# Seabird bycatch rates in swordfish longline fisheries worldwide

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## 1. Introduction

The bird streamer line (or tori line) is one of the most widely adopted and accepted methods available to reduce the bycatch of seabirds in pelagic and demersal longline fisheries (Melvin *et al* 2004). In 2006, IOTC passed Resolution 06-04, requiring longline vessels in the Indian Ocean to use a tori line when operating south of 30º South. An exemption was made for vessels targeting swordfish using a line-throwing device and the 'American longline system', which was defined as the use of light monofilament gear for mainlines and branch lines plus light sticks. Resolution 06-04 was adopted pending further considerations of seabird bycatch mitigation measures at the IOTC Commission meeting in 2007.

At its meeting on 1st August 2006, the IOTC Working Party on Bycatch (WPBy) discussed the scientific basis for the exemption for vessels targeting swordfish using the American longline system, concluding that this exemption may not be warranted. This paper summarises relevant data made available to WPBy, and describes gear characteristics of the American longline system in relation to seabird bycatch.

**Summary:**

- **Monofilament gear has a lower specific gravity than traditional gear. Light sticks will further increase buoyancy. This is in contrast to seabird bycatch mitigation measures, which are primarily aimed at increasing the sink rate of hooks (or deterring birds from the hooks until they have sunk below the surface).**
- **Data from swordfish fisheries worldwide indicate varying but high levels of seabird bycatch.**
- **Data indicate that tori lines can effectively reduce seabird bycatch in swordfish fisheries. In addition, night-setting (between nautical dusk and nautical dawn), dyed baits and weighted swivels have also been shown to reduce seabird bycatch in swordfish fisheries, but are most effective when used in combination.**

## 2. Review of swordfish gear characteristics

Since the 1980s and 1990s, vessels targeting swordfish have increasingly used mainlines and branch lines made of monofilament materials. There has also been increasing use of light sticks, squid bait, longer branch lines and fewer hooks between floats (Hoey *et al* 1988) though these are not used by all swordfish fleets (Ward & Hindmarsh 2006). The combination of monofilament mainline and branch lines along with light sticks has been termed the 'American' or 'Florida' longline system (Hoey *et al* 1988; Ward & Elscott, 2000; Ward & Hindmarsh 2006). In comparison, traditional longline gear is associated with multifilament main lines (including kuralon), and branch lines made of sections of multifilament nylon, steel and/or monofilament (Hoey *et al* 1988).

The materials differ in their buoyancy. Nylon monofilament has a specific gravity of 1.14 compared to 1.3 for kuralon, 1.38 for polyester and 1.54 for cotton (Asia Oceanic Industries Inc., 2001). In addition, light sticks and squid are buoyant (squid often having pockets of air trapped beneath the mantle, Cousins *et al* 2000). As a result of these features, the American longline system (defined as use of monofilament and light sticks) is more buoyant than other gear types, increasing the time taken for hooks to sink (Cousins *et al* 2000, Gates 2001).

In contrast, seabird bycatch mitigation measures aim to keep hooks away from seabirds by, among other things, increasing hook sink rates (e.g. by adding weighted swivels to branch lines), and by deterring seabirds from the hooks until the hooks are at sufficient depth to be out of reach (e.g., Brothers 1995; Boggs 2001; Løkkeborg &

Robertson 2002; Gilman *et al*. 2003; Melvin 2003; Robertson 2003).

> *"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)*

## 3. Seabird bycatch data

A review of data available from around the world on seabird bycatch rates in swordfish fisheries indicate varying but high levels of seabird bycatch (**Table 1**). In the US West Coast pelagic longline fishery and Hawaiian longline fishery, seabird bycatch by swordfish vessels is higher than seabird bycatch by deep-setting tuna vessels (Cousins *et al* 2000; Gilman *et al* 2003).

Seabird bycatch data from vessels targeting swordfish in the Southern Indian Ocean are mixed. In a recent experiment on Spanish research vessels designed to assess seabird and turtle bycatch and the effects of bait and hook type, seabird bycatch was low (< 0.01 birds per 1000 hooks) (Ariz *et al* 2006). In contrast, data from the South African observer program operating in a similar area recorded much higher rates of seabird bycatch in swordfish fisheries in the Southwest Indian Ocean (0.1 birds/1000 hooks, Petersen & Honig 2006). The factors underlying the differences in seabird bycatch rates by these two fleets merits further investigation. However, both were using the American longline system and setting lines at dusk. Differences include the fact that the Spanish experimental vessel used 50% circle hooks and 50% of the bait (the squid bait) were dyed green. Offal discharge was also low. In addition, most South African vessels did not use a line shooter. Also of note in the datasets is the fact that the South African observer data found that 92% of the birds caught by swordfish vessels were caught by those not using tori lines.

Data from Hawaii also highlight the effectiveness of mitigation measures in reducing seabird bycatch in swordfish fisheries. The use of a tori line on swordfish vessels was found to reduce seabird interactions and bycatch by 75-80% (McNamara *et al* 1999; Boggs 2001). Data also indicate a 80-100% reduction in seabird bycatch rates on swordfish vessels using mitigation measures such as setting hooks at night, weighted swivels on branch lines and blue-dyed bait.

## 4. Discussion

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

First, the use of light monofilament gear and light sticks increases gear buoyancy. This buoyancy is in contrast to seabird bycatch mitigation measures, which aim to increase the sink rate of hooks or to deter birds from baited hooks until hooks have sunk beyond the diving depth of most seabird species.

Second, data from swordfish fisheries worldwide indicate varying but high levels of seabird bycatch.

Third, available data indicate that tori lines can effectively reduce seabird bycatch in swordfish fisheries (e.g. McNamara *et al* 1999; Boggs 2001). In addition, other operational characteristics of swordfish fisheries exist which can be developed into seabird bycatch mitigation measures, and could be considered by the IOTC Commission meeting in May 2007. These measures include setting lines at night (between nautical dawn and dusk), use of weighted swivels on branch lines and use of dyed baits. Swordfish fisheries often set lines at night, and when hooks are set between the hours of nautical dusk and nautical dawn this is a measure which can substantially reduce bycatch of seabirds, particularly albatrosses. However, night setting is less effective during full moons, under intensive deck lighting, when setting takes place outside true darkness, and for some petrel species (e.g. Klaer & Polachek 1998, Baird 2001, Kiyota 2006, Peter Ward pers.comm.). As with all longline fisheries, optimal seabird bycatch mitigation in swordfish fisheries is likely to require a combination of mitigation measures, as already required or encouraged by South Africa, Hawaii, Australia and Taiwan (Neves et al 2006; FA COA 2005; Clemens 2006, Petersen & Honig 2006). Combinations of measures will also be considered by the Western and Central Pacific Fisheries Commission (WCPFC) in December 2006.

**Table 1. Seabird bycatch data from swordfish fisheries worldwide (bycatch rates not standardised for bird abundance). CPUE measured in birds caught per 1000 hooks**

| Region | Fishery | Target | Gear type | Bait | Mitigation measures | Time of set | Depth | Date | Seabird CPUE | Hooks observed | Notes | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Brazil | Brazilian pelagic longline | SWO | Monofilament American model. Light sticks. | Squid (occasional sardines, mackerel) | None? | Sunset or afternoon | 45-80m | | **0.09**<br>**0.75**<br>**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 | SWO | 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 Hawaii | US pelagic longline fleet based in Hawaii | SWO | | | Experiment:<br>Control<br>Tori line<br>Towed buoy<br>Dyed bait<br>Night setting<br>Offal discards | Dusk | | | <br>**18.0**<br>**6.6**<br>**6.8**<br>**17.5**<br>**0.6**<br>**2.3** | | Experimental testing of mitigation measures in swordfish fisheries | McNamara et al. 1999 |
| US Hawaii | US pelagic longline fleet based in Hawaii | SWO | | | Experiment:<br>Control<br>Night setting<br>Night setting & dyed bait | Daylight | | | <br>**2.00**<br>**0.11**<br>**0.00** | | | Boggs, 2003 |

| Region | Fishery | Target | Gear type | Bait | Mitigation measures | Time of set | Depth | Date | Seabird CPUE | Hooks observed | Notes | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| US Hawaii | US pelagic longline fleet based in Hawaii | SWO | Monofilament American longline system. Light sticks. 60g weighted swivels. 4 hooks between floats. | Squid | Experiment:<br>Control<br>Tori line<br>Dyed bait<br>Weighted swivel 60g | Day | ~ 40m | Feb 1999 | **7.60**<br>**1.82**<br>**0.43**<br>**0.61** | 6,336 | * Experiment recorded seabird interaction rates not seabird capture. Data shown have been standardised for bird abundance. | Boggs 2001 |
| US Hawaii | US pelagic longline fleet based in Hawaii | SWO | Monofilament. Light sticks (not lit), line shooter, 19 hooks between buoys, wire leader | 80% squid | Underwater setting chute<br>Dyed bait<br>Side-setting | Day | >100m. Deeper than average sword-fish set | Apr-May 2003 | **0.6**<br>**1.8**<br>**0.2** | | Lines set during day and set deep, to minimise bycatch & increase contact observations | Gilman *et al* 2003 |
| US West Coast | US pelagic fleet based in Cali-fornia | SWO | 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).<br>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 |
| SE Pacific | Spanish pelagic longline | SWO | 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 |

| Region | Fishery | Target | Gear type | Bait | Mitigation measures | Time of set | Depth | Date | Seabird CPUE | Hooks observed | Notes | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| South Africa | South African pelagic fleet | SWO | Generally monofilament. Average 5 hooks between floats, 60-80g weights on branch lines. Light sticks. Most without line shooter (90%). | Mostly squid (some fish bait , <10%) | Required to set at night, use tori lines and weighted branch lines. Not always compliant. | Twilight or night | | 1998-2005 | **0.1** | 405,000 | South Africa observer program. 25-45ºS and 20-45ºE | Petersen & Honig 2006 (IOTC-2006-WPBy-15) |
| S. Indian Ocean | Spanish pelagic longline | SWO | Monofilament American model. Light sticks. | | None | | | 2001-2003 | **0.002** | 626,400 | Fishing area 10-35ºS and 35-110ºE | García-Cortés & Mejuto 2005 (IOTC-2005-WPBy-14) |
| S. Indian Ocean | Spanish pelagic longline | SWO | Monofilament American model. Light sticks. | Squid and mackerel (experimental configuration) | Experiment with 50% circle hooks, 50% J hooks; 50% green dyed squid, 50% mackerel; low offal discharge | Dusk 7pm local time | 40-90m | 2004-2005 | **0.006** | 531,916 | Experiment on bait/hook type. Fishing area 25-35ºS and 30-50ºE | Ariz et al 2006 (IOTC-2006-WPBy-04) |
| SW Atlantic | Uruguay | SWO & Tuna | American longline system, monofilament mainline, lightsticks | Squid | Tori lines | Night | | 1998 - 2004 | **0.26** | 2,242,026 | | Jimenez 2005, Baird 2001, Jimenez & Domingo, 2006. |

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