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# Analysis of the Vessel Monitoring System information to estimate the missing effort of the Spanish "voracera" fishery in the Strait of Gibraltar area.

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## 1. Introduction and fishery description

Since the earlies 1980´s an artisanal fishery targeting the Red seabream (*Pagellus bogaraveo*, namely "*voraz*") have been developing along the Strait of Gibraltar area. The "*voracera*", a local mechanized hook line baited with sardine, is the gear used by the fleet from Tarifa and Algeciras ports. Fishing is carried out taking advantage of the turnover of the tides in bottoms from 200 to 400 fathoms. Primarily, around 25 boats carried out the fishery in 1983 and the fleet has been increasing up to more than a hundred from the 1990´s. Nowadays 2011 authorized list includes 94 fishing boats.

One common variable used in fisheries assessment is the fishing effort estimates. Effort measures can consider several units, as in case of a hook fishery: number of fishing days, number of fishing sets, number of hooks deployed, etc. In our case, till now the effort unit available chosen was the number of sales as a fishing day's proxy. It is important to emphasize that it may be inappropriate as it fails to consider the missing effort when vessels had not caught enough fish to sell at public auction. Thus, in those years where missing effort increases substantially (fishing vessels with no catches and no sale sheet to be recorded) effort was under-estimated so CPUE values should be over-estimated.

The "*voracera*" fleet is eminent artisanal and the boats involved are smaller so no EU VMS by satellite is available. However, since 2004 the Andalucía Regional Government starts the installation of its own Vessel Monitoring System in smaller boats. This system called SLSEPA

("*Sistema de Localización y Seguimiento de Embarcaciones Pesqueras Andaluzas*") performs the on-line monitoring to preserve the safety at sea, control fishing activity and improve the monitoring and assessment of fisheries resources. Boats carry on a device, namely "green boxes" (to differentiate from the EU ones), that transmits to the control center information about their position, heading, speed, etc every three minutes. Data transmission uses the GPRS/GSM technology of cellular networks instead of satellite system.

This information analysis allows the determination of preferred fishing areas, steaming routes and fishing operations of the "*voracera*" fleet. So, as a first step real figures of fishing days are provided as well as the estimated number of hauls (fishing operations) per boat. Landings geographical situations could be draw linking the VMS data with its respective sales at landing port.

## 2. Material and methods

Information source

Data analysis comprises information from the "*voracera*" fleet of the Strait of Gibraltar along the years 2009 – 2011. First, the received information was preprocessed in the control center of the Department of Agriculture and Fisheries at the Andalucía Regional Government. Later, at the Oceanographic Center of Cadiz these data were integrated into an Ms Access database for its management and integration into a Geographic Information System (GIS).

Filtering process

Only records with switch off port signal and speed less than 4 knots were chosen, based on the assumption that this is the maximum speed of fishing operations and higher speeds should corresponds to boat displacements. Previous experiences from observers on board scheme backed up this assumption. Additionally, GIS tools let other data erasure, such as: entries and exits from main port zones (Algeciras, Tarifa, Barbate and Ceuta) and shallow locations (<30 m depth).

Then, data were labeled with the target species from the landings statistics database. So, fishing trips with Atlantic bluefin tuna (*Thunnus thynnus*) or Silver scabbardfish (*Lepidopus caudatus*) identify those trips done by the "*voracera*" fleet but with another fishing gear and in different fishing zones. Any record in the areas comprised by this two other fisheries without landings is discarded and ascribed to the Tuna or Silver scabbardfish fishing days.

At last, the remainder records are those which belong to fishing operations targeting Red seabream. This is the first step to the effort estimation in the Strait of Gibraltar.

Fishing days

Red seabream fishery fishing days (trips) is a straightaway result from the previous cleaning process. The total "*voracera*" fishing trips by year could be estimated comparing the "green boxes" CPUE and the total landings information.

Fishing operations estimates

Fishing operations (hauls) were disaggregated through an algorithm which incorporates fishery knowledge. Consecutive records (without speed breaks of more than 6 minutes interval) were grouped from a minimum of 15 minutes to a maximum of 60 minutes to consider it as a same haul. Estimated Number of hauls obtained were checked through a cross validation with the reported information from the observers on board of the "*voracera*" fleet program in 2009.

Spatial distribution

The fishing effort (number of hauls) spatial distribution was obtained splitting the study area into 1 square nautical miles cell grid and summarizing the number of fishing operations within each cell. A total daily landing per boat was proportionally distributed among its estimated fishing operations. Then, landings spatial distribution could be charted along the designed cell grid.

**3. Results and discussion**

Fishing activity has been determinate for the "voracera" boats. The activity is confined to a relatively small and so located area, the Strait of Gibraltar. 2009 – 2011 green boxes data provided by Andalucía Regional Government only includes records with speed lower than 5 knots (Figure 1). Gaps between situations are the consequence of high speed absences from intermediate steaming tracks. If this was not avoided, all the Strait of Gibraltar area was a "green dot".

Every year, boats speed was characterized by a mode at 1 knot (fishing state), because 0 - 0.3 knots values belongs to port scales (Figure 2). These distributions corroborate the boat behavior during a fishing haul, with low speed (but never stopped) to steer it against the strong currents of the Strait of Gibraltar.

Along the data filtering process those areas with different target species (Atlantic bluefin tuna or Silver scabbardfish) were excluded. So, Red seabream fishing grounds defined were quite contiguous and characterized by smaller patches (Figure 3). These positions coincide with traditional red seabream fishing zones previously described by Gil and Sobrino in 2006.

Fishing activity has been determined for “voracera” fleet targeting Red seabream. Figure 4 represents the final fishing grounds obtained from 2009 to 2011. In 2011, certain boats moved to a far fishing area. This so western area is also frequented by other fleet component from Conil which fish with different gear (longlines).

The Red seabream fishing effort in terms of number of fishing days per boat (fishing trips) could be obtained from the filtered records. Table I shows summary information from the VMS analysis, including several fishing effort estimates for the 2009 – 2011 period. Also information from sale sheets (landings and sale days) is provided, as well as other CPUEs for the whole landings.

Finally, Figures 5 and 6 shows the output of the analysis aimed to evaluate the effect of the application of the proposed disaggregation method to estimate the number of hauls. Each map and each year contains cells with the assigned numbers of hauls, presenting the spatial distribution of fishing effort in terms of the number of estimated hauls grouped into 1 square nautical miles cell. While, Figure 6 shows the spatial distribution of its corresponding assigned landings. Relationships between the total fishing area and the cumulative activity in certain areas demonstrated that most fishing activity took place in a small proportion of the total fished area along the study period. The spatial distribution of the CPUE (kilos/haul) by quarter in the intermediate year (2010) appears in Figure 7. Patches distribution is common along the year but the westerns fishing grounds were visited after the first quarter, when weather conditions are milder. Daily fishing grounds choice depends on weather conditions (East or Western winds), tidal coefficient, yesterday or previous landings and, obviously, skipper opinion.

**4. Main conclusions**

Even it could be good enough for the estimation of fishing effort: “A picture is worth than a thousand words” is a very relevant saying in the case of link geo referenced boats fishing activities and its landings. The main problem found using blue boxes data is the large time interval between datasets (2 hours). Far from it, green boxes send data every three minutes that is a proper interval even for artisanal fleets like the “*voracera*”. Results obtained seem to be more suitable with the fishery reality. As guessed, the missing effort increases when the resource levels decrease.

**Acknowledgments**

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**References**

GIL, J. and I. SOBRINO, 2006. La pesquería del voraz en el estrecho de Gibraltar. In: Acuicultura, pesca y marisqueo en el Golfo de Cádiz. Consejería de Agricultura y Pesca. Junta de Andalucía. CD rom.

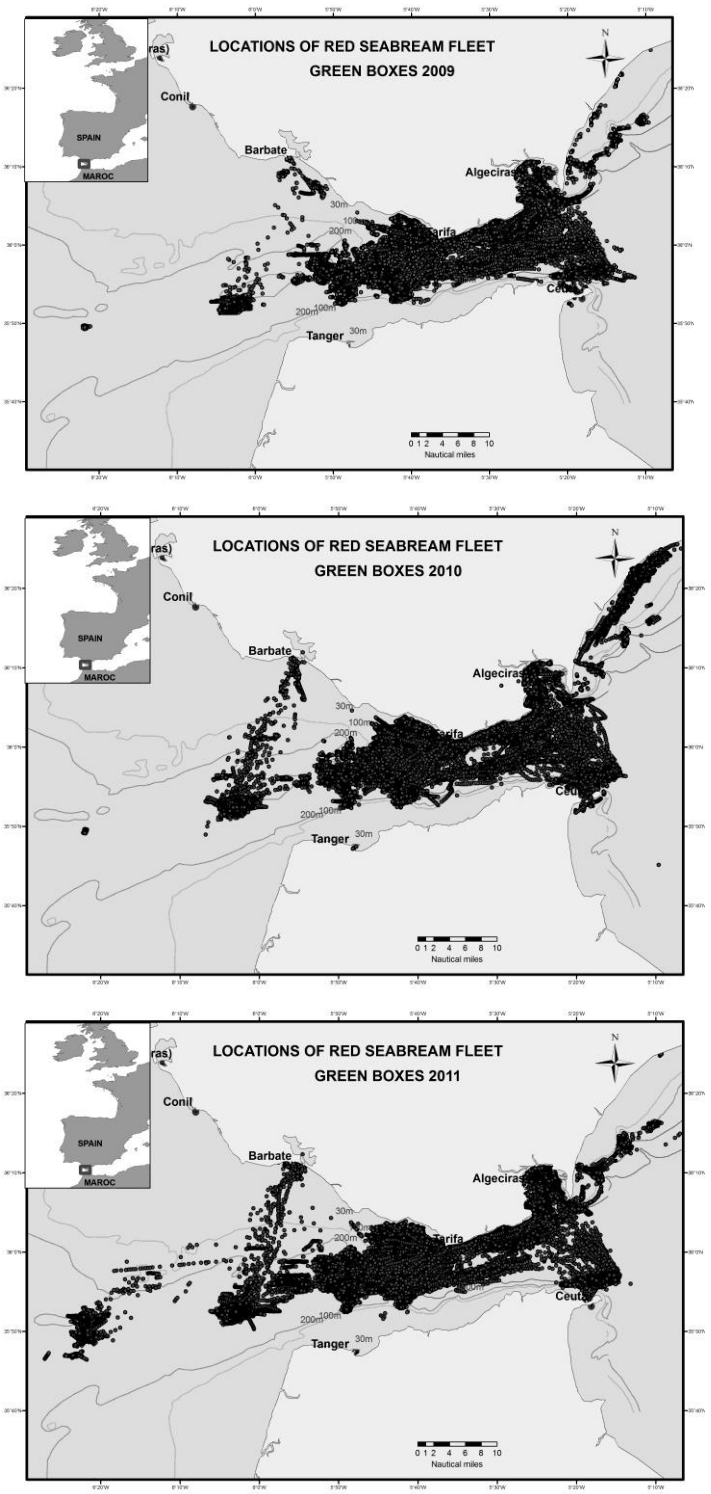


**Figure 1.** Yearly non filtered situations from "*voracera*" fleet in the Strait of Gibraltar area.

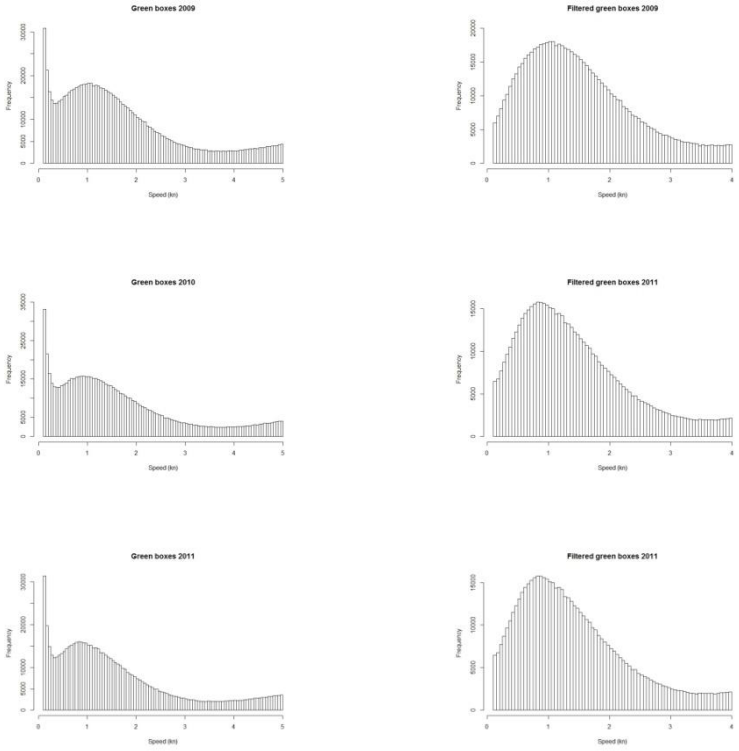


**Figure 2.** Distribution of speeds (in knots) by year, before and after VMS filtering process.

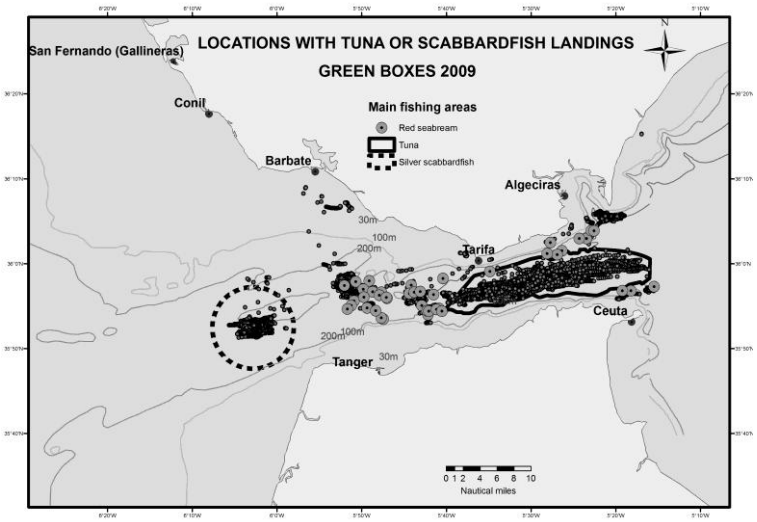


**Figure 3.** Location of traditional Red seabream fishing areas (Gil and Sobrino, 2006) and main fishing areas identified from VMS data for Atlantic bluefin tuna and Silver scabbardfish.

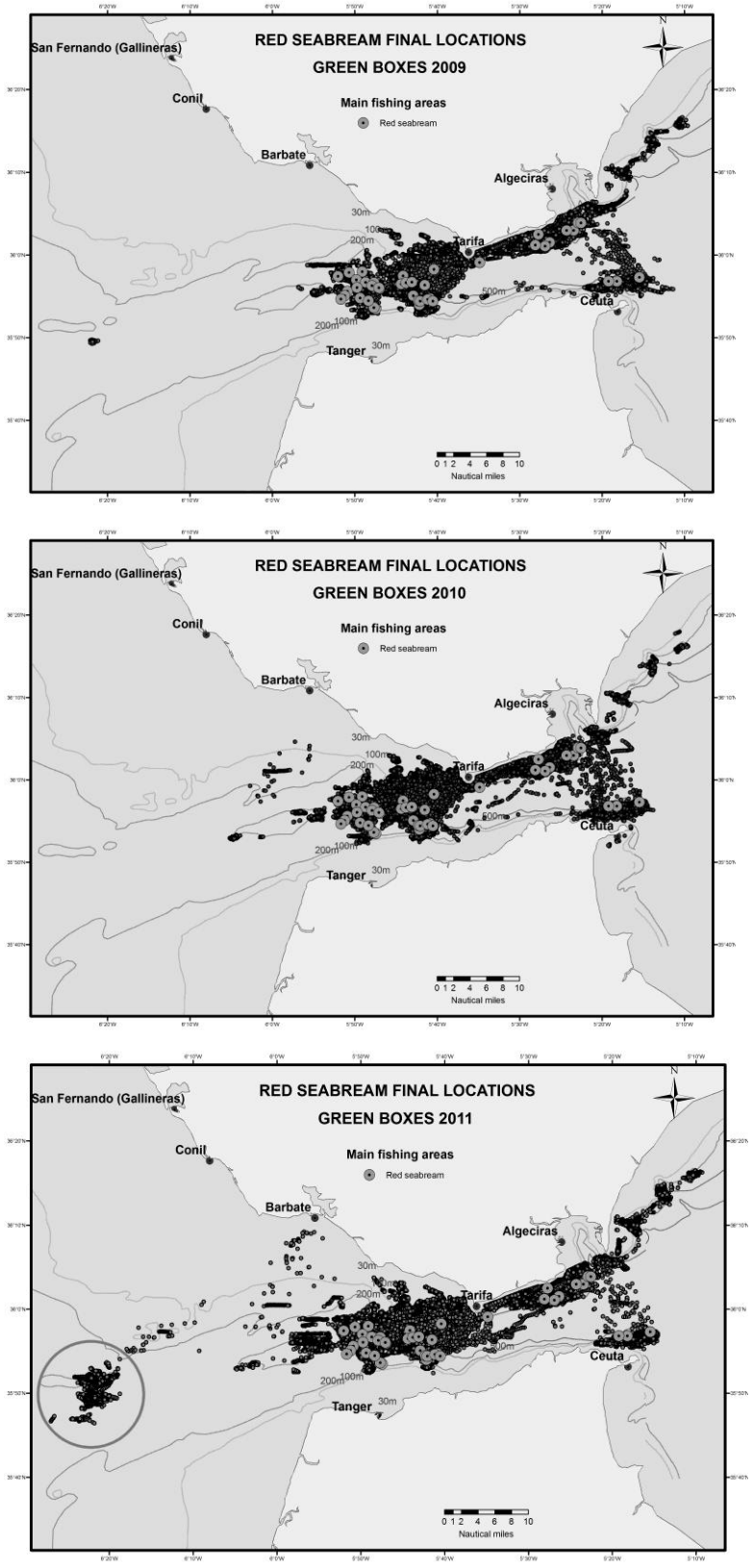


**Figure 4.** Final Red seabream fishing grounds located from 2009 – 2011 VMS data.

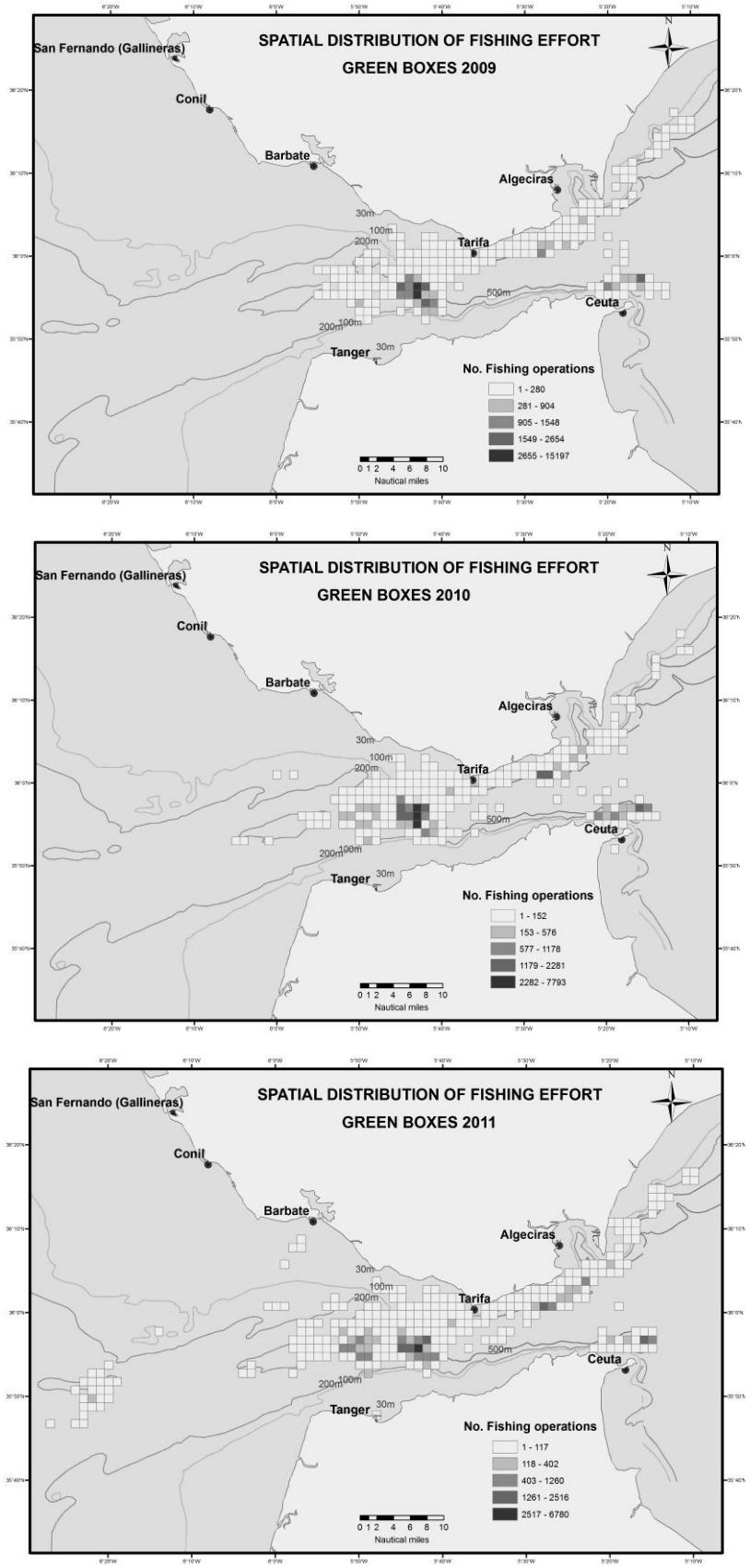


**Figure 5.** Red seabream spatial distribution of fishing effort, estimated as number of fishing operations (hauls).

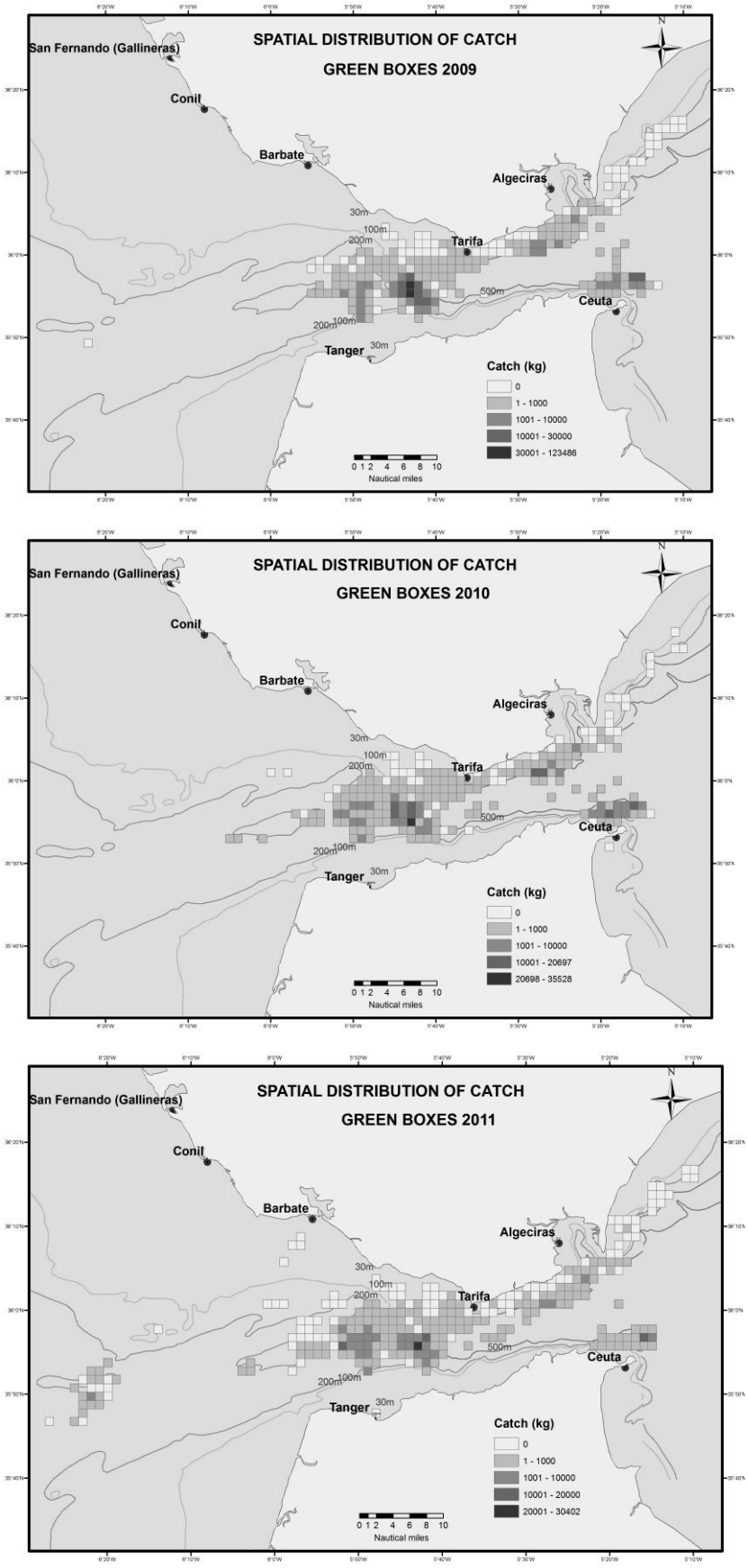


**Figure 6.** Red seabream spatial distribution of landings.

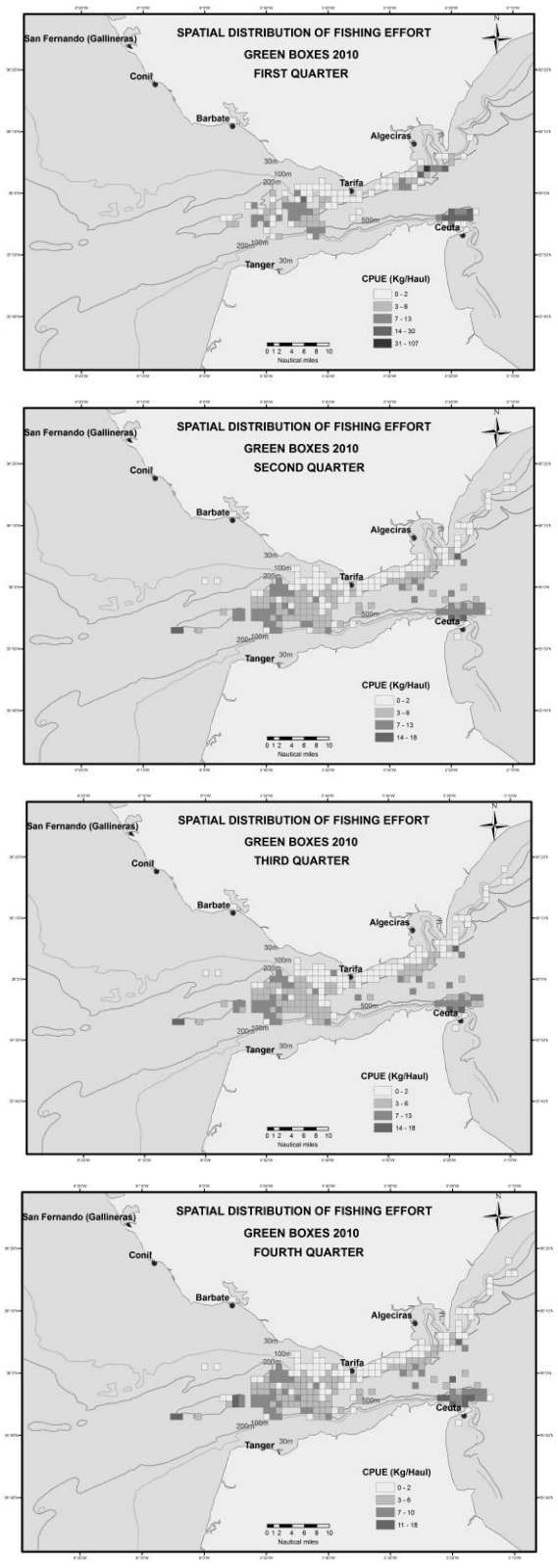


**Figure 7.** Spatial distribution of the Red seabream CPUE (kilos/haul) by quarter in the intermediate year (2010).

**Table I.** "*Voracera*" fleet VMS analysis: Summary results and its different estimates.

| **"*Voracera*" fleet / Year** | **2009** | **2010** | **2011** |
|---|---|---|---|
| **Boats** | 85 | 82 | 82 |
| **Sale sheets** | 7,200 | 5,863 | 4,711 |
| **Fishing days (trips)** | 8,373 | 7,238 | 6,160 |
| **Fishing operations (hauls)** | 60,593 | 46,579 | 38,345 |
| **Landings (in kilos)** | 459,010 | 274,882 | 190,786 |
| **CPUE 1 (Landings/Sale sheets)** | 64 | 47 | 40 |
| **CPUE 2 (Landings/trips)** | 55 | 38 | 31 |
| **Total boats** | 97 | 92 | 86 |
| **Total sale sheets** | 8,892 | 6,945 | 5,662 |
| **Total fishing days (trips)** | 10,564 | 9,629 | 7,743 |
| **Total Landings (in kilos)** | 579,139 | 365,672 | 239,286 |
| **CPUE 1´(Total landings/Total sale sheets)** | 65 | 53 | 42 |
| **CPUE 2´(Total landings/trips)** | 55 | 38 | 31 |