SCIENTIFIC ESTIMATIONS OF BYCATCH LANDED BY THE SPANISH SURFACE LONGLINE FLEET TARGETING SWORDFISH (*Xiphias gladius*) IN THE INDIAN OCEAN: 2001 – 2003 PERIOD.

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ABSTRACT

This paper presents data on the bycatch species landed by the Spanish surface longline fleet targeting swordfish (Xiphias gladius) in the Indian Ocean between 2001 and 2003. The species classified as bycatches amounted to 51.9% of the total landings in weight - large pelagic sharks amounted to 43.1%, tunas to 6.0, billfish to 0.7% and other species to 2.1%. As far as bycatch species are concerned, large pelagic sharks were the most prevalent ones with 83.0% of the catch in weight, whereas tunas amounted to 11.6%, billfish to 1.3% and other species to 4.0%. The three most prevalent species in the catch, Xiphias gladius, Prionace glauca and Isurus oxyrhinchus represented 90% of the total landings in weight during this period. Prionace glauca and Isurus oxyrhincus are the most prevalent species in the group of large pelagic sharks, reaching 88.5% and 10.0%, respectively. Preliminary data on accidental catch of turtles and sea birds caught in 555 specifically observed sets, suggest global incidence rates per hook around 3.52903E-05 for turtles (dead + alive),1.60411E-06 for dead turtles and 1.60411E-06 for dead sea birds.

Key words: bycatch, surface longline, statistics.

INTRODUCTION

The Spanish surface longline fleet initiated its exploratory fishing activity in the Indian Ocean in 1993 (GARCÍA-CORTÉS & MEJUTO 2000a). This fleet has been targeting swordfish *Xiphias gladius* (SWO) since then, although other species are caught simultaneously, mostly large pelagic sharks and to a lesser extent, tunas and billfish, as in other oceans in the world (GARCÍA-CORTÉS & MEJUTO 2000b, 2002, MEJUTO *et al*. 2000, 2002a, 2002b, 2003).

The amount of landed pelagic sharks has been increasingly important in the past few years for many fleets in all oceans. This is due to their high relative abundance in number and biomass in most oceans and fishing areas, the losses of discards of these species in many fleets which used to be numerous in the past (MEJUTO & GONZÁLEZ-GARCÉS 1984, MEJUTO 1985), the improvements in the conservation systems and the upward trend of the price of these species and its derivative products in international markets (MEJUTO & GARCÍA-CORTÉS 2004). Therefore, these species, which have been intensively caught for many decades, are now present in international markets of their bodies and fins. Recent changes have been observed in the Spanish fleet operating in the Atlantic Ocean, as the target of the fishing effort has been modified. As a result, the so-called bycatch, more precisely the *Prionace glauca*, has become a second target species for some sets, trips and areas (MEJUTO & DE LA SERNA, 2000). Since the development of the oceanic longline in the middle of the last century, the elevated prevalence of blue shark is well known in the oceanic epipelagic layers of almost all oceans in the world. This species is mostly found between 50ºN and 50ºS and it has been caught since longline fishing began, in the middle of the last century. The

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prevalence of the blue shark over other species of elasmobranchs and teleosts is probably due to their advantageous reproductive strategy, provided with an elevated renewal rate and taking advantage of the mean value of around 37 embryos per litter (CASTRO & MEJUTO 1995, MEJUTO & GARCÍA-CORTÉS *in press.*). As a result, this species is much more prevalent than other pelagic elasmobranchs and teleosts (CASTRO *et al* 2000, MEJUTO *et al* 2002b, ROSE & McLOUGHLIN 1999).

The fishing gear used by the Spanish surface longline vessels from the beginning of their activity in the Indian Ocean until the year 2000 was the "traditional longline", equipped with main line plurifilament and clips. However, it is in 2000 when the "American style" -Florida style modified- (WARD & ELSCOT 2000) longline gear is introduced in the Spanish fleet operating in the Indian Ocean, with a mean of 1100 hooks per set.

It is well known that in distant longline fleets all over the world, it is difficult to correctly identify all the bycatch species, especially when they present a certain taxonomic difficulty and / or have a low price at the markets. For this reason, we must be precautious when considering data related to low-prevalence or low-priced bycatch species. The same applies to other fishing gears targeting tuna, which provide confusing or underestimated specific identifications in logbooks.

A research project conducted by the Spanish Oceanography Institute extended its Information and Sampling Network from the Atlantic to the Indian Ocean, in order to carry out the scientific follow-up of the activity performed by this sector of the Spanish surface longline fleet. Likewise, the programme of observers on board longliners was extended to this ocean, within its limited budgetary possibilities.

The objective of this paper is to analyze and update the historical series of bycatch data of the Spanish surface longline fishery operating in the Indian Ocean provided previously, which included information until year 2000 (GARCÍA-CORTES & MEJUTO 2001). Besides, the objective is to know, to the most specific taxonomic level possible, the bycatch associated to this fishery and to define the relative global prevalence among species, which might lead us to determine the consistency of the estimations over the years and might be useful to compare data from other fleet operating with similar fishing strategies.

MATERIAL AND METHODS

The information provided on this paper is based on declarations of landings per trip, interviews with skippers at the ports and information filled out voluntarily by the fleet, obtained between 2001 and 2003, in addition to information provided by the scientific observers on board commercial vessels, both during regular fishing activities and in experimental fishing cruises targeting swordfish. More specifically, observations were carried out on 4 longliners during 5 trips in order to estimate in a preliminary manner the potential incidence of turtles and sea birds in the longline activity of this fleet. The fishing areas observed for this purpose were between 10º - 35ºS and between 35º-110ºE.

For descriptive purposes, the species related to large pelagic sharks were classified into group SHK, which is made up mainly of specimens of family Carcharhinidae (fundamentally *Prionace glauca:* PGO), followed by the family Lamnidae (mainly *Isurus oxyrhinchus:* IOO), Sphyrnidae and finally, Alopiidae. The group TUN includes different tuna species among which *Thunnus obesus (*BET), *Thunnus alalunga* (ALB) and *Thunnus albacares* (YFT) are the most important. The group of billfish was labelled as BIL and includes species from the family Istiophoridae. The group OTH includes several species, which have not been identified in certain cases (generally with low commercial value) or which have been identified in terms of species but whose catch is very rare.

The breakdown into species of the most prevalent bycatch landed, such as PGO and IOO, was mainly performed based on the information provided by the own fleet in their voluntary reports, since their taxonomic identification is easy, reliable and usual. However, the identification of species belonging to other groups such as SHK, BIL, OTH and TUN was fundamentally based on the information provided by

on-board observers, who have a limited spatial-temporal coverage. Due to the continuous geographic expansion of Spanish vessels to new fishing areas in the Eastern Indian Ocean, resulting in a lower fishing effort in the Western Indian area, it was impossible to achieve a satisfactory breakdown into species of the landings in certain cases. As a result, this has an impact on the reliability of the estimations by species. Consequently, the reported landings are in some cases assigned to a single species. The data were geographically compiled and set down in 5ºx5º squares-month and raised by spatial-temporal strata, according to the methodology described for distant longline fleets (MIYAKE 1990).

The records that were originally based on dressed weight were converted, where necessary, to units of round weight (RW) by applying different conversion factors according to the species or group of species, depending on the manipulation process applied to the fish on board. Conversion factors were defined for different species and presentations: *Prionace glauca* (PGO) Round weight (RW)= Dressed weight (DW) * 2.4074. *Isurus oxyrhinchus* (IOO) Round weight (RW)= Dressed weight (DW) * 1.4541. The other pelagic sharks (other SHK) Round weigth (RW)= Dressed weight (DW) * 1.4. All species included in the group of billfish (BIL) Round weight (RW)= Dressed weight (DW) * 1.2. The conversion factors applied to each species within the group of tuna (TUN) were Round weight (RW)= Gutted weight (GW) * 1.1 and Round weight (RW)= Dressed weight (DW) * 1.25.

RESULTS AND DISCUSSION

The group including the three most prevalent species in the catch, which are also those of highest commercial interest for human consumption (SWO+PGO+IOO), represent 90% of the total landings in the Indian Ocean. This level is very similar to that observed in the regions of SE Pacific, where the rate is estimated to be around 91%.

The group of species considered as bycatch of the swordfish (*Xiphias gladius*) surface longline fishery in the Indian Ocean between 2001 and 2003 accounted for 51.9% of the total catch landed in weight (table **1**, figure **1**). This percentage turned to be slightly lower than that observed for the Atlantic Ocean (CASTRO *et al.* 2000, MEJUTO *et a.l* 2002b). This was to be expected in view of some activities targeting PGO carried out in certain areas of the Atlantic.

Between 2001 and 2003, the bycatch was mainly large pelagic sharks (SHK), of which 2885 t/yr were landed on average. This accounts for 43.1% in weight of the total catch landed for all the species combined. The average landing of the tuna group (TUN) was 403 t/yr, which accounted 6.0% in weight of the total catch landed. The group of species with the lowest economic value (OTH) represented around 2.1% of the total yearly catch, with landings reaching 141 t /yr on average. Finally, the volume of billfish (BIL) amounted to 0.7% of the total landed catch, reaching 46 t/yr on average (table **2**, figure **2**).

The volume of landings in weight per group of species in relation to the bycatch as a whole (excluding the target species) amounted to 83.0% for the SHK group, 11.6% for the TUN group, 4.0% for the OTH group and 1.3% for the BIL group in the study period (table **3**, figure **3**). As expected, the amount of SHK was much more prevalent as compared to the other groups. However, it was lower than that observed in the landings of the Atlantic as a whole, where the SHK group represented between 95 and 99% of the bycatch, depending on the year of observation (CASTRO *et al.* 2000, MEJUTO *et al* 2002b).

In certain occasions, it was impossible to calculate the breakdown of the catch into species, due to the rapid expansion of the fleet to new fishing areas in this ocean and to the limited geographical areas covered by the observers. Figure **4** represents the recent geographic expansion of the fishing effort carried out by this fleet between 2001 and 2003.

In the years 2001 and 2002, the observers covered around 6% and 3% of the area, respectively. Although observers covered a wider areas in 2003 (15%), the observations were mainly aimed at the new experimental fishing areas in the Eastern Indian (between 85º-110º E and 20º- 35º S), where only 4 vessels were fishing. For this reason, the information obtained from these trips in eastern areas is not applicable to the whole of the fleet operating in other areas of the Indian Ocean.

The bycatch analyzed during the above mentioned period was made up fundamentally of PGO, with an average landing of 73.5%, followed by the IOO with 8.3%. The average figures for the other SHK were lower than 1%. As far as the species of the TUN group are concerned, BET and ALB must be pointed out, as both reach about 5% of the total landed bycatch, as well as YFT reaching 2.2%. The volume of landed species of the BIL group always remained below 0.5% of the total bycatch. It must be noted that the percentage in weight obtained in the OTH group by the species *Lepidocibium flavobrunneun* represented 3.5% of the total bycatch landed.

Within the SHK group, the PGO species accounted for 88.5%, followed by IOO, reaching 10.0%. These figures are very similar to those observed for the Spanish surface longliners in different oceans, where the prevalence of PGO is clearly predominant and remarkably higher as compared to the group of other bycatch species. In the TUN group, the species BET and ALB represented 47.0% and 37.7%, respectively. In the BIL group, 37.2% was identified as *Istiophorus platypterus* and 25.8% as *Tetrapturus angustirostris.* In the group of OTH, 86.1% was represented by the species *Lepidocibium flavobrunneun.*

The possible statistical improvement might have been involved in the general increase of the landing volumes in weight of the bycatch of some species during this period (2001-2003), as compared to previous years. Nonetheless, the increase observed in the number of vessels fishing in this ocean must be also taken into account, as it rose from 10 to 19 units. However, the relative prevalences observed for the 2001-2003 period are generally similar to those previously obtained by the Spanish fleet in the Indian Ocean (GARCÍA-CORTES & MEJUTO 2001), with the exception of the OTH group. This suggests an increase of landings and/or a statistical improvement for this last group.

In order to preliminarily evaluate the incidence of sea birds and turtles in this fishery, a total of 626,400 hooks were observed during 555 sets. The species of turtles and sea birds identified by the observers were *Caretta caretta*, *Dermochelys coriacea, Lepidochelys kempii, Lepidochelys olivaeca* and *Diomedea exulans,* respectively. The incidence obtained through these observations were one sea bird (dead) and 22 turtles, 21 of which were released alive and in good condition. The last one was found dead, rolled in the main line. This suggests global incidence rates per hook around 3.52903E-05 for turtles (dead and alive) and 1.60411E-06 for dead turtles in areas between 18º - 32ºS and between 37º-106ºE. Only one incidence of a sea bird (dead) was reported by 26º South latitude, suggesting an incidence rate of 1.60411E-06 for dead sea birds. Nonetheless, further observations are needed in order to obtain more consistent and representative estimations.

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LITERATURE CITED

CASTRO, J. M., J. Mejuto. 1995. Reproductive parameters of Blue shark, Prionace glauca, and other sharks in the Gulf of Guinea. *Mar. Freswater Res*., 46:967-73.

CASTRO, J. M. de la Serna, D. Macías, J. Mejuto, 2000. Estimaciones científicas preliminares de los desembarcos de especies asociadas realizadas por la flota española de palangre de superficie en 1997 y 1998. *ICCAT. Col. Vol. Sci. Pap*., Vol. LI:1882-1984.

GARCÍA-CORTES, B., J. Mejuto. 2000a. "A general overview on the activity of the spanish surface longline fleet targeting sowrdfish (*Xiphias gladius*) in the Indian Ocean for the period 1993-1998". IOTC Proceedings no.3 (2000): 140-153, WPB00-01.

GARCÍA-CORTÉS, B., J. Mejuto. 2000b. "Estimaciones científicas preliminares de los desembarcos de patudo (*T.obesus*), rabil (*T. albacares*), atún blanco (*T. alalunga*) y listado (*K. pelamis*) capturados como especies asociadas en la pesquería española de palangre de superficie en el O. Atlántico, durante el período 1988-1998". ICCAT Col. Vol. Sci. Pap. Vol. LI: 1931-1935 (CD vers. SCRS/99/112).

GARCÍA-CORTÉS, B., J. Mejuto. 2001. Preliminary scientific estimations of by-catches landed by the spanish surface longline fleet targeting swordfish (*Xiphias gladius)* in the Indian Ocean: years 1993-2000". IOTC Proceedings no.4 (2001):19-23, WPDCS01-02.

GARCÍA-CORTES, B., J. Mejuto. 2002. "Preliminary scientific estimations of tuna (tribe *Thunnini*) landed by the spanish surface longline fleet targeting swordfish in the Atlantic Ocean: Years 1999-2000." ICCAT Col. Vol. Sci. Pap. Vol. LIV:1720-1725 (CD vers. SCRS/01/101)

MEJUTO, J., A. González-Garcés. 1984. Shortfin mako, *Isurus oxyrhinchus,* and porbeagle, *Lamna nasus*, associated with longline swordfishery in NW and N spain. International Council for the Exploration of the Sea, Council Meeting 1984/G 72:10 pp.

MEJUTO, J. 1985. Associated catches of sharks, *Prionace glauca, Isurus oxyrhinchus,* and *Lamna nasus*, with NW and N Spanish swordfish fishery, in 1984. International Council for the Exploration of the Sea, Council Meeting 1985/H 42:16 pp.

MEJUTO, J., J.M. de la Serna. 2000. Standardized catch rates by age and biomass, for the North Atlantic swordfish (*Xiphias gladius)* from the Spanish longline fleet for the reiod 1983-1998 and bias produced by changes in the fishing strategy. ICCAT. Col. Vol. Sci. Pap. Vol LI (*CD vers.* SCRS/99/056).

MEJUTO, J., B. García-Cortés, J.M. de la Serna. 2000. " Estimaciones científicas preliminares de desembarcos de peces de pico capturados en el O. Atlántico y Mar Mediterráneo por la flota española de palangre de superficie de pez espada, durante el período 1988-1998." ICCAT Col. Vol. Sci. Pap. Vol. LI: 976-980 (CD vers. SCRS/99/110).

MEJUTO, J., B. García-Cortés, J.M. de la Serna. 2002 a. "Preliminary scientific estimations of Billfish (Family Istiophoridae) landed by the spanish surface longline fleet targetins swordfish in the Atlantic Ocean and Mediterranean Sea: years 1999-2000." ICCAT Col. Vol. Sci. Pap. Vol. LIV: 826-833 (CD vers. SCRS/01/102).

MEJUTO, J., B. García-Cortes, J.M. de la Serna. 2002 b. "Preliminary scientific estimations of by-catches landed by the Spanish surface longline fleet in 1999 in the Atlantic Ocean and Mediterranean Sea." ICCAT Col. Vol. Sci. Pap. Vol. LIV:1150-1163 (CD vers. SCRS/01/049).

MEJUTO, J., B. García-Cortés, R. Lorca. 2003**. "**Observación científica realizada a bordo de un palangrero de superficie comercial de la U.E.. (España), en el océano Pacífico Este durante el año 2002".Working paper. BSTC/2003

MEJUTO, J., B. García-Cortés. 2004. "Preliminary relationshipsh between the wet fin weight and body weight of some large pelagic sharks caught by the spanish surface longline fleet. ICCAT Col. Vol. Sci. Pap. Vol. LVI:243-253 (CD *vers* SCRS/2003/085).

MEJUTO, J., B. García-Cortés. *in press*. "Reproductive and reproduction parameters of the blue shark *Prionace glauca*, on the basis of on-board observations at sea in the Atlantic, Indian and Pacific Oceans". ICCAT Col. Vol. Sci. Pap. (CD *vers* SCRS/2004/103).

MIYAKE, M. 1990. Manual de operaciones para las estadísticas y el muestreo de túnidos y especies afines en el océano Atlántico. Comisión Internacional para la Conservación del Atún Atlántico (ICCAT), Madrid: 188 pp.

WARD, P., S. Elscot 2000. Broadbill Swordfish Status of World Fisheries. Bureau of Rural Sciences. BRS Report : 60-64p. Agriculture, Fisheries and Forestry - Australia.

ROSE, C.K. McLoughlin, 2001. Review of the shark finning in Australian waters. Final Report to Fisheries Resources Research Fund November 2001. *Bureau of Rural Sciences. Australia*.

Table 1. Scientific estimation of landings (tons of round weight –RW-) of the target species (*Xiphias gladius*) *vs.* combined by-catch species, done by the Spanish surface longline fishery in the Indian Ocean during the 2001-2003 period.

YEAR	2001	2002	2003
SWO	1860,2	3502,2	4289,0
BY-CATCH	1735,0	3690,5	4997,5
TOTAL	3595,2	7192,7	9286,5

Table 2. Scientific estimation of by-catch landings (tons of round weight –RW-) by group, done by the Spanish surface longline fishery in the Indian Ocean during the 2001-2003 period.

YEAR	2001	2002	2003
BIL	32,8	47,8	56,8
OTH	32,8	229,3	159,8
SHK	1383,1	2928,8	4343,7
TUN	286,3	484,6	437,1
TOTAL	1735,0	3690,5	4997,4

Table 3. Scientific estimation of landings by species (kg of round weight –RW-) of the considered by-catch in the Spanish surface longline fishery, during 2001-2003 period.

Group	SPECIES	2001	2002	2003
BIL	*Makaira mazara*	20389	0	1662
BIL	*Makaira indica*	0	0	697
BIL	*Tetrapturus audax*	0	16164	11434
BIL	*Istiphorus platypterus*	0	8900	42235
BIL	*Tetrapturus angustirostris*	12364	22711	375
BIL	*Tetrapturus pfluegeri*	0	0	363
OTH	*Brama spp.*	0	10	0
OTH	*Coriphaena spp.*	0	1833	10317
OTH	*Lepidocibium flavobunneum*	28591	200039	134686
OTH	*Lampris guttatus*	0	222	140
OTH	*Oth*	4195	19489	13701
OTH	*Rubetus pretiosus*	0	7307	461
OTH	*Sphyraena spp.*	35	420	503
OTH	*Seriola dumerili*	0	0	30
SHK	*Alopias spp.*	0	21	0
SHK	*Carcharhinus spp.*	22714	55814	19053
SHK	*Carcharhinus falciformis*	0	6	0
SHK	*Carcharinus galapagensis*	0	0	968
SHK	*Carcharhinus longimanus*	0	660	456
SHK	*Galeocerdo cuvieri*	196	81	**0**
SHK	*Isurus oxyrinchus*	146067	308252	411826
SHK	*Isurus paucus*	240	214	932
SHK	*Lamna nasus*	494	2581	1277
SHK	*Prionace glauca*	1203991	2549703	3904120
SHK	*Pseudocarcharias kamoharai*	0	0	19
SHK	*Sphyrna lewini*	0	0	147
SHK	*Sphyrna spp.*	9448	11511	4939
SHK	*Sphyrna zygaena*	0	1219	659
TUN	*Acantocibium solandri*	0	127	82
TUN	*Thunnus alalunga*	165451	241384	48153
TUN	*Thunnus obesus*	75764	109296	382140
TUN	*Gasterochisma melampus*	0	27089	0
TUN	*Thunnus maccoyii*	0	0	3365
TUN	*Katsuwonus pelamis*	233	0	3402
TUN	*Thunnus albacares*	44876	106693	0

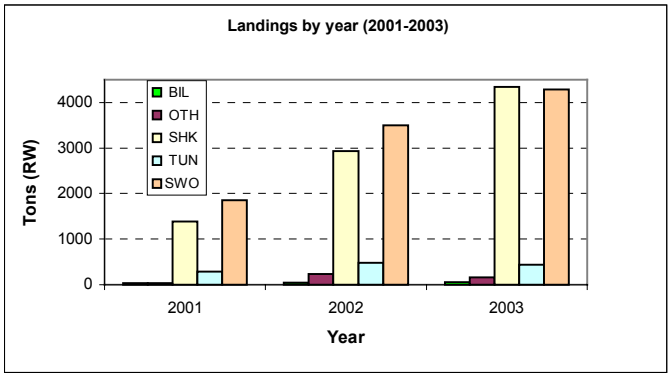

Figure 1. Scientific estimation of the landings (tons of round weight –RW-) of target species (SWO) and group of species considered as by-catch in the Spanish surface longline fishery in the Indian Ocean, during 2001-2003 period.

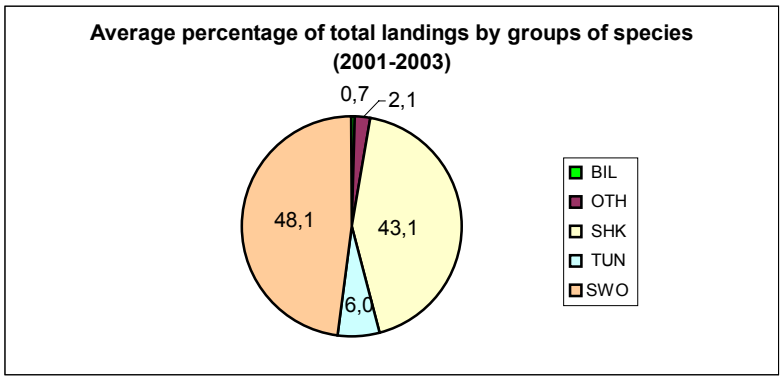

Figure 2. Scientific estimation of the percentage of the total landings (relative prevalence) by group (target and by-catch species) in the Spanish surface longline fishery in the Indian ocean, during 2001-2003 period.

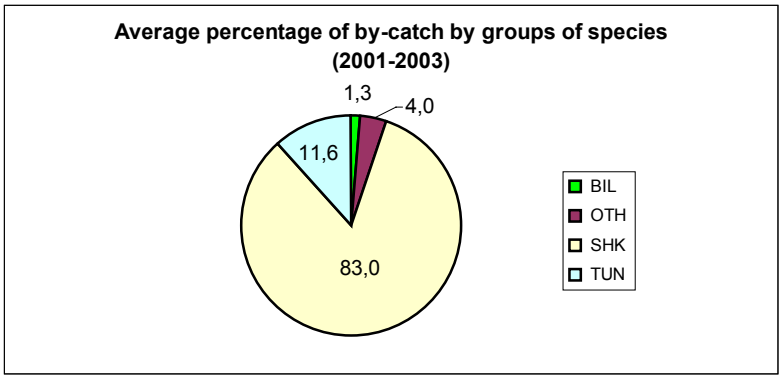

Figure 3. Scientific estimation of the percentage of landings by group within the by-catch species in the Spanish surface longline fishery in the Indian Ocean, during 2001-2003 period.

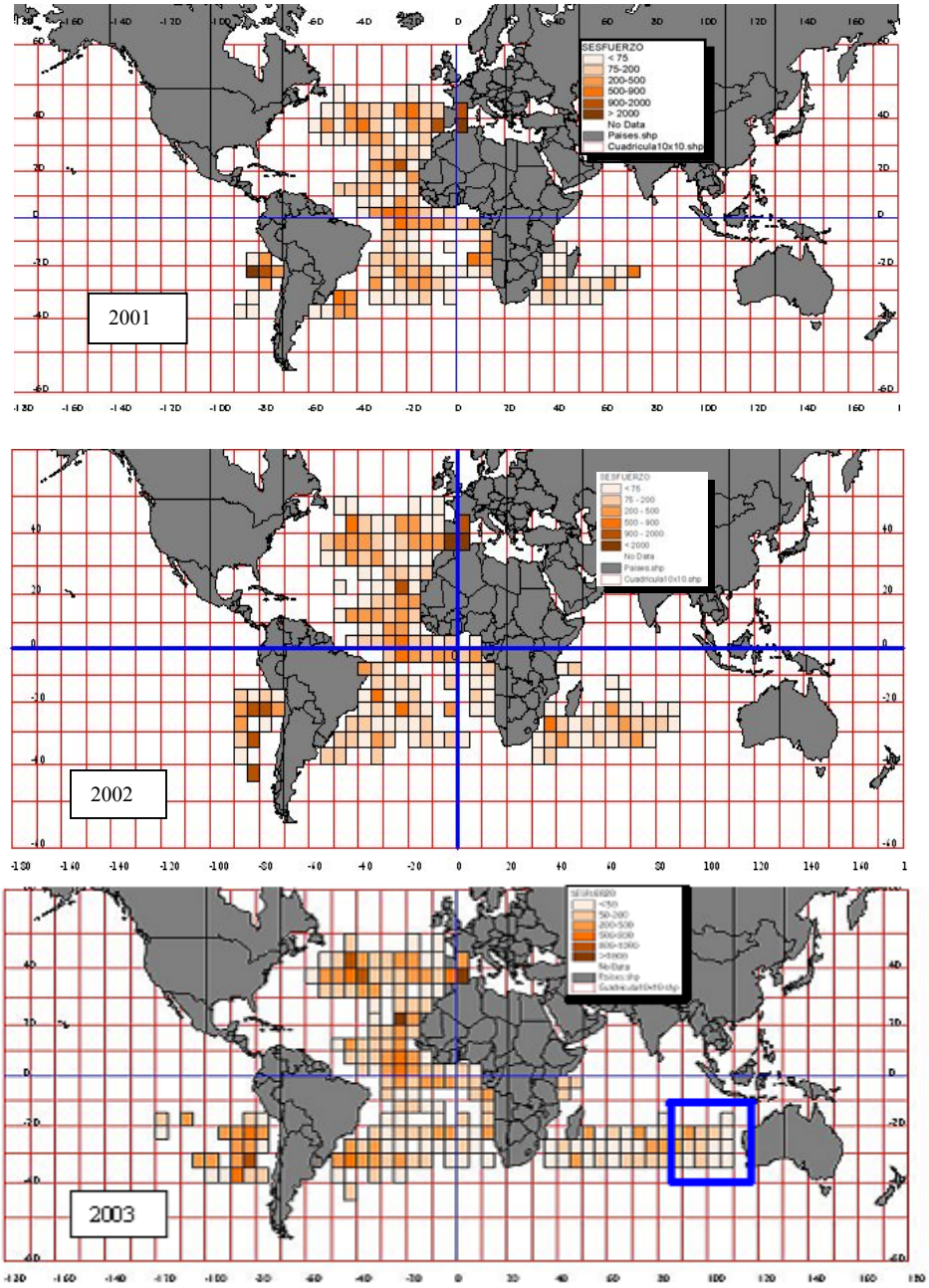

Figure 4 . Nominal effort in thousands of hooks carried out by the Spanish surface longline fleet in all areas during 2001 – 2003 period (year 2003, square in blue: new surveys areas).