Seabird bycatch in swordfish longline fisheries worldwide

BirdLife International

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Abstract
Gear configurations for vessels targeting swordfish have several features which enhance buoyancy (e.g monofilament line, light sticks, squid bait), resulting in hooks taking longer to sink and a greater zone behind the vessel where there is risk of seabird bycatch. This paper reviews seabird bycatch data from swordfish fisheries from the Southern Indian Ocean and elsewhere. While results from other regions cannot be assumed to apply equally to the swordfish fisheries in the Southern Indian Ocean, the results indicate potentially significant levels of seabird bycatch. The paper outlines some ways forward to address the issue.

Background
Nineteen of the world's 21 albatross species are globally threatened with extinction (IUCN 2004, BirdLife 2004a), and incidental catch in fisheries, especially longline fisheries, is recognised as one of the principal threats to many of these species (Brothers 1991, Robertson & Gales 1998; Croxall *et al*. 1998; Baker *et al*. 2002). The IOTC area includes around 21% of the global breeding distribution of albatrosses and petrels (BirdLife 2004b). Remote tracking data indicate that birds are concentrated in the southern part of the IOTC area below 30ºS (BirdLife 2004b, Small 2005). The Southern Indian Ocean is also an important area for juvenile and non-breeding birds migrating from the South Atlantic and South Pacific. In 2006, IOTC passed a seabird resolution which requires the use of a tori line south of 30ºS, with an exemption for vessels targeting swordfish using the 'American Longline System'[1] and line casting machines.

IOTC swordfish fisheries south of 30ºS
IOTC longline fishing effort below 30ºS has amounted to 75-100 million hooks in recent years. Swordfish amounts to over 50% of the total reported catch in weight by vessels fishing south of 30ºS (other principal fish species are albacore and big-eye tuna), though not all of this was from vessels that were targeting swordfish.

Swordfish gear configurations
Vessels targeting swordfish mostly fish during the night, and tend to set hooks in the late afternoon, at dusk, or after sunset. Increasingly, lines are made of light monofilament materials (Ward & Elscott, 2000). Lines are set shallow, typically with only 4-5 hooks between each float. Baits are usually squid, also mackerel, and light sticks are often used. Light sticks and squid are buoyant (squid often having pockets of air trapped beneath the mantle, Cousins *et al* 2000). In addition, branch lines may be 15-45m long (Ward & Escott 2000). As a result of these features, swordfish gear configurations are typically buoyant, increasing the time taken for hooks to sink. Swordfish vessels may have a 150m zone behind them in which seabirds are vulnerable, compared to a 10-15m zone for deep-setting tuna vessels (Gates 2001).

> *"When monofilament longlines are set shallow, with floatation aided by light sticks and bait, in proximity to a large population of albatrosses, then, without mitigation measures, bird takes are likely to be extensive." (Cousins et al 2000)*

Seabird bycatch data
Data from around the world indicate varying but high levels of seabird bycatch in swordfish fisheries (**Table 1**). In the US West Coast pelagic longline fishery, seabird bycatch by swordfish vessels was 60 times higher than seabird bycatch by tuna vessels (Cousins *et al* 2000).

[1] The resolution defines "American longline system" as the use of light monofilament gear components for both mainline and droplines, incorporating light sticks

Seabird bycatch data from vessels targeting swordfish in the Southern Indian Ocean are mixed. In two recent studies on Spanish research vessels (Ariz *et al* 2005, García-Cortés & Mejuto 2005), seabird bycatch was very low (< 0.001 birds per 1000 hooks). Vessels were using monofilament gear and light sticks, but no mitigations measures. In contrast, data from the South African observer program indicates higher rates of seabird bycatch in swordfish fisheries in the Southwest Indian Ocean (0.1 birds/1000 hooks, Petersen 2006), despite the requirements for use of mitigation measures on these vessels, including use of tori lines.

Further information would be valuable on the methods used to collect seabird bycatch data in the Spanish studies, including whether the observer was observing hooks as they were hauled onboard the vessel, or from inside the vessel in the fish processing area. Studies have found that around 30% of seabirds observed caught during setting are not hauled aboard (Brothers 1991, Gilman *et al* 2003a), due to for example becoming dislodged from the hook during hauling or being predated upon, and in one study it was estimated that 95% of birds hauled aboard were cut off prior to reaching the fish processing area (Gales *et al* 1998).

Data from Hawaii also highlight the effectiveness of seabird bycatch mitigation measures in reducing seabird bycatch in swordfish fisheries (**Table 2**), with experiments recording an 80-100% reduction in seabird bycatch rates on swordfish vessels using mitigation measures such as setting hooks at night, streamer (tori) lines, 60g weights on branch lines, blue-dyed bait and strategic discharge of offal.

Discussion

The available data from swordfish fisheries from the Southern Indian Ocean and elsewhere highlight three issues.

First, in some regions of the world, the American Longline System is a method associated with high seabird bycatch rates. Light sticks, long branch lines, light monofilament gear and squid bait increase buoyancy and decrease hook sink rates, which can increase the risk of seabird bycatch. It is BirdLife International’s view that the current exemption in the IOTC 2006 seabird resolution for swordfish vessels using the ‘American Longline system’ should be removed. In the US, the use of a tori line on swordfish vessels was found to reduce seabird bycatch by 80% (McNamara *et al* 1999). Data from South Africa indicate that over 90% of seabird bycatch on observed swordfish vessels was on vessels that were not using tori lines (Petersen 2006).

Secondly, a number of mitigation measures exist, in addition to tori lines, which can be used to reduce seabird bycatch. The prime example is the fact that swordfish vessels typically fish at night, and setting hooks at night is a common strategy employed and recommended to reduce bycatch of albatrosses. Nevertheless, and it is important that hooks are set at night, not in the afternoon, dusk or at sunset, when albatross mortality can be high or even higher than during the day (Melvin & Robertson, 2000). In addition, the effectiveness of night-setting is reduced by moonlight and in summer it may also be almost practically impossible for swordfish vessels to set in true darkness. Further, night setting may not reduce the bycatch of some petrel and shearwater species such as White-chinned petrel *Procellaria aequinoctialis*, which are active at night. As such, BirdLife International’s view is that night-setting (hooks set in true darkness) can be an effective measure to reduce seabird bycatch, but should be combined with use of a tori line, or other technique. Other measures for consideration include dyed baits, weighted branch lines (need to be designed with fisher safety in mind) and strategic offal discharge. Other measures currently being tested include underwater setting tubes, side setting and a bait pod which encloses the hook until release at a prescribed depth, and which may also be effective in reducing turtle bycatch.

Thirdly, the data emphasise that seabird bycatch data has a high degree of variability from one study to another. In part this reflects the stochastic nature of seabird bycatch, but also the significant effect of small differences in gear configuration, and differences in methods of data collection by observers. The IOTC’s plan to develop standardized methods for recording bycatch within IOTC longline fisheries will be of great value in helping to remedy this variability.

Table 1. Seabird bycatch data from swordfish fisheries worldwide

Region	Fishery	Gear type	Bait	Mitigation measures	Time of set	Depth	Date	Seabird CPUE	Hooks observed	Notes	Reference
Brazil	Brazilian pelagic longline	Monofilament American model. Light sticks.	Squid (occasional sardines, mackerel)	None?	Sunset or afternoon (Azevedo 2003)	45-80m		**0.09** **0.75** **1.35**	?	Review of 3 studies. Wide variation probably due to larger spatial and temporal scope in first study	Olmos *et al* 2000
US Hawaii	US pelagic longline fleet based in Hawaii	Monofilament American Longline system. 4-6 hooks between floats. Light sticks.	Squid	None	'Night'	30-90m	1994-2002	**0.26**	406,266	Data from NMFS observers	NMFS Southwest Fisheries Science Center. Cousins *et al* 2000
US West Coast	US pelagic fleet based in California	Monofilament American model. 4-5 hooks between floats, 60-80g weights on branch lines. Light sticks.	Squid	Weights on branch lines (No line casting machine). Dyed baits on most vessels.	Late afternoon or twilight	5-60m	2001-2003	**0.29**	210,360	Data from NMFS observers.	NMFS Southwest Fisheries Science Center
South Africa	South African pelagic fleet	Avg 5 hooks between floats, 60-80g weights on branch lines. Light sticks. Most (90%) no line shooter.	Mostly squid (some fish bait , <10%)	Required to set at night, use tori lines and weighted branch lines. Not always compliant.	Twilight or night		2000-2005	**0.1**	405,000	South Africa observer program.	Petersen 2006
SW Indian Ocean	Spanish pelagic longline	Monofilament American model. Light sticks.	Squid and mackerel	None	Dusk (4 pm)	40-90m	2004-2005	**0.00**	257,280	Experiment on bait/hook type. Fishing area 25-35ºS	Ariz *et al* 2005
Indian Ocean	Spanish pelagic longline	Monofilament American model. Light sticks.		None			2001-2003	**0.002**	626,400	Fishing area 10-35ºS	García-Cortés & Mejuto 2005
SE Pacific	Spanish pelagic longline	Monofilament. American longline system	Squid or mackerel	None			2002	**0.09**	Approx. 111,000	Data from Chilean-Spanish observer exchange program.	Mejuto *et al* 2003

Table 2. Albatross interaction rates for seabird avoidance methods tested in North Pacific Ocean pelagic longline swordfish and tuna fisheries. Table reproduced from Gilman *et al* 2005.

Interaction rates are expressed normalized for seabird abundance (expressed as contacts or captures per 1000 hooks per bird) and without normalizing for bird abundance (expressed in parentheses as contacts or captures per 1000 hooks). Percent reductions are based on the normalized rates unless noted otherwise.

Study[1]	Treatment	Contact rate	Contact reduction (%)	Capture rate	Capture reduction (%)
McNamara *et al.* (1999)	Control[2]	32.8 (265.7)[3]		2.23 (18.0)	
Hawaii longline swordfish gear	Blue-dyed bait	7.6 (61.6)	77	0.12 (17.5)	95
	Towed buoy	16.1 (130.4)	51	0.26 (6.8)	88
	Offal discards	15.7 (124.7)	53	0.32 (2.3)	86
	Streamer line	15.7 (127.2)	52	0.47 (6.6)	79
	Night setting			(0.60)[4]	97[4]
Boggs (2001)	Control[2]	7.60 (313.5)[3,5]			
Hawaii longline swordfish gear	Blue-dyed bait	0.43 (20.5)[5]	94		
	Streamer line	1.82 (93.4)[5]	76		
	Additional 60 g weight at bait	0.61 (25.0)[5]	92		
Gilman *et al.* (2003a)	Control[2]	0.61 (75.93)		0.06 (4.24)	
Hawaii longline tuna gear	Underwater setting chute 9 m	0.03 (1.85)	95	0.00 (0.00)	100
Boggs (2003)	Control[2]	0.78 (27.1)		0.058 (2.0)	
Hawaii longline swordfish gear	Night setting	0.053 (4.8)	93	0.0013 (0.11)	98
	Night setting and blue-dyed bait	0.01 (0.98)	99	0.00 (0.00)	100
Gilman *et al.* (2003b),	Underwater setting chute 9 m	0.30 (5.0)		0.03 (0.6)	
Hawaii longline swordfish gear	Blue-dyed bait	2.37 (64.9)		0.08 (1.8)	
	Side-setting	0.08 (1.9)		0.01 (0.2)	
Gilman *et al.* (2003b),	Underwater setting chute 9 m	0.28 (10.3)	82[6]	0.05 (1.7)	38[6]
Hawaii longline tuna gear	Underwater setting chute 6.5 m	0.20 (5.6)	87[6]	0.01 (0.5)	88[6]
	Blue-dyed bait	0.61 (23.8)	60[6]	0.03 (1.2)	63[6]
	Side-setting	0.01 (0.1)	99[6]	0.00 (0.0)	100[6]

1 Research has also been conducted by the Japan Fisheries Research Agency on the effectiveness of blue-dyed bait on reducing seabird interactions in Japan's longline tuna fishery in the western North Pacific Ocean (Minami and Kiyota 2002). Results were not published in a format that provides seabird interaction rates expressed as contact or capture per number of hooks or normalized rates for seabird abundance.

2 Control treatments in McNamara et al. (1999); Boggs (2001), Gilman et al. (2003a) and Boggs (2003) entailed conventional fishing operations with no seabird avoidance methods. Experiment conducted by Boggs (2003) set hooks during daylight hours.

3 The different contact rates observed by Boggs (2001) and McNamara et al. (1999) may be explained by the use of different definitions of what constituted a seabird contact. McNamara et al. (1999) counted the total number of times a seabird came into contact with gear near the hook, even if the same bird contacted the gear multiple times, while Boggs (2001) defined a contact where only one contact per bait was recorded as a contact regardless of whether a single bird contacted a bait multiple times.

4 This rate is not normalized for albatross abundance. McNamara et al. (1999) could not estimate seabird abundance during night setting. McNamara et al.'s (1999) control capture rate when not normalized for albatross abundance was 18.0 captures per 1000 hooks. Night setting reduced this control capture rate by 97%.

5 Contact rates are averages of rates reported by Boggs (2001) for Laysan and black-footed albatrosses.

6 Percent reductions use the control treatment contact and capture rates of Gilman et al. (2003a).

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