

## THE EFFECT OF LIGHT TORILINE ON SEABIRD BY-CATCH AND FISH CATCH RATES IN THE PELAGIC LONGLINE FISHERY OFF SOUTHERN BRAZIL

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### SUMMARY

*A study on the effects of light toriline on seabird and target fish catches was carried out by two Brazilian NGOs (NEMA and Projeto Albatroz) and sponsored by the Secretariat of Aquaculture and Fisheries of Brazilian Government. In 2007, seventeen fishing trips on commercial pelagic longline vessels off southern Brazil (177 sets and 210,270 hooks) were sampled by onboard observers alternating sets with and without light torilines. Torilines were made with light materials using nylon monofilament (branch line) or other light material as streamers. In general, the torilines were 40-70 m long and were fixed on a pole at least 4.5 m above sea surface. The colorful streamers (0.5 to 1.5 m long) were attached to the line at intervals of 1 m. Overall, this study found that single light torilines reduced by 64% the capture of seabirds, including species with the highest captures, i.e. Black-browed albatross (*Thalassarche melanophris*) and White-chinned petrel (*Procellaria aequinoctialis*). The seabird capture rate was 0.850 birds/1000 hooks in sets without toriline and decreased to 0.308 birds/1000 hooks using a single toriline. The toriline design shall be improved because seabird capture rate reported is still very high considering the NPOA-Brazil and FAO recommendations. Torilines increased the capture of target species (swordfish 32%; blue shark 15.1%; other teleost fishes 15.7%, and other elasmobranchs 17.2%) with significant economic benefits for the fleet (about US\$ 10,000 per trip 20-25 days-long). The use of torilines is beneficial for seabirds and fishermen and is a simple and inexpensive method, but should be combined with other mitigation measures to reduce capture rates to satisfactory levels. Nowadays, about 40% of domestic longliners (total of ~40 vessels) in southern Brazil use toriline to mitigate seabird by-catch.*

### RÉSUMÉ

*Une étude sur les effets des lignes "tori" légères sur les captures des oiseaux de mer et des poissons ciblés a été réalisée par deux ONG brésiliennes (NEMA et Projet Albatros) et parrainée par le Secrétariat de l'Aquaculture et des Pêcheries du Gouvernement brésilien. En 2007, 17 sorties de pêche réalisées par des palangriers pélagiques commerciaux au large du sud du Brésil (177 opérations et 210.270 hameçons) ont été échantillonnées par des observateurs embarqués à bord, les opérations étant alternées avec et sans lignes « tori ». Les lignes « tori » ont été fabriquées avec du matériel léger employant du monofilament en nylon (ligne secondaire) et d'autre matériel léger comme des serpentins. En général, les lignes « tori » mesuraient entre 40 et 70 m de long et étaient fixées à une perche située au moins à 4,5 m au-dessus de la surface de l'eau. Les serpentins colorés (0,5 à 1,5 m de long) étaient attachés à la ligne à des intervalles de 1 m. Globalement, cette étude a découvert que les lignes « tori » simples et légères réduisaient de 64% la capture des oiseaux de mer, y compris les espèces faisant l'objet des plus fortes captures, comme p.ex. l'albatros à sourcils noirs (*Thalassarche melanophris*) et le puffin à menton blanc (*Procellaria aequinoctiales*). Le taux de capture des oiseaux de mer était de 0,850 oiseaux/1.000 hameçons dans des opérations sans ligne « tori » et il a été ramené à 0,308 oiseau/1.000 hameçons en utilisant une simple ligne « tori ». Il conviendra d'améliorer la conception de la ligne « tori » étant donné que le taux de capture déclaré des oiseaux de mer est toujours très élevé si l'on considère les recommandations de NPOA-Brésil et de la FAO. Les lignes « tori » accroissent les captures des espèces-cibles (espadon 32%; requin peau bleue 15,1%; autres poissons téléostéens 15,7%; et autres élasmobranches 17,2%), apportant des bénéfices économiques considérables à la*

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flotille (environ US\$10.000 par sortie de 20 à 25 jours de durée). L'emploi de lignes « tori » est bénéfique pour les oiseaux de mer et les pêcheurs et il s'agit d'une méthode simple et peu onéreuse. Or, celle-ci devrait s'accompagner d'autres mesures d'atténuation visant à réduire les taux de capture à des niveaux satisfaisants. De nos jours, environ 40% des palangriers nationaux (total d'environ 40 navires) au sud du Brésil utilisent des lignes « tori » pour atténuer les prises accessoires d'oiseaux de mer.

## RESUMEN

Dos ONG brasileñas (NEMA y Projeto Albatroz) llevaron a cabo un estudio sobre los efectos de la línea espantapájaros ligera en las capturas de aves marinas y peces objetivo, que fue patrocinado por la Secretaría de Acuicultura y Pesca del Gobierno brasileño. En 2007, observadores embarcados muestrearon diecisiete mareas de buques comerciales de palangre pelágico en aguas al Sur de Brasil (117 lances y 210.270 anzuelos) alternando lances con y sin línea espantapájaros ligera. Las líneas espantapájaros estaban hechas con materiales ligeros y utilizando monofilamento de nylon (brazolada) u otros materiales ligeros como serpentinas. En general, las líneas espantapájaros medían entre 40 y 70 m de largo y se fijaron a un palo al menos 4,5 m por encima de la superficie del mar. Las serpentinas de colores (0,5 a 1,5 m de largo) se fijaron a la línea a intervalos de 1 metro. En conjunto, este estudio descubrió que las líneas espantapájaros ligeras únicas reducían en un 64% la captura de aves marinas, incluyendo las especies con mayores capturas como el albatros ceja negra (*Thalassarche melanophris*) y el petrel barba blanca (*Procellaria aequinoctialis*). La tasa de captura de aves marinas era de 0,850 aves/1000 anzuelos en los lances sin línea espantapájaros y descendía a 0,308 aves/1000 anzuelos utilizando una única línea espantapájaros. El diseño de la línea espantapájaros debe mejorarse ya que la tasa de captura de aves marinas comunicada sigue siendo muy elevada teniendo en cuenta el PAN de Brasil y las recomendaciones de la FAO. Las líneas espantapájaros aumentaron la captura de las especies objetivo (pez espada 32%, tintorera 15,1%, otros teleósteos 15,7% y otros elasmobranquios 17,2%) con importantes beneficios económicos para la flota (aproximadamente 10.000 \$ por marea de 20-25 días). El uso de líneas espantapájaros es beneficioso para los pescadores y para las aves marinas y es un método sencillo y barato pero que debería combinarse con otras medidas de mitigación para reducir las tasas de captura hasta niveles satisfactorios. Actualmente, aproximadamente el 40% de los palangreros nacionales (un total de ~40 buques) en el Sur de Brasil utiliza las líneas espantapájaros para mitigar la captura fortuita de aves marinas.

## KEY WORDS

*Albatross, petrel, pelagic longline fishery, catch fish rate, by-catch, Brazil, toriline*

### 1. Introduction

The Brazilian longline fisheries interact with albatrosses and petrels breeding in other areas such as Tristan da Cunha, Malvinas/Falkland Islands, South Georgia, Antarctic and New Zealand, and feeding off Brazil during both the breeding and wintering periods. Forty species of Procellariiforms (albatrosses and petrels) occurs off Brazil and 11 species (28%) are threatened by extinction according to the IUCN Red List, being seven species vulnerable and four endangered (IUCN 2007). Bugoni *et al.* (2008) reported overall capture rate of 0.229 birds/1000 hooks in the pelagic longline fleet based in Southeast and South Brazil, considering the effort of 788,446 hooks sampled from 2001 to 2007. Capture rates were higher between June and November (cold season) and affected mainly the Black-browed albatross *Thalassarche melanophris* (55% of birds captured), the White-chinned petrel *Procellaria aequinoctialis*, the Spectacled petrel *Procellaria conspicillata* and the Atlantic yellow-nosed albatross *Thalassarche chlororhynchus*.

Brazil as a signatory country of the Agreement on the Conservation of Albatrosses and Petrels – ACAP, and attending FAO/ONU recommendation, since 2001, voluntarily develops the National Plan of Action for the Conservation of Albatrosses and Petrels, launched by IBAMA in 2006. The implementation of mitigation

measures in the pelagic longline fleet is part of the goals foreseen in the NPOA/Brazil. For the adoption of toriline by the entire longline fleet, tests demonstrating reduction on seabird by-catch and its effectiveness on catching target fish are necessary. Two Brazilian NGOs - Núcleo de Educação e Monitoramento Ambiental – NEMA, and Projeto Albatroz, established a partnership sponsored by the Special Secretariat of Aquaculture and Fisheries of the Presidency of the Republic (SEAP/PR) to test toriline. The aim of this study was to evaluate the effectiveness of torilines in the pelagic longline fleet off Southern Brazil to subsidize their implementation, according to NPOA. The torilines were chosen due to previous fishermen experience with this mitigation measure, acceptability among the fishery sector and necessity to improve it.

## 2. Methods

The cruises were accomplished in 11 different pelagic longline vessels operating in Southern Brazil, between 25° and 37°S, and 29° and 51°W (**Figure 1**).

The torilines had not a standard design because they were built jointly with fishermen, according to their experience and the size of their vessel. In general the torilines were made with light materials using nylon monofilament (branch line) or other light material as streamers. In general, the torilines were 40-70 m long and were fixed on a pole at least 4.5 m above the water surface. Colorful streamers (0.5 to 1.5 m long) were attached to the line at intervals of 1 m. Tests were carried out alternating sets with and without single torilines. By-catch and target catch was recorded during hauling. Prices were obtained for the main fish groups (teleosts, elasmobranches and swordfish) and a estimative on the profitability of caught fish when torilines were deployed and without toriline deployment, were calculated during cold months (May to November) when there are higher abundance of seabirds and highest risks of seabird by-catch. The idea was to show the economic advantages of toriline adoption during the critical season.

## 3. Results

From May to October 2007, seventeen fishing trips onboard commercial pelagic longline vessels based in southern Brazil (177 sets and 210,270 hooks) were sampled by onboard observers. Five cruises departed from Santos-SP port, nine from Itajaí-SC and three from Rio Grande-RS. Toriline was tested when 93,855 hooks were deployed, and 116,415 hooks tested without toriline. Bait used was squid (31.7%), Chub mackerel (22.4%), Skipjack tuna (8.7%) and mixed (squids and other fish – 37.2%). About 80% of sets occurred in Brazilian Economic Exclusive Zone (EEZ), mainly adjacent to Santa Catarina and Rio Grande do Sul states, between isobaths of 1000 and 4000m. About 85% of sets started during the daylight hours.

### 3.1 Effect of torilines on fish capture rates

**Figure 2** shows fish catch rates (n = 12,542 specimens) during tests. Overall fish catch rate with toriline was 65.175 fish/1000 hooks, while without toriline it was 55.190 fish/1000 hooks, a 10% increase in capture rate by using toriline during cold months (May – November).

Regarding fishery productivity per target species category (**Table 1**), the fish catch rate with toriline were 15.1% higher for Blue shark, than without it. Swordfish catch rate increased 32% with torilines, and 15.7% and 17.2% increase for other teleost fish and other elasmobranches. For tunas, a small difference was observed in catch rates, with 6.755 fish/1000 hooks with toriline and 7.147 fish/1000 hooks without toriline, i.e. less than one individual per set using the mitigation device. In table 1 are shown hypothetic values of fishery production for the main species captured. It was also estimated the profitability per trip and during cold months (May to November). Pelagic longline fishing vessels might increase their income in more than US\$ 10,000 per trip or US\$ 62,000 during the whole cold months season, by using single light torilines. Considering the whole pelagic longline fleet based in southern Brazil (~40 vessels), the fishery sector could have an overall income over US\$ 2.5 millions adopting the torilines in the cold months.

The costs to implement the torilines are US\$ 380, including the pole to support toriline, which is bought only once. The main line of toriline and the streamers can be used in several trips and cost US\$ 50 to build a pair of toriline.

### **3.2 Effect of toriline on seabird by-catch**

Single light toriline reduced seabird capture rates by 64%. The seabird capture rate without torilines was 0.850 birds/1000 hooks, while the seabird capture rate using torilines was 0.308 birds/1000 hooks (**Figure 3**). In other words, every 2,155 hooks deployed without toriline, one additional seabird is killed.

Taking into account a regular longline trip, which sets around 15,000 hooks, about 12 seabirds can be captured without toriline. However, using torilines the seabird by-catch could be reduced to five individuals. Black-browed albatrosses (*Thalassarche melanophris*) and White-chinned petrels (*Procellaria aequinoctialis*) are the most frequently captured species. Considering 15,000 hooks per trip, nearly seven Black-browed albatrosses are captured when no toriline is deployed, dropping to four Black-browed per trip when using toriline. For the White-chinned petrel, about five specimens are killed in a typical trip without toriline, which can be easily reduced to one seabird by deploying toriline.

## **4. Discussion**

### **4.1 Effect of torilines on fish capture rate**

In the present study it was observed an increasing of 15.1% in fish catch rate using a single light toriline on pelagic longline fishery operating in southern Brazil. The Swordfish had higher capture increase (32%) using torilines, followed by other elasmobranchs (17.2%), other teleost fishes (15.7%) and the Blue shark (15.1%). This increasing in fishery production is attributed to reduction of 64% in seabird by-catch and reduced loss of bait due to the toriline adoption. Løkkeborg (1998, 2001), Gilman et al. (2005) and Bull (2007) also demonstrated that the use of torilines increased the capture of target species because keep the seabirds away from the risk area during the longline setting and reduces the probability of interaction between seabirds and the fishing gear. Løkkeborg (2003) recorded an increase of 32% on fish catch rate using torilines during four research trips off Norway, and also the reduction of bait loss using torilines. In previous study, it was recorded 70% of bait loss in sets without toriline and only 26% of bait loss using torilines in longline vessels operating in the same area (Løkkeborg & Bjordal 1992; Løkkeborg 1996).

### **4.2 Effect of toriline on seabird by-catch**

The present study indicated that the single toriline is effective by reducing seabird by-catch by 64%, as well as increasing fish catch rates due to reduction of bait loss during setting. Other studies testing single torilines were carried out (e.g. Imber 1994; Brothers et al. 1999; Klaer & Polacheck 1998; McNamara et al. 1999; Boggs 2001; CCAMLR 2002; Minami & Kiyota 2002). The toriline is known to reduce seabird by-catch by about 30%, but their efficacy varied depending on the type of vessel (Takeuchi 1998; Shiode et al. 2001). McNamara et al. (1999) tested toriline in pelagic longline vessels targeting Swordfish in Hawaii and recorded a reduction of seabird by-catch of 79%. This value is similar to the 76% found by Boggs (2001) in the same fleet. The reduction of seabird by-catch due to toriline deployment in pelagic and demersal longline vessels have been evaluated and proved to be effective in several countries, such as Chile (Ashford & Croxall 1998), Norway (Løkkeborg & Bjordal 1992; Løkkeborg 1998, 2001, 2003; Løkkeborg & Robertson 2002), Alaska (Melvin et al. 2001), Hawaii (Boggs 2001), New Zealand (Imber 1994; Smith 2001) and Japan (Minami & Kiyota 2002). However, results on light toriline in the pelagic longline fishery are rarely tested and results were not conclusive. In this study the seabird capture rate varied between 0.308 birds/1000 hooks using torilines and 0.850 birds/1000 hooks without it. However, despite the significant by-catch reduction using torilines, seabird capture rates are still very high when compared with the seabirds capture rates from other countries that use a pair of torilines. In Malvinas/Falkland Island, seabird capture rate is 0.019 birds/1000 hooks using a pair of torilines in the demersal longline fishery (Reid & Sullivan 2004). Recent studies in the same fishery (Otley et al. 2007) reported 0.010 seabirds/1000 hooks using torilines (or 10 seabirds captured every one million of hooks). In Argentina, the longline fishery targeting Patagonian toothfish and Kingclip, the seabird capture rates were 0.04 and 0.03 birds/1000 hooks with 99% of the setting using mitigation measures as torilines (Favero et al. 2003; Laich et al. 2006). Despite the non-negligible reduction on seabird by-catch by light single toriline, capture rates are still very high in comparison with NPOA/Brazil goal (0.001 birds/1000 hooks), which means one seabird captured per one million hooks deployed. In this study, even using the single toriline the seabird capture rate was 300 seabirds capture per million hooks, and 850 seabirds captured per million hooks without torilines. Moreover, the seabird capture rate is also higher than FAO (2003) recommendation of 0.05 birds/1000 hooks, which means 50 seabirds every one million hooks. This is enough reason to incentive the longline fleet to test pairs of toriline and improve their effectiveness, as well as other mitigation measures (e.g. night setting, blue dye baits).

## 5. Conclusion

The result of this study shows the efficiency of single light toriline to reduce seabird by-catch as well as to increase fish catch rates due to reduction of bait loss during longline setting. Around the world several mitigation measures were developed to avoid and reduce seabird by-catch in longline fisheries. In many countries, to assure the use of toriline and other measures, incentives, legislation and enforcement are mechanisms used to increase adoption of mitigation measures. In this way, we understand that this is part of a natural process which will happen in countries dealing with seabird interaction in fisheries. However, in order to have this process really absorbed by the fishery sector, it is necessary to test and improve the mitigation measures jointly with fishermen. Also, it is necessary to incentive the use of different sorts of mitigation measures, once that seabird catch rate are still very high when compared with NPOA and FAO recommendation. The effectiveness of single light torilines in other fleets and conditions remains to be tested.

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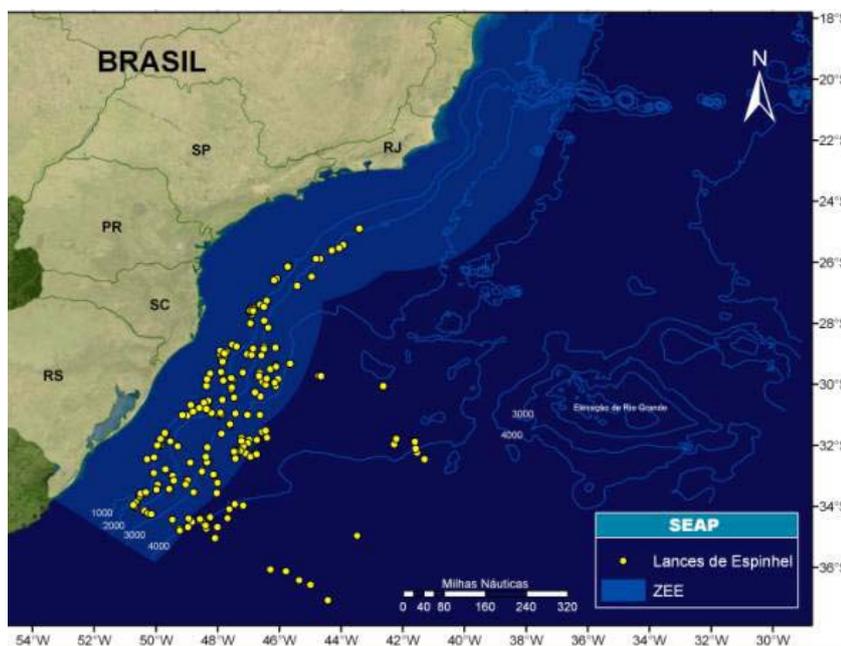
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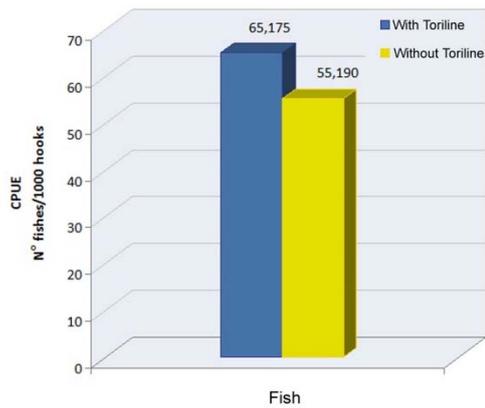
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**Table 1.** Estimative of total fish catch without and with toriline showing the increase of fish caught (Swordfish 32%; Blue shark 15.1%; other teleost fishes 15.7%, and other elasmobranchs 17.2%) and additional income per trip and per season if torilines were deployed.

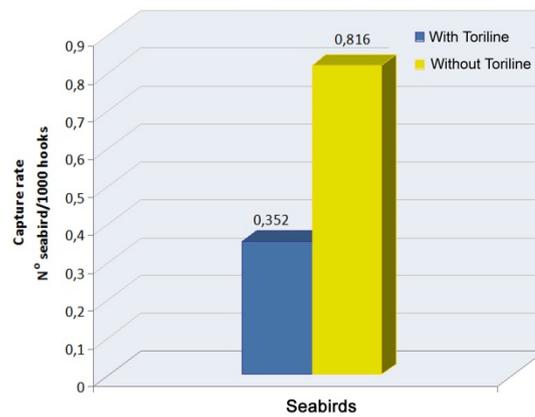
Amount (kg)	Fish	Price (per kg)	Total with toriline	Profits with toriline
5,280	Swordfish	US\$ 5.62	US\$ 26,400	US\$ 6,400
16,114	Blue shark	US\$ 1.87	US\$ 26,857	US\$ 3,523
1,172	Mako shark	US\$ 2.19	US\$ 2,279	US\$ 334
1,152	Other fishes	US\$ 0.62	US\$ 642	US\$ 87
Total = 23,723				
<b>Total / trip/ vessel</b>			<b>US\$ 56,178</b>	<b>US\$ 10,345</b>
<b>Total in cold months</b>			<b>US\$ 337,070</b>	<b>US\$ 62,070</b>



**Figure 1.** Location of 17 longline sets of the commercial pelagic longline fleet based in southern Brazil to test torilines.



**Figure 2.** Total fish Catch per Unit of Effort (CPUE) and per species by the southern Brazilian commercial pelagic longline fleet with and without toriline (number of fish capture – 6,117 with toriline and 6,425 without toriline. Number of hooks = 93,855 with toriline and 116,415 without toriline).



**Figure 3.** Comparison of seabird capture rates with and without torilines (seabird bycatch: n = 29 birds with toriline and n = 99 without toriline. Number of hooks: 93,855 with toriline and 116,415 without toriline).