Agreement on the Conservation of Albatrosses and Petrels

# ACAP Review and Best Practice Advice for Reducing the Impact of Demersal Longline Fisheries on Seabirds

*Reviewed at the Tenth Meeting of the Advisory Committee*
*Wellington, New Zealand 11 – 15 September 2017*

## 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.

This document provides advice about best practices for reducing the impact of demersal longline fishing on seabirds. These best practice bycatch mitigation measures should be applied in areas where fishing effort overlaps with seabirds vulnerable to bycatch to reduce the incidental mortality to the lowest possible levels. The ACAP review process recognises that factors such as safety, practicality and the characteristics of the fishery should also be taken into account when considering the efficacy of seabird bycatch mitigation measures and consequently in the development of advice and guidelines on best practice.

This document also provides information regarding measures that are currently under active development. ACAP will continue to monitor the development of these measures and the results of scientific research about their effectiveness.

Additionally, this document provides information about mitigation measures that are not recommended. A wide range of potential seabird bycatch mitigation measures have been proposed over time; however, not all of these have proven effective. ACAP considers that certain mitigation measures are ineffective, based either on scientific studies, or a lack of evidence in substantiation of claims made about the mitigation measure.

The document comprises two components. The first component provides a summary of ACAP's advice regarding best practice measures for reducing seabird bycatch in demersal longline fisheries, and the second component outlines the review of mitigation measures that have been assessed for demersal longline fisheries.

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# ACAP Summary Advice for Reducing the Impact of Demersal Longline Fisheries on Seabirds

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## BEST PRACTICE MEASURES

The most effective measures to reduce incidental catch 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 at **night**.

Where line weighting is integral to the fishing gear, compared to bird scaring lines and night setting, it has the advantage of being more consistently implemented, hence facilitating compliance and port monitoring. 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 that 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.

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.

Best practice mitigation measures for demersal longline fisheries are listed individually below; The recommendations are categorised into general best practice measures (1), followed by best practice measures for line setting (2) and line hauling (3) operations.

## 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 mechanism 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

The use of 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 a 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 m/s 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 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.

It is recommended to use a weak link to allow the bird scaring line to break-away from the vessel in the event of a tangle with the main line, and, a secondary attachment between the bird scaring line and the vessel to allow the tangled bird scaring line to be subsequently attached to mainline and recovered during the haul.

**Large vessels (≥24 m in length)**

Two (paired) bird scaring lines should be used simultaneously.

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.

**Small vessels (<24 m in length)**

One or two (paired) 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 6m above sea level.
- The lines should achieve an aerial extent of at least 75 m when setting at ≥ 4 knots, or 50 m if setting at speeds < 4 knots.
- Streamers should be brightly coloured and reach the sea-surface in calm conditions, and placed at intervals of no more than 5m. Streamers may be modified over the first 15 m to avoid tangling.

Sufficient drag must be created to maximise aerial extent and maintain the line directly behind the vessel during crosswinds. This may be achieved using either towed devices or longer in-water sections.

## 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 Bird Exclusion Device (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 preferably be retained on board during hauling (and definitely during setting) 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 RECOMMENDATIONS

### 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. MITIGATION MEASURES THAT ARE UNDER DEVELOPMENT OR REQUIRE FURTHER INVESTIGATION

**The Kellian Line Setter:** an underwater setting device identified as a potential mitigation device in New Zealand inshore bottom longline fisheries. It operates by running the mainline through a set of rollers towed behind the vessel at depth. The design of the device has undergone a number of iterations, and is still under development and requires testing, including under commercial fishing conditions to determine effectiveness and optimal setting depths.

**Mitigation measures to increase sink rates of baited hooks on floated longlines**: Floated longlines are associated with elevated levels of seabird attack rates of baited hooks compared to lines that do not use floats. Further work is required to identify mitigation measures that improve the sink rate of baited hooks on floated longlines.

## 6. MITIGATION MEASURES THAT ARE NOT RECOMMENDED

ACAP considers that the following measures lack scientific substantiation as technologies or procedures for reducing the impact of demersal longline fisheries on seabirds.

**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.

**Lasers** - insufficiently researched, and serious concerns remain regarding the potential impacts on the health of individual birds.

The ACAP review of seabird bycatch mitigation measures for demersal longline fisheries is presented in the following section.

# ACAP Review of Seabird Bycatch Mitigation Measures for Demersal Longline Fisheries

Agreement on the Conservation of Albatrosses and Petrels

*Reviewed at the Tenth Meeting of the Advisory Committee*
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## INTRODUCTION

A range of technical and operational mitigation methods have been designed or adapted for use in demersal 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 available to birds, actively deterring birds from baited hooks, 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.

The suite of mitigation measures available may vary in their feasibility and effectiveness depending on the area, seabird assemblages, fishery and vessel type, and gear configuration. Some of the mitigation methods are well established and explicitly prescribed in pelagic longline fisheries; however, additional measures are undergoing further testing and refinements.

The Seabird Bycatch Working Group (SBWG) of ACAP has comprehensively reviewed the scientific literature dealing with seabird bycatch mitigation in demersal longline fisheries and this document is a distillation of that review. At each of its meetings, the SBWG reviews any recent research or information regarding seabird bycatch mitigation, and updates the review and best practice advice accordingly. Currently, the combined use of weighted branch lines, bird scaring lines and night setting, is considered best practice mitigation for reducing seabird bycatch in pelagic longline fisheries.

## THE ACAP REVIEW PROCESS

At each of its meetings, the ACAP SBWG considers any new research or information pertaining to seabird bycatch mitigation in demersal longline fisheries. The following criteria are used by ACAP to guide the assessment process, and to determine whether a particular fishing technology or measure can be considered best practice to reduce the incidental mortality of albatrosses and petrels in fishing operations.

**Best Practice Seabird Bycatch Mitigation Criteria and Definition**

**i.** Individual fishing technologies and techniques should be selected from those shown by experimental research to significantly[1] reduce the rate of seabird incidental mortality[2] to the lowest achievable levels. Experience has shown that experimental research comparing the performance of candidate mitigation technologies to a control of no deterrent, where possible, or to status quo in the fishery, yields definitive results. Analysis of fishery observer data after it has been collected on the relative performance of mitigation approaches are plagued with a myriad of confounding factors. Where a significant relationship is demonstrated between seabird behaviour and seabird mortality in a particular system or seabird assemblage, significant reductions in seabird behaviours, such as the rate of seabirds attacking baited hooks, can serve as a proxy for reduced seabird mortality. Ideally, when simultaneous use of fishing technologies and practices is recommended as best practice, research should demonstrate significantly improved performance of the combined measures.

**ii.** Fishing technologies and techniques, or a combination thereof, should have clear and proven specifications and minimum performance standards for their deployment and use. Examples would include: specific bird scaring line designs (lengths, streamer length and materials; etc.), number (one vs. two) and deployment specifications (such as aerial extent and timing of deployment); night fishing defined by the time between the end of nautical dusk and start of nautical dawn; and, line weighting configurations specifying mass and placement of weights or weighted sections.

**iii.** Fishing technologies and techniques should be demonstrated to be practical, cost effective and widely available. Commercial fishing operators are likely to select for seabird bycatch reduction measures and devices that meet these criteria including practical aspects concerning safe fishing practices at sea.

**iv.** Fishing technologies and techniques should, to the extent practicable, maintain catch rates of target species. This approach should increase the likelihood of acceptance and compliance by fishers.

**v.** Fishing technologies and techniques should, to the extent practicable not increase the bycatch of other taxa. For example, measures that increase the likelihood of catching other protected species such as sea turtles, sharks and marine mammals, should not be considered best practice (or only so in exceptional circumstances).

**vi.** Minimum performance standards and methods of ensuring compliance should be provided for fishing technologies and techniques, and should be clearly specified in fishery regulations. Relatively simple methods to check compliance should include, but not be limited to, port inspections of branch lines to determine compliance with branch line weighting, determination of the presence of davits (tori poles) to support bird scaring lines, and inspections of bird scaring lines for conformance with design requirements. Compliance monitoring and reporting should be a high priority for enforcement authorities.

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[1] Any use of the word 'significant' in this document is meant in the statistical context

[2] This may be determined by either a direct reduction in seabird mortality or by reduction in seabird attack rates, as a proxy

On the basis of these criteria, the scientific evidence for the effectiveness of mitigation measures or fishing technologies/techniques in reducing seabird bycatch is assessed, and explicit information is provided on whether the measure is recommended as being effective, and thus considered best practice, or not. The ACAP review also indicates whether the measure needs to be combined with additional measures, and provides notes and caveats for each measure, together with information on performance standards and further research needs. Following each meeting of ACAP's SBWG and Advisory Committee, this review document and ACAP's best practice advice, is updated (if required). A summary of ACAP's current best practice advice is provided in the preceding section of this document.

## SEABIRD BYCATCH MITIGATION FACT SHEETS

A series of seabird bycatch mitigation fact sheets have been developed by ACAP and BirdLife International to provide practical information, including illustrations, on seabird bycatch mitigation measures (http://www.acap.aq/en/resources/bycatch-mitigation/mitigation-fact-sheets). The sheets, which include information on the effectiveness of the specific measure, their limitations and strengths and best practice recommendations for their effective adoption, are linked to the ACAP review process, and are updated following ACAP reviews. Links to the available fact sheets are provided in the relevant sections below. The mitigation fact sheets are currently available in English, French, Spanish, Portuguese, Japanese, Korean and Mandarin.

## BEST PRACTICE MEASURES

### 1. 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.

***Notes and Caveats***

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 (Copello *et al.* 2016).

***Minimum standards***

Currently, the area around South Georgia (Islas Georgias del Sur)[3] (CCAMLR Subarea 48.3) is closed for fishing between September and mid-April each year (which coincides with the breeding seasons of most seabirds at South Georgia/Islas Georgias del Sur[3]), 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.

***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.

## 2. Externally weighted lines:

## a) Spanish system

***Scientific evidence for effectiveness in demersal fisheries***

**Proven and recommended mitigation method**. Should 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).

***Notes and Caveats***

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

[3] "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".

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, Paterson *et al*. 2017).

***Minimum standards***

Global minimum standards have not been 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.

***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.

***Mitigation Fact Sheet***

https://www.acap.aq/en/resources/bycatch-mitigation/mitigation-fact-sheets/762-fs-02-demersal-longline-line-weighting-external-weights/file

## 2. Externally weighted lines:

## b) Chilean method (trot line with nets)

***Scientific evidence for effectiveness in demersal fisheries***

**Proven and recommended mitigation method**. Although effectively preventing 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.

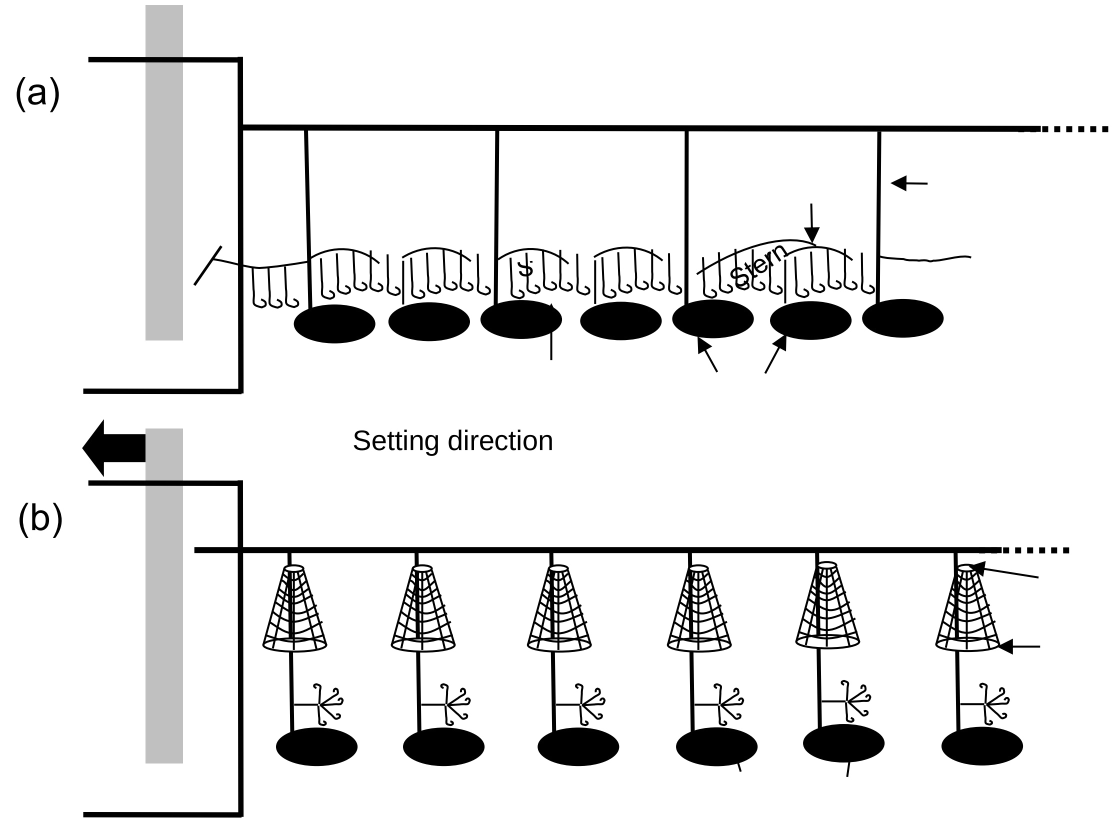


**Figure 1**. Typical configurations of the traditional Spanish double line system (a) and Chilean (trotline) system (b) showing differences in gear design and location of weights in relation to hooks. The open-ended secondary/connecting lines (not joined by a continuous hook line) and proximity of weights 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.

### *Notes and Caveats*

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.

### *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 “2a”, above).

***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 diving 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.

***Mitigation Fact Sheet***

https://www.acap.aq/en/resources/bycatch-mitigation/mitigation-fact-sheets/1799-fs-04-demersal-longline-line-weighting-chilean-system/file

## 2. Externally weighted lines:

## c) Autoline

***Scientific evidence for effectiveness in demersal fisheries***

**Proven and recommended mitigation method.** 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.

***Notes and Caveats***

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).

***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.

***Research needs***

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

***Mitigation Fact Sheet***

https://www.acap.aq/en/resources/bycatch-mitigation/mitigation-fact-sheets/762-fs-02-demersal-longline-line-weighting-external-weights/file

## 3. Integrated weighting of lines

***Scientific evidence for effectiveness in demersal fisheries***

**Proven and recommended mitigation method**. 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).

***Notes and Caveats***

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).

***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.

***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.

***Mitigation Fact Sheet***

https://www.acap.aq/en/resources/bycatch-mitigation/mitigation-fact-sheets/1504-fs-03-demersal-longline-integrated-weight-longlines/file

## 4. Night setting

***Scientific evidence for effectiveness in demersal longline fisheries***

**Proven and recommended mitigation method**. Should be used in 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).

***Notes and Caveats***

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

***Minimum standards***

Night is defined as the period between the times of nautical twilight (nautical dark to nautical dawn as set out in the Nautical Almanac tables for relevant latitude, local time and date.).

***Implementation monitoring***

Requires Vessel Monitoring Systems (VMS) and fishery observers.

***Research needs***

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

***Mitigation Fact Sheet***

https://www.acap.aq/en/resources/bycatch-mitigation/mitigation-fact-sheets/1824-fs-05-demersal-pelagic-longline-night-setting/file

## 5. Single bird scaring line

### *Scientific evidence for effectiveness in demersal fisheries*

**Proven and recommended mitigation method**. 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, Paterson *et al.* 2017) and is suitable for small vessel under 24 m in length, with some modification (Goad & Debski 2017).

### *Notes and Caveats*

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.

It is recommended to use a weak link to allow the bird scaring line to break-away from the vessel in the event of a tangle with the main line, and, a secondary attachment between the bird scaring line and the vessel to allow the tangled bird scaring line to be subsequently attached to mainline and recovered during the haul (Goad & Debski 2017).

### *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.

For small vessels (<24 m), we recognise that the length of aerial extent will vary by setting speed, with 75 m being achievable for vessels setting at ≥ 4 knots, or 50 m if setting at speeds < 4 knots, that streamers may be modified over the first 15 m to avoid tangling, and that drag may be achieved using either towed devices or longer in-water sections (Goad & Debski 2017).

### *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).

### *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.

### *Mitigation Fact Sheet*

https://www.acap.aq/en/resources/bycatch-mitigation/mitigation-fact-sheets/1912-fs-01-demersal-longline-streamer-lines/file

## 6. Paired or multiple bird scaring lines

### *Scientific evidence for effectiveness in demersal fisheries*

**Proven and recommended mitigation method**. 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).

### *Notes and Caveats*

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.

### *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.

***Research needs***

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

***Mitigation Fact Sheet***

https://www.acap.aq/en/resources/bycatch-mitigation/mitigation-fact-sheets/1912-fs-01-demersal-longline-streamer-lines/file

## 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).

***Notes and Caveats***

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 (Islas Malvinas)[3] 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.

***Mitigation Fact Sheet***

https://www.acap.aq/en/resources/bycatch-mitigation/mitigation-fact-sheets/1907-fs-12-demersal-pelagic-longline-haul-mitigation/file

## OTHER CONSIDERATIONS

## 8. Side-setting

***Scientific evidence for effectiveness in demersal fisheries***

**Not recommended as a specific mitigation measure 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.

***Notes and Caveats***

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.

***Minimum standards***

Only tested 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 to 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.

***Research needs***

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

***Mitigation Fact Sheet (for pelagic longline vessels)***

https://www.acap.aq/en/resources/bycatch-mitigation/mitigation-fact-sheets/769-fs-09-pelagic-longline-side-setting/file

## 9. Underwater setting funnel/chute

***Scientific evidence for effectiveness in demersal fisheries***

**Unproven and not recommended as a mitigation measure at this time**. 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).

***Notes and Caveats***

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).

### *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.

### *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).

### *Mitigation Fact Sheet*

https://www.acap.aq/en/resources/bycatch-mitigation/mitigation-fact-sheets/766-fs-06-demersal-longline-underwater-setting-chute/file

## 10. Line-setter/shooter

### *Scientific evidence for effectiveness in demersal fisheries*

**Unproven and not recommended as a mitigation measure at this time**. 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.

### *Notes and Caveats*

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.

### *Minimum standards*

Not considered a mitigation measure at this time.

### *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.

### *Mitigation Fact Sheet (for pelagic longline fisheries)*

https://www.acap.aq/en/resources/bycatch-mitigation/mitigation-fact-sheets/771-fs-11-pelagic-longline-bait-caster-and-line-shooter/file

## 11. Thawing bait

### *Scientific evidence for effectiveness in demersal fisheries*

**Unproven and 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).

### *Notes and Caveats*

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*

**Unproven, and not recommended as a mitigation measure at this time**. 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).

### *Notes and Caveats*

The shark liver oil investigated 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).

### *Minimum standards*

None yet.

### *Implementation monitoring*

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

### *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.

## 13. Strategic management of offal discharge

### *Scientific evidence for effectiveness in demersal fisheries*

**Not recommended as a primary mitigation measure**. 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).

### *Notes and Caveats*

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 discharge during the entire 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.

### *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.

### *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.

## 14. Blue-dyed bait

### *Scientific evidence for effectiveness in demersal fisheries*

**Unproven and not recommended as a mitigation measure at this time**. 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.

### *Notes and Caveats*

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.

***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.

***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.

***Mitigation Fact Sheet***

https://www.acap.aq/en/resources/bycatch-mitigation/mitigation-fact-sheets/770-fs-10-pelagic-longline-blue-dyded-bait-squid/file

## 15. Hook size and shape

***Scientific evidence for effectiveness in demersal fisheries***

**Unproven and 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).

***Notes and Caveats***

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

***Minimum standards***

No global standard

***Implementation monitoring***

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

***Research needs***

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

# MITIGATION MEASURES UNDER DEVELOPMENT OR WHICH REQUIRE FURTHER DEVELOPMENT OR INVESTIGATION

## 16. Kellian Line Setter

### *Scientific evidence for effectiveness in demersal fisheries*

**Unproven and not recommended as a mitigation measure 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 that involves running the mainline through a set of rollers towed behind the vessel at depth.

### *Notes and Caveats*

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.

### *Minimum standards*

Not considered a mitigation measure at this time.

### *Research needs*

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

## 17. Lasers

### *Scientific evidence for effectiveness in demersal longline fisheries*

**Unproven and not recommended, bird welfare issues need to be addressed.** Preliminary research using lasers in a North Pacific trawl fishery did not show a detectable response in daylight hours, and that reactions to the laser at night varied between species, and whether the seabirds were feeding in the offal plume or following the vessel (Melvin *et al.* 2016).

### *Notes and Caveats*

There are ongoing concerns about the safety (to both birds and humans) and efficacy of laser technology as a seabird bycatch mitigation tool.

### *Minimum standards*

Not Applicable.

### *Need for combination*

Not Applicable.

### *Implementation monitoring*

Not Applicable.

***Research needs***

Bird welfare issues must be addressed before further at-sea testing is progressed.

## 18. Mitigation measures to improve sink rates of baited hooks on floated longlines

Demersal longline vessels that use floated gear (which incorporates subsurface floats on the mainline to raise the hooks off the seabed) are particularly susceptible to seabird bycatch, with one study reporting that albatrosses attacked floated longlines at rates ten times more than longlines without floats (Gladics *et al.* 2016). The sink rate of the slowest sinking hooks, where seabird bycatch is most pronounced, is the key factor to consider when prescribing mitigation measures for demersal longline fisheries using floated gear. The slowest sink rates are associated with deployment of buoys in demersal fishing gear (Debski 2016). Increasing the length of buoy lines improves the sink rate. Where buoy lines are operationally problematical due to the fishing gear configuration, then extra space (5 m or more) on either side of buoys should be left without baited hooks to reduce the risk of seabird bycatch on the slowest sinking sections of the line. However, the relationship between line weighting and buoy line lengths to achieve a target fishing depth at maximum sink rate is not well understood, and further work is therefore required to investigate this balance.

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