A METHOD FOR ASSESSING FEK/LEK AS A PRACTICAL TOOL FOR ECOSYSTEM-BASED FISHERIES MANAGEMENT: SEEKING CONSENSUS IN SOUTHEASTERN BRAZIL

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Abstract

Studies of fisher's ecological knowledge (FEK) and local ecological knowledge (LEK) have been rarely undertaken for practical application in a management context. Here, we describe a novel methodology which was designed under an ecosystem-based fisheries management framework. The procedure was adapted from the Delphi technique which seeks experts consensus, and focused on several spatial and temporal issues related to the small-scale fisheries of the northern coast of São Paulo, Brazil (particularly, in Ubatuba). Experts were selected from a preliminary survey to participate in two sequential rounds of semi-structured interviews at landing sites and coastal fishing communities. The issues addressed: (1) fishing grounds and bycatch species of each fishing gear; (2) spatial and seasonal occurrence of mature females and recruits of the main commercial species and (3) suggestions for local fisheries management (e.g. mesh and size of gillnets, closure seasons, gears restriction by fishing area). It was possible to identify consensus rates on the ecological information, as well as on the management issues. The former allowed the construction of maps representing fishing grounds and the local spatial distribution of different fishing stocks *strata*. We illustrate the output by focusing on three fishery stocks: the seabob-shrimp *Xiphopenaeus kroyeri*, the croaker *Micropogonias furnieri*, and the inshore squid *Loligo* spp. As a whole, the methodology proved to be useful for the definition of essential fish habitats, and the results provided new guidelines for future local fisheries management and conservation initiatives, such as marine protected areas.

Introduction

Communities dependent on natural resources have often wide experience-based knowledge about the ecosystem they interact. However, local ecological knowledge (LEK), or fishers' ecological knowledge (FEK) studies (Johannes et al. 2000; Berkes et al. 2000; Gasalla 2004; Begossi 2008; Silvano et al. 2008) have been rarely undertaken for practical application in ecosystem-based fisheries management (EBFM) schemes (Gasalla and Tutui 2006; Gasalla and Diegues 2010).

In this type of management, the focus is on an integrated vision of the ecosystem, rather than on individual target fishery stocks, and includes social and economic factors (Murawski 2000). The concept of "Essential Fish Habitat"(EFH), based on the "health" of the habitat and its productivity, should be an integral part of EBFM issues (Rosenberg et al. 2000). The identification of EFHs is important to protect areas that are critical to marine resources (Conover and Coleman 2000), including spawning and nursery grounds of commercially important species.

Here we argue that FEK can be useful to identify EFHs (Bergmann et al. 2005), particularly where detailed scientific datasets are unavailable (Silvano and Begossi 2010) and fishers can be the only source of information of environmental and stocks conditions (Johannes et al. 2000).

At most developing countries, including Brazil, governments face many structural failures to gather data, implement regulations and make the appropriate management of marine living resources (Pauly 1995). On the other hand, resource-dependent communities have often been politically, culturally and socioeconomic marginalized (Brook and McLachlan 2005). However, there is no operational room for such exclusion under an ecosystem approach. In this sense, stakeholders must be indeed included in management processes, ensuring quality of life of fishermen, fisheries productivity and sustaining the biological diversity simultaneously (Bundy et al. 2008; Lawson et al 2008).

Therefore, this paper aims to present a tested method, adapted from the Delphi technique, and its efficiency to assess strategic FEK. It provides more accurate responses to issues potentially important to support EBFM initiatives, including the identification of EFHs, marine protected areas (MPAs) design and planning, and key fishery data for decision makers and fishing communities.

Study area

Ubatuba is located on the north coast of São Paulo (between 23^{o} 20'S and 23^{o}35' S), which lies in the southeastern Brazilian shelf (Figure 1). The last receives seasonal upwelling and cool intrusions, resulting in moderately-high productivity (Heileman and Gasalla 2008).

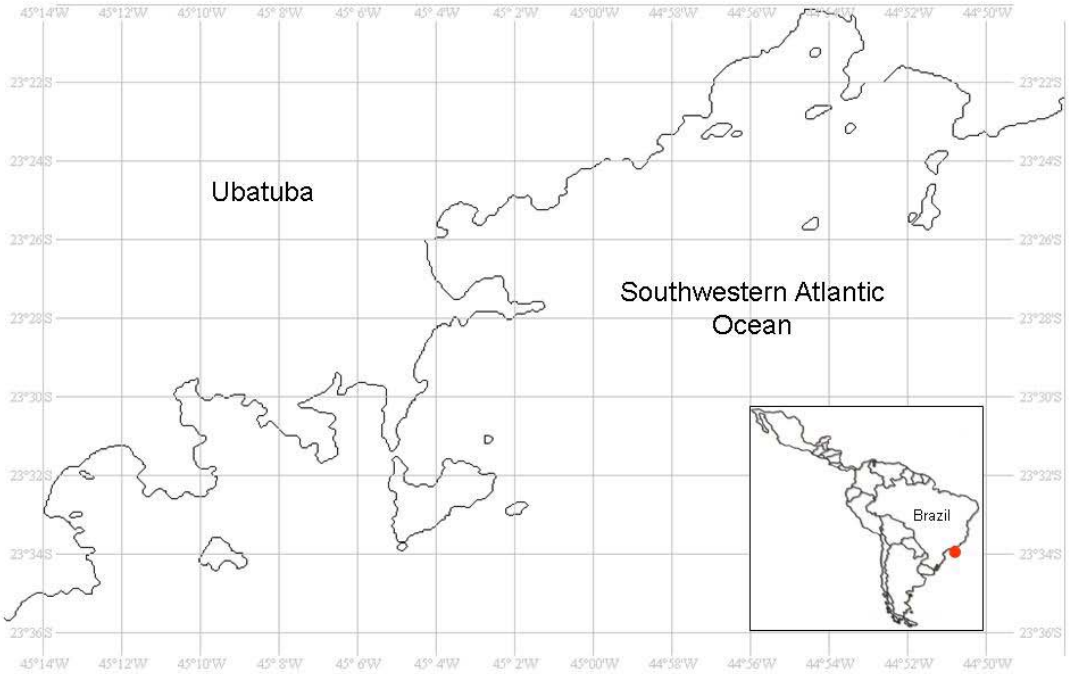


Figure 1 - Study area: Ubatuba, southeastern Brazilian shelf.

Hence, Ubatuba is characterized by intense fishing activity, mostly of small-scale. Local commercial fishing records date from 1910, and along decades fishing became a major source of income of the municipality. Signs of overfishing and declining of fisheries yields were already noted in the 1970s (Diegues 1974). Moreover, the area has been the scene of many conflicts, past and present, with regard to the use of natural resources. Nowadays, the study area is inserted in a recently created type of marine protected area which management plan is still under development.

The Adapted Delphi Methodology

The procedure was based on the Delphi Technique which seeks expert's consensus in a particular subject, through several rounds of interviews (Linstone and Turoff 1975; Zuboy 1980; Barrett 2009), on the assumption that combining the knowledge of several experienced fishers can provide more accurate results. All respondents were kept anonymous to avoid the influence of opinions and/or conflicts between informants.

Selecting experts
In order to access reliable and valid data from FEK, it is essential to identify the most qualified and experienced fishers to be responding the questionnaires (Moreno et al. 2007).

Initially, during April-July 2009, a pilot phase included visits along the major landing sites and fishing communities of Ubatuba, when 109 fishers were interviewed, following semi-structured questionnaires under a "snowball" procedure. Each interviewed fisher himself indicates the next interviewees (Scholz et al. 2004; Silvano and Begossi 2010).

Further, we selected a total of 40 key fishers after reaching specific criteria, as being:

1) Experience in fisheries;
2) Age 40 or older;
3) Working regime on fishing;
4) Willingness to participate.

The definition of the criteria was based on Bergmann et al. (2005) and Silvano (2006).

Seeking consensus
We invited the key fishers to participate in two sequential rounds of semi-structured interviews. The undertaken sequence is described as follows:

- First round of interviews: application of questionnaires for the selected 40 key fishers concerning spatial and temporal issues related to the small-scale fisheries. It was run during August-December 2009, along 11 fishing communities and 3 main landing sites.
- Results were tabulated and presented to the key fishers.
- Second round of interviews: the interviewees could review their past contributions, according to new total data. This second round of consultations occurred during February-March 2010.
- Data analyses: identification of the levels of consensus.
- Presentation of the final findings to the key fishers.

We considered that each specific information showed a reliable rate of consensus when more than 50% of key fishers referred to it during the 2 rounds of interviews.

Addressed issues
The issues addressed in the questionnaires included: catch areas and seasons of occurrence of spawning stocks and recruits, location of fishing grounds, bycatch species and suggestions for local fishery management and regulations.

In order to demarcate spatial data, we used maps where fishers could locate their fishing spots and the areas of concentration of "females with eggs" (spawners) and "juveniles" (recruits) of their main target species.

Results

The selection of "experts" allowed us to access the oldest knowledgeable fishers in the communities and landing sites. Thus, 76% of the interviewees selected aged more then 45 years and presented at least 30 years at fisheries in the study area.

Data provided by key fishers allowed the identification of:
(1) Spatial and seasonal occurrence of mature females and recruits of commercial species; (2) Fishing grounds (3) bycatch species; (4) suggestions for local fisheries management (e.g. mesh and size of gillnets, closure seasons, gears restriction by fishing area) (Figure 2).

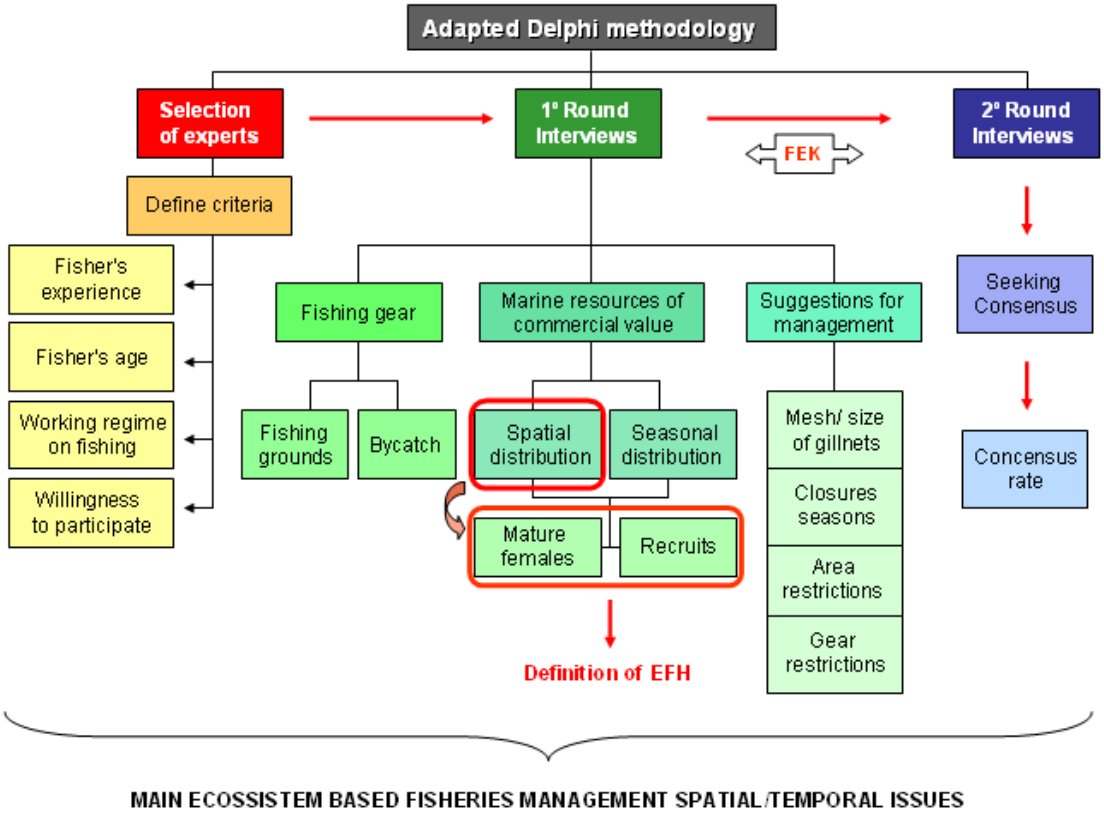


Figure 2 - Summary of the stages addressed during the process of accessing FEK/LEK as a practical tool for ecosystem-based fisheries management in Southeastern Brazil.

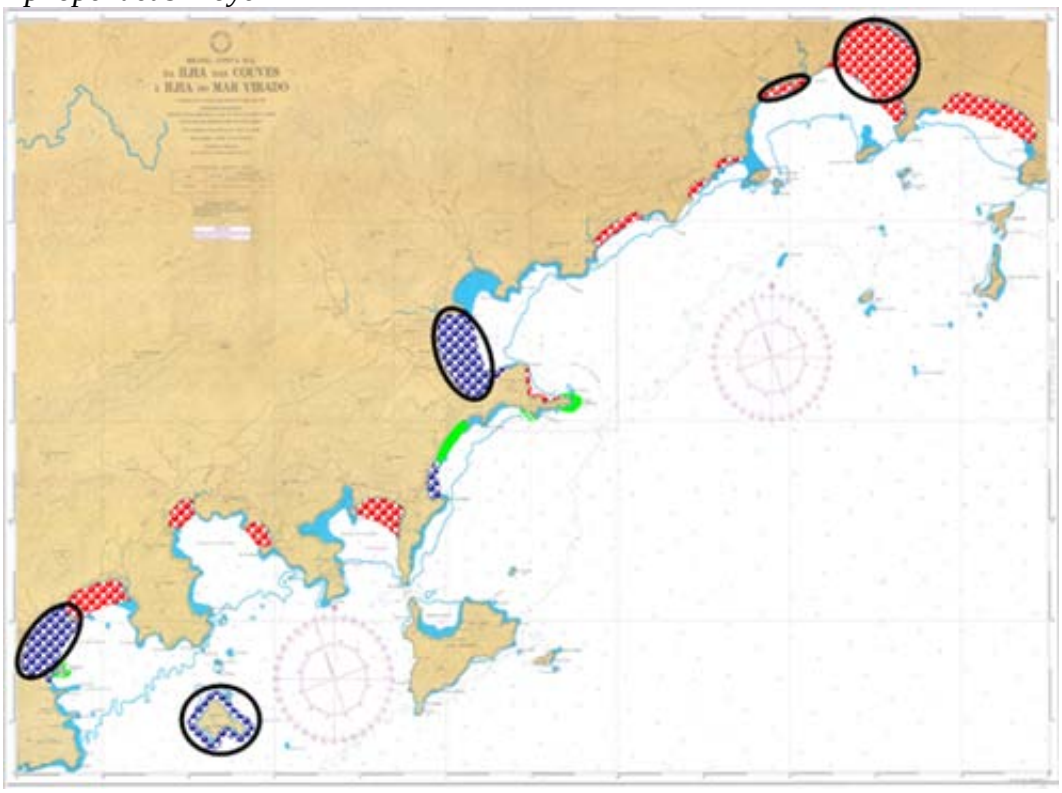
Commercial species ecological data

Specific output on spatial and temporal issues are illustrated for three different fishery stocks: the seabob-shrimp *Xiphopenaeus kroyeri*, the croaker *Micropogonias furnieri* and the inshore squid *Loligo spp*.

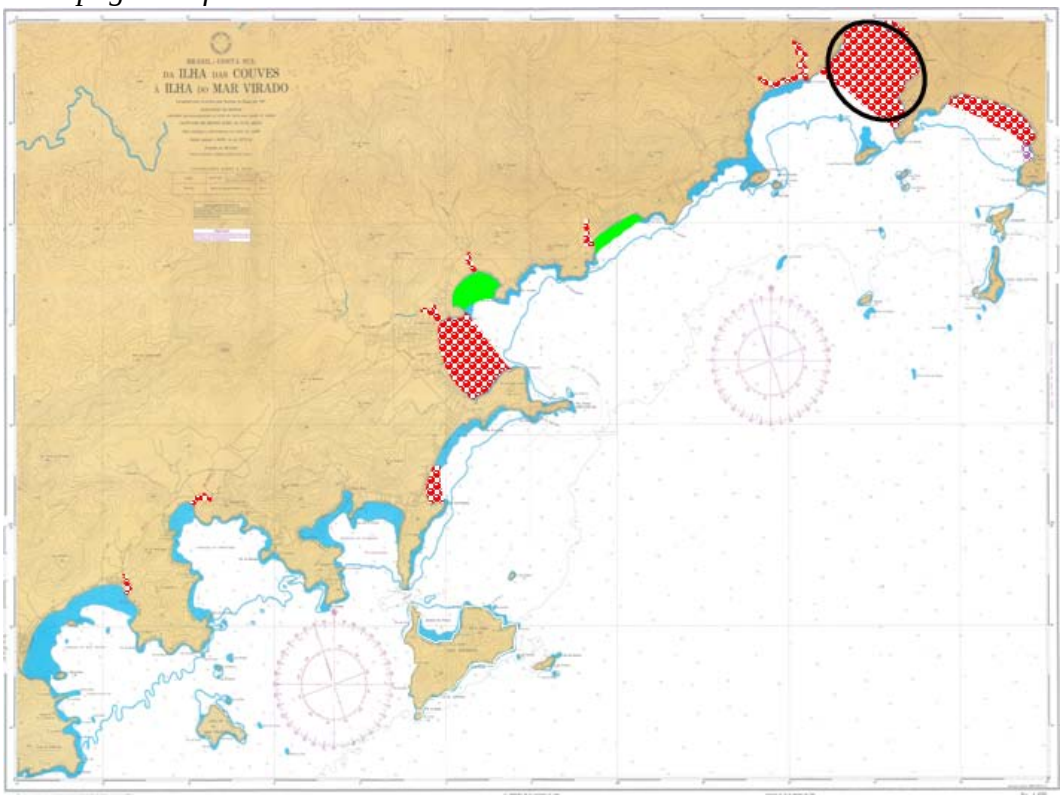
After the whole process, the construction of maps with spatial data (Figure 3) and graphics with seasonal data (Figure 4) were possible, as based on selected FEK in respect to the occurrence of spawners and recruits.

The areas cited by more than 50% of the key fishers were considered as potential EFH.

a) *Xiphopenaeus kroyeri*



b) *Micropogonias furnieri*



c) *Loligo* spp.

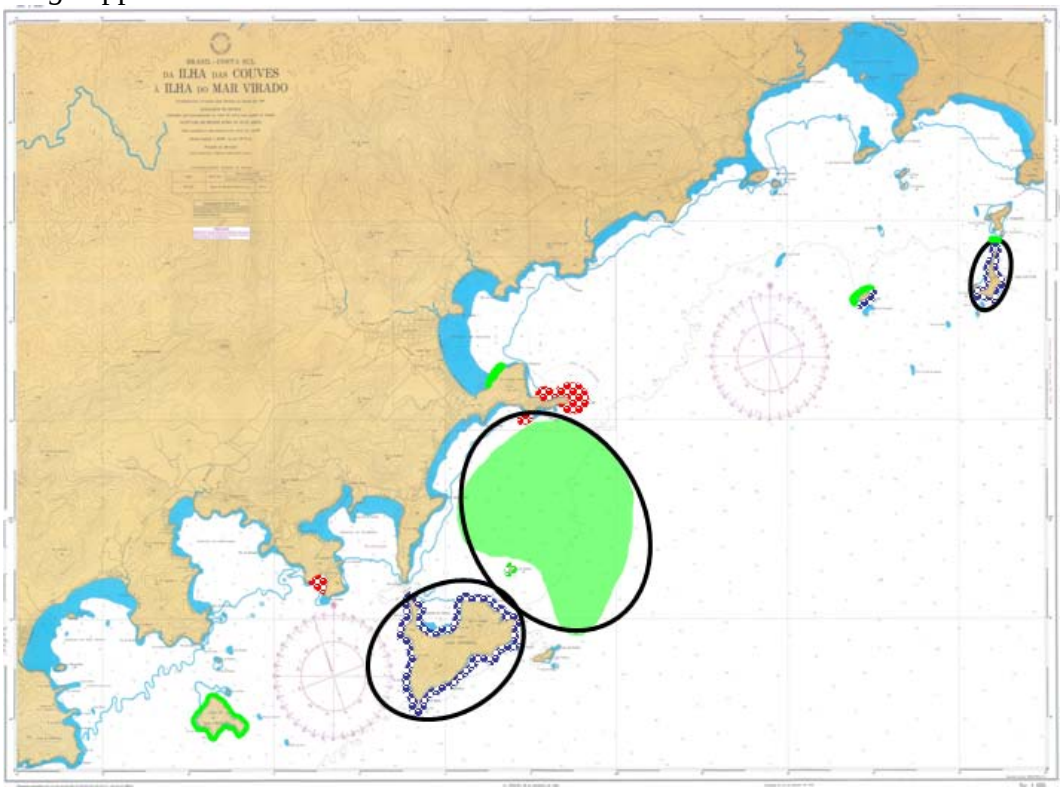
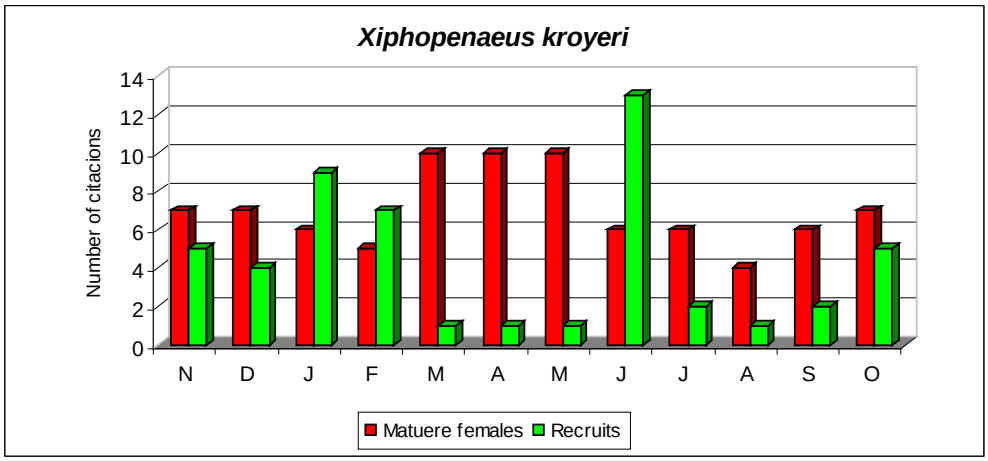
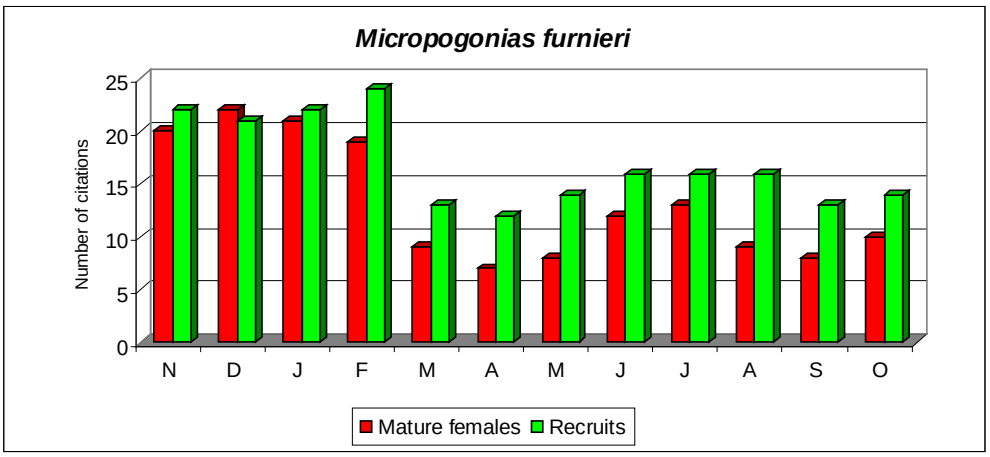


Figure 3 – Area of occurrence of mature females (in red), recruits (in green), and both, (in blue) of: a) *Xiphopenaeus kroyeri*, b) *Micropogonias furnieri* and c) *Loligo* spp., as indicated by the fishers. The circulated areas are those cited by more than 50% of interviewees.

d) *Xiphopenaeus kroyeri*



e) *Micropogonias furnieri*



f) *Loligo* spp.

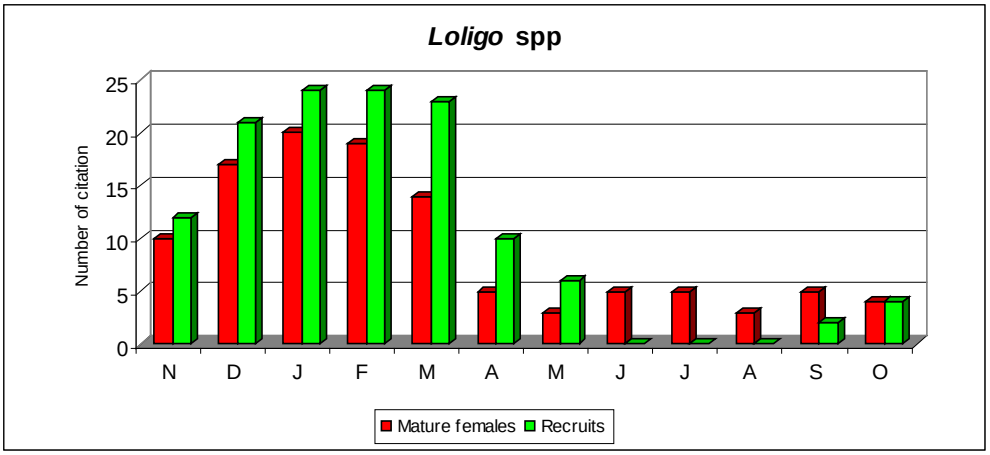


Figure 4 – Seasonality of the spawning stock and recruitment: citation of the monthly occurrence of mature females (in red) and recruits (in green) of: d) *Xiphopenaeus kroyeri*, e) *Micropogonias furnieri and* f) *Loligo* spp.

Regarding seasonality, it was possible to identify significant rate of consensus for the occurrence of: 1) recruitment of *Xiphopenaeus kroyeri* in January and June, and occurrence of mature females, from March-May; 2) mature females of *Micropogonias*

furnieri from November to February, and recruits mostly from June to August; 3) mature females and recruits of *Loligo* spp. from December-March.

The former requires special attention, once there may be particular influence of fisher's economic interests in pointing this period to avoid fishing bans during summer holidays (December to February). March-May is the actual "closure season" of the fishery for *Xiphopenaeus kroyeri*, which seems to not affect local sales in this most important period of profitability.

We found compatibility between the data transmitted by key fishers and previous scientific surveys for the seasonal occurrence for mature females and recruits of the shrimp *Xiphopenaeus kroyeri* (Natividade 2006; Silva et al. 2007), the croaker *Micropogonias furnieri* (Vazzoler 1971a, 1989b; Costa and Araújo 2003) and the squid *Loligo* spp (Rodrigues and Gasalla 2008; Postuma and Gasalla 2010).

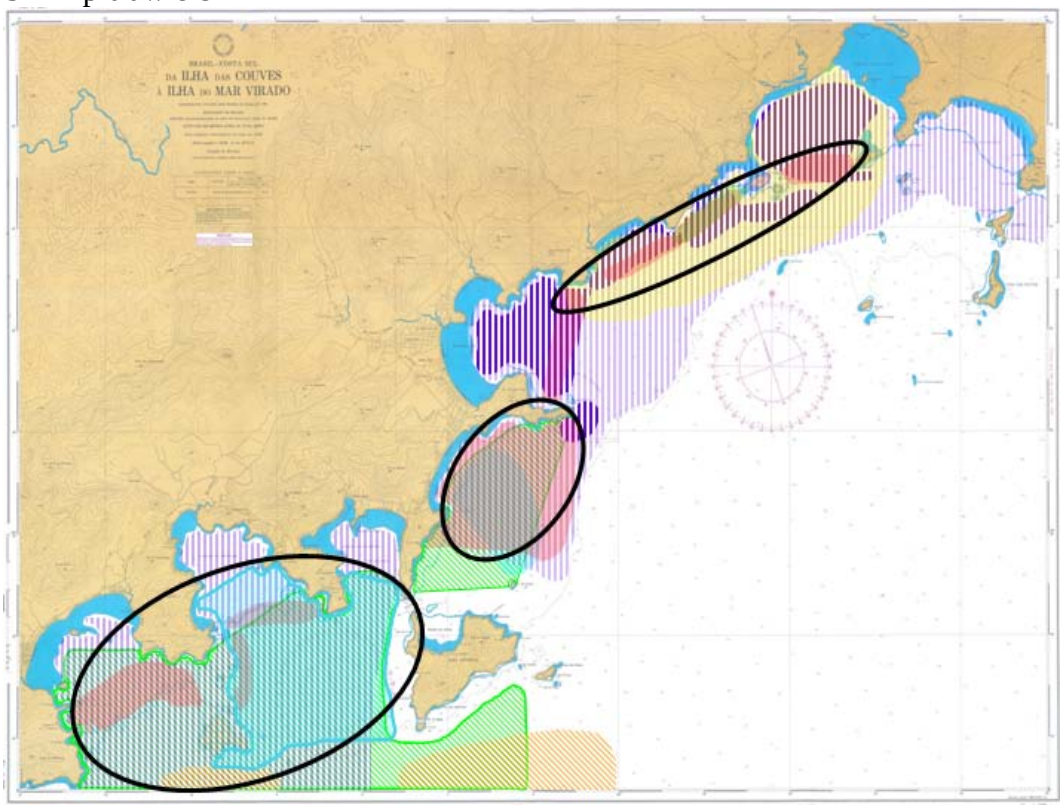
Fishing gear features

The questions aimed to the fishing gears of the species here addressed were: 1) fishing grounds, 2) bycatch species, and 3) management suggestions (Table 2). The former allowed the construction of general maps (Figure 4).

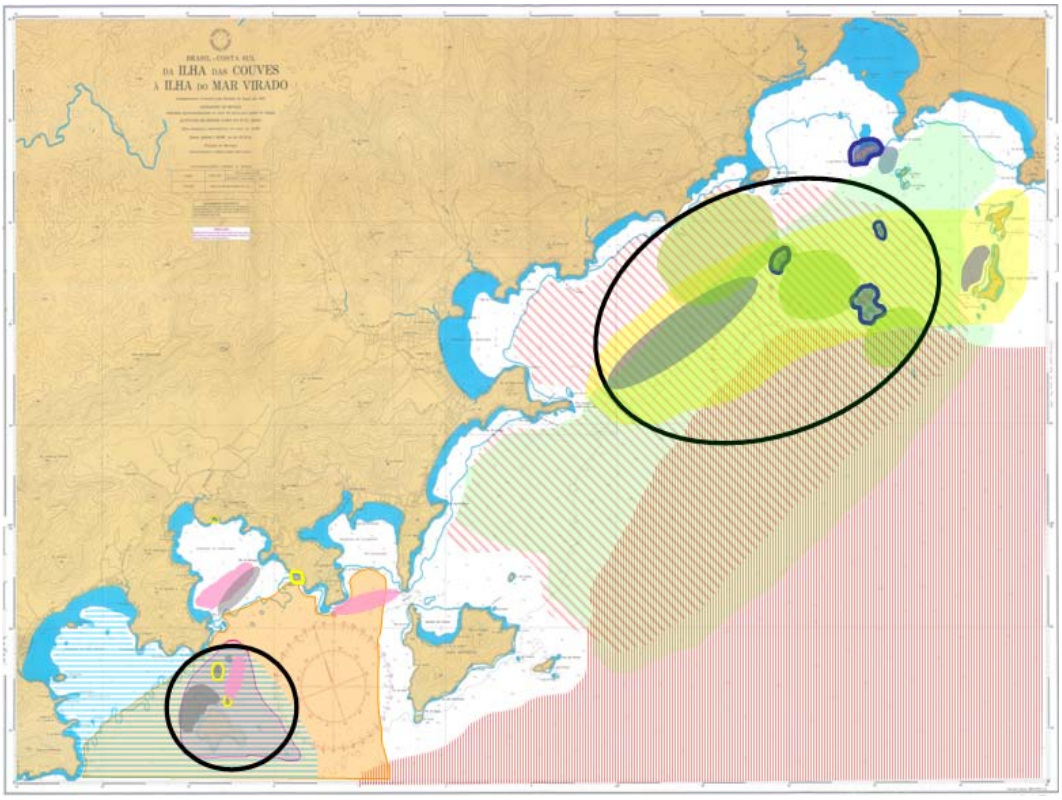
Table 2 – Summary of information on the fishing gears for the addressed stocks: 1) target species; 2) number of bycatch species and number of those that presented more the 50% of citations; 3) number of fishing grounds pointed out on maps by the key fishers, and those cited by more than 50% of the interviewees; 4) number of management suggestions for each fishing gear and number of suggestions cited by more then 50% of interviewees.

Fishing gear	**Target species**	**Bycatch species**		**Fishing grounds**		**Management suggestions**	
		Nº	>50%	Nº	>50%	Nº	>50%
Shrimp-trawlers	*Xiphopenaeus kroyeri*	46	11	9	3	4	2
Gillnets	*Micropogonias furnieri*	17	6	16	2	7	5
Hand jigs	*Loligo* spp.	0	0	17	6	0	0

a) Shrimp-trawlers



b) Gillnets



c) Hand jigs

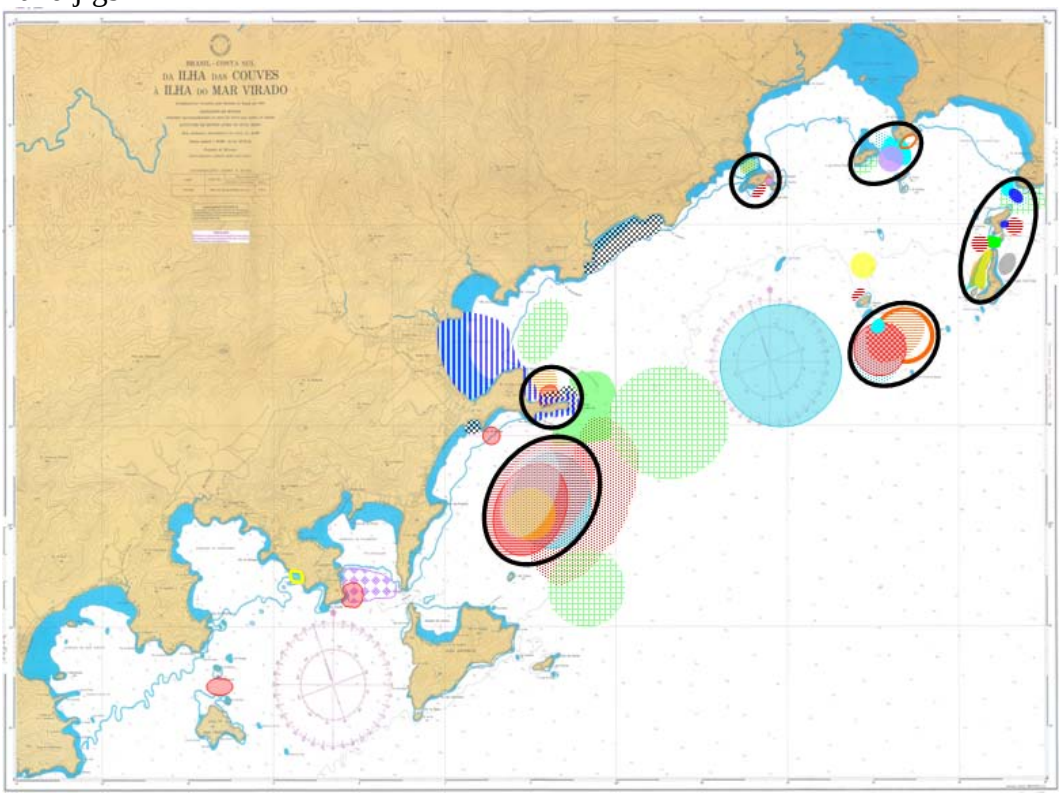


Figure 5 - Maps of the total area of operation of: a) shrimp-trawlers, b) gillnets, and c) hand jigs. Each color refers to the area of each fisher. The most significantly cited areas, (by more than 50% of fishers), are circulated.

Discussion

We found the described methodology as a transparent, consensual and useful tool to assess FEK and for their inclusion in EBFM, once it allowed not only the identification of the most experienced fishers in the area, but also to find consensus in the information transmitted.

The identification of resources temporal and spatial distribution, including EFH, is of great value for EBFM and for planning MPA management (Bergmann et al. 2004a, 2005b). Besides, mapping the most important fishing grounds and bycatch species will allow effective measures for the conservation of resources, and, simultaneously, may ensure specific rights for fishers themselves.

Another important point relies on fisher's suggestions for local fisheries management, since identifying measures which are both accepted by fishermen and scientifically valid, is of utmost relevance for the planning of fisheries management based on the ecosystem and its success (Himes 2003; Bundy et al. 2008; Lawson et al 2008).

Additionally, the incorporation of LEK/FEK and fishers participation in management plans are also important in order to decentralize government and institutional power, reduce conflicts between fishers and governmental institutions, promote community development and support for required enforcements ensuring the representativeness of these actors in public policy (Begossi 2008). The possible forms of participation range

from government consultations to these actors, constitution of advisory councils, and reciprocal cooperation in planning and supervision (Berkes 2006).

Nevertheless, some considerations should be made. According to Brook and McLachlan (2005), the personality of the interviewer, the level of familiarity with the interviewees, the approach and the method used, fundamentally influence the study results and the nature of the responses in LEK studies. In that way, along the steps outlined, we noted that the bonds narrowed, allowing greater reliability in the data provided by the fishers, since this empirical knowledge is not disseminated quickly and accessed at once (Drew 2005).

The approach was quite delicate at the moment of the fieldwork due to a top-down implementation of a new São Paulo's marine protected area, which threatened fishing activities and was not based on fishing communities consultations. Obviously, fishers found themselves apprehensive and insecure about the possible consequences in their lifestyles and income. However, the increasing contact and respect developed during the application of the method here described allowed fishers to show greater confidence in transmitting their knowledge.

The Adapted Delphi Methodology seems a simple exercise to be employed, if some points are carefully considered in order to avoid failures in results reliability:

1. The researcher must demonstrate impartiality to the issues addressed, to exclude the possibility of imposing own views and preconceptions upon a subject;
2. The efficiency of the techniques of summarizing and presenting response after the rounds of interviews must be high;
3. Never ignore and not explore disagreements, what can lead to an artificial consensus;
4. Ensure to choose an appropriate and representative group of respondents, by selecting those that proved experience to contribute to the research.

Some constraints of the method include:

1. Doesn't allow fishers to undertake real-time discussion of different points of views and possible exchange of knowledge, since the interviews are applied individually and the respondents are kept anonymous.
2. When a fisher lacks a specific knowledge he, or she, can behave simply speculating, as some experienced fisher may not admit unknowing a particular question.
3. Fisher's own interest may influence the answers biasing obtained results (e.g. by not pointing out the "real" spawning season of a species if it occurs during holidays, to avoid future fishing closures during an important period of income);
4. A degree of subjectivity always remains due to the reasons outlined above

In summary, our critical considerations on the proposed method seem to be in accordance with what was previously found by other authors on the Delphi technique (Linstone and Turoff 1975; Zuboy 1980; Drew 2005; MacMillan and Marshall 2005).

Concluding remarks

The methodology proved to be useful for the identification of EFH and EBFM issues, by providing innovative input and guidelines for decision makers. However, it has to be emphasized that, as systems vary temporally and spatially, FEK studies needs to be frequently updated.

Fisher's ecological knowledge is indeed a necessary and irreplaceable data source for fisheries management under community-based schemes in Brazil and elsewhere, but especially in data poor environments. However, its approach and assessment is not simple or trivial, requiring effective and locally elaborated methods and communication skills (Gasalla and Diegues 2010).

We concluded that this methodology may be of great value for assessing the traditional, many-sided and valuable knowledge of fishers.

Acknowledgements:

We thank all the fishers from Ubatuba for their kindly contributions; the logistics staff of the Northern Research Station of the University of São Paulo Instituto Oceanográfico in Ubatuba, the University of São Paulo Graduate Program on Biological Oceanography, and the financial support of the Brazilian National Research Council (CNPq).

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