Seabird, turtle and shark bycatch in South African pelagic longline fisheries

South Africa/BirdLife & WWF Responsible Fisheries Programme
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Abstract

Different gear configurations and operations result in different bycatch rates. Bycatch rates (catch per 1000 hooks) for seabirds, turtles and sharks were 0.1, 0.1 and 7 respectively in the swordfish fishery and compared to 0.5, 0.005 and 3 respectively in the tuna directed fishery. Seabird catch rates in both fisheries are higher than the FAO recommended 0.05 birds/1000 hooks and thus are of concern. Seabird mitigation measures are a condition of these permits in both fisheries and proving very successful. This paper reviews all available data collected by fisheries observers on board these vessels from 1998 to 2005.

Introduction

South African waters are important for seabird and turtle conservation. 15 of 24 seabirds and 5 of 7 turtles threatened with extinction as a result of mortality in longline fisheries forage in these waters including 2 critically endangered turtles (i.e. leatherback and hawksbill turtles). South Africa has addressed this issue by ratifying the relevant agreements (The Agreement for the conservation of Albatrosses and Petrels and the Indian Ocean and South east Asia turtle agreement), are developing a NPOA-seabirds, have adopted an NPOA-sharks and have seabird mitigation measures as a condition of longline fisheries permits.

South Africa has two pelagic longline fisheries, namely a swordfish directed fishery dominated by South African flagged vessels and a tuna directed fishery historically dominated by Asian flagged vessels. At present 50 permits are allocated, 20 swordfish and 30 tuna directed, each year. This paper outlines gear configurations, effort and bycatch estimates for both of these fisheries.

A) The swordfish directed fishery

South African vessels typically target swordfish *Xiphias gladius* with a bycatch of tunas *Thunnus* spp. Fishing effort totaled 4.6 million hooks between 2000 and 2005 and ranged between 870 000 and 1.5 million per year (Table 1). Bycatch data was collected from 9% (405 000 hooks) of these hooks during this time period. Fishing predominantly takes place on the Agulhas bank and between 27 and 33 degrees south and 31 and 44 degrees east (Fig. 1).

These vessels vary in size (average 31 m, range 19-56 m, std dev 7.9 m) and carry an average of 18 (range 6-31, std dev 5) crew members. Trips (n=70) are on average 14 (range 5-38, std dev 5.8) days. In general the mainline is made up of monofilament and is approximately 50 miles. It is typically set between late afternoon and midnight (43% set in the dark, 2% in the light and 55% during twilight) and is allowed to soak until dawn (note: dark/light = start to finish in the dark/light, twilight = start in the dark or light and end in the other). The line is kept close to the surface by numerous buoys which are attached to the mainline via buoylines at an average of 194 m (range 46-370 m, std dev 108) apart and are on average 20 m (range 10-37 m, std dev 3 m) long. Additional radio or light buoys are also used to locate the line. There are between 20 and 472 (average 272, std dev 100) buoys on a line and on average five (range 3-30, std dev 3) branchlines or snoods between buoys. On average 1300 (range 1000-2500) hooks are attached to the mainline by branchlines. Branchlines are spaced evenly along the mainline at an average of 42 m (range 17-65 m, std dev 15) apart. A typical South African flagged pelagic longliner makes up their branchline to the following specifications: an upper section of approximately 18m, a swivel (usually 60-80g) and a lightstick and then a lower section of approximately 2m ending in a baited hook. 72% of lines were set with more than 50% of brachlines carrying a lightstick. 10% of observed vessels used a line setter. 89% of observed vessels used squid as bait, with the remaining 11% using a combination of squid and fish bait (pilchard, mackerel). None was recorded using live bait. In general the line is at an average speed of 8 knots.

Table 1: Summary of swordfish directed fishery effort

	Summer		Winter		Autumn		Spring		Total	
Year	Hooks	% obs	Hooks	% obs	Hooks	% obs	Hooks	% obs	Hooks	% obs
2000	276,708	2%	60,040	0%	4,700	88%	164,163	0%	505,611	2%
2001	109,436	25%	17,900	0%	18,000	10%	174,472	21%	319,808	21%
2002	253,250	8%	327,051	0%	416,932	17%	295,380	19%	1,292,613	11%
2003	382,579	0%	316,228	1%	313,480	18%	639,097	8%	1,651,384	7%
2004	185,970	9%	81,300	15%	218,050	1%	83,100	0%	568,420	5%
2005	72,300	0%	66,850	26%	26,900	0%	104,730	6%	270,780	9%
Total	1,280,243	6%	869,369	4%	998,062	14%	1,460,942	11%	4,608,616	9%

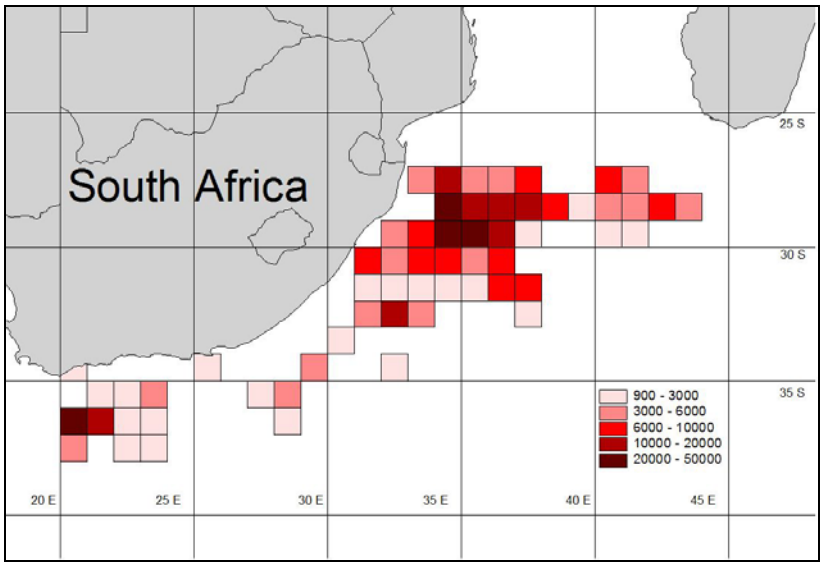


Figure 1: Observer effort on Swordfish vessels operating in the Indian Ocean

Seabirds

Seabird bycatch comprised of 55.3% white-chinned petrels *Procellaria aequinoctialis*, 26.3% Shy Albatrosses *Thalassarche cauta*, 2.6% Yellow-nosed Albatrosses *Thalassarche carteri*, 2.6% Wandering Albatross *Diomedea exulans* and the remaining 31.2% unidentified. Although catch rate varied by season and year, it averaged 0.1 birds/1000 hooks (0.04 albatrosses/1000 hooks and 0.05 petrels/1000 hooks) and a maximum of 1.2 birds/1000 hooks in 2002 (Table 2). Seabirds were predominantly caught on the Agulhas bank, but also in the open ocean especially between 28 and 29 degrees south and 43 and 44 degrees east (Fig. 2).

Table 2: Catch rates of a) albatrosses, b) petrels & c) all seabirds, caught by swordfish vessels operating in the Indian Ocean.

a)

Year	Summer	Autumn	Winter	Spring	Total
1998	*	*	*	0.08	0.08
2000	1.24	0.73	*	*	1.04
2001	0.07	0.00	*	0.00	0.03
2002	0.00	0.00	*	0.05	0.02
2003	*	0.00	0.00	0.00	0.00
2004	0.00	0.00	0.00	*	0.00
2005	*	*	0.00	0.00	0.00
Total	0.14	0.02	0.00	0.02	0.04

b)

Year	Summer	Autumn	Winter	Spring	Total
1998	*	*	*	0.00	0.00
2000	0.00	0.49	*	*	0.19
2001	0.04	0.00	*	0.05	0.05
2002	0.00	0.00	*	0.26	0.10
2003	*	0.00	0.00	0.04	0.02
2004	0.00	0.00	0.00	*	0.00
2005	*	*	0.00	0.00	0.00
Total	0.01	0.01	0.00	0.11	0.05

c)

Year	Summer	Autumn	Winter	Spring	Total
1998	*	*	*	0.08	0.08
2000	1.24	1.21	*	*	1.23
2001	0.11	0.00	*	0.05	0.08
2002	0.00	0.00	*	0.31	0.12
2003	*	0.00	0.00	0.04	0.02
2004	0.00	0.00	0.00	*	0.00
2005	*	*	0.00	0.00	0.00
Total	0.16	0.04	0.00	0.13	0.09

*** denotes no data**

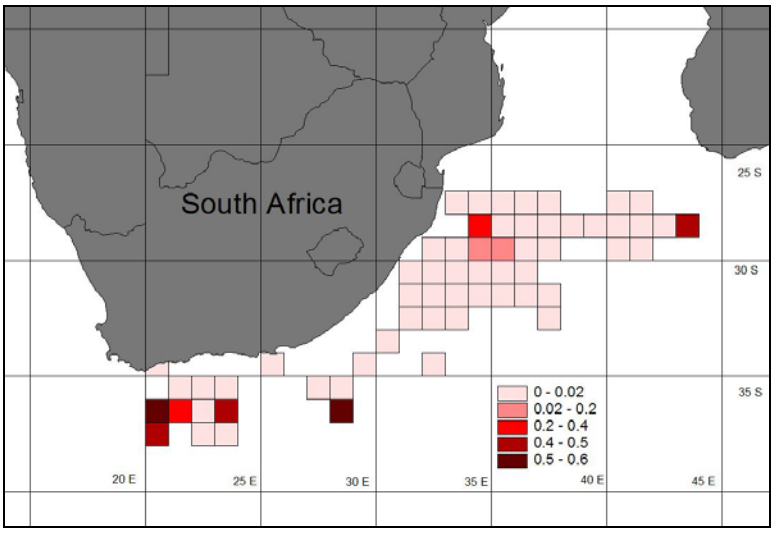


Figure 2: Distribution of seabird mortality and catch rate observed on South African swordfish vessels operating in the Indian Ocean

Turtles

Turtle bycatch comprised of 35.3% leatherback *Dermochelys coriacea*, 14.7% loggerhead *Caretta caretta*, 2.9% hawksbill *Eretmochelys imbricate*, 2.9% green *Chelonia mydas* turtles and the remaining 44.1% unidentified. Although catch rate varied by season and year, it averaged 0.1 turtles/1000 hooks (0.01 loggerheads/1000 hooks and 0.03 leatherback/1000 hooks) and a maximum of 0.3 turtles/1000 hooks in 2002 (Table 3). Catch rates as high as 1.7 turtles/1000 hooks was experience on the Agulhas Bank. Catch rates were generally lower in the open ocean and average at 0.1 turtles/1000 hooks (Fig. 3).

Table 3: Catch rates of a) Loggerhead, b) Leatherback & c) all turtles, caught by swordfish vessels operating in the Indian Ocean.

a)

Season	Spring	Summer	Autumn	Winter	Total
1998	0.00	*	*	*	0.00
2000	*	0.00	0.00	*	0.00
2001	0.03	0.00	0.00	*	0.02
2002	0.04	0.00	0.00	*	0.01
2003	0.00	*	0.02	0.00	0.01
2004	*	0.00	0.00	0.00	0.00
2005	0.00	*	*	0.06	0.04
2006	*	0.00	*	*	0.00
Total	0.02	0.00	0.01	0.03	0.01

b)

Season	Spring	Summer	Autumn	Winter	Total
1998	0.08	*	*	*	0.08
2000	*	0.00	0.24	*	0.09
2001	0.00	0.04	0.00	*	0.02
2002	0.02	0.10	0.03	*	0.03
2003	0.04	*	0.00	0.00	0.02
2004	*	0.00	0.00	0.17	0.07
2005	0.00	*	*	0.00	0.00
2006	*	0.00	*	*	0.00
Total	0.02	0.04	0.02	0.06	0.03

c)

Season	Spring	Summer	Autumn	Winter	Total
1998	0.08	*	*	*	0.08
2000	*	0.00	0.73	*	0.28
2001	0.03	0.22	0.00	*	0.11
2002	0.05	0.10	0.14	*	0.10
2003	0.06	*	0.04	0.00	0.04
2004	*	0.00	0.00	0.17	0.07
2005	0.00	*	*	0.06	0.04
2006	*	0.00	*	*	0.00
Total	0.05	0.11	0.11	0.10	0.08

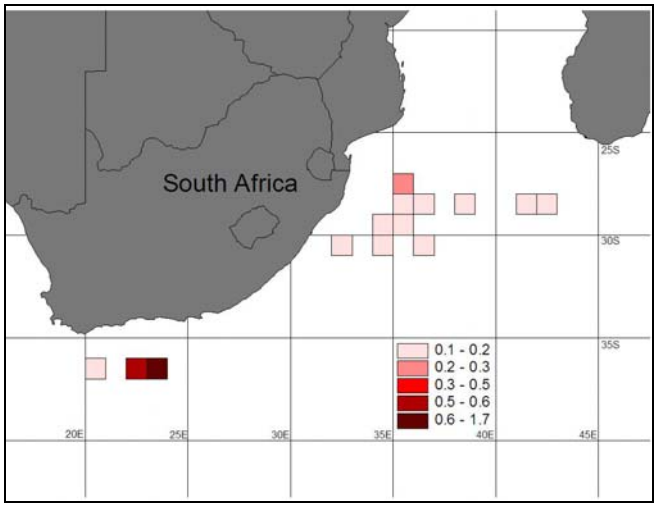


Figure 3: Distribution of catch rates of turtles caught by swordfish vessels operating in the Indian Ocean.

Sharks

Shark bycatch comprised of 43% Blue *Prionace glauca*, 20% Crocodile *Pseudocarcharias kamohari* , 12% Short-fin Mako *Isurus oxyrinchus*, 9% Bronze Whalers *Carcharhinus brachyurus*, 4% Dusky *Carcharhinus obscurus*, 2% Oceanic White Tip *Carcharhinus longimanus* , 2% Hammerhead *Sphyrna* spp and the remaining 8% by a variety of species. Although catch rates varied by season and year, it averaged 7 sharks/1000 hooks (3 blue sharks/1000 hooks, 1.37 crocodile sharks/1000 hooks and 0.8 mako sharks/1000 hooks) (Table 4). Blue and mako sharks were caught throughout the

area fished, whereas crocodile sharks were predominantly caught in the open ocean between 28 and 29 degrees south and 43 and 44 degrees east (Fig. 4).

Table 4: Catch rates of a) Blue, b) Mako c) crocodile & d) all sharks, caught by swordfish vessels operating in the Indian Ocean.

a)

Year	Summer	Autumn	Winter	Spring	Total
1998	*	*	*	3.54	3.54
2000	1.70	8.98	*	*	4.54
2001	3.05	2.22	*	1.45	2.13
2002	2.20	2.83	*	3.03	2.82
2003	*	2.29	19.50	3.60	3.22
2004	2.09	0.00	1.83	*	1.88
2005	*	*	4.55	0.00	3.31
2006	17.29	*	*	*	17.29
Total	3.40	2.75	4.47	2.78	3.02

b)

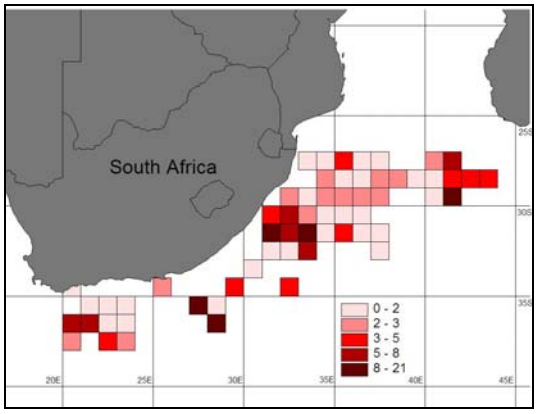
Year	Summer	Autumn	Winter	Spring	Total
1998	*	*	*	1.73	1.73
2000	1.24	4.61	*	*	2.55
2001	1.87	9.44	*	0.66	1.40
2002	1.42	0.55	*	1.44	1.01
2003	*	0.11	2.50	0.43	0.30
2004	0.06	0.00	0.08	*	0.07
2005	*	*	0.58	0.31	0.50
2006	1.25	*	*	*	1.25
Total	1.26	0.60	0.51	0.92	0.84

c)

Year	Summer	Autumn	Winter	Spring	Total
1998	*	*	*	0.08	0.08
2000	0.00	0.00	*	*	0.00
2001	0.51	0.00	*	0.90	0.72
2002	0.15	3.65	*	0.38	1.93
2003	*	0.18	0.00	0.57	0.36
2004	8.10	0.00	4.42	*	6.22
2005	*	*	0.00	0.00	0.00
2006	0.00	*	*	*	0.00
Total	1.98	1.99	1.69	0.52	1.37

d)

Year	Summer	Autumn	Winter	Spring	Total
1998	*	*	*	5.35	5.35
2000	3.40	14.32	*	*	7.65
2001	6.79	11.67	*	3.97	5.35
2002	4.70	9.55	*	6.38	7.68
2003	*	5.68	22.50	5.34	5.82
2004	13.68	2.07	9.75	*	11.53
2005	*	*	9.22	0.31	6.78
2006	18.75	*	*	*	18.75
Total	8.19	8.01	10.27	5.18	7.08



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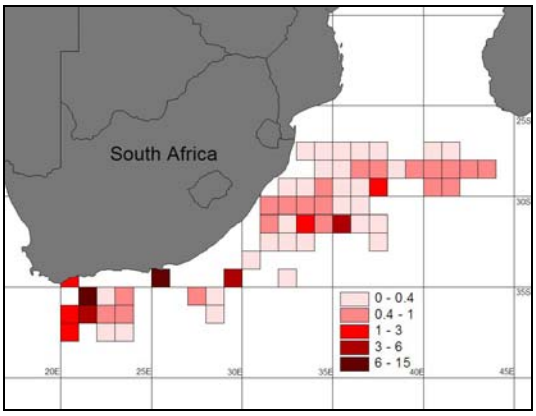

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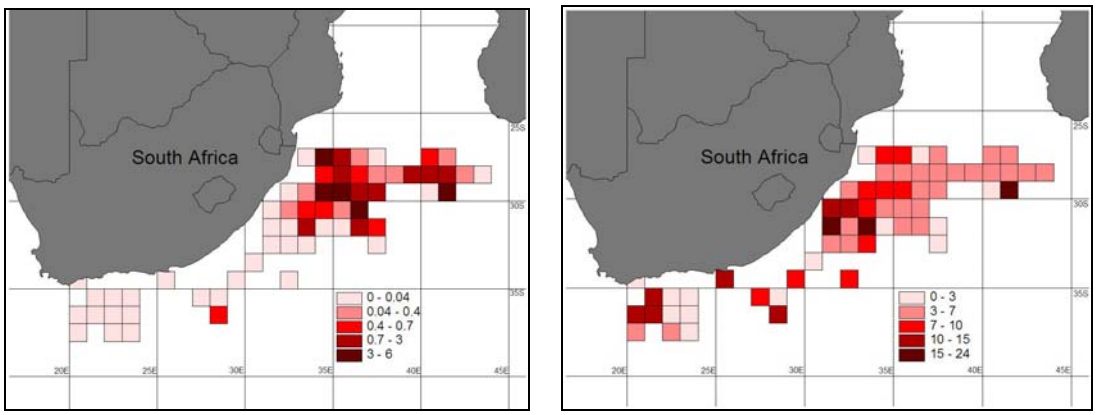


c) d)

Figure 4: Distribution of catch rates of a) Blue, b) Mako c) crocodile & d) all sharks, caught by swordfish vessels operating in the Indian Ocean.

B) The tuna directed fishery

Asian vessel operating in South Africa primarily target tunas (mainly yellow-fin, bigeye and longfin). A total of 21 million hooks were set between 2000 and 2005, 14% were observed for seabird, turtle and shark bycatch (Table 5). Fishing occurs throughout the year although there is an increase in effort in the winter. Most effort is concentrated on the Agulhas Bank and continental shelf, but vessels do venture beyond the EEZ into oceanic waters (Fig 5).

Trips are generally 45 days in length and consist of an average of 40 sets per trip. The mainline is made up of monofilament and is usually approximately 70 miles long. There are on average 234 (range 80–380) buoys on the line spaced approximately 439 m (range 150–486 m) apart. There are approximately ten (range 6-17) droppers between each buoy. Each dropper is on average 37 m (range 6-216m) long. Attached to each dropper is a hook totalling approximately 2500 (range 1000-3800) hooks per line.

Table 5: Summary of Tuna effort

Year	Summer		Autumn		Winter		Spring		Total	
	Hooks	% obs	Hooks	% obs	Hooks	% obs	Hooks	% obs	Hooks	% obs
2000	625,631	0%	332,296	0%	8,212,969	0%	1,993,762	0%	11,164,658	0%
2001	457,570	0%	1,257,784	0%	2,572,140	0%	1,496,883	129%	5,784,377	1%
2002	136,700	13%	280,980	0%	746,020	0%	0	0%	1,163,700	2%
2003	0	0%	0	0%	0	0%	0	0%	0	0%
2004	166,370	0%	0	0%	774,478	6%	684,237	500%	1,625,085	5%
2005	201,006	100%	25,620	100%	1,336,198	100%	1,255,572	100%	2,027,596	100%
Total	1,587,277	14%	1,896,680	135%	13,641,805	10%	5,430,454	25%	21,765,416	14%

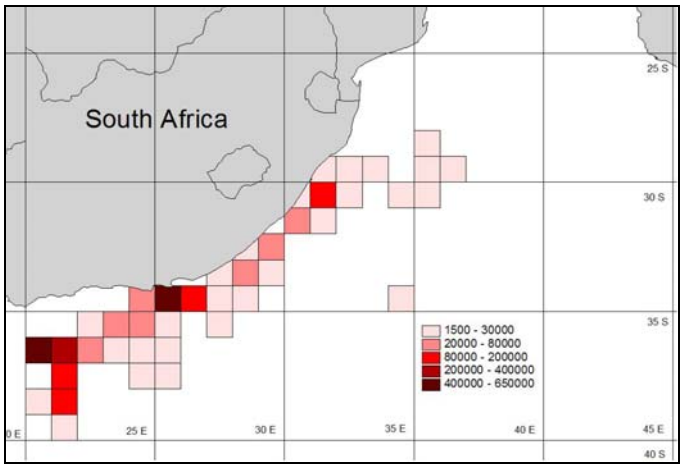


Figure 5: Observer effort on Tuna vessels operating in the Indian Ocean

Seabirds

Seabird bycatch comprised of 56.3 % white-chinned petrels, 13.3% shy albatross, 2.9% black-browed albatross, 1.9% yellow-nosed albatross, and the remaining 25% is made up of a number of species. Although catch rate varied by season and year, it averaged 0.5 birds/1000 hooks (0.1 albatrosses/1000 hooks and 0.3 petrels/1000 hooks) (Table 6). High catch rates were experience along the continental shelf, although catch rates 0.02 occurred in oceanic water further off shore (Fig 6).

Table 6: Catch rates of a) albatrosses, b) petrels & c) all seabirds, caught by tuna vessels operating in the Indian Ocean.

a)

Year	Summer	Autumn	Winter	Spring	Total
1999	*	*	*	0.00	0.00
2001	*	*	*	0.00	0.00
2002	0.00	*	*	*	0.00
2004	*	*	0.02	0.12	0.06
2005	0.02	0.08	0.14	0.11	0.12
Total	0.02	0.08	0.13	0.11	0.11

b)

Year	Summer	Autumn	Winter	Spring	Total
1999	*	*	*	0.00	0.00
2001	*	*	*	0.00	0.00
2002	0.00	*	*	*	0.00
2004	*	*	0.13	0.18	0.15
2005	0.15	0.12	0.33	0.31	0.31
Total	0.14	0.12	0.33	0.29	0.29

c)

Year	Summer	Autumn	Winter	Spring	Total
1999	*	*	*	0.00	0.00
2001	*	*	*	0.00	0.00
2002	0.00	*	*	*	0.00
2004	*	*	0.15	0.29	0.21
2005	0.18	0.20	0.68	0.42	0.53
Total	0.16	0.20	0.66	0.40	0.50

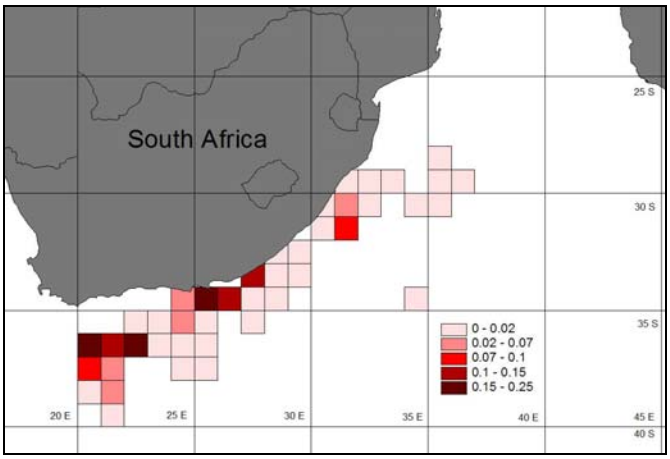


Figure 6: Distribution of seabird mortality and catch rate observed on tuna vessels operating in the Indian Ocean

Turtles

Turtle bycatch comprised of 53% leatherback, 13% loggerhead and the remaining 33% unidentified. Although catch rate varied by season and year, it averaged 0.005 turtles/1000 hooks and a maximum of 0.1 turtles/1000 hooks in 2002 (Table 7). There was a trip that caught turtles at a rate of 1.7 turtles per 1000 hooks in oceanic waters between 30 and 31 south and 35 and 36 east (Fig 7).

Table 7: Catch rates of all turtles by Tuna vessels

Year	Summer	Spring	Winter	Autumn	Total
1999	*	0.000	*	*	0.000
2001	*	0.000	*	*	0.000
2002	0.111	*	*	*	0.111
2004	*	0.000	0.000	*	0.000
2005	0.000	0.003	0.007	0.000	0.005
Total	0.009	0.003	0.007	0.000	0.005

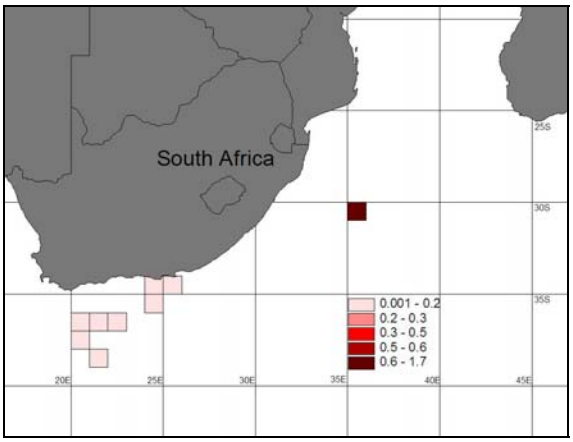


Figure 7: Distribution of catch rates of turtles caught by tuna vessels operating in the Indian Ocean.

Sharks

Shark bycatch comprised of 54% Blue, 33% Short-fin Mako, 5% Crocodile, 4% Thresher, 1% Bronze Whalers, and the remaining 3% were unidentified. Although catch rate varied by season and year, it averaged 2.7 sharks/1000 hooks (1.5 blue sharks/1000 hooks, 0.1 crocodile sharks/1000 hooks and 0.9 mako sharks/1000 hooks) (Table 8). Blue and mako sharks were caught throughout the fishery. Crocodile sharks were only caught in the open ocean between 28 and 29 degrees south and 43 and 44 degrees east (Fig. 8).

Table 8: Catch rates of a) Blue, b) Mako c) crocodile & d) all sharks, caught by tuna vessels operating in the Indian Ocean.

a)

Year	Summer	Autumn	Winter	Spring	Total
1999	*	*	*	0.36	0.36
2001	*	*	*	0.21	0.21
2002	1.56	*	*	*	1.56
2004	*	*	1.45	1.49	1.47
2005	1.04	3.43	1.80	1.24	1.51
Total	1.08	3.43	1.79	1.20	1.48

b)

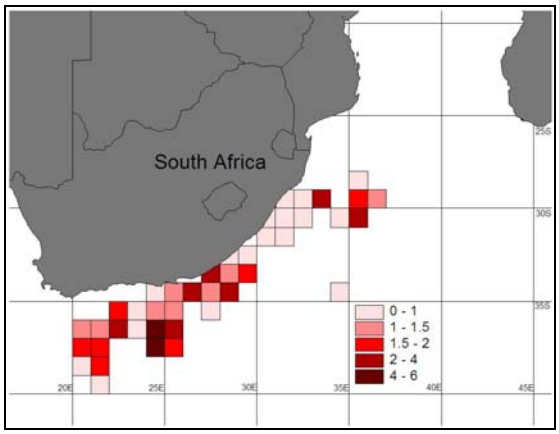
Year	Summer	Autumn	Winter	Spring	Total
1999	*	*	*	0.40	0.40
2001	*	*	*	0.57	0.57
2002	0.22	*	*	*	0.22
2004	*	*	0.80	1.11	0.93
2005	1.05	0.86	0.94	0.86	0.91
Total	0.99	0.86	0.94	0.85	0.90

c)

Year	Summer	Autumn	Winter	Spring	Total
1999	*	*	*	0.00	0.00
2001	*	*	*	0.00	0.00
2002	17.94	*	*	*	17.94
2004	*	*	0.00	0.00	0.00
2005	0.06	0.00	0.04	0.02	0.03
Total	1.53	0.00	0.04	0.02	0.14

d)

Year	Summer	Autumn	Winter	Spring	Total
1999	*	*	*	0.84	0.84
2001	*	*	*	0.88	0.88
2002	22.33	*	*	*	22.33
2004	*	*	3.62	3.80	3.69
2005	2.50	4.57	2.92	2.32	2.64
Total	4.13	4.57	2.95	2.28	2.74



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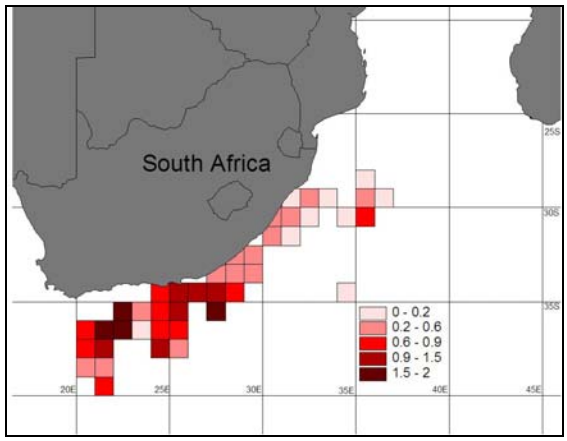

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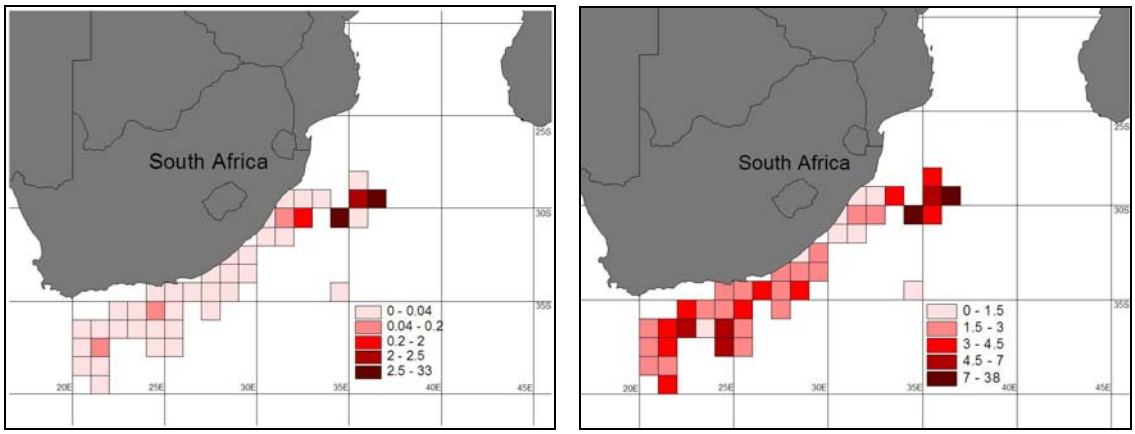

Figure 8: Distribution of catch rates of a) blue, b) mako c) crocodile & d) all sharks, caught by tuna vessels operating in the Indian Ocean.

Discussion

Given the high fishing effort in the Southern Indian Ocean bycatch rates of seabirds reported in this study are likely to result in a significant numbers of birds being killed each year. Measures to reduce seabird bycatch are a condition of the fishing permits in South Africa. Namely;

1. The vessel should have onboard a bird-scaring line (tori line), which must be flown during setting of each longline. A bird-scaring line must achieve at least 150 m aerial coverage. It needs to be attached to the vessel at least 7 m above sea level, be at least 150 m long, have at least 28 paired streamers spaced 5 m apart (starting 10 m astern the vessel) and have sufficient drag (e.g. buoy, road cone or sea-anchor).

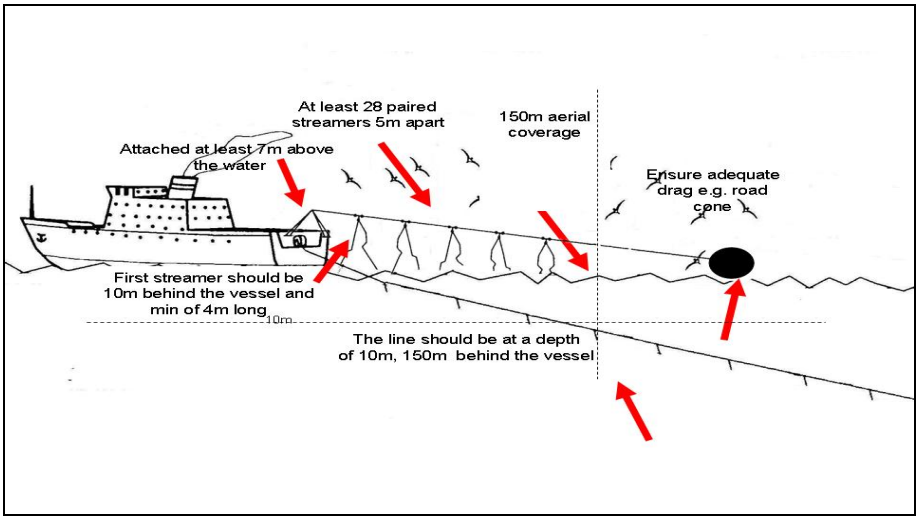

Figure 9: Tori or bird-scaring line specifications

The effect of tori or bird-scaring lines was investigated in the South African swordfish fishery and found that 92% of all birds killed were caught by vessels not

using the mitigation measure. They are thus extremely effective at reducing seabird bycatch.

2. Offal dumping shall take place on the opposite side of the vessel from that on which lines are hauled. No dumping of offal may take place during setting.
3. Deck lighting should be kept to a minimum, without compromising safety. All deck lights should be shaded in such a way that the beam is directed down towards the deck.
4. All bait must be appropriately thawed, and where necessary, the swim bladder punctured to ensure rapid sinking of bait.
5. All birds and turtles caught alive on the haul should be released
6. Observers on board shall bring back whole specimens of all seabirds killed during longline fishing operations. Vessels without observers are also required to bring all seabirds, which are killed (or their heads, feet, bands) in longlining operations to port
7. Setting may only take place at night (i.e. between nautical dusk and dawn)
8. Both the main line and branch lines (snood) must be properly weighted to ensure optimal sinking rates (approximately 0.3 m/sec or to reach a depth of 10m, 150m behind the vessel)

Line sink rate trials were conducted on South African Swordfish vessels. These trials investigated three experimental groups namely, unweighted branchlines, one 60 g weight and two 60g weights. Each achieved an average sink rates of 0.12, 0.24 and 0.30 m/sec respectively. Thus, only branchlines weighted with two 60 g weighted swivels sank at the desired rate of 0.3 m/sec (fig 3). An ANOVA revealed a significant difference between experimental groups (F-686.4, p=0.0000). The "one weight" group sank significantly faster than the "no weight" group (p=0.0001). However there was no statistically discernable difference between the use of one 60 g swivel and two (p=0.2). The experimental group with no weights never reached the ideal line sink rate of 0.29 m/s. The group using one 60g weight reached this rate 7 out of 21 sets and the group using two 60g weights obtained the ideal line sink rate 9 of 21 sets.

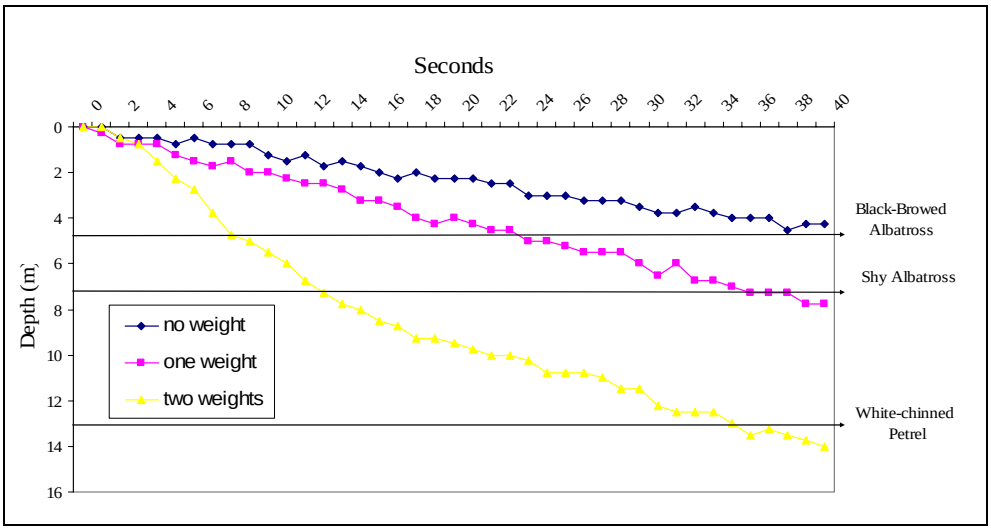

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Figure 10: Results of line sink rate trials conducted on South African swordfish vessels.

Line sink rate trails in the tuna directed fishery revealed that the sinks at an average rate of 0.12m/sec. Slow sink rates will increase the time the hook is within the reach of the birds and thus increase the numbers of birds caught.

Conclusions

1. Seabird catch rates in both fisheries are higher than the FAO recommended 0.05 birds/1000 hooks and thus are of concern.
2. Given their vulnerability turtle bycatch rates are likely to be significant and may warrant further investigation.
3. Tori or bird-scaring lines should be deployed on all vessels (i.e. tuna and swordfish vessels) operating south of 27 degrees.
4. An independent observer programme collecting verifiable seabird, turtle and shark data is essential for understanding this issue within IOTC.