Conservation Services Programme Project MIT2015-02:

Mitigating seabird captures during hauling on smaller longline vessels

J. P. Pierre

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JPEC Ltd

Executive summary

Seabird captures in longline fisheries may occur on the set, soak or haul. Bycatch reduction measures are best developed, tested and implemented for reducing seabird captures occurring during longline sets. Measures affecting the nature and extent of haul captures, and mitigation approaches to reduce those captures, are not well-known. Further, the difficulty of accurately identifying captures as occurring on the haul means that live seabird captures are typically used as a proxy for haul captures in bycatch datasets.

A global review shows four broad categories of mitigation used during longline hauling: physical barriers, measures that reduce the attractiveness of the haul area, deterrents, and operational approaches that are part of fishing. Of devices that operate as physical barriers to seabirds, bird exclusion devices, tori lines and towed buoys have been tested and proven effective in reducing seabird interactions with hauled longline gear. Discharging fish waste such that seabirds are not attracted to the hauling bay is another effective measure, and seabird abundance around vessels is reduced by retaining fish waste during hauling. While a number of deterrents and *ad hoc* or reactive approaches to reducing haul captures have been discussed in the literature (e.g. water sprays), these have generally not been empirically tested.

Information collected by government fisheries observers on 73 bottom longline and 60 surface longline trips that have occurred since 1 October 2012 on New Zealand vessels $\leq$ 34 m in overall length showed that most of these measures are in place here. However, implementation may be limited to a small number of vessels (e.g. one bottom longliner used a tori line and two surface longliners used a buoy to reduce seabird interactions with gear at hauling). Implementation may also not be consistent amongst vessels in a fleet, or on the same vessel between trips (e.g., for fish waste management, where some skippers retained all waste until after hauling or discharged when hooks were well below the sea surface, whilst others discharged used baits directly back into the hauling bay as the line was pulled in). This variation in practices creates consequent variation in haul capture risks. Further, the information already available on vessel operations in New Zealand is sufficient to enable actions to reduce haul capture risks.

Fisher and observer records returned from smaller-vessel New Zealand longline fisheries since 1 October 2009 show that 19 - 32% and 12 – 15% of seabird captures were live, and so likely to have occurred on the haul, for bottom and surface longline respectively. Reports of live-captured petrels and shearwaters captures were more common than albatross captures in datasets for bottom longline fisheries overall. However, these data are numerically dominated by captures reported from Fisheries Management Area (FMA) 1 (where no albatross captures were documented). Albatross captures were reported from bottom longline fisheries in other areas. Across the regions where surface longline fisheries occur, albatrosses dominate capture reports. In both fisher and observer datasets, and for both fishing methods, single live captures per trip were most common. This suggests that implementing reactive mitigation approaches after a live-capture event has occurred will not necessarily reduce the number of captures overall.

Recommended next steps to progress haul mitigation work in smaller-vessel bottom longline fisheries includes prioritising mitigation efforts in FMA 1, given the relatively large numbers of captures of high risk seabirds reported there. For surface longline fisheries, a fleet-level approach is recommended, given vessels are often mobile amongst FMAs due to the highly migratory nature of target fish species and relatively smaller number of vessels involved (less than 40). Mitigation efforts should include exploring device deployments (e.g. buoys) to reduce haul captures, and improving the quality and consistency of fish waste management practices that minimise capture risks during hauling. Recommendations are also provided for enhancing data collection to improve knowledge and understanding of the nature and extent of haul captures in New Zealand's smaller-vessel longline fisheries.

Contents

Introduction

Globally, the focus of seabird bycatch reduction efforts in longline fisheries has most often been on line-setting. For example, tori lines, line-weighting and night-setting are all widely recognised, documented and implemented bycatch reduction measures that reduce seabird captures when longlines are set (Bull 2007, Petersen et al. 2009, Løkkeborg 2011, Pierre 2016, Parker 2017). Fisheries management frameworks applying to longline fishing echo this focus, through adoption of requirements for the use of mitigation during line-setting (e.g. Small 2005, ACAP Intersessional Group 2014, New Zealand Government 2010, 2014).

However, captures that occur during longline hauling can comprise a significant proportion of total seabird bycatch in longline fisheries (Gilman et al. 2014, Brothers 2016). Mitigation measures that reduce seabird captures on hauling are less developed than line-setting mitigation approaches. As a result, options with proven efficacy are few (Bull 2007, Løkkeborg 2011, Parker 2017), and this is reflected in fisheries management frameworks (CCAMLR Conservation Measure 25-02, South Pacific Regional Management Fisheries Organisation (SPRFMO) Conservation Management Measure 09-2017, New Zealand Government 2010).

Interactions between seabirds and longline fishing operations during hauling include birds:

- Foraging on hooked or free-floating baits
- Foraging on hooked, discarded or lost fish
- Foraging on fish processing waste, e.g. offal
- Interacting with each other and fishing gear, when one seabird brings baited hooks or hooked fish to the surface, and another bird attempts to steal that,
- Becoming foul-hooked (e.g. in the wing or foot) or entangled in fishing gear.

Identifying haul-captured seabirds is typically an imperfect process. It is clear when birds are observed caught on the haul. However, often this is not possible and indicators of a haul capture event include seabirds being still alive on the haul, plumage that is not sodden, and a lack of rigor mortis in birds landed dead (Brothers 2016, Gilman et al. 2016). The challenges of assigning captures to a stage of the fishing operation makes it more difficult to effectively identify factors that affect the incidence of haul captures (Gilman et al. 2014).

Growing global attention on haul captures includes the Agreement on the Conservation of Albatrosses and Petrels (ACAP) identifying research priorities, including the following, for pelagic longline fisheries (Seabird Bycatch Working Group 2017):

- Live bird haul capture: investigate the nature and extent of live bird haul capture in pelagic longline fisheries.
- Haul mitigation technologies: develop methods that minimise seabird hooking during hook retrieval.

In this report, I:

- review mitigation approaches that have been proposed or investigated globally, for reducing seabird captures during longline hauling operations
- present information on haul mitigation measures in use on longline vessels, as documented by government fisheries observers in New Zealand
- explore data available on seabird captures that are likely to have occurred during longline hauls on vessels $\leq$ 34 m in overall length, and,
- provide recommendations for future work to characterise and mitigate haul captures in New Zealand's smaller-vessel longline fisheries.

Improving the outcomes of bycatch events (i.e. seabird survival after capture at hauling) is not considered in detail in this report.

Methods

Review of haul mitigation approaches

To identify published, grey and conference literature relevant to haul captures and the investigation and application of haul mitigation measures, I conducted online searches using Google and Google Scholar with the following search terms:

- longlin*
- haul*
- mitigat*
- seabird*
- bycatch
- bycaught

In addition, I perused previous reviews of seabird bycatch mitigation measures that considered longline fishing (Bull 2007, Løkkeborg 2011, ACAP 2017a, ACAP 2017b, Parker 2017). Other sources of information were the websites of Regional Fisheries Management Organisations (RFMOs), the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), and ACAP. RFMO and CCAMLR site searches focused on management measures in place in longline fisheries.

With more general searches completed, I conducted specific searches using Google and Google Scholar to extract any additional available information on specific mitigation measures. Search terms used alone, and in combination with seabird*, haul* and longlin*, included:

- Bird exclusion device
- Bird curtain
- Brickle curtain
- Tori line
- Towed buoy
- Laser
- Water

- Acoustic
- Sonic

Finally, I contacted practitioners working on longline bycatch internationally, to identify any work being planned, or in progress that is not yet publicly available.

Information collected by government fisheries observers

Documentation from observed trips

To access information recorded by government fisheries observers, Conservation Services Programme (CSP) staff compiled a list of observer trips on longline vessels that had occurred since 1 October 2012. This included 199 observer trips. Ministry for Primary Industries (MPI) staff then provided trip documentation that related to protected species captures. Documentation from eight trips was unavailable. For other trips, documentation received included:

- non-fish bycatch forms
- excerpts of observer diaries
- edited trip reports
- photographic logs
- information collected by observers to support the CSP seabird liaison programme, and,
- CSP protected species abundance counts.

Documentation included scans, Microsoft Word documents, and Microsoft Excel spreadsheets. All information was not necessarily available for each trip. For example, if there were no seabird bycatch events, non-fish bycatch forms were not completed. Where events or information relevant to haul captures were captured in photos or video (as identified in the Photographic Log), these were requested from CSP.

Where observers had collected information relevant to haul captures, this was extracted and recorded separately.

Observer data on bycatch events

Observer data on seabird captures was requested from MPI for the period starting 1 October 2009 up to the most recent available record. The extract covered vessels $\leq$ 34 m in overall length using the bottom and surface longline methods. Information requested included trip number, fishing effort observed, the date the capture was observed, seabird species, life and injury status, mode of capture, locations of fishing activity (by Fishery Management Area, FMA) and capture, target fish species, and the comments field from the observer non-fish bycatch form.

The data extracts provided by MPI were Replogs 11684 and 11697.

Deck strikes, identified by the "I" reporting code and observer comments, were removed from the dataset. Exploratory analysis included area-based consideration, by method, of capture rates, the proportion of live captures amongst total captures, species composition of live captures, live seabird captures in relation to target fish species and identification of frequently caught species in each area. Amongst species reported by observers, three gulls caught were included in groupings of petrels and shearwaters. When longlines were set across FMA boundaries, hooks set were allocated equally amongst those FMAs (by target species) and start FMA was used to categorise seabird captures.

Reports of injured and uninjured live-captures were considered together given significant uncertainty in prognoses post-release.

Fisher-reported data on bycatch events

Fisher-reported commercial catch and effort information was requested from MPI, for longline fishing vessels ≤ 34 m in overall length from 1 October 2009 to the most recent record available. Effort data included trip start and end dates, number of hooks, location of longline set by FMA, and target species for vessels using the surface and bottom longline methods. When longlines were reported to be set across FMA boundaries, hooks were allocated equally amongst those FMAs (by target). Seabird capture information for the same vessels, methods and timeframe was also requested. This included location of seabird captures, target fish species, seabird species reported caught, live (injured and uninjured), dead and total captures. The data extracts provided by MPI were Replogs 11520 and 11695.

Analogous to the exploration of observer data, exploratory analysis of the fisher-reported dataset included, by method, area-based consideration of capture rates, the proportion of live captures amongst total captures, species composition of live captures, and live seabird captures by target fish species.

Amongst species reporting codes used by fishers, “large seabird” (XSL) was grouped with albatross, and codes for gull and Sulidae species were included with petrels, shearwaters and other small seabirds.

Injured and uninjured live-caught seabirds were considered together, given the uncertainty about assessments leading to categorisation in each of these groups, and what each of these categories means in terms of survival prognosis. Further, fisher reports from bottom longliners were almost all categorised as uninjured (see Results).

Results

Haul mitigation approaches

Haul mitigation approaches fell into four broad categories:

- Physical barriers that impede seabird access to the hauling area
- Reducing the attractiveness of the hauling area
- Deterring seabirds using negative stimuli, and,
- Operational approaches that reduce seabird exposure to hauled gear.

Some approaches also had features characteristic of more than one category. For example, depending on their design, tori lines create a physical barrier as well as deterring birds from approaching due to the unpredictable movement or noise created by the line. Another example is when the vessel is used as a physical barrier, when hauling operations are conducted such that the longline emerges from the water at a steep angle very close to the hull. Approaches that could be homed in more than one category are included once only.

Physical barriers

Research identified three types of haul mitigation devices that provide physical barriers between birds and the hauling bay. These were bird exclusion devices, tori lines, and towed buoys. Reports located describe diverse designs amongst these devices. In effect, there is a continuum of device designs with characteristics of each type. For example, multiple tori line-type devices may be deployed such that a curtain effect is created (i.e. they effectively create a bird exclusion device). Tori lines with a terminal float or buoy effectively become towed buoys if streamers are removed. Device types and characteristics follow:

- Bird exclusion devices

Bird exclusion devices (BEDs) with a range of a design specifications have been applied to reduce seabird interactions with surface and bottom longline gear at hauling. BED is a broad term that includes devices also called bird curtains, Brickle curtains, and (in some cases) bird baffler-type devices.

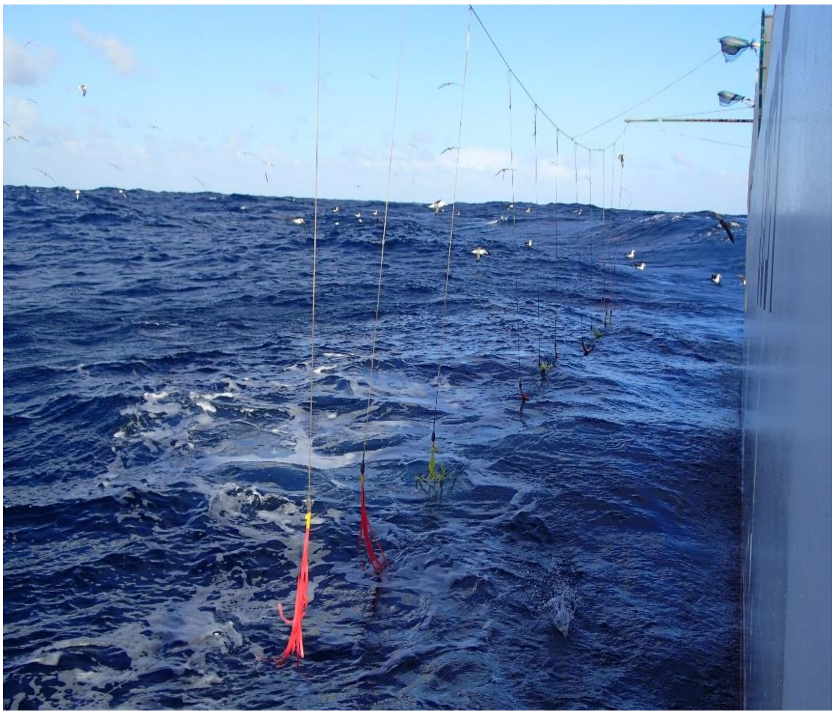
CCAMLR captured the essential performance elements of BEDs in its operational standards promulgated in Conservation Measure 25-02, applied to fishing using the longline method. These standards require that BEDs must effectively deter seabirds from flying into the area where the line is being hauled, and must prevent seabirds that are sitting on the sea surface from swimming into the hauling bay area (CCAMLR Conservation Measure 25-02). Designs typically incorporate some combination of a rail or frame from which droppers or streamers are attached, that reach buoys on the water (Figure 1) (e.g., Snell 2008, Reid et al. 2010, Gilman and Musyl 2017). Designs without buoys with lengths of rope used to create a curtain have also been reported (Duran Munoz et al. 2011).

Melvin and Walker (2008) describe a curtain-like set-up used to reduce seabird interactions with surface longline gear during hauling on a Japanese pelagic longliner operating in New Zealand waters. This comprised two bamboo booms extending horizontally from the vessel, some distance apart. A length of rope was attached to each boom, and ropes dropped vertically to a position close to the sea surface. Each rope had short streamers of yellow packing strap material attached at approximately one metre intervals along its length. Weight was added at the seaward end of each rope, to help maintain the position of the ropes in windy conditions (Melvin and Walker 2008).

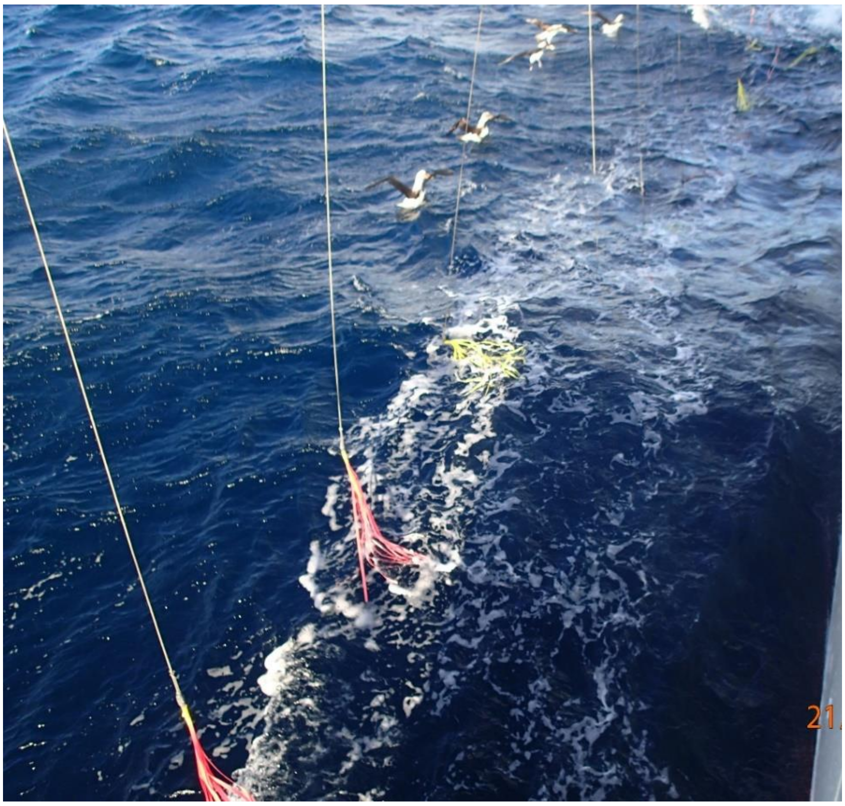
Similar to the devices reported by Melvin and Walker (2008), observers have reported the use of BEDs (in the form of bird curtains) by three large (> 48 m in overall length (LOA)) Japanese pelagic longline vessels operating in New Zealand waters. These devices comprised booms extending out from the vessel with ‘danglers’ or streamers suspended from them (Figure 2, DOC and MPI, unpubl.)

The efficacy of BEDs in reducing seabird interactions with hooks at hauling has been empirically demonstrated (Snell 2008). Qualitative assessments that BEDs are effective have also been reported (Melvin and Walker 2008, Reid et al. 2010). However, researchers note that habituation may occur such that birds eventually enter the hauling bay past the BED (Sullivan 2004). BEDs also require careful design and ongoing attention during the haul (especially when weather is rough) to ensure they do not tangle, including tangling with the longline.

Figure 1. A bird exclusion device deployed during longline hauling. (Source: www.afma.gov.au).



(a)



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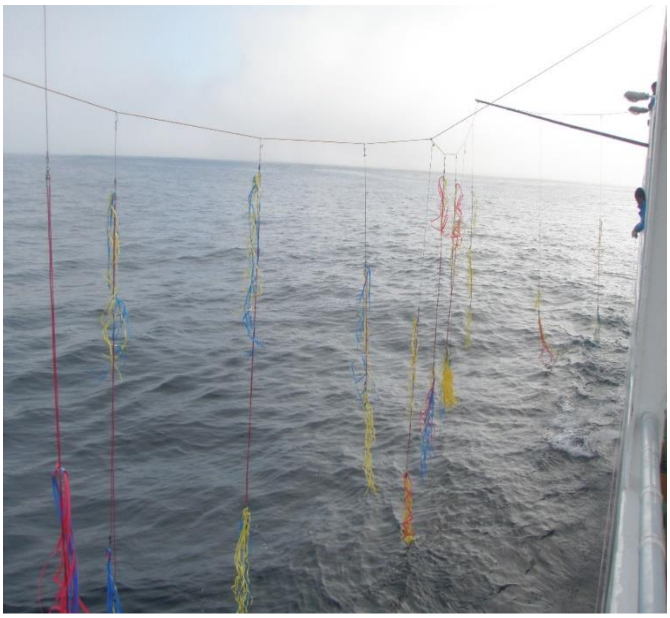


(c) (d)

Figure 2. Bird curtains deployed from two Japanese surface longliners operating in New Zealand, photographed by government fisheries observers. Photos (a), (b) and (c) are from a single vessel, and (d) is a similar curtain in place on a second vessel. (Source: DOC and MPI).

- Tori lines and towed buoys

Tori lines used during hauling also comprise a variety of designs and deployment approaches. For example, tori lines used on hauling may or may not have streamers, and may be the length of a tori line used on setting, or shorter. McNamara et al. (1999) tested a tori line 50-m in length, with four shortened streamers. This tori line was deployed from a swivelling metal base, which was positioned such that the streamers and terminal buoy protected the area where hooks came to the surface on hauling. McNamara et al. (1999) reported that the terminal buoy of the tori line bounced on the water, which distracted seabirds. The buoy's movement also increased the unpredictable movement of the streamers, which they considered had a deterrent effect. The study confirmed the efficacy of the tori line in reducing seabird interactions with hauled gear.

Gilman et al. (2014) reports tori line use during hauling on two vessels on five occasions amongst the Hawaiian pelagic longline fleet.

Towed buoy devices comprise one or more buoys attached to some length of rope and towed by the vessel. McNamara et al. (1999) found their towed buoy setup comprising a rope of 140 – 175 m in length, with a single terminal buoy, was effective in reducing seabird interactions with gear on hauling, but less so than the tori line design tested, and blue-dyed baits. Testing a two-buoy design with a middle buoy and a terminal buoy was abandoned, given the design created excessive drag. Short streamers were incorporated at one metre intervals in the rope of the preferred design, creating a device that could also be identified as a tori line.

Like BEDs, tori lines and towed buoys were reported to require attention to ensure they operated without tangling with the longline.

Goad (2018) reported on preliminary testing of a buoy device on a small New Zealand bottom longliner. This device comprised a 150-mm diameter orange float attached by a rope to an overhead pole that extended outboard of the vessel. Orange plastic pipe covered the rope, and a black plastic flag was attached to the rope just above the buoy. During testing conducted over 6 days, significantly fewer seabirds were counted close to the longline when the buoy device was in place.

- Moon pool

Moon pool designs address haul captures by completely enclosing the longline-hauling operation inside a vessel's hull. Because they are a fundamental part of the vessel's structure, moon pools must be considered as part of the vessel design process. Empirical testing of the efficacy of moon pools in reducing seabird bycatch (including haul captures) has not been undertaken (Parker 2017). However, the design suggests haul captures would be eliminated.

Reducing the attractiveness of the hauling area

Longline fishing activity inevitably presents attractants to seabirds, given the availability of bait, fish, and processing waste. Managing these attractants such that seabirds are not unduly attracted to areas in which gear is present is an effective approach to reducing bycatch, including on the haul. However, the relationship between seabird abundance, fish waste discharge, and captures (including at hauling) can be complex.

- Fish waste management (bait, fish processing waste, discards)

Significant positive relationships have been documented between fish waste discharge from demersal longliners and seabird abundance (e.g. Weimerskirch et al. 2000, Pierre et al. 2013), and albatross densities and haul bycatch rates in surface longline fisheries (Gilman et al. 2014). However, retention of fish waste increased attacks on hooked baits during hauling in one pelagic longline fishery (McNamara et al. 1999). Discharging fish waste away from the hauling bay had no effect on catch rates in one pelagic longline fishery (Gilman et al. 2014, noting the sample size differential between discharge and no discharge treatments), but reduced seabird captures in another (Petersen et al. 2009).

Discharging fish waste from a vessel at any time reinforces the connection seabirds have learned between fishing vessels and food. Therefore, in the short term, while discharging away from returning hooks and the longline in the hauling bay may reduce interactions between seabirds and longline gear, longer term it does not address the attraction of seabirds to vessels and therefore may increase bycatch risks (for example, when seabirds are attracted vessels during setting, and no offal is available for discharge to distract them away from the line-setting area (Gilman et al. 2014)).

ACAP best practice advice for fish waste management during hauling is for waste retention during hauling where practical (ACAP 2017a, ACAP 2017b). This is reflected by some fisheries management provisions (e.g., CCAMLR Conservation Measure 25-02, SPRFMO Conservation Management Measure 09-2017, Western and Central Pacific Fisheries Commission (WCPFC) Conservation and Management Measure 2017-06). If fish waste cannot be retained, ACAP best practice advice is that discharge should occur on the opposite side of the vessel to the hauling bay (ACAP 2017a). This is echoed in some fisheries management frameworks (e.g. CCAMLR Conservation Measure 25-02, WCPFC Conservation and Management Measure 2017-06, New Zealand Gazette 2010). SPRFMO requirements also include a provision for batch discharge of fish waste not more than two-hourly when demersal longline fishing, when safety concerns apply (SPRFMO Conservation Management Measure 09-2017).

- Line-weighting

Gilman et al. (2014) identified a significant positive relationship between live seabird captures and leader length in the Hawaiian pelagic longline fishery. Alongside this, live captures decreased when weighted swivels of 65 g or above were used. Leader length and weight together influence hook depth, thereby affecting seabird access to hauled hooks.

- Blue-dyed bait

Dying baits blue is assumed to make them less visible (or less appealing) to seabirds (Bull 2007). More often associated with longline-setting, McNamara et al. (1999) reported that dying baits blue was of comparable efficacy to tori lines in reducing seabird interactions with pelagic longline gear during hauling. Gilman et al. (2014) found no significant effect of blue-dyed bait on live-capture rate. Blue-dyed bait is not recommended as a haul capture mitigation method by ACAP (ACAP 2017a, ACAP 2017b).

<u>Deterring seabirds using negative stimuli</u>

Deterrents may operate through delivering negative stimuli to seabirds' sight, sound, olfaction or vision. If they are effective at all, most deterrent measures have only short-term effects in reducing seabird activity. None of the measures described below are included in ACAP's best practice recommendations (ACAP 2017a, 2017b).

- High-pressure water discharge

Various researchers have identified water as a possible mitigation measure for use during longline hauling. This may be in the form of a water spray, hose (e.g. use of the deck hose), or high pressure discharge also known as a water cannon (Bull 2007, Gilman and Musyl 2016, Parker 2017). Empirical testing undertaken has shown localised and short-term efficacy as a deterrent, while noting that windy conditions reduce this (Kiyota et al. 2001).

- Acoustic scarers

This approach encompasses any noise-based deterrent that is intended to reduce seabird attendance in close proximity to gear on hauling. Commercially produced units include the SeaBird Saver[1], gas cannons and horns. While there may be some short-term localised efficacy in deterring seabirds, habituation is likely and/or documented under ongoing use (Bull 2007, Gilman and Musyl 2016, Parker 2017).

- Fish oil

This measure involves dripping a small amount of shark liver oil on the sea surface. Preliminary testing showed significant deterrent effects for some petrels and shearwaters, but not for albatross species (Pierre and Norden 2006, Norden and Pierre 2007).

- Lasers

Lasers are a relatively recent approach to bycatch reduction. The SeaBird Saver is a commercially-available laser deterrent marketed as a bycatch mitigation measure. Some efficacy is reported from preliminary testing of laser devices, however the devices appear ineffective during daylight (Parker 2017).

<u>Other measures</u>

In addition to the relatively better documented methods described above, numerous others have been suggested to reduce seabird bycatch, either specifically during longline hauling or more generally during fishing operations. These methods have not been tested but are identified below for completeness. [P] denotes when the measure has been proposed in the context of haul capture events in pelagic longline fisheries.

- Haul speed[P]
    - Increasing haul speed (reducing the time, and by implication, opportunity) seabirds have to access baited hooks or be tangled in gear (ACAP and BirdLife International 2014, Gilman et al. 2014, Gilman and Musyl 2016)
    - Decreasing haul speed, such that longlines exit the water at angles closer to vertical and closer to the side of the vessel (therefore, the proximity of the gear to the side of the vessel may effectively impede seabird access to it (Gilman and Musyl 2016).
- Separate to consideration of haul speed *per se*, there may be a mitigation effect of hauling as close to the vessel hull as possible, if seabirds are reluctant to make contact with the vessel (Nelson 1998)[P].
- Night-hauling[P] (Brothers 2016)
- Shortening snoods[P] (Gilman et al. 2014, Brothers 2016)
- Locating weights closer to hooks[P] (Gilman et al. 2014, Brothers 2016)
- Hook size and design (Brothers et al. 1999, ACAP 2017b)
- Adding a lure to snoods to distract seabirds from bait[P] (Brothers 2016)
- Magnetic deterrents (Bull 2007)
- Electric deterrents (Bull 2007)
- Smoke (Bull 2007)

[1] http://www.seabirdsaver.com/ [Accessed 4 April 2018].

Information collected by government fisheries observers

Amongst 133 of the 191 observed trips for which documentation was received from MPI and CSP, observers had recorded information specific to seabird interactions with longline gear during hauling (73 bottom longline trips, 60 surface longline trips). This information ranged from brief comments, for example, about trends in seabird abundance during hauling, through to detailed descriptions of the practices in place on vessels that mitigated or exacerbated haul capture risks. The most detailed information was recorded by observers to support the Department of Conservation's (DOC) seabird liaison programme (Pierre 2016, Goad 2017). When observer information relating to haul mitigation approaches was recorded in qualitative form, it was sometimes difficult to interpret exactly how measures were implemented. For example, if returned baits were reported as being discharged during hauling, it was not always clear if these were being discharged directly into the hauling bay. Further, while some observers used terminology to separately describe bait, offal and discards, in other cases it was not clear if the term "offal" incorporated used bait and fish offal from processing.

The suite of mitigation measures implemented amongst smaller longline vessels operating in New Zealand waters includes many of those used worldwide.

Bottom longline vessels

- Bird exclusion devices

One vessel was reported to use a "bird baffler" device around the hauling station to reduce seabird access to returning hooks. This device was improvised following the capture of a white-capped albatross during hauling.

- Tori lines and towed buoys

An observer recorded the use of a streamerless tori line during hauling on one bottom longline vessel operating in northern New Zealand. The tori line was 25 m in length, with a terminal polystyrene float 0.7 m in length.

- Fish waste management (bait, fish processing waste, discards)

Observer records documented a range of fish waste management practices. These included never retaining used baits (9 trips), and retaining returned used baits some or all of the time during line hauling (20 trips). When baits were retained during hauling, this could be for the duration of the haul, until the end of a basket, or until a break in hauling. Returned baits were discharged directly into the hauling bay (9 trips, including two when observers reported baits being 'flicked' away from the mainline) or away from there (4 trips). During two trips, returned baits were discarded until birds arrived during hauling, and were then retained.

Observers reported a similar range of offal management practices. Vessel operators retained offal sometimes or always on 22 observed trips. Offal was never retained on 4 trips. Offal discharge occurred both at and away from the hauling station (5 and 9 trips, respectively). The timing of offal discharge was naturally affected by when processing occurred. In many cases, offal-producing catch items were not processed until after hauling, which provided for offal retention to be driven by purely operational considerations.

Observers reported the retention of discards occurring sometimes or always on 5 trips, and never during hauling on 4 trips. One observer reported fish being "popped" before discarding on one vessel, with the skipper's rationale being that these fish would not float and thereby attract birds to the vessel. In one case, space constraints on the vessel were cited as the rationale for discarding a large number of spiny dogfish (*Squalis acanthias*) caught on a longline.

There was variation in fish waste management practices both between vessels and between trips on the same vessel.

- Moving the line constantly during hauling

This measure was observed on one trip and was intended to reduce the ability of seabirds to grab onto returned baits or hooked fish.

- Keeping hooks below the surface during haul breaks

This practice was reportedly used by three skippers. One skipper cut the mainline during breaks in hauling and deployed a float. Two skippers let out a length of hook-free line during breaks in hauling. On another vessel, breaks were only undertaken when floats were due to come aboard, and the subsequent hook could sit at 14 m deep.

On one vessel, tangles were sometimes cut out of the line on hauling and resolved on deck rather than being dealt with during hauling while the gear was still in the water.

- High-pressure water discharge

On one bottom longline vessel, the deck hose was slotted into a scupper grill to create a water deterrent to seabirds during hauling.

- Blue-dyed bait (1 trip)
- Manoeuvring the vessel so the haul station was immediately above the incoming line, to reduce seabird access to the line (2 trips)
- Swinging a long-handled net (1 trip)
- Making a lot of noise aboard (e.g. shouting, clapping) (2 trips)

<u>Surface longline vessels</u>

- Tori lines and towed buoys

On one surface longline vessel, an observer recorded the deployment of a float beside the vessel during hauling when birds were active (Figure 3). A second surface longliner was reported deploying a small float from a tuna pole, over the starboard stern during hauling. The float swung in an arc over the area in which hooks surfaced during hauling.

- Fish waste management (bait, fish processing waste, discards)

As documented by observers deployed on bottom longliners, there was a range of approaches to managing fish waste amongst surface longliners. Observers documented the retention of bait during hauling some or all of the time in 21 trip reports. There were two reports of vessels never retaining returned baits. Baits were reported to be discharged at the hauling station on 2 trips, and away from the hauling station on another 3 trips. Baits were discharged during hauling (from an unknown location) on another 6 trips.

Offal was retained some of all of the time during hauling on 9 trips, and not retained on 4 trips. Offal was reported to be discharged away from the hauling station on 7 trips. Eight trips were reported where discharge occurred during hauling (but from unknown locations).

Information on discarding was limited. Discards were reported to be discharged during hauling on one trip.

- Line-weighting

Line-weighting practices are variable on surface longliners operating in New Zealand. During 2016/2017, liaison officers reported an increase from three to 12 in the number of vessels using line-weighting in proximity to the hook end of snoods. Weighting practices include weighted swivels, lumo leads and hook pods (Wells and Cleal 2017). Weighting at the clip has also been reported (Pierre 2016).

- Blue-dyed bait

The use of dyed baits was reported by observers on seven trips (three vessels). Dyed and undyed bait were sometimes used on the same line, and dying did not necessarily occur on all sets on a trip. On two trips, one vessel was observed to dye squid baits hauled prior to reusing them on the subsequent set.

- High-pressure water discharge

Water was used as a deterrent on four vessels. On two trips, observers reported the use of "water curtains" when seabirds were active during hauling. On another two trips, the deck hose was used to deter birds.

- Haul speed

Observers reported vessel operators citing a fast haul speed to reduce seabird bycatch risk on two trips.

- Jerking snoods constantly during hauling (1 trip)
- Manoeuvring the vessel so the haul station was immediately above the incoming line, to reduce seabird access to the line (1 trip)
- Making a lot of noise or arm-waving aboard (2 trips, 2 vessels)

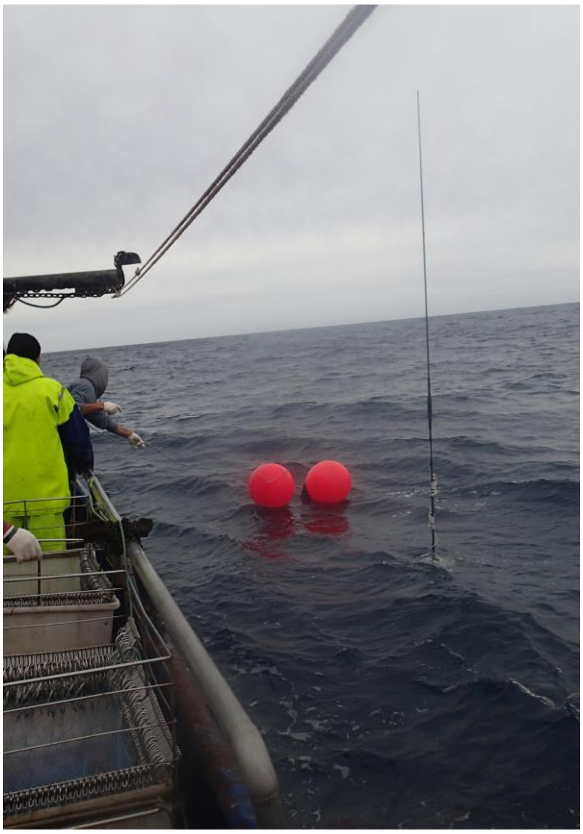


Figure 3. The buoy set-up deployed from a surface longline vessel to help reduce seabird access to the hauled line, photographed by a government fisheries observer (Source: DOC and MPI).

Fisher-reports of seabird bycatch events

Bottom longline

From 1 October 2009 to 30 October 2017 (the most recent capture record in the extract received), 893 seabird captures were reported by fishers from 43 different vessels ≤ 34 m LOA using the bottom longline method (Table 1, Appendix 1). Of these, 19.3% of captured seabirds were reported as being alive (with or without injuries). Almost all birds reported caught alive were categorised by fishers as uninjured (92.4%). Due to the amount of data on live captures amongst this data set, years were considered together, and capture data were grouped according to FMA and target species.

More than half (53%) of the seabird captures reported by fishers occurred in FMA 1. Around one quarter (24%) of the reported captures occurred in FMA 4. Five to seven percent of reported captures occurred in each of FMAs 3, 7 and 8. Less than 3% of captures occurred in FMAs 2, 5, 6 and 9 (Table 1).

Fishers reported live captures of seabirds from bottom longline operations in FMAs 1, 3, 4, 7 and 8. No live captures were reported from FMAs 2, 5 and 9 (Table 1). In FMA 1, most live captures were reported from bluenose (*Hyperoglyphe antarctica*) and snapper (*Pagrus auratus*) fishing. There were no albatross captures reported, and captured seabirds were most often identified as black petrels (*Procellaria parkinsoni*) and flesh-footed shearwaters (*Puffinus carneipes*) (Table 1). The generic reporting code XXP also encompasses these species. Live captures of albatross were reported from ling (*Genypterus blacodes*) fishing activity in FMAs 3, 4, and 7, and hapuku/bass (*Polyprion oxygeneios, P. americanus*) and school shark (*Galeorhinus galeus*) fishing in FMA 8. Four species of albatross were reported caught

(Salvin's (*Thalassarche salvini*), Buller's (*T. bulleri)*, royal (*Diomedea sanfordi, D. epomophora*) and white-capped albatrosses (*T. steadi*) (Table 1, Appendix 1).

Amongst trips for which fishers reported live captures, from one to eleven seabirds were reported caught. Most often, captures of a single bird were reported per trip (Figure 4a).

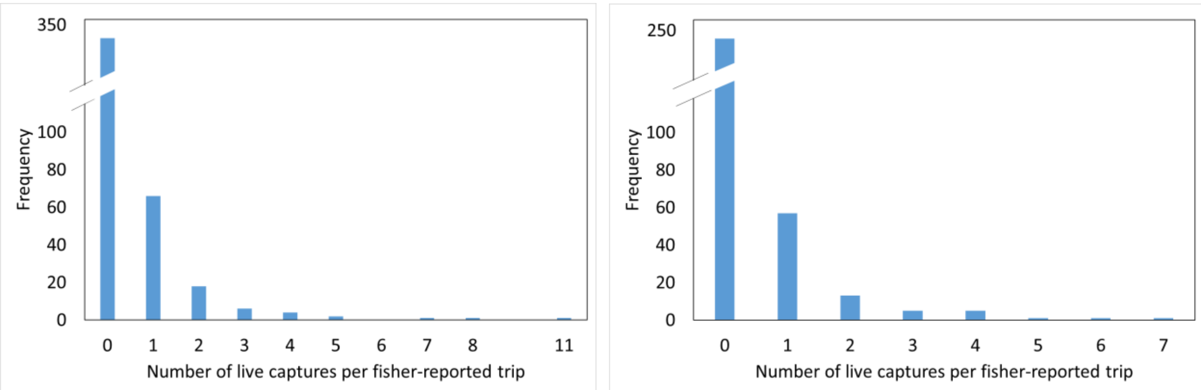
Surface longline

From 1 October 2009 to 25 July 2017 (the most recent capture record in the data extract received), 907 seabird captures were reported by fishers from 32 different vessels < 34 m LOA using the surface longline method (Table 2, Appendix 2). Of these, 15% of captured seabirds were reported as alive (with or without injuries). Most birds reported caught alive were considered uninjured by fishers (65%). As for bottom longline reports, years were considered together, and capture data were grouped according to FMA and target species.

Fishers reported captures of seabirds in surface longline operations in FMAs 1, 2, 5, 7 and 9, and live captures were included in reports from all these FMAs (Table 2). Unlike in bottom longline fisheries, the majority of live-captures reported from surface longline fisheries across target species were albatrosses. The albatrosses most commonly reported caught were Buller's, shy (*Thalassarche cauta*), snowy wandering (*Diomedea exulans*), and white-capped albatrosses. Specific and higher level (e.g. XAG, XWA) or generic (e.g. XAL) reporting codes for albatross were also used by fishers (Table 2).

Live-captures of petrels and shearwaters were reported from surface longline fisheries in much lower numbers than albatrosses, and in lower numbers than from bottom longline fisheries. There were more reports of flesh-footed shearwaters than other petrel and shearwater species. Fishers used both species-specific and generic codes (e.g. XXP) to report captures (Table 2).

Captures of a single live bird were most often reported from surface longline trips, and captures of up to seven birds per trip occurred (Figure 4b).



(a) (b)

Figure 4. Number of live captures documented in fisher-reported trips on (a) bottom longliners < 34 m in overall length, from 1 October 2009 through 30 October 2017 and (b) surface longliners < 34 m LOA from 1 October 2009 through 25 July 2017.

Table 1. Summary of live seabird captures and fishing effort reported by fishers operating bottom longline fishing vessels ≤ 34 m in overall length, from 1 October 2009 through 30 October 2017. FMA = Fisheries Management Area. Target species are blue cod (*Parapercis colias*, BCO), bluenose (*Hyperoglyphe antarctica*, BNS), gurnard (*Chelidonichthys kumu*, GUR), hapuku and bass (*Polyprion oxygeneios*, *P. americanus*, BAS, HAP, HPB), kingfish (*Seriola lalandi*, KIN), ling (*Genypterus blacodes*, LIN), red snapper (*Centroberyx affinis*), ribaldo (*Mora moro*, RIB), snapper (*Pagrus auratus*, SNA), school shark (*Galeorhinus galeus*, SCH) and tarakihi (*Nemadactylus macropterus*, TAR). Seabirds are black-backed gull (*Larus dominicanus*, XBG), black petrel (*Procellaria parkinsoni*, XBP), Buller's shearwater (*Puffinus bulleri*, XBS), Cape petrel (*Daption capense*, XCC), common diving petrel (*Pelecanoides urinatrix*, XDP), flesh-footed shearwater (*Puffinus carneipes*, XFS), fluttering shearwater (*Puffinus gavia*, XFL), gulls and terns (Laridae, XLA), northern giant petrel (*Macronectes halli*, XNP), petrels, prions and shearwaters (Hydrobatidae, Procellariidae and Pelecanoididae, XXP), sooty shearwater (*Puffinus griseus*, XSH), Westland petrel (*Procellaria westlandica*, XWP), white-headed petrel (*Pterodroma lessonii*, XWH), boobies and gannets (Sulidae, XSU), Buller's albatross (*Thalassarche bulleri*, XPB), royal albatross (*Diomedea sanfordi*, *D. epomophora*, XRU), Salvin's albatross (*T. salvini*, XSA), and white-capped albatross (*T. steadi*, XWM).

FMA	Target species	Number of seabird captures (live and dead)	% of total reported captures occurring in FMA	% of fishing effort in FMA	% of captures live	% live captures that were albatross	Seabirds caught alive
1	BAS, HAP, HPB	1	53.2	1.6	100	0	XBP (1)
	BNS	58		7.8	81.0	0	XBP (38), XSH (9)
	GUR	22		0.8	0		
	KIN	11		0.1	0		
	LIN	1		3.1	100	0	XBP (1)
	RSN	1		0.7	0		
	SNA	365		81.8	28.2	0	XBG (1), XBP (25), XBS (1), XCC (5), XFL (1), XFS (47), XLA (1), XSH (3), XSU (2), XXP (17)
	TAR	16		3.4	25	0	XDP (1), XFS (2), XSH (1)
2	BNS	2	1.6	44.3	0		
	LIN	12		40.7	0		
3	BNS	3	5.6	2.6	0		
	HAP, HPB	8		7.6	0		
	LIN	28		80.2	10.7	100	XPB (1), XSA (2)
	SCH	11		3.7	0		
4	BNS	13	24.2	6.0	0		
	HPB	37		28.8	2.7	0	XXP (1)
	LIN	130		53.0	2.3	100	XPB (2), XSA (1)
	RIB	24		2.7	4.2	0	XWH (1)
	SCH	12		8.3	0		
5	HPB	1	1.6	9.0	0		
	LIN	13		78.8	0		
6	LIN	8	0.9	99.6	0		
7	BNS	3	6.8	4.5	0		
	HAP, HPB	9		16.2	0		
	LIN	46		60.9	4.3	100	XRU (1), XWM (1)
	SCH	3		17.5	0		
8	BCO	4	5.3	2.5	0		
	BNS	8		12.3	0		
	GUR	18		18.0	11.1	0	XNP (1), XWP (1)
	HPB	4		18.3	25	100	XPB (1)
	SCH	11		37.9	27.3	66.7	XSH (1), XWM (2)
	SNA	1		2.6	0		
	TAR	1		0.1	0		
9	BAS	1	0.6	35.6	0		
	BNS	3		17.4	0		
	SNA	1		10.3	0		
Unknown	LIN	3	0.3	7.0	0		

Table 2. Summary of live seabird captures and fishing effort reported by fishers operating surface longline fishing vessels ≤ 34 m in overall length, from 1 October 2009 through 30 October 2017. FMA = Fisheries Management Area. Target species are bigeye tuna (*Thunnus obesus*, BIG), blue shark (*Prionace glauca*, BWS), Pacific bluefin tuna (*Thunnus orientalis*, TOR), southern bluefin tuna (*Thunnus maccoyii*, STN), and swordfish (*Xiphias gladius*, SWO). Seabirds are black petrel (*Procellaria parkinsoni*, XBP), Cape petrel (*Daption spp.*, XCP), common diving petrel (*Pelecanoides urinatrix*, XDP), flesh-footed shearwater (*Puffinus carneipes*, XFS), petrels (petrel unidentified, XPE), petrels, prions and shearwaters (Hydrobatidae, Procellariidae and Pelecanoididae, XXP), sooty shearwater (*Puffinus griseus*, XSH), Antipodean and Gibson's albatross (*Diomedea exulans* and *D. antipodensis*, XAG), albatross (Diomedeidae, XAL), Buller's albatross (*Thalassarche bulleri*, XPB), Salvin's albatross (*T. salvini*, XSA), shy albatross (T. *cauta*, XSY), southern black-browed albatross (*T. melanophris,* XSM), southern Buller's albatross (*T. bulleri bulleri*, XBM), southern royal albatross (*D. epomophora*, XRA), snowy wandering albatross (*D. exulans*, XAS), wandering albatross (*D. exulans* and *D. antipodensis*, XWA), and white-capped albatross (*T. steadi*, XWM).

FMA	Target species	Number of seabird captures (live and dead)	% of total reported captures occurring in FMA	% of fishing effort in FMA	% of captures live	% live captures that were albatross	Seabirds caught alive
1	BIG	159	28.8	61.7	8.8	71.4	XFS (3), XPE (1), XAL (3), XAS (1), XPB (1), XRA (3), XSY (1), XWA (1)
	STN	26		31.2	7.7	100	XAL (2)
	SWO	76		6.9	17.1	92.3	XXP (1), XAL (5), XAS (1), XSY (5), XWA (1)
2	BIG	52	17.1	35.0	9.6	100	XPB (1), XRA (3), XSA (1)
	BWS	2		0.08	50	50	XSA (1)
	STN	89		55.7	13.5	91.2	XCP (1), XAL (1), XAS (1), XBM (1), XPB (2), XSY (6)
	SWO	9		4.6	0		
	TOR	3		3.2	0		
5	STN	29	3.2	100	6.9	100	XRA (1), XWM (1)
7	STN	394	47.5	81.8	19.0	67	XBP (1), XDP (2), XFS (2), XSH (1), XWP (2), XAL (13), XAS (10), XBM (5), XPB (16), XSA (3), XSY (8), XWA (2), XWM (10)
	SWO	37		18.0	21.6	75	XSH (1), XXP (1), XAL (3), XAS (1), XWM (2)
9	BIG	14	3.4	50.1	21.4	66.7	XXP (1), XAG (1), XAL (1)
	SWO	17		46.5	5.9	100	XSM (1)

Observer reports of seabird bycatch events

Reporting

Amongst live captures in both bottom and surface longline fisheries, hooked and tangled seabirds reported by observers were considered together for the exploratory analysis presented in this report given that by far the majority of birds were hooked (Table 3).

Observers had made specific comments regarding captures that occurred on hauling, or the condition of seabird plumage that could be used to infer when captures occurred (e.g. dry, waterlogged), in nine and in 38 instances, for bottom and surface longline captures respectively. Therefore, while imperfect (Brothers 2016), live captures were considered as proxies for captures most likely to have occurred during the haul.

Given the relatively small amount of data on live captures, years were considered together, and capture data were grouped according to FMA and target species.

Table 3. Mode of capture and life status of seabirds caught in smaller vessel (≤ 34 m overall length) bottom and surface longline fisheries, reported by government fisheries observers from 1 October 2009 to 4 December 2017 (bottom longline) and 29 December 2017 (surface longline). Reports include 57 and 62 observer trips on bottom longline and surface longline fishing vessels, respectively.

		Bottom longline		Surface longline	
		Life status			
		Live	Dead	Live	Dead
Capture method	Hooked	71	161	39	311
	Tangled	5	6	5	22
	Other or unknown	2	2		3
Total		78	169	44	336

Bottom longline

Observer data received included 247 records of seabird captures by vessels ≤ 34 m LOA operating in bottom longline fisheries, from 57 observed trips. The most recent capture included in the dataset received was reported on 4 December 2017. There were 78 live captures and of these, 42% were reported with no visible injuries.

Observers reported live captures of seabirds from bottom longline fishing activity in FMAs 1, 7, 8 and 9 (Table 4, Appendix 3). Similar to fisher reports, the largest number of observed live captures occurred in FMA 1. Snapper and bluenose fishing activity accounted for most live captures there. Live captures were also recorded on lines set in FMA 1 and targeting hapuku/bass, kahawai (*Arripis trutta*) and tarakihi (*Nemadactylus macropterus*) (Table 4).

In FMA 1, black petrels and flesh-footed shearwaters were the most frequently live-caught species by far (Table 4). No live captures of albatross were reported from FMA 1, 8 or 9. In FMA 7, southern Buller's (*T. bulleri bulleri*), southern royal (*D. epomophora*), and white-capped albatrosses were reported live-caught on longlines set for ling (Table 4).

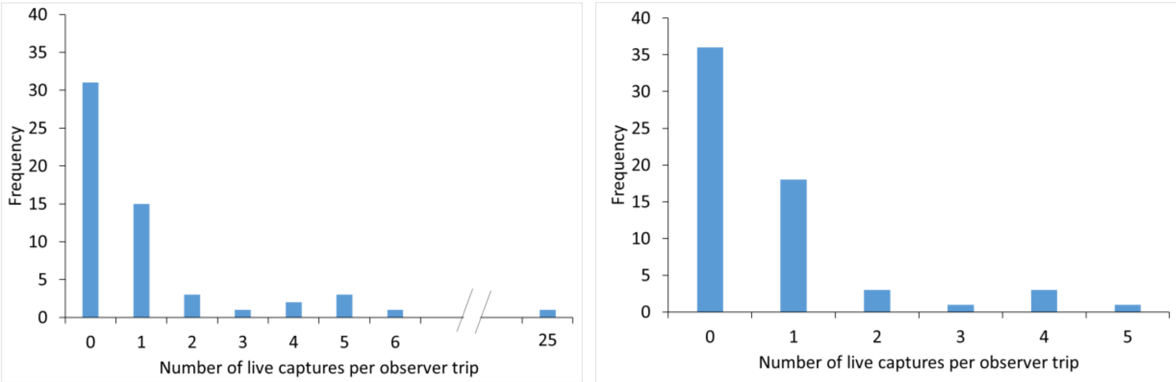
The majority of observed live capture events involved single birds. All live-capture events involved six or fewer birds per observed trip, except one instance in which 25 birds were caught alive (Figure 5a).

Surface longline

Amongst surface longliners < 34 m LOA, the dataset included 380 captures from 62 observed trips. The most recent included capture was reported on 29 December 2017. There were 44 live captures reported, of which observers considered that 18% had no visible injuries.

Observers reported live captures from FMAs 1, 2, 5, 7 and 9 (Table 5, Appendix 4). Analogous to fisher reports, observers documented relatively few live captures of petrels and shearwaters in surface longline fisheries; the majority were albatrosses. The white-capped albatross was the most commonly live-caught albatross species, and seabird overall (Table 5).

Similar to the results for bottom longline, the majority of live-capture events observed in surface longline fisheries involved single birds per trip, and observers reported live-capture events involving one to five birds per trip (Figure 5b).



(a) (b)

Figure 5. Number of live captures reported from observed trips on (a) bottom and (b) surface longliners < 34 m in overall length, from 1 October 2009, through 4 December 2017 and 29 December 2017 respectively.

Table 4. Summary of live seabird captures reported from observed trips on bottom longliners < 34 m in overall length, from 1 October 2009 through 4 December 2017, and percent of reported fishing effort that occurred during observed trips for the same vessel group, during the period 1 October 2009 through 30 October, 2017. FMA = Fisheries Management Area. Target species are bass (*Polyprion americanus*, BAS), bluenose (*Hyperoglyphe antarctica*, BNS), gurnard (*Chelidonichthys kumu*, GUR), kahawai (*Arripis trutta*, KAH), ling (*Genypterus blacodes*, LIN), snapper (*Pagrus auratus*, SNA), and tarakihi (*Nemadactylus macropterus*, TAR). Seabird species are black-backed gull (*Larus dominicanus*, XBG), black petrel (*Procellaria parkinsoni*, XBP), Buller's shearwater (*Puffinus bulleri*, XBS), flesh-footed shearwater (*Puffinus carneipes*, XFS), fluttering shearwater (*Puffinus gavia*, XFL), northern giant petrel (*Macronectes halli*, XNP), Westland petrel (*Procellaria westlandica*, XWP), southern Buller's albatross (*T. bulleri bulleri*, XBM), southern royal albatross (*D. epomophora*, XRA), and white-capped albatross (*T. steadi*, XWM).

FMA	Target species	Number of seabird captures (live and dead)	% of total observed captures occurring in FMA	% of fishing effort (hooks) on observed vessels	% of captures live	% live captures that were albatross	Seabirds caught alive
1	BAS	1	54.9	3.6	100	0	XBP (1)
	BNS	43		2.0	93	0	XBP (40)
	KAH	1		5.4	100	0	XFL (1)
	SNA	88		2.2	28	0	XBG (3), XBP (4), XFL (1), XFS (16), XNP (1)
	TAR	2		1.2	100	0	XFS (2)
2	LIN	6	2.4	1.8	0		
3	LIN	1	0.4	4.5	0		
4	LIN	45	18.3	2.9	0		
5	LIN	6	2.4	5.8	0		
7	LIN	30	12.2	2.4	20	100	XBM (3), XRA (1), XWM (2)
8	GUR	10	8.9	26.8	20	0	XNP (1), XWP (1)
	SNA	7		72.4	0		
	Unknown	5			0		
9	SNA	1	0.4	3.8	100	0	XBS (1)

Table 5. Summary of live seabird captures reported from observed trips on surface longliners < 34 m in overall length, from 1 October 2009 through 29 December 2017, and percent of reported fishing effort that occurred during observed trips for the same vessel group, during the period 1 October 2009 through 30 October 2017. FMA = Fisheries Management Area. Target species are bigeye tuna (*Thunnus obesus*, BIG), southern bluefin tuna (*Thunnus maccoyii*, STN), and swordfish (*Xiphias gladius*, SWO). Seabird species are black petrel (*Procellaria parkinsoni*, XBP), Cape petrel (*Daption spp*., XCP), flesh-footed shearwater (*Puffinus carneipes*, XFS), fluttering shearwater (*Puffinus gavia*, XFL), Westland petrel (*Procellaria westlandica*, XWP), albatross (Diomedeidae, XAL), Antipodean albatross (*Diomedea antipodensis antipodensis*, XAN), black-browed albatross (*Thalassarche impavida* and *T. melanophris*, XKM), snowy wandering albatross (*D. exulans*, XAS), southern royal albatross (*D. epomophora*, XRA), shy albatross (*T. cauta*, XSY), southern Buller's albatross (*T. bulleri bulleri*, XBM), wandering albatross (*D. exulans* and *D. antipodensis*, XWA), and white-capped albatross (*T. steadi*, XWM).

FMA	Target species	Number of seabird captures (live and dead)	% of total observed captures occurring in FMA	% of observed fishing effort (hooks)	% of captures live	% live captures that were albatross	Seabirds caught alive
1	BIG	68	22.3	5.7	5.9	75	XBP (1), XAN (1), XBM (1), XWA (1)
	STN	12		11.4	8.3	100	XKM (1)
	SWO	5		6.1	20	100	XWA (1)
2	BIG	6	11.8	2.3	16.7	100	XAL (1)
	STN	39		12.4	12.8	80	XCP (1), XKM (1), XWA (1), XBM (1), XSY (1)
5	STN	29	7.6	57.7	6.9	100	XRA (1), XWM (1)
7	STN	199	55.5	11.5	12.1	91.7	XBM (7), XKM (2), XWA (2), XWM (11), XWP (2)
	SWO	12		8.5	16.7	100	XWM (1), XAS (1)
9	BIG	9	2.6	7.8	44.4	50	XAN (1), XKM (1), XFS (2)
	SWO	1		6.1	0		

Discussion

Haul mitigation tested or in use

The review of haul mitigation conducted for this report confirmed that measures applicable to the set are much more thoroughly developed and tested than those that can be used on the haul. Further, methods for haul mitigation have not progressed significantly in recent years. Three broad categories of haul mitigation measures were identified from an implementation perspective: devices, routine operational measures, and *ad hoc* reactive measures. The measures best or most frequently described, implemented, or supported by empirical evidence are discussed. However, other measures amongst those reviewed may also warrant further investigation (see Recommendations below).

<u>Haul mitigation devices</u>

Amongst haul mitigation devices, BEDs or bird curtains are the most frequently reported as part of management frameworks, or in use, typically in larger-vessel fisheries (e.g. CCAMLR Conservation Measure 25-02, SPRFMO Conservation Management Measure 09-2017, Snell 2008, Melvin and Walker 2008, Reid et al. 2010). Such devices have been used by large vessels using both bottom and surface longline methods. However, when used on surface longline vessels in particular, the length of the snood and effective weight on the hook will have bearing on how far outboard the curtain would optimally extend to exclude birds from accessing hauled gear.

Other options that create barriers to seabirds around hauled gear are tori lines and towed buoys. Until recently, these had only reported as tested and used in Hawaiian pelagic longline fisheries (McNamara et al. 1999, Gilman et al. 2014). While preliminary, Goad’s (2018) recent testing of a buoy device on a small New Zealand bottom longliner also shows the potential for this approach to mitigating seabird interactions with longline gear at hauling. Further, devices similar to these have been reported by observers working on New Zealand’s smaller longline vessels. As for bird curtains, the position of hooks during hauling should be considered to facilitate optimal placement of buoys (e.g. in relation to snood length and hook depth).

For New Zealand’s smaller vessel longline fleet, the use of bird exclusion devices or curtains is likely to be constrained by the structures required to attach and support them. To be effective, curtains may often have to be deployed from above the hauling bay (i.e. above crew who are hauling the line), with multiple structural supports located outboard of the vessel (to ensure that hauling can occur inside the curtain). While tangling must be monitored, towed buoys or tori lines are likely to provide a simpler and more practical option for smaller vessels. These devices must still be deployed outboard from the vessel, but simpler structures are required to achieve deployment. Further, if effective, towed or hanging buoy setups seem likely to be preferable to tori line-style devices, given the options to add rigidity to the structure to help reduce tangling risks and maintain the device’s position.

Operational approaches to reducing captures at hauling

The review identified a number of operational approaches that were (or could be) used with aim of reducing seabird captures during the haul. The most tested and commonly implemented of these is management of fish waste discharge. Retaining fish waste during hauling has been identified as best practice (ACAP 2017a, ACAP 2017b). While it is recognised that at times, providing fish waste to birds present may distract their attention from hauling activity in the short term, this may also attract more birds to the vessel, and actually augment bycatch risks.

On longliners operating in New Zealand waters, a range of fish waste management practices are in place. Since the 1990s, variation in operational approaches to fish waste management has been documented amongst longline fishers (Nelson 1998, Hibell 2005, Pierre et al. 2014, Pierre 2016, Goad 2017). That is, there are still fishers who retain bait, offal, and discards until after hauling or until a break in hauling, while others discharge directly back in the hauling bay. This inconsistency in current practice both amongst vessels, and in some cases between trips on the same vessel, provides a ready opportunity for some to improve practice, to reduce bycatch risk.

Implementation of rigorous fish waste management practices would include retention of used baits and offal, ideally until the end of hauling. If that is not possible, then the lowest risk approach would be retaining this waste until there is a break in hauling when hooks are not close to the surface, and discharging it away from the hauling station (and such that it will not drift back to the hauling area). Note that for bottom longliners, there is an existing regulatory provision relating to discharge on the side of the vessel opposite to where hauling occurs (New Zealand Government 2010). Discards must be handled in accordance with legal requirements but when flexibility exists, holding dead discards until after hauling is preferable. If discards must be released during hauling, then conducting that release well away from the hauling station would minimise the associated seabird bycatch risk.

While typically considered a mitigation measure for reducing seabird captures on line-setting, line-weighting in surface longline fisheries has been shown to reduce haul captures (Gilman et al. 2014). Line-weighting requirements exist for surface liners operating in New Zealand (New Zealand Government 2014), and a range of practices is in place. Resistance to the uptake of line-weighting includes safety concerns (MPI 2014). In the short-term, fishers are unlikely to adopt weighting regimes that include the use of heavier weights closer to the hook solely to reduce the risk of live seabird captures. However, this rationale could be incorporated into broader discussions of line-weighting as an effective seabird bycatch reduction measure (i.e. applicable to longline setting and hauling).

Ad hoc methods to reduce haul capture risk

Beyond the device options and fish waste management practices identified as priorities above, there are a number of measures that can be applied on an *ad hoc* basis with the intent of reducing haul capture risks. These include water sprays, making loud noises, and waving arms or a net around the hauling area rapidly to scare birds away.

These measures can have value at times of high risk, e.g. if large numbers of birds are present or birds are aggressively foraging when gear is being hauled. However, birds may become used to *ad hoc* methods reducing their long-term efficacy if these measures are applied frequently or continuously. Further, *ad hoc* methods may involve crew spending their time away from fishing activity, which may not be tenable on a routine basis.

Capture information reported by fishers and government fisheries observers

There was broad congruence amongst some of the trends emerging from fisher and observer reported data, despite differences in the amount of data. Both datasets document a greater proportion of live captures in bottom longline fisheries than surface longline fisheries (19 - 32% fisher – observer respectively, for bottom longline, and 12 – 15% observer – fisher, for surface longline). Both sets of reported information also show relatively more live-captures of petrels and shearwaters in bottom longline fisheries, and albatrosses in surface longline fisheries. However, for bottom longline, the dataset is numerically dominated by reported captures of petrels and shearwaters from FMA 1.

In FMAs 2 – 7 where observer coverage has been deployed to monitor ling fishing, both fisher and observers report live seabird captures in FMA 7, with fisher reports also including live captures in FMAs 3 and 4. Live captures of albatrosses were reported in bottom longline fisheries in FMAs 3, 4, 5, 7 and 8.

Across surface longline fisheries, there is less area-based variation in seabird groups reported live-caught; albatrosses dominate capture reports across all FMAs. Fisher reports from FMAs 1, 2, 7 and 9 reflect broadly similar proportions of live captures. For observer reports, FMAs 1, 2 and 7 show broad similarities.

Fisher reports reflect a much broader range of bottom longline fishing activity (in terms of target fish species) than is monitored by observer coverage. For example, in FMA 4, observer information shows seabird captures for ling fishing activity only. However, fisher reports document seabird captures occurring in the course of fishing for bluenose, hapuku/bass, ling, ribaldo, and school shark, with a substantial proportion of effort targeting hapuku/bass. FMA 8 provides another example, where observers have reported seabird captures during bottom longline fishing for gurnard and snapper. In contrast, fisher reports document captures occurring when fishing for blue cod (*Parapercis colias*), bluenose, gurnard, hapuku/bass, school shark, snapper and tarakihi. Fisher-reported school shark effort was substantially higher than for any other target species.

For surface longline fisheries, there are fewer target species reported overall. Further, parallels in some data elements amongst fisher and observer data suggest that fisher reporting may be facilitated by having observers onboard. However, there are still more reports provided by fishers than documented by observers, as well as gaps in observer coverage where fisher reports provide additional information. For example, fisher reports document capture events in FMA 2 when fishing for three target species not documented by observers (blue shark (*Prionace glauca*), and Pacific bluefin tuna (*Thunnus orientalis*), and swordfish (*Xiphias gladius*)).

The importance of comprehensive coverage of target species is unknown in terms of understanding the nature and extent of haul/live seabird captures. However, when gear set-up differs amongst target species, there may be consequent differences in bycatch risk, including for live captures of seabirds. Across bottom and surface longline fisheries, these differences show the value of fisher-reported data in building an understanding of seabird captures overall, including live-capture events.

While live-capture events involving multiple seabirds do occur, the majority of reported events comprised a single bird per trip. This is relevant to bycatch mitigation approaches, in that reactive mitigation put in place after a live-capture has occurred will not maximise possible bycatch reductions. For mitigation to be most effective in reducing bycatch, it needs to be in place before a single live-capture has occurred.

Fisher and observer records differed in terms of the injury status of live-caught seabirds; the proportions of uninjured birds reported by fishers were substantially higher than reported by observers in both bottom and surface longline fisheries (42 – 92 % observer – fisher respectively, for bottom longline, and 18 – 65% observer – fisher for surface longline). While this result does not have bearing on reported capture statistics *per se*, it is relevant to considerations of cryptic mortality after live-caught seabirds are released.

With the proportions of live captures observed in New Zealand fisheries, and if live captures are a reasonable proxy for captures that occur during longline hauling, there is still significant scope and justification for improving the efficacy of seabird bycatch mitigation measures used on setting in both bottom and surface longline fisheries. This could include increasing compliance with the measures already required (Pierre 2016, Parker 2017), increasing the efficacy of these measures (e.g. through implementation of better tori line designs suited to smaller vessels (Goad and Debski 2017)), or identifying new measures to reduce captures on setting.

Recommendations for smaller New Zealand longline vessels

Characterising haul captures

The characterisation of haul captures presented in this report is based on the use of live captures as the best available proxy for haul captures. This assumption could be tested, and other elements of the characterisation could be improved, by building on existing data collection as described below. Characterising seabird captures more thoroughly is not necessarily expected to affect the regionally or fishery-based prioritisation of haul mitigation implementation in the short-term. However, over time, it would improve our understanding of the nature of haul captures and risks.

- Promote fisher reporting throughout the areas in which smaller vessel bottom and surface longline fishing occurs
  Fisher-reported data is extremely valuable as a source of information on seabird captures, including those that are likely to have occurred at the haul. The reach of this dataset exceeds the spatial and temporal extent of what is possible with observer monitoring. Ensuring that fisher reports are as complete as possible will help maximise the value of this dataset.

- Introduce capacity and capability to audit fisher-reported data
  Fisher reports provide information from a broader suite of target species than observers have monitored at sea over time. Gear setups may vary for different target species, and this variation may reflect differences in the risk of seabird captures on the haul. To build confidence that this dataset accurately describes the incidence of live captures, audit could be undertaken using electronic monitoring tools (while noting the need for handling protocols to maximise the ability to determine life status during imagery review – this will not be perfect). Audit using observer data is less desirable given the likelihood of “observer effects” (Babcock et al. 2003, MPI 2016).

- Increase information collection on seabird captures at sea
  Collecting at-sea information from longline fishing activity across a broader (more complete) suite of target fish species is an alternative approach to improving knowledge of the nature and extent of haul captures. This could be approached using cameras (noting the need to manage constraints around determining life status, as above) or human observer coverage if enhanced capacity was available above current coverage levels.

- Explore relationships between seabird abundance and assemblage composition around longline fishing vessels during hauling, and haul capture events
  Given relationships between seabird abundance and capture rates documented in other geographic locations, it is expected that live capture rates increase with the number of seabirds around the vessel. Gilman et al. (2014) found a plateau in this relationship, and data collected

from New Zealand vessels could be explored to ascertain the presence of this, or some other, relationship. Linking abundance data collected by observers to specific live capture events should be possible, given each haul is identified in both of these components of observer data.

- Update some elements of observer data collection protocols
  Government fisheries observers already collect a broad range of information from at-sea observations of longline fishing activity (e.g. Sanders and Fisher 2010). Recommendations for additional or amended approaches to data collection that will improve the resolution of haul capture events include the following. Note that new observer forms for longline fisheries are currently in preparation by MPI. These may incorporate some or all of the fields identified below. Overall, a progression towards completing specific fields using reporting codes and tick-box data collection is recommended, given interpretation challenges that arise with free text records.
    - Record the number of hooks observed (on hauling) in bottom longline fisheries. Note that hooks set is currently recorded from bottom longline fisheries. Both hooks set and hooks observed are already reported for surface longline fishing activity.
    - Create codes or a tick-box field to routinely record:
        - When a capture was observed to occur during the haul (i.e. actually observed taking place, not when the observer detected it), prior to hauling (i.e. the bird was known to *not* have been captured at haul, but was caught during the set or soak), other, or unknown.
        - When the haul capture occurred on a snood in the process of being hauled by crew, or on a snood snood still in the water that the crew had not yet reached to haul.
    - Create codes or tick-boxes to record the condition of seabirds on longline gear at hauling, including:
        - If the body was in rigor mortis
        - The extent of plumage saturation, e.g. whether plumage was soaked through, wet outside but dry underneath, or largely dry.
    - For surface longline, document the distance from the hook to snood weights in place. (This will not be routinely possible for every snood given the workload it would create for observers, and a sampling approach is required (e.g. Gilman and Clarke 2015). An example approach to data collection is presented in the Snood and Bait Log in Pierre et al. (2015).
    - When a bird is caught on a hook or entangled in a snood, the presence of weight and distance from weight to hook on that snood should be recorded. (Snood length is also desirable information in this context, and already recorded by observers as part of routine data collection).
    - Ensure that offal, bait and discard discharge regimes are documented for each haul, ideally using structured fields. The presence of fish waste discharge, type, and some estimate or indication of amount should be recorded. (The Hauling Event Log in Pierre et al. (2015) provides an example of how this could be set out).
    - Ensure that when haul mitigation devices are in place, observers document these devices (construction materials, dimensions, structure), and that observers continue to take photos of haul mitigation devices in use.

Mitigating haul captures

- Prioritising mitigation activities

For bottom longline, if reporting is representative of the true extent of seabird live-captures, focusing mitigation efforts on FMA 1 is recommended. Exploring fishing patterns further in FMA8 would also be valuable, to better ascertain the need for mitigation in this area.

For surface longline, efforts to reduce live seabird captures in FMAs 1, 2 and 7, and potentially FMA 9, are warranted. However, given that most surface lining vessels move between FMAs following highly migratory fish species populations, implementing effective mitigation strategies on vessels in one area will effectively mean other areas are also covered. Therefore, a fleet-wide approach is recommended for the surface longline fishery, which comprises less than 40 vessels (Wells and Cleal 2017).

- Devices

For smaller longline vessels, exploring haul mitigation options that involve buoys deployed on the water surface (e.g. towed or deployed from overhead) in proximity to the hauling area is recommended. Devices must be readily accessible in case of tangles. Considering the location of both the mainline and snoods in the water (particularly for surface longline fisheries) is essential to maximise potential mitigation benefit and minimise tangling risks. Device specifications and deployment will be vessel-specific to a degree, with design principles determining the dimensions of the devices used. (For example, design principles could emulate those used by CCAMLR for BEDs).

- Implementing good practice consistently to reduce haul capture risks

Fish waste discharge practices

Consistently implementing robust discharge management practices is recommended where this is not already occurring. Bait and offal retention should be routine for all hauls. If fish waste cannot be retained for the duration of hauling, it should be discharged well away from where line-hauling occurs. Making risk-minimising fish waste management practices standard for all hauls means these procedures become part of everyday operations rather than something implemented intermittently, reactively, or never. Live-capture data show that reactive mitigation implemented after a bird is caught will not resolve this bycatch problem.

Ensuring that hooks are kept well under the water surface during breaks in hauling and when waste is discharged are other common sense operational measures that should be part of standard practice, where they are not already.

Ad hoc measures during short periods of particular risk

Ad hoc measures should never be the only approach to bycatch risk management (e.g. because other mitigation options are available, habituation is likely, and they rely on human responses to perceived changes in risk). However, using a deck hose or making loud noises such as by banging on the vessel hull can have short-term risk reducing effects.

- Growing awareness

Fact sheets have been prepared for other seabird bycatch mitigation measures (e.g. tori lines). To increase knowledge amongst longline vessel operators about options for reducing seabird captures on hauling, a fact sheet could be prepared and circulated (or, if available and appropriate to the smaller-vessel fisheries in New Zealand, the revised ACAP fact sheet may suit this purpose).

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Appendix 1. Summary of fisher-reported live seabird captures in bottom longline fisheries

Live seabird captures reported by bottom longline fishers summarised for vessels < 34 m in overall length, and occurring within the period 1 October 2009 – 30 October 2017. FMA = Fisheries Management Area. Target species are blue cod (*Parapercis colias*, BCO), bluenose (*Hyperoglyphe antarctica*, BNS), gurnard (*Chelidonichthys kumu*, GUR), hapuku and bass (*Polyprion oxygeneios*, *P. americanus*, BAS, HAP, HPB), kingfish (*Seriola lalandi*, KIN), ling (*Genypterus blacodes*, LIN), red snapper (*Centroberyx affinis*), ribaldo (*Mora moro*, RIB), snapper (*Pagrus auratus*, SNA), school shark (*Galeorhinus galeus*, SCH) and tarakihi (*Nemadactylus macropterus*, TAR). Seabirds are black-backed gull (*Larus dominicanus*, XBG), black petrel (*Procellaria parkinsoni*, XBP), Buller's shearwater (*Puffinus bulleri*, XBS), Cape petrel (*Daption capense*, XCC), common diving petrel (*Pelecanoides urinatrix*, XDP), flesh-footed shearwater (*Puffinus carneipes*, XFS), fluttering shearwater (*Puffinus gavia*, XFL), gulls and terns (Laridae, XLA), northern giant petrel (*Macronectes halli*, XNP), petrels, prions and shearwaters (Hydrobatidae, Procellariidae and Pelecanoididae, XXP), sooty shearwater (*Puffinus griseus*, XSH), Westland petrel (*Procellaria westlandica*, XWP), white-headed petrel (*Pterodroma lessonii*, XWH), boobies and gannets (Sulidae, XSU), Buller's albatross (*Thalassarche bulleri*, XPB), royal albatross (*Diomedea sanfordi*, *D. epomophora*, XRU), Salvin's albatross (*T. salvini*, XSA), and white-capped albatross (*T. steadi*, XWM).

Fishing year	Month	FMA	Target species	Seabird code	Uninjured	Injured
2009/10	Oct	1	SNA	XSU	2	0
	Jan	1	BNS	XBP	3	0
	Feb	1	BNS	XBP	12	0
	Mar	1	BNS	XBP	6	0
		8	SCH	XSH	1	0
	Apr	1	BNS	XBP	0	7
		1	SNA	XBP	2	0
	May	1	SNA	XBP	6	1
2010/11	Oct	1	SNA	XFS	2	1
	Nov	1	SNA	XBP	2	0
		1	SNA	XBP	2	0
		1	SNA	XFS	3	0
		1	SNA	XXP	1	0
	Dec	1	SNA	XBP	0	1
		1	SNA	XFS	2	1
		1	SNA	XXP	4	0
	Feb	1	SNA	XBP	1	0
	Mar	1	SNA	XXP	2	0
	Apr	1	SNA	XFL	1	0
		1	SNA	XXP	1	0
	June	4	HPB	XXP	1	0
2011/12	Oct	1	SNA	XFS	2	0
	Dec	1	SNA	XFS	4	0
	Jan	1	SNA	XSH	1	0
		1	SNA	XXP	1	0
	Apr	1	SNA	XFS	1	0
	May	1	SNA	XBP	1	0
		1	SNA	XFS	2	0

Fishing year	Month	FMA	Target species	Seabird code	Uninjured	Injured
2012/13	Oct	1	SNA	XBP	11	0
		1	SNA	XFS	1	0
	Nov	1	SNA	XBP	2	0
		1	SNA	XXP	1	0
	May	1	SNA	XFS	3	0
	June	8	HPB	XPB	1	0
	July	3	LIN	XSA	1	0
	Aug	3	LIN	XPB	1	0
2013/14	Oct	1	SNA	XFS	1	0
		8	SCH	XWM	1	0
	Nov	1	SNA	XFS	3	0
		4	LIN	XPB	2	0
	Feb	1	SNA	XLA	1	0
		1	SNA	XXP	1	0
	Mar	1	SNA	XBP	1	0
		1	SNA	XFS	1	1
	Apr	1	SNA	XFS	1	0
	May	1	SNA	XFS	1	0
		1	SNA	XXP	3	0
2014/15	Oct	3	LIN	XSA	1	0
		4	LIN	XSA	1	0
	Mar	1	SNA	XFS	2	1
	Apr	1	SNA	XSH	1	0
	May	1	TAR	XSH	1	0
		7	LIN	XWM	1	0
	June	4	RIB	XWH	1	0
	July	1	TAR	XDP	1	0
	Sep	8	GUR	XNP	1	0
2015/16	Nov	8	GUR	XWP	1	0
	Dec	1	SNA	XFS	1	0
	Jan	7	LIN	XRU	1	0
	Mar	1	SNA	XFS	2	0
		1	TAR	XFS	1	0
	Apr	1	TAR	XFS	1	0
	Sep	1	SNA	XCC	5	0

Fishing year	Month	FMA	Target species	Seabird code	Uninjured	Injured
2016/17	Oct	1	SNA	XFS	1	0
		1	SNA	XXP	2	0
	Dec	1	BNS	XBP	1	0
	Jan	1	BNS	XBP	2	0
		1	BNS	XSH	1	0
		1	SNA	XFS	2	0
		1	SNA	XSH	1	0
	Feb	1	BAS	XBP	1	0
		1	BNS	XBP	7	0
		1	LIN	XBP	1	0
		1	SNA	XBG	1	0
		1	SNA	XBP	1	0
	Mar	1	BNS	XSH	2	0
		1	SNA	XFS	1	0
	Apr	1	BNS	XSH	6	0
		1	SNA	XXP	1	0
	May	1	SNA	XFS	1	0
		1	SNA	XXP	1	0
2017/18	Oct	1	SNA	XFS	1	0

Appendix 2. Summary of fisher-reported live seabird captures in surface longline fisheries

Live seabird captures reported by surface longline fishers summarised for vessels ≤ 34 m in overall length, and occurring within the period 1 October 2009 – 25 July 2017. FMA = Fisheries Management Area. Target species are bigeye tuna (*Thunnus obesus*, BIG), blue shark (*Prionace glauca*, BWS), Pacific bluefin tuna (*Thunnus orientalis*, TOR), southern bluefin tuna (*Thunnus maccoyii*, STN), and swordfish (*Xiphias gladius*, SWO). Seabirds are black petrel (*Procellaria parkinsoni*, XBP), Cape petrel (*Daption spp.*, XCP), common diving petrel (*Pelecanoides urinatrix*, XDP), flesh-footed shearwater (*Puffinus carneipes*, XFS), petrels (petrel unidentified, XPE), petrels, prions and shearwaters (Hydrobatidae, Procellariidae and Pelecanoididae, XXP), sooty shearwater (*Puffinus griseus*, XSH), Antipodean and Gibson's albatross (*Diomedea exulans* and *D. antipodensis*, XAG), albatross (Diomedeidae, XAL), Buller's albatross (*Thalassarche bulleri*, XPB), Salvin's albatross (*T. salvini*, XSA), shy albatross (T. *cauta*, XSY), southern black-browed albatross (*T. melanophris,* XSM), southern Buller's albatross (*T. bulleri bulleri*, XBM), southern royal albatross (*D epomophora*, XRA), snowy wandering albatross (*D. exulans*, XAS), wandering albatross (*D. exulans* and *D. antipodensis*, XWA), and white-capped albatross (*T. steadi*, XWM).

Fishing year	Month	FMA	Target species	Seabird code	Uninjured	Injured
2009/10	Nov	9	BIG	XAG	1	0
	Feb	1	SWO	XAL	0	1
	Mar	1	BIG	XAL	0	1
		2	BWS	XSA	0	1
			BIG	XRA	1	0
		9	SWO	XSM	1	0
	Apr	1	BIG	XSY	1	0
	May	2	STN	XPB	1	0
				XSY	0	1
	June	1	STN	XAL	1	0
		2	STN	XAL	0	1
		7	STN	XSA	1	0
				XPB	3	5
2010/11	Nov	1	BIG	XPB	1	0
		9	BIG	XAL	1	0
	Dec	1	BIG	XAL	0	1
	Jan	1	BIG	XAL	1	0
	May	2	BIG	XPB	1	0
			STN	XAS	0	1
	June	2	STN	XCP	1	0
	July	1	STN	XAL	1	0

Fishing year	Month	FMA	Target species	Seabird code	Uninjured	Injured
2011/12	Oct	1	BIG	XWA	1	0
	Jan	1	BIG	XFS	2	0
	Feb	1	BIG	XFS	0	1
		7	SWO	XWM	1	0
	Mar	7	STN	XSA	0	1
	Apr	7	STN	XSA	0	1
	May	1	SWO	XAL	1	0
		2	STN	XPB	1	0
		7	STN	XPB	1	2
				XFS	0	2
				XSY	1	3
	June	2	STN	XSY	1	1
		7	STN	XBP	1	0
				XPB	0	2
				XSY	1	0
2012/13	June	7	STN	XBM	1	0
				XWM	0	3
	Aug	7	SWO	XWM	0	1
2013/14	Apr	1	SWO	XAL	3	0
	May	1	SWO	XAS	0	1
		7	STN	XAS	0	1
				XPB	1	0
	June	7	STN	XSY	2	1
				XPB	1	0
				XWA	1	0
2014/15	Mar	1	SWO	XXP	1	0
		7	STN	XAL	4	0
	Apr	7	SWO	XAS	1	0
	July	7	STN	XAL	1	1

Fishing year	Month	FMA	Target species	Seabird code	Uninjured	Injured
2015/16	Dec	2	BIG	XSA	1	0
	Jan	1	SWO	XWA	1	0
	Feb	1	BIG	XAS	1	0
	Mar	2	BIG	XRA	2	0
		7	STN	XAL	1	0
	Apr	1	BIG	XRA	2	0
			SWO	XSY	2	3
		5	STN	XRA	1	0
				XWM	0	1
		7	STN	XAL	3	2
				XAS	7	0
				XDP	1	0
				XWM	0	1
				XWP	2	0
			SWO	XAL	2	0
				XSH	1	0
				XXP	0	1
		9	BIG	XXP	1	0
	May	2	STN	XBM	0	1
				XSY	2	0
		7	STN	XAL	0	1
				XAS	2	0
				XPB	0	1
				XWM	1	0
			SWO	XAL	1	0
	Jun	7	STN	XDP	1	0
2016/17	Nov	1	BIG	XRA	1	0
	Dec	1	BIG	XPE	1	0
	Apr	7	STN	XWM	1	3
	May	7	STN	XBM	4	0
				XWM	1	0
				XSH	0	1
	Jun	2	STN	XSY	1	0
		7	STN	XWA	1	0

Appendix 3. Summary of observer-reported live seabird captures in bottom longline fisheries

Live seabird captures reported by government fisheries observers deployed on bottom longline vessels ≤ 34 m in overall length, for the period 1 October 2009 – 4 December 2017. FMA = Fisheries Management Area. Target species are bass (*Polyprion americanus*, BAS), bluenose (*Hyperoglyphe antarctica*, BNS), gurnard (*Chelidonichthys kumu*, GUR), kahawai (*Arripis trutta*, KAH), ling (*Genypterus blacodes*, LIN), snapper (*Pagrus auratus*, SNA), and tarakihi (*Nemadactylus macropterus*, TAR). Seabird species are black-backed gull (*Larus dominicanus*, XBG), black petrel (*Procellaria parkinsoni*, XBP), Buller's shearwater (*Puffinus bulleri*, XBS), flesh-footed shearwater (*Puffinus carneipes*, XFS), fluttering shearwater (*Puffinus gavia*, XFL), northern giant petrel (*Macronectes halli*, XNP), Westland petrel (*Procellaria westlandica*, XWP), southern Buller's albatross (*T. bulleri bulleri*, XBM), southern royal albatross (*D. epomophora*, XRA), and white-capped albatross (*T. steadi*, XWM).

Fishing year	Month	FMA	Target species	Seabird code	Live birds
2009/10	Dec	1	SNA	XNP	1
	Jan	1	BNS	XBP	15
	Feb	1	BNS	XBP	12
	Mar	1	SNA	XFS	2
	Apr	1	SNA	XBP	2
		1	SNA	XFS	4
2010/11	Feb	1	BNS	XBP	2
2011/12	May	7	LIN	XBM	3
		7	LIN	XWM	1
2013/14	Oct	1	SNA	XFL	1
	Nov	1	SNA	XFS	3
	Feb	1	KAH	XFL	1
		1	SNA	XBG	1
		1	SNA	XFS	1
	Mar	1	SNA	XBP	1
	Mar	1	SNA	XFS	1
		9	SNA	XBS	1
2014/15	Feb	1	BNS	XBP	2
	May	7	LIN	XWM	1
	Sep	8	GUR	XNP	1
2015/16	Nov	8	GUR	XWP	1
	Dec	1	SNA	XFS	1
	Jan	7	LIN	XRA	1
	Mar	1	TAR	XFS	1
		1	SNA	XFS	1
		1	SNA	XFS	1
	Apr	1	TAR	XFS	1
2016/17	Nov	1	SNA	XBG	2
	Jan	1	BNS	XBP	2
	Feb	1	BNS	XBP	8
		1	BAS	XBP	1
		1	SNA	XBP	1
2017/18	Nov	1	SNA	XFS	1

Appendix 4. Summary of observer-reported live seabird captures in surface longline fisheries

Live seabird captures reported by government fisheries observers deployed on surface longline vessels < 34 m in overall length, for the period 1 October 2009 – 29 December 2017. FMA = Fisheries Management Area. Target species are bigeye tuna (*Thunnus obesus*, BIG), southern bluefin tuna (*Thunnus maccoyii*, STN), and swordfish (*Xiphias gladius*, SWO). Seabird species are black petrel (*Procellaria parkinsoni*, XBP), Cape petrel (*Daption spp*., XCP), flesh-footed shearwater (*Puffinus carneipes*, XFS), fluttering shearwater (*Puffinus gavia*, XFL), Westland petrel (*Procellaria westlandica*, XWP), albatross (Diomedeidae, XAL), Antipodean albatross (*Diomedea antipodensis antipodensis*, XAN), black-browed albatross (*Thalassarche impavida* and *T. melanophris*, XKM), snowy wandering albatross (*D. exulans*, XAS), southern royal albatross (*D. epomophora*, XRA), shy albatross (*T. cauta*, XSY), southern Buller's albatross (*T. bulleri bulleri*, XBM), wandering albatross (*D. exulans* and *D. antipodensis*, XWA), and white-capped albatross (*T. steadi*, XWM).

Fishing year	Month	FMA	Target species	Seabird code	Live birds
2009/10	Nov	1	BIG	XBP	1
		9	BIG	XAN	1
	Mar	9	BIG	XAN	1
	May	2	STN	XKM	1
	June	7	STN	XBM	1
		7	STN	XKM	2
2010/11	Nov	1	BIG	XBM	1
		9	BIG	XKM	1
		9	BIG	XFS	2
	June	2	STN	XCP	1
2011/12	Oct	1	BIG	XWA	1
	Feb	7	SWO	XWM	1
2012/13	June	7	STN	XWM	3
		7	STN	XBM	1
	Aug	9	STN	XKM	1
2013/14	June	7	STN	XWA	1
2014/15	Apr	7	SWO	XAS	1
2015/16	Dec	2	BIG	XAL	1
	Jan	1	SWO	XWA	1
	Apr	5	STN	XWM	2
		5	STN	XRA	1
		7	STN	XWP	2
		7	STN	XWM	1
	May	2	STN	XWA	1
		2	STN	XBM	1
		7	STN	XBM	1
		7	STN	XWM	1
2016/17	Apr	7	STN	XWM	4
	May	7	STN	XBM	4
		7	STN	XWM	1
	June	2	STN	XSY	1
		7	STN	XWA	1