the 3-D structure of the sea and on the distribution, abundance and behaviour of fish. But they present two major drawbacks: being expensive they cannot be performed continuously and cover exhaustively the distribution area of widely scattered stocks such as CJM; in some cases the survey is not performed over the bulk of the biomass, as occurred several times in Chilean and Peruvian surveys.

Recently the possibility of using acoustic data from platforms of opportunity (Kloser et al., 2009) and fishing vessels (Melvin et al., 2016) arose and this source of data is widely used nowadays. Although it suffers also some drawbacks, it is in condition to complete the other sources of data from satellites and surveys. In order to evaluate and facilitate the use of such data, SPRFMO created a task group on "*Fishing vessels as scientific platforms*" which presents its final report this year. The major results of the Task Group are that the fishers' acoustic data are fully and rather easily exploitable for scientific research once the vessels calibrated (a calibration procedure has been published in SPRFMO) and using common protocols (especially common target strength equations). Then, the strongest limitation in the study of habitat characteristics and variability disappears in part and it seems to us that it is time to develop a common research on habitat monitoring in the SPRFMO area and on the managed stocks, beginning with the Chilean Jack Mackerel and the demersal stocks around deep-sea mounts.

This is the reason of the proposal presented in this document.

ACTIVITIES LINKED TO THIS PROPOSAL

Definition of the habitat

It is admitted now that evolution of populations does not depend exclusively on the catch, neither on environment: behavior and population strategies of the species play an important role. These patterns are linked to habitat typology and dynamics. Therefore the concept of habitat presents a series of practical applications for ecosystem monitoring.

Habitat can be considered as a way to synthesize the environmental information inside a single indicator. It is specific to the target species. The environmental (or other) variables that have no impact on the specific habitat definition can be ignored by the study.

Habitat is used for several objectives: delimitation of the potential habitat for defining the survey areas (Zwolinski et al, Fig. 1, A); evaluation of the 3-D volume of habitat (Bertrand et al., 2014, Fig. 1, B); extrapolation of the acoustic observation windows to the area of presence of CJM (Fig. 1, C); Analysis of dynamics in the distribution area (Valdez, 2016; Hintzen et al., 2015, Fig. 1 D from ICES/FAST report, 2016); Dynamics of habitat movements along the year (Fig. 1, E); definition of populations structures (Gerlotto et al 2012; Hintzen et al 2015; Bertrand et al 2016…, Fig. 1, F); definition of impact of biophysical patterns (Vasquez et al 2016), etc.

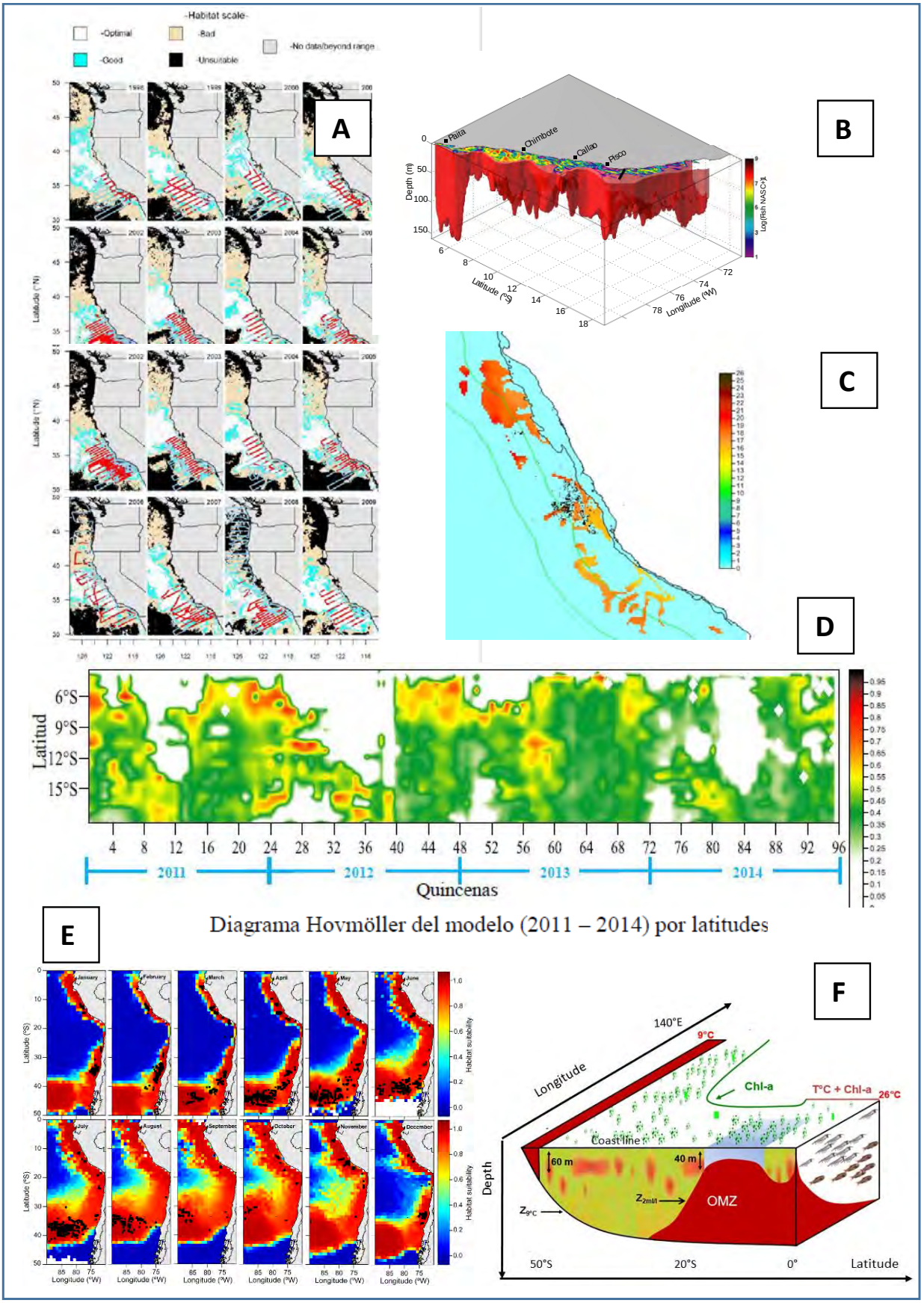

Figure 1. Different uses of habitat studies. A to F: see text

Potential activities linked to habitat studies

We suggest here a series of potential researches linked to ecosystem monitoring and habitat studies, knowing that this series is not exhaustive and that the different topics present different levels of priority and feasibility.

A. The Chilean jack mackerel

Among the economically important species exploited in the South Pacific, CJM is probably the "easiest" to study, thanks to the considerable sum of biological and ecological information accumulated (Gretchina, 2009; Gerlotto and Dioses, 2013). We will detail the potential research to develop for habitat monitoring for this species.

- Defining habitat structure and dynamics

A series of works have been performed on CJM, but also on other species, and particularly anchovy in the Peruvian (e.g. Bertrand et al., 2008) and Chilean waters (Silva et al., 2016). The effect of El Niño years have been studied in details, as well as the interactions between anchovy habitat, ecological characteristics of the environment and the fishery (Castillo, pers. comm.). Studying these experiences should be of interest to evaluate how these methods could be adapted to the CJM.

There is an important quantity of historical data on the CJM fishery and ecology (Gretchina, 2009; Gerlotto and Dioses, 2013). Using this historical data set, added to the existing results and models, would allow to define more precisely the CJM habitat and use it for practical habitat monitoring.

Several teams have already begun works on CJM habitat inside the SPRFMO area, under different points of view (Peru: SNP, IMARPE; Chile: INPESCA, IFOP; EU: IMARES, IRD). Integrating these different experiences would allow to produce a precise definition of the CJM habitat including fishery, ecology, behavior and biophysics (Yáñez et al., 2008).

- Defining the population structure

It is important to know about the current structure of CJM population(s) in order to apply correctly the demographic models (Serra, 1991; Serra and Glubokov, 2008; Hintzen et al., 2014; Vasquez et al., 2016). No consensus has been obtained on this species despite the already consistent number of studies performed. There is a need for such consensus, and habitat studies are likely to help getting it.

- Modelling the population dynamics using information on behavioural ecology

Although it is widely acknowledged that ecosystem approach is indispensable in modern fisheries research, rather few information from these habitat is included into models of population dynamics, and practically no behavioural metrics are used (Naranjo et al., 2015; Gerlotto, 2017). Dill (2017) describes the role of behavioural ecology and the limits of its use.

- Understanding (and forecasting) the changes in spatial distribution and abundance.

It is admitted that regime shifts induce a chaotic component in the dynamics of a population (Hilborn et al., 1994; Hsieh et al., 2005, among others). These changes cannot be foreseen by standard models, as they are by nature unpredictable. Nevertheless behavior of fish can be a way to foresee a potential change in the fish distribution. As behavior is linked to habitat, observing the habitat could help "ringing the alarm" when a non-linear dynamics is likely to occur due to habitat changes.

B. The Deep—sea mount populations

There are less works published on habitat for this group, although some countries inside the SPRFMO area which are exploiting these stocks with industrial fisheries have developed a long series of research (New Zealand, Australia), techniques and methods to survey the deep-sea stocks and have defined some habitat characteristics for these populations (Koslow et al., 2000; Clark et al., 2014; Haedrish et al., 2001; Penney et al., 2009; Clark and O´Driscoll, 2003; etc.). There is no fundamental difficulty to develop a research on habitat for these species.

C. Other species.

Most of the other exploited species are pelagic (giant squid, mackerel, etc.) and can be studied with the same tools and data as the CJM. The only species to which habitat studies are unlikely to be performed using the same methodology are the sharks, seabirds and marine mammals, which would require other methods and tools (e.g. electronic tags and pingers, etc.). We will not consider them in this proposal.

Organization of data bases

Information on the ecosystem comes from three sources:

- Catch data. Are used for assessment models, indispensable for knowing the impact of the fishery and many biological traits of the species; do not provide many information on the environment itself.

  Fishers' activities. They are documented through the use of VMS, observers aboard etc., e.g. the project "*Bitácoras de pesca*" from IMARPE (Ñiquen, pers. comm.). Historical Georeferenced fishing data (e.g. CPUE) present the advantage of a large space-time distribution, although they do not document on the underwater fish distribution and behavior (Silva et al., 2016; Yáñez et al., 2016). They can even be used as proxies for exploring the spatial distribution of abundance (Joo et al., 2015).

- Environment data (e.g. satellites, buoys, etc.). Used for describing ecosystems. Do not provide information on the stock and its interactions with the ecosystem. No need to insist on this point, universally used in ecology research.

- Acoustic (RV and FV). Provide both fish and a few environment information simultaneously (spatial and biomass), with some capacities to dynamic observations in the case of fisheries acoustic data and systematic frequent single transects (Institutes). But limited in coverage in space and time (limited number of RV surveys) and in providing continuous systematic samples of ecological data (FV). Besides survey results and abundance estimates, acoustics is in condition to provide many other types of data, e.g. hydrology (oxycline: Bertrand et al., 2010) or biology (Ballón et al., 2011). Acoustic information from the fishery is considered as valid for scientific analysis (under some conditions: calibration, equipment onboard, etc...).

There is a need to integrate the different sources of data. These series of data from the different fisheries should be gathered under SPRFMO umbrella, directly as metrics or through the definition of workable indicators. This represents a huge effort that could be performed with the collaboration of the data management working group of SPRFMO, which is already working on several of these data: catches and fishery data; acoustic surveys; hydrology; etc. A large experience on management of such georeferenced data bases already exists in most of the Institutes. For instance, Chilean experience on the use of GIS on pelagic resources (www.clipesca.cl) developed in the PUCV could be evaluated and extended, using jack mackerel as a case study (Yáñez et al., 2016).

PROPOSAL

IREA proposes developing activities on the ecosystem approach and monitoring through a synthetic indicator, the habitat, e.g. creating a specific working group "HABITAT DEFINITION, DESCRIPTION, MONITORING" inside the SPRFMO SC.

Rationale.

Ecosystem monitoring corresponds to a need in modern fisheries research. One way to produce information allowing habitat and ecosystem monitoring could be through the creation of a working group inside SPRFMO dedicated to this research.

One strong limitation to perform such research, i.e. the lack of 3-D in situ data, was studied by the SPRFMO Task Group on "Fishing vessels as scientific platforms" leaded by IREA, which stated in its final report that acoustic data from fishing vessels presented the same quality as scientific data and were likely to provide continuous information on the fishing grounds and new information extracted from the fishers' strategies. These information can be obtained from any modern industrial fishery, namely in the SPRFMO area fisheries on CJM and deep-sea mounts.

Besides the new pieces of information that such research using fishers' data brings, one other output could be to help defining the actual structure of the populations, and especially that of CJM. So far indeed there are a series of options as listed by the ad hoc SPRFMO workshop in 2008, but since this date a series of hypotheses and works have been done and it is time to produce a new analysis taking advantage of all the new knowledge. Nevertheless a final conclusion seems still unlikely, due to the lack of synthetic knowledge of the CJM habitat. Habitat is probably the best indicator for exploring the population structure, as demonstrated by many recent works listed above. Having more information on habitat characteristics and dynamics thanks to this group, would allow obtaining a final common conclusion on CJM population structure.

Proposed Terms of Reference

We suggest the following recommendation to be considered by the SPRFMO Scientific Committee during its session in Shanghai in September, 2017.

The SC recommends to create a dedicated working group on the wide theme of "Ecosystem Monitoring" inside SPRFMO, with the following objectives:

- With the collaboration of the Data Management working group, to collate the data and indicators from all the teams in order to constitute a global data base on habitat in the South Pacific Ocean to be managed by SPRFMO. This includes listing the different sources of information needed for an environment monitoring (e.g. satellites, fishery and fishers' data, acoustic surveys, buoys, etc.) with the objective to elaborate a general data base on environment gathering these different sources and develop (or select) a GIS to handle them.

- To process and analyze the data collected aboard fishing vessels, and especially (but not exclusively) the acoustic data, with the objective to draw a habitat definition for the Chilean Jack Mackerel and to

study its spatial (in the 3 dimensions) and temporal dynamics. This processing being performed using the protocols designed by the SPRFMO Task Group on acoustic data and the different teams.

- To define the habitat of the major species of interest inside the SPRFMO area of research, beginning with the Chilean Jack Mackerel

- To produce an annual state of the art of the habitat in the South Pacific to be delivered to the SPRFMO Scientific Committee;

- To define the structure of populations of the most important exploited species inside SPRFMO, beginning with the CJM.

- To compare and integrate the different habitat and population models developed inside the SPRFMO area by the different teams

Terms of reference for the year 2018

During the year 2018, priority should be done to:

(1) In collaboration with the data working group, establishing the state-of-the art on data collection and defining the methods for collecting, processing and analyzing the new fisheries independent data;

(2) Producing a report synthesizing habitat researches and hypotheses on CJM to be presented at the SC meeting in 2018.

We suggest that the general management of this group be carried out by IREA, as was the case for the Task group on "Fishing vessels as scientific platform" which was created for a 3 year period.

This document has been prepared by IREA with the collaboration of colleagues from EU, Peru and Chile.

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