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Developments in experimental mitigation research – Artisanal demersal longline fishery (Ecuador)

Albatross Task Force

BirdLife International, Global Seabird Programme

Seabird mortality and the effect of line weighting on sink rate of baited hooks in the Ecuadorian demersal artisanal longline fleet

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Introduction

The Albatross Task Force (ATF) was established in 2006 as the world's first international team of seabird mitigation instructors to meet the urgent conservation need to reduce seabird bycatch in commercial fisheries. The Albatross Task Force (ATF) now operates in seven countries across southern Africa and South America and this work in Ecuador represents our first in large scale artisanal fisheries.

In January 2009, the ATF held the First ATF Instructors Workshop (Coquimbo, Chile) to define work programmes and objectives for 2009/10. During this meeting the ACAP mitgation research priorities for longline and trawl fisheries, as identified by the Second Seabird Bycatch Working Group were discussed by country and fishery by ATF teams[1].

At that stage the ATF was initiating activities in Ecuador and we first wanted to identify target fisheries with mortality of Waved albatross (*Phoebastria irrorata*), which has seen a population reduction of 42% over a 13 year period (Anderson *et al.* 2008), and is currently classified as Critically Endangered (IUCN, 2011). Identifying fisheries in Ecuador which pose the greatest threat to the Waved albatross and investigating mitigsation measures for these fisheries is a primary objectives of the ATF and the ACAP Waved Albatross Action Plan. While virtually zero bycatch data was available for this species in Ecuador, seabird distribution data clearly indicated that fisheries in the south of the country exhibited the highest potential level of overalp with fishing effort (Anderson *et al.* 2003) and were thererfore targeted by the ATF as the highest priortiy for investigation.

Initial investigations suggested we target our efforts in the demersal longline fishery based in Santa Rosa, to characterise the fishery and the level of interactions/bycatch of Waved albatross, and other seabird species.

This report describes the results collected in 2010/11 and provides details of the experimental research that is being carried out to investigate options for mitigation measures for this fishery.

The objectives of the study were threefold:

1) Evaluate seabird bycatch associated with the artisanal demersal longline fleet;

2) Investigate the effect of line weighting (mass) on sink rate of baited hooks;

3) Investigate the effect of line weighting (mass) on catch rate of target and non-target species.

[1] Current teams include Argentina, Brazil, Chile, Ecuador, Namibia, South Africa and Uruguay.

Evaluation of the seabird bycatch in the fleet was carried out using standard data collection protocols while the investigation of line sink rate and target species catch included two experimental treatments:

Treatment (1): Sets with standard (450 g) stone weights placed at 50 m intervals along the main line;

Treatment (2): Sets with modified (900 g) concrete weights placed at 50 m intervals along the main line.

We tested two null hypothesis for the experimental component of this work:

H_0 1= Modified line weighting has no effect on the sink rate of baited hooks;

H_0 2= Modified line weighting has no effect on the catch rate of target and non-target species.

Fishing vessels and study area

The experiments were conducted onboard fishing vessels from the fleet based in Santa Rosa that target hake *Merluccius gayi*. These vessels have total lengths of between 6.0 to 8.5 m, use outboard motors of 40 to 85 Hp and conduct trips that last from one to three days. All vessels in the study represented typical artisanal demersal longline vessels of the Ecuadorian fishing fleet. Fishing areas included four zones to the south west of Ecuador: 'Yerbita' 01° 59' 03"S, 81° 07'59"W; 'Yerba' 02° 04' 59"S, 81° 04'35"W; 'Atrevesado' 02° 19' 12"S, 81° 08' 06" W; and the most distant from shore, Manteca 02° 34' 47" S 81° 52' 34" W.

Fishing gear and operation

The fishing gear used in the Santa Rosa fleet was composed of 700 to 900 m of 2.5 mm nylon main line to which approximately 450 Mustad size 9 J hooks were attached via 1 m long 0.9 mm monofilament snoods. Spacing between snoods was approximately 1.6 m with stone weights placed at 50 m intervals along the length of the main line. The main line was anchored at each end by 5 kg stone weights attached to 4 mm anchor lines and marked with surface buoys.

Hooks were baited on route to the fishing grounds and with approximately 1 cm x 6 cm sections of Butter fish *Peprilus spp,* Herring *Opisthonema spp,* Squid *Loligo spp* or Baracuda *Sphyraena spp* and laid out on a setting board. Setting operations were performed by a single crew member, deploying the fishing gear over the side of the vessel at a speed of approximately 1.5 – 2.0 knots. Gear was left to soak for between 30 minutes and an hour at a depth of between 160 and 220 m. During hauling operations hooks were baited and prepared for the next set. Two to four lines were set per day.

Onboard protocol

Prior to daylight sets a seabird count was recorded for all species within a 250 m hemisphere from the stern of the vessel. Environmental information was noted including wind speed (Beaufort scale), cloud cover and sea surface temperature.

The sink rate of baited hooks was recorded by attaching CEFAS G5 Time Depth Recorders (TDRs) to the main line at the central point between weights. On each set TDRs were

deployed on randomly selected sections of the main line (the start, middle or end). TDRs were configured to register depth (pressure) every second to generate the sink rate for each treatment.

The catch rate of target hake species was recorded according to size classes (small, 12-15 cm; medium, 16-30 cm; or large, 31-60 cm), which were separated by the crew into three boxes as fish were hauled on board.

Data analysis

Sink rate profiles were screened to identify errors in the data. This process identified an unusually high level of sink profiles that were influenced by the handling of the gear onboard the vessel during setting operations[2]. These profiles were removed from the data set. Mean sink rate (meters/second) of the main line was calculated for remaining TDR data for each depth class (0-2 m, 2-4 m, and 2-6 m) following the methodology in Wienecke and Robertson (2004) and compared using a Students T-test following a square root transformation.

The number of fish caught of the target species was compared for each of the three size classes plus total catch for the two Treatments (450 g and 900 g) using a Wilcoxon Signed Ranks Test.

Results

Total observed effort

In total, between 19th August 2010 to 29th September 2010 and subsequently from the 12th January and 21st June 2011 a total effort of 118,294 hooks[3] were observed between 01°59' S and 02°22' S. This effort represented a total of 79 trips and 252 setting operations (446.4 ± 86.6 hooks per set) on 11 vessels, although the majority (86.1%) of sets were observed on four vessels.

Seabird abundance

A total of 21 seabird species were recorded from 189 seabird abundance counts on board these 11 vessels. Of these species, four were present in over 50% of all abundance counts: the Waved albatross *Phoebastria irrorata* (86.2%), the Magnificent frigatebird *Fregata magnificens* (84.7%), Parkinson's petrel *Procellaria parkinsoni* (68.8%) and the Blue-footed booby *Sula nebouxii* (50.8%). All other species were present on less than 30% of abundance counts (Table 1). The average abundance of Waved albatross was highest during June, August and September (Table 2).

[2] Due to the artisanal nature of the fishery, setting operations frequently halt according to the speed of the single crew member setting the hook line and relatively high frequency of line entanglements. This interferes with the progress of the sinking line. In some cases the line is held by the person steering the boat, which causes the TDRs/line to be raised toward the surface.

[3] Due to the frequent replacement of gear, the exact number of hooks was not recorded for all sets until full experimental trips began in March 2011. Previous to March 2011, for sets where an exact number was omitted, the average number of hooks from the remaining data was used (446 hooks).

Table 1. Frequency of Occurrence (F.O.) and summary information of seabird species observed during abundance counts in the Ecuadorian demersal longline fishery

Species	Average	SD	Max	F.O. (%)
Phoebastria irrorata	11.44	8.31	46	86.24
Fregata magnificens	12.94	9.32	64	84.66
Procellaria parkinsoni	9.99	11.85	73	68.78
Sula nebouxii	3.71	3.20	18	50.79
Oceandroma spp.	6.50	4.50	20	29.63
Oceanites gracilis	10.51	9.39	38	26.98
Pterodroma phaeopygia	11.35	28.05	100	17.99
Puffinus griseus	1.66	0.77	4	15.34
Larus atricilla	5.48	8.15	35	11.11
Pelecanus occidentalis	3.52	2.58	10	11.11
Larus spp.	5.71	7.92	30	7.41
Pelecanus thagus	3.00	1.41	5	5.29
Sula leucogaster	3.75	0.89	5	4.23
Puffinus creatopus	1.67	1.21	4	3.17
Sterna hirundo	1.83	0.75	3	3.17
Sula granti	1.00	-	1	1.06
Creagrus furcatus	1.00	-	1	1.06
Sterna elegans	2.00	1.41	3	1.06
Thalassarche bulleri	1.00	-	1	0.53
Larus modestus	1.00	-	1	0.53
Larus Sabini	1.00	-	1	0.53
Sterna sandvicensis	1.00	-	1	0.53

Table 2: Average monthly abundance of Waved albatross observed from demersal longline vessels in Ecuador

Month	Average	SD	Max	N
January	0.27	0.47	1	11
February	0.18	0.39	1	17
March	0.40	0.55	1	5
April	3.00	-	3	1
May	8.00	5.29	14	3
June	10.50	3.32	15	4
August	15.44	7.98	32	41
September	10.79	8.13	46	107

Seabird interactions

From our total observed effort (79 trips, 252 sets) 27 seabirds were caught giving a Bycatch Per Unit Effort (BCPUE) of 0.24 birds / 1,000 hooks. This incidental capture included two species, the Waved albatross (all adult birds) and Parkinson's petrel. A total of 15 individuals were recovered alive (10 Waved albatross, 5 Parkinson's petrel) and 12 were recovered dead (0.11 birds / 1,000 hooks). Of the 12 birds killed, nine were Waved albatross (0.08 / 1,000 hooks) and the remaining three were Parkinson's petrel (0.03 birds / 1,000 hooks) (Table 3).

All recorded bycatch (alive and dead) in the fishery occurred between the 23rd August and 25th September 2010. No bycatch was recorded between the 12th January and 21st June 2011 including during trips where experimental testing was carried out using modified line weighting.

Bycath events occurred on both the set and haul. However, all seabird mortality occurred during the setting operation but the majority (11 birds, 91.6%) were not recovered until the haul. A single individual was recovered dead during setting operations. This indicates that the majority of bycatch events (19 birds, 70.4%) occur during the set, with only eight birds (29.6%) caught during the haul, of which all were released alive.

Table 3: Summary of seabird bycatch by species and fishing operation in the Ecuadorian demersal longline fishery

	Number of birds caught (BCPUE)					
	Phoebastria irrorata			*Procellaria parkinsoni*		
Operation	**Recovered alive**	**Recovered dead**	**Total**	**Recovered alive**	**Recovered dead**	**Total**
Set	5 (0.04)	1 (0.01)	**6 (0.05)**	2 (0.02)	0 (0.00)	**2 (0.02)**
Haul	5 (0.04)	8 (0.07)	**13 (0.12)**	3 (0.03)	3 (0.03)	**6 (0.05)**
Total	**10 (0.09)**	**9 (0.08)**	**19 (0.17)**	**5 (0.04)**	**3 (0.03)**	**8 (0.07)**

Experimental effort

Sink rate

Between the 29th April 2011 and 21st June 2011, eight trips were carried out to perform sink rate measurements for the two treatments (450 g and 900 g). During these eight trips a total of 51 TDR deployments were achieved over the course of 16 setting operations (two TDRs per treatment, per set). Following data screening a total of 24 TDR deployments were removed from the data set because of the setting operation, as described above. The sink rate was measured through the remaining 27 TDR deployments (Treatment 1: n = 14; Treatment 2: n = 13).

Sink rate analysis indicated the main line under Treatment 1 (450 g weights) sank at 0.15 m/s to a depth of two metres, at 0.17 m/s between two and four metres and 0.19 m/s between four and six metres. Under Treatment 2 (900 g weights) the line sank significantly faster down to two metres (0.28 m/s; Students' T-Test: $p<0.01$) and between two to four metres (0.32 m/s; $p<0.05$), while there was no significant difference found in sink rate from four to six metres (Table 3, Figure 1).

Table 3: Summary of sink rate measurements from 27 TDR deployments in the Ecuadorian artisanal longline fishery.

Sink rate (m/s)	**Treatment 1 (450 g)**			**Treatment 2 (900 g)**		
Depth (m)	0 – 2	2 – 4	4 – 6	0 – 2	2 – 4	4 – 6
Average	0.15	0.17	0.19	0.28	0.32	0.21
SD	0.116	0.085	0.069	0.157	0.273	0.070
Max	0.50	0.38	0.33	0.58	1.20	0.34
Min	0.04	0.10	0.12	0.12	0.15	0.10
n	14	14	14	13	13	13

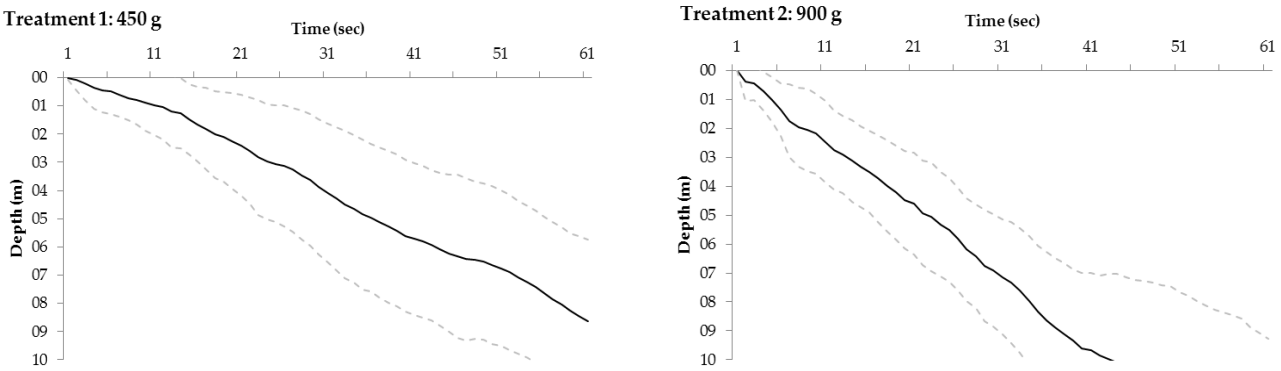

Figure 1: Sink rate profiles for main line under Treatment 1 (450 g) and Treatment 2 (900 g). Solid line and dashed lines indicate mean sink rate ± SD.

Catch rate

Catch rate was recorded for all sets under experimental conditions to compare target species catch for each treatment. From a total effort of 8,100 hooks deployed during the 16 longline sets monitored (Treatment 1: 4,050 hooks, 50%; Treatment 2: 4,050 hooks, 50%) 100% of hooks were observed during the haul. From this effort a total of 2,529 fish of the target species hake were caught.

The Wilcoxon Signed Ranks Test detected no significant difference between Treatments for the number of fish caught for small (p=0.171), medium (p=0.325) or large fish (p=0.569) nor for total catch (p=0.140) (Table 2).

Table 2: Target species catch (number of fish) per size class for Treatment 1 (450 g) and Treatment 2 (900 g) during 16 experimental lines set in the Ecuadorian artisanal longline fishery.

	Treatment 1: 450 g				**Treatment 2: 900 g**			
	Small	Medium	Large	Total	Small	Medium	Large	Total
Average	38.6	28.6	20.2	87.3	25.5	22.3	23.0	70.8
Standard Deviation	30.3	22.5	10.0	58.3	15.1	22.8	13.9	43.9
Maximum	92	68	42	189	48	88	54	173
Minimum	3	4	3	19	3	0	4	22
n	16	16	16	16	16	16	16	16

Discussion

Our results provide evidence of seabird mortality in the artisanal longline fishery based in Santa Rosa, Ecuador. Importantly, we present the first bycatch rate for Waved albatross and Parkinson's petrel in Ecuador, which are currently categorised as Critically Endangered and Vulnerable, respectively (IUCN, 2011).

We only recorded seabird bycatch during August and September, which coincides with late incubation and early chick provisioning period (Harris, 1973), when adult Waved albatross are foraging along the southern coast of Ecuador (Anderson et al. 2003). Our seabird abundance data corroborated the fact that Waved albatross are present in higher numbers in those months and in very low densities between January and May. However, monitoring of interactions, bycatch and seabird abundance throughout all seasons must be completed to start to understand the spatial and temporal nature of seabird bcyatch in this fishery and to take the first steps toward an annual bycatch estimate for the fleet.

Our results indicate that seabird interactions occur during both setting and hauling operations although all seabird mortality recorded occurred during the set. The setting operation is therefore the most urgent operation for which mitigation measures are required.

Analysis of sink rate measurements from 27 TDR deployments over 16 longline sets indicated that the use of 900 g weights significantly increases the speed at which the hook line reaches two and four meters. The hook line effectively reached double the depth over the same period of time as the lighter (450 g) standard gear used in this fishery. However, our data set is relatively small as setting procedures are inconsistent which complicates the collection of clean sink rate data. More data is required before this can be confirmed with confidence. A priority in 2011 will be to continue our experimental research in August-October when bycatch rates are highest in this fishery to investigate the effect of increased line weighting on bycatch of Waved albatross, and other species.

Our analysis identified no significant difference in the catch rate of target species but caution should be exercised when interpreting these findings due to a relatively small sample size. Further data is required before the effect of increased line weighting can be determined with statistical confidence. These data will be collected in 2011/12.

During the experimental work with modified line weighting, there were no operational difficulties indicated by the captain or crew. However, we recognise that due to the physical nature of the hauling operation, the additional weight may cause issues for the working procedures aboard the vessels of this fleet in the medium to long term. It should therefore be noted that a mechanism to assist hauling the longline gear in this fleet could be necessary if additional line weighting is to be used as a mitigation measure.

Future objectives

The main objective in Ecuador is to continue to quantify the level of seabird bycatch in the Santa Rosa fishery and to investigate the effect of line weighting on seabird mortality and target species catch in the demersal longline fishery throughout 2011/12.

The experimental design will continue to include the two treatments:

1) Concrete 1 kg weights placed every 40 m;

2) Stone 450 g weights placed every 40 m (control).

H0 = Line weighting has no effect on the sink rate of baited hooks in the demersal longline fishery.

Line weighting will continue to be evaluated in terms of the efficiency of fishing operations and we will investigate any potential mechanised means of assisting the crew to work with the heavier lines.

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References

Anderson, D.J., K.P Huyvaert, D.R. Wood, C.A. Gillikin, B.J. Frost, & H. Mouritsen (2003) At-sea distribution of waved albatrosses and the Galapagos Marine Reserve. Biological Conservation 110: 367–373.

Anderson, D.J., K.P Huyvaert, J.A. Awkerman, C.B. Proaño, W.B. Milstead, G. Jiménez-Uzcátegui, S. Cruz, & J.K. Grace (2008) Population status of the Critically Endangered Waved albatross Phoebastria irrorata, 1999 to 2007. Endangered Species Research, 5: 185-192.

Harris, M.P. (1973) Biology of Waved-Albatross Diomedea irrorata of Hood-Island, Galapagos. Ibis 115: 484.

IUCN (2011) IUCN Red List of Threatened Species. Version 2011.1. <www.iucnredlist.org>. Downloaded on 06 July 2011.

Wienecke, B. & G. Robertson (2004) Validation of sink rates of longlines measured using two different methods. CCAMLR Science, 11: 179–187.