 <p data-bbox="267 499 495 535">Agreement on the Conservation of Albatrosses and Petrels</p>	<p data-bbox="532 222 1360 260">Ninth Meeting of the Seabird Bycatch Working Group</p> <p data-bbox="857 277 1360 310"><i>Florianópolis, Brazil, 6 - 8 May 2019</i></p> <p data-bbox="555 386 1325 474">Improving safety when hauling branch lines during pelagic longline fishing operations</p> <p data-bbox="545 495 1334 571"><i>James T Johnston, Jonathon HS Barrington, Marco Favero</i></p>
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SUMMARY

Concern has been raised by relevant Regional Fisheries Management Organisations, coastal States and fishing operators about safety when hauling branch lines during pelagic longline fishing operations. This concern is focused on the potential hazard to crew during flyback events when branch line weighting is employed. It potentially hinders uptake of ACAP's best practice advice about branch line weighting as a measure for reducing the impact of pelagic longline fisheries on seabirds.

ACAP has commissioned research into the incidence of, and factors affecting flyback events in pelagic longline fisheries. Analysis of this research and other available studies concerning flyback events indicates that while flyback events are rarely reported, there have been reports of injuries and deaths. The analysis also identifies technologies and techniques that may be implemented to avoid or mitigate this workplace hazard.

The following ACAP advice paper has been drafted on improving safety when hauling branch lines during pelagic longline fishing operations. Its purpose is to inform relevant Regional Fisheries Management Organisations and coastal States about flybacks in pelagic longline fisheries and ways to avoid or mitigate this workplace hazard. The paper collates research on the factors affecting a flyback event and the consequences of flyback events. Taking the conclusions from the research, the hazard is characterised, and safety recommendations provided.

Proposed content for an ACAP factsheet has been developed about improving crew safety when hauling branch lines during pelagic longline fishing operations. Its purpose is to inform crew about flybacks in pelagic longline fisheries and ways to avoid or mitigate this workplace hazard. The factsheet provides safety precautions, ways to improve crew awareness and understanding about flyback events when hauling catch on weighted branch lines. Options for branch line weighting configurations are outlined to help reduce the potential hazard.

RECOMMENDATIONS

1. That SBWG considers the information provided about improving safety when hauling branch lines during pelagic longline fishing operations.
2. That SBWG recommends adopting the draft advice paper, and preparing a fact

sheet on improving safety when hauling branch lines during pelagic longline fishing operations.

3. That SBWG recommends dissemination of the advice paper and fact sheet to relevant Regional Fisheries Management Organisations, and coastal States, and uploading the information on improving safety when hauling branch lines during pelagic longline fishing operations to the ACAP website.

Mejora de la seguridad en el virado de las brazoladas durante las operaciones pesqueras de palangre pelágico

RESUMEN

Las Organizaciones Regionales de Ordenación Pesquera, los Estados costeros y los operadores pesqueros pertinentes manifestaron su preocupación respecto de la seguridad en el virado de las brazoladas durante las operaciones pesqueras de palangre pelágico. Esta preocupación se centra en el posible peligro para la tripulación durante los eventos de disparo que se producen cuando se utiliza el lastrado de brazolada. Asimismo, entorpece la adhesión a las recomendaciones de mejores prácticas del ACAP respecto del lastrado de las brazoladas como medida para reducir el efecto de las pesquerías de palangre pelágico en las aves marinas.

El ACAP ordenó que se investigara tanto la incidencia de los eventos de disparo como los factores que afectan a estos últimos en las pesquerías de palangre pelágico. El análisis de esta investigación y otros estudios disponibles sobre los eventos de disparo señalan que, si bien ese tipo de eventos son poco frecuentes, fueron asociados a lesiones y muertes. El análisis también identifica tecnologías y técnicas que podrían implementarse para evitar o mitigar ese peligro en el lugar de trabajo.

Se preparó el siguiente documento de asesoramiento del ACAP para mejorar la seguridad en el virado de las brazoladas durante las operaciones pesqueras de palangre pelágico. La finalidad del documento es informar a las Organizaciones Regionales de Ordenación Pesquera y a los Estados costeros pertinentes acerca de los disparos en las pesquerías de palangre pelágico y de las formas de evitar o de mitigar ese peligro en el lugar de trabajo. En el documento se cotejan investigaciones sobre los factores que afectan a los eventos de disparo y las consecuencias de estos últimos. A partir de las conclusiones de la investigación, se caracterizan los peligros y se formulan recomendaciones.

Se elaboró el contenido propuesto para la elaboración de una hoja informativa del ACAP en torno a la mejora de la seguridad de la tripulación en el virado de las brazoladas durante las operaciones pesqueras de palangre pelágico. La finalidad es informar a la tripulación acerca de los disparos en las pesquerías de palangre pelágico y de las formas de evitar o mitigar ese peligro en el lugar de trabajo. Las hojas informativas ofrecen precauciones en materia de seguridad, formas de generar conciencia y comprensión en la tripulación sobre los eventos de disparo en el virado de la captura en brazoladas lastradas. Se describen las opciones más seguras de lastrado de brazolada.

RECOMENDACIONES

1. Que el GdTCS considere la información proporcionada para mejorar la seguridad en el virado de las brazoladas durante las operaciones pesqueras de palangre pelágico.
2. Que el GdTCS recomiende adoptar el documento de asesoramiento preliminar y preparar una hoja informativa sobre mejora de la seguridad en el virado de las brazoladas durante las operaciones pesqueras de palangre pelágico.
3. Que el GdTCS recomiende la divulgación del documento de asesoramiento y la hoja informativa a las Organizaciones Regionales de Ordenación Pesquera y los Estados costeros pertinentes, y la publicación de la información sobre mejora de la seguridad en el virado de las brazoladas durante las operaciones pesqueras de palangre pelágico en el sitio web del ACAP.

Améliorer la sécurité lors du virage des lignes secondaires pendant les opérations de pêche à la palangre pélagique

RÉSUMÉ

Certaines inquiétudes ont été soulevées par les Organisations régionales de gestion de pêche, les États côtiers et les opérateurs de pêche quant à la sécurité lors du virage des lignes secondaires au cours des opérations de pêche à la palangre pélagique. Cette préoccupation s'articule autour du risque éventuel pour l'équipage lors de retour de lignes quand on utilise le lestage des lignes secondaires. Ce risque peut entraver l'adoption des conseils en matière de bonnes pratiques de l'ACAP relatifs au lestage des lignes secondaires comme mesure permettant de réduire l'impact des pêcheries palangrières pélagiques sur les oiseaux de mer.

L'ACAP a commandé une étude sur les facteurs affectant les retours de lignes dans les pêcheries palangrières pélagiques et leur incidence. L'analyse reprise dans cette étude et d'autres études disponibles portant sur les retours de palangre indiquent que bien que les retours de ligne soient rares, des lésions corporelles et des décès ont été signalés. L'étude identifie par ailleurs les technologies et les techniques qui peuvent être mises en œuvre pour éviter ou atténuer ce risque professionnel.

Le document consultatif de l'ACAP suivant a été rédigé dans une optique de renforcement de la sécurité lors du virage des lignes secondaires au cours des opérations de pêche à la palangre pélagique. Il a pour objet d'informer les Organisations régionales de gestion de pêche et les États côtiers sur les retours de ligne dans les pêcheries palangrières pélagiques et les manières d'éviter et d'atténuer ce risque professionnel. Le document rassemble des conclusions d'études sur les facteurs affectant les retours de ligne et les conséquences de ceux-ci. Selon les conclusions de l'étude, le risque est caractérisé, et des recommandations en matière de sécurité sont formulées.

Un contenu a été élaboré et proposé pour une fiche pratique de l'ACAP sur l'amélioration

de la sécurité de l'équipage lors du virage des lignes secondaires au cours des opérations de pêche à la palangre pélagique. Elle a pour but d'informer les équipages sur les retours de ligne dans les pêcheries palangrières pélagiques et les manières d'éviter et d'atténuer ce risque professionnel. La fiche pratique présente les mesures de sécurité préventives à adopter, les manières de renforcer la sensibilisation des équipages et la compréhension des retours de ligne lors du virage des lignes secondaires lestées sur lesquelles se trouvent les prises. Les options les plus sûres s'agissant des configurations de lestage de lignes y sont décrites.

RECOMMANDATIONS

1. Que le GTCA examine les informations fournies pour améliorer la sécurité lors du virage des lignes secondaires au cours des opérations de pêche à la palangre pélagique.
2. Que le GTCA recommande l'adoption du projet de document consultatif, et prépare une fiche pratique sur l'amélioration de la sécurité lors du virage des lignes secondaires au cours des opérations de pêche à la palangre pélagique.
3. Que le GTCA recommande de diffuser le document comprenant les conseils et la fiche pratique auprès des Organisations régionales de gestion de pêche et des États côtiers, et de publier sur le site Web de l'ACAP les informations sur l'amélioration de la sécurité lors du virage des lignes secondaires dans les opérations de pêche palangrière pélagique.

1. INTRODUCTION

Concern has been raised by relevant Regional Fisheries Management Organisations, coastal States and fishing operators about safety when hauling branch lines during pelagic longline fishing operations. This concern focused on the potential hazard to crew from flyback events when branch line weighting is employed. It potentially hinders uptake of ACAP's best practice advice about branch line weighting as a measure for reducing the impact of pelagic longline fisheries on seabirds.

ACAP advocates best practices for reducing impacts on the conservation of seabirds, particularly threatened 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). Branch line weighting is an effective strategy for reducing seabird bycatch, and is one of three best practice measures that are recommended by ACAP to be used simultaneously: branch line weighting, night setting and bird scaring lines (ACAP 2017). Branch line 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). Hook-shielding devices are also considered by ACAP as effective technologies for reducing seabird bycatch (ACAP 2017).

ACAP recognises the importance of improving safety in pelagic longline fisheries. In response to safety concerns about flyback events, ACAP commissioned the Australian Maritime College to undertake independent research examining the potential hazard posed by flyback events to crew when hauling catch during pelagic longline fishing operations (McCormack & Rawlinson 2016, Rawlinson *et al.* 2018). Analysis of this research and other available studies concerning flyback events indicates that while flyback events are rarely reported, there have been reports of injuries and deaths. The analysis also identifies technologies and techniques that may be implemented to avoid or mitigate this workplace hazard.

It is important to disseminate the research findings to relevant Regional Fisheries Management Organisations, coastal States and fishing operators in a way that explains the hazard posed by flyback events, and ways to avoid or mitigate this workplace hazard during pelagic longline fishing operations.

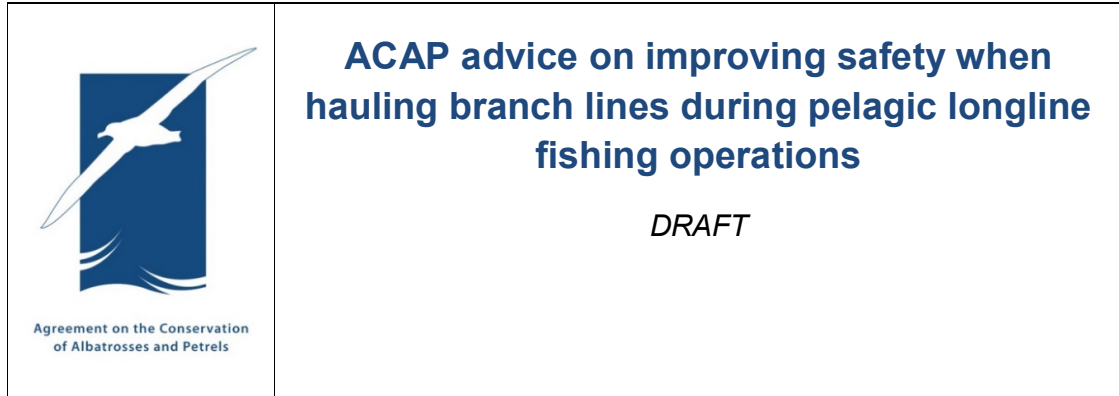
An ACAP advice paper has been drafted on improving safety when hauling branch lines during pelagic longline fishing operations (ANNEX 1). Its purpose is to inform relevant Regional Fisheries Management Organisations and coastal States about flybacks in pelagic longline fisheries and ways to avoid or mitigate this workplace hazard. The paper collates research on the factors affecting a flyback event and the consequences of flyback events. Taking the conclusions from the research, the hazard is characterised, and safety recommendations provided.

Dissemination of the ACAP advice paper to relevant Regional Fisheries Management Organisations and coastal States is expected to assist with the advocacy of ACAP's best practice advice about branch line weighting configurations for pelagic longline fisheries. This in turn is expected to assist in the uptake by relevant Regional Fisheries Management Organisations and coastal States of ACAP's current best practice advice for branch line weighting in pelagic longline fisheries, as well as the use of hook-shielding devices.

An ACAP factsheet has been drafted on improving crew safety when hauling branch lines during pelagic longline fishing operations (ANNEX 2). Its purpose is to inform crew about flybacks in pelagic longline fisheries and ways to avoid or mitigate this workplace hazard. The factsheet provides practical information concerning safety precautions, and ways to improve crew awareness and understanding about flyback events when hauling catch on weighted branch lines. Options for branch line weighting configurations are provided to help reduce the potential hazard. The factsheet aims to be a simple, direct read that is easily translatable for an international context.

Dissemination of the ACAP flyback factsheet on the ACAP website and to crew of fishing vessels undertaking pelagic longline fishing operations is important for crew safety. Understanding the nature of flyback events, as well as ways to avoid or mitigate this workplace hazard has the potential to prevent injury and death to crew involved in hauling catch on weighted branch lines. This in turn is expected to alleviate safety concerns within the fishing industry about using branch line weighting during pelagic longline fishing operations, and increase the uptake of ACAP's current best practice advice for branch line weighting as a way to reduce seabird bycatch in pelagic longline fisheries.

ANNEX 1



SUMMARY

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

1. a 'bite off' event in which the branch line 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 branch line may fly back 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 branch lines 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.

Branch line 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. Branch lines 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).

Branch line weighting is an effective strategy for reducing seabird bycatch. Three best practice measures are recommended by ACAP to be used simultaneously: branch line weighting, night setting and bird scaring lines (ACAP 2017). Branch line 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). Branch line 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 branch line 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 branch line 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 'Hook Pod' (68 g minimum weight) and 'Smart Tuna Hook (40 g minimum weight) (ACAP 2017). The former remains attached to the branch line, 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 branch line 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 branch line weighting, (d) branch line weighting configurations and (e) use of 'Hook Pods' (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 branch lines are used of some injuries and even death (McCormack & 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) branch line 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 branch line weighting.

2. INTRODUCTION

Flyback events arise when catch is being retrieved during hauling and the branch line is under tension. Flyback events occur under two circumstances:

1. **'bite off'** — a bite off event may occur when the hook is bitten off, often by a caught shark, which potentially sends the tensioned branch line 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 branch line 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 branch line 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 branch line to recoil with sufficient energy to be hazardous. Recoiling branch lines 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 caught 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 & 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 branch lines during pelagic longline fishing operations involving over a billion hooks (McCormack & 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 & Papworth 2014).

The survey was limited by only considering reports about flyback events (McCormack & Papworth 2014). The survey did not provide information about the frequency or amount of flyback events that occurred, or where the hazard posed by a 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 branch lines 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 branch lines 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 branch line 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 branch line was a significant factor affecting whether the sliding weight would slide off the line in a flyback event. Branch lines 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 branch line (Pierre *et al.* 2015).

Research found that placing a sliding weight on the branch line 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 branch line, 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 branch line 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 branch line 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 branch line 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 whether 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 branch lines 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 branch lines 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 & Rawlinson (2016). This research examined the relative safety of ACAP's recommended branch line 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 branch line 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 branch line. 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 branch line 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 branch line 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 & Rawlinson (2016) consider flyback events where the branch line 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 branch lines during pelagic longline fishing operations (see 5 below). This is particularly important where fixed weight branch line 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 branch line 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. Hook Pods (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 branch line 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 branch line, 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 branch line 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 Hook Pod (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 Hook Pod is largely made of plastic components and the recoiling hook predominately shattered the Hook Pod significantly reducing the relative hazard. However, the results varied; in circumstances where the Hook Pod remained partially attached to the branch line, the relative hazard was greater. The relative hazard was also greater for detached pieces of the Hook Pod where the fragments recoiled back with the branch line (Rawlinson *et al.* 2018).

The research demonstrates that for tear out events the use of sliding weights with a branch line 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 branch line 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 branch lines during pelagic longline fishing operations (see 5 below). This is particularly important where fixed weight branch line 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 branch line 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 branch line in the latter situation.

A flyback event only arises when the tension on the branch line 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 branch line. In these circumstances, the hazard posed by a recoiling branch line is potentially closer to that arising in a tear out event, e.g. if the crimp prevents a sliding weight from sliding off the branch line.

A flyback is only hazardous to crew in instances where the tension that is released is sufficient for the branch line 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 branch line is submerged under water—as the drag imposed on the weight by the water rapidly dissipates the energy released. The potential hazard is higher if the weight on the branch line 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 Hook Pod. 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 branch line weighting configuration.

Fixed weights are potentially hazardous in both bite off and tear out events. The weight will remain attached to the recoiling branch line 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 branch line should be kept to a minimum when hauling catch. Letting the fish run will help to minimise tension on the branch line.

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 branch line. 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.

Branch line weighting configurations with fixed weights are considered a greater relative hazard in the event of a flyback as the weight is attached to the branch line 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 branch line.

If a sliding weight is used according to ACAP's best practice advice for branch line weighting the relative hazard of a bite off event may be significantly reduced. For bite off events the use of sliding weights with branch line 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 & Rawlinson 2016).

If a sliding weight is used according to ACAP's best practice advice for branch line weighting the relative hazard of a tear out event may be significantly reduced. For tear out events the use of sliding weights with a branch line 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).

5.4 Hook-shielding devices

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

Research has found that for tear out events a Hook Pod (50 g) attached at any distance from the hook was less effective (Rawlinson *et al.* 2018). The Hook Pod 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 branch line is unweighted when it is hauled. In bite off events using a Smart Tuna Hook significantly reduces the relative hazard, as the recoiling branch line lacks any weight. In tear out events the relative hazard from the recoiling hook is greater.

6. CONCLUSIONS

6.1 General conclusions

Branch line 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 branch lines 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 branch line weighting configuration are contributing factors affecting the potential hazard posed by a flyback event. Smaller sized weights resulted in a lower 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 branch line is at a higher level of tension. This highlights that a branch line 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 branch line. 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 Hook Pod (50 g) were less effective, and the Hook Pod 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 branch line 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 branch line 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 branch lines should be considered. A no stretch branch line would not recoil in a flyback event. Underwater setting devices should be considered. These technologies may reduce or eliminate the need for branch line 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).

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ANNEX 2

Proposed content: 'ACAP factsheet on improving safety when hauling branch lines during pelagic longline fishing operations'.

Stay safe: prevent flybacks

<p>Flybacks happen when a branch line recoils back towards the fishing vessel. Flybacks may cause serious injuries to you and other crew members when hauling.</p>	<p>Flybacks happen when tension on the branch line when hauling is suddenly released, causing the line to recoil back. This can happen when a shark bites off the branch line, or when the hook is torn from the fish's mouth.</p>
<p>Flybacks are a workplace safety hazard. Follow these steps to understand and respond to this workplace hazard.</p>	

Understanding flyback hazards

<p>Flybacks may happen quickly and you will not be able to react in time. If the recoiling line hits you on your head or chest this may lead to a serious injury.</p>	
<p>This hazard concerns the deck area where you haul from. Flybacks are potentially hazardous at the open door and behind the rail nearby.</p>	<p>Flybacks are the most hazardous when the line is under tension when hauling and any branch line weight is out of the water. If the branch line and weight is submerged, the water will slow down the recoiling line significantly.</p>

Reducing flyback hazards

<p>Protect yourself from flybacks by wearing protective gear, especially if it protects your head, face and chest.</p>	<p>Reduce the potential hazard from flybacks by reducing the amount of tension on the branch line when hauling. Where practical, allow the fish to run to tire it out before hauling it in.</p>	<p>If possible, try side angle hauling methods. By using a loop or pole that is welded onto the side of the boat you may haul the catch at an angle that keeps you out of the direct path of a branch line if it flies back.</p>
<p>Use equipment that reduces the potential hazard from a flyback event. Using sliding weights or Hook Pods instead of fixed weights on a branch line significantly reduces the relative hazard. Follow best practice line weighting configurations for bite-offs and tear-outs</p> <ul style="list-style-type: none"> ❖ 40 g or greater within 0.5 m of the hook (bite off only) ❖ 60 g or greater within 1 m of the hook 		