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

Agreement on the Conservation of Albatrosses and Petrels

Reviewed at the Thirteenth Meeting of the Advisory Committee
Edinburgh, United Kingdom, 22 - 26 May 2023

INTRODUCTION

The incidental mortality of seabirds, mostly albatrosses and petrels, in longline fisheries continues to be a growing global concern. This was a major reason for the establishment of the Agreement on the Conservation of Albatrosses and Petrels (ACAP). Many mitigation methods to reduce and eliminate seabird bycatch have been developed and tested over the last 20 plus years, especially for demersal longline fisheries. Demersal longline fisheries are those in which baited hooks are set on, or near the sea floor using a variety of systems and configurations. These include systems that deploy a single hookline (manually baited or mechanically baited (single line) systems), and systems that include a second hauling line floated above a hookline or a cluster of baited hooks (Spanish and Chilean (trotline) systems). Single line hand-baiting systems store hooklines by a variety of means, while single line systems involve mechanical baiting and hooklines hung from racks. Although most mitigation measures are broadly applicable, the feasibility, design and effectiveness of some measures will be influenced by longlining method, gear configuration, and vessel size. It should be noted that most scientific literature relates to fleets of larger vessels, with artisanal fleets receiving less attention. Some of this advice may need to be modified for smaller vessels.

This document provides advice on 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. The ACAP review process recognises that factors such as safety, practicality and the characteristics of the fishery should 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 development, as well as those that are not recommended. ACAP considers some proposed mitigation measures ineffective, based on a lack of evidence. ACAP continually monitors the development of these measures and results of scientific research about their effectiveness.

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.

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 sink baited hooks as close to the vessel as possible to reduce their availability to seabirds.
- Actively deterring birds from baited hooks by means **of bird scaring lines**, and
- Setting longlines at **night**.

In cases where line weighting is integral to fishing gear, it has the advantage of consistent implementation, and compared to bird scaring lines and night setting, facilitates 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. The Chilean (trotline) system (with appropriate line weighting and branch line length) inherently prevents albatross and petrel mortality given its rapid sinking of baited hooks, 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 sink baited hooks rapidly out of the range of feeding seabirds as close to the vessel as possible. Weights should be deployed before line tension occurs to ensure that the line sinks rapidly and consistently.

2.1 a Weighted lines for Spanish gear

The use of steel weights is considered best practice, as they sink hooklines consistently. The mass should be a minimum of 5 kg at 40 m intervals.

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

2.1 b Weighted lines for Chilean (trotline with nets) system gear

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

2.1 c Weighted lines for autoline gear

Integrated weight (IW) longlines are designed with a lead core of 50 g/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. The mean sink rate of IW lines should be ≥ 0.24 m/s to 10 m depth.

Where practical, IW lines are preferred over externally weighted alternatives because of their linear sink profile from the surface and its ability to consistently achieve the minimum sink rate.

When using external weights instead of IW lines, 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 5 kg at no more than 40 m intervals.

2.2 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.

2.3 Bird scaring lines

A bird scaring line is a line that runs from a high point at the stern of a vessel to a drag generating device at its in-water terminus. Drag created by a towed device or the in-water extent of the line, lifts the length of the line closest to the vessel into the air as the vessel travels forward setting gear. Importantly, it is this aerial extent with streamers attached that scares birds from baited hooks as they sink providing a physical deterrent over the area where baited hooks are sinking. It is essential that this aerial extent match the distance astern that seabirds can access baited hooks. Weighted hooklines reduce this distance and make streamer lines more efficient at excluding foraging birds from hooks.

A weak link is recommended to allow the bird scaring line to break-away from the vessel in the event of an entanglement with the main line. The entangled bird scaring line can be 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 vessel attachment height should be at least 7 m above sea level.
- Streamers should be brightly coloured and reach the sea-surface in calm conditions, and placed at intervals of no more than 5 m.
- Sufficient drag must be created to maximise aerial extent and maintain the line directly over sinking baited hooks and astern of the vessel during crosswinds. This may be achieved using a towed devices or a bird scaring line a minimum of 150 m in length.

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 6 m 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 5 m. 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 a longer in-water sections.

2.4 Offal and discard discharge management

Seabirds are highly attracted to offal discharged from vessels. To prevent large numbers of seabirds attending line setting operations, offal and discards should be retained onboard prior to and during line setting.

3. BEST PRACTICE MEASURES - LINE HAULING

3.1. Bird Exclusion Device (BED)

Seabirds can be accidentally hooked as gear is retrieved. A Bird Exclusion Device (BED) consists of a horizontal support several metres above the water that encircles the entire hauling bay. Vertical streamers are positioned between the horizontal support and water surface. The BED configuration can also include a line of floats on the water surface connected to the vertical streamers to stabilize movement in strong winds. This configuration is the most effective method to prevent birds entering the area around the hauling bay, either by swimming or by flying. BEDs are retrieved and stowed when not hauling. For small vessels (<20 m in length), where the application of mitigation devices requiring robust support structures and on-water sections can be challenging, the use of simple haul mitigation devices has been demonstrated to be both practical and effective at deterring birds from hauling points.

3.2. Offal and discard discharge management

During setting, offal and discards should always be retained onboard. During hauling offal and discards should be retained on board or released from 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 depredation of fish. Because weights are deployed directly below the hooks, allowing hook-bearing lines to sink more rapidly beyond the foraging depths of seabirds than the traditional Spanish systems. The Chilean method is an inherently effective configuration for avoiding seabird bycatch . As this gear type deploys hook clusters, it is extremely important to remove and retain hooks from discards.

5. MITIGATION MEASURES UNDER DEVELOPMENT OR THAT REQUIRE FURTHER INVESTIGATION

Underwater Line Setter: an underwater setting device is under development in New Zealand inshore bottom longline fisheries. It operates by running the hookline through a set of rollers towed behind the vessel at depth. The device requires testing 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 partially suspend the hookline above the sea floor. During line setting, they are associated with elevated levels of seabird attacks on baited hooks at or near the surface during line setting compared to lines without floats. Further work is required to identify mitigation measures that increase 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 - insufficiently researched.

Lasers - There is currently no evidence of effectiveness, and serious concerns remain regarding the potential impacts on the health of individual birds.

Acoustic deterrents - insufficiently researched.

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 Thirteenth 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 to reduce incidental mortality of seabirds. Operationally, peak areas and periods of seabird foraging activity should be avoided. Effective technical methods include actively deterring birds from, and minimising the visibility of, baited hooks. Vessels need to be made less attractive to birds, and the distance astern and time baited hooks are available to birds must be reduced. Mitigation methods need to be easy and safe to implement, cost effective, enforceable and should not reduce catch rates of target species or increase the bycatch rates of other protected species.

The feasibility, effectiveness and specifications of mitigation measures may vary by area, seabird assemblage, fishery, vessel size, and gear configuration.

The Seabird Bycatch Working Group (SBWG) of ACAP has comprehensively reviewed the scientific literature dealing with seabird bycatch mitigation in demersal longline fisheries. This document is a distillation of that review. With the exception of the Chilean system, the combined use of weighted branch lines, bird scaring lines and night setting is considered best practice mitigation for reducing seabird bycatch in demersal 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 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. Experimental research yields definitive results when performance of candidate mitigation technologies is compared to a control (no deterrent), or to status quo in the fishery. When testing relative performance of mitigation approaches, analysis of fishery observer data can be 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, where 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 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 (https://www.acap.aq/bycatch-mitigation/bycatch-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, Simplified Chinese, Traditional Chinese, and Indonesian.

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 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 occurred 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 (Nel *et al*. 2002).

Notes and Caveats

It's difficult to separate the performance of a temporal/spatial closure from increased uptake/implementation of other mitigation measures. Likewise, some variation over time and space in the location of favoured foraging areas for seabirds is expected. However, closures are clearly an important and effective management response, especially for high risk areas, and when other measures prove ineffective (Waugh 2008). 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

Minimum standards are based on the overlap of albatrosses and petrels with fishing effort so can vary from area to area. For example, 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 (CCAMLR 2019).

Implementation monitoring

Onboard or at-sea surveillance is required to assess implementation.

Research needs

Continued gathering of temporal and spatial information of seabirds and fishing effort, should be ongoing, especially for high risk areas (e.g. adjacent to important breeding colonies) and to better understand the effects of climate change on seabirds. 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, offal management and/or night setting (Agnew *et al.* 2000; Robertson 2000; Robertson *et. al*. 2008a; 2008b; 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 them (Robertson *et al*. 2008a). It is critical that line tension astern is eliminated to ensure the smooth flow of lines and hooks from gear

[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.

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 *et al*., 2007); weights made of solid steel are preferred, in terms of mass consistency, handling, maintenance and monitoring compliance (Robertson *et al*. 2008b, Paterson *et al*. 2017).

Minimum standards

Global minimum standards have not been established. Requirements vary by fishery. For example, CCAMLR minimum requirements for vessels using the Spanish method of longline fishing are 8.5 kg mass at 40 m intervals (if rocks are used), 6 kg mass at 20 m intervals for traditional (concrete) weights, and 5 kg weights at 40 m 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. Onboard monitoring is required to assess implementation.

Research needs

Sink rates and sink profiles of line weighting regimes may vary according to vessel type, setting speed and deployment position relative 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 testing confirms the effectiveness of the line weighting regime and the sink profile in reducing seabird mortality.

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 the Chilean method effectively prevents mortality as a sole measure given that hooks sink quickly from the surface, it is prudent to also deploy a 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. The Chilean method 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.

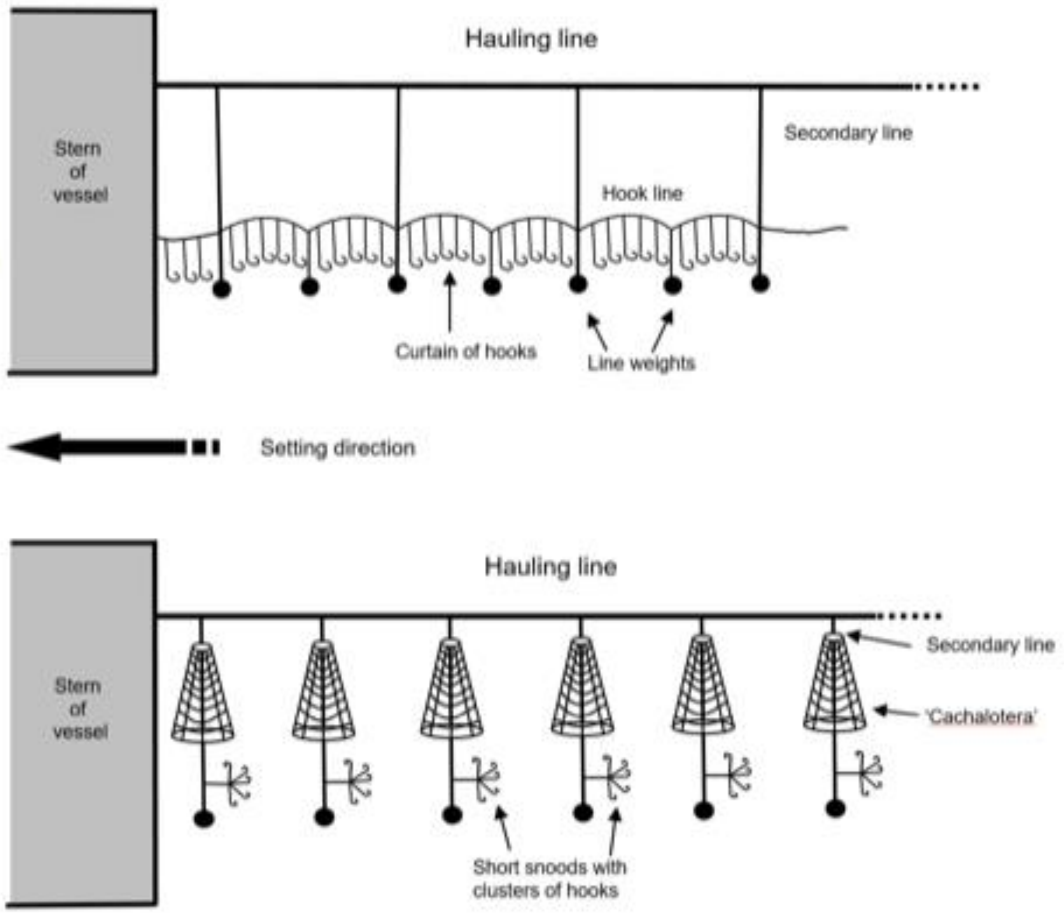

Figure 1. Typical configurations of the traditional Spanish double line system (a) and Chilean (trotline) system (b) showing differences in gear design and location of weights in relation to hooks. The open-ended secondary/connecting lines (not joined by a continuous hook line) and proximity of weights to hooks of the Chilean system enables hooks to sink rapidly with no lofting in propeller turbulence from the surface close to a vessel stern. 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. 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 especially with this gear type (Phillips *et al*. 2010). The solution to this problem is to stop hooks from being discarded. 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.

Minimum standards

Global standards not established.

Implementation monitoring

Weights need to be attached to hook-bearing secondary lines 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). Onboard monitoring is required to assess implementation.

Research needs

Effective as a solitary measure against albatrosses and most likely effective against *Procellaria* spp. 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* spp. 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) Auto-bait

Scientific evidence for effectiveness in demersal fisheries

Proven and recommended mitigation method. Weights must be used in combination with an effective bird scaring line. In the Southern Hemisphere evidence in support of line weighting specifications (below) were developed based on matching or exceeding sink rates of external weight configurations to that of integrated weight lines, not to their effectiveness at 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 to release that external weights from vessels in a manner that avoids line tension. Line tension astern may lift sections of the deployed longline already deployed out of the water farther from the vessel, and imperil seabirds.

Minimum standards

Minimum standards are informed by those currently applied to two Southern Hemisphere fisheries. 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) are required every 60 m if the hookline 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.

Implementation monitoring

Weights are attached to longlines manually. Onboard monitoring is required to assess implementation.

Research needs

Likely to be effective in deterring albatrosses and *Procellaria* spp. seabirds. Evidence is lacking for effectiveness against *Puffinus* spp. 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 weight longlines

Scientific evidence for effectiveness in demersal fisheries

Proven and recommended mitigation method. Should be used in combination with bird scaring lines, 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*. 2003; Robertson *et al.* 2006; Dietrich *et al*. 2008).

Notes and Caveats

Restricted to single line vessels. The sink rate of IW longlines can vary depending on vessel type, setting speed and deployment of line relative to propeller wash (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 *et al.* 2009). The use of lead in fishing gear is prohibited in some fishery jurisdictions.

Minimum standards

Global minimum standards are evolving. CCAMLR and New Zealand currently require IW lines with a minimum lead core of 50 g/m in their single line demersal longline fisheries.

Implementation monitoring

Weight (lead core) is integrated into the fabric of the line, so compliance with weighting requirements is intrinsic to this measure. It is impractical to alter longlines when at sea, including for vessels with long transit times to fishing grounds (e.g. Antarctic and sub Antarctic fisheries). Port inspection of all longlines onboard prior to embarkation on fishing trips is considered adequate for to assess compliance.

Research needs

The relationship between line-weighting regime, setting speed, sink rates/profiles and the distance astern seabirds can access baited hooks should be investigated for other fisheries. Testing should prioritize determining the necessary aerial extent for bird scaring lines with these factors.

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; Gladics *et. al*. 2017; Melvin *et.al*. 2019).

Notes and Caveats

Bright moonlight and deck lights reduce the effectiveness of this mitigation measure. Less effective for some crepuscular/nocturnal foragers such as the white-chinned petrel (Paterson *et al*. 2017) but more effective than setting during the day. Night setting increases the bycatch rate of Northern Fulmar *Fulmarus glacialis* (Gladics *et. al*. 2017; Melvin *et.al*. 2019). 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. Civil twilight was found equally effective as nautical twilight at reducing seabird mortalities in US west coast and Alaskan fisheries (Gladics *et. al*. 2017; Melvin *et.al*. 2019)

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

Onboard monitoring or at-sea surveillance is required to assess implementation.

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. It is the aerial extent of the line with streamers attached that is important for the prevention of birds interactions with baited hooks. Effectiveness of the streamer line is maximized when streamers are positioned above the sinking hook line, and the aerial extent matches the distance astern that seabirds can access baited hooks. Weighted longlines reduce this distance and make streamer lines more efficient at excluding foraging birds from hooks. 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 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, Melvin *et. al*. 2004; Dietrich *et al*. 2008; Paterson *et al.* 2017; Melvin *et al*. 2019) and is suitable for small vessels under 24 m in length, with some modification (Melvin & Weinstein. 2004; Goad & Debski 2017).

Notes and Caveats

Effective only when streamers are positioned over sinking hooks and the aerial extent matches the distance astern that seabirds can access baited hooks. These are the most important factors influencing their performance. 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, proper placement, as well as seabird species attending line setting (proficient divers are more difficult to deter than surface feeding birds). 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 further improve their effectiveness.

It is recommended to use a weak link to allow the bird scaring line to break-away from the vessel in the event of an entanglement with the main line (a secondary attachment between the bird scaring line and the vessel can be used to attach the break-away bird-scaring line to the mainline for subsequent retrieval during the haul).

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 (CCAMLR 2018). The bird scaring (streamer) 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 (150 m), the height of the attachment point on the vessel (7 m 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 and speed of the vessel and the sink rates of baited longlines.

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 before and after each set (they are not a fixed part of fishing gear/operations). Onboard monitoring or at-sea surveillance is required to assess implementation.

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 in individual fisheries and on individual vessels or vessel types.

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 maximized when streamers are paired and deployed so that they bracket sinking baited hook lines, and the aerial extents of the lines cover the area astern where birds can access baited hooks. Effectiveness is further increased when used in combination with other measures – e.g. night setting, appropriate weighting of line and 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 one 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 single line systems (Dietrich *et al.* 2008).

Notes and Caveats

The likelihood of entanglement with gear is potentially increased compared to using a single bird scaring line. Towing an effective device that keeps lines from crossing surface gear may improve compliance with this measure. Manual retrieval of paired or multiple bird scaring lines requires more effort than a single line. This can be overcome by using winches to retrieve lines.

Minimum standards

Current minimum standards vary across fisheries. In Alaskan demersal longline fisheries paired streamer lines are required on larger vessels (≥ feet 16.8 m) 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 typically deployed and retrieved before and after each set (they are not a fixed part of fishing gear/operations). Onboard monitoring or at-sea surveillance is required to assess implementation.

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 (BED)

Scientific evidence for effectiveness in demersal fisheries

Proven and recommended as a <u>haul mitigation measure</u>. BEDs must be used in combination with line setting mitigation measures – bird scaring lines, line weighting, night setting and offal management. The use of a BED 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). For small vessels (<20 m in length), where the application of mitigation devices requiring robust support structures and on-water sections can be challenging, the use of simple haul mitigation devices has been demonstrated to be both practical and effective at deterring birds from hauling points (Goad *et al*. 2023).

Notes and Caveats

Some species, such as the Black-browed Albatross *Thalassarche melanophris* and Cape Petrel *Daption capense*, 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

Standards are evolving. BEDs are required in high risk CCAMLR areas. The exact design is not specified, rather 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) prevent birds that are sitting on the surface from swimming into the hauling bay area). BEDs are required in the Falkland Islands (Islas Malvinas)[3] longline fishery (A. Wolfaardt pers. comm.).

Implementation monitoring

BEDs are usually deployed and retrieved before and after each set (they are not a fixed part of fishing gear/operations). Onboard monitoring or at-sea surveillance is required to assess implementation.

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. Not tested in demersal longline fisheries. For more detail see pelagic longline best practice advice

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

Onboard monitoring or at-sea surveillance is required to assess 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 due to the longline being suspended in the vessel's wake resulting in delayed sinking (Melvin *et. al*. 2001).

Notes and Caveats

Robertson *et al.* (2008c) found no significant difference between the sink rates of integrated weight longlines of single line 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. Further refinement is needed.

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.

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 in demersal longline fisheries. See pelagic longline best practice advice for more information.

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

No standards established.

Implementation monitoring

Onboard monitoring or at-sea surveillance of line setting operations is required to assess implementation.

Research needs

Testing should be extended to candidate/suitable species of conservation concern, such as white-chinned petrels *P. aequinoctialis* and sooty shearwaters *Ardenna grisea*. 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 (Islas Malvinas)[3], South Africa and New Zealand).

Implementation monitoring

Requires offal discharge practices and events to be monitored onboard.

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. See pelagic longline fisheries best practice advice for more information.

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 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 of 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.

16. Lasers

High Energy Lasers Strongly Discouraged

Scientific evidence for effectiveness in demersal longline fisheries

Available evidence shows that high energy lasers (Class 4 lasers, the highest class in terms of laser hazards) are ineffective at deterring seabirds from danger areas around fishing vessels (Melvin *et al.* 2016) and likely damage seabird visual systems with negative effects on foraging behaviour of laser exposed seabirds (Fernandez-Juricic, 2023).

Notes and Caveats

Concerns are ongoing regarding the safety (to both humans and birds) and efficacy of laser technology of unknown energy levels as a seabird bycatch mitigation tool, as they continue to be used currently in various fisheries. Available evidence shows that high energy lasers are no longer marketed for fishery applications. Currently evidence is lacking on the possibility that lasers of lower energy levels delivered in different ways (scanning, blinking, wave-length, etc.) could be used safely and be effective in some applications.

Minimum standards

Not Applicable as strongly discouraged.

Need for combination

Not Applicable as strongly discouraged.

Implementation monitoring

Not Applicable as strongly discouraged.

Research needs

As high energy lasers continue to be used in some fisheries, we encourage reporting of the extent and output power levels of laser use by ACAP Parties, including any information on effectiveness, as well as bird welfare effects.

MITIGATION MEASURES UNDER DEVELOPMENT OR WHICH REQUIRE FURTHER DEVELOPMENT OR INVESTIGATION

17. Underwater Line Setter

Scientific evidence for effectiveness in demersal fisheries

Unproven and not recommended as a mitigation measure at this time. A line setter was identified as a potential mitigation device in New Zealand inshore bottom longline fisheries, (Goad 2011). This line setter is an underwater setting device that involves running the hookline through a set of rollers towed behind the vessel at depth. Underwater line setting devices for demersal longline fisheries differ from those assessed for pelagic longline fisheries which involve a computer operated and hydraulically powered machine that deploys baited hooks individually underwater to a target 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 require 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.

18. Acoustic Deterrents

Scientific evidence for effectiveness in demersal longline fisheries

Unproven and not recommended. Published reports unavailable; however, anecdotal reports of using percussive sound as with an orchard cannon showed that birds initially disperse but quickly habituate; i.e., disperse and quickly return or ignore completely with continuous use (E. Melvin, pers comm.)

Minimum standards

Not Applicable.

Need for combination

Not Applicable.

Implementation monitoring

Not Applicable.

Research needs

Undefined

19. 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.* 2017). 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 (Debski 2016, Robertson et al 2021). Options to increase the sink rates of Merluza system gear include the use of longer float lines, equipping float lines with sinkers and the elimination of line tension astern.

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