COMISIÓN INTERAMERICANA DEL ATÚN TROPICAL
INTER-AMERICAN TROPICAL TUNA COMMISSION

WORKING GROUP ON BYCATCH

6TH MEETING

LA JOLLA, CALIFORNIA (USA)
9-10 FEBRUARY 2007

DOCUMENT BYC-6-INF A

PRELIMINARY OVERALL ESTIMATIONS OF BYCATCH LANDED BY THE SPANISH SURFACE LONGLINE FLEET TARGETING SWORDFISH (*XIPHIAS GLADIUS*) IN THE PACIFIC OCEAN AND INTERACTION WITH MARINE TURTLES AND SEA BIRDS: YEARS 1990-2005

J. Mejuto[1] , B. García-Cortés[1], A. Ramos-Cartelle[1] and J. Ariz[2]

ABSTRACT

This paper presents overall scientific estimations on bycatch landings by species, or groups of species, carried out by the Spanish surface longline fleet targeting swordfish (*Xiphias gladius*) in the Pacific Ocean. The mean level of bycatch landed by the Spanish fleet from the beginning of the fishing activity in 1990 until the year 2005 accounted for 42.6% of the total weight landed (target species and bycatch combined). Some of the bycatch landed that are worthy of note include the group of large pelagic sharks, representing a mean percentage of 95.8% of the total bycatch weight landed, followed by the tuna group (2.3%), and lastly, the billfish species (family Istiophoridae) and other species with lower levels and minor economical importance. The preliminary overall estimations of incidental mortality rates of marine turtles and sea birds -species combined- caught incidentally in Pacific regions indicate an overall mortality rate per hook of around $6.70291*10^{-6}$ and $3.71707*10^{-5}$, respectively.

INTRODUCTION.

From the outset of its activity in the Pacific Ocean, in addition to the target species *Xiphias gladius* (SWO), the Spanish surface longline fleet has been traditionally bycatching species such as billfish, tunas and large pelagic sharks, the latter being of great importance both because of their high abundance as well as their increasing economic worth in relation to previous decades (MEJUTO & GONZÁLEZ-GARCÉS 1984, MEJUTO 1985). Although during the 1980s it was common practice to catch and discard blue shark, in subsequent decades, however, this practice has gradually diminished to the point of having practically disappeared, owing to several different factors, such as the introduction of efficient freezer systems for catch preservation and the increasing economic importance of sharks and their derivatives on international markets earmarked for human consumption (MEJUTO & GARCÍA-CORTÉS 2004).

The Spanish surface longline fleet began fishing in the Pacific Ocean in 1990 to conduct a prospecting survey on swordfish (*Xiphias gladius*) abundance in areas of the SE Pacific Ocean (FAO 87). Later on, several other Spanish longliners gradually started operating in this fishing zone, coming to number 11 vessels in operation during 1992, although they carried out only partial or sporadic activity throughout the year, combining their ventures between the SE Pacific and South Atlantic areas. In subsequent years, most of the vessels left the Pacific Ocean and in year 2000 only 4 units remained in the zone, two of which undertake partial activity throughout the year. Between 1998-1999, two vessels conducted a prospecting survey of the swordfish, in this instance, in areas of the North Pacific (FAO 77-87) (MEJUTO et al. 2001a). In 2001 the number of vessels increased again, coming to a total of 10 vessels

[1] Instituto Español de Oceanografía, P.O. Box. 130, 15080 A Coruña. Spain
[2] Instituto Español de Oceanografía, P.O. Box 1373, 38120 Tenerife, Spain

operating in the Southeast Pacific. Three of these vessels made changes in the fishing gear used, switching from the traditional Spanish multifilament longline to the new "American style" or monofilament gear (Florida style modified). During the 2002-2003 period, a total of 7 of the 17 vessels in operation continued to use the traditional Spanish gear, while the rest employed the monofilament type gear. These 7 vessels kept on fishing with the traditional Spanish gear throughout 2004-2005, while the other vessels that have recently started to undertake activity in this ocean –reaching 23 in 2004 and 26 in 2005– did so using the American style gear (MEJUTO et al. 2001b, 2001c, MEJUTO et al. 2002a).

Starting in 2003 the fleet made a timid attempt to expand its fishing grounds towards zones in the central South Pacific, with the area around 120º W becoming a new fishing zone, as an alternative to supplement the traditional grounds located closer to the mainland in the SE Pacific. In 2004 and 2005 experimental fishery activities were undertaken in areas located in both the North and South Pacific, within the WCPFC convention area. These experimental fishery activities involved the development of fishing patterns that were different from those used in routine commercial operations. Over the course of this activity, substantial differences were found in terms of the prevalence among the species caught, in both the target species as well as the bycatch species.

Ever since the Spanish surface longline vessels started operating in the Pacific Ocean, a research project began broadening its information and sampling network in order to be able to monitor the activity of this part of the Spanish fleet for scientific purposes. At the same time, the onboard observer program covering other oceans was extended whenever possible and funds were made available for the Pacific Ocean to gather information in situ on the activities in areas-seasons where fishing is carried out. However, the onboard observations were carried out in 1990 and during the recent period from 1998 to 2005.

MATERIAL AND METHODS.

The data used in this paper are based on information obtained through a sampling network which includes declarations on landings and effort, interviews with skippers and other scientific information filled out voluntarily by the fleet, as well as information provided by the scientific observers on board commercial vessels carrying out regular or experimental fisheries on swordfish (MEJUTO & GARCÍA-CORTÉS, 2005).

The breakdown into species of the most prevalent bycatch landed, such as the blue shark PGO (*Prionace glauca*) and shortfin mako IOO (*Isurus oxyrhinchus*) was mainly performed based on the information provided by the fleet itself in their voluntary scientific reports, since the taxonomic identification of these species is normally easy, reliable and common practice. However, the identification at the species level of other, less frequent species belonging to certain groups such as SHK (other pelagic sharks species), BIL (billfish species), TUN (tuna species) and OTH (others species) was fundamentally based on the combined information mainly provided by onboard observers who have a limited temporal-spatial coverage. The taxonomic species identification was kept as reported.

The term "Other SHK" was used when the information provided referred to sharks other than the most frequent species, PGO and IOO. The term BIL was used in cases where it was not possible to obtain a breakdown of the billfish at the species level. The term TUN was used to indicate the years during which it was not possible to break the tuna down by species. Within the group of other species different from the above (OTH), specimens unable to be identified at the species level were classified as NIS. It was not very reliable in some cases to achieve a satisfactory breakdown into species of the landings in certain years (1991-1997) because the onboard observer program was not implemented during this whole period. The information from onboard scientific observers was included for 1990 and the 1998-2005 period. However, even within these years, in some cases the breakdown of the species groups at the species level was not reliable owing to the lack of adequate coverage by gear type and/or the important geographical expansion of the fleet in the most recent years.

When originally based on dressed weight, the records were later converted to units of round weight (RW)

by applying different conversion factors according to the species or group of species, depending on the handling 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. Others species of Carcharhinidae: Round weight (RW) = Dressed weight (DW) * 2. *Isurus oxyrhinchus* (IOO): Round weight (RW) = Dressed weight (DW) * 1.4541. The other pelagic sharks (other SHK): Round weight (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.

The landings were later classified into groups of species summarizing the information for the periods 1990-2001, 2002-2003 and 2004-2005. The first period includes information with similar fishing patterns and areas, although during 1998-1999 there are some sets with a low significance from one survey trip carried out in the North Pacific areas within the IATTC convention area. In 2002 and 2003, 62% of the vessels switched from the traditional style longline gear to the American style gear. This is why the data are grouped into this second period. The third period encompasses the years 2004-2005, during which time a large number of vessels were conducting prospecting surveys and broadening the traditional fishing zone in the SE Pacific (IATTC) towards areas situated in the central and western part of the Pacific (WCPFC). During this third period 74% of the vessels were operating with the Florida style longline.

It is important to highlight the fact that both commissions (IATTC and WCPFC) share 36 5ºx5º overlapping squares. Therefore, the bycatch obtained in these squares has been included in both the diagrams and tables estimating the bycatch of the two Commissions, with the exception of some diagrams, where the data pertaining to the overlap have been removed from their respective convention areas and displayed separately.

Diagrams representing the distribution of the fishing effort exerted –thousands of hooks– from 1990 until 2005 by 5ºx5º squares are presented to shed light on the areas where the Spanish longline fleet has be operating over the course of these years according to the data available for scientific purposes. Also provided are the overall CPUE data (landings in kg RW / thousands of hooks) of the main bycatch species or groups of bycatch species, per year and convention area.

Lastly, in order to obtain a preliminary global approach, incidence rates (interaction) and mortality rates per hook were estimated for the species of sea birds and marine turtles incidentally affected by the surface longline fishery activity. These rates were obtained using data from scientific observers in combination with data on incidental catches observed and hooks set during both commercial and experimental surveys.

RESULTS AND DISCUSSION.

The group including the three most prevalent species in the catch and landings which are also those of highest commercial interest for human consumption (SWO+PGO+IOO) represented 95.2% of the total landings in the Pacific Ocean during the period 1990-2005. This level is slightly higher than those reported for the Atlantic and the Indian oceans, estimated to be around 93% and 90%, respectively (MEJUTO et al. 2006, GARCÍA-CORTÉS & MEJUTO 2001, 2005). The landings of species considered to be bycatch of the swordfish fishery in the Pacific Ocean ranged from 283.6 to 7030.7 t during the 1990-2005 period, which accounts for a landing percentage of between 16.5% and 59.7% as compared to the total weight landing of the species retained on board (including swordfish), with an overall prevalence of 59.4 % of the total landings during this period (tables 1 and 2, figure 1).

The bycatch consisted mainly of large pelagic sharks (SHK), 1,853 t/yr of which were landed on average during the period from 1990-2005. This accounts for 38.7% of the total landings in weight for all species combined. The average landing of the tuna group (TUN) was 81 t/yr, which accounted for a mean value of 0.9% in weight of the total landings. The volume of billfish (BIL) amounted to 0.4% of the total

landings, reaching 0.7 t/yr on average. Finally, the group of species with the lowest economic value (OTH) represented around 0.4% of the total weight landings, reaching 0.09 t /yr on average (figure 2).

The landings in weight per group of species in relation to the assumed bycatch species combined (excluding the swordfish) amounted to 95.8 % for the SHK group, 2.3% for the TUN group, 0.9% for the BIL group and around 1% for the OTH group (table 3, figures 3 and 4). The amount corresponding to the SHK group was the most prevalent as compared to the other groups. These general prevalences among groups within the bycatch species groups are similar to those reported in other oceans (CASTRO et al. 2000, MEJUTO et al, 2002b, 2002c, GARCÍA-CORTÉS & MEJUTO 2001, 2002, 2005, MEJUTO et al. 2006).

The most important bycatch landings over the entire period analyzed were essentially PGO, with a mean percentage of 58.5% in relation to the total weight of the bycatch species combined. The rest of shark species accounted for mean values of 37.7% (IOO) and 1.6% (Other SHK). The PGO was also the most prevalent species (59.6%) within the SHK group followed by IOO (38.9%). The PGO was the most prevalent epipelagic bycatch species, as it was also observed in other oceans. However, the respective prevalence of PGO and IOO within the SHK group differs from observations made in other oceans (89% and 10% for PGO and IOO, respectively, in the Indian regions and 81% and 9% for PGO and IOO, respectively, in the Atlantic regions). In general, IOO was observed to be around or below 10% of the total bycatch in other oceans, but this percentage is clearly higher in the Pacific data observed.

As far as the TUN group landings (2.3% of the total bycatch combined), *Thunnus obesus* stands out as accounting for 0.7% of the total bycatch species combined, while *Thunnus alalunga* represented only 0.2%. The prevalence of both tuna species within the TUN group was as follows: *Thunnus obesus* 39.4% and *Thunnus alalunga* 14.0%. The latter prevalences observed differ from those observed in other oceans, 43% (*Thunnus obesus*) and 40% (*Thunnus alalunga*) in the Atlantic and 47% (*Thunnus obesus*) and 38% (*Thunnus alalunga*) in the Indian Ocean.

The percentage of species landed pertaining to the BIL group was 0.9% of the total bycatch. The species reported as *Tetrapturus audax* was the one in this group that accounted for the greatest landed weight during this period, which translates to a percentage of 0.1% of the total bycatch. The prevalence of *Tetrapturus audax* within the BIL group was 13.1%. The latter prevalence levels differ from those reported in other oceans: 71.6% of the BIL group was identified as *Istiophorus platypterus*, 13.1% as *Tetrapturus albidus* and 10.7% as *Makaira nigricans* in all Atlantic areas combined, while 37.2% was identified as I. platypterus and 35.8% as *T. angustirostris* in all Indian areas combined.

The OTH group represented 1% of the total bycatch landed, with a prevalence of *Lepidocybium flavobrunneum* (0.5%) and *Coriphaena hippurus* (0.1%) of the bycatch species combined. The prevalence of both of these species within the OTH group landed was 21.4% and 20.2%, respectively. The species *Lepidocybium flavobrunneum* was observed with prevalences of 76% and 86% within the OTH group in Atlantic and Indian regions, respectively.

In the 1990-2001 period, the bycatch caught with the traditional style longline –the only kind of gear being used during this period– consisted chiefly of PGO (56.5%) and IOO (41.0%), followed by Other SHK (1.4%) and the groups BIL, TUN and OTH exhibiting a very low prevalence.

In the 2002-2003 period, during which time the vessels were operating with the Florida style longline gear, the prevalence figures for PGO were similar (56.7%), while IOO underwent a slight decrease (30.7%) and the other bycatch species increased substantially, particularly TUN (5.6%), OTH (4.1%) and BIL (2.2%).

Over the course of 2004 and 2005, 74% of the vessels used the Florida style longline gear. Moreover, several experimental fishery activities were undertaken and there was a geographic expansion towards the West of the fishing zone. Despite these circumstances, the landings still revealed a high prevalence of PGO (56.5%), which is similar to the levels observed in previous periods. Also observed, however, was a

drop in IOO (24.8%), relatively higher numbers of TUN (6.5%) and an increase in the prevalence of BIL (4.6%) as well as the groups Other SHK (3.9%) and OTH (3.7%).

Figure 5 shows the prevalences (%) of the bycatch landed in 2004 and 2005 by convention area IATTC and WCPFC, respectively. The bycatch obtained in the overlap area shared by the two Commissions is shown to be either included or omitted, depending on the different diagrams. They are also given in separate diagrams. PGO is clearly the most prevalent species among species or groups in the different spatial stratifications studied, showing values that range between 52-58% of the landed bycatch species. The IOO species ranks second in importance with values in the range of 18-30%. The highest prevalence of IOO was found in the overlap region (30%) and the lowest numbers within the confines of the WCPFC region(18%). The groups Other SHK, TUN, BIL and OTH ranged between 1-12%, 4-7%, 3-5%, 2-4%, respectively.

There was an increase in the landing in weight for the overall bycatch in the last two years examined as compared to previous years (figure 1). This may be due to an improvement in the statistical processing of the data because of better sampling coverage during recent prospecting surveys and better taxonomic identification at the species level. However, other factors may also be involved, such as the increase in the amount of fish retained in some species or, in more recent years, the expansion to new fishing areas. The general increase in the prevalence of the TUN group from the year 2002 onward may be attributed to the change in fishing gear, when the vessels switched from the traditional style to the American style gear which started to be used by the majority of the vessels as of this date.

The overall landings per unit of effort data or yield (labeled as CPUE) per year obtained during the period 1990-2005 for species or groups of bycatch species is shown in figure 6. For the Pacific, as a whole remarkably high yields of PGO were observed in 1999 and 2000; more moderate yields were had in the 2001-2004 period and there was an increase in 2005, during which time the overall catch reached nearly 500 kg per thousand hooks set. In 1997 particularly low yields were recorded as a consequence of discard practices carried out specifically by some vessels during this year. As regards IOO, the second bycatch species in order of importance, the yields have remained relatively stable over the course of the time series, fluctuating between 100-250 kg per thousand hooks set. In terms of the other bycatch species or groups, increasing yields were observed starting in 1998, with numbers being especially pronounced from the year 2001 on, when most of the vessels belonging to the Spanish surface longline fleet changed fishing gears and set up routine onboard scientific observer programs.

Preliminary yield data from 2004 and 2005 pertaining to the convention areas of the two Pacific Commissions as well as to the overlap area they have in common, would suggest that the yields of PGO, IOO and the other bycatch species are generally higher in the WCPFC area (figure 7). Although PGO catches in the WCPFC zone totalled only 500 t in 2004, as compared to the over 1900 t obtained in the IATTC zone, the prevalences of PGO observed in the landings, however, were higher in the WCPFC (and overlap zone) –around 30%– versus 20% observed in the IATTC region. As regards groups or species other than PGO and IOO, the results could be positively affected by the increased statistical coverage available in the most recent years in the WCPFC and overlap areas, as compared to the IATTC zones. Similarly, the yields obtained for bycatch species or groups of species in the convention areas of the two Commissions (with the addition of the overlap area in both cases) would confirm that higher values were obtained in the WCPFC areas in 2004-2005 (figure 8).

The estimates presented come from records on landings or catches held on board and do not take into consideration discard practices or other possible uses of the catch over the time series, which might affect the prevalences and yields obtained. Although it would be necessary to conduct specific studies to estimate discard rates, they are believed to be practically non-existent or irrelevant for the species of greatest commercial interest in the most recent years, including virtually all pelagic sharks. Discard ratios were estimated for the BIL group in the different oceans. During the 1993-2005 period, in the Pacific regions, it was estimated that roughly 82% of the catch was held on board, 10% was discarded, 2%

released alive and 5% tagged and released alive. However, starting in the year 2001, the discard level was null or practically null, with the number of billfishes tagged and released alive reaching up to 6% and fishes released alive accounting for up to 2% (MEJUTO et al. in press).

Figures 9-11 give us an idea of the nominal effort applied by the Spanish surface longline fleet in the Pacific Ocean from 1990 to 2005, showing the important geographic expansion than has taken place, particularly during the most recent years.

The number of hooks observed to estimate interaction rates with marine turtles and sea birds were 3.282 millions of hooks (2.153 and 1.129 for IATTC and WCPFC areas, respectively), corresponding to 2,347 sets observed (1,248 and 1,099 for IATTC and WCPFC areas, respectively). The marine turtle species potentially affected in the convention area of the IATTC were identified as *Caretta caretta*, *Dermochelys coriacea*, *Lepidochelys olivacea*, *Chelonias mydas*. The sea bird species were *Diomedea bulleri*, *D. clororhinchus*, *D. exulans*, *D. melanophris*, *D. cauta*, *Procellaria aequinoctalis*, *P. cinerea* and *Macronectes halli*. The marine turtle species potentially affected in the convention area of the WCPFC were *Caretta caretta, Dermochelys coriacea*, *Lepidochelys olivacea*. The sea bird species were reported as *Diomedea exulans, D. inmutabilis, D. nigripes*, and *D. sanfordi*.

The overall rate of interaction by hook for the Pacific as a whole was estimated at $9.99343*10^{-5}$ for marine turtles and $3.74754*10^{-5}$ for sea birds. The overall rate of mortality was estimated to be $6.70291*10^{-6}$ and $3.71707*10^{-5}$, for marine turtles and sea birds, respectively. The interaction mortality rates for these combined species by convention area of the IATTC and WCPFC Commissions are summarized in table 5. These estimations should be considered preliminary because area-time stratification of the observations was not taken into consideration.

ACKNOWLEDGEMENTS.

We would like to thank to A. Carroceda, F. González, I. González, J. Lorenzo, M. Marín, M. Quintans, J.L. Torres and the Scientific Observers as well as all the skippers and sailors who have collaborated with us.

LITERATURE.

CASTRO J., 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 51:1882-1984.

GARCÍA-CORTÉS B., J. Mejuto (2001). Preliminary scientific estimations of by-catches landed by the Spanish surface longline fleet in the Indian Ocean: years 1993-2000. IOTC. Sci. Doc WPB-01-08.

GARCÍA-CORTÉS B., J. Mejuto (2002). Preliminary scientific estimations of tuna (tribe: Thunnini) landed by the Spanish surface longline fleet targeting swordfish in the Atlantic Ocean and Mediterranean Sea: years 1999-2000. ICCAT. Col. Vol. Sci. Pap. Vol 54: 1720-1725 (CD vers SCRS/01/101).

GARCÍA- CORTÉS, B., J. Mejuto (2005). Scientific estimations of bycatch landed by the Spanish surface longline fleet targeting swordfish (Xiphias gladius) in the Indian ocean: 2001-2003 period. IOTC-2005-WPBY-14 (Working Party on Bycatch) (www.swychelles.net/iotc/).)

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.ç

MEJUTO J., B. García-Cortés, F. González (2001a). Datos preliminares a partir de observadores científicos a bordo de palangreros de superficie (U.E.-España) durante 1998. 1999 y 2000 en el

Océano Pacífico Este. Sci. Doc. Swordfish Working Group. IATTC.

MEJUTO J. , B. García-Cortés, J.M. de la Serna (2001b). Standardized catch rates for the North and South Atlantic swordfish (Xiphias gladius) from the Spanish longline fleet for the period 1983-1999. ICCAT.Col. Vol. Sci. Pap. Vol 53 (CD vers. SCRS/00/155).

MEJUTO J., B. García-Cortés, J.M. de la Serna (2001c). Brief note about the activity of the Spanish surface longline fleet catching swordfish (Xiphias gladius) in the Atlantic and Mediterranean during the year 1999. ICCAT. Col.Vol. Sci. Pap. Vol 53 (CD vers. SCRS/00/154).

MEJUTO J., B. García-Cortés, J.M. de la Serna (2002a). A note on preliminary standardized catch rates for the North Atlantic swordfish (Xiphias gladius) from the Spanish longline fleet, for the period1983-2000. ICCAT. Col. Vol. Sci. Pap. Vol 54: 1550-1554 (CD vers SCRS/01/150).

MEJUTO J., B. García-Cortés, J.M. de la Serna (2002b). 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 54:1150-1163 (CD vers. SCRS/01/049).

MEJUTO J., B. García-Cortés, J.M. de la Serna (2002c). Preliminary scientific estimations of billfish (Fam: Istiophoridae) landed by the Spanish surface longline fleet targeting swordfish in the Atlantic Ocean and Mediterranean Sea: years 1999-2000. ICCAT. Col. Vol. Sci. Pap. Vol 54: 826-833 (CD vers SCRS/01/102).

MEJUTO J., B. García-Cortés (2004). Preliminary relationships 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. 56 (1):243-253.

MEJUTO J., B. García-Cortés (2005). Documentación sobre la preparación de datos científicos de la pesquería española de pez espada (Xiphias gladius) en las regiones del Pacífico , con especial referencia a los años más recientes 2002 y 2003. Data and Standard Review Meeting of IATTC. La Jolla California, April 29-30, 2005.

MEJUTO J., B. García-Cortés, J. M. de la Serna, A. Ramos-Cartelle (2006). Scientific estimations of bycatch landed by the Spanish surface longline fleet targeting swordfish (Xiphias gladius) in the Atlantic ocean: 2000–2004 period. ICCAT. Col. Vol. Sci. Pap. Vol 59(3): 1014-1024 (CD vers SCRS/2005/074).

MEJUTO J., B. García-Cortés, A. M. Ramos-Cartelle (in press). Preliminary approach to evaluate the importance of the discards and other uses of billfish in the Spanish surface longline fishery carried out in different oceans between 1993-2005. ICCAT. Col. Vol. Sci. Pap. (submitted as SCRS/2006/060).

Table 1. Scientific estimations in kg of round weight (RW) of the landings of the target species (Xiphias gladius) and species considered to be bycatch of the Spanish surface longline fishery, during the 1990-2005 period, all Pacific areas combined.

YEAR	TOTAL SWO	TOTAL Bycatch	TOTAL
1990	1006629	283643	1290272
1991	2794086	1067614	3861700
1992	2435044	2009273	4444317
1993	928139	752984	1681123
1994	575696	341941	917637
1995	697822	368520	1066342
1996	771642	599642	1371284
1997	2018492	399766	2418258
1998	1302496	1345483	2647979
1999	1121031	1661602	2782633
2000	1806596	1899404	3706000
2001	3426533	2922259	6348792
2002	5629190	3260351	8889541
2003	5912715	3192137	9104852
2004	6285629	4779309	11064938
2005	6211871	7030726	13242597

Table 2. List of reported bycatch species, or groups of species, and scientific estimations in Kg of round weight (RW) of landings considered to be bycatch of the Spanish surface longline fishery, during the 1990-2005 period. Species/groups taxonomic identification was kept as reported.

Group	Species / Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
SHK	Alopias spp.	0	0	1730	0	0	0	0	0	1481	0	0	0	2155	1097	4308	0
SHK	Alopias superciliosus	347	0	0	0	0	0	0	0		0	0	0	0	0	8233	6874
SHK	Alopias vulpinus	0	0	0	0	0	0	0	0		0	0	0	0	0	779	778
SHK	Carcharhinus spp.	0	0	19501	6879	0	0	550	0	8051	2009	0	0	0	9926	10776	29955
SHK	Carcharhinus altimus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	84
SHK	Carcharhinus brachyurus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5060	6088
SHK	Carcharhinus falciformis	0	0	0	0	0	0	0	0	17238	5304	0	0	0	0	25496	1002
SHK	Carcharhinus galapagensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	378	436
SHK	Carcharhinus longimanus	0	0	0	0	0	0	0	0	12688	4219	0	0	0	0	52612	6184
SHK	Carcharhinus obscurus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	226
SHK	Carcharhinus plumbeus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3077	448
SHK	Galeocerdo cuvier	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2856	1065
SHK	Isurus oxyrhinchus	125464	323581	445604	381405	151735	204009	297778	302471	572269	347605	359831	1029006	1004774	977029	1366922	1666006
SHK	Isurus paucus	0	0	0	0	0	0	0	0	2856	6358	81	0	1560	8553	18178	9153
SHK	Lamna ditropis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	281934
SHK	Lamna nasus	8432	0	0	0	0	0	0	0	8066	6965	6377	144107	14364	5688	13257	11573
SHK	Prionace glauca	144919	714754	1511095	354535	189456	164454	301055	89935	660940	1280327	1486860	1691271	1886276	1776094	2406613	4065273
SHK	Sphyrna lewini	0	0	0	0	0	0	0	0	15	0	0	0	0	0	1202	0
SHK	Sphyrna spp.	0	0	3620	357	0	0	259	0	6511	93	0	0	0	0	678	2381
SHK	Sphyrna zygaena	0	0	0	0	0	0	0	0	1181	0	0	0	0	0	2781	1751
OTH	Brama sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	4	139	0
OTH	Coryphaena hipurus	0	0	0	0	0	0	0	0	0	403	132	1745	27457	12375	38142	18968
OTH	Lepidocybium flavobrunneum	104	0	41	0	0	0	0	0	0	0	0	0	64103	61291	131536	123373
OTH	Lampris guttatus	0	0	0	0	0	0	0	0	0	0	64	0	1191	280	6742	8078
OTH	NIS	0	0	0	0	0	0	0	0	0	0	0	0	46600	47677	26824	52194
OTH	Rubettus pretiosus	208	0	0	0	0	0	0	0	0	0	0	0	882	2799	6013	15648
OTH	Sphyraena sp.	0	0	0	0	0	0	0	0	0	0	0	0	616	2436	8402	5557
BIL	BILL	0	0	0	0	0	0	0	0	0	0	0	25520	29878	99320	159491	212489
BIL	Istiophorus platypterus	0	0	2748	0	0	0	0	0	0	0	0	0	5895	3977	13188	6905
BIL	Makaira mazara	0	0	0	0	0	0	0	0	0	0	0	0	0	0	33864	49521
BIL	Makaira indica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	144
BIL	Tetrapturus angustirostris	202	0	0	0	0	0	0	0	0	0	403	0	0	169	4459	1857
BIL	Tetrapturus audax	1301	0	0	0	0	0	0	0	0	0	2597	60	722	917	48161	40166
TUN	Acanthocybium solandri	289	0	2581	0	81	6	0	798	0	0	0	0	0	54	3471	4305
TUN	Gasterochisma melampus	0	0	0	0	0	0	0	0	0	0	0	0	779	23344	3743	1600
TUN	Katsuwonus pelamis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1087	13
TUN	Thunnus alalunga	1012	0	9389	9707	285	22	0	2794	0	450	1310	0	1091	2178	13819	16464
TUN	Thunnus obesus	1047	29279	9714	0	255	22	0	2890	18429	5403	4270	1546	43860	20697	91171	40972
TUN	Thunnus albacares	318	0	2950	0	89	7	0	878	4919	2555	1449	192	6700	4697	31053	3491
TUN	Thunnus maccoyii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1033	0
TUN	Thunnus thynnus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	141
TUN	TUNA	0	0	0	0	0	0	0	0	0	0	0	28812	122448	134715	237708	309928

Table 3. Summary of the scientific estimations in kg of round weight (RW) of the landings by the most prevalent species (IOO, PGO) or groups of species (Other SHK, BIL, TUN, OTH) considered to be bycatch of the Spanish surface longline fishery, for the 1990-2005 period (all areas combined) and by Convention areas for the years 2004 and 2005 (down). Before 2004 all catches should be allocated into IATTC convention area.

Group / Year	SHK IOO	SHK PGO	SHK Other SHK	OTH OTH	BIL BIL	TUN TUN
1990	125464	144919	8779	312	1503	2666
1991	323581	714754	0	0	0	29279
1992	445604	1511095	25051	41	2748	24734
1993	381405	354636	7236	0	0	9707
1994	151735	189456	0	0	0	750
1995	204009	164454	0	0	0	57
1996	297778	301055	809	0	0	0
1997	302471	89935	0	0	0	7360
1998	572369	690940	58826	0	0	23348
1999	347505	1280327	24948	403	0	8419
2000	392831	1489890	6458	196	3000	7029
2001	1029006	1691271	144107	1745	25580	30550
2002	1004774	1886276	18149	139749	36495	174908
2003	977029	1776034	24974	126862	101683	185555
2004	1366922	2409613	149768	217758	252163	383085
2005	1656006	4085273	353672	223618	308213	403944

	Year 2004			Year 2005		
Group/Species	IATTC	OVERLAP	WCPFC	IATTC	OVERLAP	WCPFC
Isurus oxyrhinchus	1181988	16182	168752	1225360	74871	355775
Prionace glauca	1921330	40708	447575	2651919	93005	1340348
Other SHK	61407	4274	84087	47236	6213	300223
OTH	179339	1240	37179	173340	6435	43843
BILL	214498	2524	35141	233713	11220	63280
TUNA	310088	8165	64832	356084	5635	42225

Table 4. Prevalences (%) in weight of the different bycatch species or groups of species landed by the Spanish surface longline fleet in relation to the total bycatch obtained per year (1990-2005), all areas combined.

Group	Species / Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
SHK	*Alopias spp.*	0,000	0,000	0,086	0,000	0,000	0,000	0,000	0,000	0,110	0,000	0,000	0,000	0,057	0,034	0,082	0,000
SHK	*Alopias superciliosus*	0,122	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,157	0,098
SHK	*Alopias vulpinus*	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,015	0,011
SHK	*Carcharhinus spp.*	0,000	0,000	0,971	0,914	0,000	0,000	0,092	0,000	0,621	0,121	0,000	0,000	0,000	0,302	0,205	0,337
SHK	*Carcharhinus altimus*	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,001
SHK	*Carcharhinus brachyurus*	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,097	0,087
SHK	*Carcharhinus falciformis*	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	1,281	0,319	0,000	0,000	0,000	0,000	0,486	0,014
SHK	*Carcharhinus galapagensis*	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,007	0,005
SHK	*Carcharhinus longimanus*	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,943	0,254	0,000	0,000	0,000	0,000	1,003	0,088
SHK	*Carcharhinus obscurus*	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,003
SHK	*Carcharhinus plumbeus*	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,059	0,005
SHK	*Galeocerdo cuvier*	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,055	0,015
SHK	*Isurus oxyrinchus*	44,233	30,309	22,177	50,652	44,375	55,359	49,659	75,662	42,540	20,914	20,682	35,213	30,818	30,607	26,055	23,554
SHK	*Isurus paucus*	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,215	0,383	0,004	0,000	0,049	0,268	0,346	0,130
SHK	*Lamna ditropis*	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	4,010
SHK	*Lamna nasus*	2,973	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,622	0,419	0,336	4,581	0,441	0,178	0,253	0,165
SHK	*Prionace glauca*	51,092	66,949	75,206	47,097	55,406	44,626	50,206	22,497	51,353	77,054	78,440	57,875	57,855	55,638	54,831	58,106
SHK	*Sphyrna lewini*	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,001	0,000	0,000	0,000	0,000	0,000	0,023	0,000
SHK	*Sphyrna spp.*	0,000	0,000	0,190	0,047	0,000	0,000	0,043	0,000	0,491	0,006	0,000	0,000	0,000	0,000	0,013	0,034
SHK	*Sphyrna zygaena*	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,088	0,000	0,000	0,000	0,000	0,000	0,053	0,025
OTH	*Brama sp.*	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,003	0,000
OTH	*Coryphaena hippurus*	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,024	0,007	0,060	0,842	0,388	0,727	0,261
OTH	*Lepidopus caudatus*	0,037	0,000	0,002	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	1,966	1,920	2,507	1,755
OTH	*Lampris guttatus*	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,003	0,000	0,037	0,009	0,129	0,115
OTH	NS	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	1,396	1,494	0,511	0,742
OTH	*Rubettus pretiosus*	0,073	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,027	0,088	0,115	0,223
OTH	*Sphyraena sp.*	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,019	0,076	0,160	0,085
BIL	BILL	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,873	0,916	3,027	2,907	3,022
BIL	*Istiophorus platypterus*	0,000	0,000	0,137	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,181	0,125	0,251	0,098
BIL	*Makaira mazara*	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,645	0,663
BIL	*Makaira indica*	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,002
BIL	*Tetrapturus angustirostris*	0,071	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,021	0,000	0,000	0,005	0,085	0,026
BIL	*Tetrapturus audax*	0,459	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,137	0,002	0,022	0,029	0,918	0,572
TUN	*Acanthocybium solandri*	0,102	0,000	0,133	0,000	0,024	0,002	0,000	0,200	0,000	0,000	0,000	0,000	0,000	0,002	0,066	0,052
TUN	*Gasterochisma melampus*	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,024	0,728	0,071	0,023
TUN	*Katsuwonus pelamis*	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,021	0,000
TUN	*Thunnus alalunga*	0,357	0,000	0,467	1,289	0,083	0,006	0,000	0,699	0,000	0,027	0,069	0,000	0,033	0,068	0,253	0,234
TUN	*Thunnus obesus*	0,399	2,742	0,483	0,000	0,086	0,006	0,000	0,723	1,370	0,325	0,225	0,053	1,346	0,647	1,738	0,583
TUN	*Thunnus albacares*	0,112	0,000	0,147	0,000	0,026	0,002	0,000	0,220	0,366	0,154	0,076	0,007	0,205	0,147	0,592	0,050
TUN	*Thunnus maccoyi*	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,020	0,000
TUN	*Thunnus thynnus*	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,002
TUN	TUNA	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,986	3,756	4,220	4,531	4,792

Table 5. Overall estimation of the interaction (live and dead) and mortality rates (dead) for marine turtles and sea birds by Convention area. Data from the overlapping area are included in both Convention areas.

	IATTC		WCPFC	
Species	*Interaction rate*	*Mortality rate*	*Interaction rate*	*Mortality rate*
Marine Turtles	6,50301E-05	7,89651E-06	0,000166474	4,42750E-06
Sea Birds	4,04115E-05	3,99470E-05	3,18780E-05	3,18780E-05

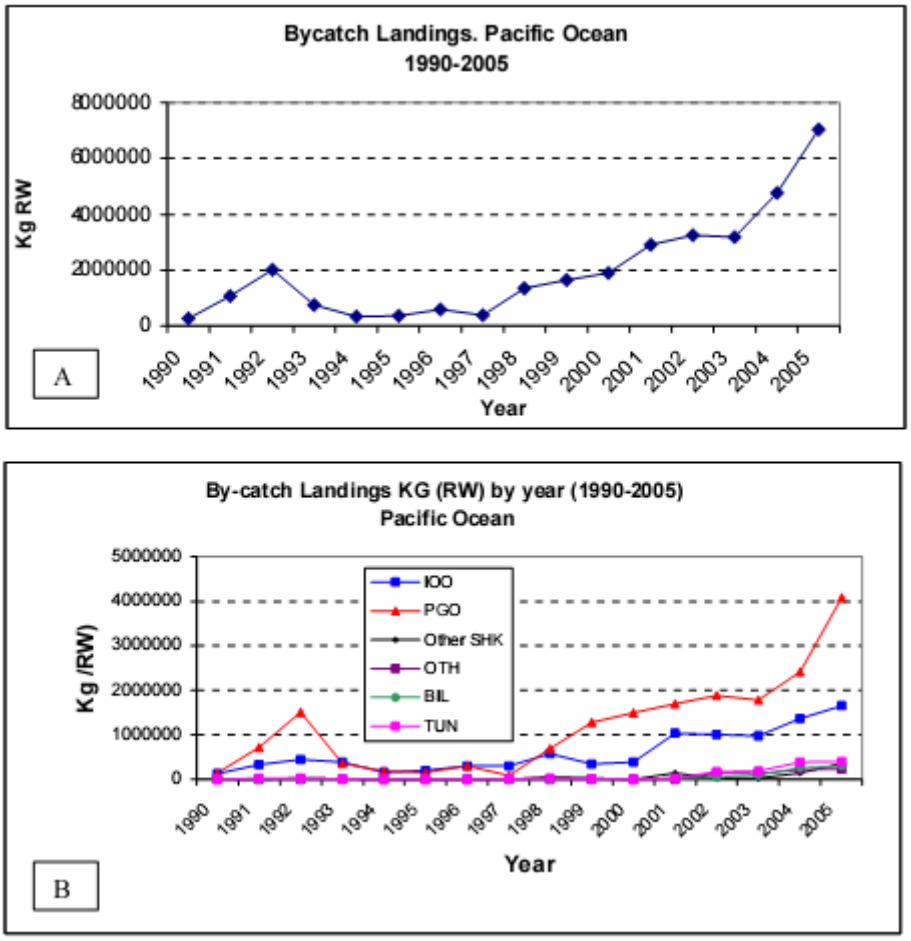

Figure 1. Scientific estimations of landings of bycatch species (kg round weight) by the Spanish surface longline fleet from 1990-2005 in the Pacific Ocean. (A) : All bycatch species combined. (B): By species or group of bycatch species.

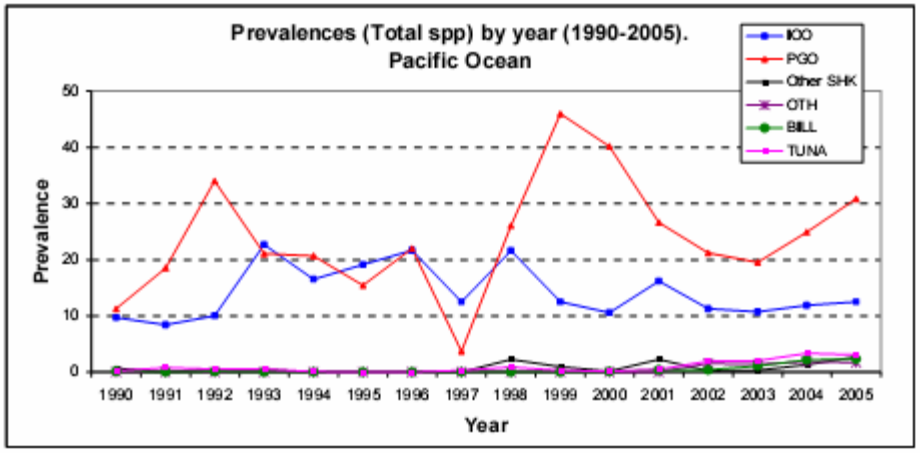

Figure 2. Annual prevalence (%) of each bycatch species or group of species in relation to the total landings in weight of all the species combined (target species+ bycatch species), during the 1990-2005 period.

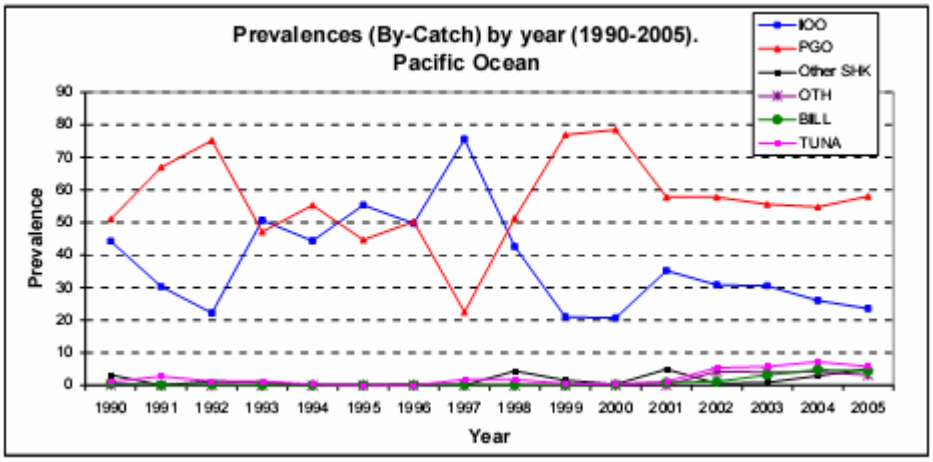

Figure 3. Annual prevalence (%) of each bycatch species or group of species in relation to landings in weight of the bycatch species combined during the 1990-2005 period.

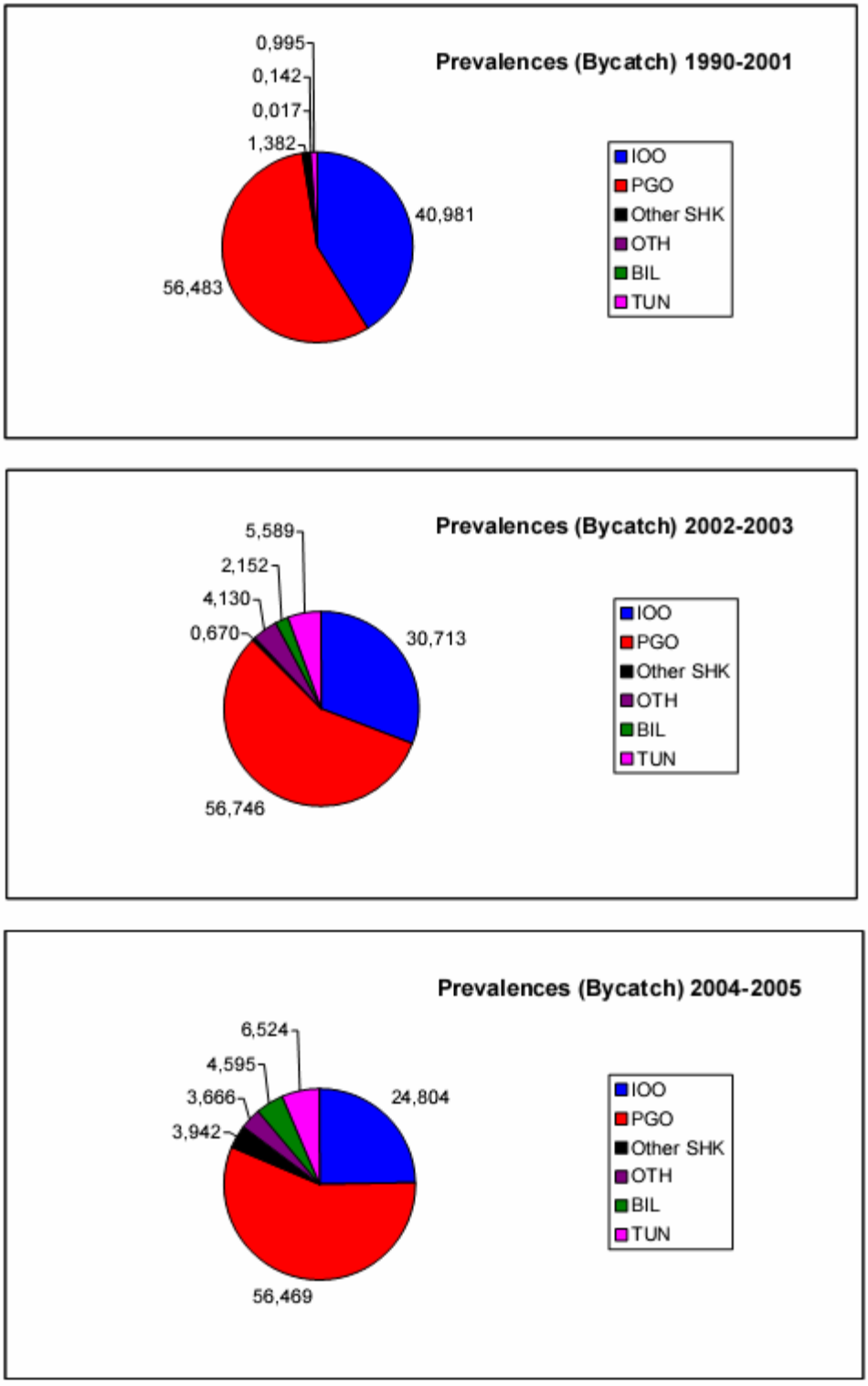

Figure 4. Prevalence (%) by species and group of species in relation to the total weight of bycatch landed by the Spanish surface longline fleet in the Pacific Ocean for different periods (1990-2001, 2002-2003 and 2004-2005).

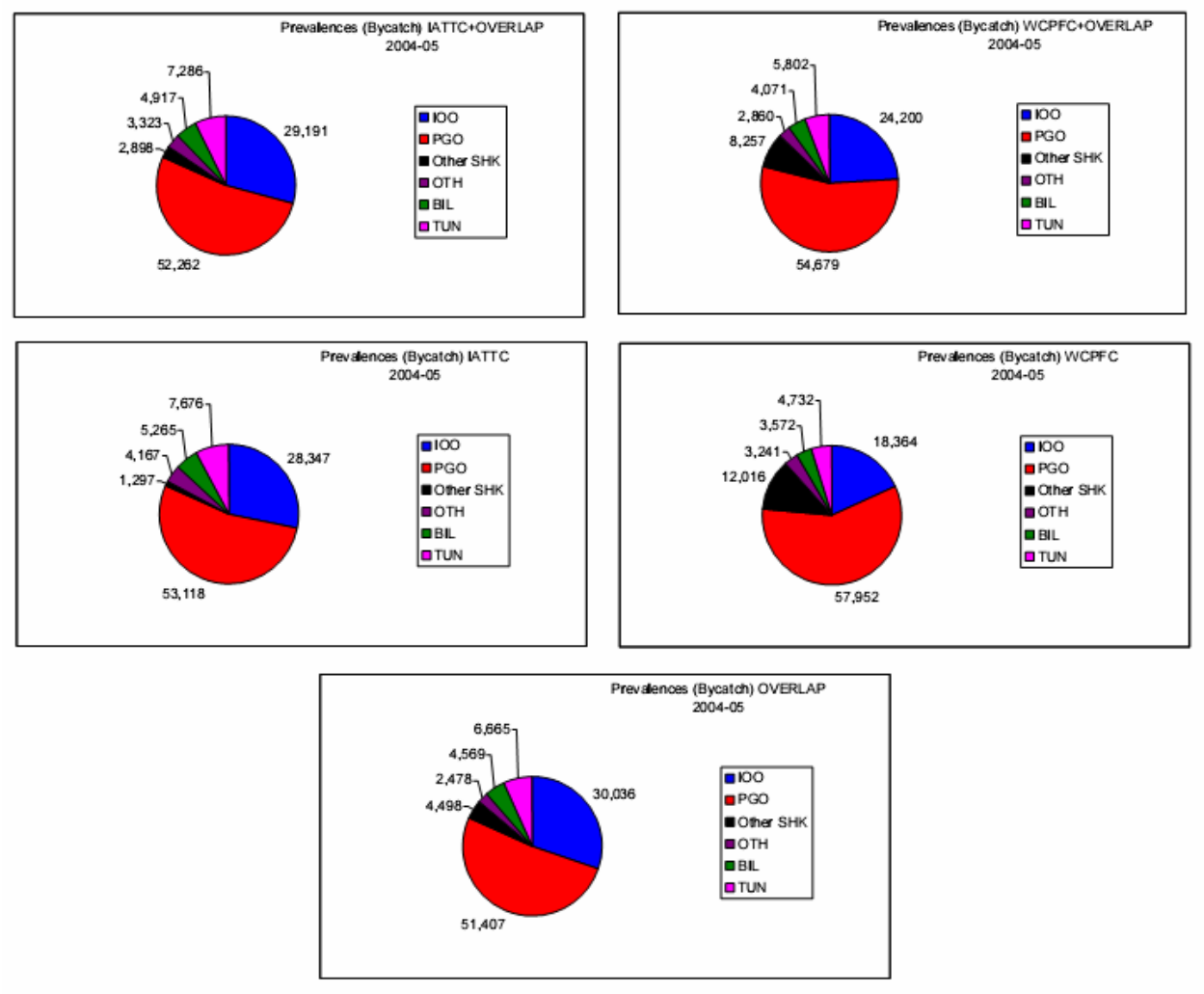

Figure 5. Prevalence (%) by species or group of species in relation to the total bycatch landed and by convention area of the Commissions in the Pacific Ocean from 2004-2005, considering the overlap area in each one (above), without considering the overlap area in each one (centre) or only considering the overlap area separately (below).

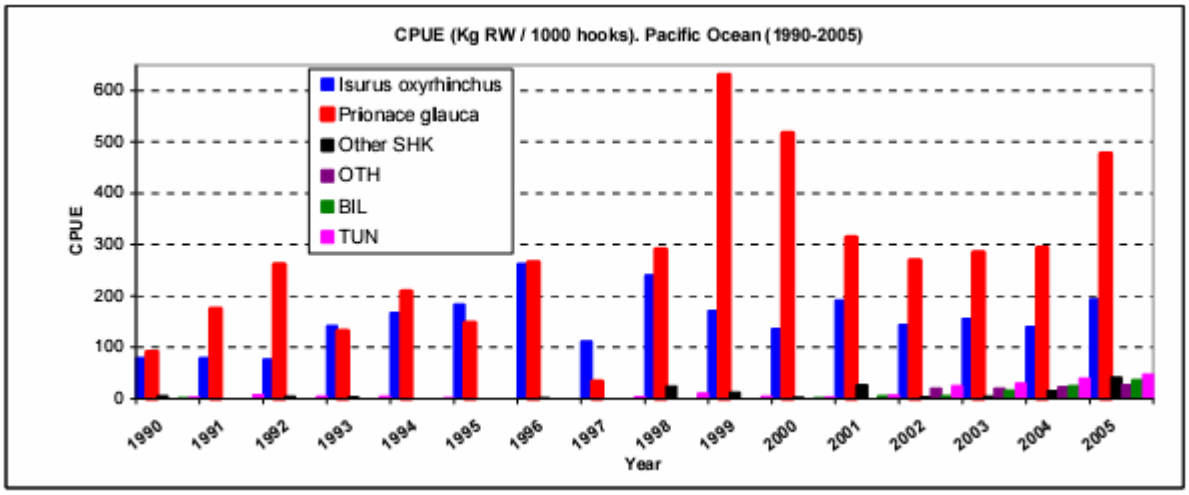

Figure 6. Fishing yields in kg per thousand hooks (landings per unit of effort) of the bycatch species or groups of species obtained by the Spanish swordfish fleet in the Pacific Ocean during the 1990-2005 period.

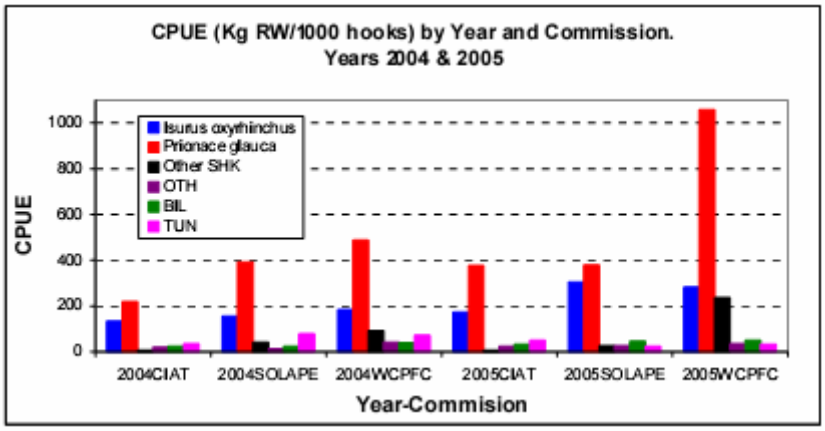

Figure 7. Fishing yields in kg per thousand hooks (landing per unit of effort) of the bycatch species or groups of species obtained by the Spanish swordfish fleet by strict Convention Area and in the overlap area between the two for the years 2004 and 2005.

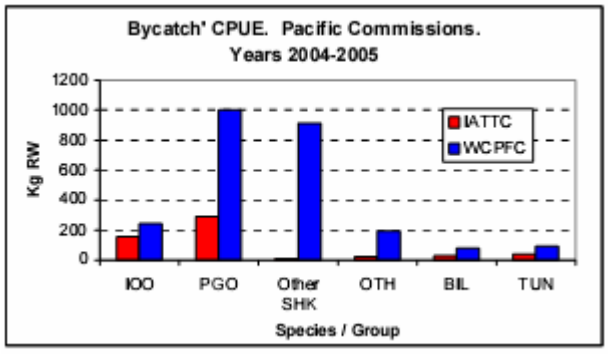

Figure 8. Fishing yields in kg per thousand hooks (landing per unit of effort) of the bycatch species or groups of species obtained by the Spanish swordfish fleet by Convention Area including the overlap area in both for the years 2004 and 2005 combined.

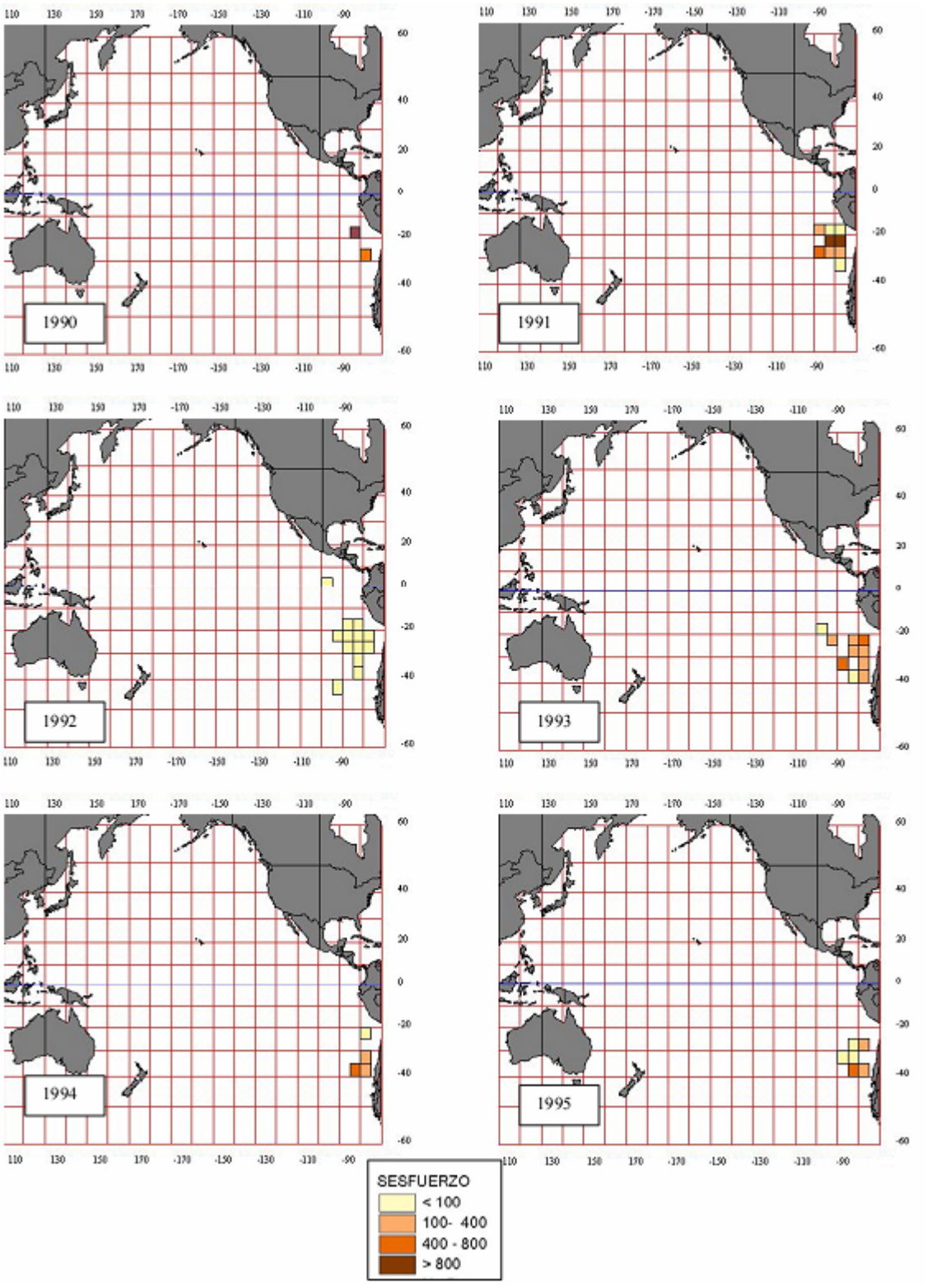

Figure 9. Fishing effort (thousand hooks) of the Spanish longline fishery targeting swordfish, by 5ºx5º squares in the Pacific Ocean and year (1990-1995)

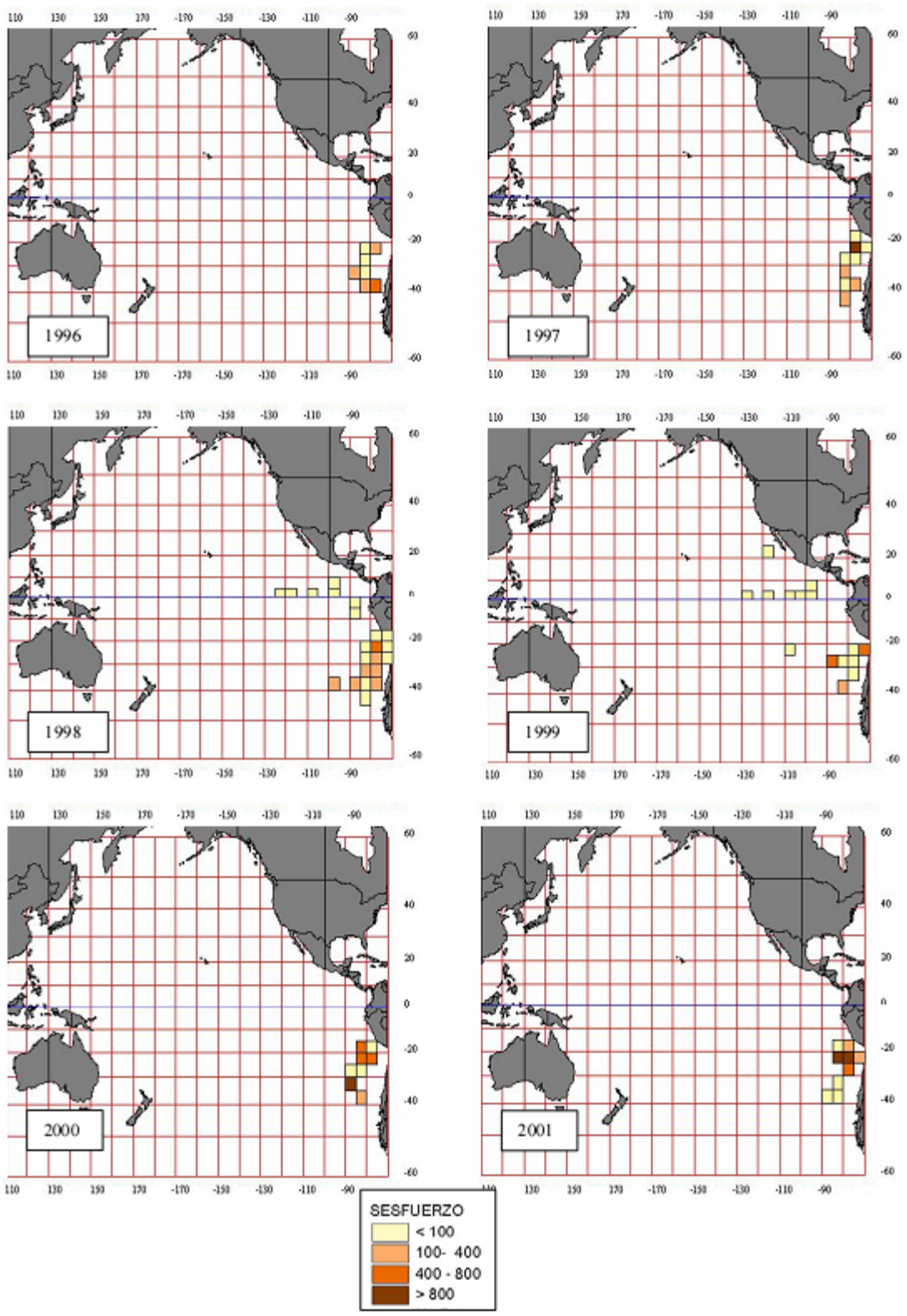

Figure 10. Fishing effort (thousand hooks) of the Spanish longline fishery targeting swordfish, by 5ºx5º squares in the Pacific Ocean and year (1996-2001).

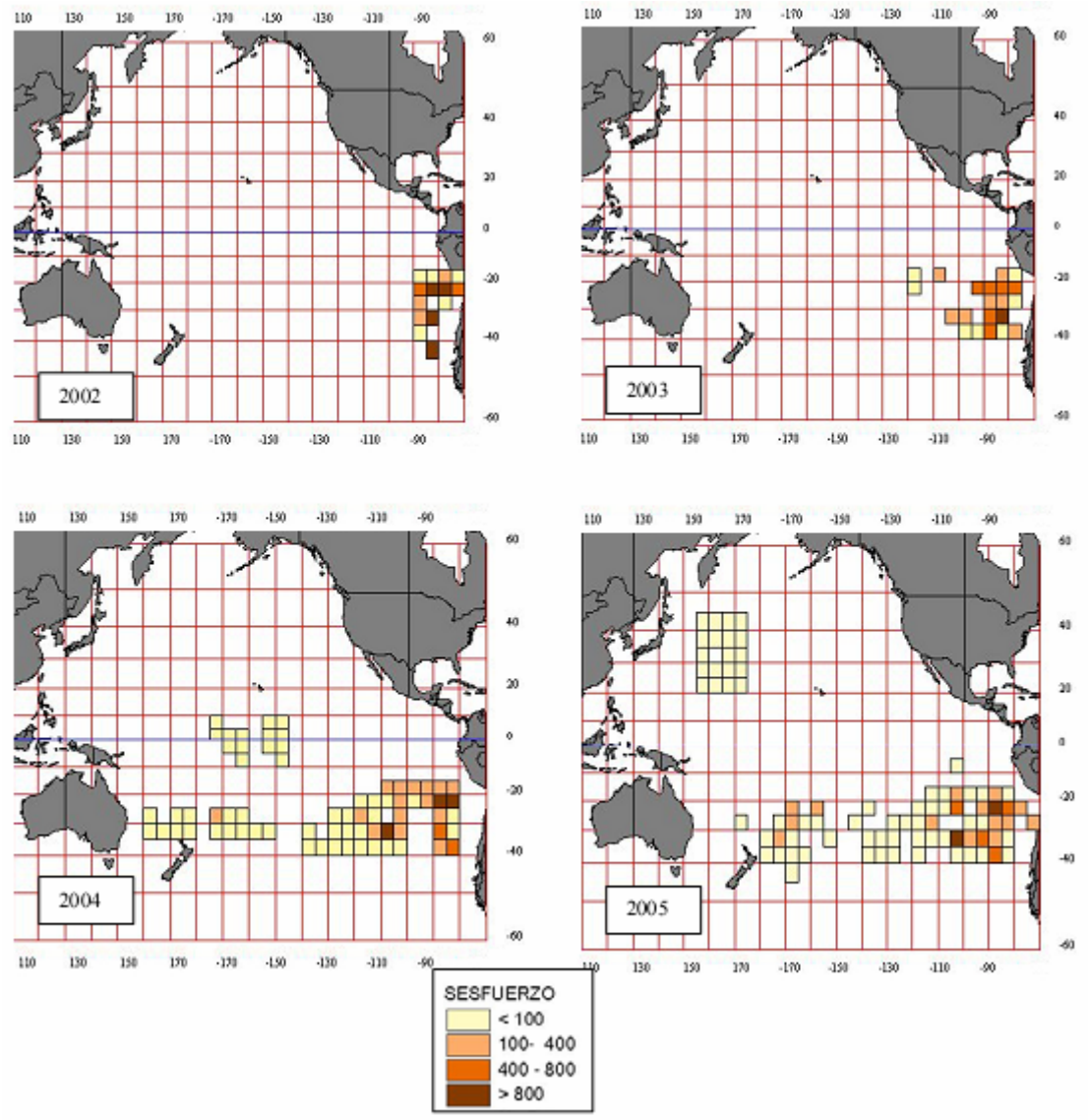

Figure 11. Fishing effort (thousand hooks) of the Spanish longline fishery targeting swordfish, by 5ºx5º squares in the Pacific Ocean and year (2002-2005).