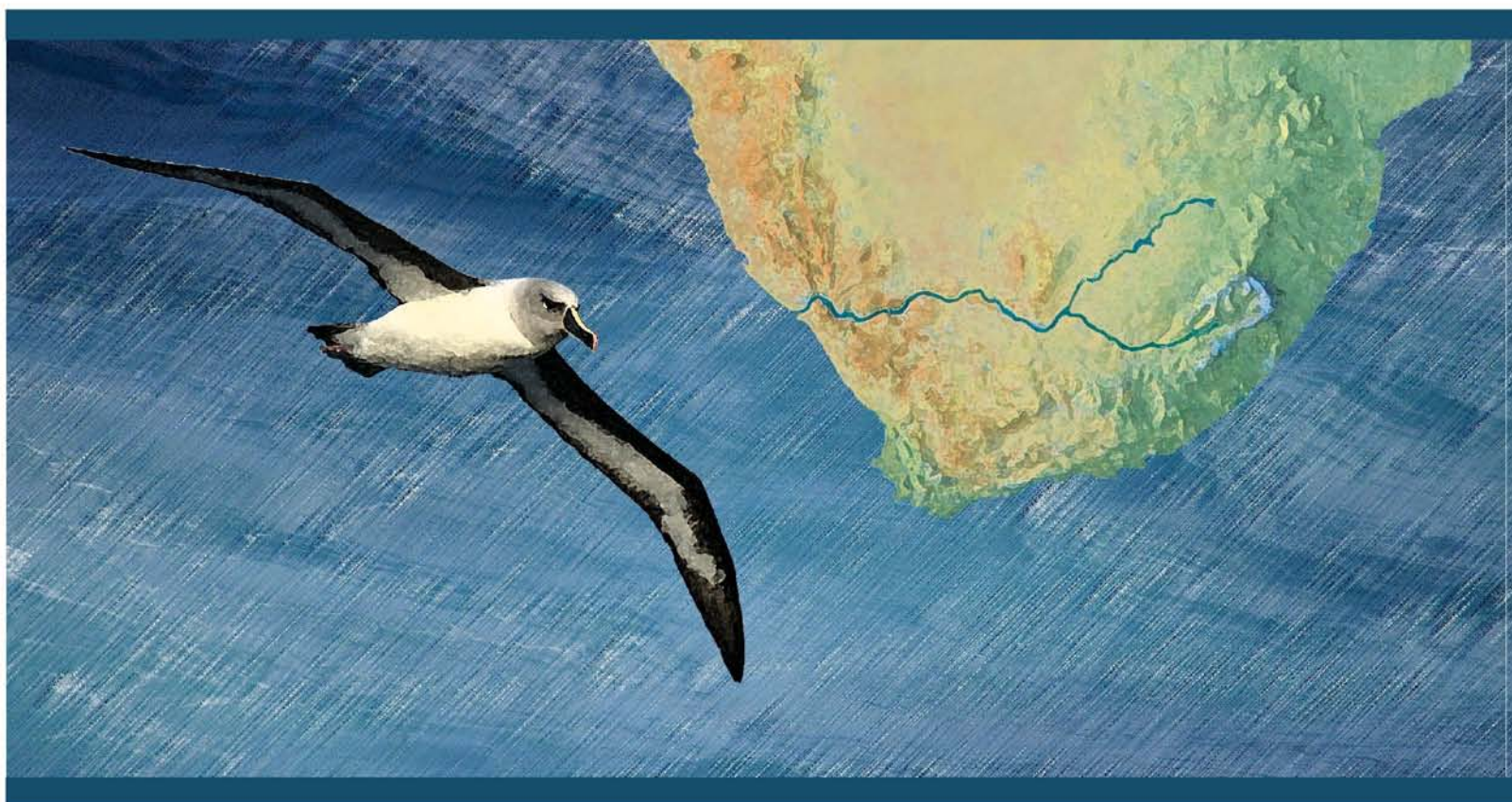


National Plan of Action for Reducing the Incidental Catch of Seabirds in Longline Fisheries



August 2008
South Africa

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**environment
& tourism**

Department:
Environmental Affairs and Tourism
REPUBLIC OF SOUTH AFRICA

SOUTH AFRICA

NATIONAL PLAN OF ACTION for Reducing the Incidental Catch of SEABIRDS in Longline Fisheries



Foreword



South Africa is committed to the Code of Conduct for Responsible Fisheries voluntarily agreed to by the Members of the United Nations Food and Agriculture Organisation (FAO). On the basis of the code of conduct, four International Plans of Action (IPOA) were developed. The IPOA is aimed at reducing the incidental catch of Seabirds in Longline Fisheries. FAO Members were encouraged to adopt and implement National Plans of Action (NPOA).

South Africa realises the many challenges facing seabirds, in a rapidly changing environment. In general a reduction in seabird populations has been observed. As part of our commitment to address this challenge, South Africa has commenced implementation of an Ecosystem Approach as such we are increasingly taking into consideration other elements of the ecosystem over and above fish species. Our country further introduced strict permit conditions in efforts to reduce the catch of seabirds by fishers. This National Plan of Action for Reducing the Incidental Catch of Seabirds in Longline Fisheries also known as the NPOA-Seabirds, further attests to our commitment to managing seabirds and fisheries responsibly.

A handwritten signature in black ink, which appears to read 'Nosipho Ngcaba'.

Ms Nosipho Ngcaba

Director-General

Department of Environmental Affairs and Tourism

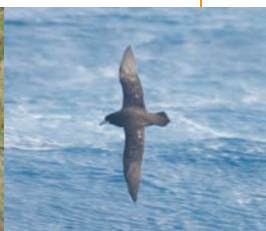
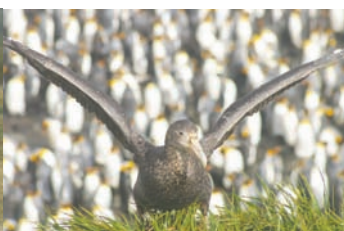
SOUTH AFRICA

August 2008



Table of Contents

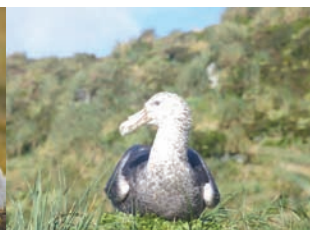
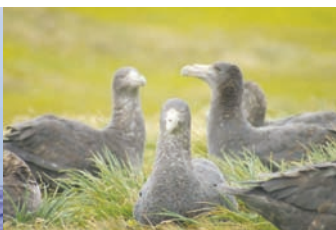
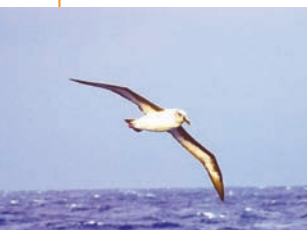
1.	Glossary of Acronyms	4
2.	Introduction	5
	Background	
	Overview of relevant fisheries	
	Seabird bycatch in South African fisheries	
3.	Current Mitigation of Incidental Catch of Seabirds	11
	Longline fisheries	
	Trawl fisheries	
	Fisheries monitoring programme	
4.	Legislation and Policy	18
	International	
	Regional	
	National	
5.	Actions	23
	Prescription of mitigation measures	
	Research and development	
	Education, training and publicity	
	Data collection	
	Addressing poor compliance	
	Conclusion	
6.	Acknowledgements	27
7.	Selected References	28
8.	Additional Reading	30
	Mitigation measures still under refinement: longline	
	Mitigation measures tested and found ineffective: longline	
	Future possibilities: longline	
	Mitigation measures still under refinement: trawl	
	Mitigation measures tested and found less effective: trawl	





I. Glossary of Acronymns

ACAP	Agreement for the Conservation of Albatrosses and Petrels
CCAMLR	Commission for the Conservation of Antarctic Marine Living Resources
CMS	Convention for Migratory Species
DEAT	Department of Environmental Affairs and Tourism
FAO	Food and Agriculture Organisation of the United Nations
ICCAT	International Commission for the Conservation of Atlantic Tunas
IOTC	Indian Ocean Tuna Commission
SEAFO	South East Atlantic Fisheries Organisation
UNCLOS	United Nations Convention on the Law of the Sea
UNFSA	United Nations Fish Stocks Agreement
WSSD	World Summit on Sustainable Development



2. Introduction



Background

Since the 1990s there has been global concern about the bycatch of seabirds in fishing operations, in particular longline and trawl fisheries (Brothers 1991, Bergin 1997, Croxall & Gales 1998, Nel et al. 2002, Sullivan et al. 2006, BirdLife International 2007). The incidental mortality of these species has been widely held responsible for the declining populations and threatened conservation status of several species (BirdLife International 2007). Seabirds have an economic value in terms of non-consumptive eco-tourism activities (Yorio et al. 2001, Garrod & Wilson 2003, Topelko & Dearden 2005). Because they breed on land and their populations can therefore be accurately monitored, seabirds are also indicators of the health of the ecosystem (Cherel & Weimerskirch 1995, Best et al. 1997).

The Benguela Upwelling System is one of the world's most productive systems, attracting millions of top predators such as seabirds (Shannon & Field 1985, Best 1997). Many of

these species travel thousands of kilometres, sometimes across oceans, to feed in its nutrient rich waters (Weimerskirch et al. 1999, Baker et al. 2007, Fretey et al. 2007). Not surprisingly, the Benguela Upwelling System also supports several large commercial fisheries operating within countries' Exclusive Economic Zones (EEZ) as well as on the high seas (Sauer et al. 2003). The spatial overlap of large numbers of top predators and large commercial fisheries in a confined area has the potential to lead to high and unsustainable catches of threatened species.

Table 1: List of species recorded by observers as being caught by longliners and trawlers.

Common Name	Scientific Name	IUCN Status
Shy/White-capped Albatross	<i>Thalassarche cauta/steady</i>	Near Threatened
Black browed Albatross	<i>Thalassarche melanophrys</i>	Endangered
Indian Yellow-nosed Albatross	<i>Thalassarche carteri</i>	Endangered
Atlantic Yellow-nosed Albatross	<i>Thalassarche chlororhynchos</i>	Endangered
Grey-headed Albatross	<i>Thalassarche chrysostoma</i>	Vulnerable
Southern Royal Albatross	<i>Diomedea epomophora</i>	Vulnerable
Northern Royal Albatross	<i>Diomedea sanfordi</i>	Endangered
Tristan Albatross	<i>Diomedea dabbenena</i>	Endangered
Wandering Albatross	<i>Diomedea exulans</i>	Vulnerable
Sooty Albatross	<i>Phoebastria fusca</i>	Endangered
Northern Giant Petrel	<i>Macronectes halli</i>	Near Threatened
Southern Giant Petrel	<i>Macronectes giganteus</i>	Vulnerable
White-chinned Petrel	<i>Procellaria aequinoctialis</i>	Vulnerable
Spectacled Petrel	<i>Procellaria conspicillata</i>	Critically Endangered
Cape/Pintado Petrel	<i>Daption capense</i>	Near Threatened
Great-winged Petrel	<i>Pterodroma macroptera</i>	Least Concern
Great Shearwater	<i>Puffinus gravis</i>	Least Concern
Flesh-footed Shearwater	<i>Puffinus carneipes</i>	Least Concern
Sooty Shearwater	<i>Puffinus griseus</i>	Near Threatened
Antarctic Prion	<i>Pachyptila desolata</i>	Least Concern
Wilson's Storm-petrel	<i>Oceanites oceanicus</i>	Least Concern
European Storm-petrel	<i>Hydrobates pelagicus</i>	Least Concern
Cape Gannet	<i>Morus capensis</i>	Vulnerable
Sub-Antarctic Skua	<i>Catharacta antarctica</i>	Least Concern
Kelp Gull	<i>Larus dominicanus</i>	Least Concern
Sabine's Gull	<i>Larus sabini</i>	Not listed



South African waters are of global importance for conserving seabirds. The coastal waters are a rich foraging area for albatross and petrel species, mainly as a result of fishing operations (Nel & Taylor 2002, BirdLife International 2007). A total 26 species has been recorded caught by South African fisheries, 13 of which are threatened with extinction (Table 1). Ryan et al. (2002) estimated that between 19 000 and 30 000 seabirds were killed per year by the South African pelagic longline fishery during 1998–2000. Barnes et al. (1997) evaluated seabird bycatch in the South African demersal longline fishery and estimated that approximately 8 000 White-chinned Petrels were killed in 1995. In general, these studies were based on limited sample sizes (108 and 12 sets, respectively) collected over short periods of time (Barnes et al. 1997, Ryan et al. 2002). More recently analysis of observer data from 1998–2005 revealed that approximately 2 900 (1 100–5 600) and 225 (range 220–245) birds are killed each year (2000–2005) (Petersen et al. 2008). Seabird bycatch in the Patagonian toothfish longline fishery decreased from 911 in 1996 to only three in 2002. Seabird bycatch was evaluated in the demersal trawl fishery (2004 and 2005) and a total of 18 000 (8 000–31 000) birds are estimated to be killed per year (Watkins et al. 2008), although there has been a significant reduction in hake trawl mortalities since the introduction of tori lines in August 2006 (Watkins, pers comm.).

Globally there is strong resolve to reduce the incidental mortality of seabirds both in terms of species conservation (CMS, ACAP) and fisheries management (WSSD, UNCLOS, UNFSA, FAO, ICCAT, IOTC and SEAFO). This sets the scene for national implementation. For seabirds, effective and relatively inexpensive methods of reducing the number of animals killed in these fishing operations have been developed (Alexander et al. 1997, FAO 1999, Melvin & Robertson 2000, Melvin et al. 2004). South Africa's commitment to address these issues is largely reflected in fisheries policy and permit conditions. However, implementation of these measures could be much improved. Efforts should be focused on raising awareness, compliance and bringing interested and affected parties together to identify solutions in a participatory manner.

This 2008 version of the National Plan of Action for Seabirds (NPOA-Seabirds) is an abridged and updated version of the draft NPOA-Seabirds of 2004, which is available on the FAO website at <ftp://ftp.fao.org>.

Overview of relevant fisheries

South Africa supports demersal and large pelagic fisheries within its continental EEZ: a demersal longline and trawl fishery targeting Cape hakes *Merluccius* spp. and pelagic longline fisheries targeting tuna *Thunnus* spp, Swordfish *Xiphias gladius* and sharks. South Africa also has a Patagonian toothfish, *Dissostichus eleginoides*, fishery operating in the vicinity of the Prince Edward Islands.

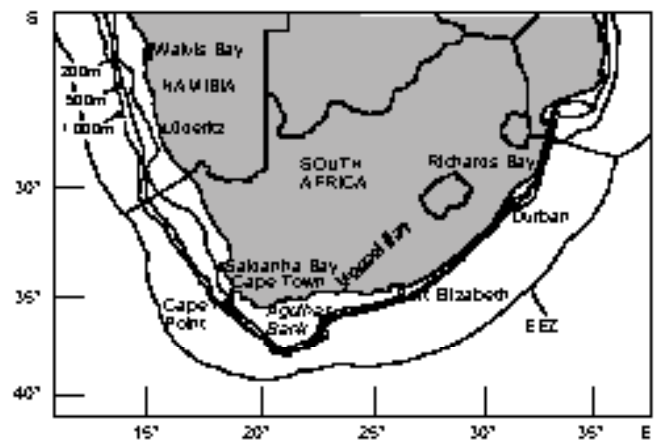


Figure 1: Map of South Africa's and southern Namibia's Exclusive Economic Zones, in relation to the 200 m, 500 m and 1 000 m isobaths.

PELAGIC LONGLINE FISHERY

The earliest record of a South African domestic pelagic longline fishery dates back to the early 1960s (Cooper & Ryan 2003). This fishery predominantly targeted Albacore *Thunnus alalunga*, Southern Bluefin *T. maccoyii* and Bigeye *T. obesus* Tunas (Cooper & Ryan 2003). Effort in the domestic fishery waned in the mid 1960s. Thereafter, pelagic fishing effort was largely conducted by Japanese and Taiwanese vessels under bilateral agreements with South Africa. These Asian vessels set their gear relatively deeply, frequently during the day, seldom used lightsticks and primarily targeted tuna species. Their fishing effort accounted for 96% of the approximately 12 million hooks set annually within the South African EEZ during 1998–2000 (Ryan & Boix-Hinzen 1998, Ryan et al. 2002). In 1995, a permit was issued to conduct a joint venture operation between a South African



and Japanese vessel. This joint venture showed that tunas and Swordfish *Xiphias gladius* could be exploited profitably in South African waters and consequently 30 experimental permits were issued in 1997 to South African flagged vessels. Vessels targeting Swordfish typically use the American longline system, set their gear relatively shallow, use lightsticks and set their lines primarily at night.

A policy decision was made in 2004 to expand and “South Africanise” the South African large pelagic longline fishery (DEAT 2004, 2005, 2007). This process commenced in 2002 when all foreign licences to target tunas and Swordfish in South African waters were withdrawn (DEAT 2004). This resulted in a smaller domestic fishery operating in South Africa’s EEZ. The domestic fishery was developed in 2004 when 50 (20 swordfish directed and 30 tuna directed) commercial fishing rights were made available for allocation (DEAT 2004, 2005, 2007). The rationale for this expansion was to improve South Africa’s catch history and thereby motivate for larger country allocations at Regional Fisheries Management Organisations (RFMOs), such as the International Convention for the Conservation of Atlantic Tunas (ICCAT) (South Africa is a member) and Indian Ocean Tuna Commission (IOTC) (South Africa is not a member, but a co-operating party) (Department of Environmental Affairs and Tourism (DEAT) 2004, 2005, 2007).

Since South Africa is not traditionally a tuna fishing nation, foreign flagged vessels were once again allowed into the fishery in 2005 on the following basis: a) South Africanisation and transformation would occur through a step-wise increase in employment of local crew; b) skills would be transferred to South African fishers; and c) all foreign flagged vessels would re-flag to South Africa in a period of one year (DEAT 2004, 2005, 2007). The element of re-flagging is being reviewed by the Department of Environmental Affairs and Tourism.

This fishery currently operates out of Cape Town, Durban and Richards Bay (Sauer et al. 2003, Fig 1). South African vessels typically undertake trips of 15 days’ and Asian vessels of 45 days’ duration. Fishing takes place predominantly on the continental shelf along the west coast and on the Agulhas Bank, although some fishing activity takes place off the east coast, especially in summer. Average annual fishing effort in 2005 was approximately 4 million hooks.

HAKE LONGLINE FISHERY

An experimental demersal longline fishery targeting Kingklip *Genypterus capensis* in the continental shelf waters around South Africa was initiated in 1983 (Japp 1993). Due to concern over the sustainability of the Kingklip resource the fishery was closed in 1990. In 1994, a five-year experimental longline fishery directed at Cape hakes *Merluccius capensis* (mainly inshore) and *M. paradoxus* (mainly offshore) was started. During this period the number of active vessels varied between 32 and 71 (Japp 1993, Japp & Wissema 1999). This fishery operates out of Cape Town, Mossel Bay and Port Elizabeth (Fig. 1) and typically undertakes trips of approximately six days in duration. In 1998, this fishery became commercial and has remained so until the present. Fishing typically takes place along the continental shelf along the western and southern coasts in depths of 100–600 m (Japp 1993, Japp & Wissema 1999). In 2007, the Total Allowable Catch (TAC) for hakes was 135 000 mt, divided between the trawl (90%), longline (6.6%) and handline (3.4%) sectors (Brandao et al. 2002, Butterworth & Rademeyer 2005, DEAT 2005b).

PATAGONIAN TOOTHFISH LONGLINE FISHERY

Experimental longline fishing by five South African-flagged vessels for Patagonian toothfish commenced within the Prince Edward Islands’ EEZ in October 1996 after observations and reports of considerable illegal fishing. It has been estimated that Illegal, Unreported and Unregulated (IUU) fishing vessels removed over 26 000 tonnes of toothfish from the Prince Edward Islands EEZ in the five-year period from July 1996 to June 2001, with as many as 13 IUU vessels operating at one time. In 1996, a quota of 1200 tonnes was divided equally among five licensed vessels and 1663 tonnes were caught. A quota of 2500 tonnes, or 500 tonnes a vessel, was set for the 1996/97 CCAMLR (Commission for the Conservation of Antarctic Marine Living Resources) fishing season. The vessel quota was thereafter reduced in stages to 450 tonnes for the whole EEZ for the 2000/01 season. During the short history of this fishery the total catch and catch per unit effort have both dropped dramatically and fish size caught has been reduced, as has the licensed catch quota.



Fishing takes place within the 200-nautical mile Exclusive Economic Zone surrounding the Prince Edward Islands (falling within FAO Fishing Area 51, Subareas 58.6 and 58.7 and Division 58.4.4). Longlining is concentrated on sea mounts with depths generally not exceeding 1500 m. At times, South African flagged vessels have fished outside the EEZ in FAO Subarea 58.6 and Area 51. Most vessels used the single-line system with autobaiters. One vessel used the Spanish (double-line) hand-baited system.

DEMERSAL TRAWL FISHERY

The demersal trawl fishery for hake is the most valuable fishery in South Africa (FAO 2001) and comprises two sectors: an offshore, deep-sea sector and an inshore sector (Payne 1989). Seabird bycatch is considered to be negligible in the inshore sector. The offshore trawl fishery started in the 1890s, mainly targeting Agulhas *Austroglossus pectoralis* and West Coast *A. microlepis* sole (Payne 1989). In the mid 1940s, annual catches were 1 000 t, which increased to 50 000 t by 1950 and had reached 115 000 t by 1955 (Sauer et al. 2003).

During the 1960s, foreign vessels entered the fishery and catches escalated to a million tonnes per year. The International Commission for the Southeast Atlantic Fisheries (ICSEAF) was established in 1972, to investigate and control the international fisheries for hake off South Africa and Namibia (Sauer et al. 2003). Most hake caught were juvenile fish and in 1975 the minimum mesh size was increased from 102 to 110 mm.

Between 1977 and 1992 the stocks collapsed. South Africa declared its 200 nautical mile (nm) EEZ in 1977 which reduced the number of foreign trawlers operating in South African waters by 25% (Sauer et al. 2003). Individual quotas were first granted in 1979, the bulk being allocated to the two major companies. In 1985 a policy was introduced to broaden access to the fishery, resulting in the number of participants increasing from seven in 1986 to 21 in 1992.

Post 1992 saw major changes in quota allocations and the entry of new participants from previously disadvantaged communities (Sauer et al. 2003). The number of participants in the deep-water sector increased to 56 in 2000. In 2005 there were 79 vessels in the fleet which undertook approximately 60 000 trawls. The CPUE decreased fourfold from 1955 to

1997 (Sauer et al. 2003). Vessels operate mostly out of Cape Town and Saldanha Bay (near Cape Columbine) and typically undertake 6 day trips.

Seabird bycatch in South African Fisheries

PELAGIC LONGLINE FISHERY

Twelve species of seabird have been confirmed incidentally caught by this fishery, nine of which are considered threatened. Data from 1998-2005 show that birds were caught at an average rate of 0.44/1000 hooks, resulting in an average of 2 900 birds killed per year decreasing from approximately 5 900 in 1998 to 1 800 in 2005 (Petersen et al. 2008). Three techniques for extrapolating total seabird mortality were investigated and little difference between estimates found. White-chinned Petrels *Procellaria aequinoctialis* were caught most commonly (68.9%) at a rate of 0.30/1000 hooks (1 650 killed each year).

Albatrosses made up 30.3% of the bycatch or 0.14/1000 hooks. Three species were recorded in significant numbers: shy-type (mostly White-capped *Thalassarche steadi*) (0.09/1000 hooks, 600 per year), Black-browed *T. melanophrys* (0.02/1000 hooks, 125 per year) and Indian Yellow-nosed Albatrosses *T. carteri* (0.01/1000 hooks, 85 per year) (Petersen et al. 2008). Generalised linear models were used to explain bycatch patterns and revealed that individual vessel is the most important explanatory variable, followed by vessel flag, moon phase, season, sea state, the use of a tori line, time of set, area and bathymetry (Petersen et al. 2008). Most birds (88%) were caught by Asian flagged tuna directed vessels (72% of albatrosses and 97% of petrels). Asian tuna directed vessels caught seabirds at a rate of 0.51/1000 hooks (0.58/1000 hooks in winter and 0.14/1000 hooks in summer) compared to South African swordfish directed vessels which caught seabirds at a rate of 0.23/1000 hooks (0.22/1000 hooks in winter and 0.24/1000 hooks in summer) (Petersen et al. 2008).

More birds were caught during full moon (1.07/1000 hooks) compared to new moon (0.09/1000 hooks). Albatrosses were mainly caught on the Agulhas Bank and along the continental



shelf, especially in the Atlantic Ocean. Petrels, especially White-chinned Petrels, were caught on the Agulhas Bank, but had a higher catch rate along the east coast of South Africa (Petersen et al. 2008). Although there were subtle differences between species, all species were more likely to be caught in the austral winter and spring (June to October). Estimates of the numbers of birds killed per year are lower than previous studies. The improvement was most likely linked to the termination of the foreign bilateral agreements, as well as improved awareness among fishers linked to ongoing education campaigns. Some of the apparent decrease in catch rate could reflect reduced numbers of birds at sea, as a result of ongoing population decreases in several key species (Petersen et al. 2008).

HAKE LONGLINE FISHERY

Based on observer data from 1998 to 2005, seabirds were caught at a rate of 0.008/1000 hooks and seabirds were killed at a rate of 0.003/1000 hooks (Petersen et al. 2008). Generalised linear modelling revealed a significant decrease in catch rate from 0.033/1000 hooks in 2000 to 0.001/1000 hooks in 2006 (Petersen et al. 2008). The White-chinned Petrel *Procellaria aequinoctialis* was the most commonly caught species (36%) at a rate of 0.003/1000 hooks. Albatrosses comprised 5% of the total catch and were caught at a rate of 0.0004/1000 hooks (Petersen et al. 2008). Only yellow-nosed albatrosses *Thalassarche chlororhynchus/carteri* were identified. Shearwaters were caught at a rate of 0.001/1000 hooks and comprised 17% of the catch. Cape Gannets *Morus capensis* were caught at a rate of 0.001/1000 hooks and comprised 17% of the catch (Petersen et al. 2008). An estimated total of 225 (range 220–245) birds are killed per year by this fishery. 'Vessel', area and light conditions were all significant predictors of seabird bycatch (Petersen et al. 2008). Counts of seabirds associated with fishing vessels revealed White-chinned Petrels to be the most common species, followed by Great Shearwaters *Puffinus gravis* and Pintado Petrels *Daption capense* (Petersen et al. 2008).

PATAGONIAN TOOTHFISH LONGLINE FISHERY

During the six-year period 1996/97 to 2001/02, estimated annual catch rate in the sanctioned fishery decreased from 0.29/1000 hooks to 0.001/1000 hooks, and the numbers of

birds killed declined from 911 in the first year to only three in the last (and zero in South Africa's EEZ in 2006-2008), despite an increase in fishing effort in the early years. The marked improvement in mortality rates is thought due to a gain in fishing experience, improved compliance with mitigation measures, especially night-setting, and the fact that increased fishing effort in the more recent years took place at greater distances from the islands, where catch rates have been lower. Fifty-five percent of sets were made during the day in the first year of the fishery, decreasing to 1% in 2001/02. Mortality rates were significantly higher on day sets for albatrosses and giant petrels but not for White-chinned Petrels.

Overall, observers reported that 1 840 birds of 12 species were killed from 23 million hooks set, at an average rate of 0.08/1000 hooks. Most (80%) birds killed were White-chinned Petrels *Procellaria aequinoctialis*. Most other species were killed in the first year of the fishery, notably 126 Grey-headed Albatrosses *Thalassarche chrysostoma*. Most birds were killed during their summer breeding seasons, although Grey Petrels *Procellaria cinerea* were killed during winter months, when they breed. Most birds killed were breeding adults, assumed to have come from the Prince Edward Islands (as supported by a number of band returns). The only immature birds were giant petrels *Macronectes* spp. Albatrosses were caught closer to the islands than were White-chinned Petrels *Procellaria aequinoctialis*. Most petrels were foul-hooked, whereas albatrosses tended to be caught by the bill.

DEMERSAL TRAWL FISHERY

At least 30 birds were killed in 190 hours of dedicated observations of demersal trawl warps in the hake fishery during 2004 and 2005 (Watkins et al. 2008). Most were killed when their wings were entangled around the trawl warp and they were dragged under by the force of the water passing over the warp. Albatrosses were killed most frequently: shy-type albatrosses *Thalassarche cauta/steady* (43% of all birds killed) and Black-browed Albatrosses *T. melanophrys* (37%), with smaller numbers of White-chinned Petrels *Procellaria aequinoctialis* (10%), Cape Gannets *Morus capensis* (7%) and Sooty Shearwaters *Puffinus griseus* (3%) (Watkins et al. 2008). Mortalities occurred mainly during dumping of fishery wastes, and were more frequent in winter, when more birds attended fishing vessels. Average mortality rates were 0.56



(95% CI 0.32-0.82) birds killed per hour during dumping in winter; 0.21 (0.07-0.38) during dumping in summer, and 0.09 (0.02-0.19) when not dumping in winter (Watkins et al. 2008). No birds were killed in the absence of dumping in summer. Albatrosses suffered a disproportionately high mortality rate, with 15% of birds dragged under drowning, compared to 4% of all other species. Deaths resulting from entanglement in fishing nets mainly affected Cape Gannets *Morus capensis*, and

occurred at an average rate of 3.0 (0.9-5.4) birds per 100 trawls (n=331 trawls) (Watkins et al. 2008). Serious warp incidents were independent of age among albatrosses, but there was a tendency for immature gannets to have a higher interaction rate than adults. Crude extrapolation suggests that total mortality is some 18 000 (8 000-31 000) birds per year, of which 85% are killed on warps and 15% entangled in nets (Watkins et al. 2008).



3. Current mitigation of incidental Seabird mortality



Longline fisheries

Mitigation measures work by either keeping birds away from baited hooks (e.g. tori lines), reducing the time the hook is available to the birds (e.g. line weighting or line setting chutes), avoiding peak periods of bird foraging (e.g. night setting) or making vessels or bait less attractive to the birds. It is vital that these measures are simple, easy to implement and cost effective.

“TORI” OR BIRD-SCARING LINE

A tori or bird-scaring line consists of a line with a number of streamers attached to it. This line is towed from the stern of the vessel while the baited fishing lines are being set. The streamers are designed to cover the point where the bait enters the water and distract foraging birds from taking the baited hooks. If longline gear is not sufficiently weighted and remains on or close to the surface beyond the area protected by the tori line it will have a limited effect on reducing seabird mortality. It is therefore important to ensure that longline gear sinks to below at least 10 m while under the protection of the tori line. The system works well for surface feeding birds, however, diving birds can still dive down to the bait outside

of the effective area of the streamers. Still, this method has been demonstrated to reduce bycatch rates by up to 96% (Brothers et al. 1999a). However, the success depends on design and setting conditions as well as crew willingness and input.

A number of trials were conducted in South African waters and produced the following specifications as a guideline for a best-design. These specifications have been included in South African fishing permit regulations. A bird-scaring line should achieve 150 m aerial coverage. To achieve this it should 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) (Fig.2). The bird-scaring line must be deployed on the windward side of the main line, unless two streamers are used, in which case they must be deployed on either side of the main line.

The key to an effective bird-scaring line is maximising the portion of the line which is in the air. The best way to achieve this is to make the point of attachment on the vessel as high as possible. An outrigger pole, sometimes referred to as a tori pole, can be mounted to provide this height. Ideally an outrigger pole should be extended from the side of the

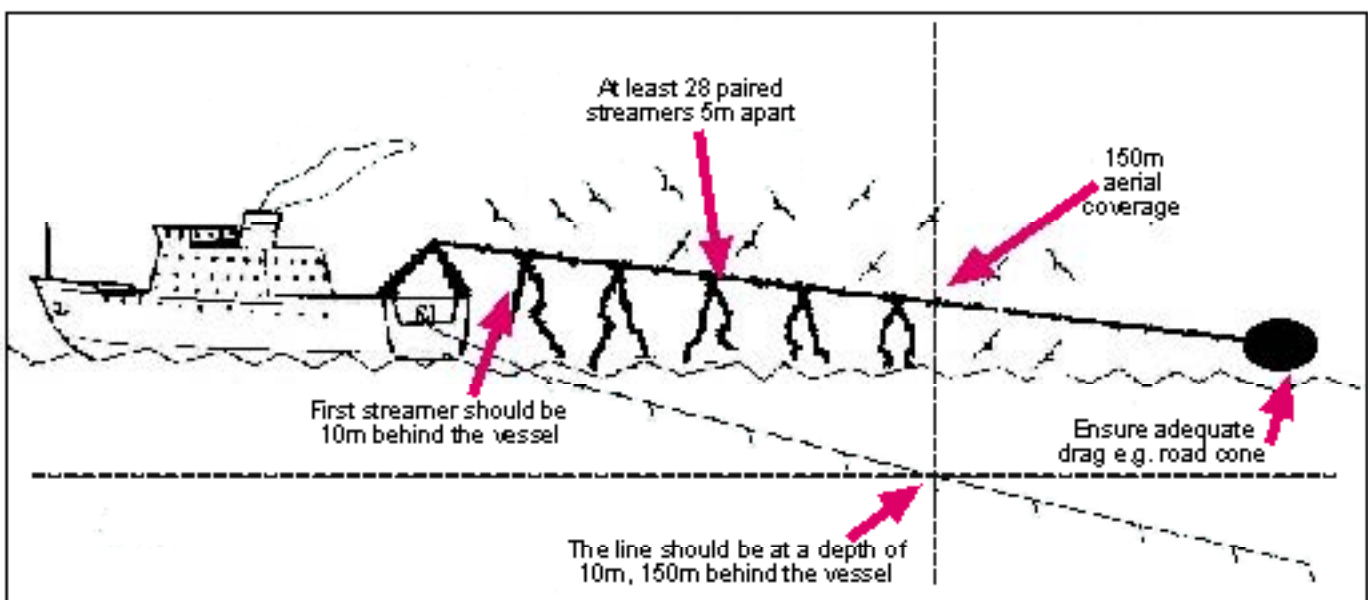


Figure 2: Bird-scaring line and longline sink rate specifications



vessel to keep the tori line away from fishing gear thereby reducing the chance of entanglement. The aerial coverage is also improved by attaching an item, e.g. a buoy, which creates drag to lift the line out of the water. Streamers can be made from plastic strapping or PVC tubing. They should be a bright colour, preferably red. Streamers shall be placed at least 5 m intervals along the entire aerial section of the line. The erratic movement of the streamers increases their efficacy. Attaching light sticks to streamers may increase the efficacy of the bird-scaring line when setting at night.

Vessels operating in the CCAMLR Convention area are to fly the bird-scaring line specified below:

1. The aerial extent of the streamer line, which is the part of the line supporting the streamers, is the effective seabird deterrent component of a streamer line. Vessels are encouraged to optimise the aerial extent and ensure that it protects the hookline as far astern of the vessel as possible, even in crosswinds.

2. The streamer line shall be attached to the vessel such that it is suspended from a point a minimum of 7 m above the water at the stern on the windward side of the point where the hookline enters the water.
3. The streamer line shall be a minimum of 150 m in length and include an object towed at the seaward end to create tension to maximise aerial coverage. The object towed should be maintained directly behind the attachment point to the vessel such that in crosswinds the aerial extent of the streamer line is over the hookline.
4. Branched streamers, each comprising two strands of a minimum of 3 mm diameter brightly coloured plastic tubing or cord, shall be attached no more than 5 m apart commencing 5 m from the point of attachment of the streamer line to the vessel and thereafter along the aerial extent of the line. Streamer length shall range between minimums of 6.5 m from the stern to 1 m for the seaward end. When a streamer line is fully deployed, the branched streamers should reach the sea surface in the absence of wind and swell. Swivels or a similar device should be

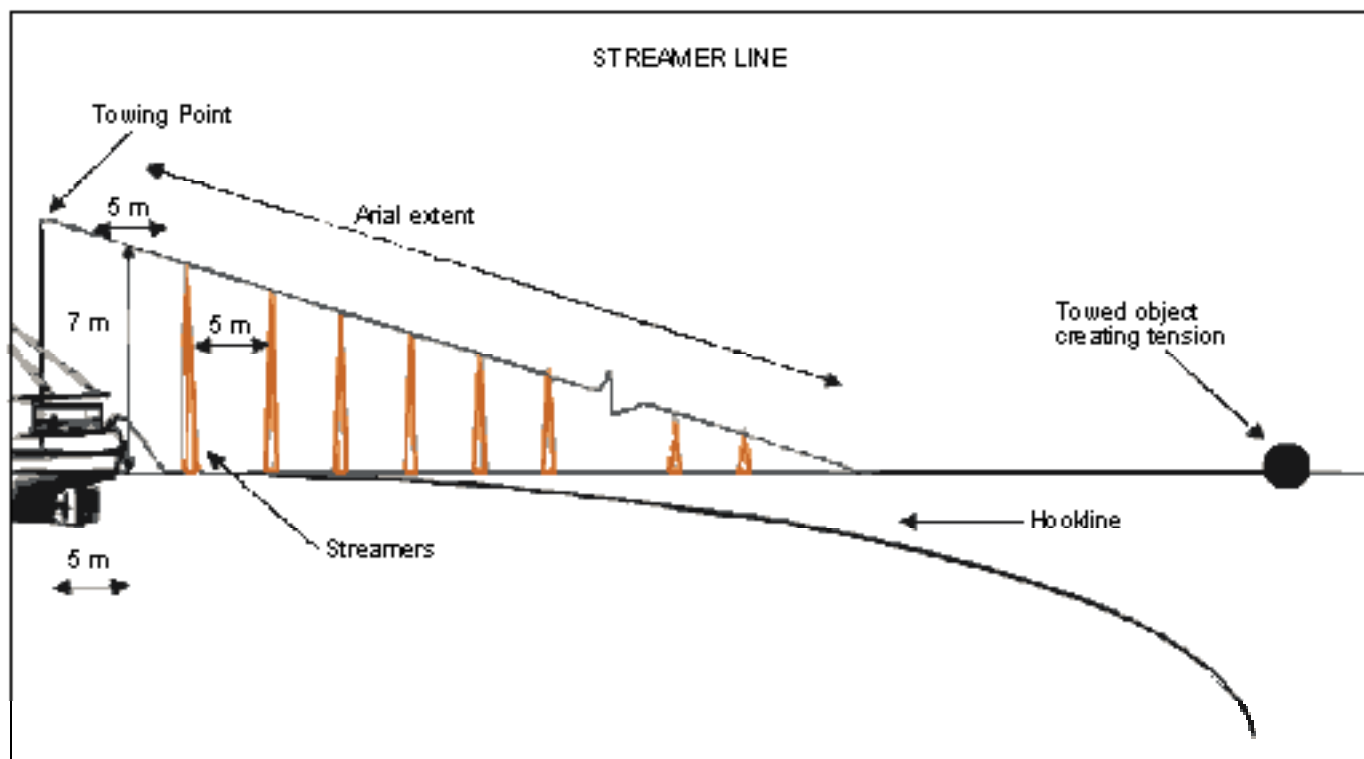


Figure 3: CCAMLR specified tori line



placed in the streamer line in such a way as to prevent streamers being twisted around the streamer line. Each branched streamer may also have a swivel or other device at its attachment point to the streamer line to prevent fouling of individual streamers.

- Vessels are encouraged to deploy a second streamer line such that streamer lines are towed from the point of attachment each side of the hookline. The leeward streamer line should be of similar specifications (in order to avoid entanglement the leeward streamer line may need to be shorter) and deployed from the leeward side of the hookline.
- Plastic tubing should be of a type that is manufactured to be protected from ultraviolet radiation.

LINE WEIGHTING (AND REDUCING SETTING SPEEDS)

Albatrosses are relatively shallow divers, 0.3-12.4 m (Prince et al. 1994) although some petrels can dive considerably deeper than this depth, e.g. Sooty Shearwater *Puffinus griseus* can dive to a maximum depth of 67 m (Weimerskirch and Sagar 1996). By maximising the rate at which the longline sinks, one will minimise the time the hook is within the reach of the birds, and thus reduce the chance of birds being drowned.

Various "line weighting" regimes have been investigated and proposed for demersal and pelagic longlining (Brothers et al. 2001, Anderson and Mcardle 2002, Robertson et al. 2003, Moreno et al. 2006, Honig and Petersen 2006). Although the gear will be configured according to the particular fishery, a line sink rate of 0.3 s⁻¹ is recommended. This sink rate will allow the hooks to reach a depth of at least 10 m while under the aerial coverage of a well constructed bird-scaring line (150 m).

Pelagic longlining: Optimal line sink rates of 0.3 m.s⁻¹ are a requirement of the South African longline fishery, yet gear configurations to achieve this sink rate have not been established. Five gear configurations were investigated (Petersen et al. 2008): the American longline system using no weighted swivel, 60 g and 120 g weighted swivels, the use of a wire trace and the Asian pelagic longline system. None of these weighting regimes achieved 0.3 m.s⁻¹ consistently. The fastest line sink rates were achieved by the addition of a 120 g

weighted swivel (average 0.35 m.s⁻¹). However, the relative improvement from 60 g (average 0.24 m.s⁻¹) to 120 g may not warrant the additional cost and may further compromise crew safety (Petersen et al. 2008).

Similar studies have been conducted in pelagic longline fisheries operating off New Zealand (Anderson and Mcardle 2002) and Australia (Brothers et al. 2001). These studies found that during normal line setting using unweighted branchlines a considerable proportion of hooks were within the known diving range of a number of seabirds frequenting these vessels (Brothers et al. 2001, Anderson and Mcardle 2002). The addition of a 60 g swivel weight within 1-2 m of the hook attained a line sink rate of 0.45 m.s⁻¹. This results in the hook being out of the reach of most seabirds, excluding Sooty Shearwaters, after 30 seconds (it was estimated that the bird-scaring or tori line provided protection for 29.3 sec) (Anderson and Mcardle 2002). Brothers et al. (2001) found that the heavier the weight, and the closer it is to the hook, the more rapidly it will sink. In this study, sink rates of 0.26 m.s⁻¹ to 0.30 m.s⁻¹ were attained using either an 80 g weight within 3 m of the hook, or a 40 g weight at the hook. However, for such line weighting regimes to be effective in reducing seabird bycatch, they need to be deployed in conjunction with an effective bird scaring or tori line.

Demersal longlining for hake – Various weighting regimes (4, 6, 8 kg weights spaced at 40, 50 and 60 fathoms) have been investigated locally for this fishery which uses the Spanish double longline system (Petersen et al. 2008). No significant difference was found in the sink rate to 2 m, 5 m, 10 m and 15 m for dropper lines between weighting regimes. However, there was a significant difference in the sink rate for the portion of the line near the weight. 4 kg weights sank significantly slower than the 6 kg weights which in turn sank slower than the 8 kg weight (Petersen et al. 2008). There was no significant difference in the catch rate of hake *Merluccius* spp. between the dropper (84.73/1000 hooks) and the weight (100.53/1000 hooks), but there was a significant increase in the catch rate of Kingklip, the three most commonly caught demersal sharks (Short-spine Spiny Dogfish *Squalus mitsukurii*, Yellow-spotted Catshark *Scyliorhinus capensis* and Izak Catshark *Holohalaelurus regani*) and the most commonly caught skate (Biscuit Skate *Raja straeleni*) near weights compared to near droppers (Petersen et al. 2008). Thus while hake catches are unlikely to



be reduced by increased weighting, other vulnerable species of fish, shark and skate may be affected. Given that relatively few birds are caught in this fishery off South Africa, the increased impact on non-target fish species may outweigh the potential benefits of increased weighting on reduced seabird bycatch (Petersen et al. 2008).

Demersal longlining for Patagonian toothfish – Demersal longline vessels fishing for Patagonian toothfish are required by the CCAMLR regulations to achieve a line sink rate of at least 0.3 m.s⁻¹. This is done by attaching 8.5 kg weights every 40 m or 6 kg weights every 20 m on the line. Autoliners are recommended to attach a 5 kg weight every 50-60 m and vessels using an internally weighted line must achieve a sink rate of 0.2 m.s⁻¹. CCAMLR fisheries conservation measure 24-02 (CCAMLR 2005) requires vessels to demonstrate a sink rate of 0.3 m.s⁻¹ prior to commencing fishing on each fishing trip in non territorial waters using either time-depth recorders or the “bottle test”. Details of these tests may be found on the CCAMLR website (www.ccamlr.org). Each vessel has to demonstrate that its line sinks at the prescribed rate before it may commence fishing.

FROZEN VERSUS THAWED BAIT

Thawed baits sink more rapidly than frozen baits. In experiments conducted on Japanese pelagic longliners, Brothers et al (1998) found that on average 1.1 birds per 1000 hooks were caught using frozen bait, compared to 0.6 birds per 1000 hooks using partly thawed and 0.3 birds per 1000 hooks using thawed bait demonstrating the effectiveness of this measure.

SETTING LINES AT NIGHT

Albatrosses generally feed during the day, but lower numbers may forage at night. Therefore by setting lines between dusk and dawn, the danger of catching these birds is greatly reduced (Harper 1987). However the smaller petrels e.g. White-chinned Petrel, may feed at night and are therefore less protected (Harper 1987). Although, this measure is effective in reducing seabird bycatch, especially the capture of albatrosses, in isolation it is unlikely sufficient to reduce seabird bycatch. Seabirds will be especially vulnerable on clear, bright nights such as those during full moon periods.

Gilman et al. (2005) showed a 97-100% reduction in the capture of *Laysan Phoebastria immutabilis* and Black-footed *Phoebastria nigripes* Albatrosses in the Hawaiiin longline fishery, and Klaer and Polacheck (1998) a 91% reduction in the capture of all seabird species in the Japanese pelagic longline fishery when setting took place at night as opposed to during the day. In a study conducted in South African waters, it was found that the pelagic longline fishery, which sets a high proportion of their sets during daylight, catch approximately 0.2 birds per 1000 hooks while the demersal longline fishery which sets their lines primarily at night only catch 0.04 birds per 1000 hooks.

This difference can in part be accounted for by the difference in setting time (Petersen et al. 2006). There is further evidence from a pilot study conducted in Namibia which revealed higher catches of 0.3 birds per 1000 hooks between full and half moon compared to no birds caught between quarter and new moon periods (Goren 2007). Analysis of fisheries observer data and the use of generalised linear models indicate that the time of setting and moon phase were important indicators of seabird mortality in South Africa and therefore by limiting fishing to night setting and/or outside of full moon periods seabird mortality could be substantially reduced (Petersen et al. 2008) (Fig 4).

The tuna directed fishery is required to set their lines at night, but not the swordfish directed sector. This decision is based on the premise that Swordfish *Xiphias gladius* catches are highest at dusk. Evaluation of observer data (1998–2005) confirms that Swordfish catch rates are the highest when setting takes place at dusk (6.56/1000 hooks). There was no effect on catch rates of Swordfish or tuna over full moon. Limiting fishing effort during full moon could therefore be considered as an additional management option for mitigating seabird mortality in the fishery.

OFFAL MANAGEMENT

Albatrosses and petrels are opportunistic scavengers and fishing vessels processing at sea and discarding offal provide a feeding opportunity for these birds (Ryan and Moloney 1988). Therefore by minimising or eliminating discards seabirds will not be attracted to fishing vessels. Seabirds are most at risk of being caught during setting (Brothers et al. 1999a). Therefore



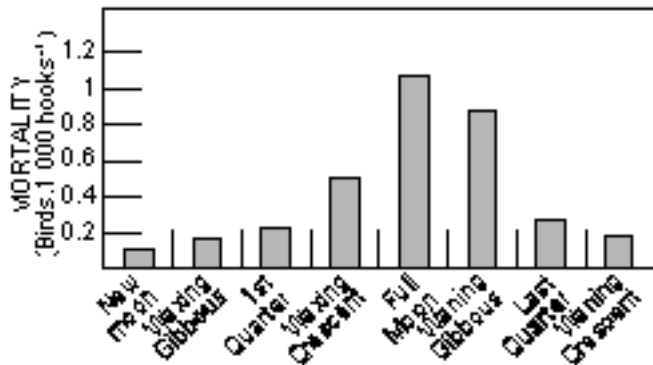


Figure 4: The effect of moon phase on seabird mortality, 1998–2005.

discarding should not take place during this time. If discarding is necessary during hauling, crew should be instructed to do so on the opposite side thereby reducing the risk of capture of birds.

CONCLUSION

There is no single solution, but rather a suite of measures that should be used in combination to mitigate seabird bycatch. The choice may differ from fishery to fishery depending on gear configuration, preferred operation and species complexes involved. Fisheries regulations in South Africa address seabird bycatch; however two issues remain unresolved. Firstly, line sink rate trials need to be completed in order to advise on appropriate measures in this regard. Secondly, implementation of these regulations has been poor and requires improved enforcement.

Trawl fisheries

MODIFIED, PAIRED BIRD-SCARING OR TORI LINE

Bird-scaring or tori lines towed alongside warps deter birds from entering the area where most collisions occur. In the Falklands, it has been shown that paired tori lines reduce seabird mortality by up to 80%. Initial trials conducted in South Africa suggest that a pair of bird-scaring lines set over the warps greatly reduce the numbers of birds entering the danger zone where the warps enter the water.

Bird-scaring lines are cheap and easy to use. They should be deployed outside of both warp cables and attached to the stern at the maximum practical height above the water line. Each line should consist of 30-50 m of rope with a buoy or road cone attached at the seaward end for tension, and should be deployed such that the seaward end enters the water at least 10 m behind the point at which the trawl warp enters the water (Fig 5). Each bird-scaring line should have at least six streamers (preferably of 10-17 mm diameter garden hose to prevent possible entanglement with warps) attached at intervals of no more than 2.5 m, commencing 5 m from the stern. Each streamer should reach the water's surface in calm sea conditions. The bird-scaring lines should be deployed after shooting and retrieved prior to hauling to minimize entanglement, but must be flown during trawling. Discarding of offal should not occur during setting.

OFFAL MANAGEMENT

Albatrosses and petrels are opportunistic scavengers and fishing vessels processing at sea and discarding offal provide a feeding opportunity for these birds. To reduce numbers of birds following fishing vessels, discarding any item of an edible nature, even cardboard packaging should be avoided during setting. Managing fishery discards is an important way to reduce seabird mortalities. By reducing fishery discards the incentive for seabirds to forage behind fishing vessels is reduced. Albatrosses, which are particularly vulnerable to trawl warp collisions, prefer whole fish. The following options could be considered to manage discards:

- a) Freeze discards into blocks
 - Pro: No discharge or discharge in a form unpalatable to seabirds
 - Con: Storage, freezing capacity reduced, trip length reduced
- b) Fishmeal
 - Pro: Definitive solution
 - Con: Expensive, vessel refitting, additional storage for meal and anti-oxidant
- c) Interim waste storage
 - Pro: Discharge when no gear deployed
 - Discharge at night or trawl by trawl
 - No significant modification to vessel stability
 - Con: Storage requirements, design may be limiting
 - Complications of fish held over from previous haul
 - Sacrifice storage



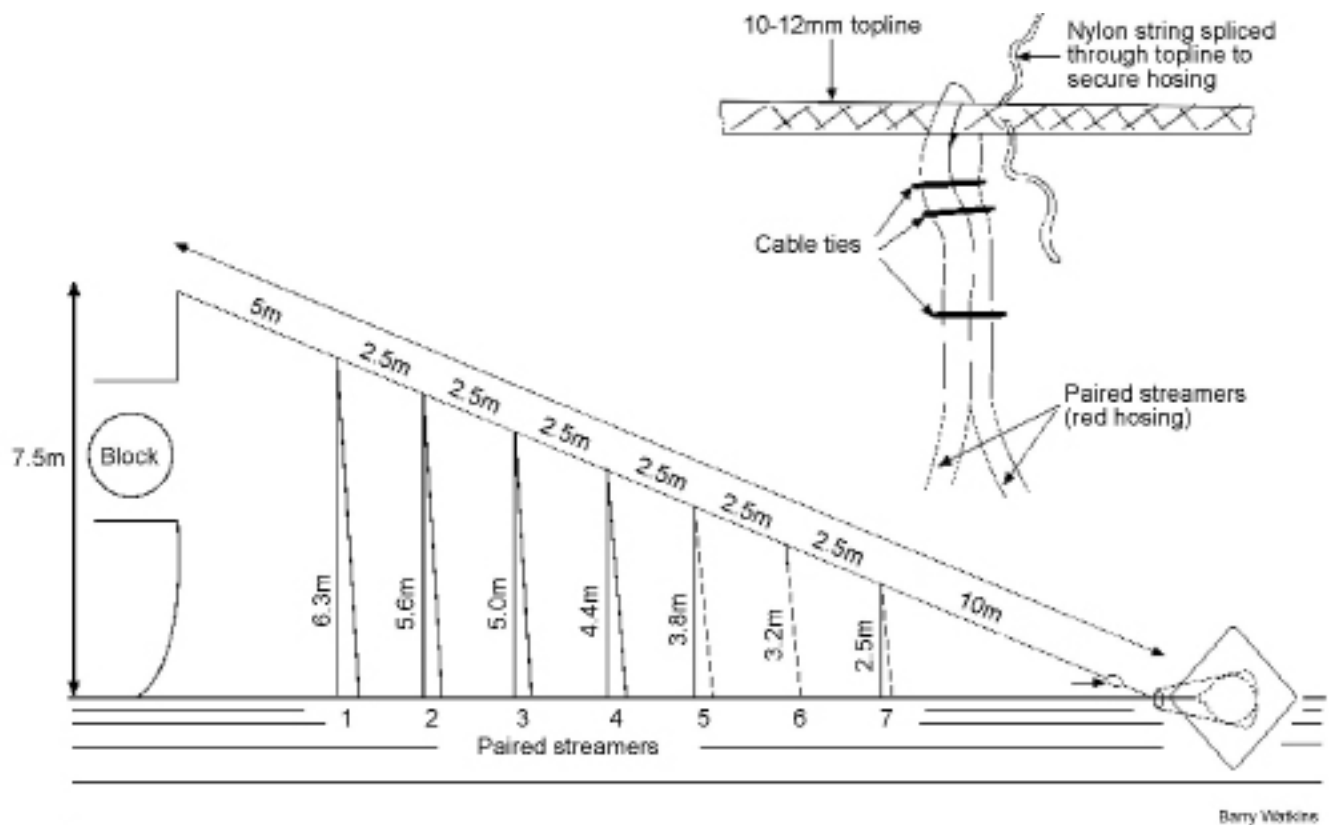


Figure 5: Trawl bird-scaring line specifications

- d) Mincing of fish to a small particle size
 - Pro: Reduces intensity of foraging behaviour
 - Waste in a form that increases dispersal of waste
 - Minimal space and factory design change
 - No storage or change to vessel stability
 - Con: Discharge attracts seabirds to danger area of warps
 - Seabirds may adapt foraging cues
 - Tolerance of mincer to hard objects (rocks etc.)
- e) Discharge minced offal under pressure from the side of the vessel
 - Pro: Water jet to 5m from side of vessel
 - Discharge through pipe mounted on a boom
 - Con: Discharge in front of warps – interactions may occur
 - Strong winds may limit water jet
- f) Discharge minced offal underwater
 - Pro: Discharge in front of propeller
- g) Discharge minced offal via floating hose astern
 - Pro: Minced discharge out of danger zone
 - Low pump pressure required
 - Pipe blockage accessible
 - One of cheapest options
 - Con: Possible prop entanglement
 - Retrieve prior to hauling
- h) Permanent storage on board (in 'liquid' form)
 - Utilizing empty fuel tanks and "pickling" of minced offal by adding food acids and salt
 - Pro: No discharge: no attraction to seabirds
- Prop wash discharge astern of warps
- Discharge by pipe fitted to vessel side
- Con: Hauling vessel stationary or moving backwards: discard in net area
- Prop wash may upwell in danger zone
- Pipe blockage to be fixed in port
- Expensive



- Stability, fuel and storage capacity not effected
 - Con: Potential contamination of fuel tanks
 - Storage of hazardous chemicals on board
 - Logistics balancing fuel consumption to waste production
- i) Discharge in a form unattractive to seabirds
- Offal minced and cooked at 70°C: stock water and bones piped overboard
 - Pro: Unpalatable to seabirds
 - Batch processing less storage
 - Con: Expensive
 - Two tanks: one for filling and one for “cooking”

CONCLUSION

Since seabird bycatch in trawl fisheries has been identified relatively recently, it is likely that refinement and development of mitigation measures will take place in coming years.

Fisheries monitoring programme

Fisheries scientific observers collect valuable information on the seabird bycatch which allows a detailed analysis of both the number of seabirds killed as well as how, where and when they were killed. It is imperative that observers are adequately trained to ensure correct species identification. This has been highlighted as a short-coming in the past (Petersen et al. 2008) and should be addressed in future initiatives. Observers can also play a role in educating fishers and demonstrating

mitigation measures at sea. Furthermore, observers can play a key role in monitoring compliance. For example, observers in South African fisheries report that tori lines were only used on 51% of sets in the pelagic longline fishery and 9% in the demersal longline fishery (Petersen et al. 2008). This has the implication that tori lines are less likely to be used when observers are not present. Compliance improved to 73% of sets in 2005 when improved observer coverage was the result of a condition placed on joint-venture vessels operating in the fleet. Similar improvements in compliance with improved observer coverage have been reported elsewhere (Gales et al. 1998). Even though observers are not onboard to bring about compliance, their mere presence is likely to have an effect. Increasing observer coverage is therefore likely to be important to increase compliance.

For South African flagged vessels, permit holders are to ensure that a minimum of 20% of all fishing days per quarter are monitored by an on board observer. Foreign flagged vessels operating under joint venture agreements are required to carry an on board observer on all fishing days (i.e. 100% observer coverage). The toothfish fishery currently also operates at 100% observer coverage under CCAMLR regulations. Failure to comply with this regulation shall result in the initiation of proceedings under section 28 of the Marine Living Resource Act of 1998 (Act No 18 of 1998) (MLRA). The observer shall be responsible to collect seabird bycatch data at sea and to return whole specimens of all seabirds killed during fishing operations. The observer shall also monitor all fishing operations, record any transgressions of the MLRA, and from time to time conduct mitigation trials.





4. Legislation and Policy

International

The concept of an ecosystem approach to fisheries (EAF) has been widely accepted as a preferred manner of managing fisheries and is entrenched in various international legal instruments and policy statements. This is perhaps most aptly illustrated in the 2002 World Summit on Sustainable Development (held in Johannesburg, South Africa) and the Johannesburg Plan of Implementation, which urged states to apply an Ecosystem Approach to Fisheries by 2010 (UN 2002).

The 1982 United Nations Convention on the Law of the Sea (UNCLOS) is the principle global legal instrument governing the management of our oceans. With 150 ratifications (www.un.org) this agreement has been widely accepted as customary international law. Although UNCLOS does not explicitly refer to an ecosystem approach to fisheries in its text, it does require states to consider the effect of fishing activities on “species associated with or dependent upon harvested species with a view to maintaining or restoring populations of such associated or dependent species above levels at which reproduction may become seriously threatened” (Article 61, paragraph 4). South Africa ratified UNCLOS in 1997.

The more recent UN Fish Stocks Agreement¹ (UNFSA) of 1995, developed under the auspices of UNCLOS, is more explicit in its endorsement of an EAF. It requires member States to “...minimize...catch of non-target species, both fish and non-fish species ... and impacts on associated or dependent species, in particular endangered species, through measures including, to the extent practicable, the development and use of selective, environmentally safe and cost-effective fishing gear and techniques” (Article 5).

South Africa has ratified the UNFSA. This Agreement is important because several species targeted by means of longlines within South Africa’s EEZ’s are in fact straddling and/or highly migratory species (tunas, swordfish

and sharks). The UNFSA asserts that coastal States and States fishing for straddling stocks and highly migratory species in the adjacent areas have a “duty to co-operate for the purpose of achieving compatible measures in respect of such stocks.” (Article 7, paragraph 2).

In 1995 the Food and Agriculture Organisation of the United Nations (FAO) adopted a Code of Conduct for Responsible Fisheries (<http://www.fao.org/fi>). This code explicitly endorses an ecosystem approach to fisheries management and considers the integrity of the entire ecosystem and promotes the development of gear and techniques which maintain biodiversity and conserve vulnerable populations. Moreover, it advocates minimising waste, catch of non-target species and impacts on associated or dependent species. The code, although not legally binding, provides internationally accepted guidelines for the development and implementation of national fisheries policies, including the use of species selective gear. South Africa is a signatory to this Code of Conduct.

The FAO has further endorsed the need to reduce bycatch of vulnerable species through the development of International Plans of Action (IPOA’s) for both seabirds and sharks. Under this process individual countries are required to develop National Plans of Action (NPOA’s) that demonstrate the measures that individual countries will take to reduce impacts to these vulnerable suites of species. The NPOA-seabirds is an undertaking aimed at reducing mortalities of seabirds in longline fishing to insignificant levels and the NPOA sharks was developed as a result of the increasing commercial and bycatch takes of pelagic shark species, and the awareness of the vulnerability of these apex predators to fishing.

The Convention for Migratory Species (CMS) has recognised that migratory species are particularly vulnerable to bycatch in fisheries and require cohesive international efforts to curb these impacts. In this regard, the CMS has been instrumental in developing international Agreements and Memoranda of Understanding (MOU’s) that specifically address the issue of bycatch of seabirds and sea turtles. These include the 2002 Agreement on the Conservation of Albatrosses and Petrels (ACAP). South Africa was instrumental in the development of this Agreement and was a founder signatory.

¹ Full name: Agreement for the implementation of the provisions of the UN Law of the Sea Convention relating to the conservation and management of straddling fish stocks and highly migratory fish stocks. Also referred to as the Fish Stocks Agreement.



Regional

Regional fisheries management organisations (RFMOs) of relevance to South Africa include: the International Convention for the Conservation of Atlantic Tunas (ICCAT) (South Africa is a member), the Indian Ocean Tuna Commission (IOTC) (South Africa is a co-operating non-member), the Commission for the Conservation of Southern Bluefin Tuna (CCSBT) (South Africa is a co-operating non-member), the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) (South Africa is a member) and the South East Atlantic Fisheries Organisation (SEAFO) (South Africa is a member).

ICCAT and IOTC which entered into force in 1969 and 1996, are responsible for the management of tuna and billfish fisheries throughout the Atlantic and Indian Oceans respectively. Their mandate covers tuna and tuna-like species. Recent resolutions addressing seabird bycatch have been adopted. In the case of ICCAT, resolutions on seabirds were adopted in 2002 (Resolution 02-14) after initial proposals in 2001 and 2002. The resolution encourages members to collect data on seabird interactions, urges members to implement NPOA-seabirds, and resolves that the Scientific Committee will report to the Commission on the impact of incidental mortality on seabirds 'when feasible and appropriate'. The Scientific Committee has encouraged members to include experts on seabirds at its meetings (ICCAT 2003b, 2004b), and in 2003 and 2004 the Scientific Committee made a recommendation to the Commission that ICCAT hire a bycatch coordinator (ICCAT 2004b, ICCAT 2004a). ICCAT also has a bycatch sub-committee which addresses bycatch issues. The IOTC has established a Working Party on Data Collection and Statistics, which considered bycatch issues in December 2001 at its Third Session (most notably of sharks) and recommended that an observer scheme be adopted. In 2002 the IOTC resolved to establish a Working Group on Ecosystems and Bycatch (WGEB). A resolution concerning seabirds (06/04) and a recommendation on incidental mortality of seabirds (05/09) caught in association with fisheries managed by IOTC have been adopted.

CCSBT which entered into force in 1994 applies to Southern Bluefin Tuna *Thunnus maccoyii* and has the objective of ensuring

the conservation and optimum utilization of the species through appropriate management. The Convention recognizes ecologically related species as living marine species, including seabirds that are associated with Southern Bluefin Tuna. The Commission of the CCSBT established an Ecologically Related Species Working Group (WG-ERS) in 1995, with terms of reference, inter alia, that it "... provide advice on measures to minimize fishery effects on ecologically related species, including but not limited to gear and operational modifications". At the first meeting of the WG-ERS use of bird-scaring lines was promoted (with the Working Group adopting guidelines for their design and deployment), as was the avoidance of dumping offal during both setting and hauling. Collection of data on mortality of seabirds from longlining for Southern Bluefin Tuna was to commence in 1995. At its Third Annual Meeting, in February 1997 the Commission recommended that Parties to the CCSBT adopt a suite of mitigation measures to reduce seabird mortality by longliners fishing for Southern Bluefin Tuna. At its Fourth Meeting in September 1997, the Commission adopted the proposal of the WG-ERS that use of bird-scaring lines (described as "Tori poles") be mandatory for vessels of Parties south of 30° South, and requested their use north of this.

CCAMLR came into force in 1982 following signature in 1980. The Convention, and its Commission, aims to take an ecosystem approach to conserving marine living resources in the Southern Ocean that will maintain ecological relationships and prevent or minimize risks of changes not potentially reversible within two to three decades. In 1989 the Commission first noted the problem of seabird mortality in longline fisheries in the Southern Ocean and urged its Members to introduce mitigation measures as soon as possible. In 1991 it adopted its first mitigation measure: the requirement to use bird-scaring "streamer" lines. CCAMLR's *ad hoc* Working Group on Incidental Mortality Arising from Longline Fishing (WG-IMALF, now WG-IMAF) was established in 1993. It annually reviews information on seabird mortality from longline fishing within the CCAMLR Area and estimates the total numbers of birds killed each year by both sanctioned and IUU fishing for toothfish *Dissostichus* spp. It recommends conservation measures to reduce such mortality to the Commission via the Scientific Committee (Conservation measure 25-02). In 1994 its proposals to restrict line setting to night-time and not to dispose of offal during line setting were adopted by



the Commission. From 1997, the Commission postponed the opening of the longline fishing season in international waters, including in the vicinity of the Prince Edward Islands, successively from 1 March to 1 May in 2002, with it closing on 31 August. In the Prince Edward Islands EEZ, fishing is year round: the idea for this is that licensed vessels act as a deterrent to illegal, unregulated and unreported fishing. CCAMLR adopted its catch documentation scheme (CDS) in 1999, and it became binding on CCAMLR Members in May 2000. The CDS aims to monitor and certify international trade in toothfish in an effort to reduce IUU fishing, which is expected in turn to lead to a reduction in seabird mortality.

SEAFO which came into force in 2003 is responsible for managing fisheries operating on the high seas in the Southeast Atlantic (FAO Statistical Area 47). The application of an ecosystem approach is a cornerstone of the guiding principles (Article 3 c, d, e and f) of this modern convention, which includes a plan for a regional observer programme (with seabird bycatch data included in data collection protocols) as well as a regional enforcement system that will include both port and at-sea inspections (SEAFO 2001). SEAFO will manage non-tuna fish stocks, such as alfonso, orange roughy, armourhead, wreck fish, deepwater hake and red crab. At present longline fisheries managed under this agreement are negligible.

Recently South Africa, Angola and Namibia signed an agreement formally to establish the Benguela Current Commission (BCC), allowing for greater harmonisation of management of marine resources between the national jurisdictions of the three countries within the Large Marine Ecosystem (LME). The institutional structures of the BCC include an Ecosystem Advisory Committee that will advise the Commission on the “ecological sustainable use” of the Benguela Current LME. The Benguela Current Commission is the culmination of over 10 years of shared efforts by scientists from Angola, Namibia and South Africa.

National

In South Africa, the principle Act guiding the utilization of living marine resources is the Marine Living Resources Act 1998 (Act No. 18 of 1998). This Act explicitly endorses the concept of

“ecological sustainable development” and recognizes the need to “protect the ecosystem as a whole, including species which are not targeted for exploitation...”, (Sections 2a and e) as its guiding principles. Furthermore, in the General Policy on the Allocation and Management of Long Term Commercial Fishing Rights (2005), the South African government commits itself to “implementing an Ecosystem Approach to Fisheries Management by 2010”.

All seabirds affected by South African longline and trawl fisheries are protected in terms of the Sea Birds and Seals Protection Act 1973 (Act No. 46 of 1973). This Act prohibits the killing, capture or willful disturbance of seabirds unless sanctioned in terms of a permit issued by the Minister of Environmental Affairs & Tourism or a delegated representative. Furthermore, the South African Policy on the Management of Seals, Seabirds and Shorebirds (2007) commits the government to adopt “plans of action to reduce the incidental mortality of seabirds, seals and shorebirds caused by fishing operations”.

Various measures to mitigate seabird bycatch have been included in South African fisheries regulations through permit conditions. These permit conditions are reviewed on an annual basis.

PELAGIC LONGLINE PERMIT CONDITIONS

1. The vessel must have onboard an approved tori line, which must be flown during the setting of each longline. A tori line must achieve at least 150 m aerial coverage. It must be attached to the vessel at least 7 m above sea level, be at least 150 m long and have at least 28 paired streamers spaced 5m apart (commencing 10 m astern the vessel). There must be sufficient drag (e.g. buoy, road cone or sea-anchor). Streamers (minimum requirement) for all vessels other than those operating in CCAMLR Convention Area: 6 pairs of 4 m; 6 pairs of 3 m; 8 pairs of 2 m; 8 pairs of 1 m (i.e. a total of 28 pairs of streamers).
2. Both the main line and branch lines (snood) must be properly weighted to ensure optimal sinking rates (approximately 0.3 m.s⁻¹ or to reach a depth of 10 m, 150 m behind the vessel).
3. Offal dumping must take place on the opposite side of the vessel from that on which the lines are hauled. No dumping of offal may take place during setting.



4. Deck lighting should be kept to a minimum, without safety being compromised. All deck lights should be shaded in such a way that the beam is directed down towards the deck.
5. All bait must be properly thawed, and where necessary, the swim bladder punctured to ensure the rapid sinking of bait.
6. All birds caught must first be brought on board and thereafter any live birds should be released.
7. The start and completion of line setting shall be conducted at night only; defined by the period between nautical dusk and nautical dawn (compulsory for tuna permit holders, voluntary for swordfish permit holders)
8. The Permit Holder is restricted to a seabird mortality limit of 25 birds per year irrespective of vessel replacements. Once this limit is reached the Permit Holder is required to stop fishing for the remainder of the year, unless the Permit Holder can show that it complied with permit conditions 3 and 6 for very set made. Compliance to these measures shall be determined by the seabird mitigation checklist which is completed by both the skipper and the observer on a daily basis when an observer is on board. In addition, the onus is on the Permit Holder to: 1) Have the vessel inspected by a Fishery Control Officer prior to each departure to ensure that an approved tori line and bird de-hooking device are on board; and 2) Ensure that the skipper(s) and officers undergo a one day training course from Birdlife South Africa, before 1 July 2008, on how to effectively reduce seabird mortality.
9. Permit Holders which have reached their seabird mortality limit of 25 birds and have complied with all the necessary mitigation measures as stated above (point 8) may continue fishing subject to authorisation from the Department. This authorisation is only valid for a further 25 seabirds and on condition that the Permit Holder complies with the following additional seabird mitigation measures: 1) setting shall only be conducted at night as defined between nautical dusk and nautical dawn; and (2) Either no setting shall be conducted one day before and one day after full moon (i.e 3 days around full moon) or the Permit Holder would have to demonstrate line sink rates in excess of 0.3m/sec. Failure to comply with permit conditions in point 8 and the additional mitigation measures will result in the termination of fishing for the remainder of the year. No further exemptions will be

granted once the additional 25 seabird limit has been reached.

HAKE LONGLINE PERMIT CONDITIONS

1. Longlines shall be set at night only (i.e. during the hours of darkness between the times of nautical twilight).
2. During longline fishing at night, only the minimum ship's lights necessary for safety shall be used. All deck lights should be shaded in such a way that the beam is directed down towards the deck.
3. Dumping of offal must be minimised and must take place only on the opposite side of the vessel from that on which lines are hauled. No dumping of offal may take place during setting.
4. Fishing operations shall be conducted in such a way that hooklines (defined as the groundline or mainline to which the baited hooks are attached by snoods) sink beyond the reach of seabirds as soon as possible after they are put in the water. The Department is undertaking tests to determine the optimal line weighting regime for local conditions and full specifications will be published once the tests have been completed. The following specifications from CCAMLR serves as a guideline in the interim: Vessels using autoline systems should add weights to the hookline or use integrated weight hooklines while deploying longlines. Integrated
5. weight (IW) longlines of a minimum of 50 g/m or attachment to non-IW longlines of 5 kg weights at 50 to 60 m intervals are recommended. Vessels using the Spanish method of longline fishing (double line) should release weights before line tension occurs. Weights of at least 8.5 kg mass, spaced at intervals of no more than 40 m, or weights of at least 6 kg mass spaced at intervals of no more than 20 m are recommended.
6. The Permit Holder must ensure that the vessel has a streamer line (tori line) onboard. The streamer line/s shall be deployed during longline setting to deter birds from approaching the hookline. The streamer line shall be a minimum of 150 m in length and include an object (buoy, road cone or sea-anchor) towed at the seaward end to create tension to maximise aerial coverage. The object towed should be maintained directly behind the attachment point to the vessel such that in crosswinds



the aerial extent of the streamer line is over the hookline. Streamer length shall range between minimums of 6.5 m from the stern to 1 m for the seaward end. When a streamer line is fully deployed, the branched streamers should reach the sea surface in the absence of wind and swell. Swivels or a similar device should be placed in the streamer line in such a way as to prevent streamers being twisted around the streamer line. Each branched streamer may also have a swivel or other device at its attachment point to the streamer line to prevent fouling of individual streamers. Vessels are encouraged to deploy a second streamer line such that streamer lines are towed from the point of attachment each side of the hookline

7. Every effort should be made to ensure that birds captured alive during longlining are released alive and that wherever possible hooks are removed without jeopardising the life of the bird concerned.
8. All banded birds killed must be retained whole (frozen or on ice) and returned to port. Other birds killed must be retained, either whole (preferable) or heads and feet (the heads and feet from each bird to be tied together) and returned to port. On landing the birds must be handed over to the Fishery Control Officer.
9. No fishing hooks, fishing line or plastics may be discarded.

PATAGONIAN TOOTHFISH PERMIT CONDITIONS

CCAMLR Conservation Measure 25-02 (2002) is a permit condition for all licensed South African vessels irrespective of the area they are operating within. The regulations may be summarized as:

1. A bird-scaring line to CCAMLR specifications shall be used during the setting of longline gear
2. Line setting to be only undertaken at night (defined by between nautical dusk to dawn)
3. No offal to be discarded during line-setting
4. Fish hooks to be removed from offal and fish heads prior to discharge
5. Offal to be jettisoned on the opposite side of the ship from the hauling station

6. Appropriate line weighting (6 kg weights at no more than 20 m intervals, or 8.5 kg weights at no more than 40 m intervals for the Spanish system). Otherwise, solid steel weights of at least 5 kg mass should be used, spaced at intervals of no more
7. Vessels using autoline systems should add weights to the hookline, or use integrated weight (IW) hooklines while deploying longlines. IW longlines of a minimum of 50g.m⁻¹ or attachment to non-IW longlines of 5 kg weights at 50-60 intervals are recommended.
8. A device designed to discourage birds from accessing baits during the haul of longlines shall be deployed (This does not apply to all CCAMLR areas but it does apply to our EEZ).

From 1997, fishing has not been allowed within five nautical miles of the Prince Edward Islands, increased to eight nautical miles and finally to 12 nautical miles (and not between the two islands in the group).

HAKE TRAWL PERMIT CONDITIONS

1. A tori line should be outside of both warp cables. The tori lines should be attached to the stern at the maximum practical height above the water line
2. Each tori line should consist of 30-50 m of rope with a buoy or road cone attached at the seaward end for tension, and should be used such that the seaward end enters the water at least 10m behind the point at which the trawl warp enters the water.
3. Each tori line should have at least six paired streamers (preferably of 10-17 mm diameter garden hose to prevent possible tangling with warps) attached at intervals of no more than 2.5 m, commencing 5 m from the stern. Each streamer should reach the water surface in calm sea conditions.
4. The tori lines may be used after shooting and brought in prior to hauling to minimise entanglement, but must be flown during trawling.
5. Discarding of offal should not occur during the shooting of the trawl gear. Offal discards attract seabirds and during shooting tori lines cannot be used.



5. Actions



Prescription of mitigation measures

The over-riding principle of this NPOA is that each South African longline and trawl fishery has in place a set of prescribed mitigation measures aimed at reducing seabird mortality to less than the interim target of 0.05 birds/1000 hooks or 0.05 birds/trawl day per vessel. These measures will be reviewed at regular intervals, both in terms of their efficacy and of research and developments in mitigation methods on a global scale.

Mitigation methods included in permit conditions should describe the method clearly and concisely. In general, fisheries regulations should be defined by gear configuration and fishing operation rather than by the desired outcome. This facilitates both accurate implementation and enforcement. For example, foreign flagged vessels which do not add weights to their lines are often in breach of the regulation to achieve a line sink rate of $0.3 \text{ m}\cdot\text{s}^{-1}$. A compliance officer cannot enforce this regulation without the use of a time depth recorder to calculate the line sink rate.

To facilitate enforcement, this permit condition should rather be defined by the gear configuration tested to achieve a desired line sink rate, for example 60–120 g weight placed 2 m from the hook (Brothers et al. 2001, Petersen et al. 2008). At present this is not the case for the South African pelagic longline fishery and this requires addressing. Alternatively, vessels could be required to demonstrate that they meet the desired line sink rate prior to entering the fishery. A precedent for this exists in CCAMLR fisheries conservation measure 24-02 (CCAMLR 2007) which requires vessels to demonstrate a sink rate of $0.3 \text{ m}\cdot\text{s}^{-1}$ prior to commencing fishing.

Research and development

Following the FAO's IPOA-Seabirds, South Africa should undertake research and development on the issue of seabird mortality in longline and trawl fisheries to:

- (i) develop practical and effective deterrent devices,

- (ii) improve technologies and practices to reduce incidental capture of seabirds, and
- (iii) evaluate the effectiveness of mitigation measures.

Research of relevant aspects of the biology and conservation management of the affected species of seabirds should also continue.

Education, training and publicity

Low compliance is frequently the result of a lack of understanding of the life history characteristics of seabird populations (Bergin 1997, Robertson 1998, Gilman 2001). Fishers, who are accustomed to catching less vulnerable species, perceive the relatively low catch rates of seabirds as insignificant (Robertson 1998). Seabirds are opportunistic scavengers attracted to fishing vessels as they discard fisheries waste (Brothers et al. 1991, 1999a,b, Bergin 1997), often in large numbers, creating the impression to fishers that seabirds are plentiful. For effective implementation of mitigation measures it is essential to educate fishers (Bergin 1997) about the fact that seabird populations are indeed declining at unsustainable rates due to their K-selected life history traits (Warham 1996, Croxall & Gales 1998, Gales 1998). Compliance with the use of tori lines improved dramatically from virtually non-existent to approximately 50% in the longline fishery partly as a result of an education programme launched in South Africa in 2004.

Awareness materials should include both the conservation aspects of the problem and the economic benefits of reducing bait loss to birds (in the case of longline). To date, relatively little activity has taken place within South Africa in this regard with fishers, or with other groups, and activities undertaken to date have almost exclusively been by BirdLife and the WWF Responsible Fisheries Programme. The Department of Environmental Affairs and Tourism, through its branch Marine and Coastal Management, recently supported and encouraged bycatch awareness campaigns and is working collaboratively with WWF-South Africa's Responsible Fisheries Programme and BirdLife to this end.



The following activities should be undertaken at regular intervals:

- (i) training of fisheries observers in seabird identification and the use of mitigation measures,
- (ii) training of fishers on an Ecosystem Approach to Fisheries management and in particular the use of mitigation measures required in fishing permits,
- (iii) training of compliance staff in seabird identification, mitigation measures and enforcement,
- (iv) distribution of seabird identification and mitigation booklets to observers, skippers and compliance staff,
- (v) production of a set of seabird posters by the BirdLife International Seabird Conservation Programme, sponsored by Irvin & Johnson, Ltd, and
- (vi) writing articles on an ad hoc basis for commercial fishing and environmental magazines, giving of media interviews to radio, TV and press, and filming of TV programmes.

Data collection

In order to assess regularly the levels of seabird mortality and to ascertain the levels of compliance with prescribed mitigation measures, it is necessary to run an onboard observer scheme in longline and trawl fisheries known to cause seabird mortality. Such observers are to be properly trained. Although trawl fisheries carry fisheries observers on 20% of fishing trips, they spend their time collecting data in the factory and would therefore not capture seabird bycatch data in their current activities. It is essential that observer protocols for trawl fisheries be adapted to include warp observations to capture seabird interactions. Suggested activities are described below, for which the design and usage of standardised procedures and recording forms are required.

COLLECTION OF DATA ON SEABIRD MORTALITY

The following requirements are to be met:

- (i) observer schemes for longline and trawl fisheries will continue to operate at the 20% minimum and 100% for toothfish and foreign flagged vessels, the cost of these schemes to be borne by the respective fisheries,
- (ii) observers must aim to observe a minimum of 75% of

hooks on each set (but preferably higher) and in the case of trawlers, one trawl per day for the duration of the trip preferably when discarding is taking place. The remainder of the time the observer is in the factory collecting fisheries data and out of sight of seabird mortality.

- (iii) A data collection protocol should be developed for trawlers. Since seabirds are seldom hauled onboard warp observations would need to be conducted from a position on the trawl deck which would allow the observer to observe the area where the warp enters the water. The warps need to be observed during setting and when offal is being discarded during trawling. Interactions should be recorded for warp interactions (collision and drownings) and net entanglements. Information relating to fishing operation (setting, trawling or hauling) and the level of discarding (whole fish, macerated fish, no discarding etc) when mortality occurred should be recorded.
- (iv) all seabird corpses brought aboard all fishing vessels (not only those with observers aboard) must be kept for examination ashore after suitable packaging and deep-freezing, along with information on vessel name, observer name, species' identification, presence of markings such as metal or colour bands, how it was hooked (e.g. swallowed hook or foul-hooked) (longline) or warp/net (trawl), position and date. If storage space is limiting, then as a minimum, the head, legs + feet and any bands present must be retained from each corpse,
- (v) information on birds killed including species, age class should be collected,
- (vi) information on mitigation measures used and their efficacy should be collected,
- (vii) information on birds caught alive must be kept including species, age class and sex ideally by photographic record, presence of markings such as metal and colour bands, how it was hooked or entangled, condition on release (healthy, sick-looking, injured, etc.), position, date, and
- (viii) on a voluntary basis information on species and numbers occurring during setting and hauling may be kept, along with information on attack rates of bait, foraging methods and interactions between species.
- (ix) a system is to be put in place to allow for the handing over of seabird corpses on docking for examination.



COLLECTION OF FISHING DATA

The following is to be collected, *inter alia*, in order to allow for an estimation of seabird catch rates in relation to mitigation measures in place:

- (i) In the case of trawling, the numbers of trawls per day should be recorded. In the case of longlining the number of sets and numbers of hooks per set, hook spacing, line length and baiting percentage,
- (ii) fishing positions (coordinates at the beginning and end of fishing), depths, course settings, wind directions during setting (for trawling, wind direction not restricted to setting), sea and meteorological conditions, and dates,
- (iii) start and finish times and vessel speeds during setting and hauling (longline) and during setting, trawling and hauling (trawl),
- (iv) descriptions and usage of prescribed and any other mitigation measures, including descriptions of streamer lines in use (single or paired, overall length, height of deployment, number and lengths of streamers etc.), weighting regimes (mass and interval of weights), offal discharge (timing in relation to setting and hauling, position on the vessel), deck-lighting regimes (usage, brightness, direction), and
- (v) assessments by a sampling regime of the numbers of hooks and entangled lines discarded attached to fish heads, etc.

Addressing poor compliance

Adhering to regulations is a combination of enforcement and voluntary compliance (Brothers et al. 1999a). The latter is essential because not all vessels can be inspected at all times.

INCENTIVES

To encourage voluntary compliance, skippers should be made aware of the conservation status of these animals. They also need to be included in the decision making processes to ensure that mitigation and management measures implemented are practical and cost-effective and have the support of the fishing industry from the start. Incentives for compliance should include increased access to rights and quota allocations

for those fishing responsibly. Eco-labels such as the Marine Stewardship Council and the Sustainable Seafood Initiative can also encourage voluntary compliance (May 2003, Jacquet & Pauly 2007). As consumers become more aware of the threats to the world's oceans, so they begin to use their discretion when making the choice of which products to purchase (May 2003, Jacquet & Pauly 2007). Fishing industries which act responsibly are more likely to secure a market advantage than those who do not. The South African hake trawl fishery has Marine Stewardship Council certification. Addressing bycatch was a condition placed on this certification. Tori lines and offal management requirements were implemented in the trawl fishery in 2006 and compliance was estimated to be 80% during the day within the first two years (B. Watkins pers. comm.). This is a substantial improvement from the situation in the longline fishery where virtually no compliance for the first ten years was observed, and is largely attributable to the Marine Stewardship Council certification highlighting the role eco-labels and market driven forces can play in implementing solutions.

ENFORCEMENT

It is important that the cost of non-compliance and risk of being caught be sufficiently high to outweigh the benefit. This is frequently not the case in South African fisheries where penalties implemented for breaking bycatch related regulations are insignificant and fall short of acting as an incentive to comply. Penalties need to be brought in line with the commercial interests of the fishery to act as a disincentive. This alone is likely greatly to facilitate implementation of mitigation measures.

A further option is the setting of upper precautionary catch limits, beyond which fishing may cease. Such limits should ideally be placed per vessel rather than across a fleet. In all cases 'vessel' was the best predictor of mortality (Petersen et al 2008). Bycatch is not evenly distributed throughout the fleet, with a handful of vessels responsible for killing the majority of seabirds (Petersen et al. 2008), a finding consistent with Klaer and Polacheck (1998). Setting upper precautionary catch limits can therefore act to eliminate problem vessels or force compliance with mitigation measures. It can also act as an incentive for skippers to comply, because a vessel complying with regulations is unlikely to reach an appropriately set upper precautionary catch limit and thus likely to continue fishing



unhindered by the limit. A 25 bird per vessel limit has been placed on the South Africa Large Pelagic Longline sector since January 2008.

Conclusion

The single biggest challenge facing conservationists and fisheries managers to overcome and reduce bycatch in longline and trawl fisheries in South African waters is addressing the low voluntary compliance to mitigation measures. The harsh reality

is that although win-win situations should be sought, they occur infrequently. Even for seabirds, where there are cost-effective, practical solutions that operate in the economic interest of the fishery, seabirds continue to be killed and their populations continue to decrease (BirdLife International 2007). Every effort should be made to understand the problem, find cost-effective, practical solutions, educate fishers, include them in decision making processes and ensure incentives. Experience has shown that these will only take compliance so far, after which effective enforcement is necessary.



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8. Additional reading

Mitigation measures still under refinement: longline

UNDERWATER SETTING CHUTE

Baited hooks may be set below the surface using a funnel fitted to the stern of the vessel, which guides the line directly from the vessel to below the water surface (Ryan and Watkins 2002). The system still requires refinement and is not widely used. A South African toothfish vessel used this system in 1998-2000 with some success, indicating its potential use (Ryan & Watkins 2002). At present funnels are designed mainly for a single line system however; investigations are underway to modify the system to accommodate the double line system. Gilman et al. (2005) demonstrated a 100% reduction in seabird bycatch levels in the Hawaiian pelagic longline fishery although later demonstrated less success. There have been serious problems with its effectiveness reported especially when entanglements occur and cause the line to lie on the surface for extended periods of time (Gilman et al. 2002), resulting in higher than normal mortalities of seabirds. A study conducted in Australia reported 0% reduction (AFMA unpublished data)

UNDERWATER SETTING CAPSULE

This method is similar to the underwater setting chute. In this case, baited hooks are deployed in a capsule attached to a cable, which is designed to open at a depth of 5-10 m and release the baited hook (Brothers et al. 2000). As with the underwater setting chute, line entanglements have been reported to occur. Further testing and modification is underway (G Robertson pers. comm.).

SIDE SETTING

This method requires the line to be set from the side of the vessel resulting in hooks sinking by the time they reach the stern of the vessel. This method was tested in combination with 60 g weights and a "bird curtain" (pole out the side with streamers) in the Hawaiian pelagic longline fishery and found

to reduce the incidental mortality of Laysan and Black-footed Albatrosses up to 100% (Gilman et al. 2003). This method is currently employed in the Hawaiian and Australian pelagic longline fleet (Gilman et al. 2003). It needs wider testing in a number of localities with other species complexes (e.g. deeper diving species).

FISH OIL

This method won the WWF "Smart Gear" award in 2005 for the most innovative idea to reduce seabird mortality. It has been tested in the Spanish and New Zealand demersal longline and some success has been demonstrated. Fish oil is released on the surface of the water during setting and has been shown to reduce seabird activity in the vicinity of the vessel (www.wwf.org).

DYED BAITS

Dying baits blue so that they are less visible to seabirds was investigated as a measure to reduce seabird deaths. A number of studies were conducted and reported mixed successes (Gliman et al. 2003, 2005). Gliman et al. (2003) found a 95% reduction in mortality of Laysan and Black-Footed Albatrosses in Hawaii, but in a later study they found it less successful (63% reduction) than side-setting. This method is more successful using squid rather than fish bait. At this stage this method is not practically feasible as there is no commercially available dye and it is a rather messy job (Gilman et al. 2005).

BAIT CASTING MACHINE

This measure has the potential to reduce bird bycatch because a) bait can be cast outside turbulent area caused by the propeller theoretically resulting in an increased line sink rate, b) bait can be cast into area protected by a tori line and c) bait can be cast in varying positions to avoid concentrations of seabirds. Where direction and distance can be altered, Brothers (1993), in a study conducted in the South East Indian Ocean, showed a reduction in the level of seabird bycatch by 50% when the bait caster was used in combination with a tori line and thawed bait. Since this study conflicting results have been reported (e.g. Brothers 1999).



Mitigation measures tested and found ineffective: longline

LIVE BAIT

The concept of using live versus dead bait was investigated. It was thought that live fish would actively swim down from the surface. Observations suggest that fish may also swim to surface and thus be ineffective as a mitigation method. Brothers et al. (1999b) compared catch rates of live versus dead bait and found little evidence of a reduction in seabird catch rates

WATER CANNON

This method involves the use of a high-pressure fire hose that produces directed high-pressure water above baited hooks and thus deters seabirds from baited hooks. This method was tested by the Japan Tuna Fisheries Co-operative Associations in 1997, although its effectiveness against seabird bycatch was not quantified. The distance reached was considered inadequate and insufficient to avoid incidental capture of seabirds on its own (Kiyota et al. 2001). According to the observer the cannon was switched off due to cold water affecting crew (Brothers, Cooper & Lokkerborg 1999)

Future possibilities: longline

HOOK DESIGN

It has been suggested that hook designs (J-hooks, circle-hooks) have differing influences on seabird bycatch rate (Borneo workshop report 2005). However, little or no work to investigate this has been conducted to date.

Mitigation measures still under refinement: trawl

DEVICE AROUND WARP ENTRY POINT

When albatrosses are competing for food, they typically sit on the ocean with their wings open. This behaviour increases their risk of entanglement with the warp cable. By placing a ring or a buoy at the point where the warp enters the water, seabirds could be kept away from this high risk area and thus reduce seabird mortality. Trials are being conducted attaching a PVC tube of 100mm diameter around the warp. Limitations include the height of the swell.

FALKLAND ISLAND WARP SCARER

This measure consists of a series of karabiner-style devices joined by a length of square netting. A brightly coloured hose (streamer) hangs from each karabiner into the sea to scare birds from the warp. Each streamer should reach the surface of the water in calm conditions. The Warp Scarer is deployed after shooting and retrieved prior to hauling, and while trawling it is in operation it is held in position by two ropes ('lazy lines') tied-off to the stern of the vessel. This measure was developed and tested in the Falkland Islands where it was found to be effective at reducing contacts between seabirds and the warp cable.

OTHER IDEAS

Several plastic or light metal buoys (bright red or yellow) are joined together and attached to the warp by means of a karabiner. This device is attached prior to setting operations and removed once the doors have docked. Once attached, the device slides freely down the cable to where the cable meets the water which is where the majority of fatal collisions occur. The device moves freely up and down the cable with wave surges.



Mitigation measures tested and found less effective: trawl

BRADY BAFFLER

The Brady Baffler has been developed by Keith Brady over several years of at-sea trials in New Zealand. It is designed to prevent birds that are scavenging for factory discharge from congregating at the stern of trawlers in the region where the warp cables enter the water. It consists of four booms, two

on either side of the warp cable, and two on either side of the vessel protruding perpendicular to the sides of the vessel. Hanging from each boom are ropes with plastic cones. As the vessel moves the cones prevent the birds from gathering near the warp cables. The Brady Baffler can be set at the beginning of a fishing trip and, except in extreme weather conditions it does not require retrieval until the end of the trip. The Baffler has undergone sea trials on several trawlers in New Zealand and the Falkland Islands and has been shown to be operationally robust in a range of sea states. However, when compared with bird-scaring lines and the Falklands warp scarer it was found that in isolation it is ineffective at reducing seabird mortality.

