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The contribution of Graham Robertson and Ed Melvin was critical in the planning and development of the projects reported in this document.

The vast majority of the experimental mitigation research described in this report has been carried out on commercial fishing vessels. It is thanks to the support of fishing companies in each country that such work can continue.

EXECUTIVE SUMMARY

In 2006, BirdLife's Albatross Task Force (ATF) was established to meet the urgent conservation need to reduce seabird bycatch in longline and trawl fisheries. Since that time seven ATF teams¹ have been established in southern Africa and South America at locations where vulnerable seabird populations overlap with longline and trawl fisheries.

The first teams to commence operations are now reporting bycatch reductions in their local fleets, including achievements such as:

- ✓ Through the adoption of strict regulations in the Asian distant pelagic longline fleet in South Africa, seabird bycatch was reduced by 85% in 2008;
- ✓ Since work began in the Chilean pelagic longline fleet, the seabird bycatch has dropped from an estimate of over 550 birds in 2007 to around 22 birds in 2009;
- ✓ From ATF observations on longline vessels in Brazil, observed seabird bycatch has been reduced from 0.99 birds per 1,000 hooks in 2007 to 0.11 birds per 1,000 hooks in 2009.

Despite these promising successes, to sustain such bycatch reductions over the long-term it is essential to identify a best practice suite of measures for pelagic longline fisheries and to have these adopted on a fleet wide basis in all target fisheries. Towards this end, in 2009 the ATF worked in six countries in South America and southern Africa to implement a mitigation research programme aimed at identifying best practice mitigation for pelagic longline and trawl fisheries. Our research programme was based primarily on tori line design, use and performance in pelagic longline and demersal trawl fisheries.

In most cases our results are preliminary and require further data collection in 2010 to provide definitive best practice advice, but the body of work provides a clear advance on several aspects of the design and performance of mitigation measures in these fisheries.

Pelagic Longline Fisheries:

Research in Brazil, Chile and Uruguay suggests three important findings:

1. A single bird-scaring line/ tori line in pelagic longline fisheries reduces seabird bycatch when compared with a control of no tori line (Uruguay);
2. In conjunction with the current line-weighting regimes being used in pelagic longline fisheries in Brazil and Chile our preliminary data suggests that the use of long streamers may have limited benefit in reducing seabird attack rate compared to short streamers, in areas with relatively low seabird abundance; and

¹ A detailed breakdown of current ATF teams can be found in Appendix A

3. Tori line towed devices remain the primary source of entanglements with fishing gear, particularly longline surface floats.

Demersal Trawl Fisheries:

Two important aspects of tori line use can be concluded from these experiments:

1. Seabird interactions with warp cables are significantly reduced through the deployment of a tori line in Argentinean and Namibian demersal trawl fleets;
2. The amount of time tori lines cross over trawl warp cables is significantly reduced through the use of an off-setting towed device.

Further mitigation research has been planned for 2010 and next year we hope to report on definitive results from several countries that provide the basis of the uptake of best practice mitigation measures in ATF target fisheries, and beyond.

INTRODUCTION

In 2006, BirdLife's Albatross Task Force (ATF) was established to meet the urgent conservation need to reduce seabird bycatch in longline and trawl fisheries. Since that time seven ATF teams² have been established in southern Africa and South America at locations where vulnerable seabird populations overlap with longline and trawl fisheries.

The ATF employs local experts to work in ports and at-sea with the fishing industry and government agencies in order to promote, demonstrate and facilitate the adoption of mitigation measures in target fisheries.

While the achievements already made by the ATF have been extremely positive, the teams have to a degree, been restricted by technical advances in mitigation measures – a relatively young science. During the first ATF Instructor's Workshop in January 2009, a list of country-specific mitigation research priorities tabled at the Seabird Bycatch Working Group (SBWG) of the Agreement on the Conservation of Albatross and Petrels (ACAP) in November 2008 was adapted to identify mitigation research objectives for each ATF team.

These objectives were developed into specific research projects that would be carried out within the context of commercial fisheries during 2009 to refine our understanding of best practice mitigation. It was recognised that to conduct a comprehensive international research project would constitute the majority of ATF instructor effort over the course of the year. To work towards the future implementation of our results we agreed that report our preliminary findings to the ACAP SBWG in April 2010.

The results of this research programme are aimed at providing sound scientific evidence to facilitate the adoption of appropriate mitigation in fisheries of coastal States, and ultimately to influence measures taken in Regional Fisheries Management Organisations (RFMOs). The experimental research plans that were devised during the workshop were focussed on bird-scaring line (here after referred to as tori line) configuration and use in pelagic longline and trawl fisheries plus the effect of line weighting on target species catch in pelagic longline fisheries.

The layout has been ordered by fishing techniques (longline and then trawl) and subsequently by country. The bulk of the report reflects the body of work compiled during the mitigation research programme. However, we also highlight and discuss major achievements by each team in terms of seabird bycatch reduction, educational and awareness raising and our emerging focus on strengthening National Observer Programmes.

² A detailed breakdown of current ATF teams can be found in Appendix A

LONGLINE FISHERIES

One of the fundamental technical barriers to eliminating seabird bycatch remains the identification of an effective suite of measures for pelagic longline fisheries. Mitigating seabird bycatch in such fisheries is inherently more difficult than in demersal longline fisheries. This is due to fundamental differences in gear design with demersal gear being configured to sink rapidly to the sea-bed while pelagic gear is configured to float in the water column, and this facilitates the capacity for seabirds to dive and bring baited hooks back to the surface ('secondary hook-ups') in lightly weighted pelagic gear.

A new line of research is required to find solutions. Continued failure to conduct the at-sea research required to provide unequivocal best practice mitigation advice for these fisheries is a serious impediment to progress towards halting the decline of many albatross and petrel populations.

Pelagic longline gear is typically set in the evening or at night, which limits the amount of time observers can monitor the performance of tori lines. In order to collect data on how the tori line 'behaves' once deployed, ATF instructors used the time that was available before nightfall to monitor the setting operations. During these observations four main elements were recorded, including tori line aerial extent, tori line entanglements with fishing gear, seabird abundance during the set and seabird mortality.

Although seabird mortality associated with longline fisheries is the primary driver of population declines for many albatrosses and petrels, mortality events are a statistically rare event. However, a relationship between seabird attack and mortality rates has been demonstrated in pelagic longline fisheries (Melvin *et al.* 2010), which enables attack rate to be used as a proxy to indirectly quantify seabird mortality. Projects presented here therefore incorporated seabird attack protocols to facilitate the identification of seabird mortality in our target pelagic longline fisheries in Brazil, Chile and Uruguay.

1.0 BRAZIL

Caio Marques, Fabiano Peppes, Leo Sales & Tatiana Neves



1.1 Summary

The seabird bycatch rate recorded onboard pelagic longliners observed by the ATF Brazil in 2009 was 0.11 birds per 1,000 hooks. This suggests a marked decline in bycatch rates compared to 0.99 birds per 1,000 hooks from the same fleet in 2007. These estimates are calculated from six trips (total effort of 65,445 hooks over 52 sets) in 2007 and nine trips (total effort of 145,190 hooks over 122 sets) during 2009.

Prior to conducting mitigation research on tori lines an initial collaborative effort with the Uruguayan ATF team was conducted to trial different materials in order to improve tori line design for both teams. Lighter materials and an improved towed device have generated greatly improved tori lines that afford better protection to sinking hooks.

Although the results on the comparison of light tori line designs with an emerging pelagic tori line design is still not conclusive due to limited sample size, the preliminary implications are that both designs may be equally efficient when used in combination with current line weighting, which it should be noted is well below what is considered best practice. This work will be continued during 2010 to increase the sample size and further understand the relationship between tori line performance and line weighting.

1.2 At-sea research

A comparison of the effectiveness of light tori lines and an emerging pelagic tori line design in reducing seabird bycatch in the Brazilian pelagic longline fleet

The objectives of the study were twofold:

- 1) To determine the entanglement rate related to the use of a towed device that provides increased aerial coverage of the tori line;
- 2) To evaluate and compare the effectiveness of a single streamer line with long and short streamers at reducing the attack rate of seabirds on baited hooks during pelagic longline setting operations.

The experimental design included two treatments:

- 1) A single light tori line (based on designs used in Brazil, with short streamers);
- 2) A single emerging pelagic tori line design with longer streamers.

Null hypotheses (H_0) = there is no difference in seabird attack rate on baited hooks when using a single tori line with long streamers compared with short streamers;

Experiments were conducted onboard three vessels, the *Capitão Lucas* and *Oceano Brasil* from the fishing company Itafish based in Santos, and the *Akira V* based in Itajaí. The three vessels selected represented typical pelagic longline vessel characteristics for the Brazilian fleet. The fishing area was in the south east of Brazil, from 25° S to 47° S and between 35° W and 50° W.

The fishing gear used on these vessels was the 'American System'; composed of a single monofilament longline with monofilament branch (secondary) lines (Figure 1). Between 35 and 37 nautical miles of longline was set during each line, with one line set per day.

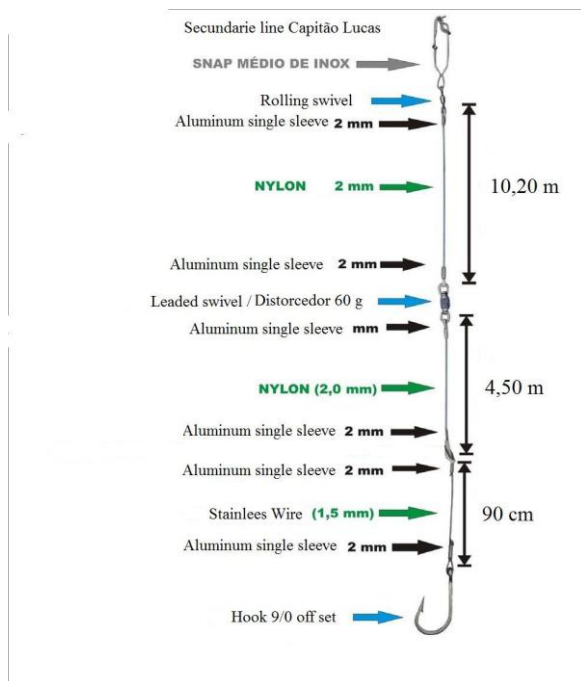


Figure 1: Branch (secondary) line gear configuration on Brazilian pelagic longline vessels

Setting speed of the vessel was approximately 7.3 knots; sets began from 17:00 hours onwards and finished in the early hours of the morning. In order to maximise data collection opportunities during daylight hours, every effort was made to work with the captain and crew to start line setting as early in the afternoon as possible. Line hauling began at approximately 05:00 hours.

1.3 Mitigation measures

The effectiveness of two tori line designs was compared (see Figure 2):

Treatment 1: a single light tori line (based on designs used in Brazil), which consists of short streamers (around 1 m) attached to the backbone at 2 m intervals.

Treatment 2: a single emerging pelagic tori line design with longer streamers, based on work by Washington Sea Grant (Melvin *et al.*, 2009).

On each tori line, the back bone material used was 3.0 mm nylon monofilament line for the first 60 m and subsequently 2.7 mm for the following 40 m. The backbone was attached 8 m above sea level on the port side via a purpose built tori pole. An un-weighted swivel was placed close to the attachment point and another in the backbone at 60 m from the stern and a third at the attachment point for the towed device.

Towed device

As a precursor to the experiment, tensions tests were carried out in collaboration with the ATF Uruguay team (Proyecto Albatros y Petreles – Uruguay) to identify the most appropriate towed device for the fishery (See appendix B). The selected device was chosen from five options³ that were each subjected to a series of qualitative trials on coastal vessels and tests on land. Tests included material weight, breaking strain, generation of drag in the water and ease of use (deployment / retrieval).

The selected design, based on work by Melvin *et al.*, (2009) was constructed from a 30 m seaward extension of 2.8 mm polypropylene line with lengths of rigid plastic straps tied at 0.2 m intervals along its length. A biodegradable alternative is being sought for the plastic straps. The device was chosen for the simplicity, economical cost, and ease of use plus the superior line tension that the design provided, which maximised the aerial extent. Additionally, the chosen design presented a relatively low number of entanglements compared to the other devices.

Light tori line

Polypropylene coloured streamers were used on the light tori line. One meter long bundles of six streamers (three lengths of two meters, doubled in half) were attached every two meters along the length of the tori line backbone. White streamers were attached at ten metre intervals to facilitate the estimation of tori line aerial extension. The first bundle of streamers was attached ten meters from the stern (Figure 2a).

Emerging pelagic tori line

Streamers of UV protected Kraton tubing were attached (via a snap) at five metre intervals along the length of the tori line backbone. See Figure 2(b) for schematic.

³ The towed devices included: two off-setting devices (a tube and a board), a length of polypropylene line with intertwined packing straps, a traffic cone and a length of 40mm bulk rope.

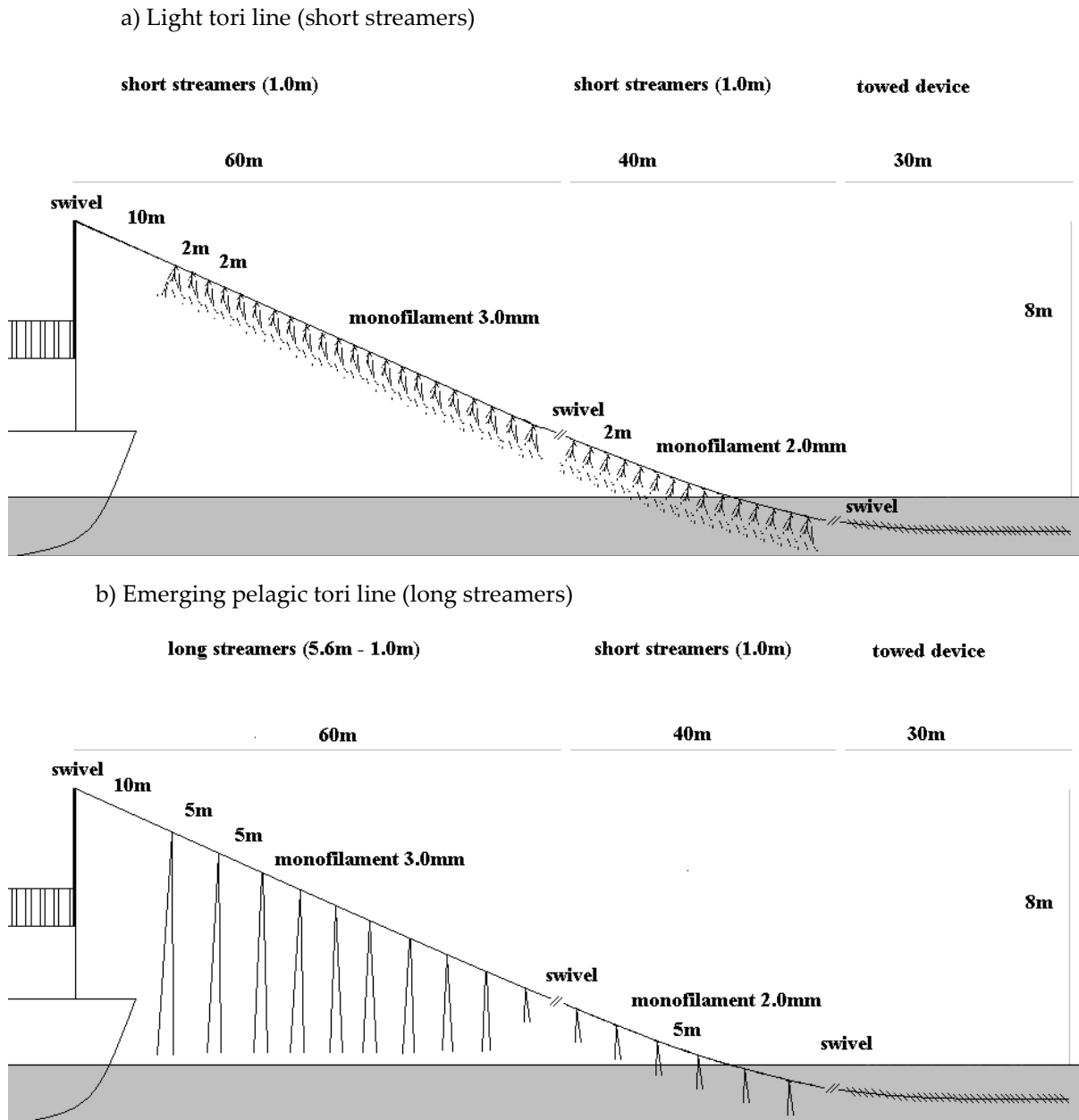


Figure 2: Configuration of light (a) and emerging pelagic (b) tori line designs

1.4 Onboard protocol

The number of seabirds by species was estimated immediately prior to the set within a hemisphere of 200 m centred at the vessel stern. The number of seabird attacks on baited hooks was recorded as a function of distance aft (0-25 m, 25-50 m, 50-75 m, 75-100 m and >100 m) following the methodology presented in Melvin *et al.* (2009). Observation of these factors depended on available light during each set. Observations made in poor visibility were discarded from the analysis.

Tori line aerial extent was estimated for each observation period using the known distance between streamers. Detailed information was recorded each time the tori line became entangled.

When seabird mortality was recorded during the haul, the section, buoy and hook position were noted to enable the mortality event to be related to observations made during line setting.

1.5 Data analysis

Aerial extent of tori line designs were compared using a one-way ANOVA. Seabird attack rates (setting interactions) were grouped according to distance aft (0-50 m, 50-75 m, 75-100 m and >100 m) and by species for multiple comparisons of tori line performance. As data screening identified non-parametric distribution, seabird attack rates per distance aft were compared for each treatment with a Mann –Whitney U test. A Kruskal-Wallis test for multiple comparisons was then used to compare seabird attack rates per distance category aft within each treatment.

1.6 Results

From the 27th March to the 6th October and between 25°37' S and 47°40' S a total effort of 145,246 hooks were deployed during 122 setting operations (1,190.54 ± 185.07 hooks per set). A proportion of setting operations was conducted in daylight hours for 57% of all lines (65 sets) thereby permitting seabird interaction observations to be recorded for analysis.

Mean total seabird abundance throughout the experiment was 122.80 ± 111.57 birds. Of the 13 species recorded attending the vessel during setting operations, White-chinned petrels (*Procellaria aequinoctialis*) represented the most frequently encountered (25.90% of observed sets), followed by Spectacled petrels (*Procellaria conspicillata*) (21.99%), Black-browed albatross (*Thalassarche melanophrys*) (16.61%), Atlantic Yellow-nosed albatross (*Thalassarche chlororhynchos*) (11.24%) and Greater shearwater (*Puffinus gravis*) (9.93%). Together, these five species made up over 97.41% of the total abundance of seabirds observed during sets.

The observed tori line aerial extension aft of the vessel was significantly different (ANOVA: $F = 19.95$; $p < 0.0001$) at 95.88 ± 13.03 m and 82.23 ± 17.09 m for the light and emerging pelagic tori lines, respectively (Figure 3). This difference was thought to be due to the difference in weight caused by the longer streamers and the snaps used to attach them to the backbone.

A total of 10 entanglements (15.4% of experimental sets, $n = 65$) were recorded, six whilst using the light tori line and four with the emerging pelagic tori line. Although these entanglements all occurred at night and were therefore not observed, the recovery of the towed device on hauling suggested it was the cause of the entanglement.

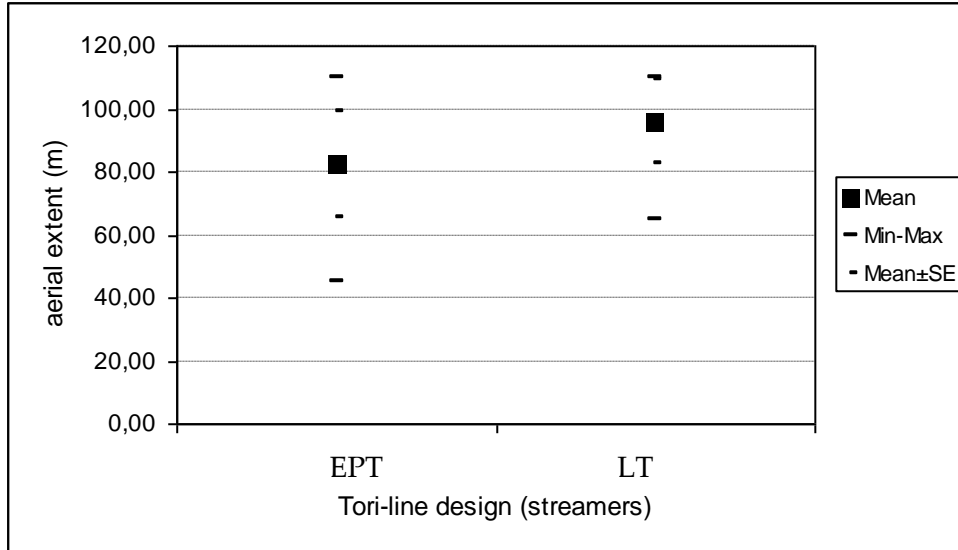


Figure 3: Mean aerial extension for the two tori line designs (Emerging Pelagic Tori line, EPT and Light Tori line, LT) used in the experiment.

Observation of seabird attacks on baited hooks during the set resulted in 1,077 minutes of effort during which a total of 168 attacks were observed. The average attack rate was 0.07 ± 0.34 attacks per minute for the light tori line and 0.08 ± 0.16 attacks per minute for the emerging pelagic tori line. No significant difference was identified for the mean attack rate within the aerial extent (distance categories up to 100 m) of the two tori line treatments (Mann-Whitney $P > 0.05$) (Table 1). For the emerging pelagic tori line design (Treatment 2) there was a significant increase in attack rate beyond 100 m from the vessel stern compared to light tori lines (Treatment 1) (Kruskal-Wallis test for multi comparisons: $P < 0.05$) (Figure 4).

Table 1: Mean attack rate \pm SD, N value, U statistic and P values for the Mann-Whitney U Test comparing seabird attack rates for emerging pelagic tori lines (EPT) and light tori lines (LT).

	EPT ($n=17$)	LT ($n=19$)	N value EPT / LT	U	P value
Total*	0.0752 ± 0.16	0.0703 ± 0.34	40 / 36	979	0.0065
0-50 m	0.0076 ± 0.03	0.0016 ± 0.01	4/1	1197	0.2909
50-75 m	$0.0299 \pm 0,08$	$0.0216 \pm 0,15$	17/11	1074	0.0151
75-100 m	0.0378 ± 0.11	0.0471 ± 0.21	19/24	1129	0.1261
>100 m	0.1479 ± 0.26	0.0132 ± 0.04	85/7	855	0.0004

*Within the aerial extent of the corresponding tori line design

The main species recorded attacking baits were Greater shearwater (40 attacks, 28.17%), Spectacled petrel (26 attacks, 15.48%), Black-browed albatross (19 attacks, 13.38%) and Cape petrel (17 attacks, 11.97%). Nine birds were recorded killed during the experiment at a rate of

0.119 birds / 1,000 hooks. Four mortalities were recorded during tori line treatments (0.086 birds / 1,000 hooks), this included one White-chinned petrel during the use of light tori lines (Treatment I), and two White-chinned petrels and one Black-browed albatross during emerging pelagic tori lines (Treatment II). Four Black-browed albatross and one White-chinned petrel were killed when no tori lines were used (0.170 birds / 1,000 hooks). Although the experiment was not designed with a control treatment of no tori line, due to operational issues there were relatively frequent occasions throughout the experiment when no tori line was used ($n=29$).

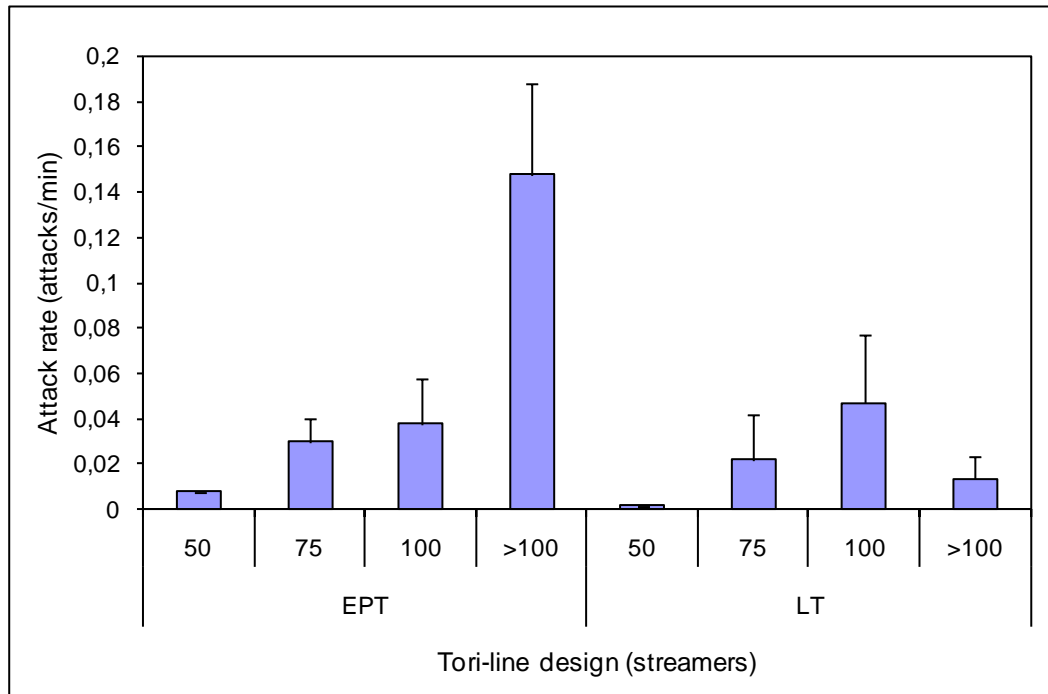


Figure 4: Mean attack rate per distance aft of the vessel for each tori line design. Whiskers indicate Standard Error.

1.7 Discussion

The results of this research project should be interpreted with caution due to a relatively small sample size related to low levels of seabird interactions recorded during this study. However, some interesting preliminary findings were made that suggest the Brazilian light tori lines could be as effective at reducing seabird attacks on baited hooks as the emerging pelagic tori line model with long streamers. However, considerably more data is required to support these findings before it is possible to make any unequivocal statements or recommendations about the relative effectiveness of the two types of tori lines.

The mean seabird abundance of 122.80 ± 111.57 birds per set compared to a total of only 168 attacks on baited hooks suggests that both tori line designs afforded a degree of protection to the longline during setting operations. Particularly given that 55% of recorded attacks were recorded beyond the 100 m distance category, which in most cases (see Figure 4) was beyond the

aerial extent of the tori lines. It is insightful to compare these findings with Time Depth Recorder (TDR) data collected on the longline vessel *Akira V* in September 2008 with a similar gear configuration. The *Akira V* had 60 g swivels placed 6m from the hook which is comparable to the 5.5m used in our current trials outlined above (see Figure 1) and the vessel on both occasions had a setting speed of 7.3 knots. These TDR data (47 reps across 14 sets, with Wildlife Computers Mk9 TDRs attached 30 cm from the hook) identified a sink rate of 0.17 m/s @ 2 m depth, 0.20 m/s @ 4 m and 0.28 m/s @ 10 m. This suggests that baited hooks would be at a depth <10 m at up to 135 m astern, which would be 53 m past the mean aerial extent of the EPT and 39 m past the LT. This is reflected in the relatively high attack rates recorded beyond 100 m from the stern of the vessel. See the 2010 ATF Workshop Report (Buenos Aires, February 2010) for details of the next phase of experimentation which was designed to further understand the relationship between line sink rates and aerial coverage of tori lines.

1.8 On-shore developments

Port visits

Throughout 2009 there were 62 port visits conducted in Brazil, in the ports of Santos, Itajaí and Rio Grande. Visits included informal interviews with over 80 members of the fishing industry with the explicit intention of discussing mitigation use, development and seabird conservation goals. On average five visits took place per month.

Raising awareness

In 2009, over 6,700 educational brochures/newsletters were distributed to the fishing industry including managers, captains, crew and fishing companies, plus to students and local researchers. These educational materials included books and leaflets produced by Projeto Albatroz and the Uruguayan publication *Boletín Atlántico Sur*. All were specially prepared to inform and update industry on the best practice use of mitigation measures in longline fisheries.

Additionally, Projeto Albatroz and the ATF were involved in a television report shown on *TV Tribuna* over the course of a month that highlighted ecological issues related with the Santos Bay area.



2.0 CHILE

Rodrigo Vega, Luis Cabezas and Carlos Moreno



2.1 Summary

Since the ATF began work in the Chilean pelagic longline fleet, the seabird bycatch has dropped from an estimate of over 550 birds in 2007 to around 22 birds in 2009. This reduction is thought to be a direct result of ATF efforts to work with the National Observer Programme to improve tori lines design and their level of adoption by the industrial vessels in the fleet.

During 2009, the team in Chile has added important information to the current understanding of fishing gear sink rate, and how this relates to tori line use in the pelagic longline fishery. The sink rate of hooks on the larger industrial vessels is much slower than on smaller craft, explaining the higher bycatch previously associated with these vessels.

Onshore, considerable effort has been focused on working with the Fishery Development Institute (IFOP) to strengthen the National Observer Programme to increase the coverage of seabird interactions and monitoring of the adoption of mitigation measures in the pelagic longline fishery.

2.2 At-sea research

The effect of tori line design in the reduction of seabird bycatch in the Chilean pelagic longline fleet

The objective of the study was to compare the effectiveness of single tori lines with short streamers to those with long streamers.

The experimental design included two treatments:

- 1) A single tori line with long streamers;
- 2) A single tori line with short streamers.

Null hypotheses (H_0)= There is no significant difference in seabird attack rate on baited hooks when using a single tori line with short-streamers compared with streamers that reach the water's surface.

The research was carried out during a single 3-month trip on a 53 m pelagic longline vessel from the swordfish (*Xiphius gladius*) fleet based in Coquimbo. The swordfish fishery operates off

central Chile between 20 - 40° S and 75 – 90° W, from the Chilean Basin in the south to the Peruvian Basin in the north and west as far as the East Pacific Rise.

The fishing gear employed by the vessel during the study was the ‘American System’ (see Vega & Licandeo, 2009 for details), composed of a single monofilament longline with monofilament branch (secondary) lines. Between 39 and 73 nautical miles of longline was set during each line, with one line set per day.

Branch lines consisted of a snap, 15 m of 2.1 mm monofilament top section followed by a 75 g weighted swivel, 3 m of 2.1 mm monofilament bottom section, 0.6 m of stainless steel wire tracer and a size 9/0 offset hook. Setting speed of the vessel averaged 10.5 knots. Setting began between 17:00 - 19:00 hours, finishing in the early hours of the morning. In order to maximise data collection opportunities during daylight hours, every effort was made to work with the captain and crew to start line setting as early in the afternoon as possible.

2.3 Mitigation measures

Two alternative tori line designs were used; short-streamer and long-streamer tori-lines (Table 2). Both designs were attached via a tori pole on the port side, 11 m above sea level. Each design used a common backbone material and attachment point plus the same towed device.

Table 2: Details of two experimental tori line designs

	Short-streamer tori line	Long-streamer tori line
1. Attachment	11 m above sea level	11 m above sea level
2. Backbone material	3.5 mm monofilament	3.5 mm monofilament
3. Backbone length	100 m	100 m
4. Streamer material	Kraton orange tubing	Kraton orange tubing
5. Streamer length	1 m	7.8 m – 2 m
6. Number of streamers	16	13
6. Quick release (breaker)	20 cm cord	20 cm cord
7. Towed device	10 m of 20 mm diameter bulk rope	10 m of 20 mm diameter bulk rope

The towed device used was a 10 m section of 20 mm diameter bulk rope that was attached to the trailing (seaward) end of the tori line. A quick release section of cord was included in the design immediately before the towed device due to concerns about entanglements with fishing gear. This quick release was intended to break under strain to prevent dangerous incidents whilst setting the fishing gear.

2.4 Onboard protocol

The number of seabirds by species was estimated immediately prior to setting within a hemisphere of 250 m centred at the vessel stern. The number of seabird attacks on baited hooks was recorded as a function of distance aft (0-50 m, 50-75 m, 75-100 m and >100 m) following the methodology presented in Melvin *et al.* (2009). Observations were carried for multiple 15 minute periods, the number of observation periods (1-6) varied depending on light conditions. Observations made in poor visibility were discarded from the analysis.

Tori line aerial extent was estimated for each observation period using the known distance between streamers. Detailed information was recorded each time the tori line became entangled. Time depth recorders⁴ were used to provide information on the sink rate of the hook lines. Wildlife Computers Mk9 TDRs were attached 30 cm above the hook and deployed on the middle (third) hook between floats and randomly allocated to one of three sections (start, middle or end) of the longline.

When seabird mortality was recorded during the haul, the section, buoy and hook position were noted to enable the mortality event to be related to observations made during line setting.

2.5 Data analysis

Aerial extent of tori line designs were compared using a one-way ANOVA. Seabird attack rates (setting interactions) were stratified according to distance aft (0-50 m, 50-75 m, 75-100 m and >100 m) and by species for multiple comparisons of tori line performance. As data screening identified non-parametric distribution, seabird attack rates per distance aft were compared for each treatment with a Mann –Whitney U test. A Kruskal-Wallis test for multiple comparisons was then used to compare seabird attack rates per distance category aft within each treatment.

2.6 Results

From the 27th July to the 17th October and between 26°16' S and 32°49' S, a total effort of 96,590 hooks were deployed during 64 setting operations (1,509.22 ± 105.53 hooks per set). 75% of all lines (48 sets) were included in the experiment.

Mean total seabird abundance throughout the trip was 43.15 ± 25.66 birds. Of the 22 species recorded attending the vessel during setting operations, only three had a frequency of occurrence of over 80%: Cape petrels (97.92%), White-chinned petrels (97.92%) and Black-browed albatross (81.25%). These three species made up over 86% of the total abundance of seabirds observed during sets.

The observed tori line aerial extension aft of the vessel was significantly different (ANOVA: $F_{1,46} = 90.02$; $P < 0.0001$) at 73.13 ± 7.19 m and 56.04 ± 5.10 m for the tori line with short streamers and that with long streamers, respectively (Figure 5). A total of seven (14.6% of experimental sets) entanglements were recorded, four whilst using the short streamer tori line and three with the

⁴ Initially four TDRs were used, but two were lost during setting operations mid trip.

long streamer tori line. 100% of entanglements were caused by interference between the towed device and the fishing gear during setting operations.

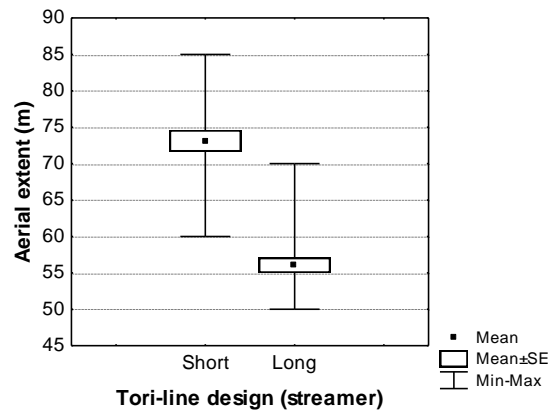


Figure 5: Mean aerial extension for the two tori line designs used in the experiment with Standard Error and minimum / maximum values.

Sink rate analysis from 132 repetitions over 48 sets (observed sets) indicated that the average sink rate to a depth of two, four and ten meters was 0.21, 0.24 and 0.28 m/s respectively. With this sink rate, baited hooks were still available within the diving range of *Procellaria* petrels (<10 m) at 189 m astern of the vessel, which is >100m beyond the aerial extent of both tori line treatments.

Observation of seabird attacks on baited hooks during the set resulted in 3,314 minutes of effort, during which time a total of 471 attacks were observed. The average attack rate within the aerial extent of each line was 0.021 ± 0.076 attacks per minute for the short streamer tori line (<75 m) and 0.010 ± 0.032 attacks per minute for the long streamer tori line (<50 m). Although the short streamer tori line revealed a higher average attack rate, the difference was not significant (Mann-Whitney U test: $P > 0.05$). Nor was there a significant difference in attack rates between treatments when the data was stratified according to distance aft (Mann-Whitney U tests: Table 3). However, in both treatments there was a significant increase in attack rate beyond 100 m from the vessel stern (Kruskal-Wallis test for multi comparisons: $P < 0.05$) (Figure 6).

Table 3: Mean attack rate ± SD, number of attacks, U statistic and P values for the Mann-Whitney U Test carried out to compare seabird attack rates for each treatment.

	S-S tori line (n=24)	L-S tori line (n=24)	n value (S-S/ L-S)	U	P-value
Total*	0.021 ± 0.076	0.010 ± 0.032	34/21	280,0	0,87
0-50 m	0.006 ± 0.024	0.010 ± 0.032	16/21	275,0	0,79
50-75 m	0.008 ± 0.030	0.016 ± 0.039	18/32	253,5	0,48
75-100 m	0.025 ± 0.052	0.018 ± 0.033	44/38	278,0	0,84
> 100 m	0.116 ± 0.233	0.082 ± 0.087	157/145	262,5	0,60

*Within the aerial extent of the corresponding tori line design

The main species recorded attacking were White-chinned petrels (282 attacks, 60%), Cape petrels (*Daption capense*) (129 attacks, 27%) and Black-browed albatross (28 attacks, 5.9%). Despite the relatively low attack rate of Black-browed albatross, this species accounted for three of the four birds killed during the experiment (0.04 birds / 1,000 hooks). When comparing seabird attack rate for each species, the White-chinned petrels attacked along the entire length of the aerial extent of the tori lines (0-50 m, 50-75 m and 75-100 m), with no significant difference between treatments ($P>0.05$ for all distance categories). The Black-browed albatross attacked exclusively beyond 100 m with the short streamer treatment; and 75-100 m and >100 m with the long streamer treatment.

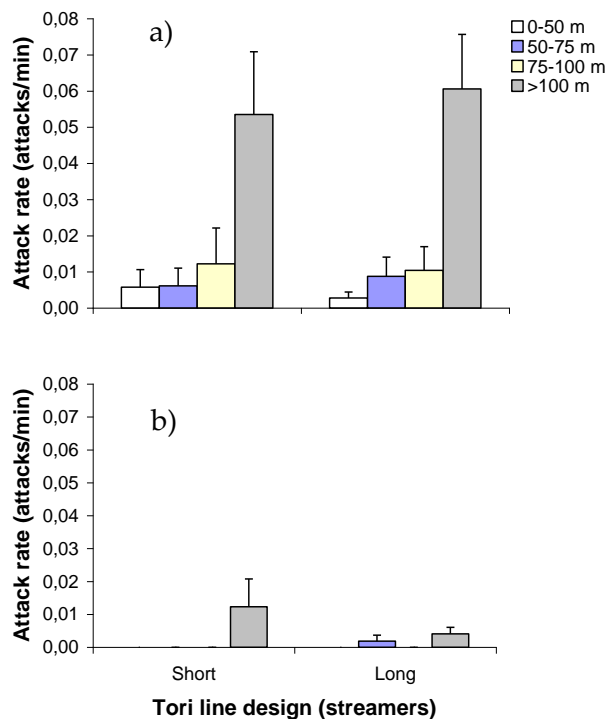


Figure 6: Mean attack rate by White-chinned petrels (a) and Black-browed albatross (b) per distance aft of the vessel for each tori line design. Whiskers indicate Standard Error.

2.7 Discussion

Our analysis indicates no significant difference between attack rates within the overall aerial extent of the two treatments or within individual distance categories, although there was a trend for more attacks on the treatment with short streamers. White-chinned petrels were the species most frequently recorded attacking baits within the aerial coverage of both treatments. It is hoped that further data collection in 2010 will facilitate a more statistically robust understanding of the relative effectiveness of the two tori line designs. It should be noted that there was a significant difference in the mean aerial extent of the two treatments. As the configuration of the two treatments was identical except for the length of streamers we can assume with some confidence that this difference in aerial distance was caused by the increased weight of the longer streamers (1.2 vs 4.1 kg). The relatively low number of attacks recorded within the aerial

extent of the two treatments suggests that both tori lines reduced seabird attack rate. TDR data indicates that baited hooks were still at <10 m at around 190 m astern of the vessel. This is supported by the relatively high proportion of Black-browed albatross attacks recorded beyond 100 m.

Whilst the results from this study demonstrated similarities in the effectiveness of the two tori line designs, the aerial extent that was observed could be significantly improved using an alternative towed device such as the design used in Brazil and Uruguay.

Sink rate comparison between Brazil and Chile

Sink rate data collected in Brazil in 2008 (onboard one of the same vessels used to conduct our research in 2009) and that collected in Chile as part of our 2009 research project suggests that baited hooks sink to 10 m at a similar rate (Table 4). We calculated that gear would be at a depth <10 m at up to 135 m astern in Brazil, and 189 m in Chile. Given that the 75 g swivel is 3.5 m from the hook in Chile compared to 60 g at 5.5 m in Brazil, the difference in the distance astern at which hooks are available at <10 m is thought to be largely a result of the increased setting speed of 10.5 knots in Chile, compared to 7.3 knots in Brazil. These data clearly demonstrate that under current line weighting regimes, tori lines are not a sufficient deterrent to abate seabird mortality as baited hooks remained accessible well beyond the protection of all tori line models trialled in this research.

Table 4: Comparative sink rates (m/s) of secondary (branch) lines in Chile (2009) and Brazil (2008)

	2 m	4 m	10 m
Chile	0.21	0.24	0.28
Brazil	0.17	0.20	0.28

2.8 On-shore developments

Observer programmes

In Chile, the national observer programme is run by IFOP, based in Valparaiso. Over the past three years ATF Chile has helped prepare the scientific observers in the pelagic longline fleet with courses on the basics of seabird bycatch, seabird identification and onboard protocols to correctly record bycatch events. This initiative was conducted under the umbrella of projects designed to meet with the recommendations contained in the Chilean National Plan of Action – Seabirds. During 2009, several observer courses were carried out (Table 5).

Table 5: Observer Courses performed by the ATF team, Chile

<i>Date</i>	<i>Location</i>	<i>Objective</i>	<i>N° attendees</i>
March 2009	Coquimbo	Data collection - seabird census and interaction with fisheries	9
May 2009	Valparaiso	Seabird necropsy protocol and practical course	4
October 2009	Coquimbo	Seabird necropsy protocol and practical course	6
November 2009	Talcahuano	Introduction to the conservation of seabirds related with fisheries	33
November 2009	Talcahuano	Seabird identification	33

The development of the collaboration with IFOP represent considerable effort in 2009, including 32 formal meetings with IFOP management in Valparaiso and Coquimbo. Based on the success of the work carried out with the observers in the pelagic longline fleet, the ATF in Chile has now signed an agreement with IFOP to continue this process with observers working in fleets in the south of Chile, including the ports of Talcahuano, Puerto Montt, Aysén and Punta Arenas. Funds to enable this process to move forward were secured through an application to ACAP by IFOP with support from ATF personnel. The target fleets in these ports include semi-demersal longline, demersal trawl and purse seine fisheries.

As an additional activity creating links between the ATF, IFOP and the broader seabird community in Chile, instructors from ATF Chile carried out a taxidermy session with specimens of albatross recovered from the pelagic longline fleet. The two birds, a Buller's albatross (*Thalassarche bulleri*) and a Black-browed albatross will be stored as study specimens for future use.

Port visits

Throughout the year 52 fishing trips were made by seven Coquimbo based pelagic longline vessels targeting swordfish. Of these trips 36 were made with a scientific observer from IFOP, the remaining trips were conducted on vessels that did not have suitable conditions to carry an observer (health and safety or available space issues). ATF instructors conducted 14 port visits to these longliners, which included a minimum of one visit to each vessel. To reinforce best practice advice on mitigation measures, particularly tori lines, these visits were conducted with an accompanying IFOP scientific observer (Table 6).

Table 6: Port visits conducted in Chile during 2009

<i>Port</i>	<i>N° Visits</i>	<i>Instructor / Coordinator</i>	<i>N° Vessels</i>
Coquimbo	8	Rodrigo Vega	5
Coquimbo	6	Luis Cabezas	4

Raising awareness

To celebrate the national environment day on the 5th June, the ATF in Chile participated in an event in the port of Coquimbo. The 6th Regional Environment Fair was organised by the Municipality of Coquimbo and included the presentation of conservation and environmental projects in the town centre over the course of the day. It was an ideal opportunity to reach a large amount of people, including general public, port workers and several local schools. Additionally, presentations were given at the local university, La Universidad Catolica del Norte.



3.1 Summary

The Uruguayan team created a mixed tori line design following collaborative preparations with the Projeto Albatroz team in Brazil. As a first step to defining the final design, the tori line has been introduced to part of the pelagic longline fleet to test performance through the experimental research programme. Preliminary results indicate that the use of this tori line significantly reduces seabird bycatch compared to a control treatment of no tori line.

While this result is extremely promising additional data collection is required in 2010 to strengthen the statistical power of our analysis and to provide more robust evidence to support the adoption of the mixed design tori line for the pelagic Uruguayan fleet.

3.2 At-sea research

Effectiveness of tori lines in reducing seabird bycatch in the Uruguayan pelagic longline fleet

The key objective of the study was to investigate whether a single tori line reduces seabird bycatch rates in the Uruguayan pelagic longline fishery.

Two treatments were included in the experimental design:

- 1) Lines set with a single 'mixed' tori line;
- 2) Lines set without a tori line (control).

Null hypotheses (H_0) = A single tori line use does not reduce the incidental bycatch of seabirds in pelagic longline fisheries in Uruguay

The study was carried out over the Uruguayan slope (34-37° S, 51-54° W) between July and November 2009. Trips were carried out onboard two Uruguayan commercial longline fishing vessels, each with a total length of 25.5 m and a breadth of 6 m. Additionally, a 36 m research vessel was equipped to replicate commercial pelagic longline fishing activities.

All vessels included in the study operated with an 'American System' longline (for details see Jiménez *et al.*, 2009). Branch (secondary) lines consisted of a snap, which connects the branch line to the mainline, a length of 2.0 m monofilament top section followed by a 75 g weighted swivel, 4.5 m of 2.0 mm monofilament bottom section, and a size 9/0 offset hook.

3.3 Mitigation measures

The tori line used in this experiment was a mix between the light tori line (Neves *et al.* 2008) and the emerging pelagic tori line developed by Washington Sea Grant (Melvin *et al.*, 2009). This mixed tori line was developed in collaboration between Proyecto Albatros y Petreles (PAP) and Projeto Albatroz (Brazil).

The tori line consists of three sections (figure 7):

1) Aerial section of 100 m – Polyamide 2.0 mm monofilament backbone with a combination of long streamers that reach the water surface attached at 5 m intervals and 1 m streamers attached at 1 m intervals, up to 75 m, and subsequently at 2 m intervals.

2) Breakaway section – 20 m of monofilament (polyamide, 2.0 mm) attached to the aerial section with an un-weighted swivel, and to the towed device with a snap. This section included a weak link that would allow the towed device to break away in the event of an entanglement.

3) The towed object consisted of a 30 m multifilament (polyethylene 4.0 mm) line with 0.80 m length packing straps⁵ placed every 0.20 m.

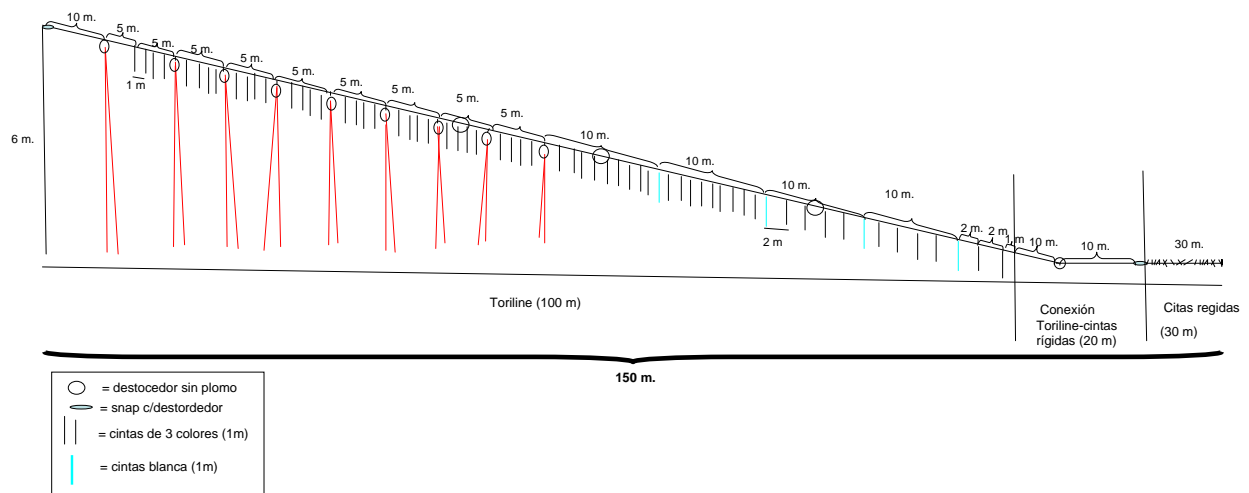


Figure 7: Schematic of the tori line configuration used in the Uruguayan research

3.4 Onboard protocol

During tori line treatments, aerial extent was estimated for each observation period using the distance between streamers. Detailed information was recorded each time the tori line became entangled. Observations on seabird attack rate during the set were recorded using PAP protocols⁶.

⁵ Alternative, biodegradable materials are being investigated to remove the risk posed by packing straps

⁶ PAP seabird attack rate protocols are similar to those in Melvin *et al.*, (2009) and were used in order to maintain in-country data recording continuity.

When seabird mortality was recorded during the haul, the section, buoy and hook position were noted to enable the mortality event to be related to observations made during line setting.

3.5 Data analysis

Version 2.6.1 of R (R Development Core Team 2009) was used to conduct a binomial General Linear Model (GLM) to determine the effect of the variables on seabird bycatch events. Variables included in the model were: time of set (day / night), vessel identity (vessel 1, 2 or 3), wind speed (low: Beaufort 0-2 and high: Beaufort 3-5) and tori line (presence or absence). Model selection by Akaike's Information Criterion (AIC) was performed to select potential factors affecting seabird bycatch events. The model with the lowest AIC value was selected.

It was not possible to include the seabird abundance in the model as the majority of lines were set at night. Also, due to a relatively small sample size and the fact that the experiment was conducted during the peak season (May-November) and zone (shelf break) for seabird bycatch (Jiménez *et al.* 2009a), fishing season and area were excluded from the model. Although moon phase is known to have a significant impact on bycatch rates (Jiménez *et al.* 2009) it was excluded from this model because two of the three bycatch events recorded during the study occurred during the daylight proportion of the set. We will investigate including moon phase in the model when the sample size is increased in 2010.

3.6 Results

During three fishing trips 23 longlines were set (17 sets on commercial vessels, six on a research vessel), with a total fishing effort of 23,609 hooks. This included 12 lines (12,700 hooks) with a tori line (Treatment I) and 11 (10,909 hooks) as a control treatment (Treatment II). 100% of hauling operations were observed and a total of 5 birds were recorded to be killed (0.21 / 1,000 hooks). All five birds were caught during sets with no tori line, representing a BCPUE for the control treatment of 0.46 birds / 1,000 hooks.

As it was not possible to record seabird attack rates on baited hooks during nocturnal sets, more data is required during daylight setting operations to investigate the performance of the 'mixed' tori line. The tori line obtained an aerial extent of 80.63 ± 0.88 m aft of the vessel and preliminary data suggest that the tori line performed well in reducing seabird attacks. However, difficulties were experienced with the towed device becoming entangled with the longline in five of the 12 sets (41.7%). This was due to a change in ship course or wind direction, moving the tori line across the fishing gear.

The results from the GLM indicate that the only significant variable effecting seabird catch rate was the presence of a tori line ($P < 0.05$), explaining the main proportion of deviance in the model (Table 7). According to the AIC the final model is: birds ~ tori line, with an AIC of 16.9 [compared to that (AIC = 20.81) in the basic model], indicating the tori line was the most important factor when explaining seabird bycatch.

Table 7: Deviance analysis table of explanatory variables for seabird bycatch from the binomial model

Bionomial model factors	d.f	Residual deviance	Change in deviance	<i>p</i>	% of total deviance
NULL		17.8			
Vessels	2	15.4	2.4	0.302	27
Time of the set (Day-Night)	1	14.6	0.8	0.363	9
Wind speed *	1	13.8	0.8	0.370	9
Toriline	1	8.8	5.0	0.026	55

3.7 Discussion

While the number of predictor variables included in the model was limited by small sample size, the current model indicates that seabird bycatch rates were significantly reduced by the use of the single mixed tori line.

3.8 On-shore developments

Observer programmes

Proyecto Albatros y Petreles – Uruguay has a very close working relationship with the National Onboard Observer Programme (PNOFA). This relationship facilitates a close link between ATF and the local observer programme. PNOFA observers were provided with tori lines and practical instructions by ATF instructors to demonstrate best practice use onboard other vessels in the longline fleet. By maintaining this close relationship with PNOFA, the ATF in Uruguay can reach many more vessels and their captains.

Port visits

In Uruguay, the work programme involves regular visits to the main ports of Montevideo and/or Paloma. The objective of these visits was informal discussion with captains and crew of pelagic longliners (and trawlers, when available) regarding the construction and performance of tori lines, and other mitigation measures, such as line weighting.

Raising awareness

The ATF in Uruguay has developed a highly successful educational/awareness tool that is widely distributed throughout other ATF countries including Brazil, Argentina, Chile, and beyond. The *Boletín Atlántico Sur* (South Atlantic Bulletin) is written and designed by the ATF Uruguay team and used to raise awareness within the fishing fleets and wider industry. Information presented is diverse and includes not only seabird issues but also general fishery information, interviews with crew members and wider conservation issues related to the fisheries sector.

Additionally, the ATF team in Uruguay presented the initial results and processes of the past years to a group of over 70 people during a symposia organised by the Uruguayan Geographic Studies and Recognition Group.



4.1 Summary

The use of appropriate line weighting to rapidly sink baited hooks in pelagic (and demersal) longline fisheries has been a key advocacy message to fishermen and fisheries managers for many years. Although there is currently no agreed best practice line weighting standard for pelagic longlines it is widely agreed that both the mass of weight and its position relative to the hook are critical in determining the sink profile of baited pelagic longline hooks. Fishermen around the world have strong views on the effect of line weighting on catch rates of target species (fish), and are understandably reluctant to adopt line weighting regimes that are untested in this regard.

ATF research in South Africa has started the critically important process of investigating the impact of different line weighting regimes on target catch rates. This research was conducted using 'Safe Leads', which are an alternative line weight for pelagic longline fisheries designed to improve crew safety by preventing weights flying back at the boat in the event of a 'bite-off' by a shark. Safe Leads have been developed by Fishtek⁷ in collaboration with the BirdLife Global Seabird Programme (GSP).

Our initial results are based on a very small sample size and cannot be used to draw conclusions, but have provided a promising platform from which to convert this vitally important research project into a more comprehensive data set in 2010.

See Annex 3 for an extract of the ATF 2008 Annual Report which details the circumstances surrounding the 84% reduction in seabird bycatch in the Asian distant water fleet operating in South African waters.

4.2 At-sea investigation

Effect of added weight on the catch of target and non-target species in the South African domestic pelagic longline fishery

The experiment was designed to investigate the effect of adding weight to branch lines on catch rates of target and non-target fish species. The experimental design included two treatments:

- 1) A 60 g Safe Lead placed 3.7 m from the hook;
- 2) A 150 g Safe Lead placed 3.7 m from the hook.

⁷ <http://fishtekmarine.com/safeleads.php>

Null hypotheses (H_0)= Increasing weight on branch lines from 60 g to 150 g has no effect on catch rate of target and non-target species in pelagic longline fisheries.

The experiment was conducted on a South African flagged 29 m pelagic longline vessel targeting tuna and swordfish. The vessel deployed an average of 1,200 hooks per longline set with experimental treatments (I and II) constituting half of the hooks set on each longline. The line ranged in length from 35-50 nautical miles.

Standard branch (secondary) lines consisted of two sections; a 'top' and bottom' section; the top section measured 13.5 m and was attached to the main line with a snap, the lower section measured 3.5 m and was connected to the top section via a 60-80 g weighted swivel.

In experimental lines the weighted swivel was replaced with an un-weighted swivel. Both the 60 g (Treatment I) and 150 g (Treatment II) Safe Leads (SLs) were placed ~1 cm below the un-weighted swivel on the bottom section of the line. A size 0/9 'J' hook was used and was baited with squid. Green light sticks were attached during setting prior to deployment of every branch line (see Figure 8a).

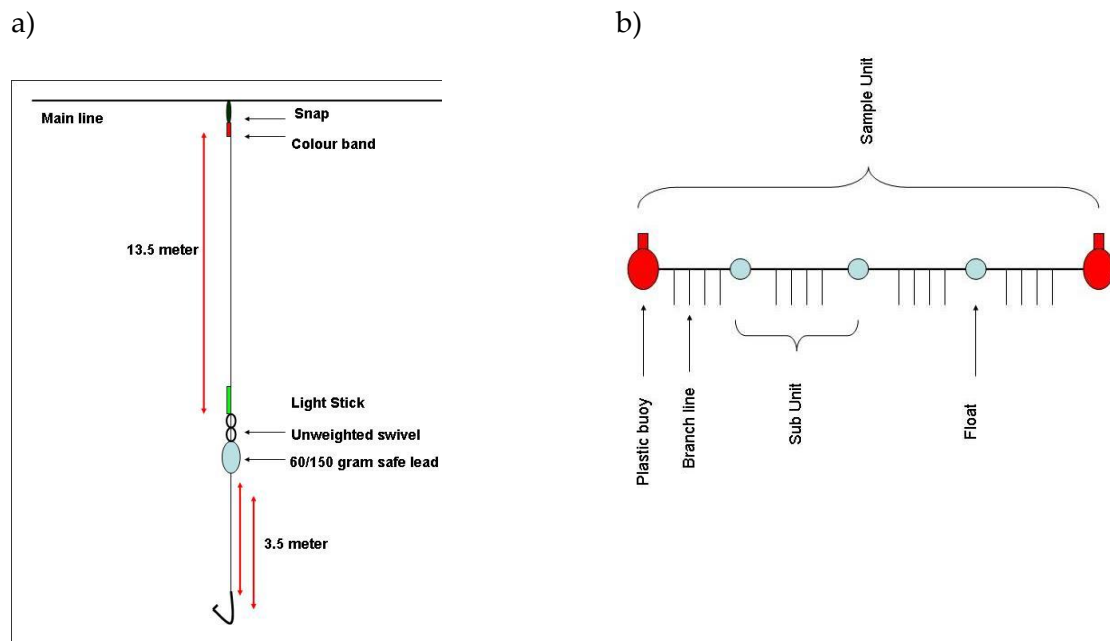


Figure 8: a) Description of an experimental branch line. The only variation was in the treatment SL (60 g and 150 g). b) Division of hooks into sample units and sub-units.

The experimental line was divided into sample units and sub-units. A sample unit comprised sixteen hooks, divided into four sub-units of four experimental branch lines each (Figure 8b).

For each line set, 24 experimental sample units were deployed with a total of 384 experimental branch lines.

The longline was divided into three sections; beginning, middle and end. Each section consisted of eight sample units separated by radio beacons. For each set the location of the experimental section (24 sampling units) within the operation line (i.e. beginning, middle or end section) was randomised. The treatment order within each section was also randomly assigned prior to the trip. Longline setting operations began between 18:30 - 20:30 hours and setting speed was approximately ~9 knots.

4.3 Onboard protocol

Setting observations

Experimental branch lines were stored and set from two bins; one containing Treatment 1 (60 g SLs) and the other Treatment 2 (150 g SLs). Sample units were colour-coded red and green to aid recording on retrieval (Figure 8).

The line was set from a central position at the stern of the vessel. Treatment hook bins were situated on the starboard (Treatment 1) and port (Treatment 2) sides. For each Treatment two crew members were included in the setting operation. The first removed the hook and branch line from the bin, attached a light stick and passed the assembly to the second crew member who baited and deployed the hook. The weighted swivel was tossed into the propeller wash, which trailed until the monofilament branch line had completely unravelled; the snap was then attached to the mainline and the hook deployed into the water between the main line and the edge of the wash. This process was repeated for Treatment 2. A fifth crewman set floats from the port quarter of the aft deck.

Hauling observations

Hauling commenced within an hour of first light. All experimental branch lines were observed and the following details were recorded:

Operational data recorded included: Treatment, time, sample unit number, sub unit number and hook number (within sub unit). For a sub-sample of 160 branch lines, the distance of SLs from their original position was measured to determine slippage toward the hook.

Catch data recorded included: Species, size and condition (e.g. partially predated). For target species i.e tunas and swordfish (*Xiphias gladius*) a size class was recorded. Sharks were assigned to one of three size classes: small (<1 m), medium (1-2 m) and large (>2 m).

All bite-off data were classified into one of five categories 0-4 (0- bite off occurs under water and weight stays under water; 1- weight lands on water; 2- weight hits the bottom half of the boat; 3- weight hits the upper half of the boat; 4- weight flies above the boat). All SLs were checked and positioned at a standard distance of 3.7m (adjacent to the un-weighted swivel) from the hook.

4.4 Results

A total of nine longline sets, incorporating 251 sample units were sampled. From this dataset 130 sample units of Treatment 1 (60 g) and 121 sample units of Treatment 2 (150 g) were collected. There was considerable variability in catch rate between sets, particularly for the bycatch (fish) species. Individual species and size category information was recorded, but given the small sample size the data could at best support an analysis of catches grouped as “target” or “by-catch”. Catch rates (expressed as number of fish per sample unit) for these groups are summarised in Table 8. The effect of treatment appears to be small or non-existent. T-tests of the differences in the means from the 2 treatments show no statistically significant difference ($P>0.05$).

Table 8: Summary statistics of catch per sample unit (16 hooks) for the target and bycatch species within treatments 1 and 2.

<i>Catch</i>	<i>Treatment</i>	<i>Hooks sampled</i>	<i>Mean</i>	<i>S.D.</i>	<i>S. E.</i>
Target Species	Treatment1	2,080	0.24	0.517	0.047
	Treatment2	1,936	0.25	0.529	0.046
	Difference		0.006		0.066
Bycatch	Treatment1	2,080	1.75	2.580	0.235
	Treatment2	1,936	1.59	2.423	0.213
	Difference		-0.160		0.316

In order to isolate the effect of treatment, we subjected the data to a generalised linear model with log link and Poisson error distribution with Set and Treatment as predictors. This model found that for both target and for fish bycatch, set was a significant predictor ($P<0.05$) but treatment was not ($P>0.05$). The estimate of the effect of Treatment 2 (150 g) for the target species is 0.023 with standard error of 0.2567. i.e. a 2.3% better catch rate using Treatment 2 compared with Treatment 1 (60 g). The 95% confidence interval for the effect size is [-0.480; 0.526]. A similar model for bycatch species estimates an effect of -0.049 with standard error 0.0978. (4.9% lower catch rate using Treatment 2 compared with Treatment 1). The 95% confidence interval for the effect size is [-0.241; 0.142].

4.5 Discussion

Our preliminary data could be interpreted to suggest that the larger weights (150 g) did not reduce target catch rates. However, the very large variation identified due to small sample size means it is not possible to make definitive statements about the relationship between line weighting and target species catch rates in the South African Domestic Longline Fishery. This research will be continued in 2010 to increase the sample size to a level that enables us to determine with confidence the effect of increased line weighting on catch rates of target and non-target fish species.

4.6 On-shore developments

Observer programmes

During 2009, the team in South Africa trained fisheries observers from two different companies; working in the pelagic and hake longline, demersal trawl, pelagic purse seine and mid-water trawl fisheries (Table 9). The aim of these workshops, training sessions and observer briefing and de-briefings was to inform the observers of seabird bycatch problems, the mitigation measures in use, and to instruct them in seabird identification in order to increase the quality of the data collected.

Table 9: Summary of observer training, workshops and briefing & de-briefing sessions carried out in 2009.

<i>Type</i>	<i>Location (company)</i>	<i>N° Observers</i>	<i>Outcome</i>
Individual Observer Training	Cape Town (CapFish)	1	Focused on seabird identification
Individual Observer Training	Cape Town (CapFish)	2	Focused on seabird identification
Workshop	Saldanha Bay (CapFish)	11	Seabird identification, seabird bycatch issues and solutions and work of the ATF
Workshop	Cape Town (CapFish)	5	Seabird identification, seabird bycatch issues and solutions and work of the ATF
Workshop	Cape Town (Anchor)	7	Seabird identification, seabird bycatch issues and solutions and work of the ATF
Observer Briefing & debriefing	Cape Town (CapFish)	3 briefed, 2 debriefed	Talk to observer and explain what permit conditions are in the fishery and how they can help collect quality data
Observer Briefing & debriefing	Cape Town (CapFish)	2 briefed, 2 debriefed	Talk to observer and explain what permit conditions are in the fishery and how they can help collect quality data

Port visits

Port visits help the team to keep in touch with crew members across the fleets. These visits also strengthen personal relations; keep the captains and crew up to date with the latest mitigation developments and allow for open discussions on seabird bycatch issues.

In 2008, after the implementation of new seabird bycatch limit regulations, there was a clear need to improve communication levels with the joint-venture pelagic longline fleet. In total, 20 visits involving 50 fishermen were conducted in 2009. Out of eleven joint-venture vessels that fished in South Africa in 2009, seven vessels were visited and eight crews were briefed by an ATF Instructor (Table 10).

Table 10: Summary of port visits conducted by ATF instructors in 2009. Numbers in parentheses represent number of joint-venture fishing masters

<i>Date</i>	<i>Port</i>	<i>Attendees</i>	<i>Fishery</i>
February	Cape Town	2	Trawl
March	Cape Town, Hout Bay	27 (2)	Longline
March	Cape Town	1	Trawl
April	Cape Town	3 (1)	Longline
May	Cape Town	4 (1)	Longline
May	Cape Town	1	Trawl
June	Cape Town	2	Longline
July	Cape Town	4 (1)	Longline
August	Cape Town	2 (2)	Longline
September	Cape Town	1 (1)	Longline
October	Cape Town	1	Longline
November	Cape Town	4	Longline
December	Cape Town	1	Longline

Raising awareness

During 2009, several talks on seabird conservation and the work of the ATF were given to clubs and groups in and around Cape Town (Table 11). The objective was to raise awareness amongst the public about the seabird bycatch problem within local fisheries, as well as highlight some of the mitigation measures currently in use.

Table 11: Talks presented during 2009. (*BLSA Club: BirdLife South Africa Club*)

<i>Instructor</i>	<i>BLSA Club</i>	<i>Other groups</i>	<i>Total</i>
Meidad Goren	2	7	9
Bronwyn Maree	2	5	7
Lisa Mansfield	2	2	4

A bold new enterprise was introduced in October 2009 - the first Save Our Seabirds Festival (SOS Festival). The Festival was held in conjunction with National Marine Month in South Africa. Events were concentrated between 12 – 18th October, but some activities, such as a national education programme, ran for the entire month. The Festival's main objectives were two-fold; firstly, to raise awareness about seabird conservation (especially the work done by the Seabird Division of BirdLife South Africa and the ATF), and secondly, to raise funds for additional seabird conservation work. In total over 107,000 South African Rand (over £9,600) was raised by SOS.

Additionally, the ATF team in South Africa generated a series of articles for the media highlighting ATF results and activities. Six newspaper articles were published, three radio interviews, two television interviews and a live web-based interview.

TRAWL FISHERIES

In recent years there has been a rapid increase in awareness of the scale and geographical extent of seabird mortality in trawl fisheries. High levels of seabird mortality have been recorded in several Southern hemisphere trawl fisheries that interact with large winged birds (e.g. albatross, Watkins *et al.* 2006). However, seabird mortality in trawl fisheries is technically less complicated to mitigate than mortality in pelagic longline fisheries, but it still requires robust and scientifically defensible evidence to support best practice. Seabird mortality in trawl fisheries can be broadly grouped into two categories: (1) birds colliding with trawl warps, netsonde and paravane cables, which particularly impacts larger birds such as albatrosses, and (2) birds becoming entangled in nets during shooting and hauling which more commonly affect smaller seabirds.

Research conducted since 2004 in the Patagonian Shelf, southern Africa, New Zealand and the Bering Sea has all concluded that the most effective way to reduce seabird mortality to negligible levels is to manage offal discharge, and ideally by limiting factory discharge to 'dirty water' resulting from processing, that does not attract large numbers of seabirds. However, in the interim the development and testing of tori lines has also been shown to be a highly effective interim measure to mitigate the problem in the short-term. ATF research in 2009 in Namibia, Argentina and South Africa all focused on improving the performance of tori lines to reduce seabird strikes on warp cables.

5.0 NAMIBIA

John Paterson & Kaspar Shimooshili



5.1 Summary

In 2009, the ATF conducted the first seabird bycatch mitigation experiments to be undertaken in Namibia. These trials investigated the effectiveness of tori lines in reducing seabird strikes with warp cables in the demersal trawl fleet. Our results suggest that seabird interactions with the warp cables can be virtually eliminated through the use of tori lines in this fishery.

Work is ongoing to use these findings to lobby for the inclusion of mitigation measures in fishery regulations, and to produce annual seabird estimates for the demersal trawl and longline fisheries.

5.2 At-sea investigation

Effectiveness of tori lines at reducing seabird bycatch in the Namibian demersal Hake (*Merluccius spp.*) trawl fishery

The experiment was designed to compare seabird interactions with trawl warp cables in the presence and absence of tori lines. Two experimental treatments were tested:

- 1) Trawls with tori lines deployed;
- 2) Trawls with no tori lines deployed (control).

Null hypotheses (H_0)= The use of tori lines in the demersal trawl fleet does not reduce seabird bycatch.

Research was conducted onboard commercial trawl vessels in the Namibian hake demersal trawl fleet between June and December 2009. Depths fished ranged between 200 to 700 meters from approximately 24° S to 18° S. All trips were conducted out of Walvis Bay, situated at 23° S. Typically four to six trawls were performed per day with two trawls occurring at night.

5.3 Mitigation measures

The tori line design replicated the standard tori line design supplied to the South African hake trawl fishery by Kommetjie Environmental Action Group (KEAG). The line consists of a 10 mm red polypropylene braided backbone rope with seven coloured paired streamers at 5 m intervals. The first streamer was positioned five meters from the stern of the vessel. The towed device used was a 760 mm long orange road cone, with two small buoys tied on the inside of the cone (Figure 9).

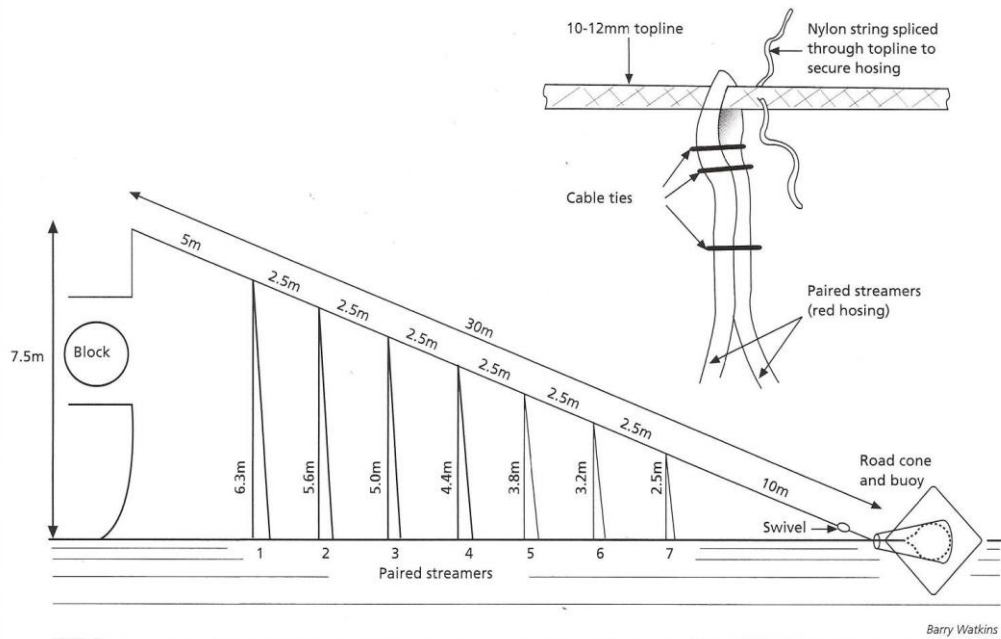


Figure 9: Tori line configuration used for experimental mitigation research

5.4 Onboard protocol

Seabird abundance was estimated at hourly intervals for all experimental trawls by conducting 15 minute counts extending 0 – 50 and 50 - 200 m aft from the stern gantry and 100 m to the port and starboard side.

Only trawls during periods with enough natural light for observations were sampled i.e. approximately 45 minutes before sunrise and 45 minutes after sunset. A single treatment was randomly assigned to each trawl. Observations of seabird interactions with warp cables were carried out in 30 minute periods and were adapted from Wienecke and Robertson (2001). The presence or absence of offal discharge was recorded for each trawl.

During Treatment 1, tori lines were set immediately after the winches stopped paying out and were retrieved after all factory processing and dumping had terminated.

5.5 Data analysis

The effect of tori lines on seabird interactions was analysed using a Chi-squared, 2x2 contingency table. We compared total interactions (all interactions grouped) over time (mins) in which a tori line was deployed (Treatment I), and not deployed (Treatment II).

A Generalized Linear Model (GLMz) with Poisson log link function was also performed to investigate the effect a range of variables on seabird interaction rates. Because the number of abundance counts conducted during a given trawl varied, we calculated an index of bird abundance for each trawl (up to 50 m aft) for species known to be adversely affected by warp interactions. Mean abundances per species were summed per trawl period and in cases where counts were not conducted during a given observation period, a mean of the index from periods either side were used.

Data screening of seabird interaction rates were tested for normality and the data fitted a Poisson distribution. Consequently, a Generalized Linear Model (GLMz) with Poisson log link function was performed to test for an experimental effect on seabird interaction rates. Seabird interaction rate was the dependent variable, dumping was the categorical explanatory variable and sea state, swell height, relative wind direction and bird abundance were the continuous predictors. Because there were zero interactions with tori lines, this term could not be included as a variable in the model. The initial model included full two-way interactions. Non-significant interactions and then terms were removed sequentially to produce the minimum best-fit model.

5.6 Results

Seabird density counts returned a mean of 206.3 (median, 105; SD, 246.9) birds per count. White-chinned petrels and Atlantic Yellow-nosed albatross were the two most abundant seabirds, occurring in 199 (94.31%) and 168 (79.62%) of the density counts, respectively ($n=211$). Together these two species accounted for over 58% of all seabirds present during fishing operations.

During 73 trawls, a total of 3,111 minutes of warp interaction observations were carried out during net setting, trawling and net retrieval. These observations are divided into four treatments;

1. Tori line deployed with offal discard present (22%)
2. Tori line deployed without offal discard (14%)
3. No tori line deployed with offal discard (26%) and
4. No tori line deployed without offal discard (38%).

A total of 186 interactions, 88% during periods with offal discard and 12% without discard, were observed during sets where no tori line was deployed, no interactions were observed while a tori line was deployed (Table 12).

Table 12: Observer effort and interaction rates per treatment

<i>Tori Line Deployed</i>	<i>Offal Discard</i>	<i>Total Minutes Observed</i>	<i>Total Interactions</i>	<i>Minutes/Interaction</i>	<i>Interactions/Minute</i>
Yes	Yes	685	0	0	0
Yes	No	431	0	0	0
Total with Tori Lines		1116	0	0	0
No	Yes	820	164	5	0.2
No	No	1175	22	53	0.02
Total Without Tori Lines		1995	186	11	0.09

There were no interactions between seabirds and trawl warps observed when tori lines were deployed. This contrasts sharply with the high number ($n=186$) of interactions when no tori line was deployed. The Chi-squared test revealed a highly significant reduction in seabird interactions when a tori line was used ($P<0.001$). This demonstrates unequivocally that deploying a suitable tori line reduces seabird interactions, and therefore seabird deaths arising from trawl fishing in Namibian waters.

The GMLz revealed highly significant effects of bird abundance, swell and offal discharge on seabird interaction rates (Table 13).

Table 13: Results of the GLM on seabird interactions

<i>Variable</i>	<i>Wald Statistic</i>	<i>P</i>
Dumping	4.96851	0.026
Swell	3.88781	0.049
Bird abundance	31.92525	<0.001

5.7 Discussion

These findings demonstrate unequivocally that deploying a suitable tori line reduces seabird interactions, and therefore seabird mortality arising from trawl fishing in Namibian waters. As a result of these results steps are in place to start working with the government to discuss the adoption of tori lines as part of the regulatory framework for the hake trawl fishery.

5.8 On-shore developments

Observer programmes

In Namibia, a legal regulation requires each trawl fishing vessel to carry two scientific observers. The ATF in Namibia has been working with the observer agency to set up an agreement that allows ATF instructors to replace one of the observers in order to carry out the necessary sea trips for data collection. In 2009, a resolution was passed that now permits this arrangement, and has resulted in significantly improved vessel access. In the demersal longline fishery, in

which the vessel size is notably smaller, a single observer accompanies each trip. It has been more challenging to develop a similar agreement for this fishery, which has limited vessel access considerably. To resolve this issue fully we are in the process of negotiating a similar arrangement to the one we have in place in the hake trawl fishery.

In terms of observer training, the ATF in Namibia has conducted Responsible Fisheries Workshops in collaboration with WWF. Two courses were held in October 2009 with the target audience of members of the fishing industry, Inspectors from the Ministry of Fisheries and Scientific Fishery Observers. Two, 2-day courses were given and a total of 45 attendees were present.

Port visits

The ATF in Namibia perform port visits on both a formal and informal basis. The main port in Walvis Bay is extensive and consists of many company warehouses and offices, several of which have private quays. Companies are therefore visited on a regular basis and *ad hoc* discussions are held with fishing captains and fleet managers, wherever possible.

From these discussions we can conclude that there is unquestionably a seabird bycatch in both the trawl and longline fleets and that there is little awareness of the conservation issues amongst the fishery managers and vessel crews. Additionally, captains from pelagic longline vessels were interviewed on a more formal level and although there was general recognition that seabirds were captured there was reluctance to admit or discuss the scale of the problem.

Raising awareness

Four public presentations were given in 2009 (Table 14). The first was presented to the general public in Walvis Bay, the second to Walvis Bay International School and a third to participants of Rossing Bay Birding day. The fourth presentation was to the Namibian Scientific Society. The Rossing birding day is a Rio Tinto Zinc initiative in collaboration with Birdlife International whereby all RTZ companies around the globe involve local schools and youth in an environmental awareness programme.

Table 14: Public talks given in Namibia during 2009

<i>Activity</i>	<i>Attendance</i>
Walvis Bay Public talk	43
Walvis Bay International School	250
Rossing Birding Day	45
Namibian Scientific Society	28

6.0 ARGENTINA

Leandro Tamini, Leandro Chavez & Fabian Rabuffetti



6.1 Summary

Not only has the Argentinean ATF team tested mitigation measures for the first time in the industrial trawl fishery, but also designed and tested a new towed device that was found to significantly reduce the frequency at which tori lines crossing over trawl warp cables.

The team is currently finalising the first annual assessment of trawl related seabird mortality and is working closely with the National Fisheries Institute to promote the collection of seabird mortality data more widely and develop mitigation measures.

6.2 At-sea research

Improving the performance of tori lines in the Argentinean trawl fishery with the use of an off-setting towed device

The objectives of the study were twofold:

- 1) To investigate the effectiveness of an off-setting towed device to minimise seabird collisions with the warp cable by reducing the exposure of the warp cables in cross winds;
- 2) To reduce entanglements of tori line streamers with warp cables.

Three treatments were used in the experimental design:

- 1) Standard tori line with a weighted buoy as the towed device;
- 2) Standard tori line with an off-setting towed device;
- 3) Control (no mitigation).

Null hypotheses I (H_0) = Tori line use does not reduce seabird interactions with trawl warp cables.

Null hypotheses II (H_0) = An off-setting towed device does not reduce entanglements between tori lines and warp cables.

The experiment was conducted on an industrial trawl vessel from the Argentinean demersal fleet between the 10th August and 22nd September. The vessel had a total length of 67m and carried 49 crew members. The main target species were common hake (*Merluccius hubbsi*), red cod (*Salilota australis*), hoki (*Macruronorus magallanicus*), grenadier (*Macrurus fasciatus*) and rock

cod (*Patagonotothen ramsayi*). Fishing took place in the south west Atlantic along the Patagonian shelf between the approximate coordinates 45°20' S / 61°10' W and 53°36' S / 61°33' W.

A demersal trawl net was used with a 25-30 m by 4.5 m gape. The diamond mesh size varied from 130 to 200 mm and the net was towed by 24 mm warp cables with exposed splices every 500 m. Trawling took place between 06:00 - 21:00 hours each day and lasted an average of 2 hours 58 minutes (SD= 1:24). Trawling speed varied between 3.8 and 4.1 knots.

6.3 Mitigation measures

Treatment 1 - Standard tori line

The standard tori line used in the experiments was composed of a 30 m long green and bright yellow polyethylene 10 mm rope. The streamers were made from bright red 2 cm width 1.5 mm PVC tubing and were attached along the length of the backbone at intervals of 2.5 m (Figure 10). Aft of the buoy a 3.5 kg weight provided extra drag.

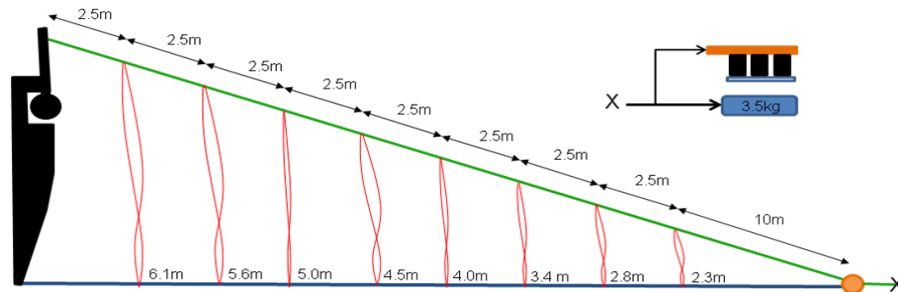


Figure 10: Tori line configuration used during experimental tests

Treatment 2 - Standard tori line with off-setting towed device

The tori line used in this treatment was identical to that in Figure 10, with the exception of the towed device. A wooden 40 x 20 x 2 cm board to which three 2 mm rectangular aluminum keels measuring 13 x 10 cm were fixed was used to replace the 3.5 kg weight behind the buoy on the standard tori line. On the lower surface of the three keels, six 400 g weights were added (Figure 11).



Figure 11: The towed device with 400g weights attached to the lower surface of the keels

Treatment 3

A control treatment of no tori line was used.

6.4 Onboard protocol

Seabird abundance was estimated for all experiments by conducting 10-minute observations within a semi-circle extending 200 m aft of the stern of the vessel.

The three treatments were deployed in succession during experimental trawls. The order in which the three treatments were deployed on each trawl was randomly allocated. Experimental treatments began once the net was on the seabed, each treatment lasting 15 minutes. Data collected during trawls that finished before all three treatments could be deployed were excluded from data analysis.

Observations on seabird interactions with the warp cables were carried out in 45 minute periods (3x 15 minutes) and were adapted from Wienecke and Robertson (2001). This included recording light and heavy contacts between birds on the wing and on the water, and the warp cable. Offal discard was recorded for each new observation period.

6.5 Data analysis

A total of 46 trawls and 2,385 minutes of observation were included in the analysis. During this observation effort it was possible to perform 53 experimental treatments, as on seven occasions offal discard continued for long enough to perform two sets of treatments.

Total contacts (light and heavy contacts on the water and in the air combined), heavy contacts (in the air and on the water) and mortality⁸ of seabirds through collisions with the trawl warp cables were compared for each of the three treatments using a Kruskal-Wallis test for multiple comparisons.

⁸ Seabird mortality included four subcategories that were grouped together; possibly damaged, damaged, possibly dead and dead.

Warp entanglement or risk of entanglement was analysed using a Chi-squared 2x2 contingency table. The total time (mins) in which the tori line was entangled ('crossed over') and not entangled ('in line' and 'offset' combined) for the two tori line treatments was compared.

6.6 Results

Results from the Kruskal-Wallis test showed that the use of a tori line (both with buoy and with an off-setting towed device) significantly reduced seabird interactions with the trawl warp cable when compared with the control of no tori line ($P < 0.01$) (Figure 12). However, there was no significant difference in seabird interactions with the trawl warp cable when comparing between a buoy and the off-setting towed device to provide drag ($P > 0.05$).

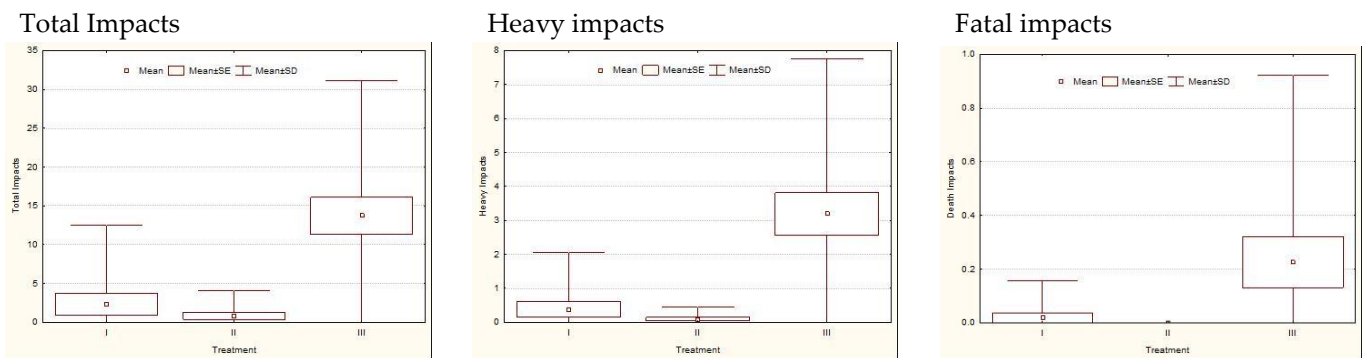


Figure 12: Total, heavy and fatal seabird impacts with warp cables recorded for each treatment. The X axis shows treatment; Treatment 1, tori line + buoy (left); Treatment 2, tori line + off-setting towed device (middle); and Treatment 3, control (right).

The Chi-squared test used to compare the effect of tori line state (crossed over versus not crossed over) during trawling indicated that the tori line with the off-setting towed devices (Treatment 2) crossed the warp cable significantly less than the standard tori line (Treatment 1) ($P < 0.0001$).

6.7 Discussion

Section 6 and 7 (Argentina and South Africa) were closely aligned projects working on improving tori line performance with the trialling of an off-setting towed device. The discussion of these projects has been combined and is presented at the end of Section 7.

6.8 On-shore developments

Observer programmes

The national observer programme in Argentina is run through the National Fishery Investigation and Development Institute (*Instituto Nacional de Investigacion y Desarrollo Pesquero*,

INIDEP) based in Mar del Plata. The ATF has been working closely with the management of INIDEP, especially the head of the observer programme Gabriel Blanco, to facilitate programmes related to the identification and recording of seabird bycatch in Argentinean fisheries. Aves Argentinas have signed a Cooperation Convention with INIDEP to help formalise this relationship. As well as frequent meetings and coordination with INIDEP the following observer-specific events were carried out in 2009, including the Argentina – Ecuador Capacity Building workshops funded through ACAP⁹ (Table 15).

Table 15: Observer Courses in collaboration with the ATF team, Argentina

Date	Location	Objective	N° attendees
March 2009	Quequén, Argentina	Seabird Identification workshop and sea-trip	12
March 2009	Quequén, Argentina	Recording Seabird Bycatch workshop	12
May, 2009	Manta, Ecuador	ACAP Capacity Building workshop for Observers in Ecuador – stage I	47
November, 2009	Mar del Plata, Argentina	ACAP Capacity Building workshop, stage II.	4

Port visits

The nature of the immense coast line in Argentina and the large, diverse fleet means that the fishing companies are based in, or close to Buenos Aires and Mar del Plata but the vessels frequent a number of ports along the length of the country. The ATF in Argentina was set up to be close to the main ports, the majority of the fishing companies and INIDEP, in order to maintain the frequent contact required to organise permissions for sea trips and experimental work. Port visits (Table 16) were performed to conduct regular interviews with fishing crews and explain the aims of the ATF and results achieved so far.

Table 16: Port visits conducted in Argentina during 2009

<i>Port</i>	<i>N° Visits</i>	<i>Instructor / Coordinator</i>	<i>N° Vessels</i>
Mar del Plata	17	Leo Tamini, Leo Chavez	13
Puerto Madryn	1	Leo Tamini	1
Ushuaia	1	Fabian Rabuffetti	1

Raising awareness

Two main industry awareness-raising events were held during 2009. The first was held in April in recognition of the support that the fishing company *El Marisco S.A.* has provided through vessel access and development of mitigation measures during sea trips. The second, in October, was developed with the fishing company *ASC South America* with the objective of disseminating information on mitigation design and best practice use in the demersal longline fishery in the south of Argentina.

⁹ See Section 8 for more details of the ACAP workshop.

In July, 2009 a presentation to the Fisheries Undersecretary on the achievements of the ATF in Argentina provided the opportunity to discuss the future steps required to coordinate the uptake of mitigation measures onboard vessels from the Argentinean fleet.

7.0 SOUTH AFRICA

Bronwyn Maree, Lisa Mansfield, Ross Wanless and Meidad Goren



7.1 Summary

As reported in previous ATF reports, the trawl fishery in South Africa has previously shown large reductions (>80%) in seabird bycatch thanks to the obligatory use of tori lines during trawling operations. However, strong cross winds reduce the protection afforded by tori lines as the device is blown over the trawl warps. As mentioned above (Section 6.7) in 2009, the South African team conducted a project closely related to the trawl project conducted by the ATF in Argentina. The South African trials demonstrated that the use of an off-setting towed device significantly reduced the cross over of tori lines across trawl warp cables (and therefore entanglements).

7.2 At-sea research

Improving the performance of tori lines in the Argentinean trawl fishery with the use of an off-setting towed device

The objectives of the study were twofold:

- 1) To investigate the effectiveness of an off-setting towed device to minimise seabird collisions with the warp cable by reducing the exposure of the warp cables in cross winds;
- 2) To reduce entanglements of tori line streamers with warp cables.

Two experimental treatments were included in the design:

- 1) A standard tori line with a standard towed device (road cone);
- 2) A standard tori line with an off-setting towed device.

Null hypotheses I (H_0) = an off-setting towed device does not affect interactions between seabirds and warp cables.

Null hypotheses II (H_0) = an off-setting towed device does not affect the entanglement rate of the tori line with warp cables.

Data were collected on three stern trawl vessels in the South African hake (*Merluccius spp*) trawl fishery. Data were conducted over six trips, from May to October 2009 along the south east coast of South Africa.

7.3 Mitigation measures

The standard tori line (Treatment I) was 30-50 m long. Six paired streamers hung from the mainline at intervals of ~5 m, each reaching the water surface under calm conditions and a road cone was used as a towed device.

The off-setting device used in Treatment II was constructed from a board of dimensions 38 cm x 48 cm. Two keels were added at a 45° angle, which reached across the length of the board diagonally (Figure 13). The two keels were connected with a smaller board, measuring 26 cm x 31 cm. An attached dive weight of 0.9 kg was used to stabilise the board.

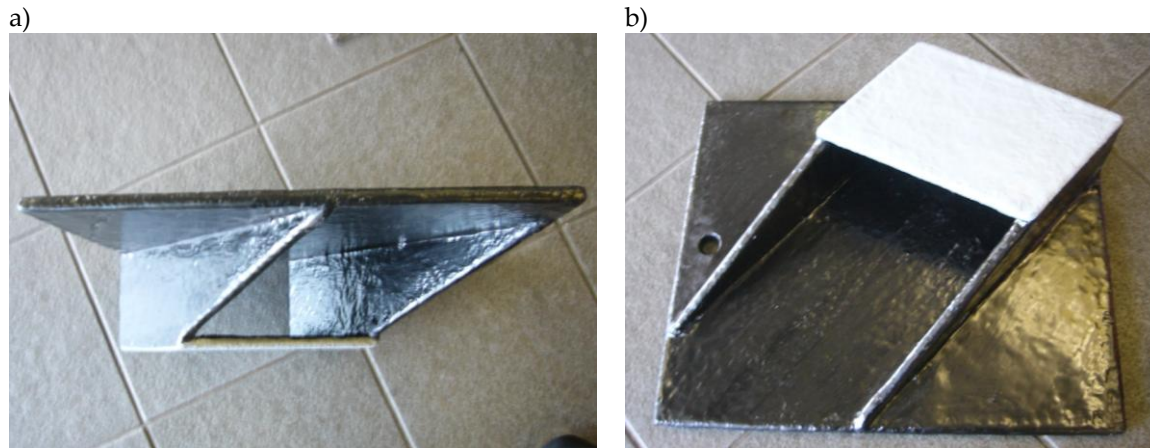


Figure 13: Off-setting towed device used in the South African demersal trawl fishery experimental trials a) side view, b) ventral view.

7.4 Onboard protocol

Seabird abundance was estimated at hourly intervals for all experimental trawls by conducting approximately 20 minute counts extending 200 m aft from the stern gantry and 100 m to the port and starboard side.

A single treatment was randomly assigned to each trawl. Seabird interaction observations were carried out in 30 minute periods and protocols were adapted from Wienecke and Robertson (2001). Where possible the nature of discard (heads, guts, whole fish, and bycatch species) was noted.

During observations the position of the tori line was divided into three categories and recorded as crossed over, in line or offset (Figure 14).

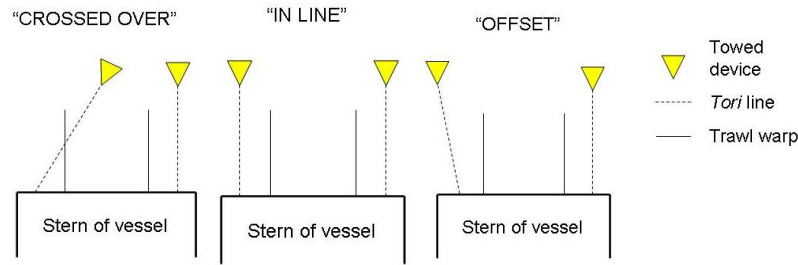


Figure 14: Degrees of tori line offset: crossed over, in line and offset.

These categories were determined by estimating the distance between the point where the warp cable entered the water and the towed device or tori line. 'In line' was categorised as occasions where the distance was less than one meter (<1 m); 'crossed over' was categorised as occasions where the tori lines crossed over the warp cable; and 'offset' was categorised as occasions where the distance was greater than a meter (>1 m).

7.5 Data analysis

A total of 64 trawls and 3097 minutes of observation were included in the analysis. Warp entanglement or risk of entanglement (i.e. when the tori line was 'crossed over' the warp cable) was analysed using a Chi-squared 2x2 contingency table. The total time (mins) in which the tori line was entangled ('crossed over') and not entangled ('in line' and 'offset' combined) was compared for the two treatments.

In order to compare the effect of an off-setting towed device on seabird interactions it was necessary to compare interaction rates between the two treatments. Seabird interaction rates (total # interactions / min) for each tori line position category were found to fit a Poisson distribution. Consequently, a Generalized Linear Model (GLMz) with Poisson log link function was performed to test for differences between seabird interaction rates and tori line position. Seabird interaction was the dependant variable, tori line position was the categorical explanatory variable and seabird approach direction (which is a proxy for wind direction relative to vessel course) and seabird abundance were continuous variables (full two-way interactions were also tested). Non-significant interactions and associated terms were removed sequentially to produce minimum best-fit models.

7.6 Results

The result from the Chi-squared test indicated that an off-setting device significantly reduces the amount of time tori lines cross over the trawl warps when compared to a standard tori line with a road cone towed device ($P < 0.001$). We therefore reject the null hypothesis that off-setting (with a towed device) does not affect trawl warp entanglement or risk of entanglement.

No significant relationship was identified for tori line position (and all associated two-way interactions) and seabird interactions with the warp cable ($P > 0.05$) and these variables were subsequently removed from the model. The approach direction of seabirds toward the warp

cables (GLMz: $P < 0.01$) and bird abundance (GLMz: $P < 0.001$) were both identified as significant variables in determining the level of seabird interactions with warp cables. We therefore reject the alternative hypothesis in favour of the null hypothesis, that an off-setting tori line with a towed device does not affect seabird interactions.

Hence, although the off-setting towed device significantly reduced the amount of time the tori lines crossed over the trawl warp cables, seabird interactions with warp cables under this improved performance were not found to be significantly lower in the South African demersal trawl fishery.

7.7 Discussion (Argentina and South Africa)

In Argentina, our results showed that the use of a tori line (both with buoy and with an off-setting towed device) significantly reduced seabird interactions with the trawl warp cable when compared with the control of no tori line.

In South Africa, the entanglement (cross-over) rate of tori lines was significantly reduced by the use of the off-setting towed device. In neither country were significant reductions identified in seabird interactions with the warp cable between the two tori line treatments (with and without the off-setting device). However, in South Africa we showed that seabird abundance ($P < 0.001$) and seabird approach direction ($P = 0.003$) had significant effects on seabird interaction rates.

The development of the off-setting towed device in Argentina was an important step in mitigating seabird bycatch in trawl fisheries. While the current datasets failed to identify a significant reduction in seabird interactions with warp cables in Argentina and South Africa, reducing the risk of entanglement of the tori line *per se* is beneficial to the fishermen and their safety, and ultimately may result in increased use of tori lines. By improving practical utility and reducing entanglements with the warp, we expect that the offsetting device will ultimately reduce seabird interactions with warps.



8.1 Summary

In November 2008, the GSP recruited a staff member in Ecuador, working with the local BirdLife Partner - Aves y Conservación. The initial objectives for the post in 2009 being to :

- Identify opportunities and activities related to the ATF, the wider GSP and Aves y Conservación within Ecuador;
- Establish close links with the fisheries sector, key government agencies and local institutions
- Initiate the first characterisation of key fishing fleets, and where possible, collate information to evaluate the level of seabird bycatch in these fisheries
- Where appropriate, consider a potential suite of mitigation measures for fisheries identified as posing the greatest threat to seabirds
- Investigate potential channels and mechanisms for coordination between individuals, agencies and organisations involved with marine biodiversity, especially seabirds.

8.2 Fisheries description

The main objectives during 2009 were to initiate the activities for the GSP in Ecuador, and to investigate the potential for establishing the ATF in-country, and, consequently, no at-sea investigations were conducted. Given the vast size of the artisanal fleets operating in Ecuador it has been demonstrated that even low levels of Waved albatross (*Phoebastria irrorata*) bycatch at the vessel level could accumulate across fleets into unsustainable mortality levels for this Critically Endangered species. In Ecuador, the GSP/ATF have worked closely with ACAP, and a wide range of government, industry and NGO stakeholders to assist in the development and implementation of the Waved Albatross Action Plan, a significant component of which addresses at-sea threats (bycatch). Initially the action plan focuses on creating the alliances and links required within the fisheries sector and government to characterise and identify threats across a wide range of artisanal and industrial fisheries. Once the threats are more fully understood future actions will be prioritised and directed to specific areas and fisheries.

The fisheries in Ecuador are regulated by the Ministry of Agriculture, Farming, Aquaculture and Fisheries (MAGAP) through the Undersecretary of Fishery Resources (SRP) and the General Fisheries Directive (DGP). The official body that investigates the fisheries sector is the National Fisheries Institute (INP). There are two broad types of fishery in Ecuador: Industrial and Artisanal.

Industrial fleet

The industrial fleet is composed of several distinct fisheries. Currently there are around 1,329 industrial vessels registered in Ecuador. Figure 15 gives an overview of main fishing areas¹⁰.

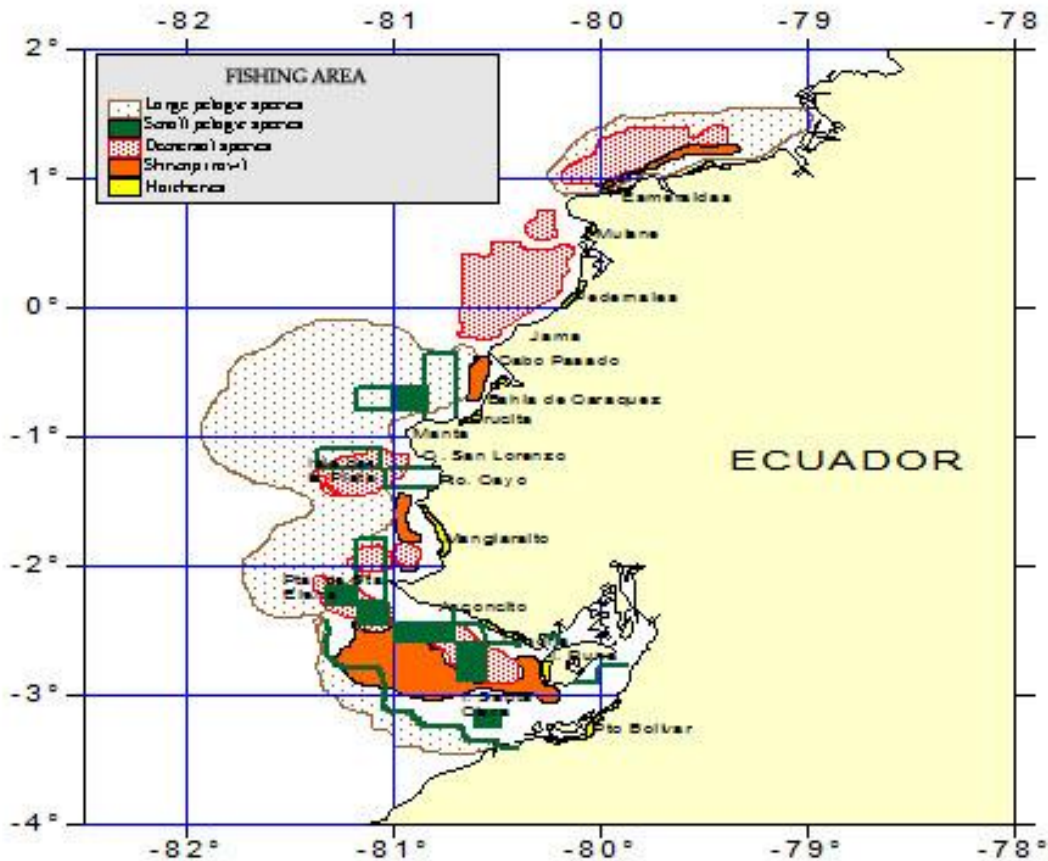


Figure 15: Main fisheries by area and target catch, including large pelagic species, small pelagic species, demersal fauna, shrimps and hatcheries.

Purse seine vessels that target a variety of small pelagic fish species are known as 'bolicheros'. There are around 66 vessels actively fishing plus another 89 that target different species assemblages considered to be 'white fish' as opposed to the more oily sardines *Etrumeus teres* caught by the bolicheros;

Purse seine vessels targeting tuna catch approximately 200,000 tonnes per year based on figures dating back to 1999. In 1975 there were 26 vessels fishing using this method and this number rose to 77 in 2002. Currently, there are 84 vessels licensed under this method.

Surface gill nets are used on industrial vessels to catch large pelagic fish such as tuna and swordfish and include a large number of sharks. Gill nets are roughly 170 m long and extend around 8 m below the water surface. The mesh size is large, around 140 mm.

¹⁰ www.subpesca.gov.ec

Shrimp trawlers that tow demersal nets to target the white shrimp (*Penaeus occidentalis*) number 161 vessels. As well as the target species these vessels also include bycatch of several species of shark, generally small sizes.

Foreign longline fleets target tuna species such as Big eye (*Thunnus obesus*) and Yellow fin tuna (*Thunnus albacares*) and swordfish under joint venture licences with local companies. Typically, fishing operations target depths of 35-50 m and cover an area extending over 45 km. There are currently 27 Spanish flagged vessels fishing in Ecuador. Since 2004, these vessels have been included in studies using local observers to identify the effect of circle hooks on the catch of target species and bycatch of turtles.

Artisanal fleet

The artisanal fleet is considered to be a small scale fishery, and is principally composed of small vessels built from wood or fibreglass that are restricted to within 8nm of the coast. However, there are also other small vessels such as 'nodrizas', which are accompanied by between three to 15 small fibreglass vessels. The nodriza acts as a mother ship and the catch is complemented through the use of the satellite vessels. There are 1,114 artisanal vessels currently registered in Ecuador, although the total including unregistered vessels is probably closer to 12,000.

These artisanal fisheries are divided into several methods:

Artisanal longline vessels use a surface longline gear to target Dolphin fish (*Coryphaena hippurus*), Swordfish, tuna species and Wahoo (*Acanthocybium solandri*), Snoop (*Scomberomorus sierra*) and Giant squid (*Dosidicus gigas*). The gear used is typically up to 10 km long with 5.8 m branch lines, set every 20 m plus a size #4 or #5 hook.

The artisanal bottom longline fishery consists of longline gear that carries up to 500 hooks of a variety of sizes (#1 - #6). Each vessel is usually equipped with two lines and targets Sea bass (*Brotula Clarkae*) although a wide range of low value demersal species are captured.

Net fisheries include several methods. Mid-water and surface gill net fisheries target Yellow fin tuna plus other tunas and swordfish and such species associated with surface longline fleets. Demersal gill net fisheries capture a wide range of low value species, and flat fish (*Paralichthys spp*) and a range of ray species. There are also artisanal fisheries for the white shrimp.

8.3 On-shore developments

Observer programmes

In Ecuador observer programmes are active in different fisheries and report to the Undersecretary for Fishery Resources and the National Fisheries Institute. The observers are currently active in four main projects:

- Turtle, marine mammal and shark bycatch in artisanal fisheries in Ecuador – a case study for Santa Rosa and Cape St. Lorenzo.;
- The use of an undersized fish excluding device for the purse seine fishery;
- Reduction of marine turtle bycatch in the artisanal longline fleet;
- Evaluation of marine mammal mortality.

Three workshops were held to enable capacity building in these projects and to start to focus on the seabird species that interact with fisheries in Ecuador. Workshops included courses on seabird identification and existing mitigation measures. A total of 75 people attended the courses from the four observer projects. During the courses a set of observer protocols were drawn up including seabird census and seabird mortality forms. Within the coming months the first year of data will be available and provide an initial indication of the level of seabird mortality in Ecuador.

These developments were, in part, related to the first stage of the ACAP Capacity Building workshop held in Manta, from the 26th – 28th May 2009. The workshop was facilitated by the Governments of Argentina and Ecuador and organised by BirdLife (Aves y Conservación and Aves Argentinas) and ACAP. This represented the first time observers from the various programmes were brought together to exchange experiences and knowledge and to discuss the development of onboard protocols to monitor seabird bycatch in Ecuador.

Presentations were given from Argentinean delegates from the INIDEP observer programme, Aves Argentinas, ACAP and representatives from BirdLife International's Global Seabird Programme. A total of 50 people attended including 40 observers and technicians and seven instructors. The main outcomes included:

- ✓ Production of seabird identification guides;
- ✓ Development of at-sea protocols for abundance estimates and seabird mortality;
- ✓ Exchange of current knowledge and insights into seabird interactions related with specific fishing gears and operations;
- ✓ Elaboration of fishing operations and practices, including gear configurations; and
- ✓ Inclusion of at-sea protocols into the government's national observer programmes.

Raising awareness

Through lobbying government and industry it has been possible to capture the interest of key authorities (fishery and environmental) and the management level of the fishing industry, and in doing so achieve a level of positive action within these groups to ensure that seabird themes are incorporated into work plans of these organisations.

The Fisheries Undersecretary, Guillermo Morán Velásquez, has supported the GSP programme and provided a formal representative of the National Fisheries, Jimmy Martinez of the Regional Fishery Service, to take charge of incorporating suitable mitigation measures once adequate information has been compiled.

The Minister of Environmental Affairs, Marcela Aguiñaga Vallejo, gave her support to the project and personally authorised the use of the official Ministry logo for all certificates and official documents related to the workshops carried out during the year.

Additionally, through work supported by the Armed Forces of Ecuador, we took part in at-sea census work of Ecuadorian waters with the aim of cataloguing the seabirds present. This work will be published through the technical entity of the Navy, INOCAR in their journal *Acta Oceanográfica*.

8.4 Discussion

The first year of actions within Ecuador has successfully secured the support from the highest possible authorities in industry and government and made the necessary first steps to producing a mortality estimate through the regional observer programmes in different fisheries.

The next steps will depend largely on the results of the mortality estimates, although at this stage it is recommended that public awareness is driven through community schemes and activities, especially within fishing communities.

CONCLUSION

The framework of the ATF was established in the planning stages of the programme in late 2004; these comprised five general principles: *Awareness Raising, Branding, Capacity Building, Funding* and *Strategic Development* within a clearly defined conservation goal as the primary objective: To reduce bycatch of albatross and petrels in targeted fisheries, and ultimately to improve the conservation status of threatened seabirds.

The bycatch reductions achieved in local fleets by the first teams to commence work (see box below), clearly demonstrate that with continued commitment and support the ATF is capable of reaching its long-term objective of making a significant contribution to 'Save the Albatross'.

Through the adoption of strict regulations in the Asian distant waters pelagic longline fleet in South Africa, seabird bycatch was reduced by 85% in 2008

Since work began in the Chilean pelagic longline fleet seabird bycatch has dropped from an estimated of over 550 birds in 2007 to around 22 birds in 2009

From ATF observations on longline vessels in Brazil, observed seabird bycatch has been reduced from 0.99 birds per 1,000 hooks in 2007 to 0.11 birds per 1,000 hooks in 2009.

Mitigation Research

The mitigation research programme conducted in 2009 has been designed specifically to identify best practice mitigation measures for ATF target pelagic longline and trawl fisheries. The GSP will then work with ACAP and through our own RFMO advocacy programme to have these findings adopted in key fisheries in Coastal States and on the high seas.

During the Second Meeting of the ACAP Seabird Bycatch Working Group, (SBWG, Hermanus, South Africa, August 2008), mitigation measure research priorities were tabled for pelagic longline and demersal trawl fisheries. At the ATF Instructor's Workshop in January 2009 these priorities were then used to determine ATF country-specific research priorities (BirdLife Global Seabird Programme, 2009). These research projects were primarily related to tori line design, use and performance in pelagic longline and demersal trawl fisheries.

This body of work demonstrates a clear advance in mitigation research across critical seabird foraging areas that overlap with pelagic longline and demersal trawl fisheries. Whilst not all projects are at a stage where decisive conclusions can be drawn from these results, current projects are planned to be completed during 2010 (see ATF Interim Workshop Report, 2010), and it is hoped that when the majority of these projects are completed at the end of 2010, we will be

in a position to provide robust and scientifically defensible best practice mitigation advice to fisheries managers and fishermen

The results provide insights into several aspects of the design and performance of mitigation measures, and are considered below by fishing method. The development of on-shore activities are dealt with separately at the end of the sections on mitigation research.

Pelagic longline

Mitigating seabird bycatch in pelagic longline fisheries remains one of the pivotal challenges for international seabird conservation efforts. While considerable advances have been made in identifying a suite of mitigation measures that reduce seabird bycatch in demersal longline fisheries mitigating bycatch in pelagic (surface) longline fisheries is inherently more difficult. This is due to fundamental differences in gear design with demersal gear being configured to sink rapidly to the sea-bed while pelagic gear is configured with a series of surface buoys to float in the water column.

Tori line designs currently used in pelagic fisheries have been influenced by industry preference driven by reservations over the use of towed devices and long streamers due to perceived and real risks of entanglement with fishing gear. Tori lines used to date in Brazil and Chile have no towed device and use short streamers. Current optimum pelagic streamer line designs recommend long streamers that reach the water's surface in light winds plus a towed device incorporating packing straps (Melvin *et al.*, 2009) or bulk rope to provide drag. The benefit of using a towed device is the resulting increase in tori line aerial extent, which provides crucial extra protection over the area where baited hooks sink during setting operations.

Short streamers have been used preferentially by industry for several reasons: the use of materials readily available onboard; ease of deployment and retrieval; and benefits due to reduction of weight. To compare the recommended long streamers with short streamers, ATF teams in both Brazil and Chile compared tori lines that were identical except for the streamer length.

In Chile, there was no significant difference in seabird attack rate between the two treatments (long vs short streamers) at any distance within the aerial extent of the tori line¹¹ (Mann-Whitney U test: $P > 0.05$). However, it should be noted that the aerial extents achieved were well below what is considered best practice and that seabird abundance was relatively low. Results from Brazil, where seabird abundance is higher, were limited by opportunities to record interactions during daylight setting operations. In 2010, further data collection is expected to provide insights into the use of long vs short streamer tori lines in these fisheries.

¹¹ It should be noted that the tori line with long streamers had a significantly shorter aerial extent than the treatment with short streamers.

Seabird attacks were significantly higher beyond the aerial extent of both tori line treatments in Chile (Kruskal-Wallis tests: $p < 0.05$). Seabird mortality was recorded for all tori line designs in Chile and Brazil, while in Uruguay no seabird bycatch was recorded when a tori line was used. Results in Uruguay demonstrated that during setting operations the presence/absence of a tori line was the only significant factor explaining seabird bycatch (GLM: $P < 0.05$).

Results from both Brazil and Chile indicate that the added weight of the longer streamers significantly reduces the aerial extent of the tori line. Tori line entanglements with streamer lines were recorded on as many as 41.7% of lines set in Uruguay, whereas lower levels were recorded in Brazil and Chile (15%). These entanglements were principally caused by surface buoys and hook lines due to high cross winds or vessel manoeuvres (course changes) during setting. This clearly suggests that while the towed device being deployed in Brazil and Uruguay have improved the aerial extent of tori lines there is still considerable work to be done to develop a towed device that prevents entanglement with longlines

Recent research in Australia (Robertson *et al.*, in press) and South Africa (Melvin *et al.*, 2009) clearly identified that pelagic longline gear is held aloft in propeller turbulence until it is some tens of metres astern. Robertson *et al.* outlined a two stage sink profile for weighted and un-weighted pelagic gear. The first stage occurs when baited hooks are set and held aloft in propeller wash, for weighted gear this is prior to the weight sinking to the point when the 'load' acts on the baited hook to increase the sink rate. The second stage occurs when the gear clears the turbulent waters and for weighted gear, when the load acts on the gear and it starts to sink in a linear profile. Secondary (branch) line bottom sections ranging from 3.5 m in Chile, 4.5 m in Uruguay and 5.5 m in Brazil would increase the time lag between the setting of the gear and the load of the weight engaging the gear to increase the sink rate of the baited hook to the second (linear) stage. In 2010, teams in Brazil and Chile will conduct research to improve our understanding of the critical relationship between the sink rate of the gear and the aerial extent of streamer lines. This will involve manipulating the length of the bottom section (i.e. distance from the hook to the weight) to identify a best practice line weighting and tori line combination.

Although there can be no direct comparison drawn from results between teams due to differing seabird assemblages and fishing gear, the initial analysis of data collected in 2009 suggests four important factors:

- A single tori line use in pelagic longline fisheries reduces seabird bycatch when compared with a control of no tori line (Uruguay);
- In conjunction with the current line-weighting regimes being used in pelagic longline fisheries in Brazil and Chile our preliminary data suggests that the use of long streamers may have limited benefit in reducing seabird attack rate compared to short streamers in areas with relatively low seabird abundance;
- Tori line towed devices remain the primary source of entanglements with fishing gear, particularly longline floats; and

- The aerial extent of pelagic tori line designs has significantly improved with the addition of a towed device incorporating rigid straps in Brazil and Uruguay.

Finally, a greater sample size is needed from our South African trials before data on the effect of added weight on target and non-target fish catch species in pelagic longline fisheries is considered in detail. This research will be completed in 2010.

Demersal trawl

The presence of offal during trawl fishing operations has been identified as the most important factor in seabird mortality associated with trawl fisheries (Watkins *et al.*, 2006; Abraham and Kennedy, 2008). This is further supported by results from warp cable observations in the Namibian trawl fleet (GLM: $P < 0.001$). However, the costs associated with the adoption of offal management measures continue to limit the research and industry innovation required to investigate appropriate offal management measures.

Meanwhile, the use of tori lines has driven significant reductions in seabird mortality associated with trawl fisheries (Watkins *et al.* 2006). New data reported here from demersal trawl fisheries in Argentina and Namibia strongly support these findings, showing statistically significant reductions in seabird interactions with fishing gear when tori lines were deployed (Kruskal-Wallis test: $P < 0.01$ and Chi-squared test: $P < 0.001$ respectively).

Whereas tori lines provide instant reductions in seabird bycatch, there has been industry concern that they become entangled with warp cables under high cross-wind conditions. This is considered to reduce their ability to prevent seabird mortality due to the cables becoming exposed during an entanglement. Additionally, entanglements cause frustrating delays to fishing operations, compromise crew safety and damage tori line materials.

In order to stabilise the tori lines whilst deployed, ATF teams in Argentina and South Africa developed towed devices that offset the tori lines to reduce the probability of entanglement with trawl warp cables, and thus improve overall performance. There was a high degree of similarity between the results from the two teams. In both the Argentinean and South African fleets, there was a significant reduction in the amount of time tori lines crossed over the trawl warp cables when the off-setting device was used when compared with a buoy as a towed device (Chi-squared test: $P < 0.0001$ and $P < 0.001$ respectively).

However, despite a reduction in the amount of time tori lines cross over the trawl warp cables, there was no significant reduction in seabird interactions when using an off-setting device when compared with a standard buoy. Considering the relatively low number of interactions between seabirds and warp cables when a tori line is deployed, regardless of the towed device, it may be necessary to collect a much larger sample size before a reduction of seabird impacts with cables can be detected.

Therefore two important aspects of tori line use can be concluded from these experiments:

- Seabird interactions with warp cables are significantly reduced through the deployment of a tori line in Argentinean and Namibian demersal trawl fleets;
- The amount of time tori lines cross over trawl warp cables is significantly reduced through the use of an off-setting towed device.

On-shore activity

The development of ATF on-shore activities, including the provision of training workshops for the fishing industry and National Observer Agencies is a feature of the Task Force work programme that becomes more advanced as in-country teams gain recognition and strengthen links with government and industry stakeholders.

A general model for ATF Instructor activities at-sea and on-shore was described in the First ATF Instructor Workshop Report 2009. Whilst the at-sea activities during 2009 have largely been dedicated to the development of the mitigation research projects, the on-shore activities have moved forward under the three main work areas mentioned in the model;

- (1) Strengthening national observer programmes through workshops and training materials,
- (2) Conducting port visits to raise awareness of best practice mitigation; and
- (3) Raising awareness through the production of educational materials and hosting local conservation events.

These three methods of interacting with industry and government stakeholders can be considered in more detail through several factors that have emerged during the development of the ATF:

1) Generation of vessel permissions

The necessity and complexity of obtaining permissions to enable ATF Instructors to board vessels for at-sea work varies greatly depending on team location. In each country it is necessary to identify key personnel within the institutions responsible for providing access to the fishing fleet. This includes government departments, the fishing companies, observer agencies and national fisheries institutes.

2) Industry awareness

Generating the right contacts within industry, which often entails identifying collaborative individuals, is the first step in achieving wider industry acceptance and eventually industry buy-in to the adoption of mitigation measures. By increasing the knowledge of the issue and stimulating a greater perception of importance for seabird conservation, other tasks can become increasingly simpler to achieve.

3) Observer training

It was recognised during the early planning of the ATF that it would be necessary to identify and work towards a long-term legacy in countries where the ATF is active. A critical part of

laying the foundations for this long-term legacy is ATF work with the national observer agencies or institutions to facilitate the development of at-sea observer protocols and seabird identification guides. Through developing and conducting training programmes for national observers the ATF has taken important first steps in generating greater seabird conservation awareness within key agencies and institutions linked directly with the fishing industry.

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APPENDIX A

Table 1: Current ATF teams and instructors

<i>Country</i>	<i>Start Date</i>	<i>Organisation</i>	<i>Project Leader</i>	<i>Instructors</i>	<i>Target Fleet</i>
South Africa	March 2006	BirdLife South Africa	Meidad Goren	Meidad Goren Bronwyn Maree Lisa Mansfield	Pelagic Longline Demersal Trawl Demersal Trawl
Brazil	September 2006	Projeto Albatroz / SAVE Brasil	Tatiana Neves	Fabiano Peppes Caio Marques Juliano Cesar ¹	Pelagic Longline Pelagic Longline Pelagic Longline
Chile	April 2007	Centro Ballena Azul	Carlos Moreno	Rodrigo Vega Luis Cabezas	Pelagic Longline Pelagic Longline
Uruguay	December 2007	Proyecto Albatros y Petreles – Uruguay / Aves Uruguay	Andrés Domingo	Sebastián Jiménez Martin Abreu	Pelagic Longline Pelagic Longline
Argentina	January 2008	Aves Argentinas	Fabian Rabuffetti	Leo Tamini Leonardo Chavez	Demersal Trawl Demersal Trawl
Namibia	April 2008	Namibian Nature Foundation / Ministry of Fisheries and Marine Resources	John Paterson	John Paterson Kaspar Shimooshili	Demersal Trawl Demersal Longline
Ecuador	November 2008	Aves y Conservación	Jorge Samaniego	Jorge Samaniego ²	

¹Juliano Cesar replaced Leonardo Sales in early 2010;

²Jorge Samaniego is employed by the Global Seabird Programme and is developing seabird awareness and onboard investigation through national observer programmes in Ecuador as a precursor to further ATF activity.

APPENDIX B

Brazil - Investigation into the forces required to extend a tori line beyond 90 m

Possibly the most critical performance standards of a tori line design is the aerial extent achieved during setting operations. In order to investigate the relationship between the force exerted by towed devices and tori line designs, tests were performed using different towed devices to compare the necessary load to maintain an adequate aerial extent of a tori line.

The summary information presented here were collected prior to experimental research cruises in Brazil. These tests were performed with the aim of evaluating:

- (1) The force required to extend a Light Tori line or Mixed Tori line to a minimum aerial extension of 90 m; and
- (2) The force (drag) exerted by each towed device when towed at speeds that simulate commercial fishing operations during a longline set.

Materials and methods

Tori line tension test

Four tori line designs were used:

- 1) Light Tori line (LT) + 2.0 mm monofilament backbone;
- 2) Light Tori line + 7.0 mm multifilament *palhinha* backbone;
- 3) Mixed Tori line (MT) + 2.0 mm monofilament backbone;
- 4) Mixed Tori line + 7.0 mm multifilament *palhinha* backbone.

The MT incorporated longer and short streamers where as the LT only used short streamers (Figure 1). Tests were performed on-land in an open area. Each tori line was attached at a height of 5.5 m, to simulate the minimum height tori lines are attached above sea level on commercial vessels. At the distal end, the tori line was attached to a car tow bar via a dynamometer at a height of 0.25 m from the ground.

Each tori line underwent a tension test, which included the suspension of the tori line out to 90 m. Once suspended, the reading from the dynamometer was recorded. This was then repeated to allow for any stretching of materials.

When the tori line reached the 90 m aerial extent, the distance that the main line was held above the ground was measured every five metres. This provided an indication of aerial extent above sea level. Tori line tension was measured with the dynamometer (± 1 kg). This procedure was repeated for each of the four proposed types of tori line design.

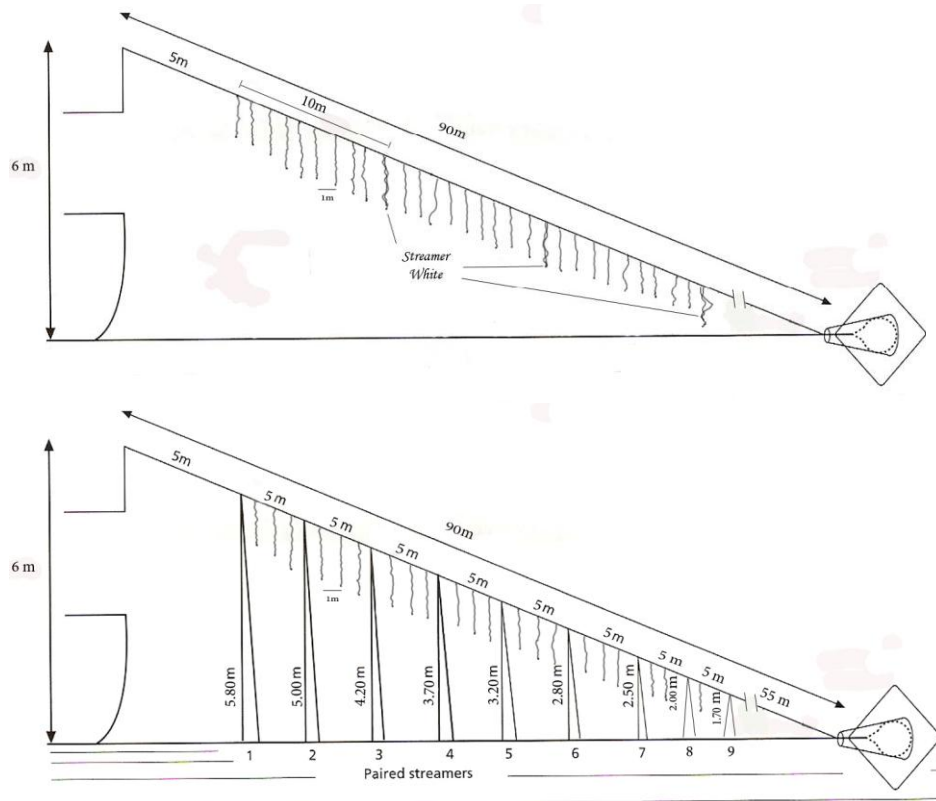


Figure 1: Light (above) and Mixed (below) tori line designs used in the tension tests

Towed device tension test

Five towed devices were used:

- 1) A 70 cm long by 10 cm diameter PVC tube + a road cone with foam bullet float based on designs by Ed Melvin;
- 2) An 82 cm by 82 cm wooden board with two tubes (17 cm x 10 cm) fitted at 45° angles;
- 3) A 20 m length of 2.8 mm multifilament rope with 0.8 m length strips made from packing straps;
- 4) A 10 m length of bulk rope measuring 4.2 cm in diameter; and
- 5) A standard 50 cm length road cone with the base removed and a polystyrene buoy + 2 kg weight inserted.

In order to test the force generated by each towed device a motor-boat was used along the River Itajaí-Açu in Itajaí, Brazil. Towed devices were dragged in turn from the stern of the vessel at maximum possible speed (5 - 7 knots). The devices were attached to the vessel via a dynamometer and a 60 m length of 7.0 mm rope. Readings were taken for the maximum and minimum force exerted by each towed device (± 1 kg) and the speed of the vessel (± 0.1 knot).

Results

The results from the tension tests on land indicated that the combination of the LT + monofilament backbone required the lowest force to achieve the aerial extent of 90 m (11 – 14 kg). This was followed by the MT + monofilament (16 – 19 kg), the LT + multifilament (25 – 28 kg) and finally the MT + multifilament (28 – 33 kg). The resulting aerial extent is displayed in Figure 2.

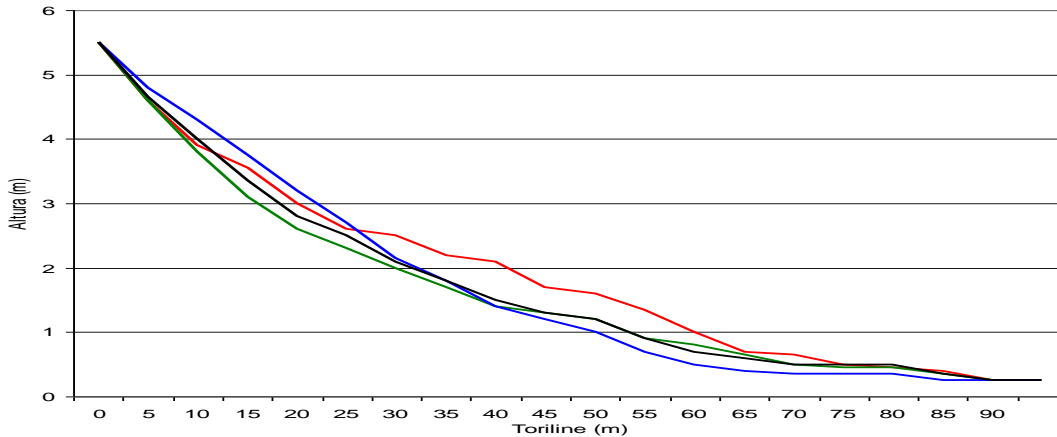


Figure 2: The aerial extent of different tori line designs, measured at each 5 meters. Red: LT + monofilament; Green: MT + monofilament; Blue: LT + multifilament; Black: MT + multifilament.

Between the towed devices tested, the PVC tube + road cone generated the greatest tension (23 – 26 Kg), while the road cone + foam bullet float generated the minimum tension (15 – 18 kg). The offsetting board was eliminated from the tests as it did not perform well in the water, sinking below the surface. Other combinations of materials were tested but none proved satisfactory. Table 1 shows the towed devices that performed well during the tests, displayed in order of tension created.

Table 1. Force exerted by dragging towed devices in decreasing order of tension.

Towed Device	Speed (Max-Min) (knots)	Tension (Max-Min) (kg)
PVC Tube + road cone and foam bullet	5.8 - 6.4	23 – 26
Bulk Rope (attached at the middle)	5.8 - 6.3	17 – 21
Bulk Rope (attached at the extremity)	5.8 - 6.2	15 – 19
7.0 mm rope + packing straps	5.5 - 7.8	14 – 19
Road cone + foam bullet	5.8 - 6.4	15 – 18

Discussion

In order to maintain an aerial extent of 90 m for the LT with a monofilament backbone, 11 – 14 kg of tension is required according to the tori line tension tests. All of the towed devices tested were able to provide this level of drag. However, in order to create the same aerial extent of 90 m for the MT with a 7.0 mm multifilament rope, a much larger tension of 28 – 33 kg would be required. None of the towed devices tested were able to provide this drag at the speeds reached in the speed boat used in the experiment. In terms of best performance, the 7.0 mm rope and packing straps were recommended plus the monofilament backbone.

APPENDIX C

South African - Asian distant pelagic longline fishery

The foreign pelagic longline fleet has a permit requirement for 100% fishery observer coverage, which is provided by Capfish SA (PTY). As reported in the ATF Annual Report (2007), data collected by CapFish observers indicated that between June and December 2007, 1,059 seabirds were caught at a catch rate of 0.36 birds/1,000 hooks. These were predominantly White-capped *Thalassarche steadi* and Black-browed albatrosses *Thalassarche melanophrys* and White-chinned petrels *Procellaria aequinoctialis*. In response to efforts made by the ATF and WWF South Africa working with both CapFish and the Department of Marine and Coastal management (MCM), a Seabird Task Group was established. The ATF team worked closely with WWF South Africa to advocate for a new suite of regulations for foreign licensed vessels through this process, and a proposal was submitted to MCM.

After several meetings of the Task Group, amendments were made to the 2007 permit conditions, and MCM approved the 2008 permit conditions which, amongst a range of new measures, included:

- 1) A prescribed sink rate of 0.3m/second, or a depth of 10m no further than 150 metres behind the vessel;
- 2) A requirement for tori lines (prescriptive design provided) to be deployed for all setting operations (night and day);
- 3) A mortality threshold of 25 seabirds per vessels, after which more stringent regulations are imposed (e.g. setting restricted to nocturnal operations, setting prohibited for 3 days around the full moon, demonstrated sink rates in excess of 0.3 m/second) and if a further 25 birds are killed the vessel is excluded from the fishery for the remainder of the season, or stringent additional prescriptions are imposed on the vessel e.g. support for mitigation research (see addendum below).

The ATF have worked closely with Capfish and MCM to establish a formal briefing and debriefing process for observers in this fishery. This enabled ATF instructors to work more closely with these observers to: (a) improve data collection standards in respect to bycatch of non-target species; (b) greatly increase the education of these observers on the need for effective mitigation, and (c) help provide observers with the knowledge and confidence to ensure vessels are compliant with fisheries regulations, including the new seabird mortality thresholds. In the foreign pelagic longline fleet in 2008 seabird bycatch was reduced by 84% to 0.052 birds / 1,000 hooks (Figure 2) when compared to the previous year. Although improvements are needed to the current model of tori line, there has been an increase in tori line mitigation compliance to 96% which is strongly related to the introduction of new regulations that included the 25 bird catch limit. On reaching this limit, vessels are required to return to port for an investigation into the reasons behind the bycatch levels exceeding the threshold and review of mitigation use onboard. This powerful incentive had immediate results with seabird bycatch in the fleet being dramatically reduced in 2008.

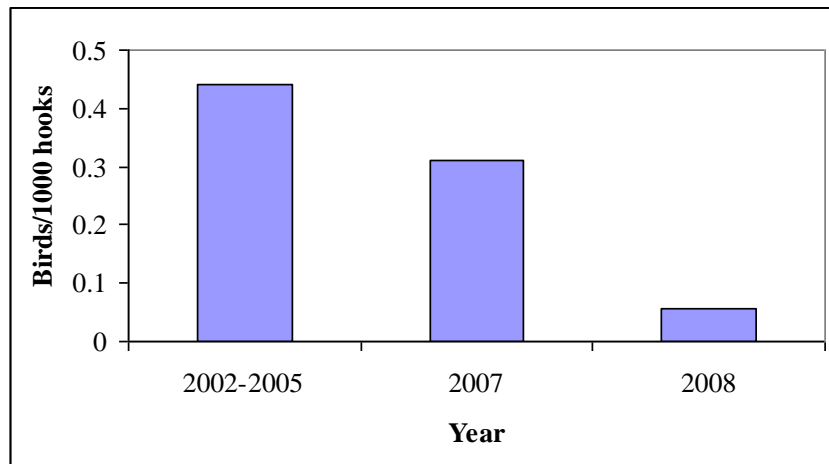


Figure 2: Seabird bycatch (birds / 1,000 hooks) in the Asian distant pelagic longline fleet since 2002 – 05 until 2008 (No Asian vessels were licensed in 2006).

This reduction in seabird bycatch in the Asian longline fleet was a major success for the ATF and the many local collaborators. While considerable work is required to ensure that this reduced level of bycatch can be replicated and improved upon in future years, it was exactly the type of success that the Task Force aims to achieve.

Addendum to ATF 2008 Annual Report extract

Although the bycatch data for the 2009 season have not yet been fully analysed, it is evident that it was not possible to maintain this level of reduction in the following (2009) fishing season, but that a marked reduction from 2007 levels was achieved. This is thought to be likely due to a combination of factors, including a shift in fishing effort, and a continued failure of the fleet to utilise appropriate line weighting in combination with a below standard tori line. However, collaborative research that was initially triggered by the 25-bird mortality threshold imposed by MCM, has resulted in a productive research arrangement between the Washington Sea Grant (and supported by the ATF) and the distant water fleet. Research conducted in the 2008 (Melvin *et al.* 2009) and 2009 (Melvin *et al.* 2010) seasons has made significant gains in identifying a best practice tori line for high seas pelagic longline vessels, and is also investigating potential line weighting regimes. It is hoped that these findings will be refined and implemented and result in a sustained reduction in seabird bycatch in this, and other pelagic longline fleets.