

Spatial distribution and identification of artisanal fishing areas in Alboran sea using GIS

Resumen.

Se analizan las posibilidades de aplicar técnicas SIG a datos de pesca artesanal, para construir cartografiado de áreas de pesca y caladeros de especies. Se incluyen comentarios sobre la utilidad de los resultados como ayuda para la gestión.

Summary.

In this paper we discuss the possibilities of applying GIS techniques to artisanal fisheries data, with the aim to propose fishing areas and species fishing grounds cartography. Some comments about the usefulness of the resulting maps are included.

Keywords: Alboran Sea, artisanal fleet, fishing grounds, GIS.

Geographical data location: Alboran Sea.

Temporal data location: 1987-1990.

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1. Input data.

Data correspond to a study about artisanal fisheries entitled "Small scale fisheries in the Spanish Southmediterranean region", carried out by the Centro Oceanográfico de Málaga between 1987 and 1990. During the project a big amount of data relative to fleets, gears, fishing ports, species, catches, efforts and fishing grounds were collected.

The GIS database used is composed for a big part of the information above-mentioned and a basic cartography of the area including contour lines and geographical references in the coastline (table 1).

Data about artisanal fleet that fish bivalves have not been considered, since its original processing was different than the rest of fleets. So, only data about ships that regularly use fixed nets (trammelnets, gillnets or combined nets), hooks (hand lines and long-lines) and beach seines have been used.

2. Methodology.

The sampling method was based on surveys to fishermen at ports and landing points on the coastline. To get information that was more accurate about the fleets and gears fishing areas and the fishing grounds of target species, also data from direct observation in vessels were obtained.

To situate the points over nautical maps, additional information relative to depth, type of bottom and proximity to known references on the coastline was used.

In the case of fishing areas were originally made filling a grid of 1x1 minutes with all the observations about the fishing situations recorded, taking into account both target and no-target species and all types of gears. Areas delimitation was created in function of several information relative to fished species, used gears, fleets incidence, depth, type of bottoms and fishermen's remarks. The tables associated contain information about species occurrence, range of depth and percentage of visiting fleets by type of gears. The geographical delimitation of fishing grounds was obtained through assembling points neighbouring among them and spatially isolated from others.

Maps were only created for target species fished by fixed nets and hooks: *Pagellus acarne*, *P. erythrinus*, *Pagrus pagrus*, *Mullus* spp. and *Sepia officinalis*. The associated information is relative to the fished species and the used gear.

In this way it was possible to delimit spatially the fishing areas of the fleets and the fishing grounds of the target species, obtaining two types of basic maps. To incorporate the information in a GIS format, original maps were digitized and tables with the associated characteristics of each feature were constructed (figure 1,2,3 and 4).

Data have been recorded in a Dbase format, using a set of relational tables containing the suitable information. It has not been necessary to make a more elaborate database since most of the information coming from existing maps with a scarce associated alphanumeric information. In that way all the relations between tables (link, join) have been made in Arcview, even the graphics production.

Database contains information in all the basic types integrated in a GIS format:

- Points: geographical references on the coastline, fishing ports or trawlers observations.
- Lines: depth contour lines, rivers, ...
- Polygons: fishing areas, fishing grounds, type of bottoms, ...
- Grid: density of trawler observations.
- Graphics: species and gears hotlinks.
- Other alphanumeric information: fleets description and census.

Nearly all the information in the maps is qualitative, since there are not data about catches or efforts (in number of days, for example) associated to the different areas. Although fishing areas size and location are approximates, the method, based in the reiteration of data in the same areas, allows to get a reliable vision of the fishing grounds spatial distribution, especially on a small scales.

3. Outputs.

Primarily, we can obtain two types of maps:

- Fleets fishing areas cartography. Figure 5.
- Target species fishing grounds cartography. Figure 6.

It is possible to obtain new cartography derived from the basic maps that help us to answer some questions in which underlies spatial components. So, it is very easy to produce a map containing the same fishing areas than in figure 1, classified in such a way that each one represents an indication of the estimated effort (in percentage of the total number of ships that habitually visit each area) by type of gear (figure 7). It can be observed that the highest concentration of ships take place in the central part of the area, appearing the lower activity at the western zone (figure 7a). Other results we can obtain are relative to the spatial distribution by type of gear (figures 7b, 7c and 7d).

In order to know the spatial overlapping between target species fishing grounds, interaction analysis, by means of intersection of adequate polygons, were made. In this case, it is possible to estimate which is the degree of spatial competition between gears, as a basis to examine hypothetical conflicts (figure 8).

Moreover, this analysis could provide a notion about the mono-especificity of the fishing grounds. The results obtained in maps can be quantified, and displayed by graphics as percentage of coincident fishing grounds as for gears as for target species (figure 9).

It is possible to relate in a layer information relative both the trawl fishery and the artisanal fishery (figure 10). Through direct observations of trawlers in the area, performed from helicopters, it can be obtained the spatial distribution of the trawlers in a density map form. This raster map can be overlapped with the artisanal fishing ground map, in order to analyse the competition degree between fisheries.

4. Remarks.

The aim of this work is to make use of existing information applying the GIS capabilities, to get new results dealing with spatial questions. Most of the information was originally recorded in maps and directly incorporate in a GIS software by digitizing. Afterwards, allowable data were associated to the GIS features. Therefore this project is just an example of how to obtain easily new information layers that can be used for determined proposes.

Hence, the results are very dependent from the previous information format and in no way the project can be considered as a model to management artisanal fisheries. In this last case, it must be necessary to design an appropriate relational database containing georeferenced data in a more adequate format, to produce better results about CPUE^{TS} spatial distribution.

Now we are concerned in the development of a new and more appropriated database that include information about catches, in order to obtain the catches per effort unit and information about the activity in several ports, so we can extrapolate our data to any period, because it is impossible to get data each day in each port. The new data model is in figure 11, on the one hand contains descriptive tables like species, ports, gears, etc. and in the other hand we have information about catches and fleet activity.

TYPE	ORIGIN	INFORMATION
BASIC CARTOGRAPHY	GEBCO	Bathimetry, coast lines
	IEO	Bathimetry, coast lines, geographical references, provinces
	IGN	Coast lines
SPECIFIC DATABASES	IEO	General fishing areas
		Fishing areas by gears
		Ports and landing points
		Species
		<i>Pagellus acarne</i> fishing grounds
		<i>Pagellus erythrinus</i> fishing grounds
		<i>Pagrus pagrus</i> fishing grounds
		<i>Mullus</i> spp. fishing grounds
		<i>Sepia officinalis</i> fishing grounds
		Other species
		Fleet characteristics
		Fleet census
		Fleet activity

Table 1. Artisanal project data.

PESQUERIAS ARTESANALES DEL
 MAR DE ALBORAN 1.987
 PROYECTO COOPERATIVO IEO/CEE

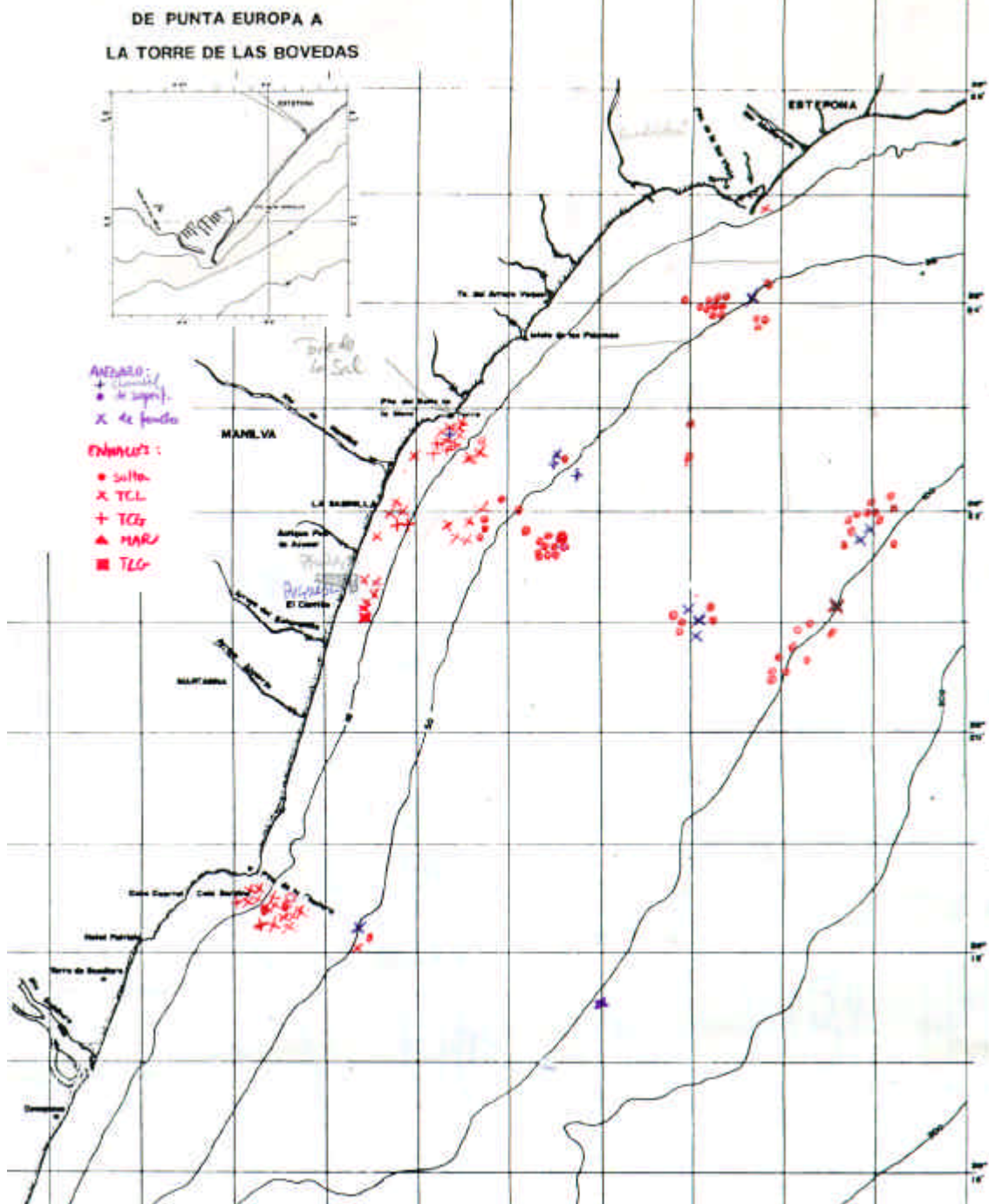


Figure 1. An example of some original data. In this case each point corresponds to the location of catches of *Pagellus acarne* with a particular gear.

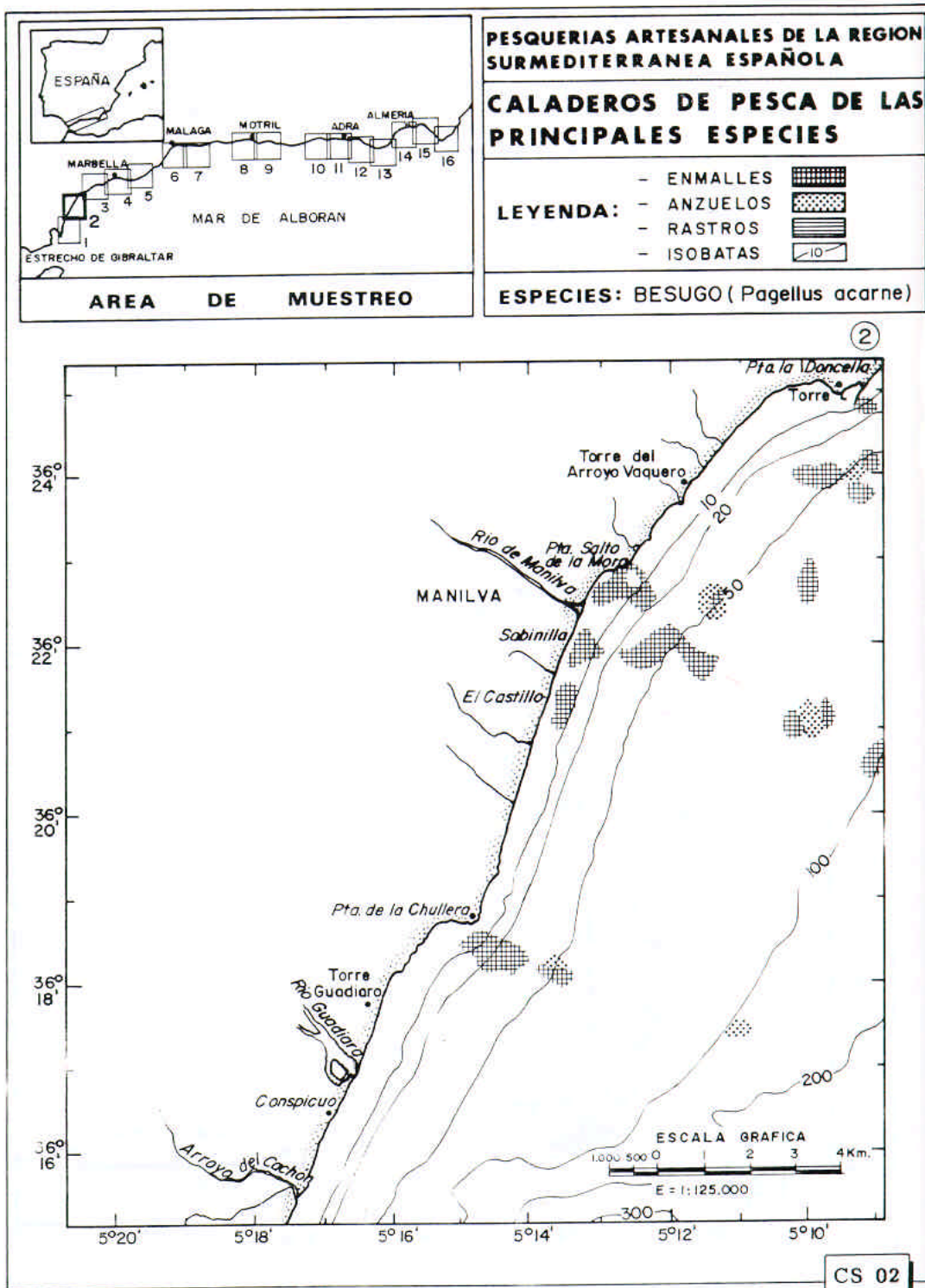


Figure 2. Original cartography of fishing grounds for *Pagellus acarne*.

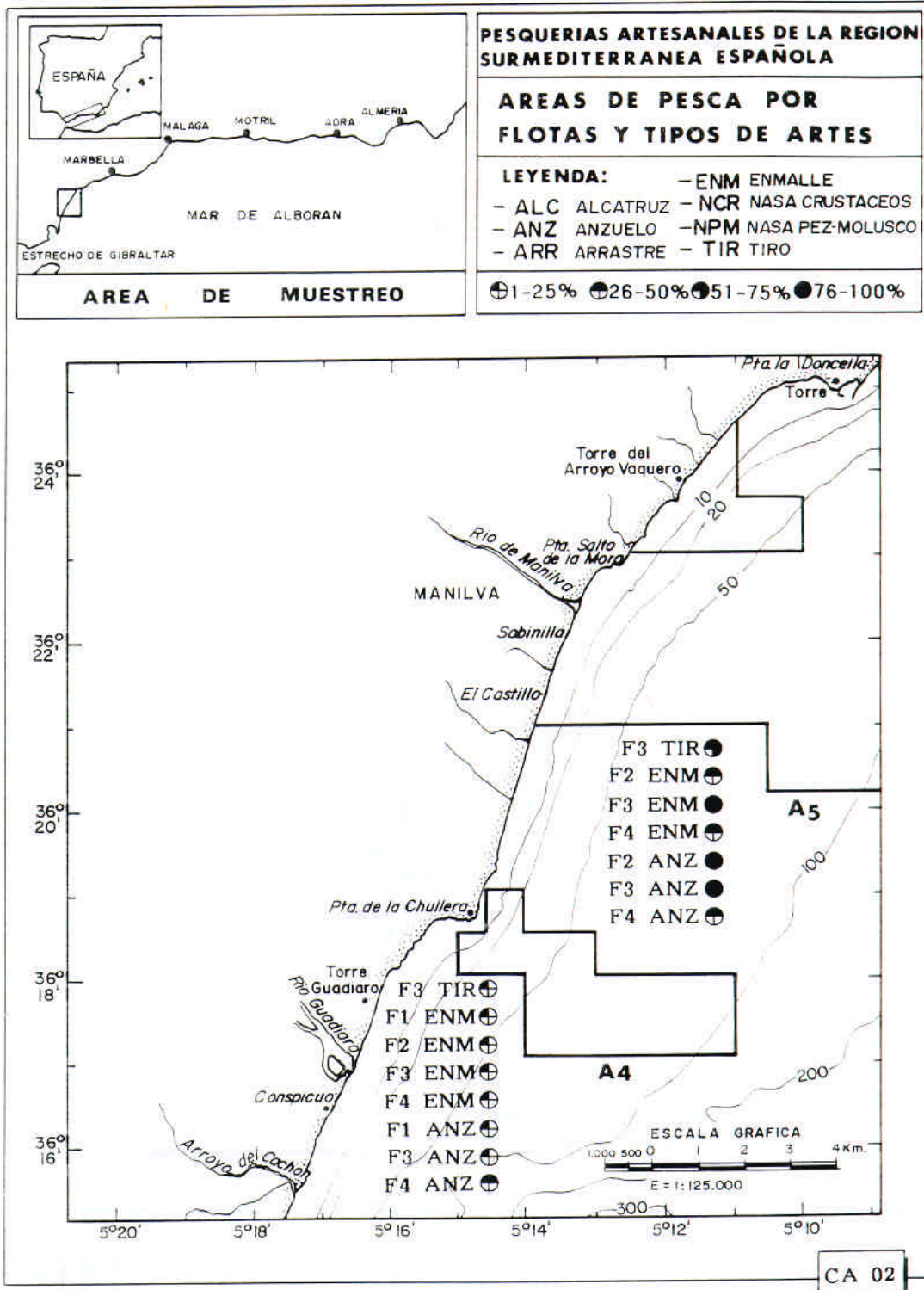


Figure 3. Original cartography of artisanal fishing areas.

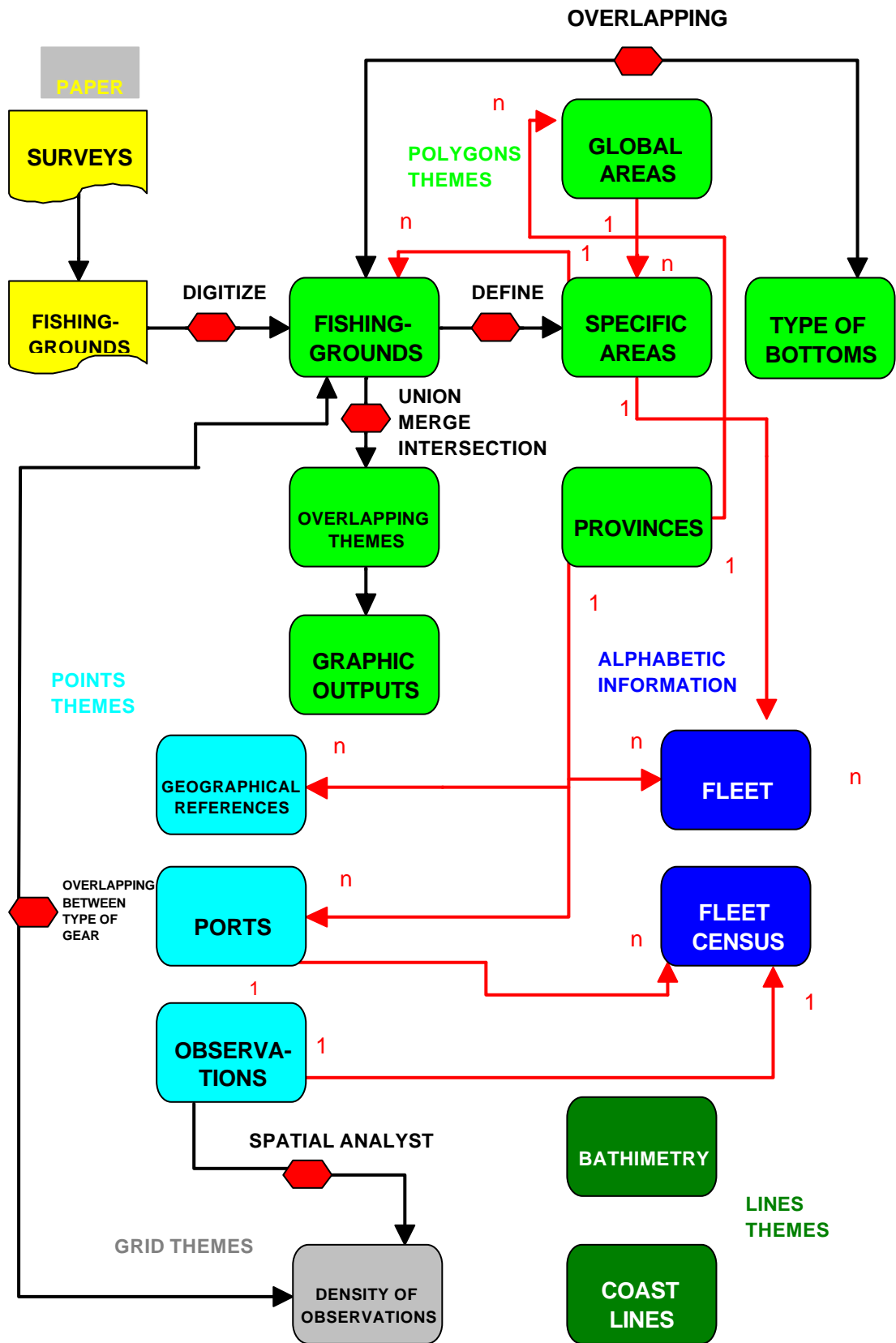


Figure 4. General data processing.

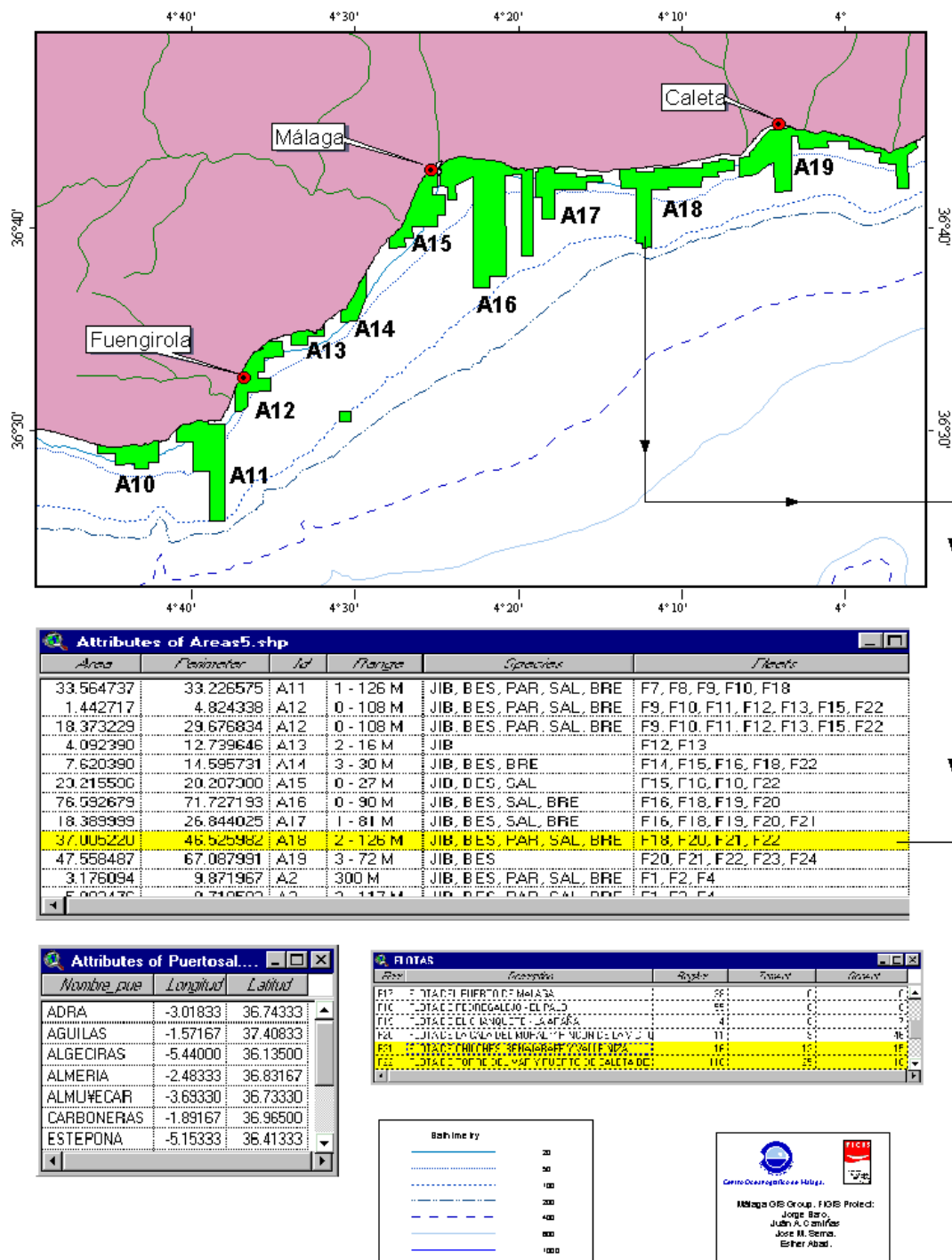


Figure 5. Cartography of fishing areas into the GIS system and their tables related.

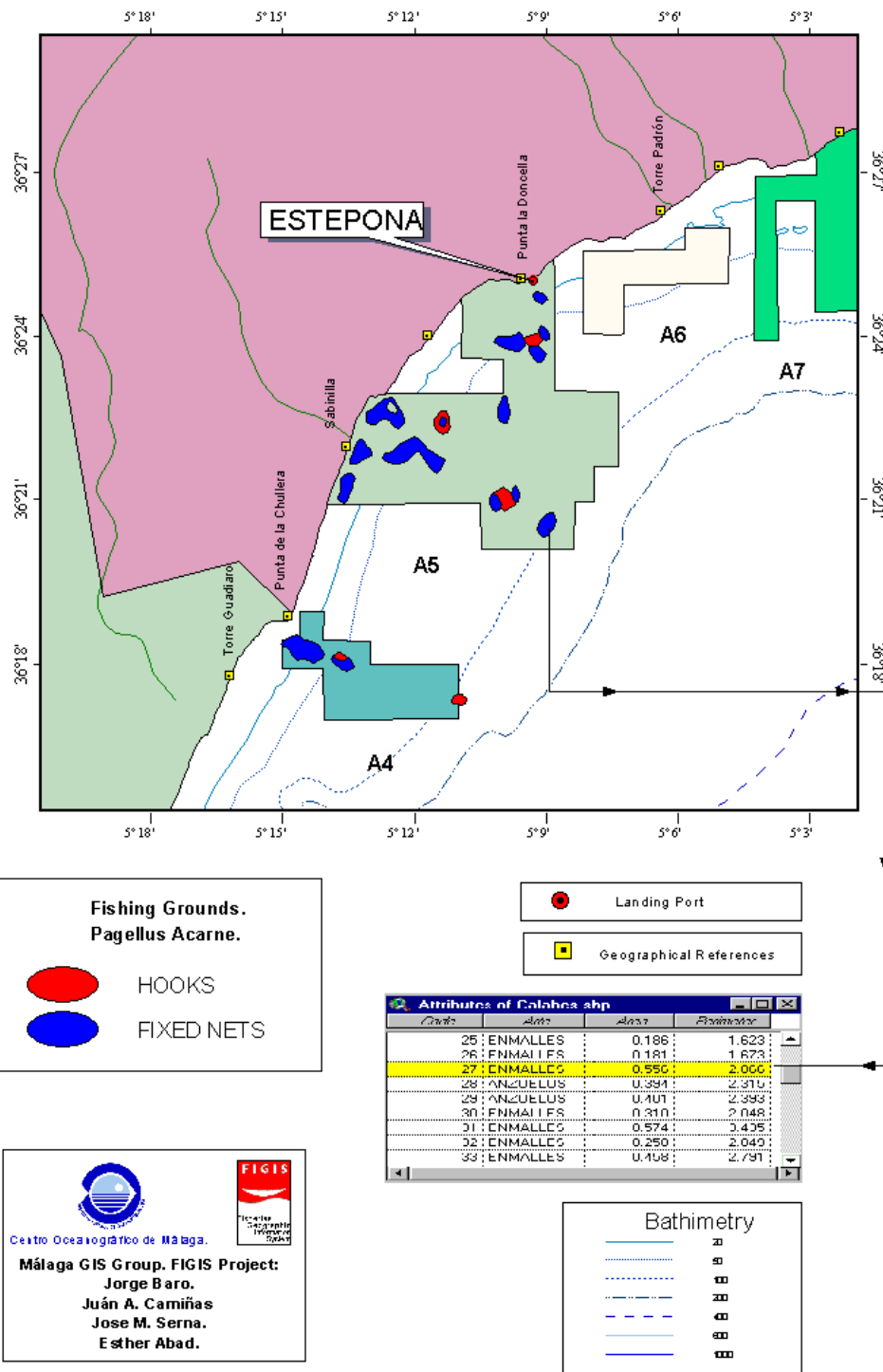


Figure 6. Target species fishing grounds, case for *Pagellus acarne*.

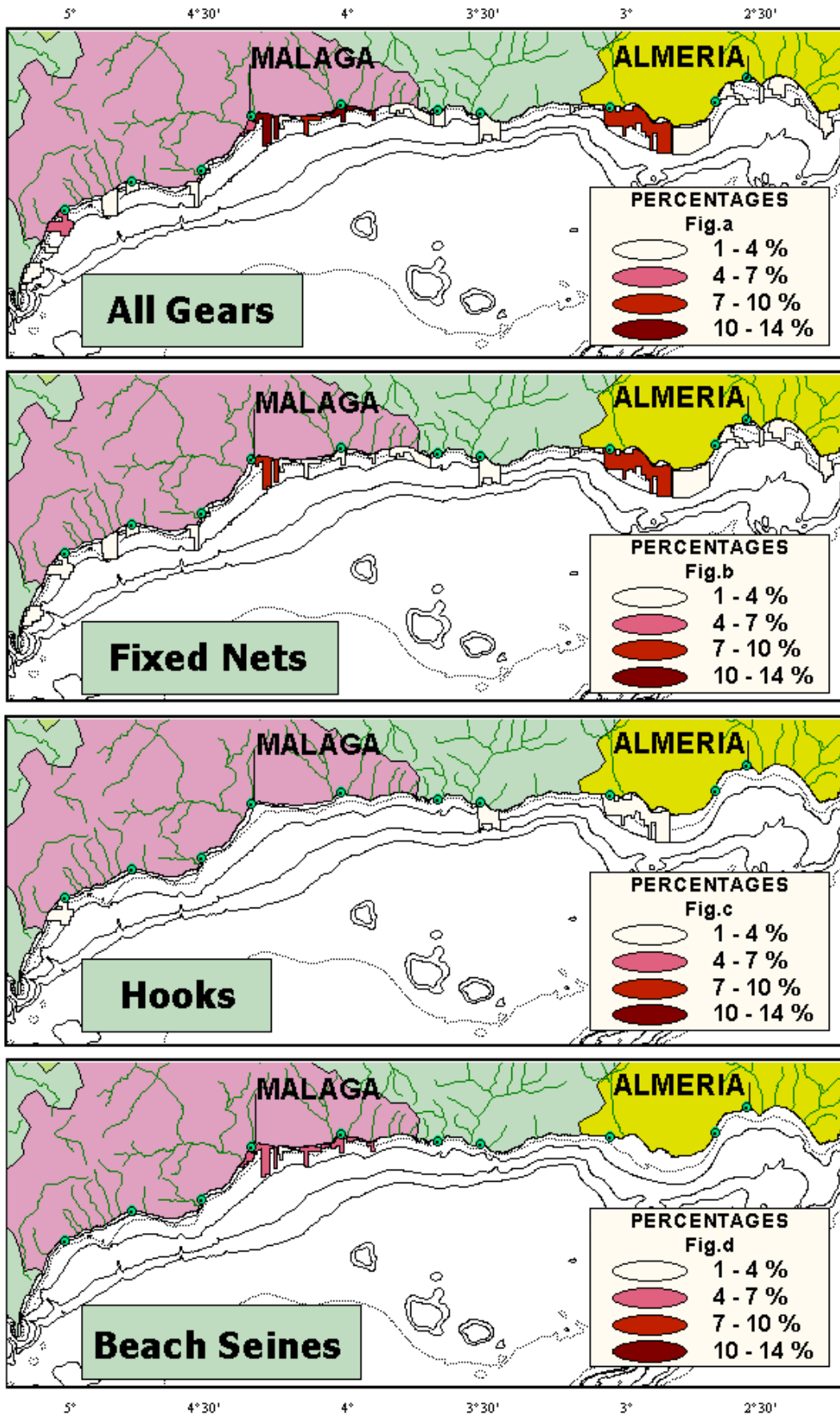
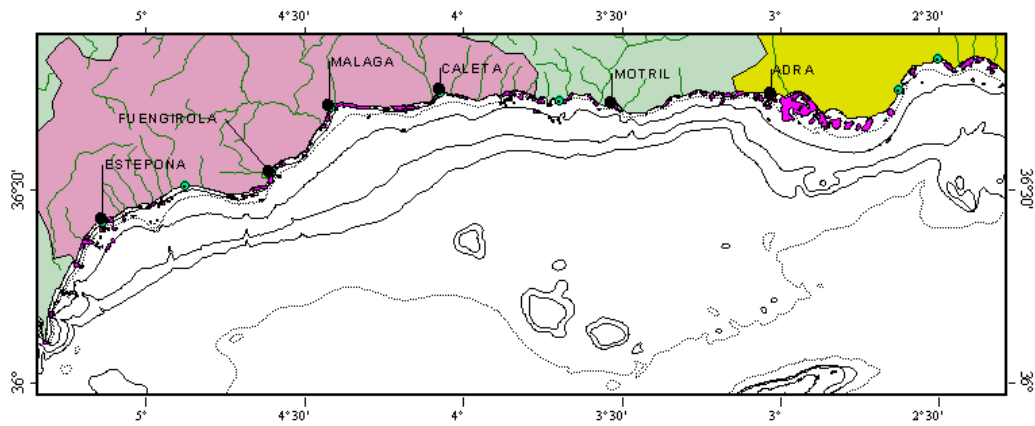


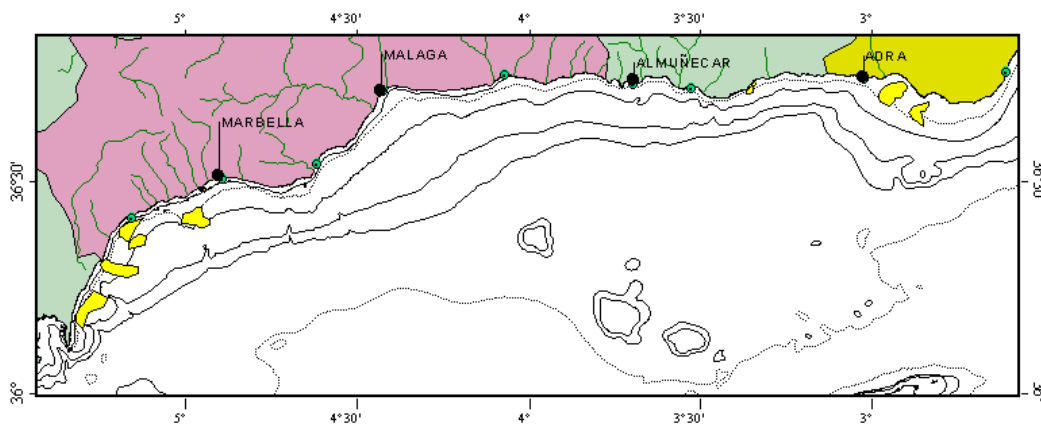
Figure 7. Fraction (in percentage) of the total number of ships, by type of gear, that habitually fish in each area.



Fixed Nets.

Target Species

Sepia officinalis
Pagellus acarne
Mullus spp
Pagellus erythrinus
Pagrus pagrus



Hooks.

Target Species

Pagellus acarne
Mullus spp
Pagellus erythrinus
Pagrus pagrus



Figure 8. Target species fishing grounds by type of gear.

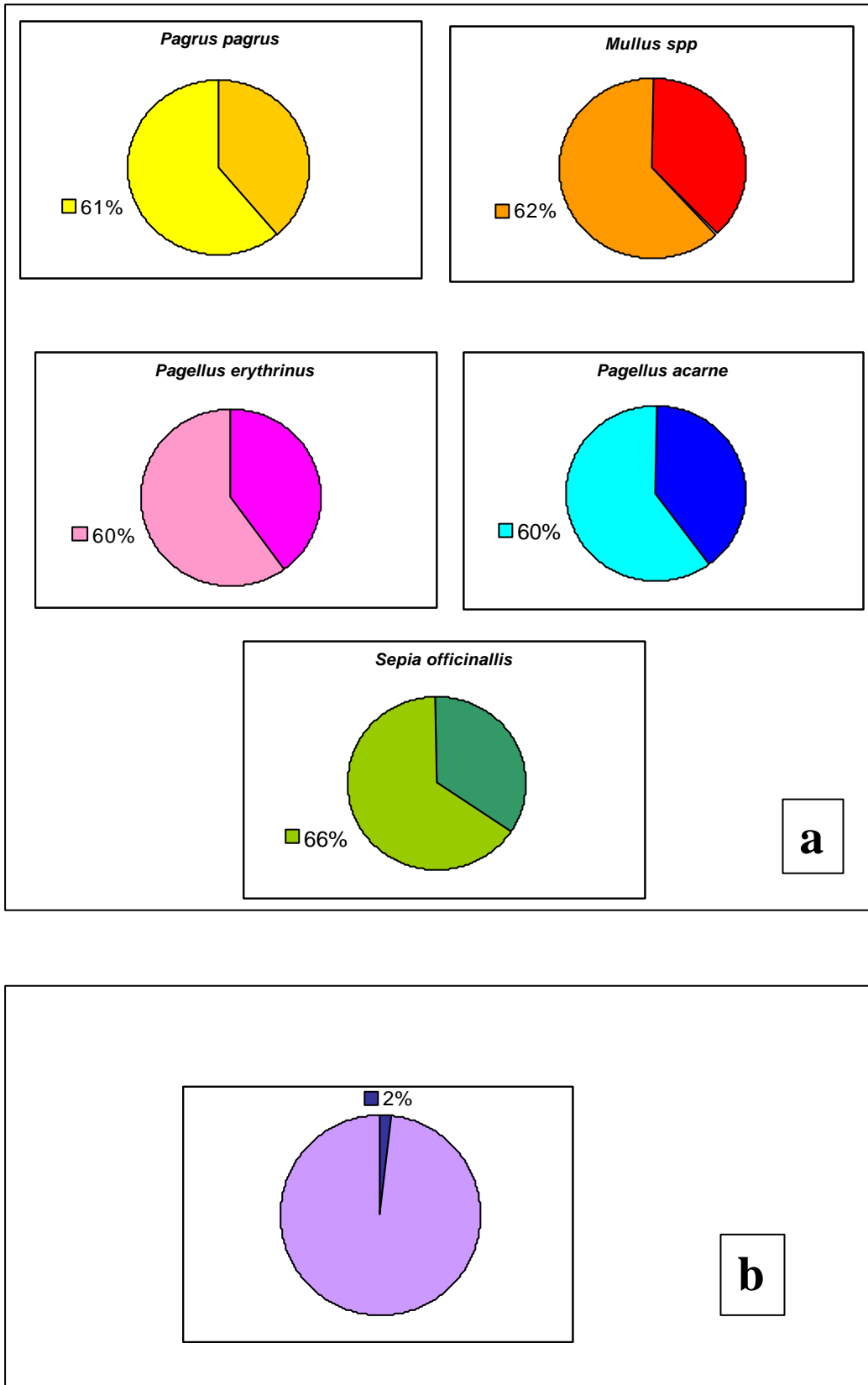


Figure 9a. Fraction (in percentage) of fishing grounds in which the target species and other target species coincide. **Figure 9b.** Spatial overlapping between fixed nets and hooks.

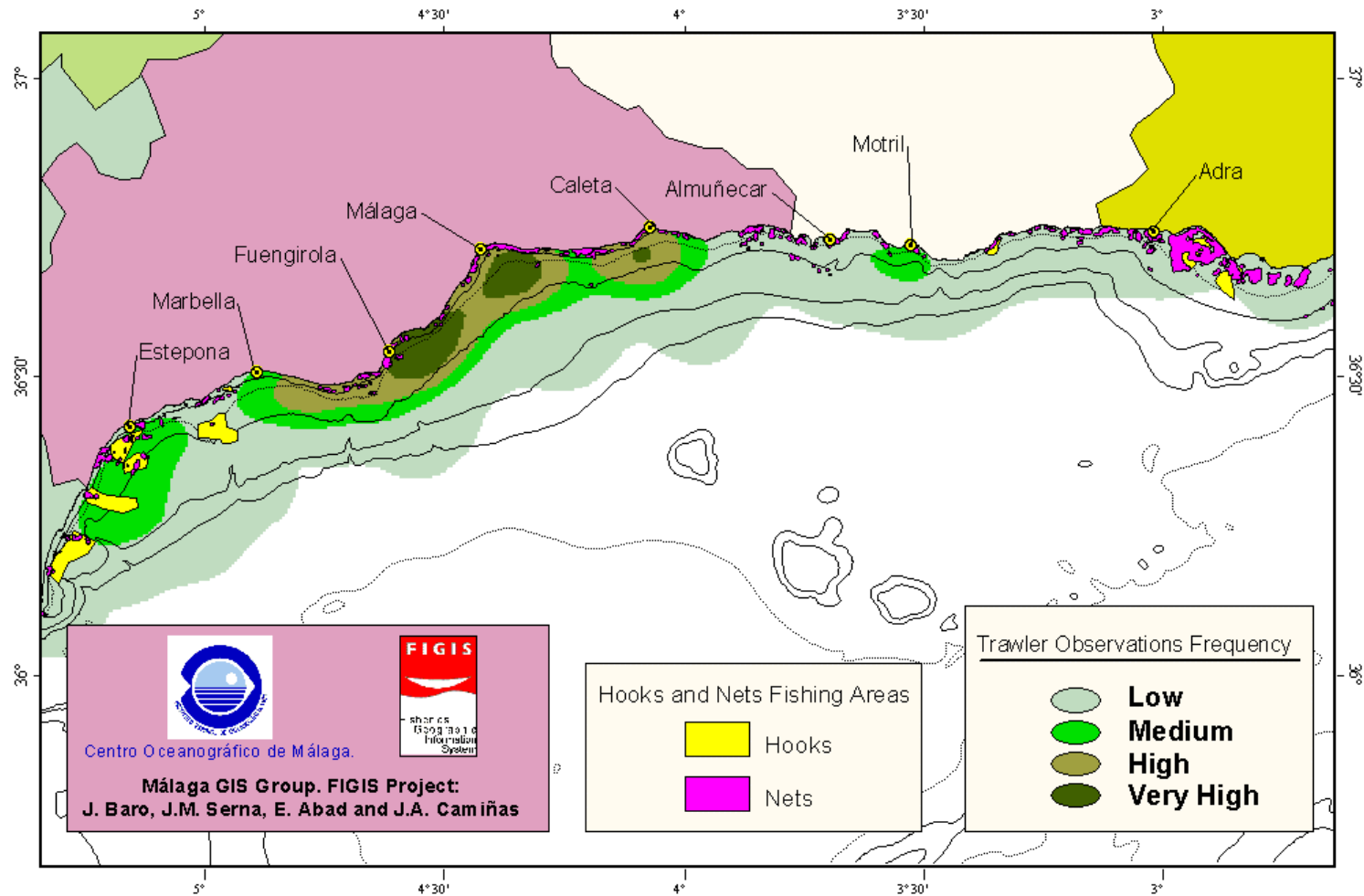


Figure 10. Spatial overlapping between trawl and artisanal fisheries..

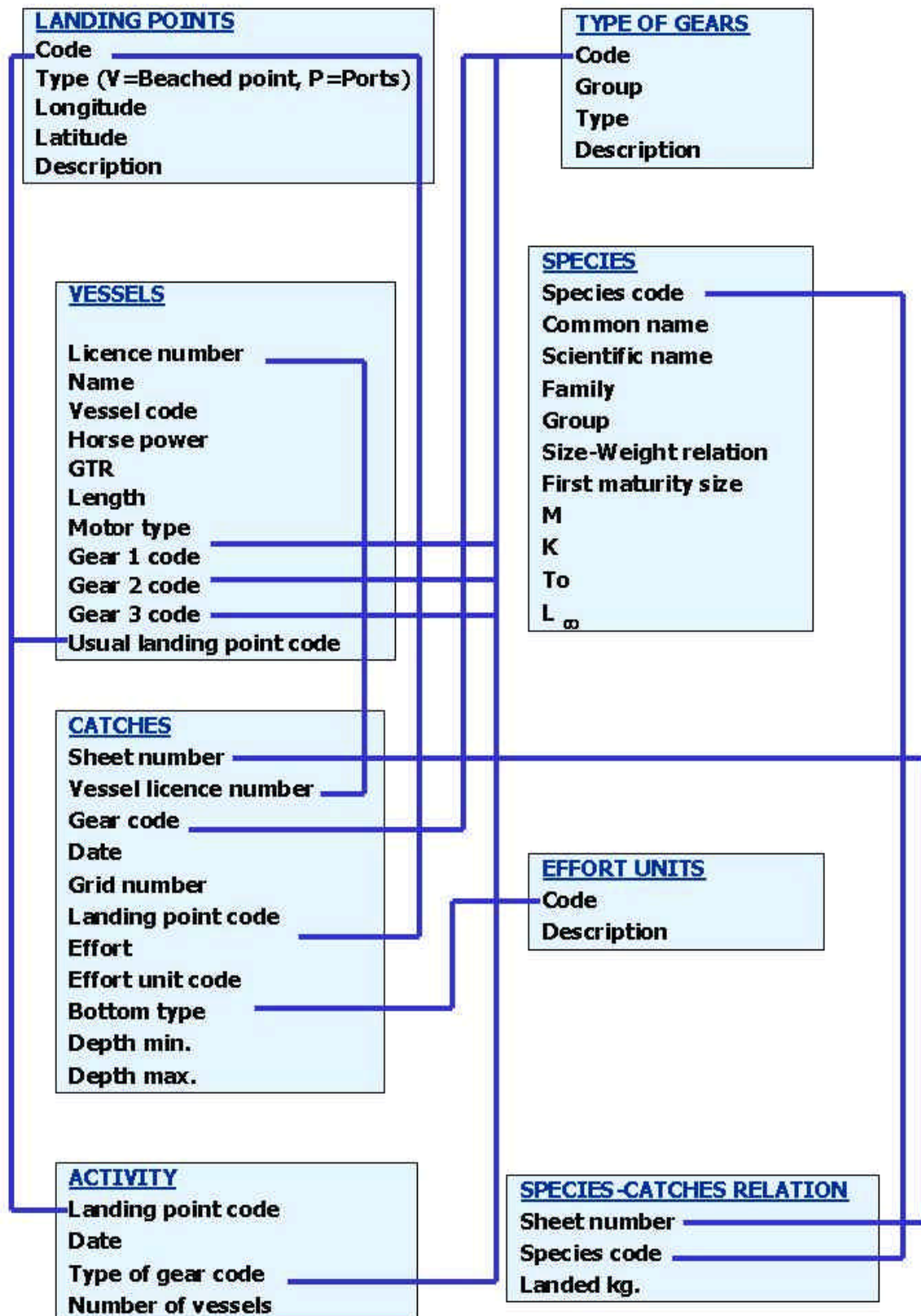


Figure 11. Database model created for the management of artisanal fisheries data, aimed to GIS use.