



Agreement on the Conservation
of Albatrosses and Petrels

ACAP Advice on Improving Safety when Hauling Branchlines during Pelagic Longline Fishing Operations

*Reviewed at the Eleventh Meeting of the Advisory Committee
Florianópolis, Brazil, 13 – 17 May 2019*

SUMMARY

The relative safety of weighted branchlines during flyback events in pelagic long line fishing requires thorough consideration. When the branchline is under tension when hauling catch, a flyback event may occur in two ways:

1. a 'bite off' event in which the branchline is bitten off, or
2. a 'tear out' event in which the catch is lost when the hook is torn out of the fish.

At that moment the tensioned branchline may flyback at speed and potentially hit the crew involved in hauling with the weight, and, in the event of a tear out, the hook will also recoil with the weight.

Flyback events are rarely reported. However, there have been a small number of reported cases where these events have caused injury and a few times death.

Weighted branchlines are implemented to reduce the incidence of seabird bycatch. Decreasing the incidental catch of seabirds is important for the conservation of seabirds, especially threatened albatross and petrel species.

Branchline weighting potentially increases the hazard from flyback events.

To avoid or minimise the hazard of a flyback event, various technologies and techniques can be implemented as part of the fishing vessel's hazard management procedure. Branchlines with sliding weights will help to reduce the hazard posed by flyback events, compared with fixed weighted swivels. The crew may employ safety precautions that reduce the potential hazard from a flyback event, and which help to protect those involved in hauling of catch if a flyback event occurs.

A combination of new technologies and better techniques can address the hazard posed by flyback event to crew. These changes will enhance workplace safety when hauling catch during pelagic longline fishing operations.

1. CONTEXT

Pelagic longline fishing is a globalised fishery. Annual fishing effort by coastal states and distant water fishing nations likely exceeds a billion hooks each year (Anderson *et al.* 2011). Incidental mortalities of seabirds during pelagic longline fishing operations is a widely recognised conservation threat to seabird species, particularly threatened albatrosses and petrels listed under the *Agreement on the Conservation of Albatrosses and Petrels* (ACAP)¹ (Brothers 1991, Gales *et al.* 1998). Global seabird bycatch in longline fisheries (pelagic longline and demersal longline) is estimated to be at least 160,000 (and potentially in excess of 360,000) seabirds every year (Anderson *et al.* 2011).

ACAP aims to achieve and maintain a favourable conservation status for albatrosses and petrels. ACAP has developed advice and guidance to mitigate threats to albatrosses and petrels on land and at sea, including best practice advice for reducing the impact of pelagic longline fisheries on seabirds (ACAP 2017).

Branchline weighting is an effective strategy for reducing seabird bycatch. Three best practice measures are recommended by ACAP to be used simultaneously: branchline weighting, night-setting and bird scaring lines (ACAP 2017). Branchline weighting is integral to the fishing gear and, compared to bird scaring lines and night-setting, has the advantage of being more consistently implemented, hence facilitating compliance and port monitoring (ACAP 2017). Branchline weighting increases the sink rate of a baited hook, reducing the time when the baited hook is within the diving range of seabirds (Barrington *et al.* 2016). Studies have demonstrated that branchline weighting, where there is more mass closer to the hooks, sink most rapidly and consistently (Barrington *et al.* 2016), significantly reducing seabird bycatch (Gianuca *et al.* 2013, Jiménez *et al.* 2013, Claudino dos Santos *et al.* 2016, Jiménez *et al.* 2017). ACAP recommends the use of three weighted branchline configurations (ACAP 2017):

1. 40 g or greater attached within 0.5 m of the hook, or
2. 60 g or greater attached within 1 m of the hook, or
3. 80 g or greater attached within 2 m of the hook.

Hook-shielding devices are effective technologies for reducing seabird bycatch. There is less seabird bycatch when the baited hooks are protected from seabird attacks by a hook-shielding device (Sullivan *et al.* 2017, Baker *et al.* 2016, Barrington 2016). ACAP recommends the use of hook-shielding devices that encase the point and barb of baited hooks to prevent seabird attacks during line setting until a prescribed depth is reached (a minimum of 10 m), or until after a minimum period of immersion has occurred (a minimum of 10 min) that ensures that the baited hooks are released beyond the foraging depth of most seabirds (ACAP 2017). ACAP presently recommends using two hook-shielding devices that meet ACAP's stipulated performance requirements, the 'Hookpod' (68 g minimum weight) and 'Smart Tuna Hook' (40 g minimum weight) (ACAP 2017). The former remains attached to the branchline, while the latter detaches at depth during setting.

¹*Agreement on the Conservation of Albatrosses and Petrels*, done on 19 June 2001, 2258 UNTS 257 (entered into force 1 February 2004).

Pelagic longline fishing vessels are a workplace. Crew face a range of workplace hazards during fishing operations. One of these hazards is a flyback event (Sullivan *et al.* 2012). Research has been undertaken to characterise the hazard posed to crew during a flyback event. ACAP has contributed to the funding of this research. The research has examined what happens when the branchline is under significant tension and that tension is released in circumstances that simulate a flyback event (see 3.2 below). Further research has considered both bite off and tear out events, and whether the flyback event is affected by factors including: (a) release of tension under water v the water surface, (b) where the hook is bitten off ('bite off' events) v where the is torn out of the fish ('tear out' events), (c) fixed weight v sliding weight branchline weighting, (d) branchline weighting configurations and (e) use of 'Hookpods' (see 3.3 below). Understanding how a flyback event may occur helps crew to recognise circumstances when the hazard of flyback event is greater when hauling during pelagic longline fishing operations.

The hazard to crew from flyback events is widely recognised. Although flyback events are rarely reported, there have been reports in fisheries where weighted branchlines are used of some injuries and even death (McCormack and Papworth 2014). The potential speed at which a flyback event occurs ordinarily means that the crew will not be able to take any evasive action. The potential consequences of a flyback event highlight the need to implement workplace hazard management procedures on fishing vessels undertaking pelagic longline fishing operations (Marine Safety Solutions 2008).

Research has considered ways to characterise the hazard posed by flyback events during pelagic longline fishing operations. This research highlights the importance to mitigate the hazard of flyback events and the benefits to crew safety if this workplace hazard is addressed (see 3.3 below). This research has considered: (a) ways to reduce the tension on the branchline when hauling catch, (b) benefits of sliding weights v fixed weights, (c) branchline weighting configurations that reduce the potential hazard from bite offs and tear outs while using sliding weights, (d) value of employing angled hauling strategies and (e) value of personal protective equipment. Understanding ways to avoid or mitigate flyback events helps crews to develop workplace hazard management procedures that improve crew safety when hauling during pelagic longline fishing operations. This in turn helps to respond to safety concerns within affected fisheries about using branchline weighting.

2. INTRODUCTION

Fly back events arise when catch is being retrieved during hauling and the branchline is under tension. Fly back events occur under two circumstances:

1. **'bite off'** — a bite off event may occur when the hook is bitten off, often by a shark, which potentially sends the tensioned branchline recoiling back towards the vessel.
2. **'tear out'** — a tear out event may occur when the catch is lost off the hook, which potentially sends the tensioned branchline and hook recoiling back towards the vessel.

Flyback events are rarely reported. There is no substantive information available about the likelihood of a flyback event occurring in the globalised pelagic longline fishery. There is limited information about the potential hazard posed by flyback events to crew.

The potential hazard from flyback events is significantly reduced in some circumstances. If the tension on the branchline is released while the weight attached to the line is underwater, drag underwater quickly dissipates the energy released. As well, the amount of tension on the line when a bite off or tear out occurs may be insufficient for the branchline to recoil with sufficient energy to be hazardous. Recoiling branchlines and weights in flyback events may in these instances strike the vessel hull or fall short into the water depending on the amount of tension on the line and how submerged the weight is. In some pelagic longline fisheries a flyback event may occur when a hooked shark is alongside the vessel and the line is purposely cut to release it (Rollinson 2017).

Flyback events have the potential to cause injury to crew involved in hauling catch. Flyback events are likely under-reported. Flyback events that do not result in injury to crew are predominantly not reported (Pierre *et al.* 2015, Rollinson 2017).

3. STUDIES

3.1 Survey

A survey study has been undertaken concerning flyback events. This study considered pelagic longline fishing over a 20-year period between 1994 and 2014 (McCormack and Papworth 2014). The survey involved six countries; Australia, Chile, New Zealand, South Africa, the United Kingdom and the United States. Over the survey period there were 12 reported injuries and three deaths from flyback events from weighted branchlines during pelagic longline fishing operations involving over a billion hooks (McCormack and Papworth 2014, Anderson *et al.* 2011). The reported events noted that the crew member was struck in the head in a majority of instances (McCormack and Papworth 2014).

The survey was limited by only considering reports about flyback events (McCormack and Papworth 2014). The survey did not provide information about the frequency or amount of flyback events that occurred, or where the hazard posed flyback event was not considered significant. These data are not routinely collected or reported during fishing operations. Following a death in a New Zealand pelagic longline fishery in 1996, New Zealand moved to no longer use weighted branchlines in its pelagic longline fisheries (Marine Safety Solutions 2008).

3.2. Research

3.2.1 Early Research

Early safety research sought to characterise the hazard posed by flyback events in pelagic longline fisheries. Consideration was given to whether early sliding weight designs were safer than fixed weights in flyback events (Marine Safety Solutions 2008). The research tested branchlines at varying levels of tension to determine the velocity of attached fixed weights and sliding weights and whether the weights would recoil with force. Sliding weights were found to have a significant reduction in velocity, compared to fixed weighted swivels, due to their ability to slide off the branchline when it recoiled, with the detached weight falling into the water in most cases (Marine Safety Solutions 2008). A later study found that the level of tension and the position of the weight on the branchline was a significant factor affecting whether the sliding weight would slide off the line in a flyback event. Branchlines under tension above 20 kg that had weights placed no more than 2 m from the hook were found to slide off the line.

Weights placed at distances greater than 2 m from the hook were not as effective at sliding off the line, even under higher levels of tension on the line (Sullivan *et al.* 2012).

3.2.2 Recent Research

At-sea studies have been undertaken concerning flyback events. Bite off events were found to occur on a more frequent basis compared to tear out events due to catching sharks (Robertson *et al.* 2013, Rollinson 2017). Tear out events occurred due to the accidental loss of the catch, which in some cases was controlled by the crew member responsible for the hauling operation (Robertson *et al.* 2013). An at-sea study reported that of a total of 17 flyback events 14 were bite offs while three were tear outs (Rollinson 2017). Another study found that in one bite off event, the shark bit off the line at the hook between the hook and the crimp, causing the line to recoil in a manner like a tear out event, i.e. the attached sliding weight was unable to slide off the branchline (Pierre *et al.* 2015).

Research found that placing a sliding weight on the branchline close to or at the hook was effective in having the sliding weight slide off in a bite off event (Robertson *et al.* 2013).

Research found that in a tear out event, placing the sliding weight at or close to the hook meant that the sliding weight did not slide off the branchline, as the collision energy arising from the recoiling hook was insufficient for the hook to be sheared off when it hit the sliding weight (Robertson *et al.* 2013, Rawlinson *et al.* 2018).

Research suggests that a balance is needed in tear out events between the mass of the sliding weight and its position from the hook, so that the recoiling hook would be shorn off the branchline when it hit the sliding weight as the collision energy arising from the recoiling hook is sufficient for the hook to be sheared off when it hit the sliding weight (Robertson *et al.* 2013, Rawlinson *et al.* 2018).

3.2.3 Potential hazard during flyback events

Previous research focused on velocity and the conditions of severe flyback events. McCormack (2015) conducted research that characterised the hazard posed by flyback events to crew. The research determined the velocity of the recoiling weights attached to the branchline and then calculated the kinetic energy involved during a flyback event. The kinetic energy varied significantly depending upon where the weight was positioned on the branchline and whether the weight was submerged or out of the water when the flyback occurred. If the weight was submerged the kinetic energy quickly dissipated. The weight recoiled with the greatest kinetic energy when it was at or above the surface of the water, free from any drag from the water (McCormack 2015).

McCormack (2015) also considered approaches to determine the potential significance of the hazard posed by a flyback event. She adopted the Blunt Trauma Criterion (BTC) as a measure of relative safety. This criterion takes into account the velocity, mass, size and kinetic energy of the weight (Sturdivan *et al.* 2004, Frank *et al.* 2011). It applies these measurements to determine the effect of the weight at the point of impact on the person struck, i.e. the significance of the hazard. By applying the BTC, McCormack (2015) reported that a smaller weight resulted in a lower BTC score, however the effect of weight size was negligible if the flyback event occurred at a high velocity.

This research supports establishing a hazard management procedure to improve safety when hauling branchlines during pelagic longline fishing operations (see 5 below).

3.3 ACAP Research

ACAP commissioned the Australian Maritime College to undertake independent research on improving safety when hauling branchlines during pelagic longline fishing operations that built on the earlier studies. This research applied the approach developed by McCormack (2015) to examine the kinetic energy involved, and the relative safety of a flyback event.

3.3.1 Bite off events

Bite off events were the focus of research by McCormack and Rawlinson (2016). This research examined the relative safety of ACAP's recommended branchline weighting configurations during flyback events. The research determined the velocity, kinetic energy and BTC scores for different fixed and sliding weight configurations in simulated bite off events. Only two of ACAP's three recommended branchline weighting configurations were able to be tested (for 40 g and 60 g fixed and sliding weights), as 80 g sliding weights were not commercially available at the time of experimentation.

A baseline was determined where the BTC score indicated that serious injury would occur at least 50% of the time from a flyback event involving a fixed-weight branchline. Sliding weights placed within 1 m of the hook significantly reduced the relative hazard, as they consistently slid off the line in a bite off event. Sliding weights were found to have a mean slippage of three metres when the line was under high tension (80 kg). All fixed weight branchline configurations were considered a greater relative hazard in a flyback event.

The research demonstrated that for bite off events the use of sliding weights with branchline configurations of 40g or greater attached within 0.5 m of the hook, and 60g or greater attached within 1m of the hook significantly reduced the relative hazard. Further research will be required to assess the relative safety of a sliding weight of 80g or greater attached within 2 m of the hook.

It is important to recognise that the findings of McCormack and Rawlinson (2016) consider flyback events where the branchline is under high tension (80 kg). The relative hazard posed to crew in pelagic longline fishing operations is likely to rarely reach that considered in the safety research.

The research supports establishing a hazard management procedure to improve safety when hauling branchlines during pelagic longline fishing operations (see 5 below). This is particularly important where fixed weight branchline configurations are employed.

3.3.2 Tear out events

Tear out events were an additional focus of research undertaken by Rawlinson *et al.*(2018). This research examined the relative safety of ACAP's recommended branchline weighting configurations during flyback events. The research determined the velocity, kinetic energy and BTC scores for different fixed and sliding weight configurations in simulated bite off and tear out events. Hookpods (50 g) were also tested to determine their effectiveness in shearing the hook off in a tear out event.

Fixed weighted swivels were considered a greater relative hazard in a flyback event (Rawlinson *et al.* 2018). The BTC scores were above the level where serious injury would occur at least 50% of the time from a flyback event. The research showed that the point of impact of the weight and hook were closely aligned and struck very near the path along which the branchline was being hauled.

Sliding weights significantly reduced the relative hazard in some settings (Rawlinson *et al.* 2018). Research found that in the event of a tear off event, if heavier sliding weights (60g) were positioned within 1 m of the line, the sliding weight slid off the branchline, as the collision energy arising from the recoiling hook was sufficient for the hook to be sheared off when it hit the sliding weight. This branchline weighting configuration 60 g or greater within 1 m of the hook significantly reduced the relative hazard in a tear out event. Research found that lighter sliding weights (40g) positioned at 0.5 metres closer to the hook were less effective in their ability to shear the hook off.

The research found the Hookpod (50 g) was ineffective in a tear out in shearing off the hook from the line in a majority of flyback events (Rawlinson *et al.* 2018). The Hookpod is largely made of plastic components and the recoiling hook predominately shattered the Hookpod significantly reducing the relative hazard. However, the results varied; in circumstances where the Hookpod remained partially attached to the branchline, the relative hazard was greater. The relative hazard was also greater for detached pieces of the Hookpod where the fragments recoiled back with the branchline (Rawlinson *et al.* 2018).

The research demonstrates that for tear out events the use of sliding weights with a branchline configuration of 60g or greater attached within 1m of the hook significantly reduced the relative hazard. Further research will be required to assess the relative safety of a sliding weight of 80g or greater attached within 2 m of the hook.

It is important to recognise that the findings of Rawlinson *et al.* (2018) considered flyback events under experimental conditions where the branchline is under high tension (80 kg). The relative hazard posed to crew in pelagic longline fishing operations is likely to rarely reach that considered in the safety studies.

The research supports establishing a hazard management procedure to improve safety when hauling branchlines during pelagic longline fishing operations (see 5 below). This is particularly important where fixed weight branchline configurations are employed.

4. IDENTIFYING THE HAZARD

In any industrial setting there are workplace hazards. There is a range of workplace hazards on fishing vessels. Flyback events are a potential hazard that may occur when hauling catch during pelagic longline fishing operations.

The hazard posed by a flyback event has certain characteristics.

A flyback event hazard only arises when the branchline is under tension when hauling catch. The potential hazard increases as the tension on the line increases, by the actions of the crew placing the line under tension by hauling the catch, and/or by the actions of the hooked fish by swimming against the direction at which the line is being hauled. Although the crew can manage the former situation, vigilance is required to manage tension on the branchline in the latter situation.

A flyback event only arises when the tension on the branchline is released when hauling catch. This may occur under two circumstances: (1) a bite off event, and (2) a tear out event (see 2 above).

In some circumstances, a bite off may occur between the hook and the crimp that attaches the hook to the branchline. In these circumstances, the hazard posed by a recoiling branchline is potentially closer to that arising in a tear out event, e.g. if the crimp prevents a sliding weight from sliding off the branchline.

A flyback is only hazardous to crew in instances where the tension that is released is sufficient for the branchline to recoil directly towards the area where hauling is occurring.

The potential hazard posed by the recoiling line is dissipated if the bite off or tear out occurs while the weight on the branchline is submerged under water—as the drag imposed on the weight by the water rapidly dissipates the energy released. The potential hazard is increased if the weight on the branchline is at or above the waterline.

Flyback events may occur at high velocities. In these instances, there will be insufficient time for the crew involved in hauling catch during pelagic longline fishing operations to take action to avoid being hit by any recoiling projectile.

The hazard posed by a flyback event potentially affects the crew involved in hauling catch on the port or starboard sides of the vessel, either at the open door or behind the adjacent bulwark. The crew may potentially be struck by the recoiling line, the weight on the line, the hook, and fragments, e.g. from a recoiling Hookpod. The potential hazard to crew is reduced when personal protective equipment, particularly hard hats and face shields are worn. The potential hazard to crew is significantly reduced if the line is hauled at an angle, away from the open door.

Sliding lead weights have the ability to slide off the line in a flyback event. This may significantly reduce any hazard in a bite off event, and may significantly reduce any hazard in a tear out event, depending on the branchline weighting configuration.

Fixed weights are potentially hazardous in both bite off and tear out events. The weight will remain attached to the recoiling branchline in a flyback event.

5. ADDRESSING THE HAZARD

5.1 Hazard management procedure

The hazard posed by a flyback event may be addressed by implementing an appropriate workplace hazard management procedure. The hazard management procedure should focus on the potential for flyback events to occur when crew are hauling catch during pelagic longline fishing operations. The procedure should outline the technologies and techniques for avoiding or minimising the hazard posed by a flyback event to crew.

Technologies and techniques for avoiding or minimising a flyback event should be used in combination.

5.2 Core procedures

Where possible tension on the branchline should be kept to a minimum when hauling catch. Letting the fish run will help to minimise tension on the branchline.

Personal protective equipment should be used by crew involved in the hauling of catch. Wearing this safety equipment will help to reduce the potential hazard from a flyback event. Core protective equipment includes hard hats and helmets that help protect the head, as well as shields and visors that help protect the face. Additional protective equipment should also be considered to protect the upper chest.

Angled hauling methods help to remove the crew involved in hauling catch from the direct path of a recoiling branchline. Poles or loops can be welded onto the vessel's bulwark that allow for hauling to proceed away from the open door and the direct path of a flyback event. The bulwark provides additional protection to crew when angled hauling methods are employed.

5.3 Fixed weights

Where fixed weights are used, the core workplace hazard management procedures should be employed.

Branchline weighting configurations with fixed weights are considered a greater relative hazard in the event of a flyback as the weight is attached to the branchline when it recoils. The hazard to crew is similar in both bite off and tear out flyback events.

5.4 Sliding weights

Sliding weights should be preferred over fixed weights. Sliding weights are designed to slide off a recoiling branchline.

If a sliding weight is used according to ACAP's best practice advice for branchline weighting the relative hazard of a bite off event may be significantly reduced. For bite off events the use of sliding weights with branchline configurations of 40g or greater attached within 0.5 m of the hook, and 60g or greater attached within 1m of the hook significantly reduced the relative hazard (McCormack and Rawlinson 2016).

If a sliding weight is used according to ACAP's best practice advice for branchline weighting the relative hazard of a tear out event may be significantly reduced. For tear out events the use of sliding weights with a branchline weighting configuration of 60 g or greater within 1 m of the hook significantly reduced the relative hazard (Rawlinson *et al.* 2018). Research has found that lighter sliding weights of 40 g or greater attached within 0.5 metres of the hook were less effective (Rawlinson *et al.* 2018).

5.5 Hook-shielding devices

Research demonstrates that for bite off events the Hookpod (50 g) has similar characteristics of a sliding weight 40g or greater attached within 0.5 m of the hook. The Hookpod will slide off the branchline in a flyback event and significantly reduced the relative hazard (Rawlinson *et al.* 2018).

Research has found that for tear out events a Hookpod (50 g) attached at any distance from the hook was less effective (Rawlinson *et al.* 2018). The Hookpod was also found to break into fragments during the tear out event and the relative hazard was greater (Rawlinson *et al.* 2018).

The 'Smart Tuna Hook' was not the subject of research into flyback events. This hook-shielding device is distinct, in that when setting occurs the shield detaches from the hook 10 min after immersion in seawater (Baker *et al.* 2016, ACAP 2017). This means that the branchline is unweighted when it is hauled. In bite off events using a Smart Tuna Hook significantly reduces the relative hazard, as the recoiling branchline lacks any weight. In tear out events the relative hazard from the recoiling hook is greater.

6. CONCLUSIONS

6.1 General conclusions

Branchline weighting is an important best practice technique for reducing seabird bycatch in pelagic longline fisheries. ACAP best practices recommend weighting configurations that help to minimise seabird bycatch, particularly bycatch of threatened albatross and petrel species. Hook-shielding devices also contribute to reducing seabird bycatch.

Pelagic longline fishing is an industrial activity with consequent workplace hazards to crew involved in hauling catch. Flyback events are a workplace hazard that arises when crew are hauling catch on branchlines in circumstances where the line is under tension and that tension is released in a bite off or tear out event. Completely eliminating the hazard from flyback events is difficult. Research has characterised the hazards to crew from flyback events when hauling catch.

Hazard management procedures are essential to crew safety during pelagic longline fishing operations. Research has identified ways to help reduce the relative hazard from flyback events.

For fixed weights, the weight, size and position on the line of the branchline weighting configuration are contributing factors affecting the potential hazard posed by a flyback event. Smaller sized weights resulted in a marginally decreased relative hazard, however the difference in weight is negligible when a flyback event occurs at a higher velocity. The highest relative hazard concerning a flyback event was when the weight was at or above the water line. The energy arising from a flyback event was quickly dissipated if the weight was submerged when the tension on the line was released, due to the drag imposed by the water.

To reduce the hazard from flyback events when a bite off event occurs, sliding weights of 40g or greater attached within 0.5 m of the hook, and 60g or greater attached within 1m of the hook significantly reduced the relative hazard. Sliding weights were found to have a mean slippage of 3 m when the branchline is at a higher level of tension. This highlights that a branchline weighting configuration where a sliding weight is placed close to the hook will help to reduce the hazard from a flyback event.

Tear out events are a greater relative hazard. This is because the hook potentially recoils with the weight on the branchline. In flyback events when a tear out event occurs, sliding weights of 60g or greater attached within 1m of the hook significantly reduced the relative hazard. Lighter sliding weights of 40g or greater attached within 0.5 metres of the hook and the Hookpod (50 g) were less effective, and the Hookpod was also found to break into fragments during the tear out event.

6.2. Future Studies

Research conducted to date has provided important insights concerning the hazards associated with branchline weighting in pelagic longline fisheries. This research has identified a range of technologies and techniques that help to respond to this workplace hazard.

Additional research is recommended. ACAP's recommended branchline weighting configuration of 80 g or greater attached within 2 m of the hook should be assessed, if an 80 g sliding weight becomes commercially available. No stretch branchlines should be considered. A no stretch branchline would not recoil in a flyback event. Underwater setting devices should be considered. These technologies may reduce or eliminate the need for branchline weighting, as setting occurs by stealth at a depth beyond the depth ordinarily reached by diving seabirds (Robertson *et al.* 2015, Robertson *et al.* 2018).

REFERENCES

- ACAP, 2017. Review and Best Practice Advice for reducing the impact of pelagic longline fisheries on seabirds. Agreement on the Conservation of Albatrosses and Petrels, Wellington, Revised at the Tenth Meeting of the Advisory Committee, Wellington, New Zealand, 11-15 September 2017. Available at: <https://acap.aq/en/bycatch-mitigation/mitigation-advice>
- Anderson, O., Small, C., Croxall, J., Dunn, E., Sullivan, B., Yates, O., and Black, A., 2011. Global seabird bycatch in longline fisheries. *Endangered Species Research* **14**: 91-106
- Baker, G.B., Candy, S.G., and Rollinson, D., 2016. Efficacy of the 'Smart Tuna Hook' in reducing bycatch of seabirds in the South African Pelagic Longline Fishery. Agreement on the Conservation of Albatrosses and Petrels, Seventh Meeting of the Seabird Bycatch Working Group, La Serena, Chile, 2-4 May 2016, [SBWG7 Inf 07](#)
- Barrington, J.H.S., 2016. 'Hook Pod' as best practice seabird bycatch mitigation in pelagic longline fisheries. Agreement on the Conservation of Albatrosses and Petrels Seventh Meeting of the Seabird Bycatch Working Group, La Serena, Chile, 2-4 May 2016, [SBWG7 Doc 10](#)
- Barrington, J.H.S., Robertson, G., and Candy, S.G., 2016. Categorising branchline weighting for pelagic longline fishing according to sink rates. Agreement on the Conservation of Albatrosses and Petrels, Seventh Meeting of the Seabird Bycatch Working Group, La Serena, Chile, 2-4 May 2016, [SBWG7 Doc 07](#)
- Brothers, N., 1991. Albatross mortality and associated bait loss in the Japanese longline fishery in the Southern Ocean. *Biological Conservation* **55**: 255-268
- Claudino Dos Santos, R., Silva-Costa, A., Santa'Ana, R., Gianuca, D., Yates, O., Marques, C., and Neves, T., 2016. Comparative trials of Lumo Leads and traditional line weighting in the Brazilian pelagic longline fishery. Agreement on the Conservation of Albatrosses and Petrels, Seventh Meeting of the Seabird Bycatch Working Group, La Serena, Chile, 2-4 May 2016 [SBWG7 Doc 14](#)

- Frank, M., Bockholdt, B., Peters, D., Lange, J., Grossjohann, R., Ekkernkamp, A., and Hinz, P., 2011. Blunt criterion trauma model for head and chest injury risk assessment of cal. 380 R and cal. 22 long black cartridge actuated gundog retrieval devices. *Forensic Science International* **208**: 37-41
- Gales, R., Brothers, N., Reid, T., Seabird mortality in the Japanese tuna longline fishery around Australia, 1988-1995. *Biological Conservation* **86**: 37-56
- Gianuca, D., Peppes, F.V., César, J.H, Sant'Ana, R., and Neves, T., 2013. Do leaded swivels close to hooks affect the catch rate of target species in pelagic longline? A preliminary study of southern Brazilian fleet. Agreement on the Conservation of Albatrosses and Petrels, Fifth Meeting of the Seabird Bycatch Working Group, La Rochelle, France, 1-3 May 2013 [SBWG5 Doc 33](#)
- Jiménez, S., Domingo, A., Abreu, M., Forselledo, R., and Pons, M., 2013. Effect of reduced distance between the hook and weight in pelagic longline branchlines on seabird attack and bycatch rates and on the catch of target species, Agreement on the Conservation of Albatrosses and Petrels, Fifth Meeting of the Seabird Bycatch Working Group, La Rochelle, France 1-3 May 2013 [SBWG5 Doc 49](#)
- Jiménez, S., Forselledo, R., and Domingo, A., 2017. Effect of reduced distance between the hook and the weight in pelagic longline branchlines on seabird attack and bycatch rates and on the catch of target species. Agreement on the Conservation of Albatrosses and Petrels, Eight Meeting of the Seabird Bycatch Working Group, Wellington, New Zealand, 4-6 September 2017 [SBWG8 Inf 27 Rev 1](#)
- Marine Safety Solutions, 2008. *Safe Lead impact study: Impact comparisons between SLL snoods fitted with Safe Leads, weighted swivels and no line weighting*. Marine Safe Solutions, Port Nelson, New Zealand, 24p.
- McCormack, E., 2015. The relative safety of pelagic longline weighting configurations during a fly-back event. (Dissertation submitted in part completion of BAppS (Hons) Institute of Marine and Antarctic Studies, University of Tasmania) 94p.
- McCormack, E., and Papworth, W., 2014. Review of evidence of injuries sustained by fishers in the course of using weighted lines in pelagic longline fisheries. Sixth Meeting of the Seabird Bycatch Working Group, Punta del Este, Uruguay, 10-12 September 2014 [SBWG6 Doc 15](#)
- McCormack, E., and Rawlinson, N., 2016. The relative safety of the agreement on the Conservation of Albatrosses and Petrels (ACAP) recommended minimum specifications for the weighting of branchlines during simulated fly-backs. Agreement on the Conservation of Albatrosses and Petrels, Seventh Meeting of the Seabird Bycatch Working Group, La Serena, Chile, 2-4 May 2016 [SBWG7 Doc 08](#)
- Pierre, J.P., Goad, D.W., and Abraham, E.R., 2015. *Novel approaches to line weighting in New Zealand's inshore surface-longline fishery*. Final report prepared for the Department of Conservation: Conservation Services Programme project MIT2012-04, Dragonfly Data Science, Wellington, New Zealand 41p.

- Rawlinson N., Haddy, J., Williams, M., Milne, D., Ngwenya, E., and Filleul, M., 2018. The relative safety of weighted branchlines during simulated fly-backs (cut-offs and tear-outs), Final Report. AMC Search, Launceston, Tasmania 50p.
- Robertson, G., Ashworth, P., Ashworth, P., Carlyle, I., Jiménez, S., Forselledo, R., Domingo, A., Candy, S.G., 2018. Setting baited hooks by stealth (underwater) can prevent the incidental mortality of albatrosses and petrels in pelagic longline fisheries. *Biological Conservation* **225**:134–143
- Robertson, G., Ashworth, P., Carlyle, I., and Candy, S.G., 2015. The development and operational testing of an underwater bait system to prevent the mortality of albatrosses and petrels in pelagic longline fisheries. *Open Journal of Marine Science* **5**: 1-12
- Robertson, G., Candy, S., and Hall, S., 2013. New branchline weighting regimes to reduce the risk of seabird mortality in pelagic longline fisheries without affecting fish catch. *Aquatic Conservation: Marine and Freshwater Ecosystems* **23**: 885–900
- Rollinson, P.R., 2017 Understanding and mitigating seabird bycatch in the South African pelagic longline fishery.(Dissertation submitted in part completion of PHD, University of Cape Town, South Africa), 169p.
- Sturdivan, L.M., David, B.S. MS., Viano C., Champion H.R., 2004. Analysis of injury criteria to assess chest and abdominal injury risks in blunt and ballistic Impacts. *The Journal of Trauma Injury, Infection and Critical Care* **56**: 3: 651–663
- Sullivan B.J., Kibel P., Robertson G., Kibel B., Goren M., Candy S., and Wienecke B. 2012. Safe Leads for safe heads: safer line weights for pelagic longline fisheries. *Fisheries Research* **134-136**: 125-132
- Sullivan, B.J., Kibel, B., Kibel, P., Yates, O., Potts, J.M., Ingham, B., Domingo, A., Gianuca, D., Jiménez, S., Lebepe B., Maree B.A., Neves T., Peppes F., Rasehlomi., Silva-Costa A., and Wanless R.M., 2017. At-sea trialling of the Hookpod: a 'one-stop' mitigation solution for seabird bycatch in pelagic longline fisheries. *Animal Conservation* **21**: 159-167