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Influence of electric fishing lights on sink rates of baited hooks in Brazilian pelagic long line

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SUMMARY

Recently, electric fishing lights (EFL) have been adopted by the southern Brazilian pelagic longline fleet. Each EFL carries two AA batteries, and given its weight out of the water (~160 g) some fishermen argue this device is a replacement for the new line weighting regime of 60g within 2 m of the hook.

A total of 66 repetitions during 11 sets were obtained to compare the sink rate of baited hooks with weighted swivels placed at 3.5 and 5.5 m from the hook, in each case with and without EFLs. The 3.5 m treatments presented the mean fastest sink rates (0.281 - 0.515 m/s), while 5.5 m treatments presented the mean slowest sink rates (0.182 - 0.431 m/s). The addition of an EFL above leaded swivels tended to decrease sink rate when set with 3.5 m leaders and increase sink rates with 5.5 m leaders but results were not significant. These results suggest that 3.5 m leader lines with ≥60 g leaded swivels, with or without EFLs may achieve satisfactory sink rates while 5.5 m leaders do not.

RECOMMENDATIONS

1. The use of electric fishing lights should not be interpreted as a way to increase sink rates of baited hooks in pelagic longline.
2. Leaded swivels with 60-75 g should not be placed more than 3.5 m of the hooks in order to guarantee minimum sink rates required for reduce seabird-longline interactions.

Influencia de las luces eléctricas de pesca en las tasas de hundimiento de los anzuelos cebados en la pesca con palangre pelágico de Brasil

Recientemente, la flota de pesca con palangre pelágico del sur de Brasil ha adoptado las luces eléctricas de pesca (LEP). Cada LEP lleva dos baterías AA, y debido a su peso fuera del agua (aproximadamente 160 g) algunos pescadores señalan que este dispositivo reemplaza el nuevo esquema de pesas de la línea de 60g ubicados dentro de los 2 m del anzuelo.

Se realizaron 66 repeticiones durante 11 lances para comparar la tasa de hundimiento de los anzuelos cebados con los destorcedores con peso colocados a 3,5 y 5,5 m de distancia del anzuelo, en cada caso con y sin LEP. Los tratamientos de 3,5 m presentaron las tasas de hundimiento medias más rápidas (0,281 – 0,515 m/s), en tanto que los tratamiento de 5,5 m presentaron las tasas de hundimiento medias más lentas (0,182 – 0,431 m/s). La colocación de LEP sobre los destorcedores de plomo tendió a reducir la tasa de hundimiento cuando se colocó con líneas de 3,5 m y a aumentar las tasas de hundimiento con líneas de 5,5 m, pero los resultados no fueron significativos. Estos resultados sugieren que las líneas con 3,5 m con destorcedores de plomo de ≥60 g, con o sin LEP pueden lograr tasas de hundimiento satisfactorias, mientras que las líneas de 5,5 m no lo logran.

RECOMENDACIONES

1. El uso de luces eléctricas de pesca no debe interpretarse como una forma de aumentar las tasas de hundimiento de los anzuelos cebados en la pesca con palangre pelágico.
2. Los destorcedores de plomo con 60-75 g no deberían colocarse a más de 3,5 m de los anzuelos para garantizar las tasas mínimas de hundimiento necesarias para reducir las interacciones de las aves marinas con el palangre.

Influence des feux de pêche électriques sur la vitesse d'immersion des hameçons munis d'appâts dans la pêche à la palangre pélagique au Brésil

Depuis peu, la flotte de la pêche à la palangre pélagique du sud du Brésil utilise des feux de pêche électriques. Chaque feu de pêche électrique est muni de deux piles AA. Étant donné le poids de ce dispositif hors de l'eau (~160g), certains pêcheurs affirment qu'il peut remplacer le nouveau système de lestage des palangres, qui prévoie un lest de 60g placé à moins de 2 m de l'hameçon.

Les 66 répétitions obtenues au cours des 11 mises à l'eau ont permis de comparer la vitesse d'immersion des hameçons munis d'appâts et celle des émerillons lestés placés à 3,5 m et 5,5 m de l'hameçon, dans chaque cas avec et sans feux de pêche électriques. Les émerillons placés à 3,5 m présentaient la vitesse d'immersion moyenne la plus rapide (0,281 - 0,515 m/s), tandis que les émerillons placés à 5,5 m présentaient la vitesse d'immersion moyenne la plus lente (0,182 - 0,431 m/s). L'ajout d'un feu de pêche électrique sur les émerillons lestés ralentissait la vitesse d'immersion lorsqu'ils étaient placés à 3,5 m et augmentait la vitesse d'immersion lorsqu'ils étaient placés à 5,5 m, mais les résultats n'étaient pas pertinents. Ces résultats laissent à penser que des bas de ligne munis d'émerillons lestés ≥60 g, avec ou sans feux de pêche électriques, peuvent atteindre une vitesse d'immersion satisfaisante, contrairement aux bas de ligne de 5,5 m.

RECOMMANDATIONS

1. L'utilisation des feux de pêche électriques ne devrait pas être considérée comme un moyen d'augmenter la vitesse d'immersion des hameçons munis d'appâts dans la pêche à la palangre pélagique.

2. Des émerillons lestés de 60-75g ne devraient pas être placés à plus de 3,5 m des hameçons pour garantir la vitesse d'immersion minimale prescrite permettant de réduire les interactions avec les oiseaux marins lors de la pêche à la palangre.

1. INTRODUCTION

The incidental mortality of seabirds in pelagic longlines is the major cause of population declines threatening most of albatrosses and large petrels species (Lewison and Crowder 2003, Anderson *et al*. 2011). Currently there is a large and growing number of solutions for reduce seabird mortality in longlines. The combination of certain mitigation measures can almost eliminate seabird bycatch, however no single mitigation can reliably prevent seabird mortality. The combination of night setting, bird scaring lines and well weighted branch lines are the best practice mitigation in pelagic longline fisheries (ACAP 2011).

The sink rate of baited hooks is arguably the major issue to address to reduce seabirds-longline interactions. Even when tori lines are used, to make it effective, the baited hooks must achieve safety depths (deeper than the dive range of most petrels species) within the protection of a tori line. Many factors are known to affects sink rate of baited hooks in pelagic longline, as the bait type (e.g. squid, mackerel, sardine, skipjack flash) and its state (e.g. dead or alive, frozen or thawed); the mainline tension during deployment; and line weight regimes (use or not of leaded swivels, as well as its mass and distance from the hooks) (Anderson & McArdle 2002, Peterson *et al*. 2008, Robertson *et al*. 2010, Roberson *et al.* 2013).

The best weighting regimes recommended are those that reach a depth of 10 m while under the protection of a toriline with ~100 m aerial coverage (Petersen *et al*. 2008, Melvin *et al*. 2009a). Experiments indicated that ≥60 g placed no more than 3 m from the hooks is likely to achieve these sink rates under most operational conditions (Melvin *et al*. 2009b, Robertson *et al*. 2010, Gianuca *et al*. 2011). Following this premise, among the best practices to reduce seabird mortality in pelagic longline recently recommended by the ACAP (2011) and ICCAT (2011), is to use at least 60 g leaded swivel no more than 3.5 m from the hook.

The use of chemical light sticks, and more recently battery powered electric fishing lights (EFL), increases the catch rate of some main target species by attracting target species directly or by attracting its prey (Berkeley *et al*. 1981, Freeman 1989, Ortiz & Scott 2001, Hazin *et al.* 2005). Despite the addition of this kind of devices to branch lines (usually ~2 m from the hooks) alters the surface/volume ration of the terminal portion of the branch lines and potentially the sink rate of baited hooks, there is no investigation dedicated to this issue.

Recently, EFL have been adopted by southern Brazilian pelagic longline fleet, and its use and popularity are growing among fishermen and ship owners. Each EFL carries two AA batteries, and given its weight out of the water (~160 g) some fishermen argue that the use of this kind of device increases the sink rate of baited hooks, and use this untested premise as justification for do not adopting the required line weighting.

Considering this scenario, the aim of the present study was to investigate the effect of EFL on the sink rate of baited hooks in branch lines with 3.5 m leaders (recommended line weightings) and 5.5 m leaders (preferred by southern Brazilian longliners).

2. METHODS

2.1. Fishing gear and fleet

The southern Brazilian Fleet is composed by around 50 steel or wooden hull vessels, of 15 to 29 m total length. This fleet target tunas, swordfish and sharks, and operates off south and southeast Brazil, from 25° S to 35° S, and 45° to 55° W, using mainly the ports of Rio Grande-RS (32° 02’ S; 52° 05’ W) and Itajaí-SC (26° 54’ S; 48° 39’ S).

The fishing gear used by the southern Brazilian pelagic longline vessels is composed, in general, by a continuous mainline made of 3.8 mm or 3.0 mm nylon monofilament, ranging between 20 to 40 miles long. The branch lines are made of 2.0 mm nylon monofilament, ranging between 10 to 50 m long, and containing one lead swivels (60 or 75 g) plus one hook. The length of the leader (portion of line between hook and leaded swivel) varies from 3 m to 10 m, and ~5.5 m (3 fathoms) is the most common (Figure 1). The total number of hooks on the longline varies from 600 to 1,200. Radio buoys are attached between intervals of 45 small buoys, and the number of radio buoys varies between three and seven, which are attached to mainline through a propylene multifilament 15.0 mm cable 20 m long. Few smaller vessels (~15 m) do not use radio buys. The variations in style and magnitude of fishing gear presented above are related to the preferences of each skipper and to the infrastructure of the each vessel.

Recently, electric fishing lights have been substituting chemical light sticks in the southern Brazilian fleet, specially by fishermen targeting swordfish. Among the longliners using electric fishing lights, the proportion of branch lines containing this device range from 25% to 80%. The electric fishing light most used by southern Brazilian longliners, which was the model used for the present study, is made of poly carbonate resin, contains 2 AA batteries, and are attached to a branch line via small snaps, immediately above the leaded swivels (Figure 1 and 2). This device has a 15 cm circumference at its widest point and 9 cm of length, as well as a external volume of 120 ml and internal volume of 40 ml. When loaded with AA batteries (10 ml each) the electric lights contain 20 ml of air inside. The electric lights weights 160 g, including the snaps.

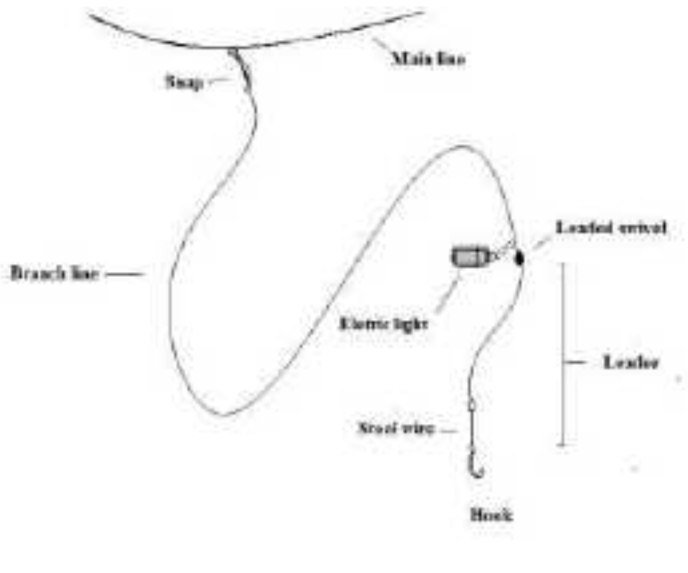

Figure 1. Schematic drawing of a typical branch line from Brazilian pelagic longliners, showing the position where electric lights are attached.

Figure 2. Electric fishing light attached to a branch line just above the 75 g leaded swivels.

2.2. Data collection

We conducted two fishing trips on board two pelagic longliners from the southern Brazilian fleet in order to collecting data on the effect of electric lights on the sink rates of baited hooks.

The first trip was carried out in August 2012 on board the FV *Ana Amaral I*, a wooden vessel 29.5 m length, using branch lines with 75 g leaded swivels positioned at 4 m from the 10/0 J hooks. The second trip was carried out in October 2012 on board the FV *Rei do Atum*, a 22 m iron hull vessel , using 60-75 g leaded swivels positioned at 5.5 m from the 9/0 circle hooks. In both vessels branch lines were ~40 m long with a 30 cm wire trace.

On each vessel we provided specifically built experimental branch lines that were deployed amongst the vessels normal gear. We established four treatments to investigate sink rates:

Treatement 1 - 3.5 m leader,

Treatment 2 - 3.5 m leader plus EFL,

Treatment 3 - 5.5 m leader, and

Treatement 4 - 5.5 m leader plus EFL.

All experimental branch lines contained 75 g leaded swivels, and thawed skipjack flesh as bait (~20 cm length).

During setting operations experimental branch lines from each of the four Treatments were fitted with CEFAS G5 Time Depth Recorders (TDRs) 30cm from the hook. These were handed to fishermen and attached to branch lines in the middle of the basket. TDRs were set to record time and depth (pressure) at one second intervals. Water entry time was recorded using a wrist watch that had been synchronised with the TDR previous to the set.

2.3. Data analysis

For each TDR treatment we verified the time to 2 m, 4 m, 6 m and 10 m depth, and then calculated sink rates of baited hooks within each of the following depth strata: 0-2 m, 2-4 m, 4-6 m and 6-10 m. In addition we verified the depth after 17 sec and 27 sec, which corresponds, respectively, to 50 m and 80 m astern, assuming a setting velocity of 6 knots (2.96 m/s). These distances astern were selected as 50 m astern is the critical area for seabirds interactions in the absence of a tori line (Melvin & Walker 2009, Gianuca *et al*. 2011, Jiménez *et al*. 2012) and 80 m is the mean aerial coverage of the Brazilian short streamer tori line (Gianuca *et al*. 2011).

Mean sink rates for each 0-2 m, 2-4 m, 4-6 m and 6-10 m strata, as well as mean depth of baited hooks after 17 and 27 sec, were compared between treatments using One Way ANOVA. The mean time to sink to 2, 4, 6 and 10 m were compared between treatments using One Way ANOVA after square root transformation. A Tuckey test was used posteriorly for both analysis.

3. RESULTS

Over 11 sets we obtained 66 sink profiles of baited hooks;16 with 3.5 m leader, 17 with 3.5 m leader plus EFL, 15 with 5.5 m leader, and 15 with 5.5 m leader plus EFL (Annex A).

The baited hooks with 3.5 m leaders (T1) had the fastest mean sink rates (0.281 - 0.515 m/s), while the baited hooks with 5.5 m leaders (T3) had the slowest mean sink rates (0.182 - 0.431 m/s) (Figure 3). The addition of an EFL above leaded swivels tended to decrease sink rate when set with 3.5 m leaders (T2) and increase sink rates with 5.5 m leaders (T4). Despite this tendency, the differences in general were not statistically significant, however, within the first 2 m depth, the mean sink rate of baited hooks with 5.5 m leaders (T3, 0.182 m/s) was significantly) increased with the addition of electric lights (T4, 0.245 m/s; $F = 5.671$; $p<0.05$). (Figure 3, Table 1).

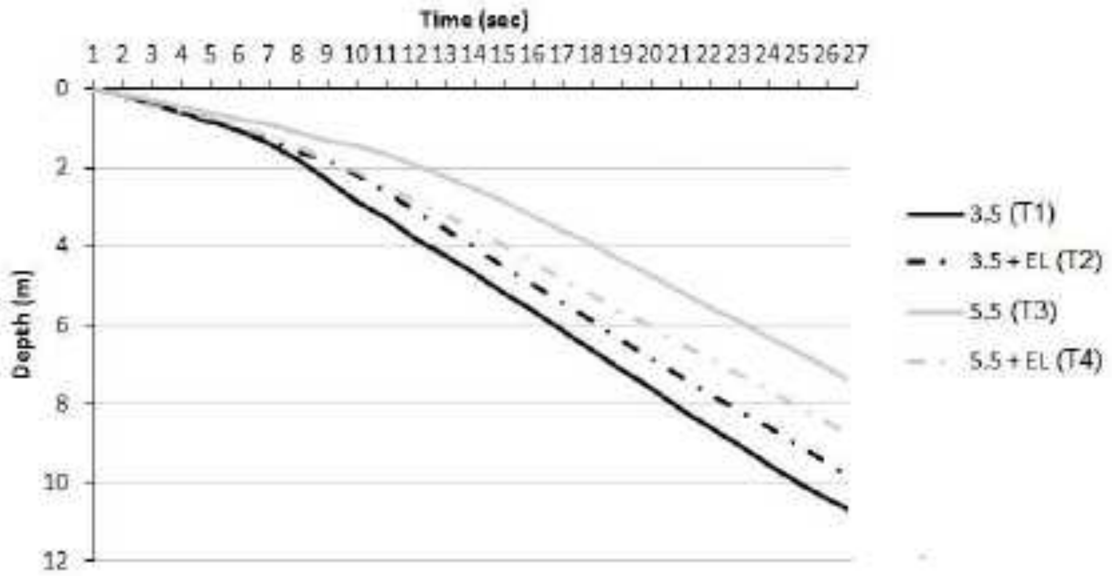

Figure 3. Mean sink profiles of baited hooks accordingly to leader length (3.5 m or 5.5 m) and presence or absence of electric lights (EL) during the first 27 sec after deployment (period protected by the tori line).

Table 1. Mean sink rate (m/sec) of baited hooks for each depth strata according to leader length (3.5 m and 5.5 m) and presence or absence of electric lights (EL). Additionally are presented One-way ANOVA results comparing the effect of electric lights on sink rate of baited hooks with 3.5 and 5.5 m leaders, as well as the effect of 5.5 m leaders on sink rate of baited hooks in comparison with 3.5 m leaders.

Depth strata	**3.5 (T1)**	**3.5 + EL (T2)**	**Difference**	**F**	***p***
0 - 2	0.281	0.248	-0.033	1.291	0.265
2 - 4	0.487	0.473	-0.014	0.100	0.753
4 - 6	0.515	0.466	-0.049	0.672	0.575
6 - 10	0.480	0.486	0.006	0.020	0.884
Depth strata	**5.5 (T3)**	**5.5 + EL (T4)**	**Difference**	**F**	***p***
0 - 2	0.182	0.245	0.063	5.671	0.023*
2 - 4	0.377	0.436	0.059	2.476	0.124
4 - 6	0.431	0.426	-0.005	0.014	0.904
6 - 10	0.376	0.408	0.033	0.493	0.505
Depth strata	**3.5 (T1)**	**5.5 (T4)**	**Difference**	**F**	***p***
0 - 2	0.281	0.182	-0.100	16.552	0.001**
2 - 4	0.487	0.377	-0.110	10.221	0.004**
4 - 6	0.515	0.431	-0.084	2.938	0.094
6 - 10	0.480	0.376	-0.104	8.143	0.009**
Depth strata	**3.5 + EL (T2)**	**5.5 + EL (T4)**	**Difference**	**F**	***p***
0 - 2	0.248	0.245	-0.004	0.015	0.899
2 - 4	0.473	0.436	-0.037	0.589	0.544
4 - 6	0.466	0.426	-0.040	0.534	0.522
6 - 10	0.486	0.408	-0.078	2.068	0.159

** p<0.01; * p<0.05

The baited hooks with 3.5 m leaders and no EFL (T1), sank to 2 m, 4 m and 6 m on average significantly faster than baited hooks with 5.5 m leaders with no EFL (T3) (F = 4.939 - 6.983; p<0.01 – p<0.05). T1 also sank significantly faster to 10 m than T3 (F = 8.652; p<0.01) (Figure 4).

The highest percentage of baited hooks that were still within the first five metres after 17 sec (50 m astern, the critical area for seabirds interactions), corresponded to Treatment 3 - 5.5 m leader, which represented the worst performance sink rate . The highest percentage of hooks that sank beyond 10 m after 27 sec (80 m astern, representing the end of tori line coverage), was 69% for 3.5 m leader, which indicated the best performance sink rate (Table 2).

The mean depth of baited hooks in T1 and T2, 27 sec after deployed was deeper than 10 m (10.6m and 11.2m, respectively). In contrast the 5.5m leaders (T3 and T4) did not meet the 10 m depth threshold within the same time period, with a mean depth of 9.3 m and 7.6 m, respectively. After 27 sec, the mean depth of baited hooks with T3 (5.5 m leaders without EFL) was significantly shallower than the mean depth of hooks with 3.5 m leaders (T1 and T2) (F = 5.346; p<0.01 - p <0.05) (Figure 5).

One baited hook with 3.5 m leader plus EFL was abruptly raised from 7.0 m (22 sec after deployment) to 1.2 m depth, and another one with 3.5 m leader and no EFL was raised from 9.5 m (37 sec after deployment) to 0.5 m depth. These two events were interpreted as interactions with medium size petrels (Annex A).

Table 2: Percentage of baited hooks set with a TDR for each treatment that were within a depth of 0-5 m by the time they reached 50 m astern and for those that reached a depth greater than 10 m by the time they reached 80 astern.

	Treatment 1	Treatment 2	Treatment 3	Treatment 4
Configuration	3.5 m	3.5 m + EFL	5.5 m	5.5 m + EFL
0-5 m depth at 50 m astern	13%	27%	60%	47%
>10 m depth at 80 m astern	69%	47%	13%	33%

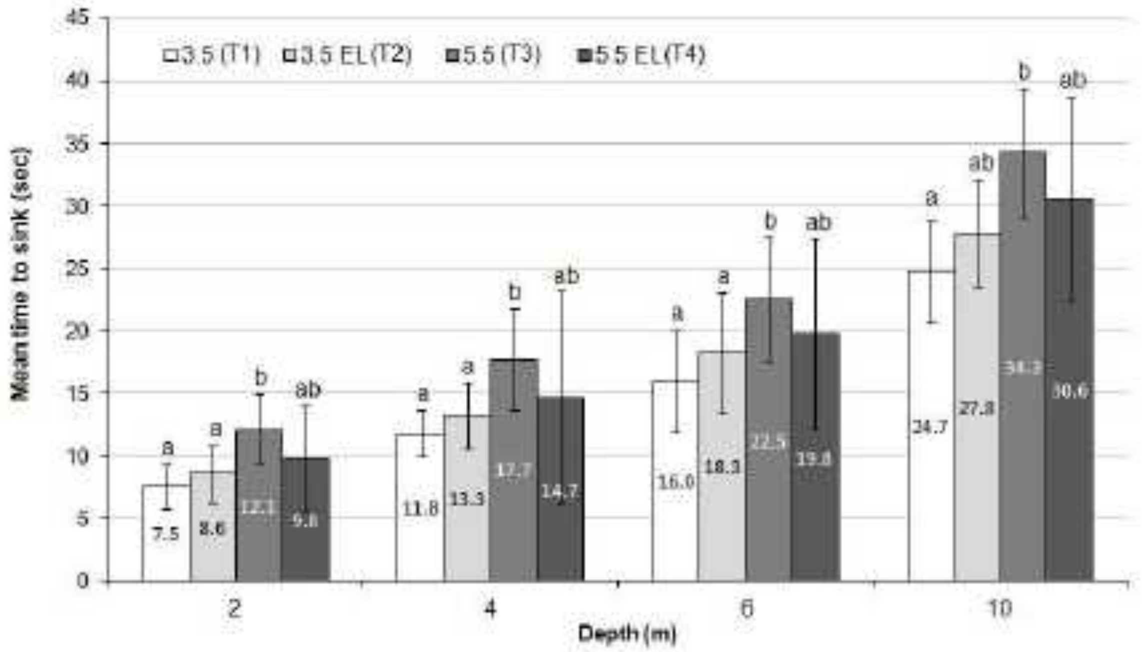

Figure 4. Mean time delayed by baited hooks under each treatment to 2 m, 4 m, 6 m and 10 m depths. The bars represents Standard Deviation. The mean time to sink at each depth class was compared between treatments using One-way ANOVA after square root transformation, followed by Tuckey test. Into each depth class, means values significantly different ($p < 0.05$) are not accompanied by common letters.

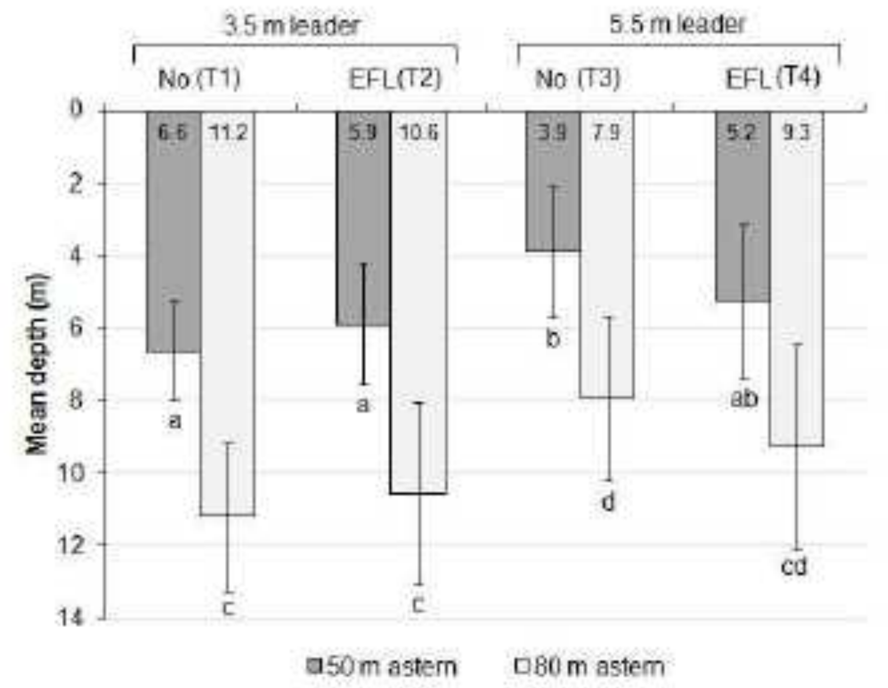

Figure 5. Mean depth of baited hooks under each treatment after 17 sec and 27 sec, corresponding to 50 m and 80 m astern respectively. The mean time to sink at each depth class was compared between treatments using One-way ANOVA, followed by Tuckey test. Means values significantly different ($p < 0.05$) are not accompanied by common letters.

4. DISCUSSION

The addition of EFL above leaded swivels tended to decrease sink rates when 3.5 m leaders were used, however the presence of this device increases sink rates when 5.5 m were used. Despite the presence of an EFL increasing the sink rate of baited hooks with 5.5 m leaders, 67 % of the baited hooks from 5.5 m and EFL (T4) did not reached the 10 m depth benchmark within 80 m astern, thus remaining in the diving range of medium size diving petrels (Huin 1994, Ronconi *et al*. 2010) after the tori line protection. Taking account longline settings without a tori line, the critical area for seabird attacks is within 50 astern (Melvin & Walker 2009, Gianuca *et al*. 2011, Giménez *et al*. 2012). Based on the findings of Prince *et al.* (1994) the mean depths of baited hooks 50 m astern on T3 and T4 were also within the dive range of *Thalassarche* albatrosses (5 m) in addition to medium size diving petrels.

In contrast, despite the presence of EFL decreasing the sink rates of baited hooks with 3.5 m leaders (T2), 47% of the baited hooks from T2 achieved 10 m depth within 80 m astern. In addition, the mean depths of baited hooks on T1 and T2 50 m astern were deeper than the 5 m dive range of *Thalassarche* albatrosses (Prince *et al*. 1994).

This document presents the first sink rates for Brazilian pelagic longliners that meet ACAP best-practice line weighting recommendation and compares and contrasts the effect of EFL on the sink rates of branchlines with 3.5 m and 5.5 m leaders. Our results indicate that 3.5 m leaders with ≥60 g leaded swivels is likely to achieve satisfactory sink rates under Brazilian pelagic longline fishing conditions, while the 5.5 m leaders did not, supporting the ACAP recommendation on line weighting (ACAP 2011) and agreeing with other studies demonstrating that shorter leaders increases sink rates (Robertson *et al.* 2010, Gianuca *et* *al*. 2011, Robertson *et al*. 2013). Despite using 75 g leaded swivels instead of 60 g, the sink rates should be comparable to 60 g leaded swivels sink profiles as it has been demonstrated that there is no significant difference between sink profiles of branch lines containing 75 g or 60 g leaded swivels (Robertson *et al*. 2010).

Regardless of the dark night (new moon) two baited hooks (3% from 66 TDR deployments) were accessed from 7-10 depths in the same longline setting (09/07/2013), showing the strong ability of medium size diving petrels to access baited hooks even at night. During this setting operation, there were 52 diving petrels present around the vessel that were considered capable of diving to these depths (2 *Puffinus gravis*, 10 *Procellaria aequinoctialis* and 40 *Procellaria conspicillata*). These records of seabird-longline interaction corroborates the study of Jiménez *et al*. (2011) on the role of medium size diving petrels in retrieving baited hooks to or near the water's surface where they become available for albatrosses. These records also reinforce the necessity of using tori lines even at night in order to deter the access of seabirds to baited hooks, avoiding both the mortality of seabirds as well as the loss of baits.

5. ACKNOWLEDGMENT

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ANNEX A

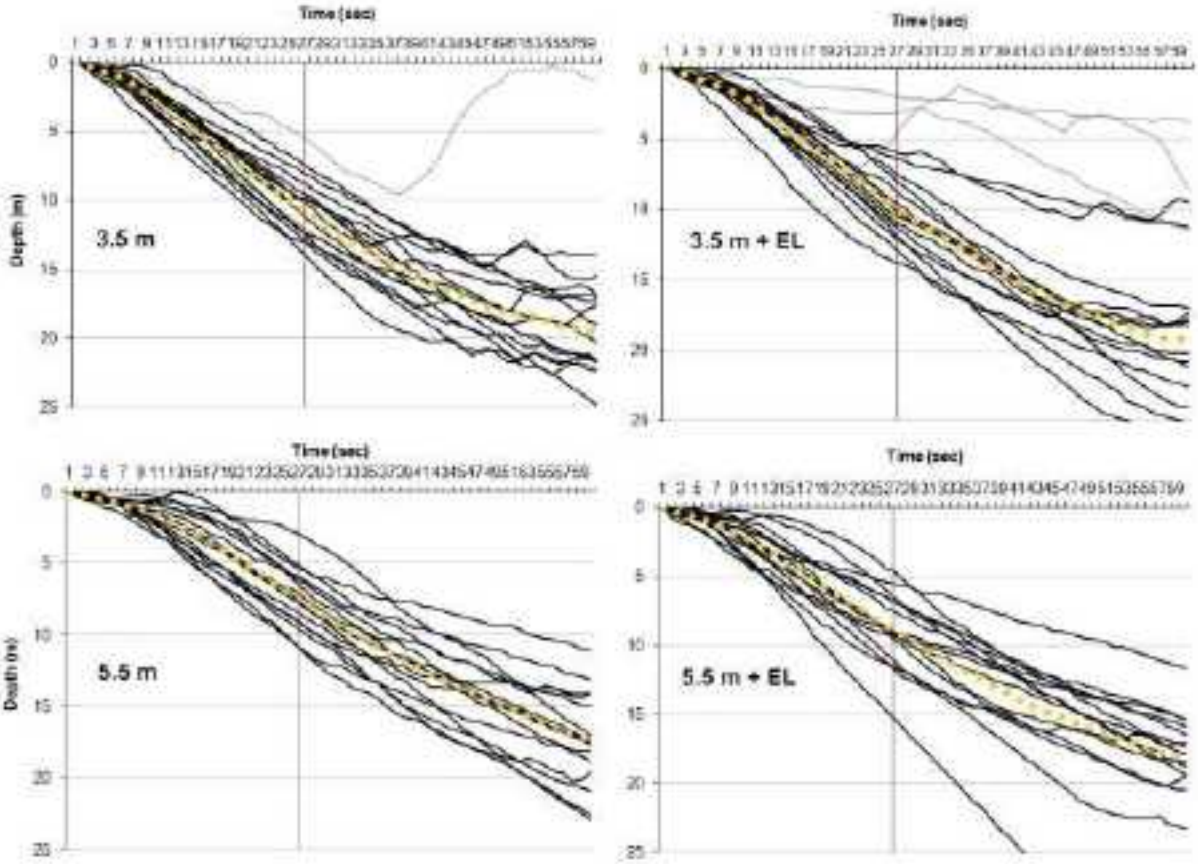

Figure 1. Sink profiles of baited hooks accordingly to leader length (3.5 m or 5.5 m) and presence or absence of electric lights (EL). Grey lines represents unusual sink profiles which were excluded from statistical analyses, dashed yellow line represents mean sink profiles, and the red line crossing the graph indicates the limit of the toriline coverage (27 sec).