Agreement on the Conservation of Albatrosses and Petrels

ACAP SUMMARY ADVICE FOR REDUCING IMPACT OF DEMERSAL LONGLINES ON SEABIRDS

Reviewed at the Ninth Meeting of the Advisory Committee
La Serena, Chile, 9 – 13 May 2016

SUMMARY

The most effective measures to reduce incidental take of seabirds in demersal longline fisheries are:

- use of an appropriate line weighting regime to maximise hook sink rates close to vessel sterns to reduce the availability of baits to seabirds.
- actively deterring birds from baited hooks by means of bird scaring lines, and
- setting by night.

Further measures include bird deterrent curtains at the hauling bay, responsible offal management and avoiding peak areas and periods of seabird foraging activity. Current knowledge indicates the Chilean, or trotline, system with appropriate line weighting and branch line length will prevent albatross and petrel mortality and is considered best practice mitigation for demersal longline fishing.

With other demersal longline fishing methods, it is important to note that there is no single solution to reduce or avoid incidental mortality of seabirds, and that the most effective approach is to use the measures listed above in combination.

INTRODUCTION

The incidental mortality of seabirds, mostly albatrosses and petrels, in longline fisheries has been of growing global concern. This was a major reason for the establishment of the Agreement on the Conservation of Albatrosses and Petrels (ACAP). A large number of mitigation methods to reduce and eliminate seabird bycatch has been developed and tested over the last 10 to 15 years, especially for demersal longline fisheries. Within demersal longlining, there are different systems – the autoline system, the Spanish double line system, and more recently the Chilean (trotline) system. Although most mitigation measures will be broadly applicable, the feasibility, design and effectiveness of some measures will be influenced by the type of longlining method and gear configuration used. In particular it should be noted that most scientific literature relates to fleets of larger vessels, with longline usage from artisanal fleets receiving less attention. Some of this advice may need to be

modified for smaller vessels. ACAP has comprehensively reviewed the scientific literature dealing with seabird bycatch mitigation in demersal fisheries and this document is a distillation of the review.

Best practice mitigation measures for demersal longline fisheries are listed below; the first recommendation is a general measure followed by those for line setting and line hauling.

1. BEST PRACTICE MEASURES - GENERAL

1.1 Area and seasonal closures

The temporary closure of important foraging areas (e.g. areas adjacent to important seabird colonies during the breeding season when large numbers of aggressively feeding seabirds are present) has been a very effective way to reduce incidental mortality of seabirds in fisheries in those areas.

2. BEST PRACTICE MEASURES - LINE SETTING

2.1 Line weighting

Lines should be weighted to get the baited hooks rapidly out of the range of feeding seabirds. Weights should be deployed before line tension occurs to ensure that the line sinks rapidly out of reach of seabirds.

2.2 Weighted lines for Spanish gear

Steel weights are considered best practice. The mass should be a minimum of 5kg at 40m intervals.

Where steel weights are not used, longlines should be set with a minimum of 8.5kg at 40m intervals when using rocks, and a minimum of 6kg at 20m intervals when using concrete weights.

2.3 Weighted lines for Chilean (trotline with nets) system gear

Line weights should conform to those for the Spanish system (see above).

2.4 Weighted lines for autoline gear

Integrated weight longlines (IWL) are designed with lead core of 50g/m. Their key characteristic is that they sink with a near-linear profile from the surface (minimal lofting in propeller turbulence) and are effective at sinking quickly out of reach of foraging seabirds. IWL should average ≥ 0.24 to 10 m depth.

Where it is practical to use IWL gear in a fishery, IWL is preferred over externally weighted alternatives because of its linear sink profile from the surface and consistent ability to achieve the minimum sink rate.

When using external weights on non-IWL autoline gear, the minimum average sink rate should be 0.3 m/s to 10 m depth. A faster sink rate is necessary with this configuration to minimise the lofting of sections of line between line weights in propeller turbulence. The sink

rate can be achieved with a minimum of 5kg at no more than 40m intervals.

2.5 Night setting

Setting longlines at night (between the times of the end of nautical twilight and before nautical dawn) is effective at reducing incidental mortality of seabirds because the majority of vulnerable seabirds are diurnal foragers.

2.6 Bird scaring lines

Bird scaring lines are designed to provide a physical deterrent over the area where baited hooks are sinking.

Two bird scaring lines should be used.

The design of the bird scaring lines should include the following specifications:

The attachment height should be at least 7m above sea level.

The lines should be at least 150m long to ensure the maximum possible aerial extent.

Streamers should be brightly coloured and reach the sea-surface in calm conditions, and placed at intervals of no more than 5m.

A suitable towed device should be used to provide drag, maximise aerial extent and maintain the line directly behind the vessel during crosswinds.

2.7 Offal and discard discharge management

Seabirds are attracted to offal that is discharged from vessels. Ideally offal should be retained onboard but if that is not possible, offal and discards should not be discharged while setting lines.

3. BEST PRACTICE MEASURES - LINE HAULING

3.1. Bird exclusion device (BED)/Brickle curtain

During hauling operations birds can accidentally become hooked as gear is retrieved. A BED consists of a horizontal support several metres above the water that encircles the entire line hauling bay. Vertical streamers are positioned between the support and water surface. The seabird deterrent effectiveness of this streamer line configuration can be increased by deploying a line of floats on the water surface and connecting this line of floats to the support with downlines. This configuration is the most effective method to prevent birds entering the area around the hauling bay, either by swimming or by flying.

3.2. Offal and discard discharge management

Ideally offal should be retained onboard, but if that is not possible offal and discards should be either, preferably, retained on board during hauling or released on the opposite side of the vessel to the hauling bay.

All hooks should be removed and retained on board before discards are discharged from the vessel.

4. OTHER CONSIDERATIONS

4.1. Chilean method

The Chilean method of longline fishing was designed to prevent toothed whale depredations of fish. Because weights are deployed directly below the hooks, and because hook-bearing lines sink with a vertical profile in the seabird foraging depths (not horizontally, as in the traditional Spanish method), lines sink rapidly, making it an effective method for avoiding bycatch of foraging seabirds.

To eliminate the ingestion of hooks by seabirds during line hauling operations, care must be taken to retain all hooks onboard and not discard them overboard, either as unwanted hooks or as hooks embedded in discarded fish.

5. NOT RECOMMENDED

The following mitigation options are NOT recommended best practice:

Hook design – insufficiently researched

Olfactory deterrents – insufficiently researched

Underwater setting chutes - insufficiently researched.

Side setting - insufficiently researched and operational difficulties.

Blue-dyed bait, thawed bait - not relevant in demersal longline gear

Use of a line setter - not relevant in demersal longline gear.

ACAP REVIEW OF SEABIRD BYCATCH MITIGATION MEASURES FOR DEMERSAL LONGLINE FISHERIES

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This Annex summarises the results of studies that have been carried out to develop, test and improve seabird mitigation measures in demersal longline fisheries. A comprehensive range of technical and operational mitigation methods have been designed or adapted for use in demersal and semi-pelagic longline fisheries. These methods aim to reduce incidental mortality of seabirds by avoiding peak areas and periods of seabird foraging activity, reducing the time baited hooks are near the surface and thus available to birds, actively deterring birds from baited hooks, and making the vessel less attractive to birds and minimising the visibility of baited hooks. Apart from being technically effective at reducing seabird bycatch, mitigation methods need to be easy and safe to implement, cost effective, enforceable and should not reduce catch rates of target species. There is no single solution that will eliminate seabird bycatch; the most effective approach is to use a combination of measures. The suite of measures available may vary in their feasibility and effectiveness depending on the area, seabird assemblages involved, fishery and vessel type and gear configuration. Some of the mitigation methods are now well established and explicitly prescribed in longline fisheries. However, other measures are relatively recent and require further testing and refinements, and there is a need to ensure that the collaborative approach to research and monitoring that has characterised field of seabird bycatch mitigation continues.

BEST PRACTICE GUIDELINES	
1.	Night setting
2.	Area and seasonal closures
3. a)	Externally weighted lines: Spanish system
b)	Externally weighted lines: Chilean method (drop lines with nets)
c)	Externally weighted lines: Autoline
4.	Integrated weighting of lines
5.	Single bird scaring line
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OTHER CONSIDERATIONS
8. Side setting
9. Underwater setting funnel/chute
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11. Thawing bait
12. Olfactory deterrents
13. Strategic management of offal discharge
14. Blue-dyed bait
15. Hook size and shape
MITIGATION MEASURES UNDER DEVELOPMENT
16. Kellian Line Setter

BEST PRACTICE GUIDELINES

1. Night setting

Scientific evidence for effectiveness in demersal fisheries

PROVEN AND RECOMMENDED. Recommend combination with bird scaring lines and/or weighted lines, especially to reduce incidental mortality of birds that forage at night (Ashford *et al*. 1995; Cherel *et al*. 1996; Moreno *et al*. 1996; Barnes *et al*. 1997; Ashford & Croxall 1998; Klaer & Polacheck 1998; Weimerskirch *et al*. 2000; Belda & Sánchez 2001; Nel *et al*. 2002; Ryan & Watkins 2002; Sánchez & Belda 2003; Reid *et al*. 2004; Gómez Laich *et al.* 2006).

Minimum standards

Night defined as the period between the times of nautical twilight (nautical dark to nautical dawn).

Caveats /Notes

Bright moonlight and deck lights reduce the effectiveness of this mitigation measure. Not as effective for crepuscular/nocturnal foragers such as the white-chinned petrel but even for these species night setting is more effective than setting during the day. In order to maximise effectiveness of this mitigation measure, deck lights should be off or kept to an absolute minimum, and used in combination with additional mitigation measures, especially when setting in bright moonlight conditions. Night setting is not a practical option for fisheries operating at high latitudes during summer. Setting should be completed at least 3 hours before sunrise to avoid the predawn activity of white-chinned petrels

Research needs

Effect of night setting on catch rates of target species for different fisheries.

Implementation monitoring

Via VMS and fishery observers.

2. Area and seasonal closures

Scientific evidence for effectiveness in demersal fisheries

PROVEN AND RECOMMENDED. Must be combined with other measures, both in the specific areas when the fishing season is opened, and also in adjacent areas to ensure displacement of fishing effort does not merely lead to a spatial shift in the incidental mortality. A number of studies have reported marked seasonality in seabird bycatch rates, with the majority of deaths taking place during the breeding season (Moreno *et al.* 1996; Ryan *et al*. 1997; Ashford & Croxall 1998; Ryan & Purves 1998; Ryan & Watkins 1999; Ryan & Watkins 2000; Weimerskirch *et al*. 2000; Kock 2001; Nel *et al*. 2002; Ryan & Watkins 2002; Croxall & Nicol 2004; Reid *et al*. 2004; Delord *et al*. 2005). In some studies, mortality has been almost exclusively within the breeding season. Several studies have also shown that proximity to breeding colonies is an important determinant of seabird bycatch rates (Moreno *et al*. 1996; Nel *et al*. 2002). The much higher rate of seabird bycatch during the breeding period led to the temporal closure of the fishery in CCAMLR sub-area 48.3 from 1998, which contributed to a ten-fold reduction in seabird bycatch (Croxall & Nicol 2004). Movement of fishing effort away from the Prince Edward Islands coincided with a reduction in seabird bycatch in the sanctioned Prince Edward Island fishery.

Caveats /Notes

It's difficult to separate the temporal closure from the increased uptake/implementation of other mitigation measures, but it is clearly an important and effective management response, especially for high risk areas, and when other measures prove ineffective. There is a risk that temporal/spatial closures could displace fishing effort into neighbouring or other areas which may not be as well regulated, thus leading to increased incidental mortality elsewhere.

Research needs

Further information about the seasonal variability in patterns of species abundance, and particularly how these interact with the spatial and temporal characteristics of fishing effort, especially for high risk areas (e.g. adjacent to important breeding colonies). In some studies, incidental mortality has been greatest during the chick-rearing period (Nel *et al*. 2002; Delord *et al*. 2005), whereas others have reported highest mortality during the incubation period (Reid *et al*. 2004). This difference likely relates to where the birds are foraging in relation to fishing effort at the time, and highlights the importance of understanding this interaction. Research is also required to determine the regional impact of closures on catches of target species.

Minimum standards

Currently, the area around South Georgia (Islas Georgias del Sur)[1] (CCAMLR Subarea 48.3)

[1] "A dispute exists between the Governments of Argentina and the United Kingdom of Great Britain and Northern Ireland concerning sovereignty over the Falkland Islands (Islas Malvinas), South Georgia and the South Sandwich Islands (Islas Georgias del Sur e Islas Sandwich del Sur) and the surrounding maritime areas".

is open from May 1st to Aug 31st or till established catch limit is reached, as provided for by CCAMLR Conservation Measures in force (41-02/2007).

Implementation monitoring

Via VMS or fishery observers within national economic zones, and via aerial and at-sea surveillance if IUU fishing is suspected.

3. Externally weighted lines:

a) Spanish system

Scientific evidence for effectiveness in demersal fisheries

PROVEN AND RECOMMENDED. Must be combined with other measures, especially effective bird scaring lines, judicious offal management and/or night setting (Agnew *et al.* 2000; Robertson 2000; Robertson *et. al*. 2008a; 2008b; Melvin *et al*. 2001; Moreno *et al*. 2006; Moreno *et al*. 2008).

Caveats /Notes

Spanish system longlines are buoyant and weights must be attached to sink gear to fishing depth. Longlines with externally added weights sink unevenly, faster at the weights than at the midpoint between weights. Although gear configuration and setting speed influence the sink profiles of the hook lines (Seco Pon *et al*. 2007), the principle determinants of sink rates are the mass of the weights and the distance between weights (Robertson *et al*. 2008a). It is critical that tension astern is eliminated to ensure the smooth flow of hooks from gear baskets. This can be done by ensuring the correct packing of lines and snoods in baskets, preventing hooks snagging on snood baskets and by ensuring that weights are released from the vessel before line tension occurs (Robertson *et al*. 2008a,b). Weights must be attached and removed for each set-haul cycle, which is onerous and potentially hazardous for crew members. Weights comprised of rocks enclosed in netting bags and concrete blocks deteriorate and require ongoing maintenance/replacement and monitoring to ensure weights are the required mass (Otley 2005); weights made of solid steel are preferred, in terms of mass consistency, handling, minimal-to-no maintenance and compliance (Robertson *et al*. 2008b).

Research needs

Sink rates and profiles of line weighting regimes may vary according to vessel type, setting speed and deployment position in relation to propeller turbulence. It is important that the sink rate relationships of different line weighting regimes are understood for a particular fishery (or fishery method) and that the effectiveness of the line weighting regime and the sink profile in reducing seabird mortality is tested.

Minimum standards

Global minimum standards not established. Requirements vary by fishery and vessel type. For example, CCAMLR minimum requirements for vessels using the Spanish method of longline fishing are 8.5kg mass at 40m intervals (if rocks are used), 6kg mass at 20m intervals for traditional (concrete) weights, and 5kg weights at 40m intervals for solid steel weights.

Implementation monitoring

Fishing gear is deployed manually. Weights are attached by hand during line setting and removed during line hauling. Distance between weights and the mass of the weight used may vary in accordance with fishing strategy and for operational reasons. Observer presence on vessel is required to assess implementation.

3. Externally weighted lines:
b) Chilean method (trot line with nets)

Scientific evidence for effectiveness in demersal fisheries

PROVEN AND RECOMMENDED. Although effectively prevents mortality as a sole measure, prudent to use in combination with a single bird scaring streamer line. This method (first tested on large longline vessels in 2005) is a variant of the traditional Spanish double line method of longlining and was developed in Chile to minimise depredation of Patagonian toothfish by toothed whales (Figure 1). This system makes use of net sleeves or 'cachaloteras' which envelop captured fish during hauling. Hooks are clustered on secondary lines to which weights are attached, resulting in very fast hook sink rates (mean: 0.8 m/s c.f. 0.15 m/s for the Spanish system) in the first 15-20 m (the length of the secondary lines) of water column. Has the capacity to reduce (or eliminate) seabird mortality to negligible levels (Moreno *et al*. 2006; Moreno *et al*. 2008; Robertson *et al*. 2008b). Because of its effectiveness in reducing impacts of toothed whales, this method is currently used in many longline fleets operating in South American waters (Moreno *et al*. 2008), as well as in the south west Atlantic.

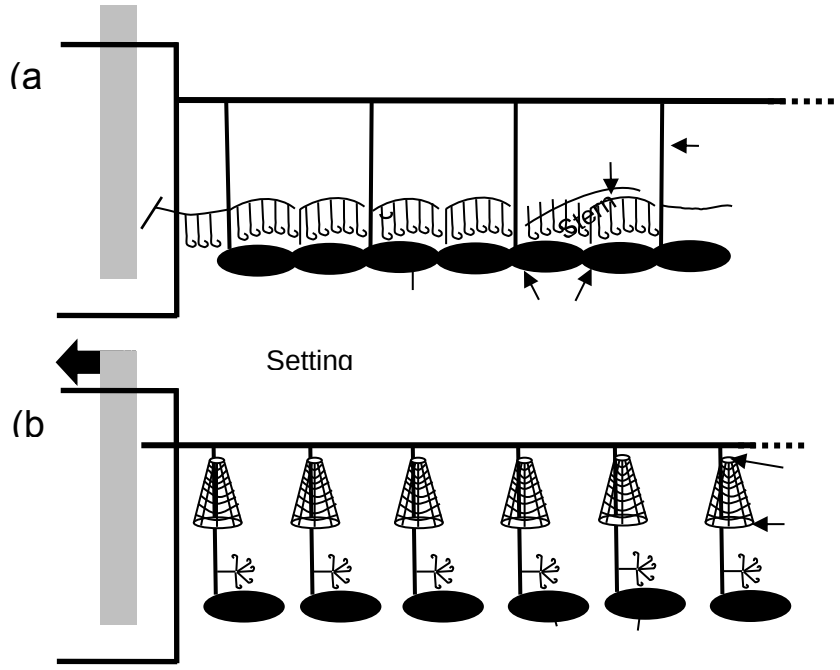

Figure 1. Typical configurations of the traditional Spanish double line system (a) and Chilean (trotline) system (b) showing differences in gear design and location of weights in relation to hooks. The open-ended secondary/connecting lines (not joined by a continuous hook line) and proximity of weights to hooks of the Chilean system enables hooks to sink rapidly and with a linear profile (no lofting in propeller turbulence) from the surface close to vessel sterns. Drawings not to scale.

Caveats /Notes

This is a relatively new system, is possibly still in the evolutionary stages, and should be monitored and possibly refined further. Concern has been raised about the excessive discarding of fish bycatch (e.g. grenadiers) with embedded hooks and the ingestion of these hooks by albatrosses following vessels (Phillips *et al*. 2010). The solution to this problem is to stop hooks from being discarded in the first place. This is best achieved by banning the discarding of hooks as part of the licence conditions, as is already done in many fisheries, and also increasing awareness amongst fishers, observers and operators to facilitate compliance with such a ban. Another concern is that vessels can switch between Spanish method and Chilean method within fishing trips and even within sets of the longline; this is a key reason why further monitoring is required.

Research needs

Effective as a solitary measure against albatrosses and most likely effective against *Procellaria* sp petrels due to the very rapid sink rates to depths beyond the known dive range of this group of seabirds. Research is required to determine effectiveness against *Puffinus* sp shearwaters.

This is a relatively new fishing method and may be in the process of refinement. It is important to monitor changes to gear design, especially those likely to affect the sink rates of baited hooks.

Minimum standards

No global standards yet.

Implementation monitoring

Hook-bearing secondary lines require weights be attached in order to sink. However, alternating between this fishing method and the traditional Spanish method within fishing trips is problematic. While this capacity exists the requirements for the Spanish system should apply (see “a”, above).

3. Externally weighted lines:
c) Autoline

Scientific evidence for effectiveness in demersal fisheries

PROVEN AND RECOMMENDED. Must be used in combination with an effective bird scaring streamer line. In the Southern Hemisphere evidence pertains to effect of added external weights on longline sink rates, not effectiveness in deterring seabirds. Attachment of 5 kg weights at no more than 40 m intervals increased mean sink rate from 0.1 m/s (unweighted gear) to 0.3 m/s on the section of longline mid-way between line weights (Robertson 2000). This rate exceeds that of integrated with longlines, which have been thoroughly tested against seabirds (see below). Attachment of external weighs necessary in Antarctic toothfish fisheries to comply with the minimum sink rate (0.3 m/s) required by CCAMLR operating in high latitude areas in summer, where it was not possible to set lines at night.

Caveats /Notes

As for the Spanish system it is important that external weights be released from vessels in a manner that avoids tension astern (tension astern may lift sections of the longline already deployed out of the water).

Research needs

Likely to be effective in deterring albatrosses and *Procellaria* sp seabirds. Evidence is lacking for effectiveness against *Puffinus* sp shearwaters.

Minimum standards

CCAMLR requires as a minimum 5 kg mass at intervals no more than 40 m. It is also required that weights be released before line tension occurs. In the New Zealand fisheries, a minimum of 4 kg (metal weight) or 5 kg (non-metal weight) be attached every 60 m if the hook bearing line is 3.5 mm or greater in diameter, and a minimum of 0.7 kg of weight every 60m when the line is less than 3.5 mm diameter. The New Zealand minimum standards also include requirements relating to the use of floats.

Implementation monitoring

Weights are attached to longlines manually. Observer presence on-board vessel is required to assess implementation.

4. Integrated weighting of lines

Scientific evidence for effectiveness in demersal fisheries

PROVEN AND RECOMMENDED. Should be used in combination with bird scaring lines, judicious offal management and/or night setting. Apart from the practical advantages of integrated weight (IW) longlines – superior handling qualities and practically inviolable – the IW longlines sink more quickly and uniformly out of reach of most seabirds compared with externally weighted lines. IW longlines have been shown to reduce substantially mortality rates of surface foragers and diving seabirds, while not affecting catch rates of target species (Robertson *et al.* 2002; Robertson *et al*. 2003; Robertson *et al.* 2006; Dietrich *et al*. 2008).

Caveats /Notes

Restricted to autoline vessels. The sink rate of IW longlines can vary depending on vessel type, setting speed and deployment of line relative to propeller wash (Melvin & Wainstein 2006; Dietrich *et al.* 2008). Setting speed influences the extent of the seabird access window – the area in which most seabirds are still able to access the baited hooks in the absence of bird scaring lines (Dietrich *et al*. 2008). Use of IW lines is likely to increase the portion of the line on the seafloor, and may lead to increases in the bycatch of vulnerable fish, shark and ray species. This may be mitigated by placing a weight and a float on a 10 m line at the point of the dropper line attachment, thus ensuring the line sinks rapidly to 10 m, out of reach of vulnerable seabirds, but remains off the seabed (Petersen 2008).

Research needs

The relationship between line-weighting regime, setting speed, sink rates/profiles and the seabird access window should be investigated for other fisheries (i.e. those that haven't already been tested –Bering Sea, Alaska, and New Zealand ling fishery) including with additional mitigation measures (particularly bird scaring lines); these investigations would be useful in determining the necessary aerial extent of the bird scaring lines.

Minimum standards

Global minimum standards not in place. CCAMLR currently require as a minimum IW lines with a lead core of 50g/m, which is also required in the New Zealand demersal longline fishery.

Implementation monitoring

Weight (lead core) integrated into fabric of longline, so compliance is intrinsic in this measure. It is expensive and time consuming to alter longline when at sea, including for vessels with long transit times to fishing grounds (e.g. Antarctic and sub Antarctic fisheries). Port inspection of all longline on board prior to embarkation on fishing trips considered adequate for assessment of compliance.

5. Single bird scaring line

Scientific evidence for effectiveness in demersal fisheries

PROVEN AND RECOMMENDED. Effectiveness is increased when using multiple bird scaring lines and when used in combination with other measures – e.g. night setting, appropriate weighting of line and judicious offal management. The use of a single bird scaring line has been shown to be an effective mitigation measure in a range of demersal longline fisheries, especially when used properly (Moreno *et al.* 1996; Løkkeborg 1998, 2001; Melvin *et al.* 2001; Smith 2001; Løkkeborg & Robertson 2002; Løkkeborg 2003).

Caveats /Notes

Effective only when streamers are positioned over sinking hooks. Single bird scaring lines can be less effective in strong crosswinds (Løkkeborg 1998; Brothers *et al.* 1999; Agnew *et al.* 2000; Melvin *et al.* 2001; Melvin *et al.* 2004). In the event of strong crosswinds, bird scaring lines should be deployed from the windward side. This problem can also be overcome by using paired bird scaring lines (see below).The effectiveness of the bird scaring lines is also dependent on the design, the aerial coverage of the bird scaring line, seabird species present during line setting (proficient divers being more difficult to deter from baits than surface feeding birds) and the proper use of the bird scaring line. The aerial coverage and the position of the bird scaring line relative to the sinking hooks are the most important factors influencing their performance. There have been a few incidents of birds becoming entangled in bird scaring lines (Otley *et al*. 2007). However it must be stressed that the numbers are minuscule, especially when compared with the number of mortalities recorded in the absence of bird scaring lines. Bird scaring lines remain a highly effective mitigation measure, and efforts should be directed to improving further their design and use so that their effectiveness can be improved further.

Research needs

The use and specifications/performance standards are fairly well established in demersal longline fisheries. However, there is scope to improve further the effectiveness and practical use of bird scaring lines on individual vessels or vessel type.

Minimum standards

Current minimum standards vary. CCAMLR was the first conservation body that required all longline vessels in its area of application to use bird scaring lines (Conservation Measure 29/X adopted in 1991). The bird scaring line has gone on to become the most commonly applied mitigation measure in longline fisheries worldwide (Melvin et al. 2004). CCAMLR currently prescribes a range of specifications relating to the design and use of bird scaring lines. These include the minimum length of the line (150m), the height of the attachment point on the vessel (7m above the water), and details about streamer lengths and intervals between streamers. Other fisheries have adapted these measures. Some, such as those in New Zealand and Alaska have set explicit standards for the aerial coverage of the bird scaring lines, which varies according to the size of the vessel.

Implementation monitoring

Bird scaring lines are usually deployed and retrieved on a set-by-set basis (they are not a fixed part of fishing gear/operations). Requires fisheries observers, video surveillance or at-sea surveillance (e.g. patrol boats or aerial over-flights).

6. Paired or multiple bird scaring lines

Scientific evidence for effectiveness in demersal fisheries

PROVEN AND RECOMMENDED. Effectiveness is increased when used in combination with other measures – e.g. night setting, appropriate weighting of line and judicious offal management. Several studies have shown that the use of two or more streamer lines is more effective at deterring birds from baited hooks than streamer line (Melvin *et al.* 2001; Sullivan & Reid 2002; Melvin 2003; Melvin *et al.* 2004; Reid *et al.* 2004). The combination of paired streamer lines and IW longlines is considered the most effective mitigation measure in demersal longline fisheries using autoline systems (Dietrich *et al.* 2008).

Caveats /Notes

Potentially increased likelihood of entanglement with other gear. Use of an effective towed device that keeps lines from crossing surface gear essential to improve adoption and compliance. See also above comment about bird entanglements in bird scaring lines. Manually attached and operated paired or multiple bird scaring lines requires some effort to operate (a 150m double line takes about 8-10 men to retrieve). One way of overcoming this is to make use of electronic winches.

Research needs

Further trialling in fisheries which currently only use single streamer lines.

Minimum standards

Paired streamer lines required in Alaskan fisheries and encouraged/recommended by CCAMLR, except in the French exclusive economic zone (CCAMLR Subarea 58.6 and Division 58.5.1), where paired streamer lines have been compulsory since 2005. Paired streamer lines have also been required in the Australian longline fisheries off Heard Island since 2003 (Dietrich *et al*. 2008)

Implementation monitoring

Bird scaring lines are usually deployed and retrieved on a set-by-set basis (they are not a fixed part of fishing gear/operations).Requires fisheries observers, video surveillance or at-sea surveillance (e.g. patrol boats or aerial over-flights.

7. Haul bird exclusion devices

Scientific evidence for effectiveness in demersal fisheries

PROVEN AND RECOMMENDED AS A HAUL MITIGATION MEASURE. Must be used in combination with other mitigation measures – bird scaring lines at setting, line weighting, night setting and judicious offal management. The use of a bird exclusion device such as a Brickle curtain can effectively reduce the incidence of birds becoming foul hooked when the line is being hauled (Brothers *et al.* 1999; Sullivan 2004; Otley *et al*. 2007; Reid *et al*. 2010).

Caveats /Notes

Some species, such as the black-browed albatross and cape petrel, can become habituated to the curtain, so it is important to use it strategically – when there are high densities of birds around the hauling bay (Sullivan 2004).

Minimum standards

A device designed to discourage birds from accessing baits during hauling operations is required in high risk CCAMLR areas (exact design not specified, but it is required that they fulfil two operational characteristics: 1) deter birds from flying into the area where the line is being hauled, and 2) prevents birds that are sitting on the surface from swimming into the hauling bay area). Also required in the Falkland Islands[1] (Islas Malvinas) longline fishery, where the Brickle Curtain is recommended (A. Wolfaardt pers. comm.).

Implementation monitoring

Bird exclusion devices are usually deployed and retrieved on a haul-by-haul basis (they are not a fixed part of fishing gear/operations. Requires fisheries observers, video surveillance or at-sea surveillance.

OTHER CONSIDERATIONS

8. Side setting

Scientific evidence for effectiveness in demersal fisheries

NOT RECOMMENDED AT THIS TIME. Must be used in combination with other mitigation measures, especially the use of a bird curtain (Gilman *et al*. 2007), and bird scaring lines. Has not been widely tested in demersal longline fisheries. In trials in the New Zealand ling fishery, side setting appeared to reduce seabird bycatch; however, the results were not convincing and there were practical/operational difficulties, with the line becoming entangled in the propeller (Bull 2007). Sullivan (2004) reported that side setting has been used in some demersal fisheries (e.g. shark fisheries) which have experienced negligible incidental mortality.

Caveats /Notes

Practical difficulties, especially in difficult weather/sea conditions. In many cases it may be difficult and expensive converting the vessel's deck design to employ a side setting system.

Research needs

Largely untested in the demersal fisheries, especially in the Southern Ocean, where the seabird assemblages include proficient diving seabirds. Research urgently needed.

Minimum standards

Only in Hawaii for the pelagic longline fisheries, where it is used in conjunction with a bird curtain and weighted branch lines (45g within 1m of hook); side setting is defined as a minimum of 1m forward of the stern.

Implementation monitoring

Requires longline be set with the aid of a device(s) (e.g., autobaiter; line shooter) from a fixed position on vessels that is crucial to the operational effectiveness of line setting. Port inspection of line deployment set-up considered to be adequate to assess implementation.

9. Underwater setting funnel/chute

Scientific evidence for effectiveness in demersal fisheries

NOT RECOMMENDED AT THIS TIME. Must be used in conjunction with other mitigation measures – bird scaring lines, weighted lines, night setting and judicious offal management. An underwater setting funnel has been tested in demersal longline fisheries in Alaska, Norway and South Africa, with all studies showing a reduction in the mortality rate, although the extent of the reduction varied between studies (Løkkeborg 1998, 2001; Melvin *et al*. 2001; Ryan & Watkins 2002).

Caveats /Notes

Present design is mainly for a single line system. Results from studies to date have been inconsistent, likely due to the depth at which the device delivers the baited hooks and the

diving ability of the seabirds in the fishing area studied. The pitch angles of the vessel, which are influenced by the loading of weight and sea conditions, affect the performance of the funnel (Løkkeborg 2001).

Research needs

Need to investigate improvements to the current design to increase the depth at which the line is set, especially during rough seas. Should also be tested with integrated weight lines to determine whether this improves bycatch reduction. Also need to investigate optimal use of device together with other mitigation measures (bird scaring lines and weighted lines).

Minimum standards

Not yet established.

Implementation monitoring

On-board monitoring, such as full-time observer coverage, video surveillance or at-sea inspection is recommended to monitor implementation..

10. Line setter/shooter

Scientific evidence for effectiveness in demersal fisheries

NOT RECOMMENDED AT THIS TIME. Must be combined with other measures, such as bird scaring lines, night setting, weighted lines and judicious offal management. Less used in demersal long-line fisheries; variation in the precise method of operation is cause of variation in efficacy. In Norway, no statistical differences were detected in catch rates of northern fulmars between sets with and without a line shooter (Løkkeborg & Robertson 2002; Løkkeborg 2003). In Alaska, use of a line shooter increased seabird bycatch (Melvin *et. al*. 2001). However, the reasons for this finding are unclear.

Caveats /Notes

Robertson *et al.* (2008c) found no significant difference between the sink rates of integrated weight longlines of autoline vessels that were set with and without a line setter in the Ross Sea, and were doubtful that the use of line setters would lead to substantial reductions in interactions between seabirds and longlines. Unequivocal evidence of effectiveness in reducing seabird bycatch is lacking. In need of further refinement.

Research needs

Need to investigate whether refinement/modification of the device will be able to overcome the problem of propeller wash and ensure consistently rapid sink rates and significantly reduced seabird mortality. Not considered a mitigation measure at this time.

Minimum standards

Not considered a mitigation measure at this time.

11. Thawing bait

Scientific evidence for effectiveness in demersal fisheries

NOT RECOMMENDED AS A PRIMARY MITIGATION MEASURE. Not as much of an issue compared with pelagic longlining. For autoliners, the bait must be at least partially thawed before they can be sliced by the automated baiting system; in the Spanish system, the interval between manually baiting the hooks and setting the lines is sufficiently long to allow for thawing (except in very low ambient temperatures); and the line weighting regime overcomes most of the problems with frozen bait (Brothers *et al.* 1999).

Caveats /Notes

Effect is likely to be very minor. Not a primary measure.

Research needs

No priority research needs.

12. Olfactory deterrents

Scientific evidence for effectiveness in demersal fisheries

NOT RECOMMENDED AS A MITIGATION MEASURE AT THIS TIME. Must be used in combination with other mitigation measures – bird scaring lines at setting, line weighting, night setting and judicious offal management – especially until further testing has been conducted. Dripping shark liver oil on the sea surface behind vessels has been shown to effectively reduce the number of seabirds (restricted to burrow-nesting birds) attending vessels and diving for bait in New Zealand (Pierre & Norden 2006; Norden & Pierre 2007).

Caveats /Notes

The shark liver oil did not deter albatrosses, giant petrels, or Cape petrels from boats (Norden & Pierre 2007). The potential impact of releasing large amounts of concentrated fish oil into the marine environment is unknown, as is the potential for contaminating seabirds attending vessels and the potential of seabirds to become habituated to the deterrent (Pierre & Norden 2006).

Research needs

Testing should be extended to candidate/suitable species of conservation concern, such as white-chinned petrels and sooty shearwaters. Research is also required to identify the key ingredients in the shark oil that are responsible for deterring seabirds, and the mechanism by which the birds are deterred. The potential “pollution” effects also need to be investigated.

Minimum standards

None yet.

Implementation monitoring

Monitoring of line setting operations by observer placement or video surveillance is required to assess implementation.

13. Strategic management of offal discharge

Scientific evidence for effectiveness in demersal fisheries

NOT RECOMMENDED AS A PRIMARY MITIGATION MEASURE. Must be used in combination with other mitigation measures – bird scaring lines. line weighting, and night setting. Some studies have shown that dumping homogenised offal (which is generally more easily available and thus attractive to seabirds than bait) during setting attracts birds away from the baited line to the side of the vessel where the offal is being discharged, and thus reduces bycatch of seabirds on the baited hooks (Cherel *et al*. 1996; Weimerskirch et al. 2000).

Caveats /Notes

Although strategic offal discharge has been shown to be effective at reducing seabird bycatch around Kerguelen Island, there are many risks associated with the practice. Offal discharge needs to be continued throughout the setting operation so as to ensure the birds do not move on to the baited hooks. This will only be possible in fisheries where line setting is short, and there is sufficient offal to sustain the line-setting period. This measure also has the potential to foul hook birds if offal is discharged with hooks. It is crucial, then, that all offal is checked for hooks before being discharged. Given these risks, and the fact that the presence of offal is a critical factor affecting seabird numbers attending vessels, most fisheries management regimes require that no offal can be discharged during line setting, and that if discarding is necessary at other times it should take place on the side of the vessel opposite to where the lines are being hauled.

Research needs

Further information needed on opportunities to manage offal more effectively – considering both practical aspects and seabird bycatch mitigation – in the short and long term.

Minimum standards

In CCAMLR demersal fisheries, discharge of offal is prohibited during line setting. During line hauling, storage of waste is encouraged, and if discharged must be discharged on the opposite side of the vessel to the hauling bay. A system to remove fish hooks from offal and fish heads prior to discharge is required. Similar requirements are prescribed by other demersal longline fisheries (e.g. Falkland Islands[1] (Islas Malvinas), South Africa and New Zealand).

Implementation monitoring

Requires offal discharge practices and events to be monitored by fisheries observers or video surveillance.

14. Blue-dyed bait

Scientific evidence for effectiveness in demersal fisheries

NOT RECOMMENDED AS A PRIMARY MEASURE AT THIS TIME. Must be used in combination with other mitigation measures – bird scaring lines. line weighting, night setting and judicious offal management The performance of this measure has only been tested in

the pelagic longline fishery (Boggs 2001; Minami & Kiyota 2004; Gilman *et al.* 2007; Cocking *et al.* 2008), and with mixed success.

Caveats /Notes

New data suggests that this measure is only effective with squid bait (Cocking *et al.* 2008). It has not been tested in demersal fisheries, possibly due to larger number of hooks deployed and thus the need for considerably more bait (Bull 2007). There is no commercially available dye. Onboard dyeing is practically onerous, especially in inclement weather. In the long-term birds may become habituated to blue-dyed bait.

Research needs

Need for tests of efficacy and practical feasibility in demersal longline fisheries, especially in the Southern Ocean to determine its effectiveness as a long-term mitigation measure. Research would also need to determine the effect of dyed bait on catches of target species.

Minimum standards

Mix to standardized colour placard or specify (e.g. use 'Brilliant Blue' food dye (Colour Index 42090, also known as food additive number E133) mixed at 0.5% for a minimum of 20 minutes).

Implementation monitoring

The current practice of dyeing bait on board vessels at sea requires observer presence or video surveillance to assess monitor implementation. Assessment of implementation in the absence of on-board observers or video surveillance requires baits to be dyed on land and monitored through port inspection of all bait on vessels prior to departure on fishing trips.

15. Hook size and shape

Scientific evidence for effectiveness in demersal fisheries

NOT RECOMMENDED AS A PRIMARY MITIGATION MEASURE. Must be used in combination with other mitigation measures – bird scaring lines. line weighting, night setting and judicious offal management Hook size was found to be an important determinant in seabird bycatch rates of Argentinean and Chilean longline vessels fishing in Subarea 48.3 in the 1995 season, with smaller hooks killing significantly more seabirds than larger hooks (Moreno *et al.* 1996).

Caveats /Notes

Other than the finding in Moreno *et al.* (1996), little or no work has been conducted to investigate the impact of hood design and shape on seabird bycatch levels.

Research needs

Determine impact on seabird bycatch and on catch of target species.

Minimum standards

No global standard

Implementation monitoring

Port inspection of all hooks on board considered adequate for monitoring implementation.

MITIGATION MEASURES UNDER DEVELOPMENT

16. Kellian Line Setter

Scientific evidence for effectiveness in demersal fisheries

NOT RECOMMENDED AT THIS TIME. The Kellian Line Setter was identified as a potential mitigation device in New Zealand inshore bottom longline fisheries, (Goad 2011). The Kellian Line Setter is an underwater setting device and involves running the mainline through a set of rollers towed behind the vessel at depth.

Caveats /Notes

An initial prototype had been developed through a series of at-sea trials which were conducted during 2011. While these trials were encouraging, the issue of weights and floats fouling on the rollers required resolution (Goad 2011). A new prototype has been developed and refined in a flume tank (Baker and Frost 2013) for application in a range of demersal longline operations.

Research needs

Resolution of mainline loss issues under flume tank conditions prior to further evaluation in at-sea trials.

Minimum standards

Not considered a mitigation measure at this time.

REFERENCES

Agnew, D. J., A. D. Black, J. P. Croxall, and G. B. Parkes. 2000. Experimental evaluation of the effectiveness of weighting regimes in reducing seabird by-catch in the longline toothfish fishery around South Georgia. CCAMLR Science 7:119-131.

Ashford, J. R., and J. P. Croxall. 1998. An assessment of CCAMLR measures employed to mitigate seabird mortality in longline operations for *Dissostichus eleginoides* around South Georgia. CCAMLR Science 5:217-230.

Ashford, J. R., J. P. Croxall, P. S. Rubilar, and C. A. Moreno. 1995. Seabird interactions with longlining operations for Dissostichus eleginoides around South Georgia, April to May 1994. CCAMLR Science 2:111-121.

Baker, G.B. and Frost, R. 2013. Development of the Kellian Line Setter for Inshore Bottom Longline Fisheries to reduce availability of hooks to seabirds. Preliminary report. ACAP SBWG5 Doc 10.

Barnes, K. N., P. G. Ryan, and C. Boix-Hinzen. 1997. The impact of the Hake Merluccius spp. longline fishery off South Africa on procellariiform seabirds. Biological Conservation 82:227-234.

Belda, E. J., and A. Sánchez. 2001. Seabird mortality on longline fisheries in the western Mediterranean: factors affecting bycatch and proposed mitigating measures. Biological Conservation 98:357-363.

Boggs, C. H. 2001. Deterring albatrosses from contacting baits during swordfish longline sets. Pages 79-94 in E. F. Melvin, and J. K. Parrish, editors. Seabird Bycatch: Trends, Roadblocks and Solutions. University of Alaska Sea Grant, AK-SG-01, Fairbanks, AK.

Brothers, N. P., J. Cooper, and S. Løkkeborg. 1999. The incidental catch of seabirds by longline fisheries: worldwide review and technical guidelines for mitigation. FAO Fisheries Circular 937.

Bull, L. S. 2007. Reducing seabird bycatch in longline, trawl and gillnet fisheries. Fish and Fisheries 8:31-56.

Cherel, Y., H. Weimerskirch, and G. Duhamel. 1996. Interactions between longline vessels and seabirds in Kerguelen waters and a method to reduce seabird mortality. Biological Conservation 75:63 - 70.

Cocking, L. J., M. C. Double, P. J. Milburn, and V. E. Brando. 2008. Seabird bycatch mitigation and blue-dyed bait: A spectral and experimental assessment. Biological Conservation 141:1354-1364.

Croxall, J. P., and S. Nicol. 2004. Management of Southern Ocean fisheries: global forces and future sustainability. Antarctic Science 16:569-584.

Delord, K., N. Gasco, H. Weimerskirch, C. Barbraud, and T. Micol. 2005. Seabird mortality in the Patagonian Toothfish longline fishery around Crozet and Kerguelen Islands, 2001-2003. CCAMLR Science 12:53-80.

Dietrich, K. S., E. F. Melvin, and L. Conquest. 2008. Integrated weight longlines with paired streamer lines - best practice to prevent seabird bycatch in demersal longline fisheries. Biological Conservation 141: 1793-1805.

Gilman, E., N. Brothers, and D. R. Kobayashi. 2007. Comparison of three seabird bycatch avoidance methods in Hawaii-based pelagic longline fisheries. Fisheries Science 73:208-210.

Gilman, E., N. Brothers, and R. Kobayashi. 2005. Principles and approaches to abate seabird by-catch in longline fisheries. Fish and Fisheries 6:35-49.

Goad, D. 2011. Trialling the ‘Kellian Device’. Setting bottom longlines underwater. Unpublished report by Vita Maris to New Zealand Department of Conservation. Vita Maris Ltd: Papamoa, New Zealand.

Gómez Laich A, M Favero, R Mariano-Jelicich, G Blanco, G Cañete, A Arias, MP Silva Rodriguez, H Brachetta. 2006. Environmental and operational variability affecting the mortality of Black-Browed Albatrosses associated to long-liners in Argentina. Emu 106: 21-28.

Klaer, N., and T. Polacheck. 1998. The influence of environmental factors and mitigation measures on bycatch rates of seabirds by Japanese longline vessels in the Australian region. Emu 98: 305-306.

Kock, K.-H. 2001. The direct influence of fishing and fishery-related activities on non-target species in the Southern Ocean with particular emphasis on longline fishing and its impact on albatrosses and petrels - a review. Reviews in Fish Biology and Fisheries 11:31-56.

Løkkeborg, S. 1998. Seabird by-catch and bait loss in long-lining using different setting methods. ICES Journal of Marine Science 55:145-149.

Løkkeborg, S. 2001. Reducing seabird bycatch in longline fisheries by means of bird-scaring and underwater setting. Pages 33-41 in E. F. Melvin, and J. K. Parrish, editors. Seabird Bycatch: Trends, Roadblocks and Solutions. University of Alaska Sea Grant, Fairbanks, AK.

Løkkeborg, S. 2003. Review and evaluation of three mitigation measures-bird-scaring line, underwater setting and line shooter--to reduce seabird bycatch in the north Atlantic longline fishery. Fisheries Research 60:11-16.

Løkkeborg, S., and G. Robertson. 2002. Seabird and longline interactions: effects of a bird-scaring streamer line and line shooter on the incidental capture of northern fulmars Fulmarus glacialis. Biological Conservation 106:359-364.

Melvin, E. F. 2003. Streamer lines to reduce seabird bycatch in longline fisheries. Washington Sea Grant Program WSG-AS 00-33.

Melvin, E. F., and J. K. Parrish, editors. 2001. Seabird bycatch: trends, roadblocks and solutions. University of Alaska Sea Grant, AK-SG-01-01, Fairbanks, AK.

Melvin, E. F., J. K. Parrish, K. S. Dietrich, and O. S. Hamel. 2001. Solutions to seabird bycatch in Alaska's demersal longline fisheries. Washington Sea Grant Program. Project A/FP-7. WSG-AS 01-01. University of Washington, Seattle WA.

Melvin, E. F., and G. Robertson. 2001. Seabird mitigation research in long-line fisheries: Status and priorites for future research and actions. Marine Ornithology 28:178-181.

Melvin, E. F., B. Sullivan, G. Robertson, and B. Wienecke. 2004. A review of the effectiveness of streamer lines as a seabird by-catch mitigation technique in longline fisheries and CCAMLR streamer line requirements. CCAMLR Science 11:189-201.

Melvin, E. F., and M. D. Wainstein. 2006. Seabird avoidance measures for small Alaskan longline vessels. Project A/FP-7. Washington Sea Grant Program.

Minami, H., and M. Kiyota. 2004. Effect of Blue-Dyed Bait and Tori-Pole Streamer on Reduction of Incidental Take of Seabirds in the Japanese Southern Bluefin Tuna longline fisheries. CCSBT-ERS/0402/08. CCSBT, Canberra.

Moreno, C. A., J. A. Arata, P. Rubilar, R. Hucke-Gaete, and G. Robertson. 2006. Artisanal longline fisheries in Southern Chile: Lessons to be learned to avoid incidental seabird mortality. Biological Conservation. 127:27-37.

Moreno C.A., R. Castro, L.J. Mujica & P. Reyes. 2008.Significant conservation benefits obtained from the use of a new fishing gear in the Chilean Patagonian Toothfish Fishery. CCAMLR Science 15: 79-91.

Moreno, C. A., P. S. Rubilar, E. Marschoff, and L. Benzaquen. 1996. Factors affecting the incidental mortality of seabirds in the Dissostichus eleginoides fishery in the south-west Atlantic (Subarea 48.3, 1995 season). CCAMLR Science 3:79-91.

Nel, D. C., P. G. Ryan, and B. P. Watkins. 2002. Seabird mortality in the Patagonian toothfish longline fishery around the Prince Edward Islands, 1996-2000. Antarctic Science 14:151-161.

Norden, W. S., and J. P. Pierre. 2007. Exploiting sensory ecology to reduce seabird by-catch. Emu 107:38-43.

Otley, H. 2005. Seabird mortality associated with Patagonian toothfish longliners in Falkland Island waters during 2002/03 & 2003/04. Falkland Islands Fisheries Department, Stanley, Falkland Islands.

Otley, H. M., T. A. Reid, and J. Pompert. 2007. Trends in seabird and Patagonian toothfish Dissostichus eleginoides longliner interactions in Falkland Island waters, 2002/03 and 2003/04. Marine Ornithology 35:47-55.

Petersen, S.L. 2008. Understanding and mitigating vulnerable bycatch in longline and trawl fisheries off southern Africa. Unpublished PhD thesis, University of Cape Town, Cape Town, South Africa.

Phillips, R.A, C. Ridley, K. Reid, P. J. A Pugh, G. N. Tuck, N. Harrison. 2010. Ingestion of fishing gear and entanglements of seabirds: monitoring and implications for management. Biological Conservation 143: 501-512.

Pierre, J. P., and W. S. Norden. 2006. Reducing seabird bycatch in longline fisheries using a natural olfactory deterrent. Biological Conservation 130:406-415.

Reid, E., B. Sullivan and J. Clark. 2010. Mitigation of seabird captures during hauling in CCAMLR longline fisheries. CCAMLR Science 17: 155-162..

Reid, T. A., B. J. Sullivan, J. Pompert, J. W. Enticott, and A. D. Black. 2004. Seabird mortality associated with Patagonian Toothfish (Dissostichus eleginoides) longliners in Falkland Islands waters. Emu 104:317-325.

Robertson, G., M. McNeill, B. King, and R. Kristensen. 2002. Demersal longlines with integrated weight: a preliminary assessment of sink rates, fish catch success and operational effects. CCAMLR-WG-FSA-02/22. CCAMLR, Hobart.

Robertson, G., M. McNeill, N. Smith, B. Wienecke, S. Candy, and F. Olivier. 2006. Fast sinking (integrated weight) longlines reduce mortality of white-chinned petrels (*Procellaria aequinoctialis*) and sooty shearwaters (*Puffinus griseus*) in demersal longline fisheries. Biological Conservation 132:458-471.

Robertson, G., E. Moe, R. Haugen, and B. Wienecke. 2003. How fast do demersal longlines sink? Fisheries Research 62:385-388.

Robertson, G., C. A. Moreno, J. Crujeiras, B. Wienecke, P. A. Gandini, G. McPherson, and J. P. Seco Pon. 2008a. An experimental assessment of factors affecting the sink rates of Spanish-rig longlines to minimize impacts on seabirds. Aquatic conservation: marine and freshwater ecosystems 17:S102-S121.

Robertson, G., C. A. Moreno, E. Gutiérrez, S. G. Candy, E. G. Melvin, and J. P. Seco Pon. 2008b. Line weights of constant mass (and sink rates) for Spanish-rig Patagonian toothfish longline vessels. CCAMLR Science 15: 93-106.

Robertson, G., J. Williamson, M. McNeill, S. G. Candy, and N. Smith. 2008c. Autoliners and seabird by-catch: do line setters increase the sink rate of integrated weight longlines? CCAMLR Science 15: 107-114.

Robertson, G. G. 2000. Effect of line sink rate on albatross mortality in the Patogonian toothfish longline mortality. CCAMLR Science 7:133-150.

Ryan, P., and B. Watkins. 2000. Seabird by-catch in the Patagonian toothfish longline fishery at the Prince Edward Islands: 1999 - 2000. CCAMLR-WG-FSA 00/30. CCAMLR, Hobart.

Ryan, P. G., C. Boix-Hinzen, J. W. Enticott, D. C. Nel, R. Wanless, and M. Purves. 1997. Seabird mortality in the longline fishery for Patagonian Toothfish at the Prince Edward Islands: 1996 - 1997. CCAMLR-WG-FSA 97/51. CCAMLR, Hobart.

Ryan, P. G., and M. Purves. 1998. Seabird bycatch in the Patagonian toothfish fishery at Prince Edward Islands: 1997-1998. CCAMLR-WG-FSA 98/36. CCAMLR, Hobart.

Ryan, P. G., and B. P. Watkins. 1999. Seabird by-catch in the Patagonian toothfish longline fishery at the Prince Edward Islands: 1998-1999. CCAMLR-WG-FSA 99/22. CCAMLR, Hobart.

Ryan, P. G., and B. P. Watkins. 2002. Reducing incidental mortality of seabirds with an underwater longline setting funnel. Biological Conservation 104:127-131.

Sánchez, A., and E. J. Belda. 2003. Bait loss caused by seabirds on longline fisheries in the northwestern Mediterranean: is night setting an effective mitigation measure? Fisheries Research 60:99-106.

Seco Pon, J. P., P. A. Gandini, and M. Favero. 2007. Effect of longline configuration on seabird mortality in the Argentine semi-pelagic Kingclip Genypterus blacodes fishery. Fisheries Research 85:101-105.

Smith, N. W. M. 2001. Longline sink rates of an autoline vessel, and notes on seabird interactions. Science for Conservation 183. Department of Conservation, Wellington.

Sullivan, B. 2004. Falkland Islands FAO National Plan of Action for Reducing Incidental catch of seabirds in Longline Fisheries. Royal Society for the Protection of Birds.

Sullivan, B., and T. A. Reid. 2002. Seabird interactions/mortality with longliners and trawlers in Falkland Island waters 2001/02. Falklands Conservation, Stanley, Falkland Islands.

Weimerskirch, H., D. Capdeville, and G. Duhamel. 2000. Factors affecting the number and mortality of seabirds attending trawlers and long-liners in the Kerguelen area. Polar Biology 23:236-249

Other references and resources

Løkkeborg S. 2008. Review and assessment of mitigation measures to reduce incidental catch of seabirds in longline, trawl and gillnet fisheries. FAO Fisheries and Aquaculture Circular, No. 1040. Rome.

BirdLife International and ACAP. 2014. Bycatch mitigation fact-sheets. https://www.acap.aq/en/bycatch-mitigation/bycatch-mitigation-fact-sheets