

ESTIMATIONS OF NON-RETAINED CAPTURE OF SWORDFISH, *XIPHIAS GLADIUS*, IN THE SOUTHWESTERN ATLANTIC OCEAN

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SUMMARY

The objective of this contribution is to assess the proportion of captured swordfish (Xiphias gladius) that is retained on board fishing vessels and the proportion that is discarded back at sea based on data obtained by scientific observers. Data were recorded in Uruguayan and Japanese flagged vessels operating in Uruguayan and international adjacent waters. The number of swordfish observed between 1998 and 2011 in the Uruguayan-flagged vessels was 25,318. In the Japanese-flagged vessels 7,551 individuals were observed in the period 2009-2011. Proportions of the different catch dispositions (retained, retained bitten, discarded dead, discarded bitten, released alive and lost) in relation to the total swordfish capture are presented. These preliminary results suggest that the retained bitten and the non-retained catch of swordfish (most of it being discarded dead) may represent a considerable proportion of the total catch and could result in underestimations of abundance and fishing mortality.

RÉSUMÉ

L'objectif du présent document est d'évaluer la proportion d'espadon (Xiphias gladius) capturé qui est retenue à bord des navires de pêche et la proportion qui est rejetée à l'eau sur la base des données obtenues des observateurs scientifiques. Les données ont été consignées à bord de navires battant le pavillon de l'Uruguay et du Japon et opérant dans les eaux uruguayennes et les eaux internationales adjacentes. Le nombre d'espadons observés entre 1998 et 2011 à bord des navires sous pavillon uruguayen s'élevait à 25.318. Dans le cas des navires battant le pavillon du Japon, 7.551 spécimens ont été observés entre 2009 et 2011. Les proportions des différentes composantes de la capture (rétention à bord, rétention à bord de spécimens mordus, rejet mort, rejet de spécimens mordus, rejet vivant et perte) par rapport au total de la capture d'espadon ont été présentées. Les résultats préliminaires donnent à penser que la capture retenue de spécimens mordus et la capture non retenue d'espadon (dont la majeure partie est rejetée à l'état mort) peut représenter une proportion importante de la capture totale et pourrait donner lieu à des sous-estimations de l'abondance et de la mortalité par pêche.

RESUMEN

El objetivo de estas contribuciones es evaluar la proporción de pez espada (Xiphias gladius) capturado que se retiene a bordo de los buques pesqueros y la proporción que se descarta en el mar basándose en los datos obtenidos por observadores científicos. Los datos se recogieron en buques con pabellón de Uruguay y de Japón que operan en aguas uruguayas y en aguas internacionales adyacentes. El número de peces espada observado entre 1998 y 2011 en los buques con pabellón de Uruguay fue de 25.318. En los buques con pabellón de Japón se observaron 7.551 ejemplares en el periodo 2009-2011. En el documento se muestran las proporciones de las diferentes disposiciones de la captura (retenida, retenida mordida, descartada muerta, descartada mordida, liberada viva y perdida) con respecto a la captura total de pez espada. Estos resultados preliminares sugieren que la captura de pez espada retenida mordida y no retenida (la mayoría descartada muerta) puede representar una considerable proporción de la captura total y podrían tener como resultado subestimaciones de la abundancia y de la mortalidad por pesca.

KEYWORDS

Swordfish, Southwestern Atlantic, Retained capture, Non-retained capture, Longline

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1. Introduction

The information collected by on board scientific observers regarding the classification of fishing vessels capture as retained and non-retained (released alive, discarded dead, discarded bitten or lost) can be used to estimate the proportion of the total catch that is not reported on logbooks. Non-retained capture can be relevant when conducting abundance and fishing mortality estimations, as well as fishing efficiency assessments (Domingo *et al.* 2011a). In the 2013 Albacore Data Preparatory Meeting Uruguay presented the first estimates of albacore discards. The preliminary results showed that the percentage of non-retained capture of the Uruguayan and Japanese fleets was 12.2% and 3.6%, respectively, in the Uruguayan EEZ and adjacent international waters (Domingo *et al. in press*). Based on these results, the Group recommended to extend these studies to other longline fisheries, and also recommended that CPUE series be constructed using data from both retained and discarded data (ICCAT 2013).

The objective of this study was to assess the proportion of captured swordfish that is retained as well as the proportion that is returned to the sea.

2. Material and methods

Data was obtained by scientific observers from the National Observer Program on board the Uruguayan Tuna Fleet (PNOFA) between 1998 and 2011. Two longline fleets were considered, the Uruguayan longline fleet and the Japanese longline fleet.

The Uruguayan fleet operates mainly in the Southwestern Atlantic in Uruguayan jurisdictional waters (UEEZ) and adjacent international waters. The effort observed between 1998 and 2011 reached 3,855,410 hooks in 106 fishing trips. Observer's coverage, in relation to the total effort of the Uruguayan fleet, averaged 28.8% (range: 4.8-68.6%). Japanese-flagged vessels operated almost exclusively within the UEEZ with an experimental fishing license during austral autumn and winter of 2009-2011. Coverage of this fleet was 100%, representing a total effort of 2,427,395 hooks in 25 fishing trips.

The Uruguayan longline fleet operates mainly with American type longline and targets mainly swordfish (*Xiphias gladius*) and tunas (*Thunnus obesus* and *T. albacares*), and in some cases blue shark (*Prionace glauca*). The Japanese longline fleet that operated in Uruguayan waters targeted bigeye tuna (*T. obesus*), and swordfish was taken mostly as accompanying fauna.

Data recorded for each fishing trip included: effort (number of hooks), total catch (regardless of species), total swordfish catch, and catch disposition. Catch disposition was further classified in six categories: retained, retained bitten (damage by predation), released alive, discarded dead, discarded bitten or lost (i.e. proportion of total capture that becomes detached from the gear at the moment of hauling). Predation interaction and the resultant damage of part of the catch is mainly done by marine mammals (killer whale, *Orcinus orca* and false killer whale, *Pseudorca crassidens*) and sharks (mainly Carcharhinidae and Lamnidae) and was visually examined by the observers. The nominal CPUE was calculated as the number of individuals every 1,000 hooks (ind./1,000 hooks).

3. Results and discussion

The Uruguayan longline fleet captured a total of 25,318 swordfish between 1998 and 2011 (**Table 1**). Average CPUE per trip was 9.43ind./1,000 hooks (± 6.72 s.d.) but varied significantly among years (Kruskal-Wallis, $\chi^2 = 30.6382$, $df = 13$, $p < 0.01$) and showed a decreasing tendency towards most recent years (**Figure 1a**). Overall, the proportion of swordfish in relation to the total capture for each fishing trip was low, although different among years (Kruskal-Wallis, $\chi^2 = 28.8416$, $df = 13$, $p < 0.01$). On average swordfish captures represented 14.8% (± 10.7) of the total catch between 1998 and 2011, and in 61.3% of all fishing trips analyzed the percentage exceeded 10% (range: 0.08-48.1%; **Figure 2a**). Considering all fishing trips combined, the proportion of non-retained swordfish over total captured was 5.0% (61.6% discarded dead, 18.3% lost and 20.1% released alive), comprising a total of 1,277 individuals, and was not statistically different among years (Kruskal-Wallis, $\chi^2 = 12.2502$, $df = 13$, $p = 0.507$; **Figure 3a**). Predation frequency combining retained and non-retained catch was 4.3% ($n = 1,078$). Bitten specimens that were nevertheless retained on board represented an overall 2.2% of all retained individuals. Non-retained capture per trip averaged 7.6% (± 7.9) and, of all individuals discarded dead, 70.3% had suffered variable degrees of predation (**Table 2**).

Regarding the Japanese longline fleet, a total of 7,551 swordfish were captured during 2009-2011 (**Table 1**). Average CPUE per trip was 3.23 ind./1,000 hooks (± 1.09) and did not varied significantly among years (Kruskal-Wallis, $\chi^2 = 1.0222$, $df = 2$, $p = 0.600$; **Figure 1b**). The proportion of swordfish over total catch in the Japanese fleet was much less variable than that of the Uruguayan fleet, and although it presented significant differences among years these were marginal (Kruskal-Wallis, $\chi^2 = 5.9974$, $df = 2$, $p = 0.0499$). On average, swordfish captures represented 4.7% (± 1.8) of total catch, and no fishing trip had values greater than 10% (range: 2.1-9.1%; **Figure 2b**). Considering all fishing trips combined, the proportion of non-retained swordfish over total captured was 24.5% (75.6% discarded dead, 5.7% lost and 18.8% released alive), comprising a total of 1,849 individuals. The proportion of non-retained swordfish varied significantly between years (Kruskal-Wallis, $\chi^2 = 8.2166$, $df = 2$, $p = 0.0164$; **Figure 3b**). Predation frequency combining retained and non-retained catch was 11.5% ($n = 871$). Bitten specimens that were nevertheless retained on board represented an overall 2.0% of all retained individuals. Non-retained capture per trip averaged 20.3% (± 14.6) and, of all individuals discarded dead, 54.2% had suffered variable degrees of predation (**Table 2**).

Comparing both fleets some differences were appreciated (see **Table 1 and 2**). Nominal swordfish CPUE and the proportion of swordfish over the total catch were 2.1 and 2.9 times higher in the Uruguayan fleet, respectively. The percentage of non-retained swordfish was largely different between fleets, with the Japanese vessels discarding on average 4.8 times more swordfish than the Uruguayan fleet. In terms of numbers, the Japanese fleet discarded 1.8 times more dead individuals than the Uruguayan fleet. However, considering the target species of both fleets, these differences may be largely due to the fact that swordfish is a target species for the Uruguayan fleet but not for the Japanese.

Nevertheless, these preliminary results should be interpreted with caution as they are gross overall comparisons that most likely are affected by several factors such as fishing gear configuration (smaller hooks and much longer branchlines in the Japanese fleet), fishing area and depth (Uruguayan fleet set the gear from 30 to 100 m deep, while Japanese fleet set it between 100 and 200 m deep; Domingo *et al.* 2011b), season, water temperature and bathymetry, that were not here addressed. In this regard a more thorough and rigorous statistical analysis is needed to properly assess the differences among both fleets, as well as how other variables may be affecting the degree of predation, CPUE, and percentages of retention and discards.

Regarding the individuals that suffered damage by the interaction with predators such as marine mammals and sharks, most of them were discarded dead. However, these also affected the retained catch, representing around 2% of total swordfish retained on board for both fleets (**Table 2**). This capture is classified as “Retained bitten” and most of it is kept for the fishermen or consumed on board. A study conducted in the southwestern Atlantic Ocean based on data obtained by the PNOFA and logbooks, found that swordfish is the most affected species by marine mammal predation, and that autumn and winter are the trimesters with highest frequency of predation. The author also observed that year, geographical position and distance from the coast are variables that have a significant effect on predation interactions (Passadore, 2010). These results may explain the differences observed between the frequency of predation in the Japanese and Uruguayan fleets since the former operated largely over the continental shelf break and adjacent waters, where cetaceans are more abundant (Passadore 2010). The Uruguayan fleet on the other hand, operated over a larger area also including oceanic and international waters. To date, no quantitative, nor qualitative data such as this exists for shark predation in the area, but studies in other regions have shown that they could also produce substantial damage to fisheries catch (Lawson, 2001; Gilman *et al.*, 2008; Mandelman *et al.*, 2008). Over western and central Pacific Ocean, Lawson (2001) reported lower frequencies of predation (2.9%, whales and sharks combined) in longline fisheries compared those reported here, and also observed that tuna, tuna like species and billfishes were the species most commonly preyed.

Finally, although preliminary, these results suggest that the retained bitten and the non-retained catch of swordfish (most of it being discarded dead) may indeed represent a considerable proportion of the total catch, which at the same time might not be reflected in logbooks and landing reports. In vessels with indoor fishing deck this proportion could be even greater because of the difficulty to observe the lost catch. Thus, depending on the magnitude of this category in relation to the total catch, some estimations such as fishing mortality and relative abundance might be underestimated. This issue should be studied in better detail in order to assess if it should be incorporated in future stock evaluations.

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Table 1. Swordfish catch statistics for the Japanese and Uruguayan pelagic longline fleet operating in Uruguayan jurisdictional waters and adjacent international waters.

Fleet		Effort	Tot. Cap.	SWO Tot. Cap.	CPUE	% SWO	% Ret.	% not Ret.
Japan (2009-2011)	Total	2427395	180657	7551	3.11	4.18	75.51	24.49
	Mean	97096	7226	302	3.23	4.69	79.66	20.34
	s.d.	40911	3642	145	1.09	1.84	14.63	14.63
Uruguay (1998-2011)	Total	3855410	205178	25318	6.57	12.34	94.96	5.04
	Mean	36371.79	1935.64	238.85	9.43	14.79	92.39	7.61
	s.d.	58370.84	2523.20	377.50	6.72	10.67	7.94	7.94

Tot. Cap.: fleet total catch; **SwoTot.Cap.:** swordfish total catch; **CPUE:** swordfish nominal catch per unit of effort (ind./1,000 hooks); **% SWO:** percentage of total catch represented by swordfish; **% Ret.:** percentage of total swordfish catch that were retained on board; **% not Ret.:** percentage of total swordfish captured that were not retained on board.

Table 2. Swordfish catch disposition for the Japanese and Uruguayan pelagic longline fleet operating in Uruguayan jurisdictional waters and adjacent international waters.

Fleet		N° Ret.	N° Ret. B.	% Ret. B.	N° notRet.	N° Disc.	% Disc.	N° Disc. B.	% Disc. B.	N° Lost	% Lost	N° RA	% RA
Japan (2009-2011)	Total	5702	114	2.00	1849	1397	75.55	757	54.19	105	5.68	347	18.77
	Mean	228	5	1.91	74	56	65.72	30	58.37	4	7.12	14	23.16
	s.d.	97	4	1.73	83	70	26.58	26	34.87	5	9.25	16	23.59
Uruguay (1998-2011)	Total	24041	525	2.18	1277	787	61.63	553	70.27	234	18.32	256	20.05
	Mean	226.80	4.95	1.82	12.05	7.42	48.40	5.22	56.68	2.21	18.37	2.42	25.54
	s.d.	367.29	10.02	2.06	16.01	11.60	36.72	9.51	42.90	4.13	25.07	3.55	28.12

N° Ret.: number of swordfish retained on board; **N° Ret. B.:** number of swordfish captured that were retained bitten; **% Ret. B.:** percentage of total swordfish retained that were bitten; **N° not Ret.:** number of swordfish captured but not retained on board; **N° Disc.:** number of swordfish discarded dead (regardless if they were bitten or not); **% Disc.:** percentage of total swordfish captured but not retained that were discarded dead (regardless if they were bitten or not); **N° Disc. B.:** number of swordfish discarded bitten; **% Disc. B.:** percentage of total swordfish discarded dead that were also bitten; **N° Lost:** number of swordfish lost during hauling; **% Lost:** percentage of total swordfish captured but not retained that was lost during hauling; **N° RA:** number of swordfish released alive; **% RA:** percentage of total swordfish captured but not retained that were released alive.

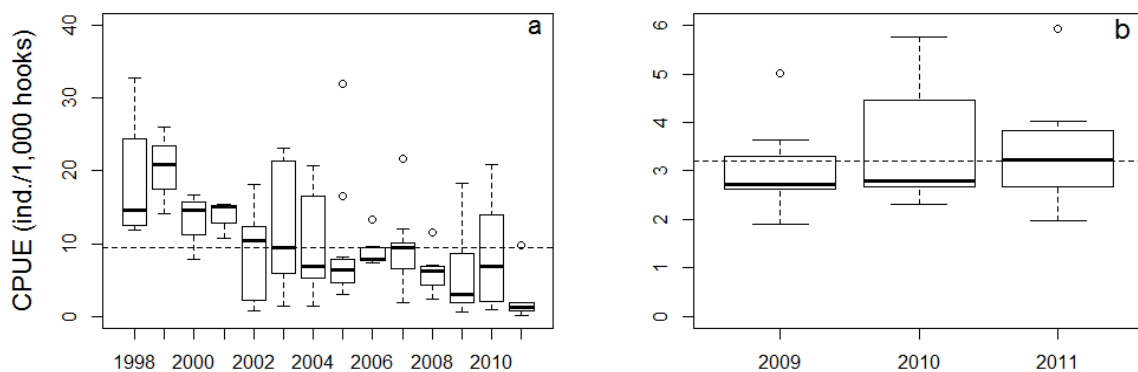


Figure 1. Swordfish CPUE by year for the Uruguayan longline fishery (a) and Japanese longline fishery (b). Dashed horizontal lines indicate overall CPUE mean values.

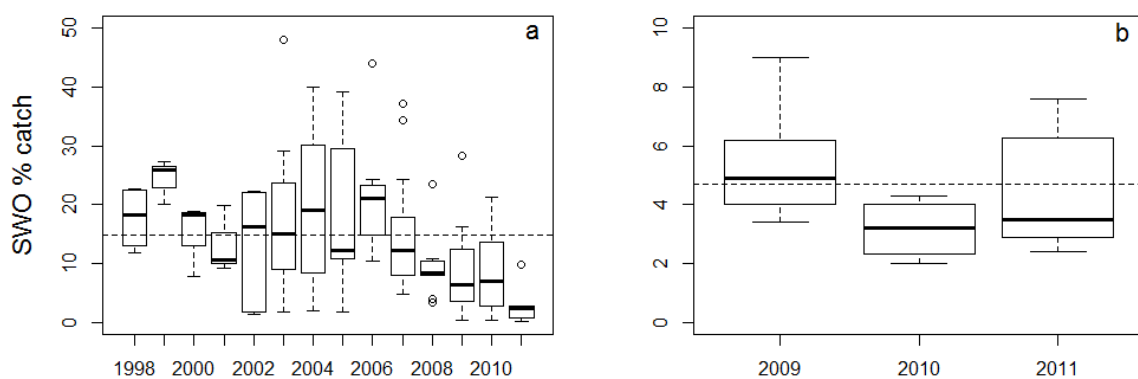


Figure 2. Percentage of swordfish over total catch for the Uruguayan longline fishery (a) and Japanese longline fishery (b). Dashed horizontal lines indicate the overall mean values.

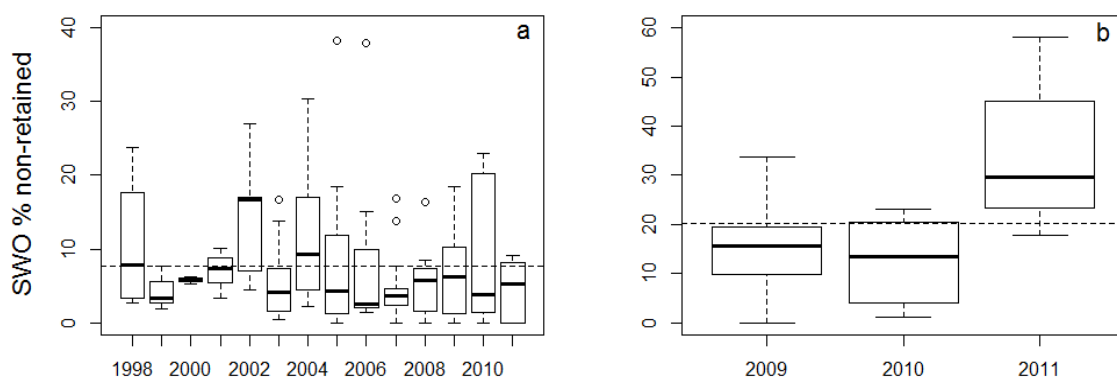


Figure 3. Proportion of total swordfish captured by the Uruguayan longline fishery (a) and Japanese longline fishery (b) that was not retained on board. Dashed horizontal lines indicate the overall mean values.